A REVISION OF SOME SILESIAN GONIATITES USING CLUSTER ANALYSIS

By

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ABSTRACT

This thesis is primarily concerned with the application of numerical methods of taxonomic analysis to some Silesian goniatite assemblages. The taxa investigated here have been regarded in the past as belonging to the families Homoceratidae, Reticuloceratidae and Gastrioceratidae, plus the genus Homoceratoides. These are studied throughout their range, which is from the base of the Chokierian stage, Namurian, to the base of Westphalian C. British faunas are concentrated upon, but it is also of interest to investigate relationships with overseas faunas.

The history of research into Silesian goniatites is discussed, and a brief account is given of the geological background to the subject, from which the precise difficulties and points of interest become apparent. The various taxonomic techniques which have been and are used in palaeontology are critically examined, and it is concluded that orthodox methodologies are inadequate for the present task. The statistical technique of cluster analysis is, however, found to be suitable, and a new system of taxonomic analysis of goniatites is developed, based on phenetics. Methods of arriving at objective morphospecific divisions, higher taxonomic divisions, specimen determinations and phylogenies are devised and described.

These techniques are then applied to data collected from the various goniatite faunas, and a complete and new systematic scheme is derived. British morphospecies are redescribed and all relevant genera have required redefinition. A new genus is described (Otleyoceras), and new species are described of Homoceras, Vallites, Homoceratoides, Otleyoceras, Bilinguites, Cancelloceras, Agastrioceras and Gastrioceras.

The variation within faunas is described graphically and is found to have parallels with diverse other ammonoid groups. The mode of evolution is discussed, although the evidence is found to be ambiguous, and speculative phylogenies are proposed.

Finally, some examples are given of how numerical analysis can be useful in biostratigraphy.

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CHAPTER 1

INTRODUCTION

1.1. SCOPE OF RESEARCH

1.1.1. TAXONOMIC SCOPE

This thesis is concerned principally with the taxonomy of a group of goniatites of mid-Carboniferous age.

A problem exists in defining the precise taxonomic limits within which a systematic revision is to be confined, in that, initially, one must refer these limits to the existing systematic structure, and it is precisely this structure which possesses the weaknesses that invoke the need for such a revision.

A taxon within an outmoded classification is likely to have a relationship with its successors within a new scheme which is either polyphyletic or paraphyletic, *sensu* Hennig (1966) and Ashlock (1971). To be sure that a taxonomic revision is monophyletic (*sensu* Hennig, 1966) in scope, in that it embraces all known taxa within a group and no others, one must commence with a study that incorporates all possible candidates for inclusion in the final group, and subsequently exclude taxa from the study when they are proven to be distinct. This is clearly an inefficient approach. It is preferred here to maximise the quantity of meaningful results by allowing a breadth of scope which is quite possibly not monophyletic with respect to the structure thereby established. The taxonomic scope of this study is therefore more readily described in the terms of the pre-existing systematic structure, despite the schematic inelegance.

The taxa dealt with in this study may be listed as follows:

All genera of the families
Homoceratidae Spath, 1934 sensu Ruzhentsev and Bogoslovskaya, 1978;
Reticuloceratidae Librovitch, 1957 sensu R & B, 1978;
Gastrioceratidae Hyatt, 1884 sensu R & B, 1978;
plus the genus Homoceratoides Bisat, 1924, in the sense used by British authors.

All genera considered were included in the superfamily Goniatitaceae Haan, 1825 by Ruzhentsev (1962), and hence in the suborder Goniatitina and order Goniatitida.

Inevitably, the results of this study suggest redefinitions of these families, so that species are liable to be removed from these families, and no doubt other species not studied here should, in fact, be included.

The above list coincides quite closely with the loose but often used term "thick-shelled goniatites" (Ramsbottom et al, 1962), as contrasted with the contemporaneous "thin-shelled" genera, eg. Anthracoceras and Dimorphoceras. This emphasis is appropriate because it is almost entirely the "thick-shelled goniatites" which are used in biostratigraphic zonation of the part of the Silesian considered here.

1.1.2. STRATIGRAPHIC SCOPE

The total stratigraphic range involved in this study is equivalent to the total range of the taxa considered; ie. from the first occurence of Homoceras subglobosum at

SUB-SYSTEM	SERIES	STAGES	GONIATITES				Mesothems (Ramsbottom 1977)
			INDEX	ZONES (chronozones) (Ramsbottom 1969)	Subchronozones (Ramsbottom 1969) emend 1974	marker goniatite bands	
SILESIAN	STEPHANIAN	STEPHANIAN C B A					
		CANTABRIAN					
	WESTPHALIAN	WESTPHALIAN D					
		WESTPHALIAN C	'A'	'Anthracoceras'		'A.' cambriense	
		WESTPHALIAN B				'A.' hindi 'A.' aegiranum	
		WESTPHALIAN A				A. vanderbeckei	
			G_2 b	G. listeri			
			G_2 a	G. subcrenatum		G. subcrenatum	
	NAMURIAN	YEADONIAN	G_1 b	Gastrioceras cumbriense	(not divided)		N11
			G_1 a	Gastrioceras cancellatum	G. crenulatum G. cancellatum G. branneroides	G. cancellatum	
		MARSDENIAN	R_2 c	Reticuloceras superbilingue	G? sigma R. superbilingue		N10
			R_2 b	R. bilingue	R. metabilingue R. bilingue		N9
			R_2 a	R. gracile	(not divided)	R. gracile	
		KINDERSCOUTIAN	R_1 c	R. reticulatum	R. coreticulatum R. reticulatum		N8
			R_1 b	R. nodosum	(not divided)		N7
			R_1 a	R. circumplicatile	R. dubium R. todmordenense R. circumplicatile	Hod. magistrorum	N6
		ALPORTIAN	H_2 c	Homoceratoides prereticulatus	Ht. prereticulatus V. eostriolatum		
			H_2 b	Homoceras undulatum	(not divided)		N5
			H_2 a	Hudsonoceras proteus	(not divided)	Hd. proteus	
		CHOKIERIAN	H_1 b	Homoceras beyrichianum	(not divided)		N4
			H_1 a	Homoceras subglobosum	(not divided)	H. subglobosum	
		ARNSBERGIAN	E_2	Nuculoceras nuculum	N. nuculum N. stellarum		N3
				Cravenoceratoides nitidus	Ct. nititoides Ct. nitidus Ct. edalensis		N2
				Eumorphoceras bisulcatum	E. bisulcatum C. cowlingense	C. cowlingense	N1
		PENDLEIAN	E_1	Cravenoceras malhamense	(not divided)		
				Eumorphoceras pseudobilingue	(not divided)		
				Cravenoceras leion	E. hudsoni E. stubblefieldi E. tornquisti	C. leion	
DINANTIAN (pars)	VISÉAN (pars)	BRIGANTIAN (pars)					

TABLE 1

Table 1. Silesian stratigraphy, showing stages and goniatite zones. This thesis deals with goniatites from the base of the Chokierian to the base of Westphalian C.

(Adapted from Ramsbottom et. al., 1978, Plate 1) the base of the Chokierian stage to the last occurrence of Gastrioceras depressum in the Aegiranum Marine Band at the base of Westphalian C (see Table 1). However, occurrences of the relevant goniatites throughout most of the Westphalian are sparse and detailed consideration is not accorded to horizons above the Listeri Marine Band in Westphalian A.

Throughout this range in Britain the goniatites under consideration are concentrated, often in large numbers, in relatively thin marine horizons (see Section 1.2.2.). One or more of these marine horizons occurs in each of the established biozones, and each marine horizon has its own distinctive goniatite fauna, due apparently to evolutionary change.

1.1.3. GEOGRAPHIC SCOPE

The geographic scope of this study is dictated by the quality of accessible information. Faunas from England, Wales and Ireland are readily accessible in British collections, especially the collection of the Institute of Geological Sciences, which has formed the basis of much of the present study. In addition, new collections have been made from a number of localities, especially for this study. The examination of large numbers of specimens from locations in the British Isles has allowed a detailed analysis of variation within faunas which has resulted in the redefinition of many species and higher taxa. This has been possible to a lesser degree with some faunas from Belgium and West Germany, which were examined by the author during visits to collections in Brussels, Essen, Bochum and Gottingen. It has not been possible to examine more than a few specimens from other more distant localities, for example the important faunas from the U.S.A. (Arkansas), Canada (Ellesmere Island), the U.S.S.R. (southern Urals), Spain, North Africa and China; and although much information can be gleaned from published accounts of these faunas, the basis of specific distinctions cannot be brought into question, and only generic and higher groupings can be critically investigated in parallel with the more proximal North West European faunas. The stratigraphic considerations involved here are correspondingly varied in detail; greater precision being sought in correlating faunas within N.W. Europe than in correlating between continents.

1.2. PALAEOGEOGRAPHICAL AND SEDIMENTOLOGICAL SCENARIO

1.2.1. PALAEOGEOGRAPHY

Conclusions derived from palaeomagnetic and stratigraphic data regarding the disposition of sea and land during the Namurian and early Westphalian have been summarised by Ramsbottom (1971), who in addition speculates on likely current directions. Seas intermittently covered most of the British Isles except for the elongate Wales-Brabant Island, which stretched approximately WNW - ESE (relative to present geography) across Ireland, Central Wales, the southern Midlands of England and towards what is now the coast of the Netherlands. The sea was bounded to the north by a large land mass in the vicinity of the Scottish Highlands and extending over much of North America, and to the south by the somewhat smaller European massif, which separated the seas over the present British Isles from the extensive Tethys ocean. Ramsbottom postulates that dominantly east-west currents washed into the early Namurian seas of Britain from an inlet of the Tethys in the vicinity of the Donetz basin, U.S.S.R., via a passage through Poland. This route was blocked, however, later in the Namurian, with consequent effects on the distribution of faunas. Other currents may have washed from the Tethys into south-eastern North America, via the Mediterranean region, and into Arctic Canada via Russia.

These broad generalisations about likely ocean currents and geography in the Silesian allow hypotheses to be erected as to the time and place of the resulting faunal migration routes. The approach used in the present study allows these hypotheses to be tested.

1.2.2. CYCLICITY IN THE SILESIAN

The dominant aspect of the Silesian scenario in Britain was the increasing encroachment of deltas into the seas of Northern Britain and, to a somewhat lesser extent, South West England, South Wales and Southern Ireland. This encroachment, however, was not continuous throughout the Silesian. Ramsbottom (1977) has interpreted the entire Namurian succession in terms of a series of eleven major cycles, or mesothems, representing phases of alternating eustatic regression and transgression (see Table 1). Transgressive phases are represented, where sufficiently well developed, by thin (usually less than 1 m) mudstones or limestones with a marine fauna including thick-shelled goniatites - it is these layers which are of particular relevance to this study. Regressive phases are represented either by thick deltaic sandstones, in environments relatively proximal to a land mass, or by turbiditic sandstones or poorly fossiliferous pyritic shales, in basinal environments.

During transgressive phases, marine faunas are able to spread over both basinal and coastal regions, but these two environments are not alike in total fauna. Near-shore environments are indicated by the presence of clearly benthonic organisms, such as crinoids and brachiopods, with or without goniatites. Basinal environments are indicated by absence of a definite benthonic fauna, and goniatites and pectinoids are strongly dominant. Heptonstall (1964) argued from hydrostatic considerations that the typical goniatite/pectinoid association is, in fact, a benthonic assemblage, but this is not supported by other evidence.

It is generally believed that basinal marine shales were deposited on a stagnant, deoxygenated sea floor on which life, at least for shelly macrofauna, was impossible, and that the fauna is entirely nektonic or epipelagic. Holdsworth (1966) suggests that these same faunal restrictions may be the result of a poorly defined sediment/water interface, at least in the case of certain bullion bands. Unequivocally benthonic organisms are only found, therefore, where wave action and currents or some other shallow water process affected the sea bed.

Mesothems in the Silesian are not simple cyclic phenomena but are in fact each composed of lesser pulses or cyclothems. Each cyclothemic transgressive pulse of a mesothem is manifested in an increase in marine fauna, and it seems that successive cyclothemic transgressions within a mesothem are of successively greater extent (see, for example, Ramsbottom, 1979, fig. 2). The incoming of marine faunas within a cyclothem can be seen in great detail in many cases, for example in the Ashover borehole (Ramsbottom *et*. *al*., 1962), and it seems that the succession of faunas is a result simply of increase in salinity associated with increase in water depth and distance from land (see Holdsworth, 1966, fig. 3).

The eustatic nature of the cyclothems and mesothems is suggested by the widespread occurrence of apparently identical marine horizons, recognised as such by the similarity of the goniatite faunas. Once eustasy is inferred, it follows that such cyclic events, if identifiable, provide perfect chronostratigraphic markers of possibly cosmopolitan application. It is an obvious step, then, to use the thin, distinctive bands with goniatites as time planes in correlation.

1.2.3. CHRONOLOGY

Ramsbottom (1969) argues in favour of the marine horizons representing good time planes by calculating the approximate average rate of mudstone deposition throughout the Namurian, about 1 ft. in 4,000 years, which he then compares in thickness with a typical marine horizon. Another approach (Ramsbottom, 1969 & 1979) involves calculating an average time span of a goniatite fauna in the Namurian, which is about 200,000 years, and then reducing this figure by 95% to arrive at a figure of 10,000 years for the duration of the actual goniatite bearing portion of each biozone. However, these approaches assume similar rates of deposition of the goniatite-bearing shales and the intervening barren shales and mudstones. Holdsworth (1966), in contrast, compares the sedimentation of goniatite bands with that of modern pelagic oozes and suggests that a sedimentation rate of 0.59 - 1.2 cm (before compaction) per 1,000 years is feasible. This would allow the deposition of marine horizons to occupy nearly all the available time (200,000 years) between faunal changes. This is quite a credible alternative, as the deposition of thick deltaic sandstones can be extremely rapid, and goniatite-free mudstone might well accumulate considerably faster than the much more laminated and fossiliferous marine horizons. It is notable that in some basinal successions, for example in the Alportian at Samlesbury Bottoms, Lancashire, the thickness of goniatite-bearing shales rivals that of the intervening strata.

The possibility of such slow deposition of marine shales is important as it would imply the following:

1. marine horizons are not such precise chronostratigraphic planes - there may be an error of up to nearly 200,000 years;

2. incorporation of goniatites into the sediment was a relatively rare event and they may therefore have been quite uncommon predators - their abundance in compacted shale may be illusory (see Holdsworth, 1966);

3. evolution from one distinctive fauna to the subsequent one must have occurred rapidly; only the time elapsed during the possibly rapid deposition of intervening barren strata would be available. This is feasible within the framework of the theory of punctuated equilibria proposed by Eldredge and Gould (1972), which allows very rapid speciation during periods of environmental restriction, ie. during regressive peaks of cyclothems (Ramsbottom, 1981).

These possibilities must clearly be borne in mind when interpreting the results of the analyses involved in this study.

1.3. REGIONAL SETTINGS

1.3.1. THE BRITISH ISLES

1.3.1.1. The Central Province

This region, between the Wales-Brabant Island and the Craven fault belt, is the classic area in which the stratigraphy of the Namurian was first worked out by Bisat (1924). The central province comprises a sedimentary basin centred over Lancashire, where the maximum thickness of about 2,000 m of Namurian strata occurs, and with a series gulfs to the east but abrupt boundaries to the north and south. The basinal aspect of much of the sedimentation allowed a fairly continuous accumulation of deposits over most of the province throughout the Namurian, and the consequent wide extent and consistency of the major marker horizons inspired the pioneering stratigraphic work.

During the period of time relevant to this study there was a general increase in the scale of deltaic encroachment from the north and south and in most areas there were no significant sandstones until the Kinderscoutian stage. From the Chokierian to the Kinderscoutian, then, mesothems and cyclothems are merely manifested in faunal fluctuations within mudstone sequences. Conditions became increasingly less marine in the higher Namurian until, in the early Westphalian, only the maximum transgressive cyclothemic pulse of mesothem W2 (Ramsbottom, 1979, fig. 4) is represented by a good thick-shelled goniatite fauna (the Listeri Marine Band). Other cyclothemic transgressions are represented by shales with non-marine or restricted marine faunas, intercalated between thick sandstones with coals.

1.3.1.2. South Wales

A small sedimentary basin (maximum thickness less than 600 m) was centred on the Gower area in the Namurian, and Ramsbottom (1978) recognises in this all eleven of the mesothems established in the central province. Deltaic sandstones once again are derived mostly from the north and are more important in near-coastal areas, and do not spread over the centre of the basin until late in the Namurian. However, there are also substantial differences from the central province. Firstly, it is apparent that the later mesothems are more strongly transgressive; the early cycles being restricted to the Gower area, whilst N10 and N11 are almost ubiquitous (Ramsbottom, 1978, fig. 2). Secondly, there is substantial local variation in the marine horizons. Particularly anomalous is the great thickness, up to 25 m, attained locally by the Subcrenatum Marine Band as noted by Woodland *et*. *al*. (1957) from bore-hole cores. Also, the *G*. *cancellatum* marine band shows great change in thickness, fauna and lithology along the north crop of the South Wales Namurian. These unusual features are probably due to differential subsidence in a relatively structurally unstable region.

This situation is important in that its uniqueness may increase the understanding of aspects of the development of goniatite faunas which are not encountered in more typical regions.

1.3.1.3. South West England

The Namurian of Devon and Cornwall is radically different from that of the rest of the country in that it consists almost entirely of interbedded turbiditic sandstones and occasionally fossiliferous shales forming the Crackington Formation (see Freshney et. al., 1972), clearly a deep water basinal facies. It is not until the Westphalian that conditions begin to resemble those of the rest of England and Wales - the Westphalian Bideford and Bude Formations consist of deltaic sandstone cycles with intervening marine horizons, as established by Prentice (1960). The Crackington, Bideford and Bude Formations have all yielded thick-shelled goniatite faunas which have been used for stratigraphical correlation with the well known central province biozones.

The Silesian goniatite faunas of Devon and Cornwall are of particular interest for the following reasons:

1. the area was severely folded and faulted during the Hercynian orogeny (see Freshney et. al., 1972, fig. 2, and Freshney et. al., 1979, fig. 8) and goniatite determinations are critical in unravelling complex structures and reconstructing dislocated stratigraphic successions;

2. in such a geographically and sedimentologically different scenario, it is important to assess the influence, if any, of the cyclicity apparent elsewhere, and to assess the quality of the biostratigraphic correlation;

3. as in South Wales, the unique aspects of the Namurian sedimentology of the region suggest that any evidence regarding goniatite evolution which is not available in the central province may be sought here.

1.3.1.4. Ireland

The Irish Namurian and early Westphalian successions are similar in character to those of the central province.

The Irish Namurian is particularly important in that localities in counties Limerick and Clare described by Hodson (1954) and Hodson and Lewarne (1961) have yielded particularly good and abundant specimens of goniatites from H and R_1 zones.

1.3.1.5. North England and Scotland

Deposits of the relevant age in these regions are considerably thinner than the corresponding successions of the central province, this being due to relative topographic elevation in Silesian times. This has a further consequence in that marine incursion did not have such great extent and importance north of the Craven faults, and goniatite faunas are therefore not common. Namurian goniatite bands have, nevertheless, been identified as far north as Scotland but only up to the Arnsbergian stage. The only Northern England goniatite locality of particular import to this study is the type occurrence of Gastrioceras cumbriense below the Cumberland Coal Measures near Hensingham, West Cumbria.

1.3.2. OVERSEAS

1.3.2.1. Continental North West Europe

Successions in Belgium and West Germany are broadly comparable to those of the British central province. Goniatites are found in thin bands and these have been correlated with British counterparts, for example by Demanet (1941 & 1943) and Hodson (1957). These correlations usually appear sound, but detailed analysis of some correlations in this study (Chapter 7) is necessary to increase confidence in some areas.

1.3.2.2. U.S.S.R.

Ruzhentsev and Bogoslovskaya (1978) described an extensive and well preserved Silesian goniatite fauna from thin shelf-sea limestones in the Urals. Despite obvious similarities with West European faunas, there are few undoubted shared species. Given the likely sea connection and E - W currents mentioned in Section 1.2.1., it is clearly desirable that this study should consider the Russian faunas in some detail, with a view to more definite biostratigraphic and phylogenetic resolution.

1.3.2.3. North America

Silesian goniatites have been well documented from Arkansas, U.S.A. by, for example Gordon (1965) and McCaleb (1968), and from Ellesmere Island in Arctic Canada by Nassichuk (1975). These successions are rather varied, incorporating limestones, shales, sandstones and conglomerates, but all indicate shallow sea environments. Once again, these faunas show only a general similarity with European and Russian assemblages, and correlation is further confounded by the presence of large unconformities within the Namurian (see Nassichuk, 1975, text-fig. 3; Saunders *et*. *al*., 1979; Manger and Saunders, 1980, text-fig. 2). The present study will deal with North American faunas with the particular aim of reviewing the more tenuous correlations.

1.3.2.4. Other regions

Faunas of Silesian goniatites are known from various other parts of the world, notably North Africa and China, but these are not yet sufficiently well documented to justify more than a cursory treatment here.

CHAPTER 2

HISTORY OF RESEARCH

2.1. INTRODUCTION

Silesian goniatites have been the subject of a great deal of study over the years. This is no doubt due partly to aesthetic appearance of some specimens, but mostly to the biostratigraphical usefulness of these fossils both in the Namurian and the Westphalian. Correlation by means of goniatite occurrences in the Coal Measures was first achieved by J. Phillips in 1832.

It is not necessary here to give exhaustive citations of each of the hundreds of relevant works; it is desired rather to describe trends and milestones in Silesian goniatite research, and to concentrate particularly on the development of numerical approaches in the field.

2.2. THE NINETEENTH CENTURY

The pioneering work on Silesian goniatites was largely based in England, although a few important publications did arise from Germany, particularly by Haan (1825), who established the Goniatitaceae, and by Beyrich (1837). The emphasis in these early days was on careful, scholarly description of well preserved specimens, often collected not by the authors but by enthusiastic amateur naturalists. Material was often, therefore, not accurately localised and, of course, could not be referred to more than a rudimentary stratigraphic framework. In these respects, the work of Phillips (1836 and 1841) is less than satisfactory, whereas Brown (1841) appears to have been more disciplined. Both authors' descriptions have, nevertheless, remained useful. There was little innovation throughout most of the rest of the century, although towards the end there was a tendency towards more systematic treatments, with generic divisions becoming more refined. Thus the genera *Homoceras* and *Gastrioceras* were founded by Hyatt (1884) and Foord (1903) produced an important monographic work.

Haug heralded the twentieth century by introducing impressive advances on several fronts. His publication (Haug, 1898) includes a discussion of goniatite evolution, showing awareness of Darwinian thought, with a speculative diagrammatic phylogeny and a stratigraphic range chart of various genera. Originality is also shown in his careful account of variation within the *Homoceras beyrichianum* fauna, and variation during ontogeny of *Reticuloceras reticulatum*, both supported by tabulated data. Haug's example was unfortunately much neglected until the work of W. S. Bisat.

2.3. W. S. BISAT AND HIS ERA

The early part of the twentieth century did not produce any change of emphasis, although further details of German faunas were described by C. Schmidt (1924) and H. Schmidt (1925), and discoveries were being made of goniatite assemblages in the U.S.A. It remained for Bisat's 1924 publication "the Carboniferous Goniatites of the North of England and their Zones" to supply the stimulus and lay the foundations for profitable further studies. This paper is widely regarded as a classic work in the field of biostratigraphy, but it was also a significant development in goniatite systematics.

Bisat succeeded in devising a zonal scheme for the Viséan, Namurian and early Westphalian by careful collection of goniatites from successive horizons at various localities and by trying to "distinguish between and separate from each other the forms at different horizons, whilst allowing as wide a variation as possible to individuals on the same horizon" (Bisat, 1924, p. 41). In doing this Bisat was clearly conscious of evolutionary change with time, and this is confirmed by his use of the unusual taxonomic nomenclature of "mutations" in order to describe successive forms of an evolving species. Bisat distinguished twelve goniatite zones in the stratigraphic interval relevant to this study, and it is a fitting tribute to his work that they are still regarded as valid today.

Bisat's later work explored the various consequences of his original thesis and three of his papers can be cited to exemplify these directions. Firstly, Bisat sought to extrapolate his zonal scheme laterally, and his comparison of English and continental successions (Bisat, 1928) was the first of many detailed long range biostratigraphic correlations (eg. Delépine, 1941; Hodson, 1957). Secondly, his awareness of evolutionary progression resulted in a speculated phylogeny of goniatites (Bisat, 1933). Thirdly, Bisat initiated the refinement of his own zonal scheme by more detailed examination of the more complex parts of the succession (eg. Bisat, 1940; Bisat & Hudson, 1943).

An original and often overlooked item of interest from this period is the suggestion by Demanet (1943,

p. 139) that many associated pairs of species may in fact be sexual dimorphs of one species. Though receiving support from Ramsbottom & Calver (1962) this possibility has yet to be fully tested.

Before leaving this era so dominated by the work of Bisat himself, it is fitting to give credit to the many workers of the Geological Survey, later the Institute of Geological Sciences, whose careful documentation of Silesian successions in regional surveys was both a fruit and a confirmation of Bisat's research and provides an excellent example of the application of biostratigraphy in the field (see, for example Wright *et*. *al*., 1927; Wray *et*. *al*., 1930; Bromehead *et*. *al*., 1933; Stephens *et*. *al*., 1953).

2.4. MODERN RESEARCH

2.4.1. SYSTEMATICS

The development of numerical taxonomy began in the late 1950's and a textbook on the subject appeared in the early 1960's (Sokal & Sneath, 1963). However, despite the earliest application to palaeontology in the mid - 1960's and encouragement by Kaesler (1967), numerical taxonomy has been neglected in the field of goniatite systematics, which has remained traditional in its methodology. The only important development in this field has been the description of many new taxa. Patteisky (1959 & 1965) and Bouckaert (1961) have worked exhaustively on North European faunas, and Gordon (1965), McCaleb (1968), Nassichuk (1975) and Manger and Saunders (1980) are amongst those responsible for the comprehensive description of interesting North American taxa. Ruzhentsev and Bogoslovskaya (1978), as well as producing an impressive monograph of Russian goniatite faunas, developed phylogenetic inferences to the point of erecting a systematic structure which is deliberately cladistically based (see Section 3.2.2.) and as such is quite modern in concept.

An aspect of systematics of considerable importance in taxa with a long history of research, as have many Silesian goniatites, is nomenclatural accuracy. Care was not often taken with proper holotypic designation and synonymies before about the middle of this century, and it is only thanks to scholarly work in more recent years, for example by Ramsbottom and Calver (1962), that many systematic problems are clarified for the benefit of subsequent researchers.

2.4.2. STRATIGRAPHY

One tendency is the continual refinement of biostratigraphic detail, often associated with palaeoecological and sedimentological studies, as in the theses by Heptonstall (1964) and Ashton (1974). Of more general importance, though, is the synthesis of Silesian stratigraphy presented by Ramsbottom (1977, 1978, 1979) who recognises eustatic cycles throughout the Carboniferous (see Section 1.2.2.) and, in addition, is able to relate aspects of goniatite faunas to this framework (Ramsbottom, 1980).

Meanwhile, biostratigraphic correlations using goniatites continued to be made with varying success, but it deserves notice that the method of stratigraphic comparison, ie. correlation on the basis of shared taxa or by general subjective faunal similarity, has remained unchanged over the years and, if not entirely inaccurate, is certainly antiquated.

2.4.3. NUMERICAL METHODS IN GONIATITE RESEARCH

Following Haug and Bisat, Nassichuk (1975), Manger & Saunders (1980) and Ruzhentsev and Bogoslovskaya (1978) are among those who have helped to elevate tables of measurements almost to the status of standard and indispensible additions to systematic descriptions. However, these authors only tabulated a very restricted set of dimensions, and do not analyse the data. Heptonstall (1964) took the additional step of plotting primitive scatter diagrams to illustrate differences between species and faunas, but his results are not very conclusive.

Raup (1967) provided a stimulus in a different direction by analysing the geometry of ammonoid shell coiling, and deriving parameters of allometric growth. This has been the subject of several investigations (see Section 3.2.3.2.) but these have not been taxonomic studies and the use of geometric constants in taxonomy has yet to be attempted.

Saunders (1973) illustrated many ontogenetic curves and "multivariate" scatters using two or three measurements at a time. These are intended to illustrate morphological differences between species, and it is important to note that Saunders does not distinguish taxa on the basis of such plots, but in fact uses other criteria; and, indeed, the scatters and curves do not provide convincing evidence for specific divisions if used independantly.

Detailed arguments in favour of the application of numerical methods to the study of Silesian goniatites are given in Chapter 3. It should, though, be apparent from the foregoing historical resume that the field is virtually unexplored.

CHAPTER 3

ANALYTICAL TECHNIQUES

3.0. INTRODUCTION

Many problems are encountered in working within the systematic framework established by previous authors. Some of these difficulties have been hinted at in the foregoing chapters, and there will be more discussion below. Wherever possible, new taxonomic work should start from first principles, using no assumptions that are derived from the conclusions of previous orthodox taxonomic work in the field of research. The basic unit from which the present study is developed must therefore be the individual specimen, this being unambiguous and empirical. Notice, however, that stratigraphic assumptions based on previous work have had to be made, but that these assumptions are of a sufficiently general nature that confidence in them is high, and that they are falsifiable, in theory, at a later stage of this work.

The taxonomic work needed in this study, starting from first principles, consists of the following:

A. The recognition of morphospecies in populations of individuals.

The biological definition of 'species' (Mayr, 1963) requires knowledge of breeding patterns and is inapplicable in palaeontology. The term 'morphospecies' is ideally suited to the approach and the results of this work and is adopted here. The 'populations' considered here are, of necessity, composed of those individuals occurring within fairly crude stratigraphic divisions.

B. The classification of morphospecies into genera and higher taxonomic ranks.

Note that genera, families, superfamilies, etc. are artificial constructs even in genetic biology, so the divisions in palaeontology are certainly arbitrary, although in this study they will be subject to phenetic criteria.

C. The construction of a plausible phylogeny.

This may or may not be related to the systematic classification.

D. The formulation of an algorithm for the identification of new specimens.

An attempt is made here to make the process of identification operational.

3.1. RECOGNITION OF MORPHOSPECIES

The recognition in samples of fossils of distinct groups, usually called species but more correctly morphospecies, is perhaps the most common practice of palaeontologists. The palaeontological literature which results from this process suggests by its sheer abundance that palaeontologists in general find the definition of distinct morphospecies relatively easy. This is certainly not the case with the goniatite faunas considered here.

3.1.1. PROBLEMS

3.1.1.1. Ontogenetic change

All sufficiently intact specimens of goniatites show a large amount of change in many or all shell characters during ontogeny; this is the case whether characters are expressed as proportions or as absolute values. In orthodox palaeontology this creates problems because: a/ two specimens of the same species may differ radically in appearance, and the eye and brain have difficulty in assimilating and using this additional information; and b/ authors consequently need to describe all growth stages to give a complete account of a species, and this is often not done adequately.

Variation in the ontogeny of various morphospecies is shown in Figure 1.

3.1.1.2. Non-ontogenetic variation within populations

When ontogenetic effects are removed by focussing attention on specimens of just one size, there is still a large amount of variation in many or all shell characters. The degree of this component of variation is illustrated

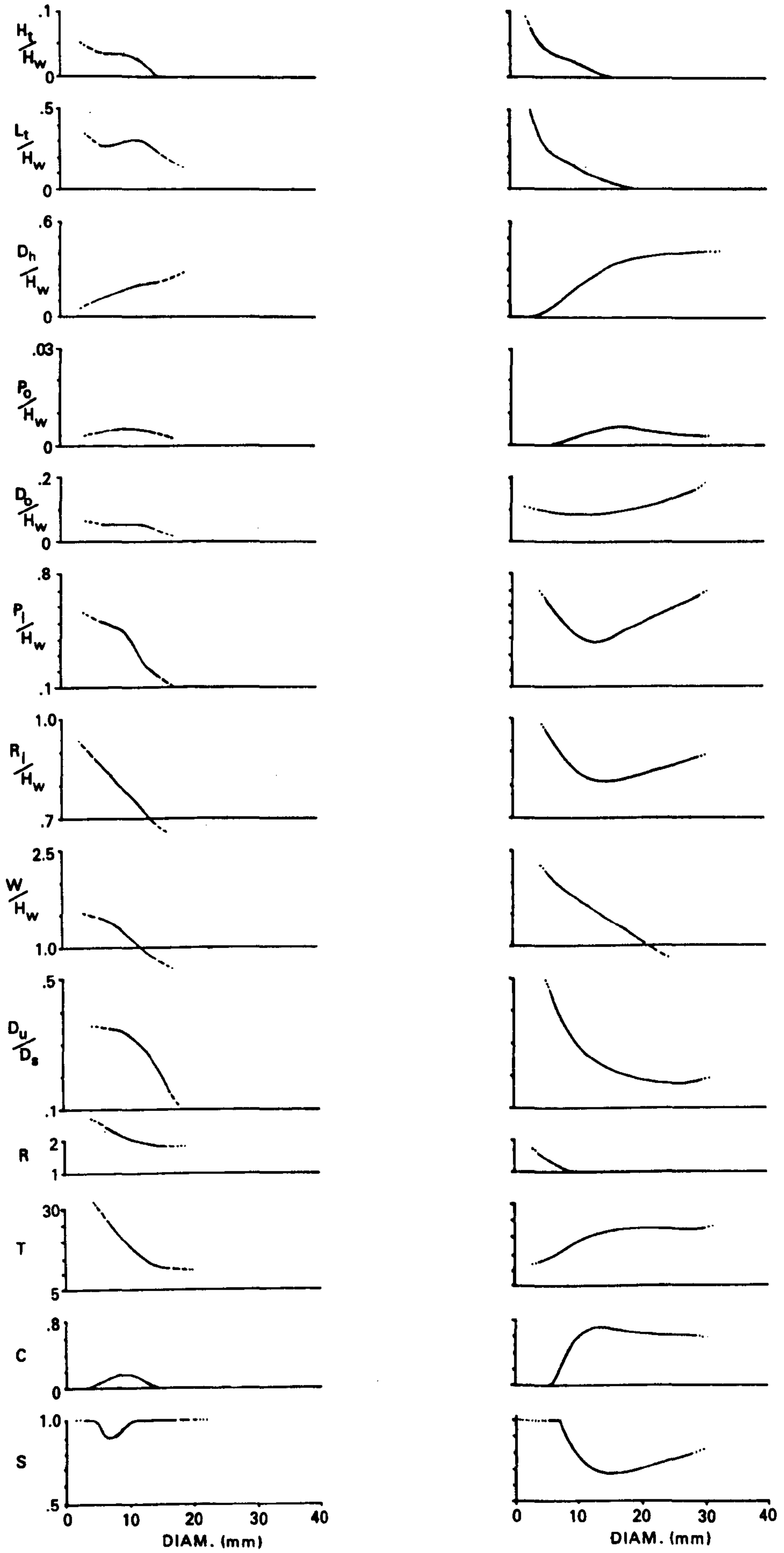


FIGURE 1. Ontogenetic curves of various characters for Homoceratoides prereticulatum (left) and Reticuloceras reticulatum (right) illustrating the great changes in all characters which accompany growth. These curves are typical of Silesian thick-shelled goniatites. For the character abbreviations, see Table 4.

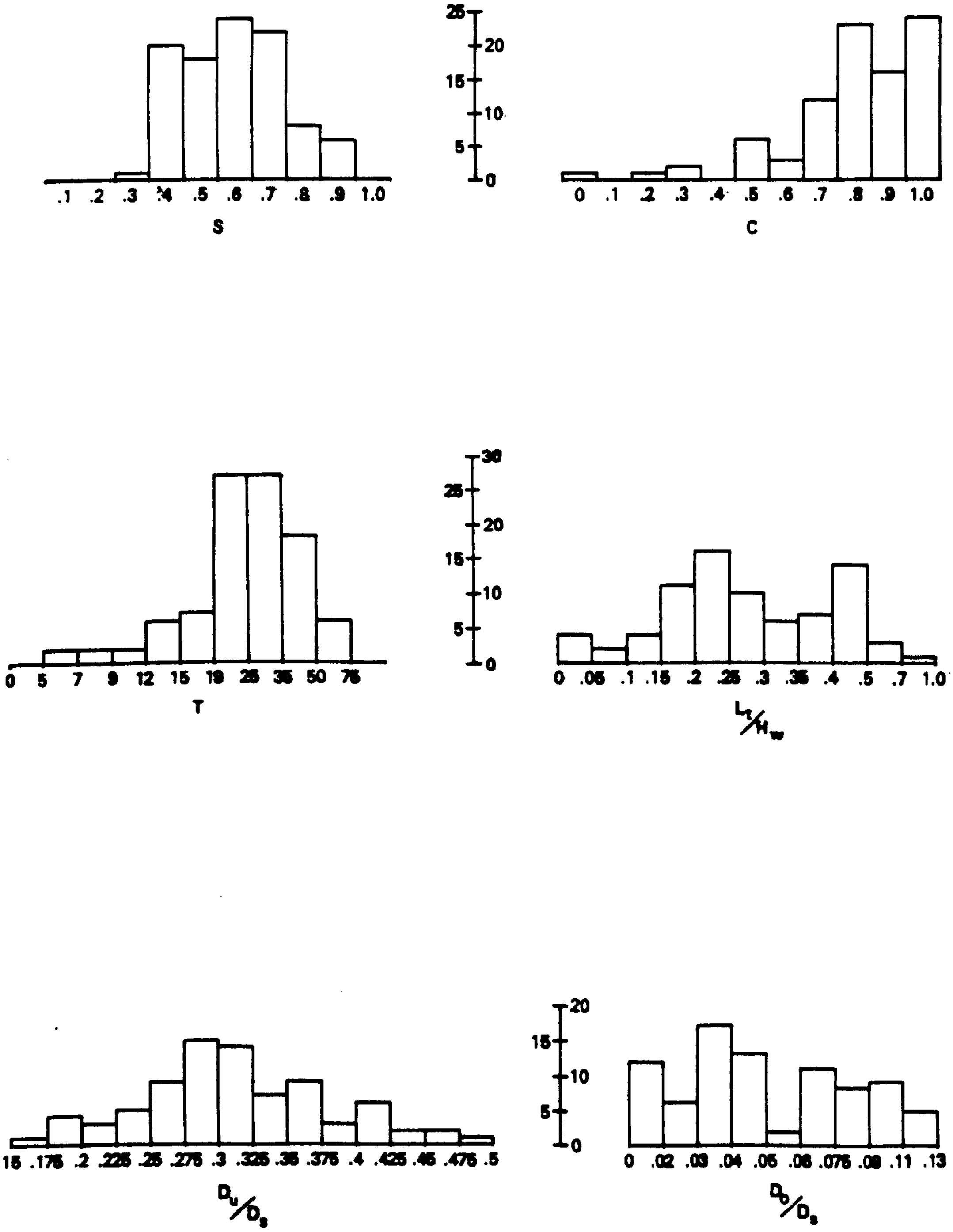


FIGURE 2. Histograms showing the frequency of character values for various characters in specimens of *Gastrioceras* *s.l.* from G_{1a} zone. The variation within the fauna is extremely great and fairly continuous. This fauna is quite typical in this respect.

Vertical scales indicate number of specimens. For character abbreviations, see Table 4.

using data from a representative stratigraphic horizon in Figure 2. This variation may be a genuine expression of the genome, in which case it is ideal for taxonomic work, or it may be due to ecological effects. Ecological effects may be indistinguishable a priori from genetic effects, except in the obvious case of physical damage. (Magraw, 1956).

It is this component of variation which has caused the greatest confusion in the literature, due to intellectual difficulties of assimilating data and practical difficulties of description and identification. It is consequently this variation which is the main subject of population analyses in this study.

Variation in many or all characters is not a problem to orthodox palaeontology where there is high correlation between characters; this is noticeably not the case in most goniatite populations.

3.1.1.3. Differing preservations

The contrastingly different superficial appearance between similar specimens preserved as 3-dimensional casts and as 2-dimensional crushed impressions has confused some authors (eg. Patteisky 1965, see Section 5.4.) but this need not be a real difficulty.

3.1.2. SOLUTIONS

Problems of this type have been dealt with in various ways in the past, but few of these are entirely satisfactory. The range of possible approaches include the following:

3.1.2.1. Assessment "by eye"

This, the most common approach in traditional palaeontology, is more difficult the larger the variability in populations, and it has consequently not been successful in dealing with Carboniferous goniatites. The process consists, loosely, of isolating two or more type specimens of conspicuously differing appearance from an assemblage and then, by crude comparison, allocating new specimens to one or other of the groups. Occasionally new specimens may be regarded as sufficiently dissimilar to require the erection of a new group. Identification involves naming new specimens after one or other groups, which are usually but not always called species, if they are "close" in appearance; otherwise, and very commonly, the prefix cf. is used to denote uncertainty.

This method is quite clearly subjective; taxa erected in this way may be more intellectual fabrications than they are real, and different workers inevitably disagree. It is impossible to assess by eye whether or not variation is continuous between two type specimens, and whether or not the chosen types are genuinely central to the range of variation of the morphospecies. Both these considerations are important from theoretical and practical viewpoints.

Another criticism is that assessment by eye tends naturally to bias in favour of the most conspicuous features, whereas there may be no grounds for supposing that these are any more important than visually trivial details. This is a form of subconcious weighting (see below).

These criticisms are certainly adequate to preclude the adoption of this traditional methodology in the present study. However, it should be noted that the results achieved in this way in the past are not necessarily entirely wrong, this depending on the skill of the worker, and that many accurate biostratigraphic and other deductions have been built on these insecure foundations.

3.1.2.2. Character weighting

One response to the problem of variation in many characters is to partially or completely eliminate from consideration certain characters which are regarded as unimportant, and to base taxonomic division on a restricted set of "important" characters, which therefore become positively weighted. Groups defined in this way by possession of one or a set of unique character states are called monothetic groups.

This method has the advantage of simplifying the mental process of taxonomic procedure, simply by reducing the amount of data being considered at one time. It also allows the formulation of an algorithm for identification, for example a dichotomous key.

Character weighting is, as suggested above, probably carried out subconsciously in much taxonomic work, but may also be used deliberately. An example of the former is in those species descriptions which include a paragraph on "diagnostic or distinguishing features". Characters not regarded as diagnostic of a species are either invariant (unlikely in most goniatite populations) and in a state similar to that found in other species, or, more likely, <u>are</u> variable within the species, in which case the character has been subdued from conscious consideration, ie. given zero weight. An example of deliberate weighting is the use of the criteria "absence of tubercles and development of a carinate keel at maturity" which have been used by workers in distinguishing the species *Agastrioceras carinatum*.

Despite the attraction of increased simplicity of taxonomic work when character weighting is carried out, this methodology must be rejected because the simplicity is artificial. Sneath & Sokal (1973) list seven fundamental arguments against character weighting. The essence of these is that the weighting of a character gives that character an *a priori* importance and influence in the resulting taxonomic structure, and that the imposition of this taxonomic importance must be subjective, as objective importance can only be deduced from the results of taxonomy. In other words, although some characters may be genuinely more important in distinguishing forms, we cannot be sure of this until the results are obtained of an objective taxonomic analysis which makes no assumptions about importance, ie. uses equal weighting.

3.1.2.3. Scatter diagrams

Scatter diagrams were, historically, among the first vaguely statistical techniques used to distinguish forms in a variable population. The essential principle involved here is the representation of each specimen as a point in a 2- or 3- dimensional ordination with mutually perpendicular axes corresponding to character measurements or ratios. With appropriate combinations of characters, the taxonomist hopes that points will plot out in separate fields, which can be identified as taxonomic groups. Although only a few characters can be analysed at one time, it is not necessarily a subjective method because, in principle, all combinations of characters can be tried. Those plots which show the best differentiation will suggest which, if any, are the best characters to use in distinguishing forms; those characters are therefore found empirically and are not subjectively assumed. However, a survey of scatter diagrams in the literature will show that the choice of characters for the axes is nearly always subjective; the diagrams are usually arranged to illustrate the variation with respect only to what the author regards as important characters.

Scatter diagrams usually have two axes, but it is also feasible to illustrate and visualise 3-dimensional scatters. Normally only one character contributes to each axis, but if other scatters show a good linear correlation between two characters, it may be profitable to use the ratio of the two on one axis, although this involves the loss of information. It is therefore rarely possible to plot useful scatters which incorporate data from more than four characters - this is an important drawback.

Scatter diagrams using various permutations of characters have been plotted for some Gastrioceras populations; two of these are illustrated in Figure 3. None of these has yielded an undoubted division into clusters. This raises another difficulty - many scatters are ambiguous and the recognition of clusters can itself be subjective.

The lack of clear clusters in any of the scatters of

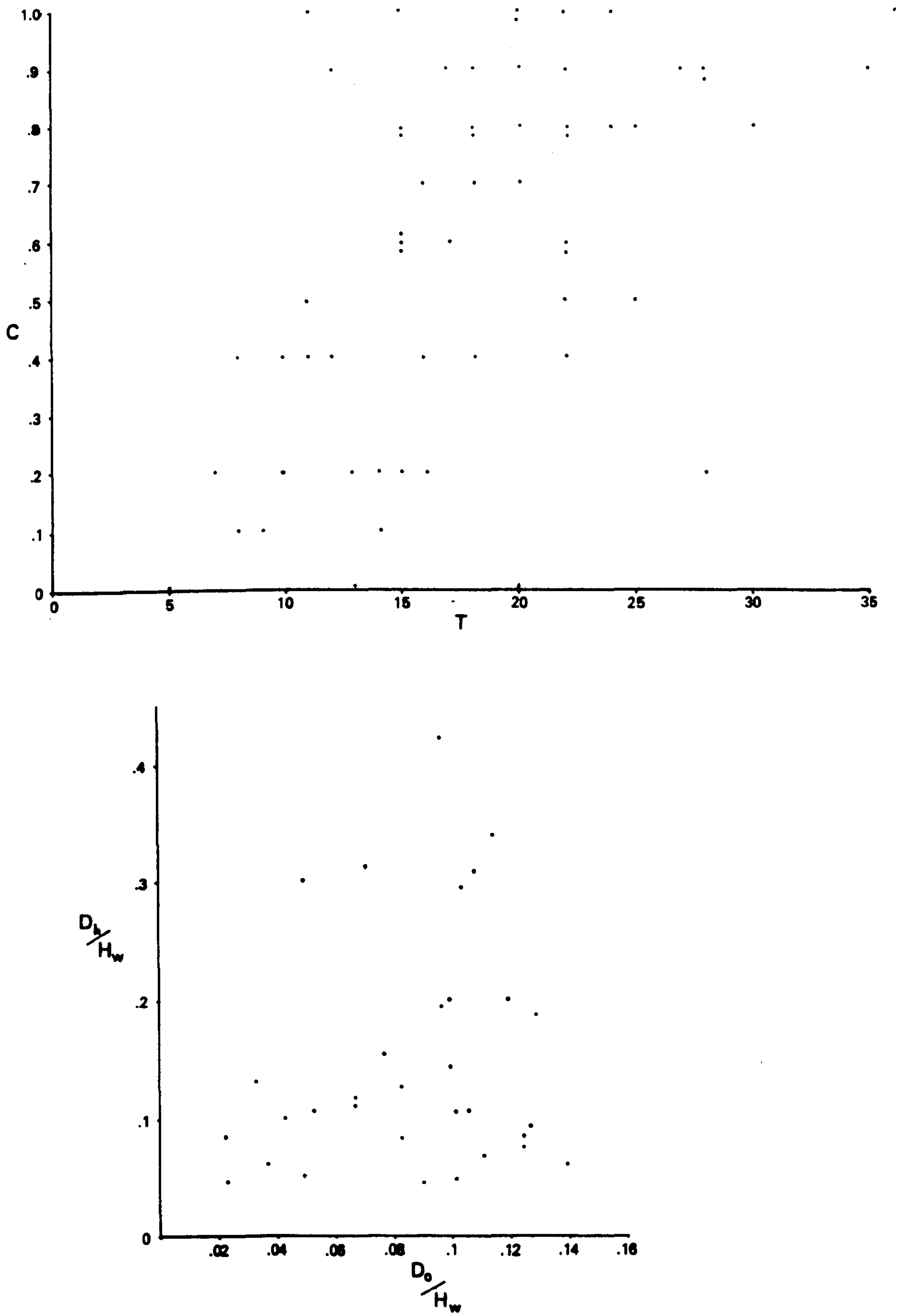


FIGURE 3. Bivariate scatter diagrams of specimens from the G_{1b} zone fauna. Clusters are not conspicuous and the scatters cannot be subdivided with confidence. These scatters are typical.

For character abbreviations, see Table 4.

Gastrioceras plotted does not imply that no clusters exist. Obviously, clusters might have been apparent on scatters using combinations of characters which were not tried - it is not practicable to try out all permutations of about 20 available characters. Also, it is quite feasible that real clusters exist which are only apparent when the correlations of larger numbers of characters are investigated.

For these reasons, any scatter restricted graphically to two dimensions is unlikely to be of great taxonomic value. The real morphological scatter of specimens in a population can only be truly expressed in a space of n dimensions, where n is the total number of characters that can be used, and this requires the special techniques of multivariate analysis.

3.1.2.4. Multivariate analysis

Multivariate techniques allow the simultaneous consideration of any number of characters in order to arrive at a taxonomic conclusion. Consequently it is possible to eliminate subjectivity in the process of distinguishing forms in a population. This is done simply by establishing the operational procedure of using all possible characters. Any resulting groups are termed polythetic (defined by Beckner, 1959, p. 22), the important property of such groups being that they can not necessarily be defined by the possession of any particular character states.

Most multivariate techniques involve the search for structure within a scatter of points ordinated in n-dimensional space. If the present problem, ie. the definition of groups within goniatite faunas, is expressed in these terms, the points represent specimens and each dimension represents a character (n= no. of characters). Shell diameter, which relates to the stage of ontogenetic development, can be used as a character, in which case a suite of specimens of the same morphospecies at various growth stages will necessarily form a linear series (see Fig. 4a). Indeed, an hypothetical morphospecies could be defined by an appropriate description of the space occupied by the ontogenetic continua of its constituent individuals. It is theoretically quite feasible for distinct morphospecies to overlap in parts of their ontogenies. Another complication is that, due to sampling difficulties, a population may not include representatives of all growth stages of a morphospecies (Fig. 4b). A consequence of these hypothetical distributions of specimens is that one significant cluster in such a space need not represent one true morphospecies - it may include parts of two or more. Also, different ontogenetic stages of one species may form discrete clusters. Note that these same observations apply even if shell diameter is not included as a character; it is used here to ease conceptualisation. The removal of that dimension from the diagram in Figure 4a would result in no change in the topology of the structure, see Figure 5a.

There is, then, an uncertain correlation between clusters and morphospecies under the conditions described. However, if specimens of only one shell diameter are considered at one time, then each significant cluster must

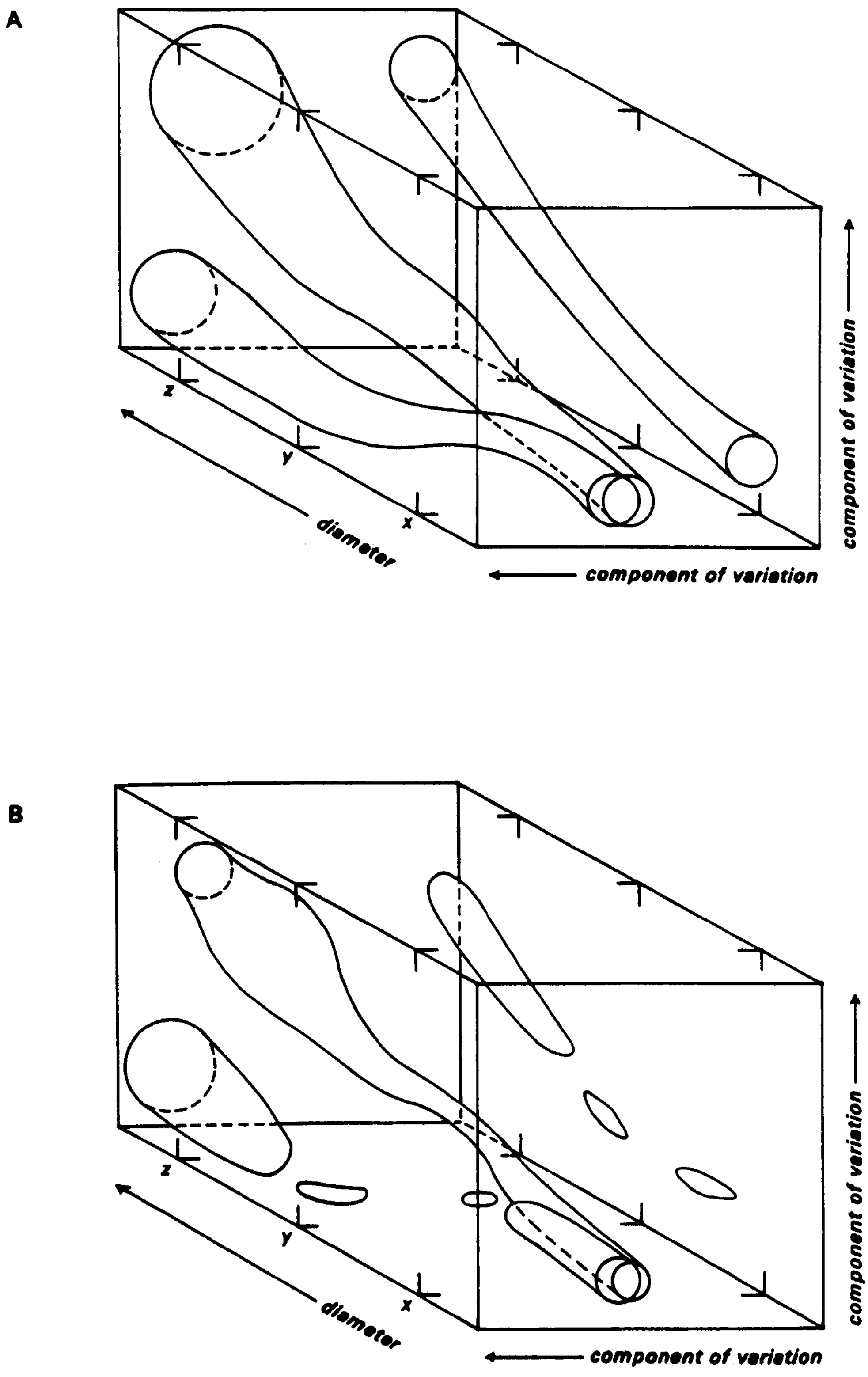


FIGURE 4. Hypothetical distribution of morphospecies in three phenetic dimensions, one of which is diameter, taken as an ontogenetic indicator. The original phenetic distribution is shown in A; the distribution after diagenetic and sampling effects is shown in B. Morphospecies are discrete to varying degrees. For the situation at diameter = x, y & z, see Figure 5.

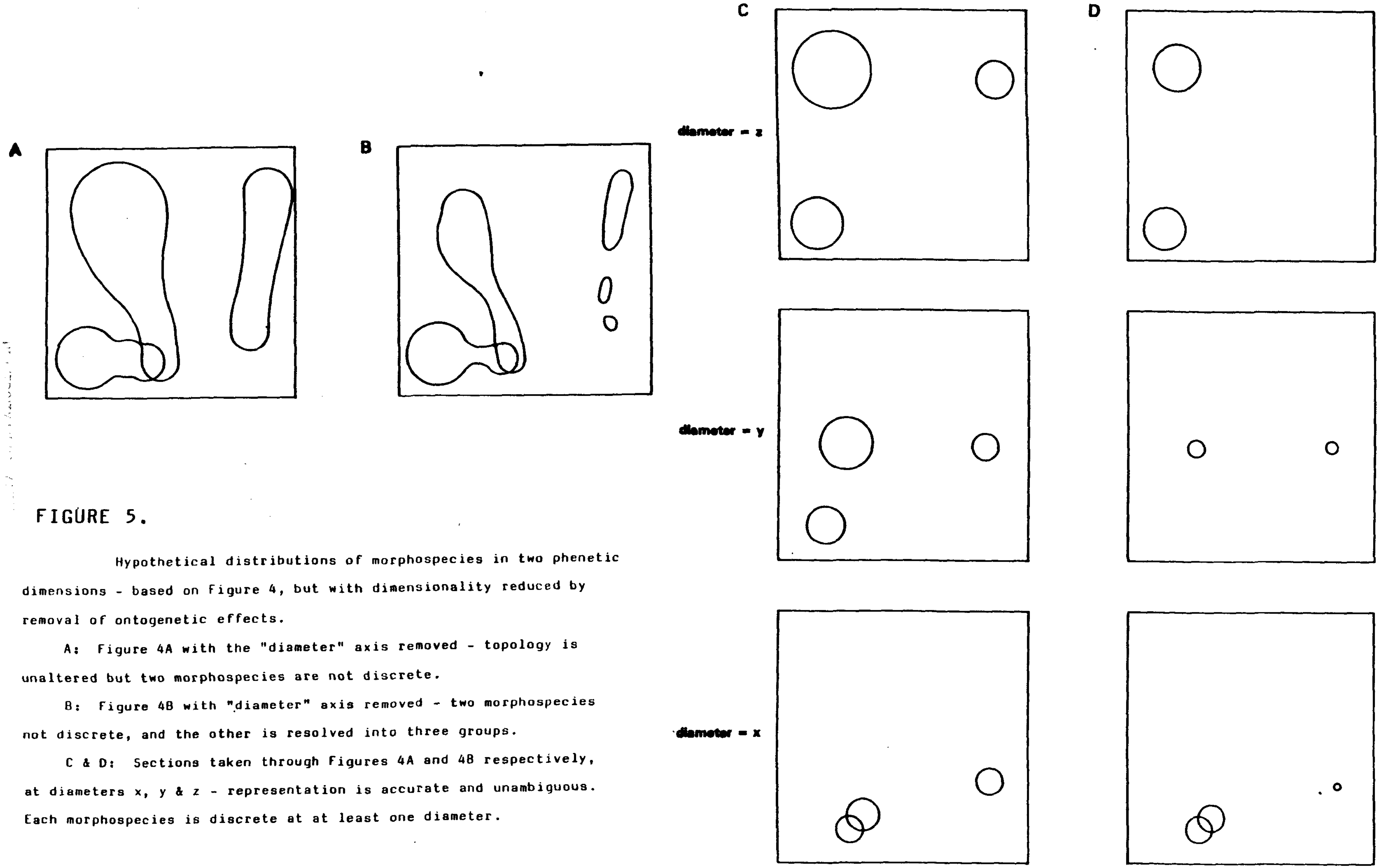


FIGURE 5.

Hypothetical distributions of morphospecies in two phenetic dimensions - based on Figure 4, but with dimensionality reduced by removal of ontogenetic effects.

A: Figure 4A with the "diameter" axis removed - topology is unaltered but two morphospecies are not discrete.

B: Figure 4B with "diameter" axis removed - two morphospecies not discrete, and the other is resolved into three groups.

C & D: Sections taken through Figures 4A and 4B respectively, at diameters x, y & z - representation is accurate and unambiguous. Each morphospecies is discrete at at least one diameter.

still be composed of specimens belonging to one or more morphospecies and, more critically, one morphospecies cannot be represented by more than one cluster. This situation may be visualised as taking slices through the structures shown in Figure 4, thereby reducing the dimensionality to the geometry shown in Figure 5b. If sufficient number of slices are examined, these should provide a complete record of the ontogeny of all significant morphospecies in the assemblage. Having defined the position of clusters at each ontogenetic "slice", it remains to tie up the consecutive clusters to reconstruct a complete set of ontogenetic continua. This involves practical problems discussed in Section 3.1.4.6., but three theoretical points are summarised here:

1. Every significant cluster on each "slice" is important and cannot be ignored; each cluster must indicate the presence of at least one morphospecies.

2. A morphospecies need only be distinct from its neighbours at one ontogenetic stage. If this particular stage is not "sliced", then the morphospecies will remain invisible.

3. It is quite possible for two morphospecies to be inseparable at some ontogenetic stages. Where one cluster incorporates two morphospecies, then the definition of that cluster must be used for both, although in fact the two may differ to a non-significant degree.

All things considered, this process of isolating morphospecies as separate clusters at a series of size ranges in the population seems to fulfil the desired criteria of objectivity and operationality, and has therefore been adopted in this study.

The mathematical process of multivariate analysis whereby significant clusters are distinguished and defined is described in the next section.

3.1.3. CLUSTER ANALYSIS - THEORY

Cluster analysis classifies numbers of units into groups on the basis of similarity. It can be split into a series of component processes:

1. Choice of unit.
2. Choice and measurement of characters.
3. Calculation of coefficient of similarity.
4. Cluster detection and linkage.
5. Considerations of significance.
6. Graphical display of spatial relationships.

3.1.3.1. The Unit

In the jargon of numerical taxonomy, the basic unit under consideration is known as the operational taxonomic unit, or OTU. This may be an individual, a species, an environment, or any other concept which can be defined by component characters.

Choice of unit is related to choice of Q- or R-mode analysis. Q-mode analysis classifies OTUs on the basis of possessed characters; R-mode analysis classifies characters on the basis of possession by OTUs. In Q-mode analysis, OTUs are considered to be located in an attribute space (A-space); in R-mode analysis, characters are located in individual space (I-space).

3.1.3.2. The Characters

Cluster analysis only considers phenetic relationships, defined by Sneath & Sokal (1973, p. 29) as "similarity (resemblance) based on a set of phenotypic characteristics of the objects or organisms under study". It is emphasised as being theoretically independant of cladistic relationships. The only information to be used is that involved in the characters of the OTUs, and this information should give as complete and accurate a picture as possible.

To assess similarity between OTUs, all corresponding characters are compared and the comparisons are mathematically compounded in one of various possible ways (see Sections 3.1.3.3. & 3.1.3.4.).

From these initial considerations, the following problems arise:

a. Whilst ensuring that the choice of characters is complete, care must be taken to ensure that information is not duplicated - this would result in unintended character weighting. Duplication of information can readily occur if characters are chosen which are logically dependant. For example, if a line is divided into two parts, the total length is logically dependant on the lengths of the component parts. In this case any two measurements are logically independant, but the use of all three results in duplication of information. Note that if two characters are highly correlated empirically, but not logically, they must both be used.

b. There may be a problem of uncertain character correspondance. Strictly, a character on one OTU must be homologous with a character on another OTU in order to validate a comparison. Homology is often difficult to establish. For example, two species of animal may appear similar in possessing black and white stripes, but detailed anatomical work might show that corresponding parts of the skin possess black pigment in one species and white pigment in the other; the stripes would therefore not be homologous and the species would not be genuinely similar in these characters. In fossil material homology is impossible to prove where it is not obvious. A common-sense approach has to be used in such instances; it is likely that errors in inferring homologues may not be too serious in their affect on results.

c. A related problem is that of missing characters. When absence is due to poor preservation of a specimen, then clearly that character cannot be used in calculating similarity with another speciman. Also, where character absence is genuinely phenetic, there is usually no objection to simply coding it zero. However, where that character is part of a larger organ which is itself missing, problems arise. For example, if "presence of spots on legs" was a character used in an analysis of reptiles, it would be misleading to code this as zero for species of snake, because this would suggest that, in this respect, snakes are more similar to reptiles without spotted legs than to those with spotted legs. There is no wholly satisfactory solution to this problem.

To facilitate the calculation of similarity between OTUs, characters must necessarily be in numerical form. This can be done in binary form (presence - absence data) or in the form of a continuous or meristic multistate. Binary coding is very simple and has the advantage of allowing close analogy with the "units of information" of information theory. Its disadvantages, which it shares with meristic multistate data, are that it necessitates partitioning of a possibly continuous range of variation of a character, and the position of the partitions often has to be arbitrary. Partitioning may result in severe loss of information unless many close partitions are used, in which case character coding and data manipulation become unwieldy.

3.1.3.3. The Coefficient of Similarity

Having expressed all the OTUs under consideration in entirely numerical form by appropriate choice and measurement of characters, the next step is to apply some mathematical technique to this data in order to arrive at a measure of similarity. One value of such a coefficient is calculated for every pair of OTUs, and so the entire set of coefficients for a sample can be expressed in a t x t matrix, where t = number of OTUs in the sample.

Many different equations have been formulated to arrive at measures of resemblance; the results of all equations are very broadly similar, but in most cases differ in detail. The main differences, however, are in application and concept. Four main types are recognised; these are summarised in Table 2.

3.1.3.4. Cluster Detection and Linkage

Except for probabilistic similarity coefficients, which arrive at a classification direct from the data

TABLE 2 - COEFFICIENTS OF SIMILARITY

TYPE	EXAMPLE		ADVANTAGES	DISADVANTAGES	NOTES
	NAME	EQUATION (for symbols see footnote)			
DISTANCE COEFFICIENTS	Average Euclidean Distance d_{jk}	$d_{jk} = \sqrt{\frac{1}{n}\left[\sum_{i=1}^{n}[X_{ij} - X_{ik}]\right]^2}$	Conceptual simplicity. Applicable to binary & continuous data.		Similarity between OTUs measured as a distance in space; each dimension of that space corresponding to one character. The equation is based on the formula for the length of the hypoteneuse. Should be used with standardised data*, otherwise (Xij - Xik) tends to be larger with arbitrarily larger characters.
ASSOCIATION COEFFICIENTS	Jaccard S_j	$S_j = \frac{a}{a+b+c}$		Restricted in use to binary data.	Measures agreement between character states of two OTUs.
CORRELATION COEFFICIENTS	Pearson Product-Moment Correlation r_{jk}	$r_{jk} = \frac{\sum_{i=1}^{n}[X_{ij}-\bar{X}_j]\,[X_{ik}-\bar{X}_k]}{\sqrt{\sum_{i=1}^{n}[X_{ij}-\bar{X}_j]^2 \sum_{i=1}^{n}[X_{ik}-\bar{X}_k]^2}}$		Undesirable properties in certain circumstances (see Sokal & Sneath, 1973, pp. 139-140).	Can be visualised approximately as measuring angles between vectors connecting OTUs to the origin in character space. Best used with standardised data*.
PROBABILISTIC SIMILARITY COEFFICIENTS	See Goodall, 1966.		Uses sophisticated modern information theory.	Complexity, which increases computing time and hinders conceptualisation. Best with binary data.	These involve the trial partitioning of sets of OTUs and the testing of the resultant classification using information statistics as optimality criteria. Considers the probability of character agreement and weights accordingly.

X_{ij} - value of the th character measured in OTUj
X_{ik} - value of the th character measured on OTUk
n - no. of characters
a - no. of characters coded 1 (present) in both OTUs
b&c - no. of characters differing between OTUs

*Standardisation of data involves the adjustment of all character values so that all variables have equal means and standard deviations. It has the effect of weighting characters equally.

matrix, all the procedures described in the previous section result in a matrix of numerical values which correspond to the similarities between every pair of OTUs. It is necessary now to use these similarities to investigate the taxonomic structure by searching for groups or clusters of OTUs.

The obvious and necessary basic attribute of a cluster is that it should contain a greater density of points in space than other areas. Note that this condition can be satisfied regardless of size, shape and number of points included. In practice, clusters are generated which are nested and hierarchic. Any level of the clustering hierarchy may be of use, from 2 clusters to t - 1 clusters (t= no. of OTUs), although some levels of the hierarchy are inevitably more significant.

Clusters can be described by citing position, size and shape. Position is expressed by the co-ordinates of the centroid or mean of the contained points. Size and shape are interrelated. Where clusters are hyperspherical, only a radius is needed for description. Where clusters are hyperelliptical or irregular, it is necessary to give measurements in each dimension. This measurement may be the distance from the centroid to the most distant point of the cluster, but more usually it is the variance or standard deviation of all points.

Methods of clustering are as numerous and varied as coefficients of similarity. Most of these involve an iterative algorithm in which, at each step, OTUs are considered for admission to clusters and pairs of clusters are considered for agglomeration. It is the criteria used in these processes which vary. The most important methods are summarised in Table 3.

The results of all types of linkage and clustering are normally expressed as dendrograms, in which fusion of "branches" represents linkage and the similarity coefficient between the linked entities is given by position along a scale parallel to the branches (see Figure 6). Notice that these diagrams synthesize information from every step in the clustering algorithm - the entire hierarchy is represented. The hierarchic nature of dendrograms makes them ideal for taxonomic interpretation. However, it should be remembered that they are essentially one dimensional representations of n - dimensional character space, and information is inevitably lost.

3.1.3.5. Significance of Clusters

The representation of phenetic structure in a group of OTUs as a dendrogram leaves two outstanding problems of interpretation. Firstly, how statistically significant are the clusters; and secondly, at what level of similarity should the hierarchy be split into taxa?

A. Statistical Significance

The precise nature of this problem can be realised when it is considered that the application of clustering algorithms to <u>any</u> set of OTUs, random or ordered, will produce plausible dendrograms, and that even within random data sets there are usually noticeable clusters. It is also a problem to decide whether the significance of one cluster within the hierarchy is to be tested, or whether tests should examine the information content of

TABLE 3 - LINKAGE METHODS

METHOD		CRITERION FOR LINKAGE OF CLUSTERS	DISTORTION OF SPACE	CLUSTER SHAPE	NOTES
NEAREST NEIGHBOUR OR SINGLE LINKAGE CLUSTERING		Nearness of closest points of clusters.	Contraction	Results in "straggliness" or pronounced non-hypersphericity of clusters.	The results produced by these two methods are opposite extremes.
FARTHEST NEIGHBOUR OR COMPLETE LINKAGE CLUSTERING		Nearness of farthest points of clusters.	Dilation	Very tight and hyperspherical	
AVERAGE LINKAGE CLUSTERING	Weighted or unweighted arithmetic average	Nearness of clusters as indicated by a similarity coefficient averaged for all pairs of OTUs (one in each cluster).	Slight	Approximately hyperspherical	In weighted arithmetic average or centroid clustering, new cluster members are weighted so as to be equal in importance to the rest of the cluster in subsequent clustering steps. In unweighted versions all points are weighted equally.
	Weighted or unweighted centroid	Nearness of cluster centroids	Slight	Approximately hyperspherical	
WARD'S METHOD		Least increase in error sum of squares ie. least increase in sum of distances from each point to the centroid of its cluster.	Slight	Approximately hyperspherical - variance minimised.	
INFORMATION STATISTICS		see Table 2 (Probabilistic similarity coefficients).			

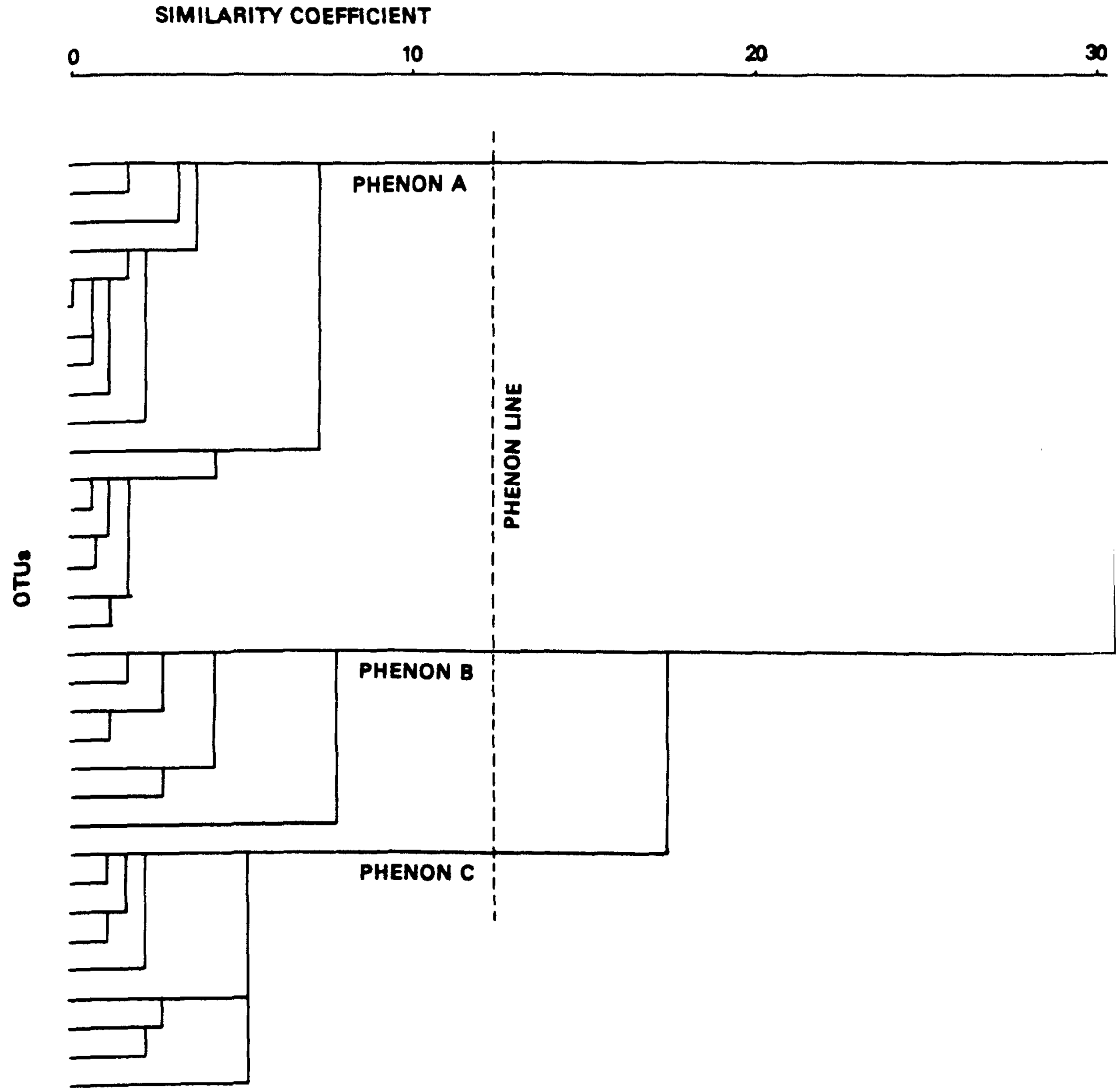


FIGURE 6. An example of a dendrogram. The termination of each "branch" represents an OTU, and similarity between OTUs and between clusters of OTUs is indicated by the position of linkage. The best "phenon line" is chosen according to the appropriate criteria and the resultant "phenons" represent the optimal higher taxa.

the whole classification. Attempts at producing a meaningful coefficient of significance are therefore complex and unsatisfactory (see Sneath & Sokal, 1973, p. 284).

A valuable insight can, however, be gained by examination of dendrograms generated from artificially doctored data; patterns can then be recognised in real data. Examples of dendrograms produced from both random and ordered data are shown in Figure 7.

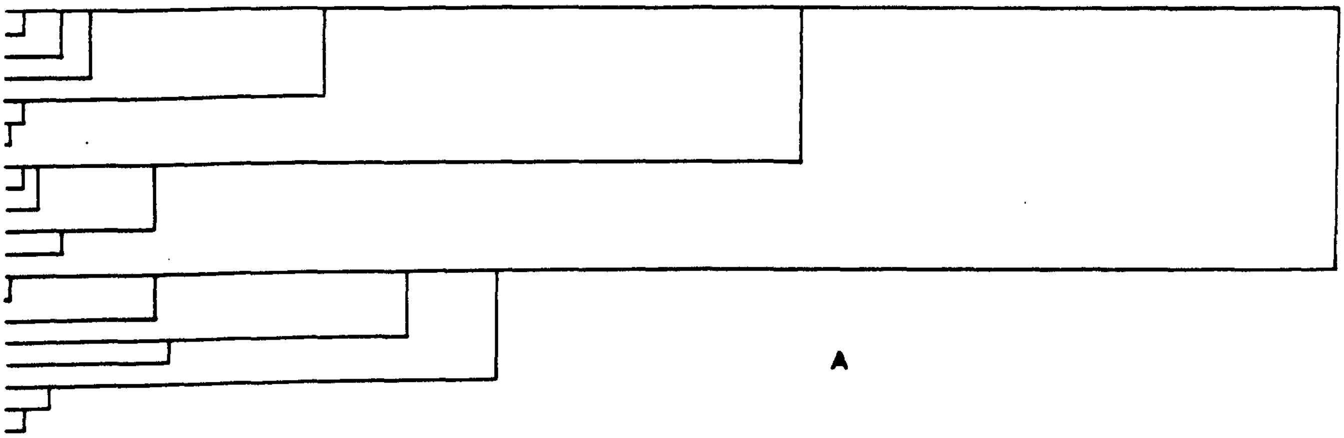
It is pertinent to note here that any non-systematic errors in data collection will result in a decrease in cluster tightness, so that any low-significance clusters generated in practice may represent original structures of higher significance.

B. Determination of Rank

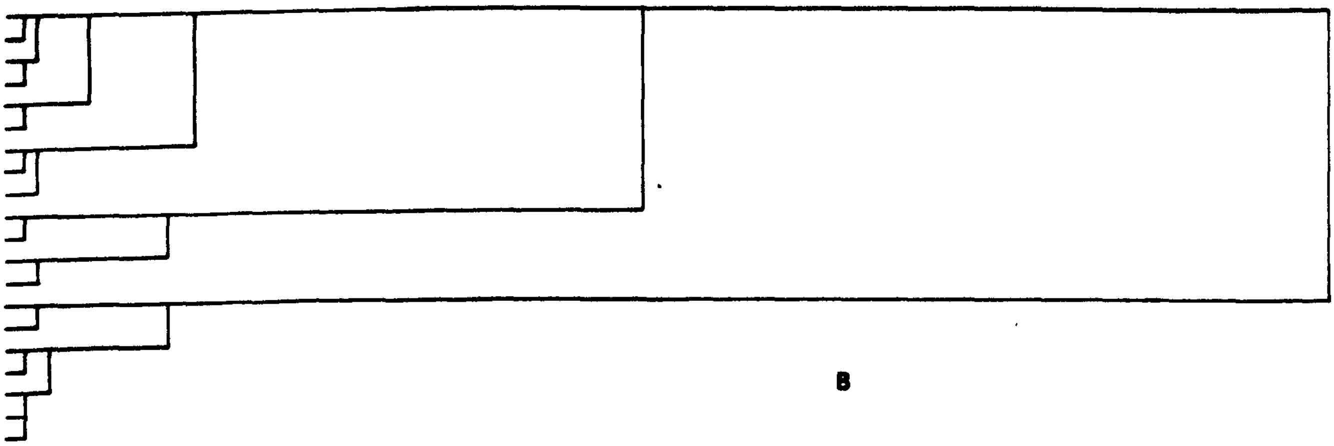
The following criteria for determining levels of rank are compatible with the desire for objectivity and are recommended in the literature:

1. The same level of similarity must be used to distinguish a given taxonomic rank throughout the OTUs of one analysis. In practical terms, this means that the dendrogram must be divided by a straight line drawn perpendicularly to the coefficient axis. Sneath & Sokal (1973) call these "phenon lines" and they are used to distinguish "phenons". The similarity coefficient at which the line is drawn can be used as a rank category; for example a 50 phenon is a group isolated by the 50 phenon line drawn at similarity coefficient = 50. Note that there are an infinite number of possible phenon lines, which allow t possible classifications (t = no. of OTUs).

2. A taxon should have a high degree of similarity



A



B

FIGURE 7. Dendrograms resulting from A: random and B: ordered data - both artificially doctored. The data for B plots in three clusters, two close and one distant.

B shows greater intra-cluster similarity.

between its constituents relative to the similarity between it and other taxa. In dendrograms this property appears as long gaps between bifurcations. This criterion may have to be compromised when considered simultaneously with 1 above.

3. Of all the phenon lines compatible with both 1 & 2, the one with the most objective importance is the line at the highest similarity coefficient. This is the lowest taxonomic rank present in the sample. Ideally, all the phenons at this level should be separated by distinct gaps, and there should be no significant non-overlapping subclusters within a phenon.

3.1.3.6. Spatial Distribution

Dendrograms allow objective interpretation and provide a convenient way of illustrating relationships between OTUs. However, as observed earlier, they are essentially a simplification of n - dimensional character space into one dimension - that of a measure of similarity. This entails a vast amount of information loss, and it is desirable that dendrograms should be complemented by a method of ordination involving more dimensions. Because of the limitations of graphical simplicity, ordination of the OTUs must be in no more than 3 dimensions. The problem, then, is to show n - dimensional spatial relationships in 2 or 3 dimensions whilst minimising distortion and information loss. The following methods have been used by various workers:

A. Principal Component Analysis. This involves the calculation of the eigenvalues and eigenvectors of a matrix of n x n correlation coefficients between characters. Any positive correlations between 2 or more characters over all OTUs implies that the distribution of OTUs in A-space is elongated in a direction with components in the dimensions corresponding to those characters. The eigenvectors give the direction of the elongation and the eigenvalues give its magnitude. Principal components analysis computes n orthogonal eigenvectors and eigenvalues in order of magnitude, and also the co-ordinates of each OTU with respect to these vectors.

This technique is of useful application in two respects. Firstly, the OTUs can be easily plotted in a 3-dimensional space in which the axes are the three eigenvectors with the largest eigenvalues; these are the first three principal components. This ordination, therefore, considers the three largest mutually perpendicular directions of variation in A-space, and so illustrates the total variation as completely as possible. Secondly, it is of interest to examine the magnitude of each component of the main eigenvectors, ie. the contribution of each character to the principal components. Each principal component of variation is likely to be related to one external factor, and the effect of this factor on each of the characters can be deciphered.

The information content of principal components plots can be enhanced by the superimposition of linkage, as derived from a clustering algorithm. This is described in Section 3.3. Linkage diagrams are based on distance in A-space, so when superimposed on principal components plots, the distortion involved in ordination becomes apparent.

Distortion is generally found to be greatest and sometimes severe when relatively close OTUs are ordinated.

B. Multiple Factor Analysis (Harman, 1967). This method is related to principal components analysis but differs in that the factor axes need not be orthogonal. The process allows the axes to be rotated independently in a search for "simple structure". The criteria for simple structure are: one factor should only influence a subset of characters; its effect on characters not in that group should be minimised; and one character should not be affected by all factors.

Unlike principal components analysis, where the correlation between factors is zero because of their orthogonal disposition, multiple factor analysis discovers factors which are mutually correlated. This is an attractive property because the underlying external factors in nature are themselves unlikely to be independent. However, the method has been criticised by Temple (1978) because it involves subjective assumptions and decisions, and is conceptually complex in comparison with principal components analysis.

C. Principal Co-ordinate Analysis (Gower, 1966). This technique is essentially similar to principal components analysis but works direct from a Euclidean distance matrix.

D. Non-metric Multidimensional Scaling. It was noted that principal components plots involve distortion in A-space. In non-metric multidimensional scaling, a measure of this stress is calculated, and the ordination is arranged so that this is minimised. The result is a desirable optimisation, but there is a considerable disadvantage in its complexity.

3.1.4. CLUSTER ANALYSIS APPLIED TO MORPHOSPECIFIC DETERMINATION

The theory of cluster analysis allows a vast number of permutations of coefficients and algorithms. It is necessary now to discuss which of these is appropriate in the present problem, namely the division of samples of goniatites into morphospecies. Consideration has to be made to the collection and arrangement of data as well as to the choice of equations.

The data collected as described in this section are included in Appendices 2, 3 & 4.

3.1.4.1. Choice of Unit

The OTU for the present set of analyses is obviously the individual specimen, and we seek to study the distribution of these in A-space using Q-mode analysis.

3.1.4.2. Definition, Choice and Measurement of Characters

A. Data Type

There are no characters of the goniatite shell which show a discrete frequency distribution - all show continuous variation over the range. This immediately suggests that characters are here best represented by continuous variables.

B. Atlas of Characters

Figures 8 & 9 and Table 4, with the accompanying notes, give a complete breakdown of shell characters which appear to be logically independent and together constitute a good estimate of the information content of a fossil goniatite specimen. Note that, because of the spiral symmetry of the shell, most character definitions can be applied to any whorl section at any growth stage; and that, due to the bilateral symmetry, they can be applied equally well

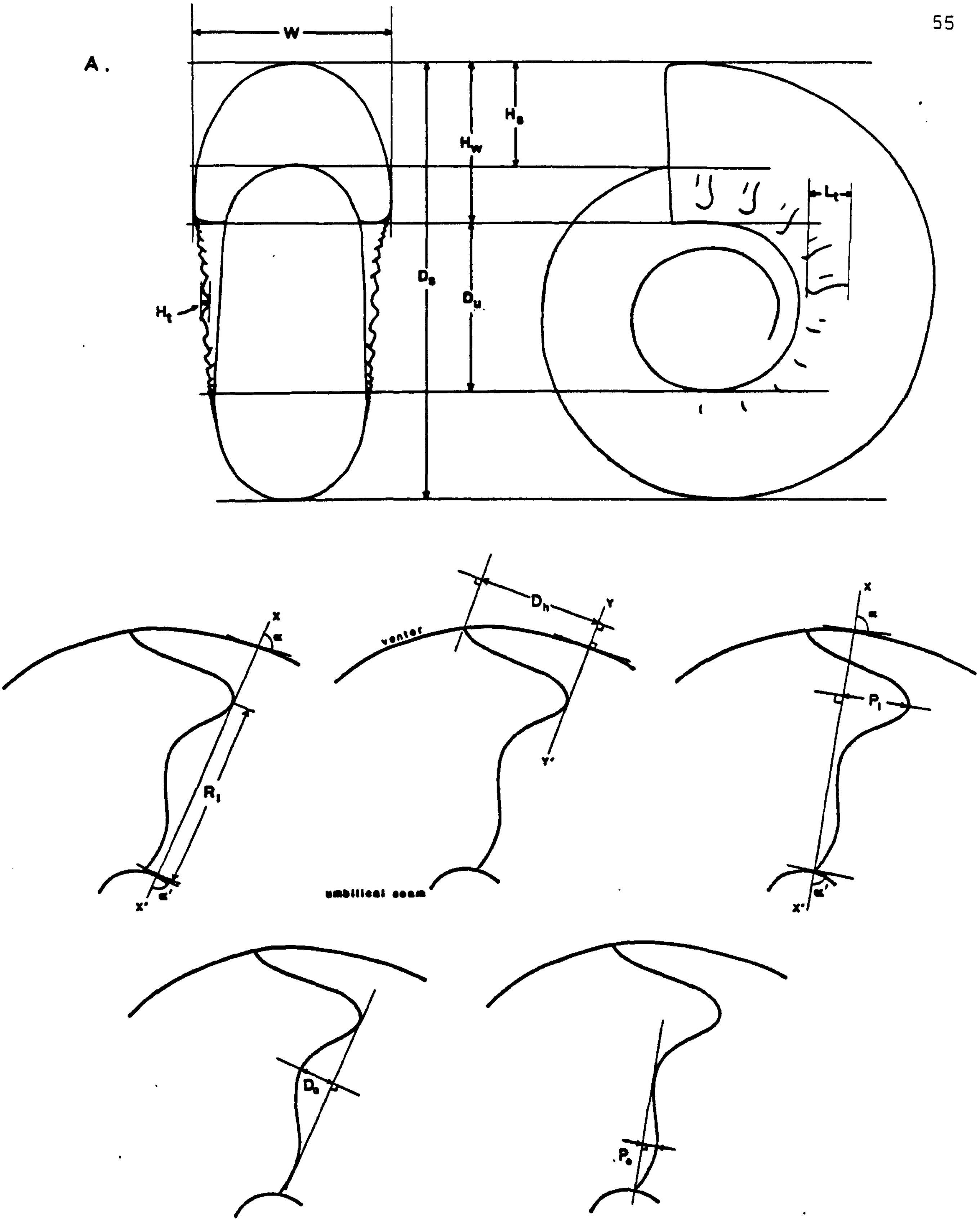


FIGURE 8. Goniatite shell characters

A: General shell dimensions. For further explanation see Table 4.

B: Apertural characters, as measured on a representative growth line, viewed perpendicular to the plane of coiling. Line X-X' intersects the tangents to the venter and to the umbilical seam at angles α and α' respectively. In the process of measurement, line X-X' is estimated so that α = α'. Line Y-Y' intersects the tangent to the venter at 90°. These lines have been found to be the most suitable for the assessment of specimens

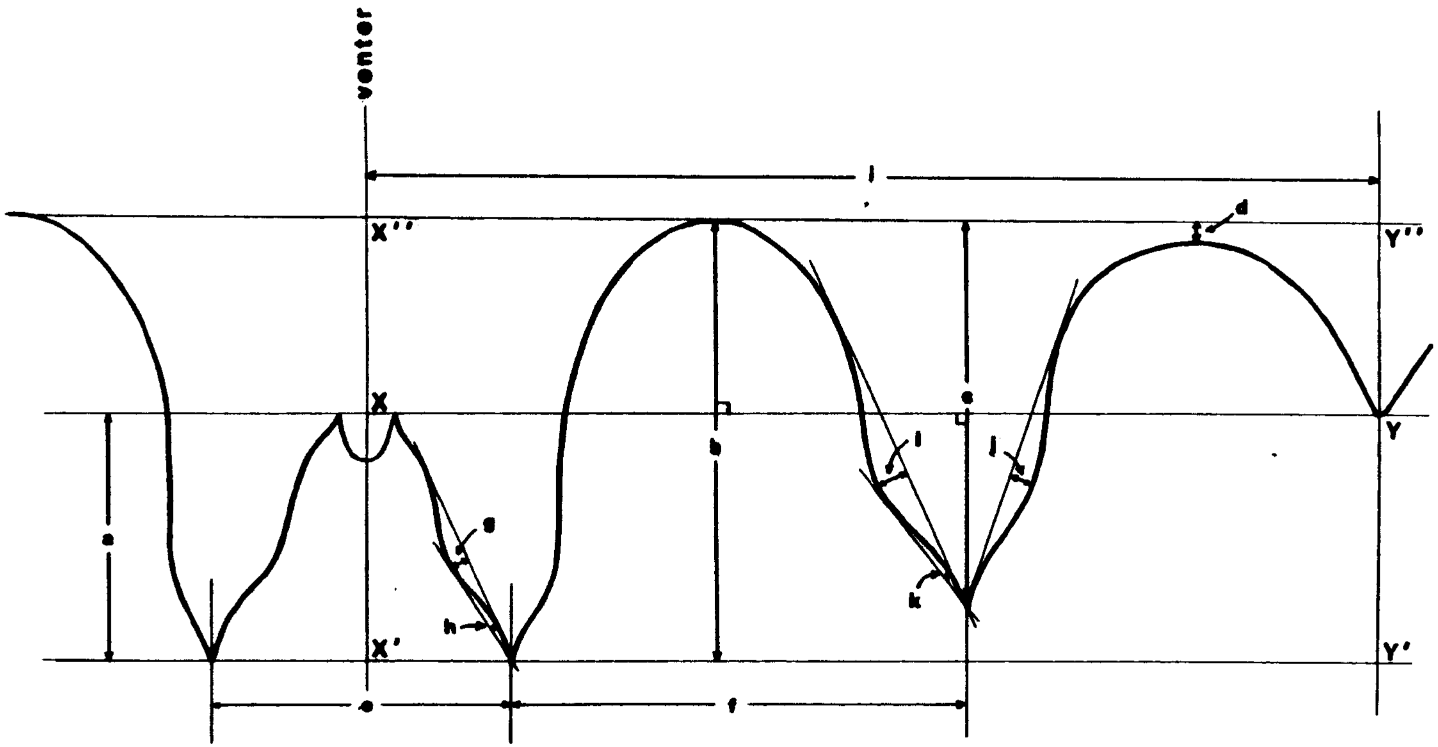


FIGURE 9. Goniatite sutural characters

The line X-Y of length l is the shortest line between the ventral saddle and the umbilical lobe around the surface of an internal mould. Lines X'-Y' and X"-Y" lie in planes parallel to the plane containing X-Y. Measurements a-k are linear in 3 dimensions; a-f are disposed parallel or perpendicular to X-Y.

The projection intended in this diagram is one in which measurements along and perpendicular to X-Y are conserved. Consequently there is some distortion in the apparent lengths of e-k, especially e and f.

TABLE 4 - CHARACTER DEFINITIONS

CHARACTER TYPE	MEASURED OR ESTIMATED CHARACTER	SYMBOL	RATIO USED	FREQUENCY OF USE IN ANALYSIS	REASONS FOR OMISSION FROM ANALYSES	NOTES
GENERAL SHELL DIMENSIONS	Shell diameter	D_s		Zero	Used as an indicator of ontogenetic stage.	Other features, eg. no. of whorls, no. of septa, volume of body chamber, apertural modifications etc. are also possible indicators of ontogenetic stage, but these are only rarely assessible and there is no reason to suppose that these criteria are any better for the purpose than shell diameter.
	Diameter of umbilicus	D_u	D_u/D_s	High	Not measurable in many fragmentary specimens.	Indicates the position of the umbilical seam of the whorl - all other characters describe the properties of the whorl itself.
	Whorl height	H_w		Zero	Logically dependant of D_u & D_s to a high degree given the spiral geometry of goniatites, especially in evolute forms.	All ratios except D_u/D_s are ratios to H_w.
	Aperture height	H_a	H_a/H_w	Zero	Not accurately measurable on a majority of specimens - errors large in proportion to amount of variation.	
	Whorl width	W	W/H_w	Fairly high	Not measurable on crushed specimens.	The ratio W/H_w is preferred to W/D_s as it relates to the dimensions of the body chamber and hence to the shape of the living animal.
ELEMENTS OF COARSE SCULPTURE	Length of tubercles or plications	L_t	L_t/H_w	Very high	Occasionally $H_t = L_t = 0$ in all specimens in a sample, and the use of these characters is rendered superfluous.	The terms "tubercle" and "plication" as used here refer to any relatively raised structure on or near the umbilical shoulder. This may be and often is simply an elevated section of a costa. The length of a tubercle or plication is measured from the umbilical shoulder ventrally to the point at which it declines to zero or to the elevation of a costa.
	Elevation of tubercles or plications.	H_t	H_t/H_w	Very high		
	No. of tubercles per 90° whorl section	N		Fairly High	Absence of tubercles.	Absence of tubercles cannot be coded N=0 as this would imply closeness to N=1 rather than, say, N=10, whereas in fact tubercle absence is probably a result of reduction in size, not number. N cannot therefore be used in analyses of samples including specimens without tubercles.

TABLE 4 CONTINUED

	Strength of costae	P		Moderate	Often not markedly variable within samples.	The term "costa" as used here refers to any stria which is sufficiently pronounced to form a corrugation of the shell which traverses the whorl from umbilical shoulder to umbilical shoulder without any great variation in strength. Coded from 0 (costae absent) to 1 (costae maximally pronounced eg. some specimens of *Homoceras beyrichianum*. Intermediates estimated 0.1, 0.2, 0.3 etc.
	Furcation of costae/tubercles	R		High	Lack of variation within sample.	Coded R=1 for no furcation, R=2 for bifurcation, R=3 for trifurcation. Intermediate values are possible where the degree of furcation varies, and are got by averaging several instances. Strictly not applicable where tubercles/costae are absent, but usually coded R=1 as R can be seen to decline as L_t, H_t and P decline.
ELEMENTS OF FINE SCULPTURE	No. of striae per 5 mm	T		Very high		Striae are here defined as fairly regularly spaced prominent growth lines which may or may not be sufficiently pronounced to form costae. The 5 mm interval is measured in a spiral direction in the vicinity of the lingua.
	Degree of development of crenulation on striae	C		Moderate	Lack of variation within sample.	Estimated from C=0 - no crenulation to C=1.0 - perfect crenulation. Where crenulation varies over the whorl section, the value of C is got by approximately averaging.
	Strength of striae vs strength of spiral ornament	S		High	Lack of variation within sample.	Spiral ornament is usually formed by crenulation being in-phase over successive striae. S is estimated from 0 - spiral ornament only, to 1.0 - striae only; 0.5 = striae and spirals equally prominent.
	No. of spiral lines per 5 mm	L		Low	Only measurable on specimens with low values of S	The 5 mm is measured perpendicular to the spirals in the vicinity of the lingua.
	Furcation of striae	F		Zero	Requires good preservation and probably not independent.	This character is usually coincident with R, and otherwise requires fine preservation.
CHARACTERS OF APERTURE	Depth of hyponomic sinus	D_h	D_h/H_w	Very high		
	Projection of lingua	P_1	P_1/H_w	High	Difficult to accurately measure low values.	
	Radius of lingua	R_1	R_1/H_w	Moderate	Difficult to define if lingua is weak.	
	Depth of ocular sinus	D_o	D_o/H_w	Very high		
	Umbilical projection	P_o	P_o/H_w	Moderate	Often invariate (P_o = 0) throughout a sample.	

TABLE 4 CONTINUED

INTERNAL CHARACTERS A. GROOVES, CONSTRICTIONS etc.	No. of constrictions per whorl			Zero	Only rarely assessible due to preservation.	Constrictions are sometimes visible on external surfaces as a bunching of striae. The value of T is not assessed in these areas.
	Ventral feature	Vg		Moderate	Often absent throughout sample.	Coded 0 = strong groove, 1 = smoothly rounded venter, 2 = strong keel, intermediates estimated.
	Ventro-lateral feature	Lg		Moderate	Often absent throughout sample.	Coded 0 → 2 as above.
B. SUTURE External Suture	Length (ventral saddle to umbilical lobe)	l		Zero	Related to shell dimensions W and H_w and used to calculate ratios.	Measured around circumference of internal mould, as are all other sutural characters. This line is used as a datum to which other measurements are disposed perpendicularly or parallel.
	Height of ventral saddle	a	a/l	Low	Infrequency of observation.	
	Height of outer saddle	b	b/l	"	Infrequency of observation.	
	Depth of lateral lobe	c	c/l	"	Infrequency of observation.	
	Relative height of lateral saddle (relative to b)	d	d/l	"	Infrequency of observation.	
	Width of ventral saddle	e	e/l	"	Infrequency of observation.	
	Width of outer saddle	f	f/l	"	Infrequency of observation.	
	Ventral concavity of ventral lobe	g	g/l	"	Infrequency of observation.	
	Acuity of ventral lobe	h	h/l	"	Infrequency of observation.	
	Ventral concavity of lateral lobe	i	i/l	"	Infrequency of observation.	
	Umbilical concavity of lateral lobe	j	j/l	"	Infrequency of observation.	
	Acuity of lateral lobe	k	k/l	"	Infrequency of observation.	
Internal Suture				Zero	Extreme infrequency of observation.	

to left and right sides. However, to avoid data duplication, only characters on one side are measured, and in this study, it is normal to record characters at only one whorl section per specimen.

C. Inadmissable Characters

Despite the extensive suite of characters listed in Table 4 above, there are inevitably items of information which remain unaccounted for, for reasons of practicality. Particularly, it is apparent that not all of the subtleties of shell ornament are listed. For example, the precise degree of curvature of various parts of the growth lines is ignored, as is the exact structure of crenulation. These characters, and others, invoke practical difficulties in that: a) it is often difficult to define such features in a way conducive to numerical coding; b) there are technical difficulties in measuring small and subtle features accurately; c) measuring such characters is very demanding of time; and d) the percentage error involved is sizeable.

There is also a small set of characters which can be regarded as objectively irrelevant for taxonomic purposes, as they are dependant on factors independent of the living organism. These are primarily diagenetic effects, for example colour and type of preservation.

3.1.4.3. Equipment and Errors

Vernier calipers were used for most of the larger measurements, finer details were measured using a X8 lens with a scale graduated down to 0.1 mm. A clear plastic millimeter rule was also found to be useful. This simple equipment permits a precision down to about 1 - 2%, which is clearly adequate given the quality of the material.

The error involved in the process of digitisation must be regarded as the difference between the information in the final data set and the information in the original object as it was when part of a living organism - it is evidence pertaining to that organism that is being sought. Errors can accumulate from the following sources:

A. Diagenesis. Any imperfection in preservation, by definition, distorts or reduces the information content of a specimen. Loss of information is obvious and unambiguous; we are more concerned here with alteration of character values. Shell ornament is not very susceptible to alteration in this manner, but shell dimensions may be markedly affected. By far the most common diagenetic effect is lateral crushing due to sediment compaction. This clearly renders whorl width unmeasurable, but the effect on dimensions parallel to the plane of coiling is less obvious. In general, these measurements would be expected to be increased, because of the flattening of curved surfaces, but usually this is partly compensated by overlap of shell fragments. The distortion is therefore uncertain and not easily estimable. Crushed specimens must nevertheless be incorporated into many analyses, and this can only be done by assuming zero distortion. Any systematic error might then be discovered empirically by examination of the results.

Regardless of any systematic distortion, it is inevitable that accuracy of representation is lost in crushing, and the resulting data will have only a fuzzy resemblance to the original phenotype. This "fuzziness" is acceptable if it is slight relative to the size of a character; for example, no amount of crushing can disguise a difference in the value of u between a specimen of $D_u/D_s = 0.2$ and another of $D_u/D_s = 0.4$.

B. Operational Error. This arises from lack of precision and lack of accuracy in the operation of measurement. Lack of precision is not a great problem - the instruments used have a sufficiently high resolution. Lack of accuracy arises when characters, although precisely defined, can not be precisely measured because of physical difficulties. An example of this is the measurement of tubercle elevation in crushed specimens - it is difficult to get the required lateral view. This type of inaccuracy probably causes a random error which further increases fuzziness.

C. Error in Estimation. Many characters are assessed on an artificial scale by estimation "by eye", for example strength of striae vs. spiral ornament. The precision involved is low, with resolution perhaps only 0.1 on a range $0 \rightarrow 1$. The lack of accuracy involved in estimation is equal to the degree of inconsistency of assessment. Any systematic error is irrelevant if consistent. Inconsistency can result from subjectivity and random effects; subjectivity can be eliminated by discipline but random effects are unavoidable. The error caused by this means may be as high as 10 - 20% of the range of a character, and this again increases fuzziness. This error margin is very high, but it should be noted that the resulting accuracy of definition is superior to using binary coding or ignoring the character altogether.

Summary of Effects of Errors

Apart from systematic errors due to preservation, which can be detected empirically from results, the errors involved can be restricted with care to random effects which blur the precise position of the specimen in A-space. The analyses to be carried out attempt to recognise clusters of OTUs; consequently, at worst, the slight randomising effect can only increase the diffuseness and hence the variance of any genuine clusters. If there is no systematic error the cluster centroids will not be significantly affected, and any genuinely discrete clusters should remain analytically distinct.

3.1.4.4. Choice of Sample for Analysis

Data collected from specimens from various stratigraphic levels and diverse localities has to be arranged into optimal samples for independent analysis. The following criteria are desirable:

1. Stratigraphic restriction, for increased resolution and sensitivity in evolutionary and stratigraphic considerations.
2. Geographic restriction, for increased provincial sensitivity.
3. Taxonomic restriction, for phenetic sensitivity.
4. Restriction to a small ontogenetic range, for reasons given in section 3.1.2.4.
5. Restriction to specimens with fairly complete sets of coded character variables. A specimen cannot be analysed with respect to missing characters.
6. Each sample should be large enough to ensure a fairly complete representation of the phenetic hierarchy.

7. Economy of effort and computer time.

Numbers 1 to 5 reduce sample size, numbers 6 and 7 tend to increase it. A compromise must be sought, and this varies from case to case. The following generalisations can be made:

1. Samples are usually restricted to one established biozone. The various horizons within that zone are not treated separately.
2. Within the British Isles, samples are not restricted geographically.
3. Samples are restricted to one family of the three under consideration (ie. Homoceratidae, Reticuloceratidae, Gastrioceratidae), assuming that these families are valid.
4. Ontogenetic restriction is to specimens with diameters within a 2 - 3 mm range in specimens 5 - 15 mm diam., and within about 4 - 5 mm range for larger specimens.
5. Sample size minimum should be about 10 and, in fact, averages about 20.

3.1.4.5. Computation

The analysis of the data collated in the manner described above requires the calculation of equations and the execution of complex algorithms as described in Section 3.1.3. This requires a powerful computing facility and a sophisticated computer program. In the present study, analysis was carried out on the Leeds University Amdahl VM 470 computer using the CLUSTAN 1C package developed by Wishart and described in a user manual (Wishart, 1978). This package is in effect an interlinked series of programs, each dealing with one stage of the many possible permutations of analysis. The exact analysis desired is selected by specifying the appropriate option in a driver program. The user has a choice of options in the following program steps:

1. Data input format.
2. Calculation of similarity coefficient etc.
3. Clustering algorithm.
4. Output of results.

The options chosen for the present problem are as follows:

1. Data input format.

The total data collected is stored on disc on three master files, one for each of the three major goniatite families. These files can be edited down to arrive at the samples to be analysed separately. Each line of the data files relates to one specimen and includes:

a. a sequential number pertaining to the position of the specimen in the master data file. This gives reference to the registered number of the specimen;
b. the identification of the specimen, as registered;
c. the size of the specimen in mm;
d. the character values in Fortran format F3.0, F4.0 or F5.0, with up to three decimal places.

The CLUSTAN package allows the user to specify a Fortran format statement to read the data. In most analyses, the data read by the computer was restricted by this means to all the character variables plus the sequential number. The inclusion of the latter allows it to be printed for reference in the output. Subsequently, the user has the option of masking parts of the read data from calculations. At this point the sequential number must be masked, plus any characters that are not coded, due to absence, in any of the specimens; either the character is masked or the specimen is deleted. In addition characters are masked if they show very little or no variation within the sample.

2. Calculation of similarity coefficient, principal components etc.

At an early stage in the running of the CLUSTAN package, the user is able to opt for calculation of product-moment correlations and principal components with eigenvectors. These are calculated before the masking operation is executed, so, when used, the entire set of unwanted data must be eliminated using an amended format specification. In the present problem, the principal components option was only occasionally selected, and product-moment correlations not at all.

As a preliminary to the calculation of similarity coefficients, the CLUSTAN package has a subroutine for standardisation of data; this is necessary and was used in all analyses.

The CLUSTAN package has 40 different options of similarity coefficients. In order to maintain a degree of objectivity it is unacceptable to select one or other of these according to the results it produces. The trial of more than one option may lead to the choice being influenced by the correspondence of results with some subjective opinion. Therefore, squared Euclidean distance was chosen for similarity coefficient calculation because:

a. it is the default option in the CLUSTAN package;
b. it is recommended on general grounds in the literature;

c. it is *a priori* conceptually simple and attractive..

3. Execution of clustering algorithm.

The CLUSTAN package offers 8 modes of clustering, and the considerations stated above with regard to choice of option apply here too. Ward's method was selected because of general recommendations in the literature. Note that there is no default option in the package.

4. Output of results.

The CLUSTAN package allows great flexibility in the format of the print-out, and options are chosen simply on consideration of information required and economy of paper. In the present series of analyses, output was chosen with the following format:

1. Program title and listing of procedures and options chosen.
2. Listing of results of each clustering iteration.
3. Dendrogram.
4. Means and standard deviations of all variables.
5. Listing of raw numeric data.
6. Minima and maxima of all variables.
7. Listing of standardised data.
8. Principal components etc. (More details in Section 3.1.3.4.)
9. First 10 nearest neighbours to each specimen.
10. Cluster diagnoses of all clusters generated in the last 8 clustering steps. The diagnosis for each cluster comprises:
    a. list of specimens included,
    b. means of each variable over specimens in that cluster,
    c. standard deviations of each variable,

d. F-ratio of each variable,

e. T value of each variable.

The F-ratio is the ratio of the variance of the variable within a cluster to the variance of that variable over the whole sample. It is a measure of the tightness of the cluster.

The T value is the difference between the within-cluster mean and the overall mean of a variable, divided by its overall standard deviation. It is a measure of the displacement of the cluster from the sample centroid.

An example of the typical program input and output is included in the Appendix.

3.1.4.6. General Interpretation and Compilation of Results.

As a result of computation carried out as described above, we can derive a series of dendrograms for each stratigraphic division. This information must be interpreted and synthesized to determine and define the various morphospecies present in each interval.

It was noted in Section 3.1.3.5. that, although dendrograms may be partitioned subject to certain criteria by phenon lines at various levels, the rank with the highest objective significance is the one resulting from a phenon line drawn at the highest similarity coefficient. This is therefore the lowest rank and, in the present case, this is best equated with the morphospecific category; to use "morphospecies" as a higher rank would imply the presence of "submorphospecies", and this would be unnecessary and confusing. The recognition of ranks higher than morphospecies is best done using data from the entire ontogeny of a morphospecies, so all other phenon lines are not used here.

In practice, the application of the various criteria for the recognition of the best position for the phenon line at morphospecific rank is impossible without compromise and uncertainty. Consequently, it is a potential source of undesirable subjectivity - the choice of phenon line may be influenced by a predisposition towards "splitting" or "lumping" individuals in certain faunas. This can be overcome by adopting a phenon line at a fixed similarity coefficient in every case.

This in turn invokes a problem. A dendrogram is derived from standardised data which are calculated using variances within a sample, therefore a phenon line at a certain similarity coefficient in one dendrogram is not exactly phenetically analogous with the same phenon line drawn on a dendrogram derived from a different sample. Conversely, if there is a true, consistent phenetic status of morphospecies, these would inevitably be distinguished at a different similarity coefficient in each case. There is, moreover, no _a priori_ basis for any kind of phenetic consistency of morphospecific homogeneity between genera, species or even different ontogenetic stages in one population, given the limited character set available in fossil material. For example, given a population of two morphospecies, there need be no relationship between the similarity coefficient at which a mature sample is ideally split, and that which splits a sample of young individuals; not only the variances of the data would differ, but also the characters which contribute most to any differentiation, and the degree to which they do so.

There is no entirely satisfactory means of dealing with this complexity. It is considered best here to adopt an objective approach whilst recognising that the criteria cited in Section 3.1.3.5. are, in principle, sound. This is done by using in every case a phenon line at a fixed coefficient decided by a consensus of estimations, based on the results of applying these criteria to all analyses. Phenon lines were selected using these criteria on all 56 dendrograms described in Section 4.1: it was found that these have a mean value of similarity coefficient of 2.94 (standard deviation = 0.95). Consequently, a phenon line at similarity coefficient = 3.0 was constructed on all dendrograms to differentiate morphospecies at each size range.

It then remains to identify sets of clusters resulting from analyses of different size intervals from the same stratigraphic division which represent the same morphospecies. This requires knowledge of the ontogenetic trend of each variable in each morphospecies. This was found by careful measurement of different ontogenetic stages on more complete specimens, data from which can be plotted in the form of segments of ontogenetic curves for each variable. Ontogenetic series of clusters were then established as follows:

1. Principal components plots were produced for each stratigraphic interval using data from specimens of all ontogenetic stages. Members of each ontogenetically restricted cluster were then isolated on the plot, and cluster centroids in this principal component space were

calculated. Ontogenetic series connecting centroids were then tentatively constructed so that: a) each ontogeny proceeded in a general direction in P.C. space with eigenvectors corresponding to the known ontogenetic trends established as above; b) the restraints noted in Section 3.1.2.4. were observed.

2. For each postulated morphospecies, cluster means of each variable were plotted and interpolated as ontogenetic curves, and these were checked for compatability with known ontogenetic segments of cluster members. Interpolation was done using straight line segments between cluster means.

In practice, ontogenetic series of clusters are often obvious, when considering the principal components plots or the output cluster diagnoses. Where ambiguous, the evidence is discussed in Section 4.1.

At this point the original aim of developing a method of distinguishing and defining morphospecies has been achieved, and the results of its application are given in Chapter 4. The precise nature of these morphospecies requires further interpretation, but evidence pertinent to this is derived from interspecific comparisons, discussed in Section 4.2., and from the detailed results.

3.2. RECOGNITION OF HIGHER TAXA

Having established taxa of the lowest rank, usually called species, the palaeontologist next seeks to aggregate taxa into successively higher ranks, for example genera and families. This is done partly out of the necessity to conform to international nomenclatural regulations (Stoll et. al., 1961) but there is also the hope that the erection of such higher taxa reflects genuine genetic structure. In either case, the process is fraught with difficulties, and higher taxa are notoriously unstable in palaeontology.

3.2.1. PROBLEMS

The ultimate problem in identifying higher taxa is philosophical: even at best such taxa are inevitably artificial constructs. It has been noted above (Section 3.1.1.) that, although a strict biological species definition exists, it is totally inapplicable in palaeontology; in higher taxa the problem is more acute in that there is no strict definition even in biology. This, however, has one fortunate consequence - palaeontologists need not aspire to emulating biological accuracy in inferring the real genetic relationship. Nevertheless, rigid and clearly defined criteria should be used so that a taxonomic structure does have some meaning.

In addition to theoretical difficulties, palaeontologists working with Carboniferous goniatites have considerable practical problems. Prominent among these is the need to assimilate evidence from all characters of the shell at all growth stages. Quantity of information present on specimens was cited as a problem in detecting morpho-species; when considering higher taxa the problem is magnified. Particularly critical are the relationships between sutural and external features, and between early and late growth stages. Several different approaches have been used in attempting to solve these problems.

3.2.2. SOLUTIONS

There are two main types of attitude to the problem of erecting higher taxa: the phenetic and cladistic approaches. These two overlap somewhat, in that it is necessary to use phenetic evidence in deducing cladistic affinity. In addition, it is often difficult to discover which approach an author has used - authors rarely specify this.

3.2.2.1. The Phenetic Approach

This, in its broadest sense, covers all attempts at classification based solely on the character states of the organisms under consideration. Evidence and inferences about phylogeny are ignored. Pure phenetics is rarely done; it is undoubtably normally corrupted as authors assume, without proper justification, that some aspects of phenetic similarity are indications of common ancestry. Nevertheless, it is clear that all phenetic studies of Upper Carboniferous goniatites in the past have been consistent in using monothetic rather than polythetic criteria.

A. Monothetic Phenetics. The consistency with which monothetic criteria are used in defining higher taxa in goniatites is so impressive that one is lead to regard it as an unwritten law. For example, Gordon (1964) distinguishes the "subgenus" Lissogastrioceras only on the basis of lack of sculpture over the venter, and Ruzhentsev and Bogoslovskaya (1978) only separate Bashkortoceras from Homoceras on the basis of presence of intra-ventral ridges.

In general, generic and higher taxonomic definitions in goniatites lay particular emphasis on characters of the suture line and of early growth stages. Other characters are frequently allowed almost limitless variation within the taxon.

It seems likely that this approach was originally conceived as a purely phenetic mode of classification, but that with the historical growth in evolutionary thought, the diagnostic characters common to all members of a taxon came to be regarded as evidence of common ancestry. Hence there may be an historical as well as a conceptual transition from phenetic to cladistic approaches.

Monothetic phenetics is unsatisfactory in defining higher taxa in the same respects as it was in defining morphospecies (see Section 3.1.2.). Any *a priori* monothetism is subjective.

B. Polythetic Phenetics. In this approach, all possible characters must be given equal weight in taxonomic assessment. Clearly, when one deals with comparison between morphospecies, many more characters are available than when comparing individual specimens. This is because: a) data from the entire ontogeny of a morphospecies can be used, whereas this is never entirely possible with one specimen; and b) data from all morphological features can be included; this seldom being possible with individual specimens because of inadequacies of preservation. Data representing a morphospecies can be compounded from any number of specimens belonging to that morphospecies.

Large numbers of characters must be used in this technique, and it is quite obvious that scatter diagrams are hopelessly inadequate, and that multivariate analysis must be used. We therefore regard morphospecies as points ordinated in n-dimensional A-space, where n = no. of characters $\simeq$ 50-100, and use clustering and other techniques to search for structure.

An immediate problem arises in the representation of all members of a morphospecies by one point. This point may be a representative type specimen (the exemplar method), an hypothetical average specimen, or an hypothetical mode specimen. The choice of a type specimen or exemplar has some practical difficulties, and it is seldom truly typical or complete, so this possibility is rejected here. Modes are more appropriate with binary data, but the graphical representation of morphospecies as a series of ontogenetic curves is ideal for translation into an hypothetical average specimen. The curves resulting from the compilation of results described in Section 3.1.4. are already averaged, being derived from cluster means, so a numerical representation of a morphospecies can be got simply by digitising these curves.

Note that this technique can be applied to species described in the literature by careful data collection from figured specimens, as well as to phenetically generated morphospecies.

Polythetic phenetic approaches are frequently criticised for failing to take account of convergence and parallelism in evolution. However, if convergence or parallelism affects all characters, then it is impossible to recognise it as such; there must be some suite of characters present which indicate separate ancestry of two species for parallelism or convergence between them to be proven. The component of resemblance due to common ancestry has been called patristic similarity (Cain & Harrison, 1960); resemblance due to convergence or parallelism is referred to as homoplastic similarity (Simpson, 1961). Both types of similarity are picked up by polythetic phenetic approaches, but if the character set is complete, it is postulated (Sneath & Sokal, 1973, pp. 32-33) that homoplastic similarity will be insignificant relative to the patristic component. Unfortunately, in the fossil record it is impossible to arrive at a complete phenetic description of the organism, and it is quite feasible that, in the only surviving structure, the shell, homoplastic similarity may indeed be dominant. This is further discussed in the section on cladistic methods.

Multivariate analysis has been applied to taxonomic problems in palaeontology in the past (eg. Temple and Tripp, 1979) but not to goniatites. It is adopted in this study despite the difficulties mentioned above because of the need for objectivity.

3.2.2.2. The Cladistic Approach

In cladistics, higher taxa are classified according to common ancestry inferred from patristic characters, regardless of overall phenetic similarity. It is desired that taxa should be monophyletic.

In the sense used here, cladistics incorporates phylogenetics, the latter being an application of the former to the special case of taxa which are not contemporary in time.

In studies of Upper Carboniferous goniatites, a cladistic approach seems to have developed from and compatibly with monothetic phenetic schemes, as noted above. It is only when authors specifically mention or illustrate phylogenetic inferences that it becomes obvious that the taxonomy is cladistically based. An example of the use of this approach is by Ruzhentsev & Bogoslovskaya (1971) who cite three trends in taxonomy - principleless, typological and phylogenetic. The "typological" trend is similar in concept to the phenetic approach: "following the path of extrahistorical examination of the facts" (R & B op. cit., p. 119) but Ruzhentsev & Bogoslovskaya make it clear that they follow the phylogenetic approach, and state "obviously, the future progress of palaeontology is connected with the phylogenetic trend in taxonomy". Figure 10 shows that their concept of all Carboniferous goniatite families and superfamilies is cladistically based. In addition, Ruzhentsev & Bogoslovskaya describe "typological morphology" as an obstacle to taxonomy, and are careful, for example, to separate species of Ramosites from the similar genus Homoceratoides on the basis of descent from a different stock.

An admirable critique of the fundamental problems involved in cladistic analysis is given by Sneath and Sokal (1973, Section 2.5.). However, cladistic work in the present field has not been done with sufficient operational precision to deserve such logical scrutiny. Criticism need

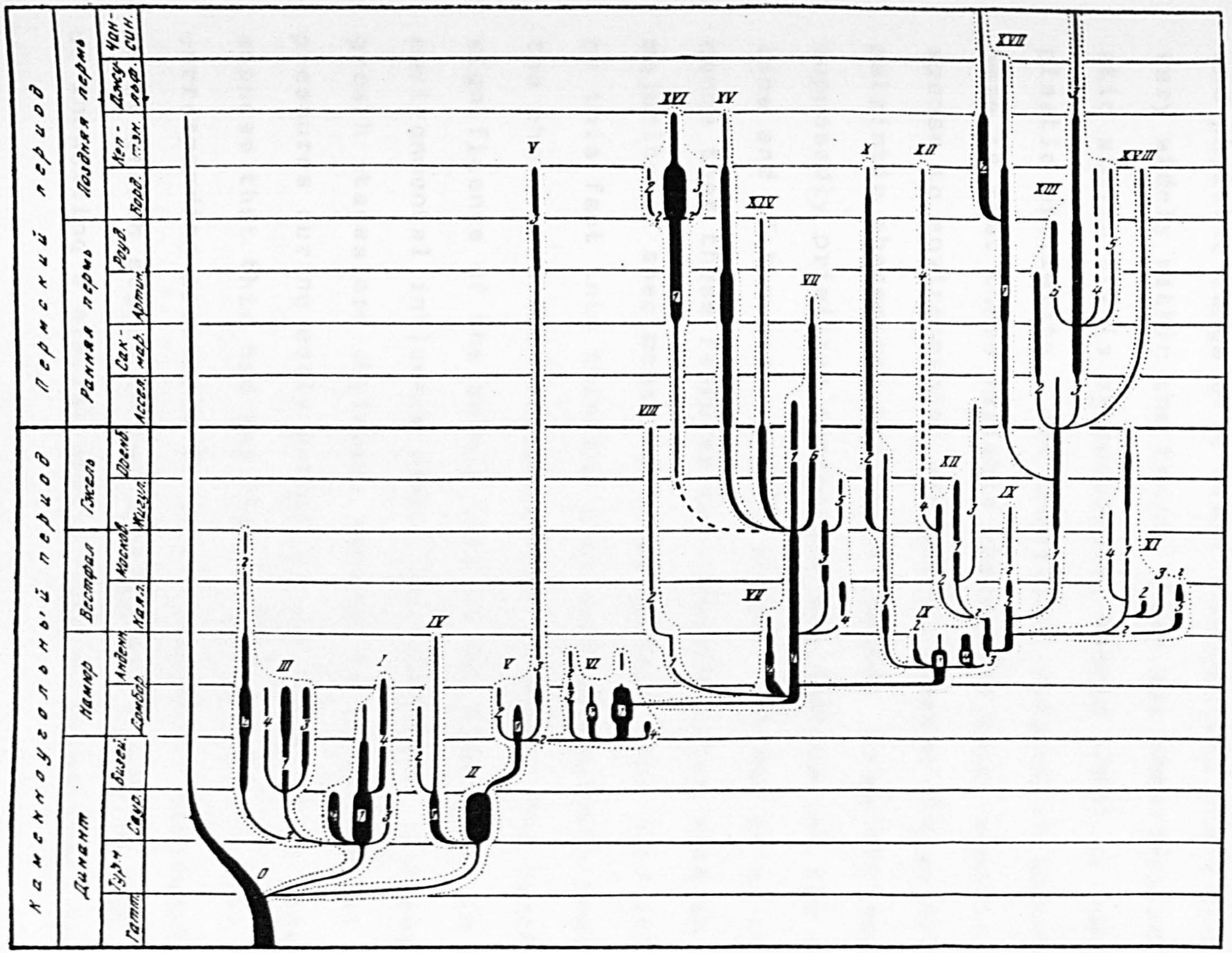


Рис. 2. Филогенетическая схема подотряда Goniatitina

O — подотряд Tornoceratina;
I — надсем. Muensterocerataceae:
1 — Muensteroceratidae,
2 — Intoceratidae,
3 — Kozhimitidae,
4 — Anthracoceratidae;
II — надсем. Pericyclaceae;
Pericyclidae;
III — надсем. Dimorphocerataceae:
1 — Girtyoceratidae,
2 — Dimorphoceratidae,
3 — Eogonioloboceratidae,
4 — Berkhoceratidae;
IV — надсем. Nomismocerataceae:
1 — Nomismoceratidae,
2 — Entogonitidae,
V — надсем. Goniatitaceae:
1 — Goniatitidae,
2 — Delepinoceratidae,
3 — Agathiceratidae;
VI — надсем. Neoglyphiocerataceae:
1 — Cravenoceratidae;
2 — Neoglyphioceratidae,
3 — Rhymmoceratidae,
4 — Ferganoceratidae;
VII — надсем. Somoholitaceae:
1 — Glaphyritidae,
2 — Stenoglaphyritidae,
3 — Pseudoparalegoceratidae,
4 — Clistoceratidae,
5 — Dunbaritidae,
6 — Somoholitidae;
VIII — надсем. Neodimorphocerataceae:
1 — Ramositidae,
2 — Neodimorphoceratidae;
IX — надсем. Gastriocerataceae:
1 — Homoceratidae,
2 — Decoritidae,
3 — Surenitidae,
4 — Reticuloceratidae,
5 — Gastrioceratidae;
X — надсем. Thalassocerataceae:
1 — Bisatoceratidae,
2 — Thalassoceratidae;
XI — надсем. Schistocerataceae:
1 — Schistoceratidae,
2 — Axinolobidae,
3 — Christioceratidae,
4 — Welleritidae,
5 — Orulganitidae;
XII — надсем. Gonioloboceratacеae;
1 — Wiedeyoceratidae,
2 — Gonioglyphioceratidae,
3 — Gonioloboceratidae,
4 — Yinoceratidae;
XIII — надсем. Neoicocerataceae:
1 — Neoicoceratidae,
2 — Metalegoceratidae,
3 — Paragastrioceratidae,
4 — Atsabitidae,
5 — Eothinitidae,
6 — Spirolegoceratidae;
XIV — надсем. Shumarditaceae;
Shumarditidae;
XV — надсем. Marathonitaceae;
Marathonitidae;
XVI — надсем. Adrianitaceae:
1 — Adrianitidae,
2 — Hoffmanniidae,
3 — Clinolobidae;
XVII — надсем. Cyclolobaceae:
1 — Vidrioceratidae,
2 — Cyclolobidae;
XVIII — надсем. Popanocerataceae;
Popanoceratidae.

FIGURE 10. Ruzhentsev & Bogoslovskaya's phylogenetic scheme for Carboniferous goniatites (Ruzhentsev & Bogoslovskaya, 1978, fig. 2). All families are either monophyletic or paraphyletic.

only be levelled here at the subjectivity underlying reconstructions of Carboniferous goniatite phylogeny. Subjectivity is manifested both in the choice of characters deemed to be of phylogenetic importance and in the actual application of these characters.

The chosen characters used to distinguish cladistic phyla are those which are supposedly primitive and patristic (the "symplesiomorphic" of Hennig, 1966). This implies that they do not vary markedly within the phenetic and phyletic range of a taxon. Meanwhile, other characters vary widely within the taxon; these may show derived patristic similarity (= synapomorphy, Hennig 1966) or homoplastic similarity. The underlying subjective assumption here is that these variable characters show sensitive response to environmental pressures, whereas the primitive patristic characters are not affected. Prominent among supposedly primitive characters are features of the suture line and of the early growth stages. It may be no coincidence that these features are concealed from view in a majority of specimens - perhaps authors have been influenced by this fact into thinking that such concealment insulated the characters from environmental effects. The functional significance of the suture line is not known, so, in fact, environmental influence cannot be ruled out. The early growth stages are obviously exposed to environmental pressures during early ontogeny, and there is no reason to suppose that this had any less selective effect than the corresponding pressures in later ontogeny. Similarity of early growth stages in two species may simply be the result of inhabiting a similar environment in early life; the dominant use of the term "homeomorphy" with regard to the late growth stages may not reflect the true situation.

Subjectivity is also prominent in the application of these supposedly primitive patristic characters to cladistic analysis. Workers compare, for example, suture lines by eye, and no numerical estimation of resemblance is made. Without such a measure, the real amount of variation present in such features cannot be defined and may be more than imagined. The criterion for recognising primitive patristic characters is therefore unsoundly based.

Despite these criticisms of method, it is nevertheless possible that workers using a cladistic approach might produce results passably close to the truth. But the nature of the evidence is such that one can never be sure of the truth, and any phylogenetic scheme is unstable given the addition of new information. This is an undesirable property of a taxonomic system, and so it is proposed here to use stable, high confidence phenetic relationships as a basis for taxonomy, and to treat phylogenetic speculations independantly.

3.2.3. CLUSTER ANALYSIS APPLIED TO RECOGNITION OF HIGHER TAXA

The theory of cluster analysis as described in Section 3.1.3. applies equally here, but the application of the method needed here differs from the application discussed in Section 3.1.4. The format of the operation is essentially the same, though, and the same type of decisions need to be made.

3.2.3.1. Choice of Unit

The OTU in the present search for higher taxa is the unit of lowest taxonomic rank: the morphospecies. For reasons given in Section 3.2.2.1., morphospecies are represented by hypothetical average specimens, derived from digitised ontogenetic curves. The OTUs included here are either those defined by cluster analysis in this study, or are "species" described with adequate data in the literature. We are interested in studying their distribution in A-space using Q-mode analysis.

3.2.3.2. Choice of Characters

The information used to define a morphospecies must be derived from the information content of constituent individuals. Therefore, the same characters can be used as were listed in Table 4. As the data needed is compiled from many specimens, it is possible and necessary to maximise the information recorded about any morphospecies by a) incorporating characters only preserved infrequently, and b) using data from all ontogenetic stages. The incorporation of infrequently preserved characters, for example those of the suture line in some morphospecies, involves the risk that the few measured values are unrepresentative, but it is thought that the advantages compensate for this source of error. The use of data from all ontogenetic stages can be done by digitising the ontogenetic curves for each character. This is possible in two ways:

A. Description by parameters. Raup (1967), Kullman & Scheuch (1970), Kant & Kullman (1978) and others all derive parameters of geometric shell growth from ammonoids.

Raup explores the distribution of cephalopod shell forms with respect to three underlying geometric parameters: whorl expansion rate, distance of whorl from axis, and whorl translation. Raup deals only with genera, and ammonoids showing clear ontogenetic change in geometry were eliminated. Both Kullman & Scheuch and Kant & Kullman studied individual species and in greater detail. Working from equations for the logarithmic spiral, these authors identify characteristic gradients on bivariate plots of various shell dimensions using double logarithmic scale. For example, Kullman & Scheuch (*op. cit.*) are able to distinguish two species of *Schartymites* on the gradients and inter sections of lines resulting from plots of log rd *vs* log Wb, where rd is the umbilical radius and Wb is the whorl width. Three linear phases of allometric growth are recognised for each species; these are summarised here:

	Ontogenetic stages ⟶					
	1		2		3	
	α	β	α	β	α	β
S. ozarkensis	.5	1.0	.62	.426	.88	.264
S. barnettensis	.31	.862	.48	.39	.12	.986

where $rd = \alpha Wb^{\beta}$

The parameter β is the allometry constant and gives the gradient; α is the integration constant and gives the intersection with the axes. Apart from being able to distinguish the values of these parameters in different species, the authors also discovered interesting permutations in the relationship between α and β. In *Balvia sphaeroidalis*, for example, β is constant but α has five different values during separate phases of ontogeny. Also, Kant & Kullman (1978) use bivariate plots of values of β at two growth stages to distinguish geographical variants of _Goniatites choctawensis_ and _Perrinites hilli_.

It is feasible, then, for the geometry of the shells to be described in terms of such parameters, and the ontogenetic curves of shell dimensions produced by the methods described in Section 3.1.4., should be expressable in this form. However, the following objections can be made:

a. It is not so easy to express the ontogenetic curves of other characters in this form. Features of the ornament, for example, are not subject to any geometrical constraint. These, therefore, would have to be digitised in some other form, and it would consequently be difficult to be sure of attaining parity between different characters. One possibility might be to use polynomial regression to derive parameters, similar to the method used by Rogers (1982) in defining the shape of bivalves.

b. Any parameters derived from ontogenetic curves have an uncertain relationship with the phenotype. Two subtly different curves might be described by vastly different parameters, and conversely two widely separated curves might have certain parameters in common, even though the absolute values of the character are at all stages totally dissimilar. It might be argued that any parametric similarity represents a genuine genetic similarity, but this involves an assumption that is not compatible with the phenetic approach adopted here.

c. The derivation of growth parameters is an undue complication. The uncertain meaning of the results do not justify the necessary time, effort and conceptual complexity. Also, the process would be an additional source of inaccuracy and error, and any imprecision in deriving parametric values would be more serious than in absolute values.

B. Description by absolute values. Ontogenetic curves can be much more obviously described by listing character values at a representative set of ontogenetic stages. This has the overwhelming advantage of operational and conceptual simplicity, and allows analysis to proceed as a natural progression from the results of Section 3.1.4. above. The one problem here is to determine the ideal ontogenetic interval at which character values should be recorded. This involves a compromise between two desiderata: a) curve description should be as complete as possible; and b) character values should be logically independent to avoid duplication of information. Although two closely adjacent growth increments are in principle totally independent, in practice it is evident that the closer two points on an ontogenetic curve, the greater the interdependence. The closeness of the digitised increments should be proportional to the general rate of change of the characters. This is greater in earlier growth stages, but it is unfortunately in these stages that knowledge and accuracy are least. All things considered, the growth stages chosen for this study, in mm shell diameter, were:

2.5, 5, 7.5, 10, 12.5, 15, 20, 25, 30, 35, 40, 50, 60.

Inadmissable Characters

Where characters are unknown or uncodable in a morphospecies, either those characters are masked from the calculation, or that morphospecies is excluded. It is necessary to determine the taxonomic position of all morphospecies, so normally many of the extensive suite of possible characters are masked. Particularly prone to elimination from analysis for this reason are characters of both large and very small growth stages. Also, characters of the suture line are masked from some analyses because these show excessive intraspecific variation with respect to total sample variation. This is shown to be an empirical fact by the observation that left and right halves of the suture line of one specimen can be phenetically distant (see Figure 11).

Errors

The only errors additional to those discussed in Section 3.1.4. are those involved in the estimation of an ontogenetic curve as described in Section 3.1.4.6. Errors in interpolation are slight, but errors in extrapolation beyond the limits of the known information may be sizeable. Extrapolation is justified as being, in some cases, the only way of achieving a reasonably complete data set for a morphospecies, and it is done objectively, up to less than 5mm.

In multivariate analysis, the approach to a correct phenetic result occurs asymptotically as the number of characters used increases towards the state of complete phenetic representation of an OTU. The large number of characters used in the present set of analyses means that the asymptote is approached and that, as a consequence, the result is stable with addition of characters and is also little affected by non-systematic errors. Basically, the effect is of a high proportion of accurate data domina-

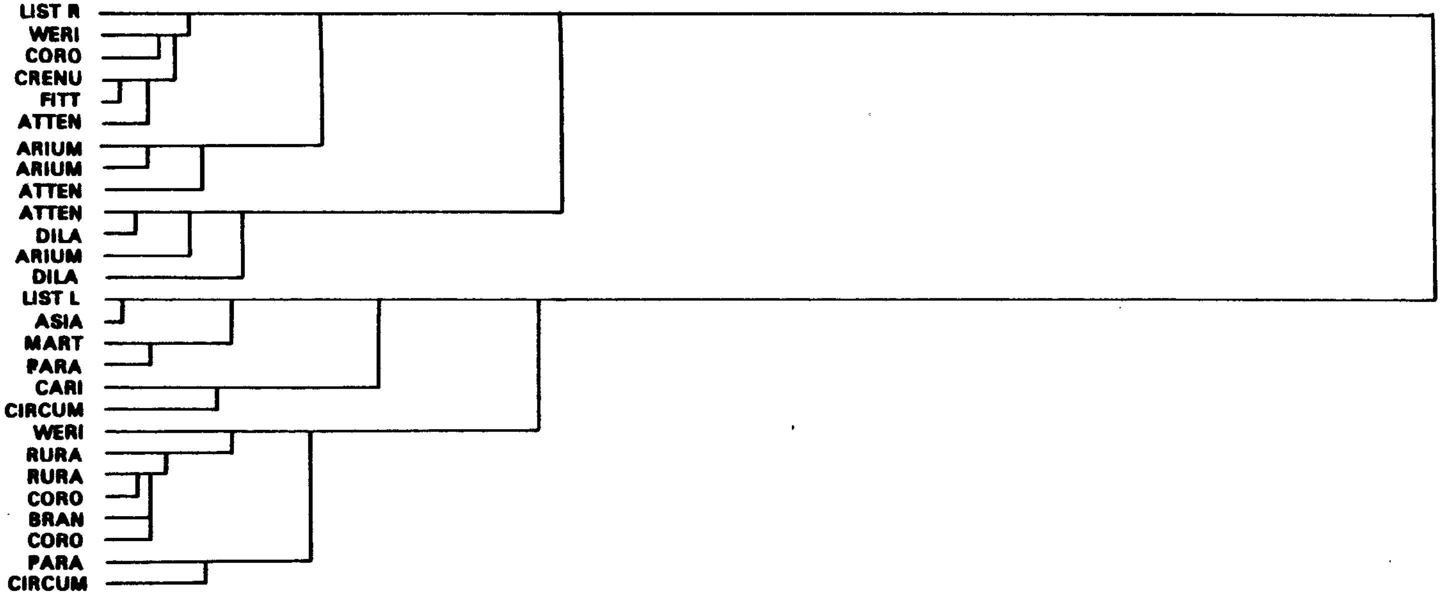


FIGURE 11. Comparison of *Gastrioceras s.l.* specimens on the basis of sutural characters only. The left and right sides of one specimen (LIST L and LIST R) suggest contradictory relationships - sutural data is, therefore, not always reliable.

ting randomising errors.

3.2.3.3. Choice of Sample for Analysis

All samples incorporate statistically defined morphospecies plus foreign "species", as described in the literature. These have been divided into four samples for analysis:

1. All morphospecies with particularly complete data sets - analysed with respect to as many characters as possible, including sutures.
2. All Homoceratidae s.l. plus <u>Homoceratoides</u>
3. All Reticuloceratidae s.l.
4. All Gastrioceratidae s.l.

2,3&4 - Analysed with respect only to characters variable within the sample. Sutural data excluded.

This division allows the consideration of the maximum possible number of morphospecies whilst ensuring the use of as many characters as possible.

3.2.3.4. Computation

The CLUSTAN 1C package was used for the present series of analyses, and computation proceeded as in the morphospecific determination (Section 3.1.4.) but with the following choices of options:

Data Input Format

The data are stored on disc on four files, corresponding to the four samples listed above. The data for each morphospecies are in the following format:

1. name or code name of morphospecies;
2. matrix of all character values - one row per growth stage, one column per character. Each value in

format F2.0, F3.0, F4.0, or F5.0 with up to 3 decimal places.

The data is read as specified by a Fortran format statement, and using this the name and any unwanted character values are eliminated from the calculation.

Calculation of Similarity Coefficient, Principal Components etc.

The option in the CLUSTAN 1C package which calculates principal components, eigenvectors, eigenvalues and factor scores was selected in all the analyses considered here. This is because of the importance of spatial distribution in interpreting clusters of morphospecies.

The similarity coefficient chosen was squared Euclidean distance, for the reasons listed in Section 3.1.4., and this was applied to standardised data.

Execution of Clustering Algorithm

Ward's method was selected for the clustering algorithm, for identical reasons to those which applied to the search for morphospecies.

Output of Results

The following printout format was chosen:

1. program title with listing of procedures and selected options;
2. results of each clustering iteration;
3. list of morphospecies labels;
4. dendrogram with branches labelled;
5. means and standard deviations of all variables;
6. list of n eigenvalues, with percentage and cumulative variance of each;

7. list of n eigenvectors, ie. components in all n dimensions;
8. first 5 factor scores of each morphospecies - the co-ordinates of the ordination in the first 5 principal components;
9. first 8 nearest neighbours to each morphospecies.

3.2.3.5. General Interpretation of Results

The results of these analyses are expressable as dendrograms and as principal components plots. These two graphical techniques show different aspects of the same relationships, and it is important to consider the attributes of both.

Firstly, it is necessary to determine the taxonomic rank signified by phenon lines drawn on the dendrogram at various levels. The criteria for choosing the value of the similarity coefficient at which significant phenon lines are best drawn are given in Section 3.1.3. The principle that the lowest rank of all significant divisions is the most objective applies here, and it is clearly desirable that this level should correspond to generic rank. In addition, this set of analyses also presents the best evidence for classification at the rank of family, but this involves a degree of subjectivity - it becomes more difficult to assess the relative merits of different phenon lines higher in the hierarchy.

Note that only four analyses are required here, and that this number is insufficient to justify any "consensus" as to an objective choice of a phenon line, as was found to be appropriate for morphospecific recognition in Section 3.1.4. Also, principal components plots give an interesting perspective to the taxa resulting from phenon lines drawn on the dendrogram. Taxa cannot be objectively defined using such ordination, but the spatial distribution thus shown can supply evidence pertaining to the significance of taxa differentiated on the basis of the dendrogram. There is justification, then, in carefully considering the merits of each individual case in placing generic phenon lines. These are discussed in the relevant sections of Chapter 4.

3.3. PHYLOGENETIC RECONSTRUCTION

3.3.1. BACKGROUND

Since the advent of Darwin's theory of evolution, palaeontologists have frequently sought to establish lineages of ancestry in the fossil record. The rapid changes with time in Silesian goniatite faunas are apparently an ideal source of evidence for evolutionary progression, and many authors (see Chapter 2) have been tempted into devising phylogenies. Earlier attempts simply sought to establish the origin of accepted taxa, but Ruzhentsev & Bogoslovskaya (1971 & 1978) specifically state that their taxa are based on phylogenetic inferences. The problems associated with the phylogenetic approach, as practised by Ruzhentsev and Bogoslovskaya, have been fully discussed in Section 3.2.2.2. The most important conclusions of that discussion which are relevant here are:

1. It is difficult to ascertain which characters are genuinely primitive and patristic, and this may frequently be done with undesirable subjectivity.
2. It is impossible to be sure about details of ancestry in the fossil record, and therefore phylogenetic theories are unstable. Consequently, phylogeny is better regarded as theoretically irrelevant to systematic studies. This is a particularly pertinent point in the British Silesian, where a complete phylogenetic record may be unobtainable due to periods of non-preservation of faunas.

For these reasons a different approach needs to be developed here, and the numerical methodology described in Sections 3.1.4. and 3.2.3. provides a suitable framework for this.

3.3.2. POLYTHETIC PHENETICS APPLIED TO PHYLOGENETIC RECONSTRUCTION

The rejection of subjective assumptions about the primitiveness of certain characters forces a polythetic phenetic approach, in which all characters are initially regarded as equally important. This, in effect, means that the best evidence for a phylogenetic relationship is overall similarity, providing of course that the relationship is feasible chronologically. Expressed another way, we can postulate that, of all possible candidates for direct descent or ascent from a species, the most likely is the one with the greatest overall similarity to that species.

This concept has quite a clear representation in numerical analyses of the type described in Section 3.2.3. - phylogenetic relationships must be suggested by closeness of morphospecies in A-space. An hierarchical analysis is not appropriate here; it is only the morphospecies, and not higher levels of the taxonomic hierarchy, upon which the processes of evolution act. Of the greatest importance here are the nearest neighbours in A-space of each morphospecies. The best means of illustrating nearest neighbour relationships in a non-hierarchical manner is by linkage of points on a principal components plot, using the nearest neighbour algorithm (see Table 3). This results in the formation of a minimum spanning tree, in which each point is linked directly or indirectly with every other point using the least possible arc length. This plot is easily constructed using output from the CLUSTAN 1C package.

One fortunate consequence of this approach is that, although phylogenetic analysis has been kept fundamentally separate from systematic considerations, similar phenetic, numerical methodologies have been used for both aspects, and so it can be expected that the results will be interrelated. Indeed, the only difference between the two types of analysis is that, for purely systematic work, morphospecies are agglomerated into distinct clusters, whereas in these phylogenetic studies the emphasis is rather on interlinking morphospecies.

3.3.3. AN ALGORITHM FOR PHYLOGENETIC RECONSTRUCTION

It was noted in Section 3.2.2.1. that parallelism and convergence are potential problems when using polythetic phenetics to distinguish higher taxa, and it is similarly a complication here. In the absence of overall parallelism or convergence, a minimum spanning tree superimposed on a principal components plot, as described above, would be a perfect phylogenetic diagram, requiring only an indication of time directionality. However, in practice, it is found that there are some relationships indicated by links between morphospecies which are impossible due to age relationships. Examples of plausible and implausible relationships are shown in Figure 12. It is normally necessary, then, for phylogenetic diagrams to depart from the topology of the minimum spanning tree. The following criteria must be observed when inferring phylogenetic links:

1. Wherever a "nearest neighbour" link is plausible, as exemplified in Figure 12, that link represents the most probable phylogenetic connection.
2. Wherever a "nearest neighbour" link is implausible as a phylogenetic connection, some degree of convergence must have occurred.

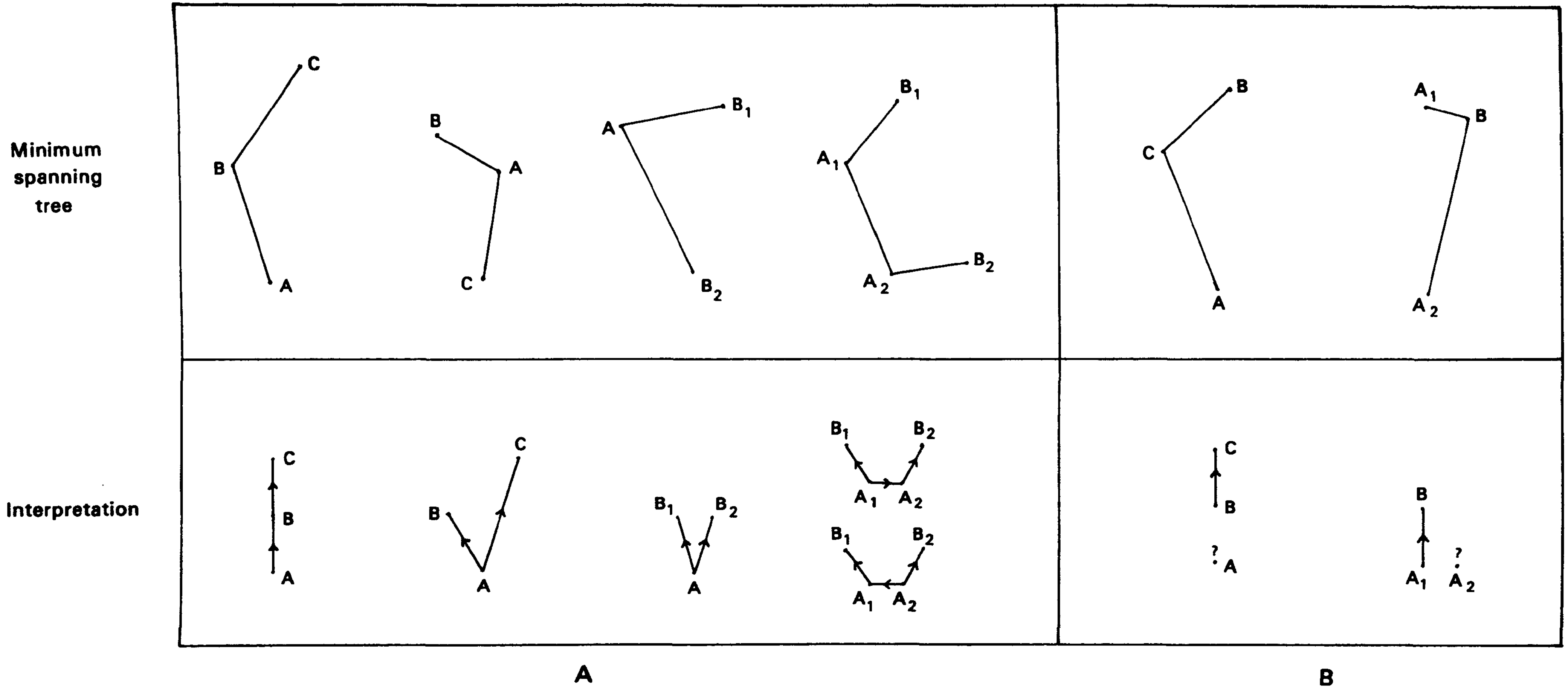


FIGURE 12. Relationship between minimum spanning trees and phylogeny. A_1, A_2 are different forms from the same stratigraphic level; A, B, C are successive levels.

A: Minimum spanning tree represents a plausible phylogeny.

B: Suggested phylogeny is implausible.

3. An implausible link must be replaced by a link to the next-nearest neighbour to arrive at the most probable phylogenetic connection.
4. Where "nearest neighbours" are widely separated in time, convergence or parallelism must be suspected. The larger the time gap, the more one should expect evidence of a genuine phylogenetic intermediate, if there were one.

Each link of the minimum spanning tree is tested and, if necessary, replaced, using these criteria until a feasible, complete and objective phylogenetic tree arises. Results of this process applied to the principal components plots shown in Chapter 4 are illustrated and discussed in Chapter 6.

3.4. IDENTIFICATION OF NEW SPECIMENS

3.4.1. BACKGROUND

In traditional palaeontology, the process of identification is much akin to the process of erecting species, and suffers from the same problems when applied to Silesian goniatites (see Section 3.1.1.). A somewhat more modern approach in palaeontology is the use of dichotomous keys, which apply a series of monothetic tests. These may be readily adapted for efficient interactive use on a computer terminal.

The criticisms of monothetic methods cited in Section 3.1.2. do not apply here, as identification only proceeds after species have been discriminated, and so monothetic criteria may have been found objectively and without *a priori* assumptions. However, monothetic methods of determination cannot be applied here because: a/ it is found that very few characters are reliably different between many pairs of goniatite morphospecies; b/ very few characters are passably constant within morphospecies; and c/ different monothetic criteria would need to be applied to different growth stages, and even different preservations, which would require a chronic increase in complexity of any dichotomous key. Once again, then, it is necessary to employ a polythetic methodology.

3.4.2. POLYTHETIC PHENETIC IDENTIFICATION

We seek, then, to establish which existing morphospecies has the greatest overall similarity with a new specimen. This is readily done in the format of the present study by numerical comparison of data from the new specimen with data from the matrices of character values of all the possible candidate morphospecies. The procedure is as follows:

1. As many characters are assessed on the specimen as possible, although normally at just one diameter.
2. This data from the new specimen is included in a data file together with data matrices for all candidate morphospecies (preferably all morphospecies from the appropriate family).
3. The data matrices are edited to eliminate all character values except those corresponding to those assessed on the new specimen.
4. The new specimen is analysed in comparison with the "standard" data using the CLUSTAN 1C package, specifying the same options as used in Sections 3.1.4.5. and 3.2.3.4.
5. The probable specific and generic identification of the specimen is suggested by its position on the dendrogram, and by its listed nearest neighbours.

Note that any number of specimens can be determined simultaneously, as long as each specimen possesses the same data set.

If a specimen is closely linked with a "standard" (see Figure 13a), then identification is unambiguous and a high probability can be attached. If the dendrogram shows a number of species as equal candidates (Figure 13b), then several possibilities exist:

1. The specimen may belong to a new morphospecies, although this type of analysis would not constitute sufficient evidence.
2. The data may not be sufficient for specific determination.
3. The specimen may have a peripheral position in the

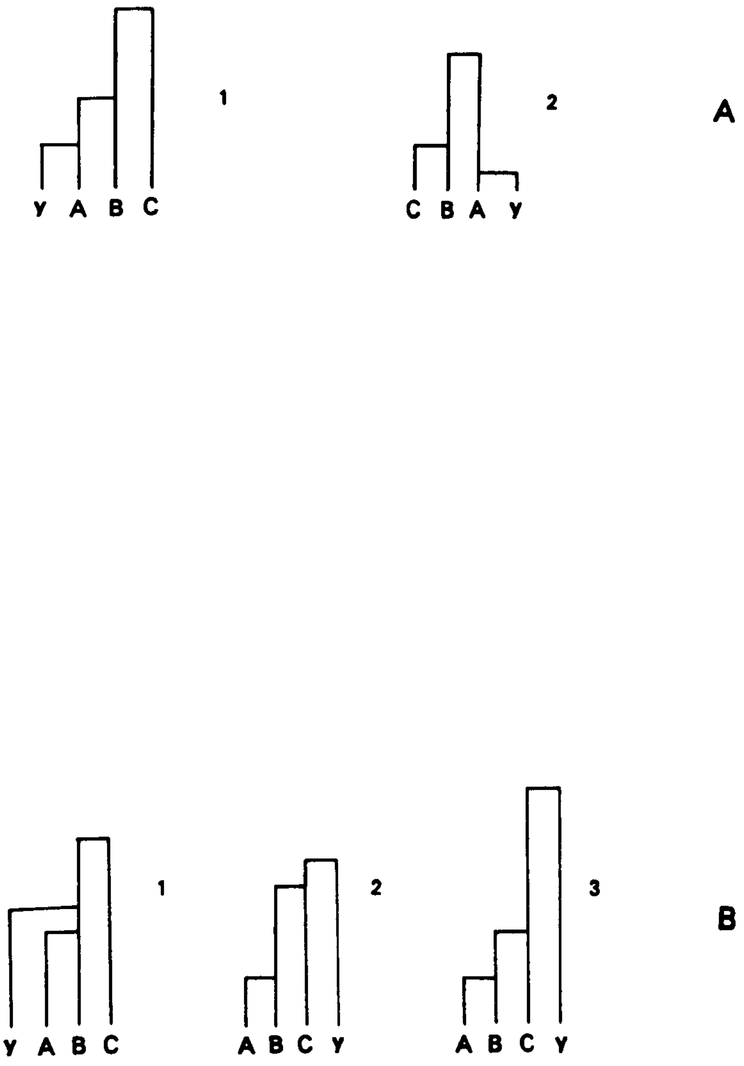


FIGURE 13. Identification of a new specimen (y) using a dendrogram - y is compared to morphospecies A, B & C.

A: Most likely identification is morphospecies A.

B: Identification less certain. In number 3, the evidence suggests that y is probably a new form.

range of variation of one of the morphospecies - probably the nearest neighbour. A principal components plot will reveal this and will indicate if specimens are, for example, intermediate between two "standard" forms.

Unfortunately, ambiguous identifications occur quite often in practice, but even these have the qualities of being objective and informative. Often, only a stratigraphic designation is required, in which case several members of the fauna can be analysed, and the probability of and confidence in a correct determination is increased.

3.4.3. PROBLEMS

A few unsolved problems peculiar to this technique need to be mentioned.

1. Each analysis can only deal with specimens of one size range and with the same set of measured characters. It is not economical to run several analyses of specimens from the same fauna, so it has been found ideal to select for identification only specimens of one size range and with a fairly complete information content. A size of about 15 mm has been found to be best; specimens of this size are both common and sufficiently differentiable into morphospecies.
2. It is desirable and practicable to analyse any number of specimens simultaneously. However, the equations used in the analyses involve the calculation of overall variance, and this will change according to the data included; with many similar specimens in an analysis the variance will change markedly. This has the consequence that a specimen may receive a different identification if analysed independently than if analysed with, say, 20 other specimens from the same fauna. Also, note that linkage and principal components are affected by the number and type

of specimens analysed. An attractive but unattainable scheme would be a "standard" principal components plot, showing positions of all the "standard" morphospecies, upon which could be ordinated the positions of new specimens.

3. This mode of identification does not take into account the variance of each morphospecies - some morphospecies may occupy much larger areas of A-space than others, but this method assumes that all are hyperspherical and with equal radius, and only takes account of distance from morphospecies centroids. Nevertheless, this may be justified in that inequality in the expanse of morphospecies in A-space may simply be the result of arbitrary sampling effects - all morphospecies are potentially equally expansive.

Clearly there is scope for further sophistication in this embryonic technique. Examples of its practical application, mainly to stratigraphic problems, are given in Chapter 7, and from this can be judged some of its merits and drawbacks.

CHAPTER 4

RESULTS OF ANALYSES

Results of analyses described in Sections 3.1.4. and 3.2.3. are given here; results of phylogenetic analyses and the application of the algorithm for identification are illustrated and interpreted in Chapters 6 and 7.

4.1. RECOGNITION OF MORPHOSPECIES

4.1.0. INTRODUCTION

The information used and generated in the process of morphospecific recognition, as described in Section 3.1.4., includes the following:

1. Measured data, used as input, from 1050 specimens of Gastrioceratidae *s.l.*, 620 of Reticuloceratidae *s.l.* and 380 of Homoceratidae *s.l.* plus *Homoceratoides*.
2. Dendrograms for each sample - on average 3-4 ontogenetic stages per fauna.
3. Cluster diagnoses for each cluster.
4. Principal components scores for each specimen in each fauna.
5. Syntheses of analyses in the form of ontogenetic curves (one curve per character per morphospecies), connecting cluster means.
6. Matrices of character values derived from digitising ontogenetic curves - one matrix per morphospecies. Some unanalysed data are measured from specimens and are incorporated in matrices, e.g. data from the suture line.

This quantity of information cannot realistically all be presented here. The basic data, measured from individual specimens, are presented as **Appendices 2-4**. Dendrograms form the basis of morphospecific distinction so it is important to illustrate these. Dendrograms shown in this section were traced from computer printout with, superimposed, the phenon line at similarity coefficient (d) = 3.0 to resolve clusters. It was noted in Section 3.1.4. that a morphospecies need only be distinct at one ontogenetic stage to be valid; consequently only those dendrograms needed to validate each morphospecies individually are presented here - this may only require one dendrogram per fauna.

The mean of each variable in each cluster is given in the cluster diagnoses and these are the basis for the digitisation of morphospecies, so these are listed for all clusters in all analyses.

Distributions of specimens in A-space for each fauna are illustrated using principal components plots, and cluster centroids are plotted on this ordination, with superimposed connections indicating ontogenetic series. Curves have also been plotted for each character, showing the interpolations between cluster means through ontogeny, but these are not presented here for economy of space. Matrices of character values for each morphospecies have been directly derived from the digitisation of these curves and therefore convey essentially the same information - these are used as numerical morphospecific descriptions in Chapter 5.

NOTES ON FORMAT OF PRESENTATION OF RESULTS IN SECTION 4.1

Stratigraphic division codes:

Each stratigraphic interval from which samples have been isolated for analysis is coded simply according to the accepted zonal abbreviation, printed in capitals, e.g. H1A for H_{1a} zone; R2CG for R_{2c} to G zones. Homoceratid analyses from R zone are prefixed with an H, e.g. HR1B for Homoceratids from R_{1b} zone.

Analysis codes:

These are formed by the last letters of the alphabet appended to the stratigraphic division code, with Z appended to the largest size interval analysed, e.g. H1AZ, G2AU etc.

Cluster codes:

Formed by numbers appended to analyses codes, e.g. H1AZ1, HR1AY3. Where only one stratigraphic division is being considered, these can be abbreviated to Z1, Y3; on dendrograms just the number suffices.

Morphospecies codes:

Formed by the first letters of the alphabet appended to the stratigraphic division code, e.g. H1AA, G2AE.

Specimen codes (on dendrograms and plots):

Up to three figure numbers. These can be cross-referenced to registered specimen numbers in the Appendix. These codes are only unique within each of the three major familial groupings. Gastrioceratid specimens prefixed X are housed in collections abroad and are listed in a separate part of the Appendix.

Dendrogram:

Numbers on left are specimen codes. The dashed line is the phenon line, the adjacent numbers are cluster codes.

Character value matrices:

Means and standard deviations of each analysed character for each cluster are shown, n = number of specimens in cluster. Blank spaces indicate unanalysed characters.

Principal components plots:

Ticks on axes represent unit P.C. score intervals. P.C.3 scores indicated by size of dots (open dots = negative score). Characters making largest positive or negative contribution to each principal component indicated in inset box. Unanalysed characters indicated by a vertical line.

For plots without cluster centroids:

All specimens with sufficiently complete data sets from one stratigraphic division are analysed. Numbers are specimen codes.

For plots with cluster centroids:

P.C. space same as above. Specimens in analysed clusters omitted; replaced with positions of cluster centroids in P.C. space. Horizontal and vertical bars through cluster centroids show 1 standard deviation of P.C. scores of cluster members either side of centroid. P.C.3 symbols enlarged to emphasise differences between centroids. Centroids labelled with cluster codes. Larger and smaller specimens, not included in cluster analyses, shown as points labelled with their diameter in mm. Overlays indicate chosen postulated ontogenetic series of clusters, with extrapolation towards larger and smaller specimens (see Section 3.1.4.6 for criteria). Each ontogenetic path is a morphospecies, and are labelled with morphospecies codes.

4.1.1. ANALYSES OF SAMPLES OF HOMOCERATIDAE *s.l.* AND HOMOCERATOIDES

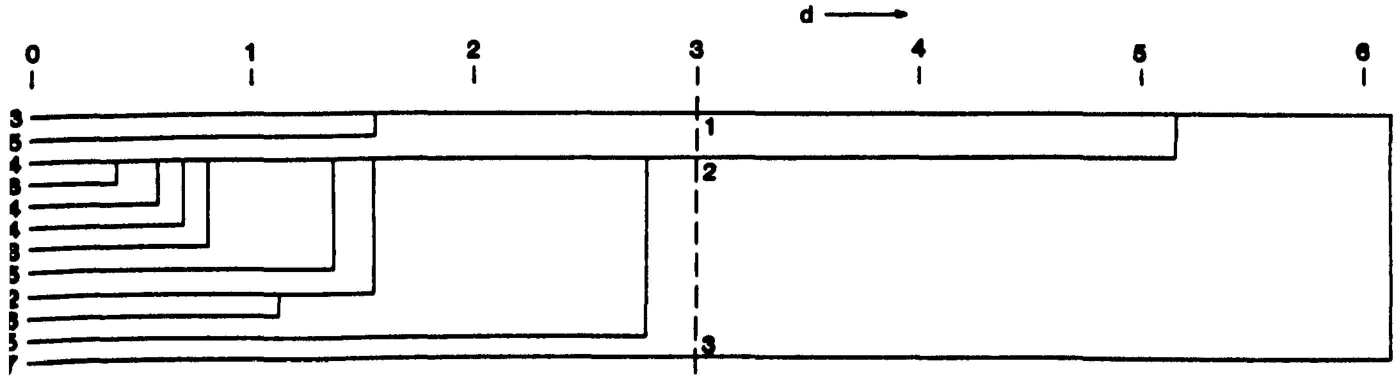
Samples were isolated from each of the following stratigraphic divisions:

H_{1a}, H_{1b}, H_{2a}, H_{2b}, H_{2c} R_{1a}, R_{1b}, R_{1c} to Westphalian.

Analysis of H_{1a} zone goniatites.

8-11 mm size range - analysis code H1AY :

Dendrogram



Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
Y 1	mean	2.00	.900		17.0		1.10	.250	.336	1.94		.095	.025		.033	.033	0
	s.d.		0		1.41		.141	.071	.114	.477		.008	.019		.008	.047	.001
Y 2	mean	9.00	.967		22.7		1.00	.011	.176	1.39		.055	.023		.038	0	0
	s.d.		.050		6.55		0	.033	.032	.208		.052	.016		.016	0	0
Y 3	mean	1.00	.900		27.0		1.00	.100	.156	1.26		.019	.010		.038	.135	.006
	s.d.		0		0		0	0	0	0		0	0		0	0	0

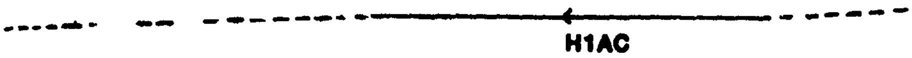
11-14 mm size range - analysis code H1AZ :

Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
Z 1	mean	3.00		.050	20.0		1.00	.033	.155	1.23		.103	.029	.005	.100	0	0
	s.d.			.050	4.00		0	.058	.015	.076		.087	.023	.008	.090	0	0
Z 2	mean	5.00		.040	14.4		1.38	.400	.160	1.30		.027	.012	.009	.134	.107	.005
	s.d.			.089	2.88		.311	.100	.022	.107		.025	.008	.009	.077	.064	.002
Z 3	mean	2.00		.050	15.0		1.20	.500	.286	1.77		.102	.033	.020	.020	.116	.004
	s.d.			.071	1.41		.283	.141	.025	.064		.003	.009	.023	.029	.061	0

Comments:

This is one of a very few analyses in which the size of the umbilicus does not contribute significantly to the first principal component of variation. Nevertheless P.C.1 is the vector in which ontogenetic variation lies, and ontogenetic continua between clusters


H1AC

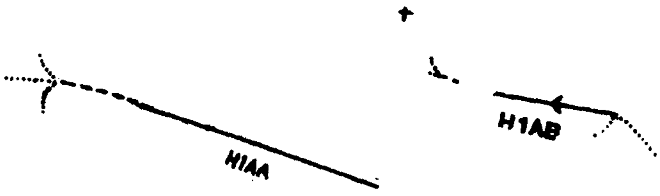
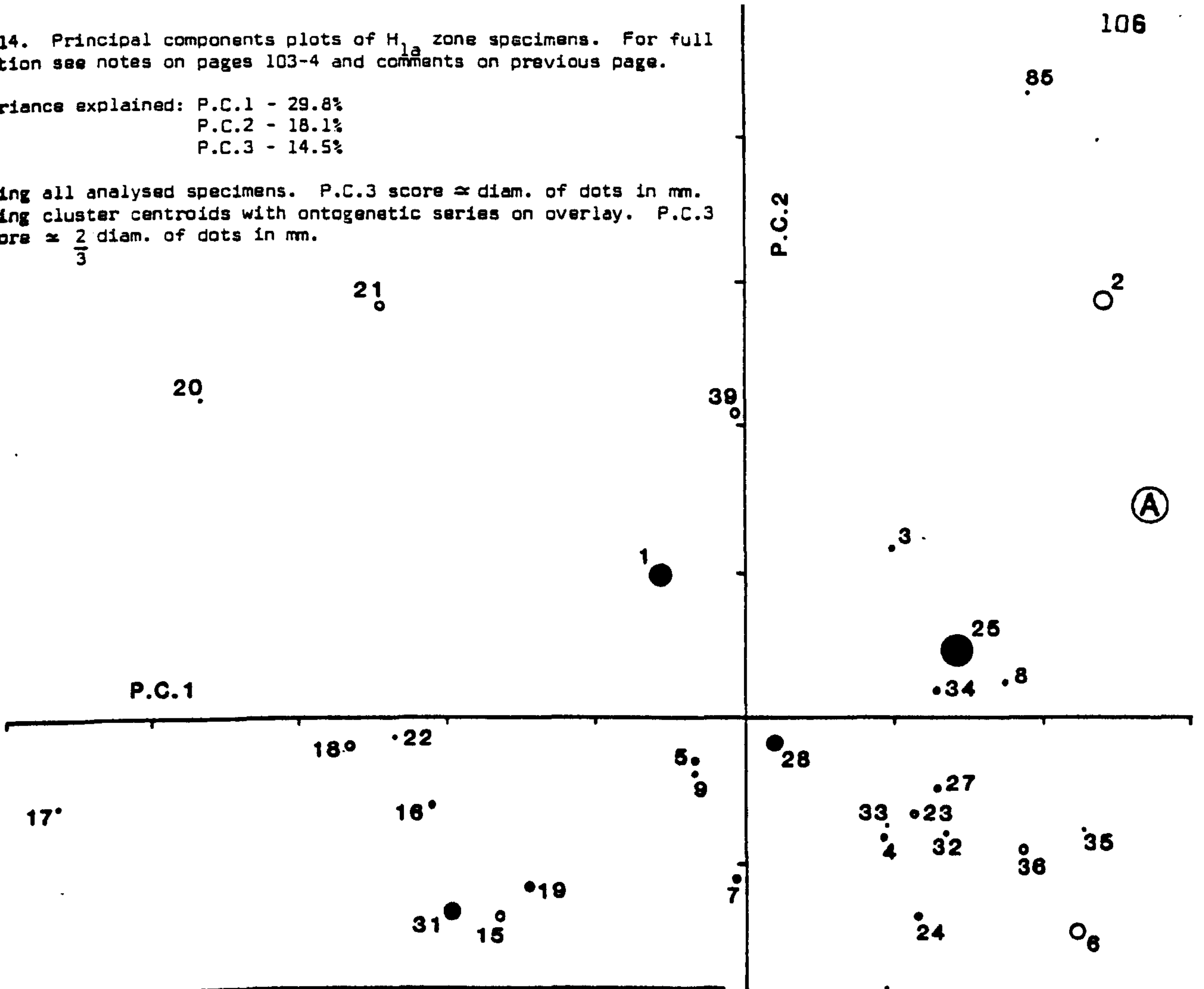

H1AA
H1AB

FIGURE 14. Principal components plots of H_{1a} zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 29.8%
P.C.2 - 18.1%
P.C.3 - 14.5%

A: Showing all analysed specimens. P.C.3 score ≃ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ $\frac{2}{3}$ diam. of dots in mm.



	S	C	T	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1			+	−						−	−	−	−
PC2					+	+		+	+				
PC3	−	+				−		+	+				

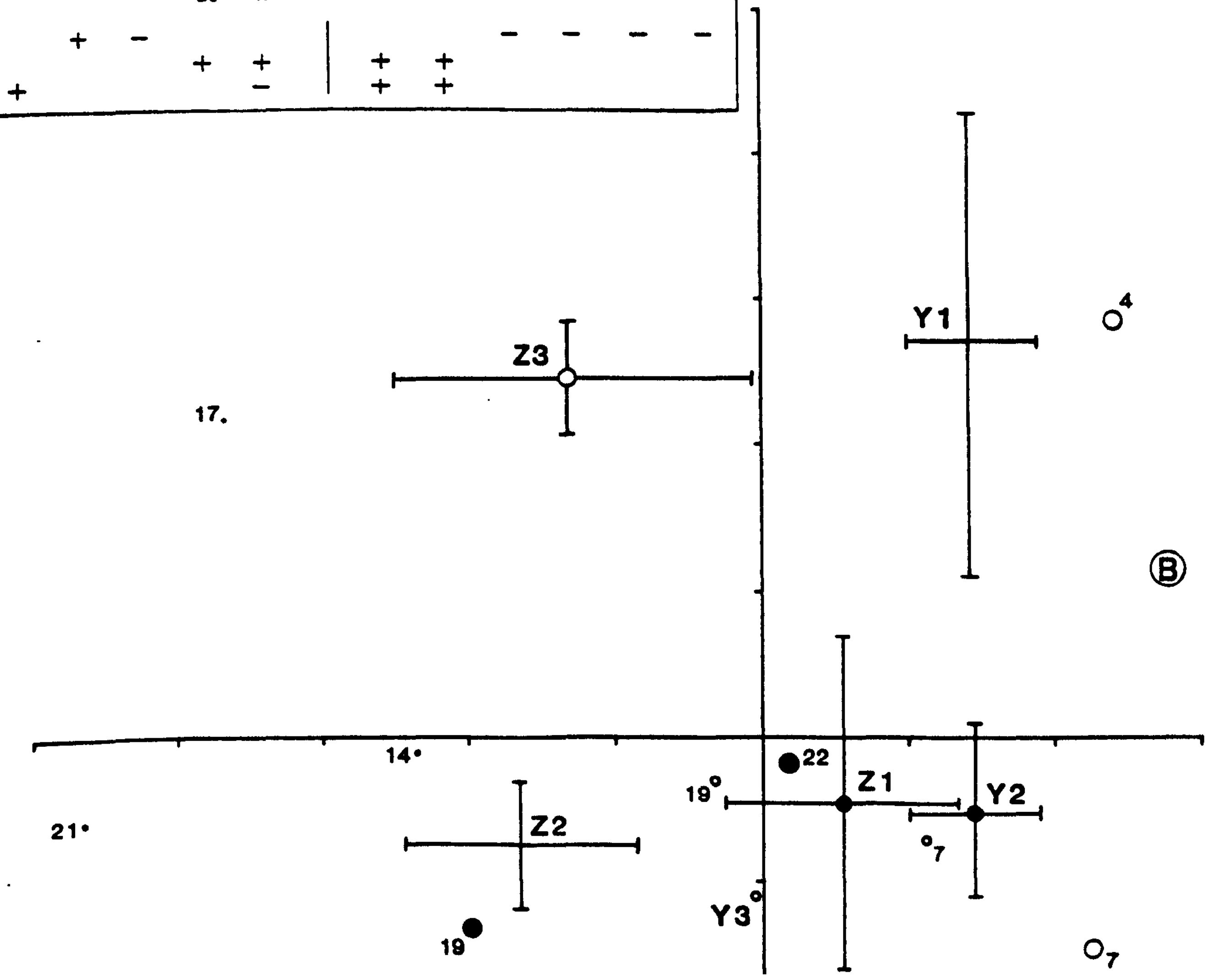
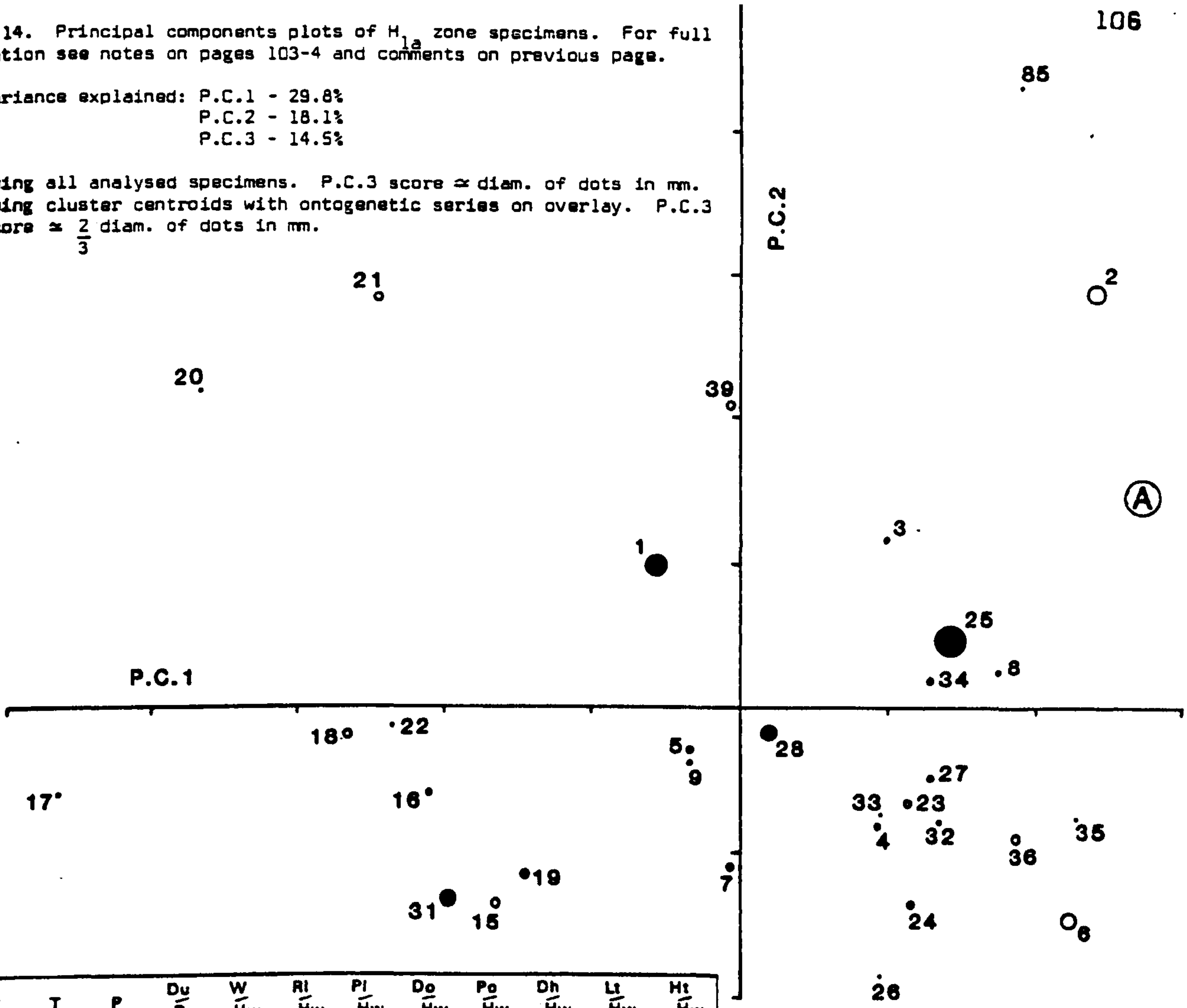


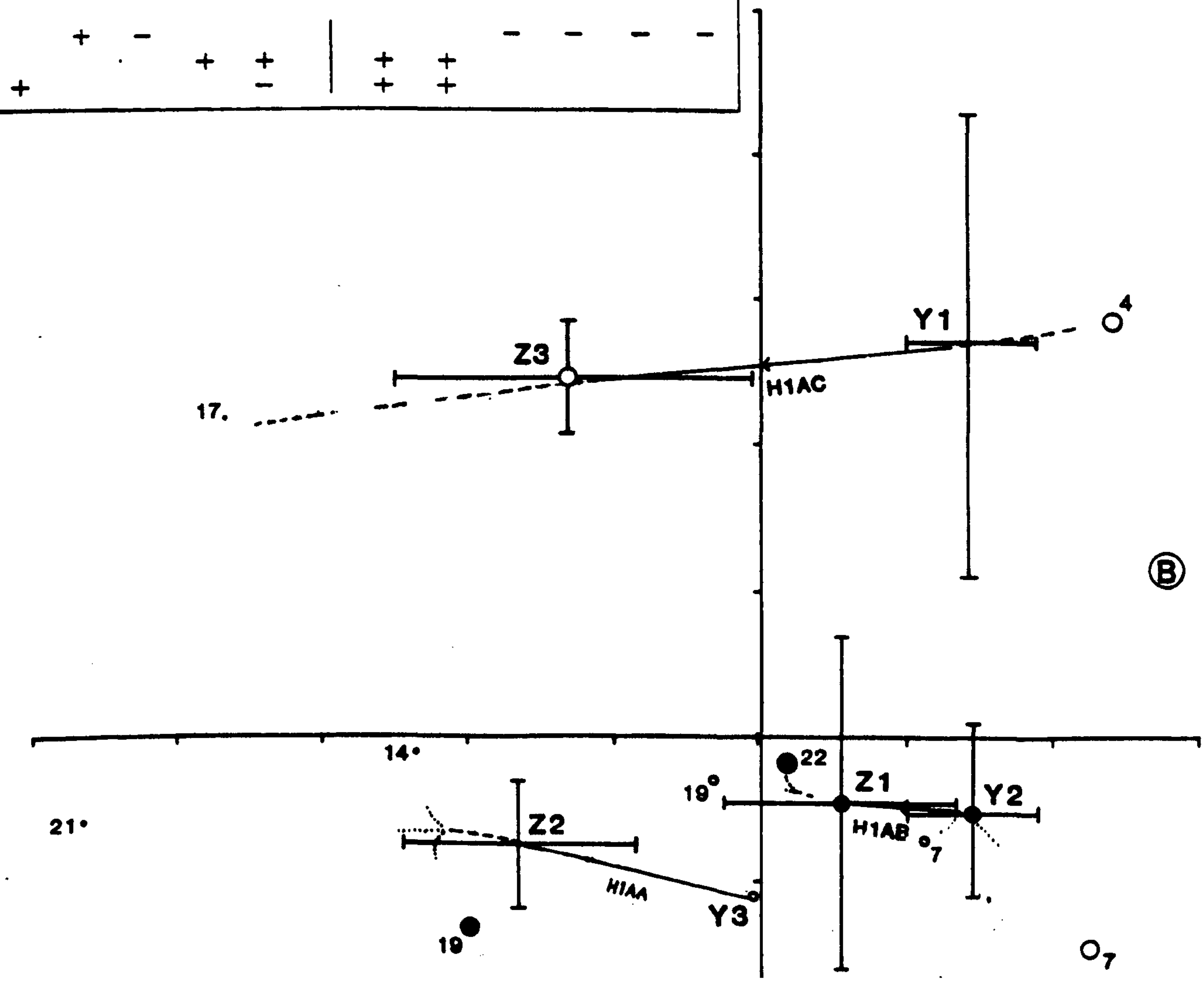
FIGURE 14. Principal components plots of H_{1a} zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 29.8%
P.C.2 - 18.1%
P.C.3 - 14.5%

A: Showing all analysed specimens. P.C.3 score ≃ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ $\frac{2}{3}$ diam. of dots in mm.



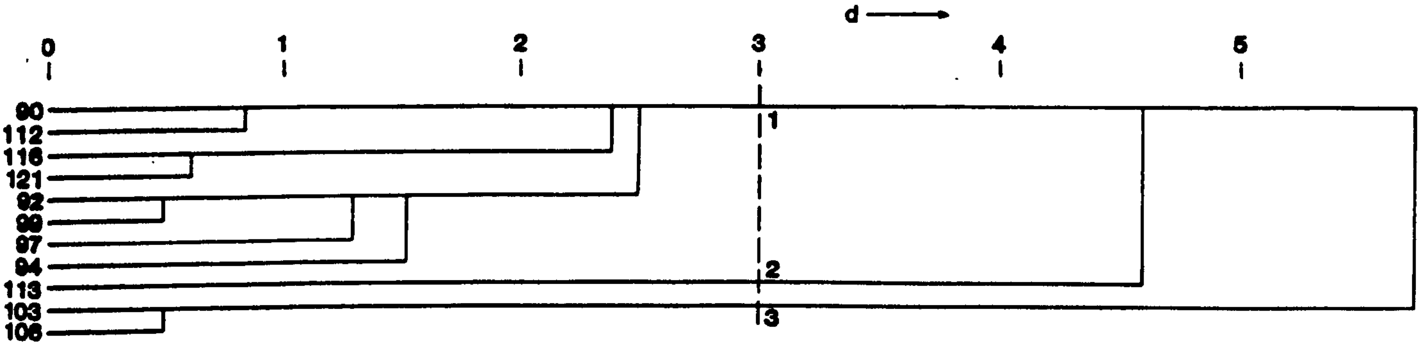
	S	C	T	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1			+	−						−	−	−	−
PC2					+	+		+	+				
PC3	−	+				−		+	+				



Analysis of H_{1b} zone goniatites.

12-15 mm size range - analysis code H1BZ :

Dendrogram

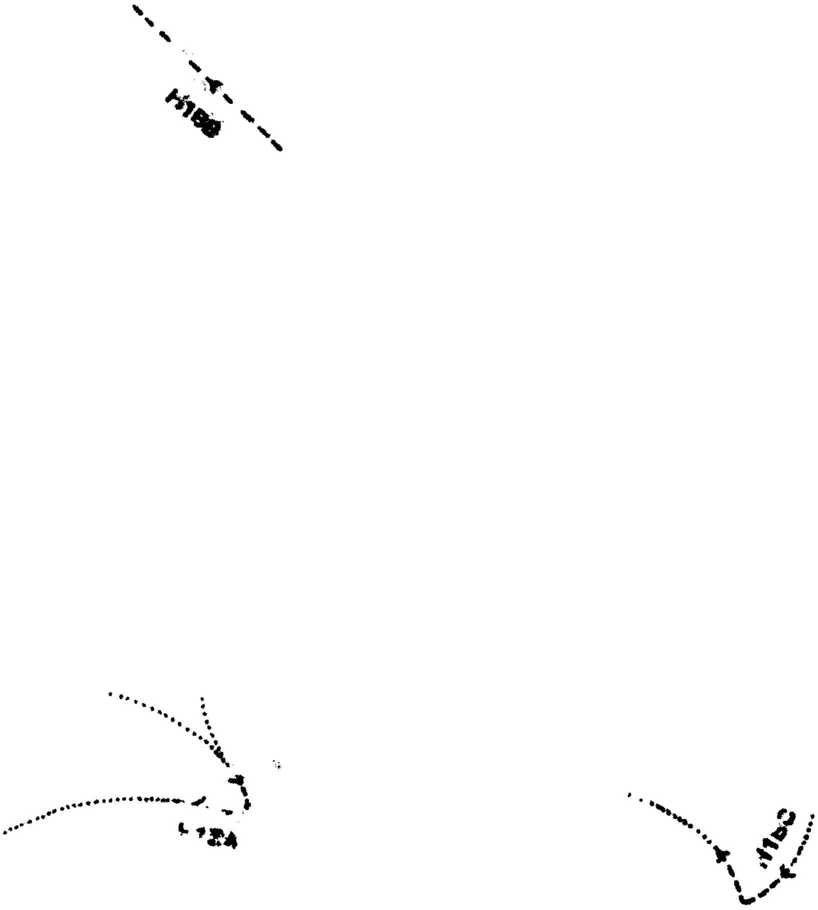


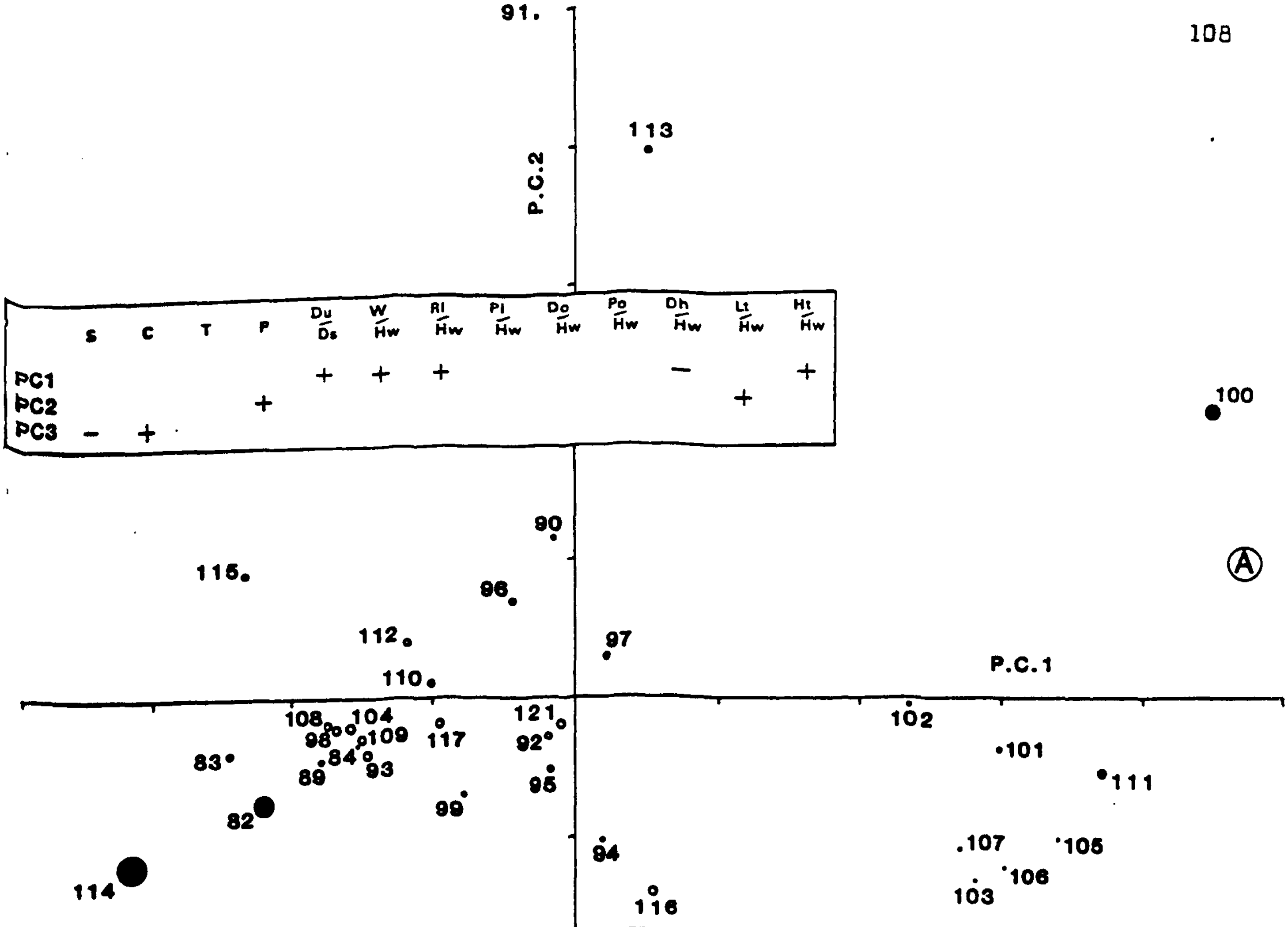
Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Z 1	mean	8.00			9.93		1.03	.662	.234		.765	.151	.023	.009	.078	.045	.002
	s.d.				3.89		.106	.192	.081		.119	.115	.017	.012	.093	.039	.002
Z 2	mean	1.00			13.0		1.80	.500	.257		.757	.014	.014	.003	.114	.286	.017
	s.d.				0		0	0	0		0	0	0	0	0	0	0
Z 3	mean	2.00			7.50		1.00	.950	.468		.975	.737	.046	.002	0	.067	.011
	s.d.				2.12		0	.071	.039		.004	.058	.026	.003	0	.003	0

Comments:

More extensive collections from H_{1b} zone have become available since this analysis was completed; these are examined in Chapter 7. This sample is sufficient to clearly distinguish three morphospecies, which show unusually little morphological overlap through ontogeny.


H15B
12A
H15C

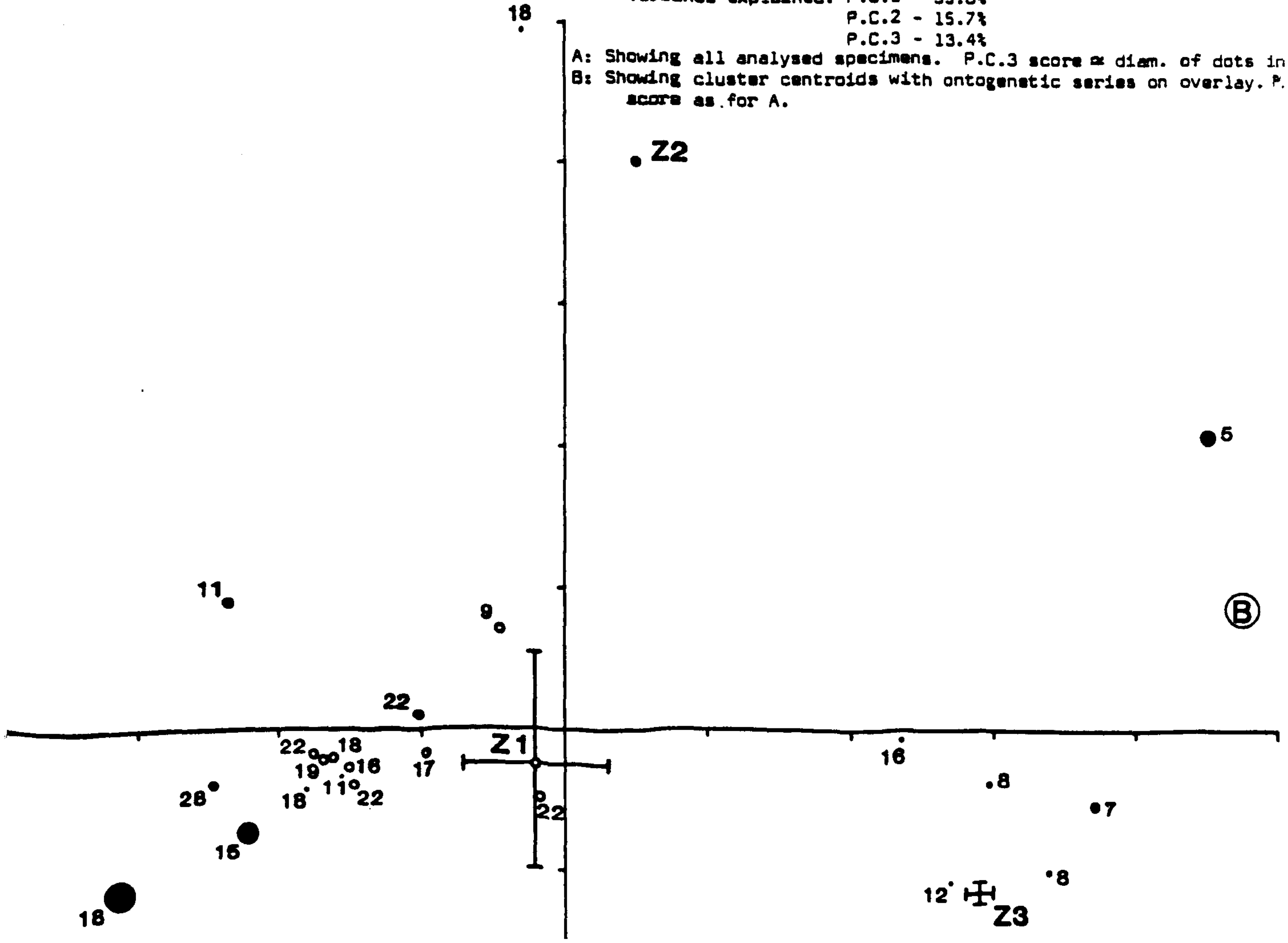


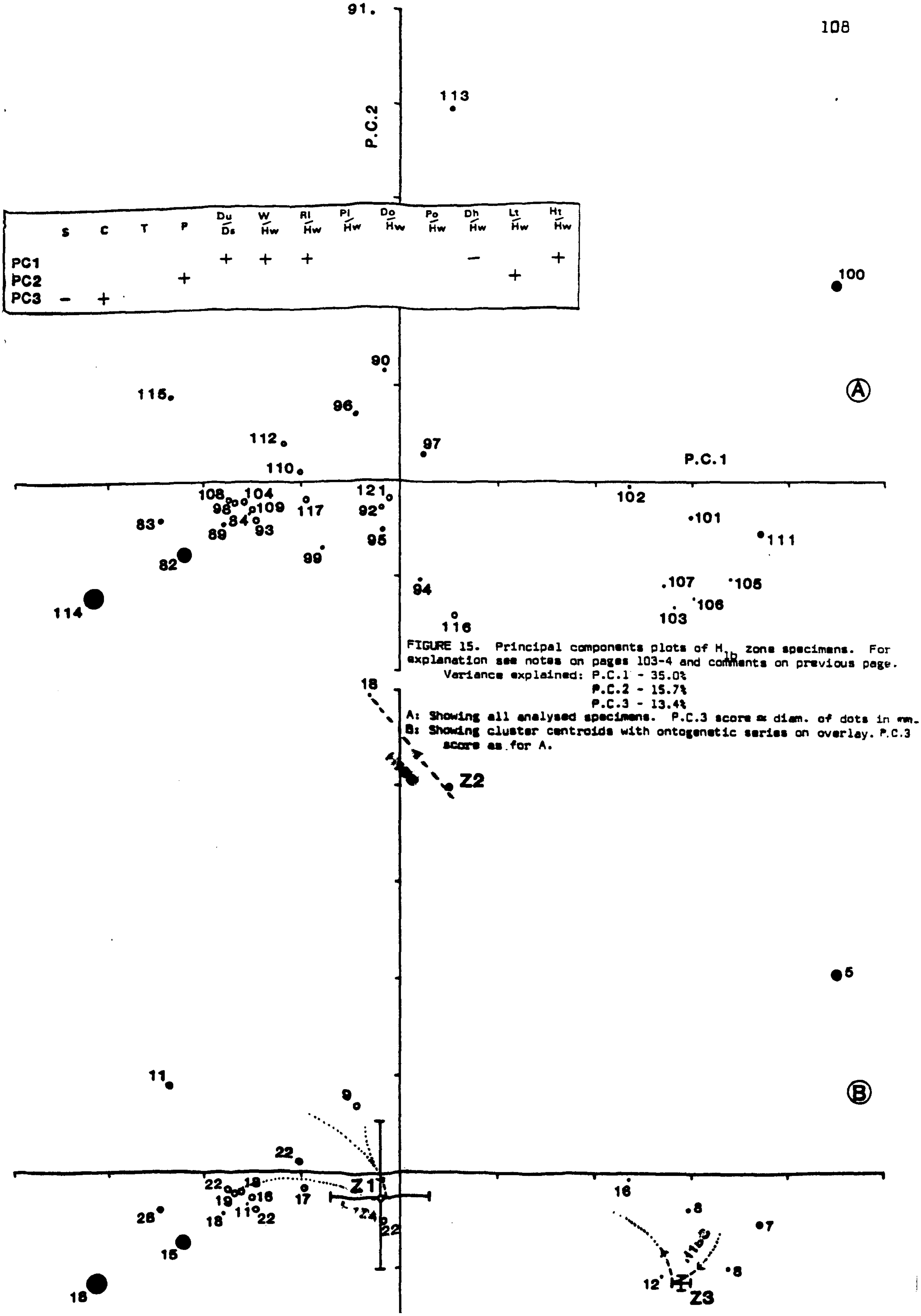
	S	C	T	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1					+	+	+				−		+
PC2				+								+	
PC3	−	+											

FIGURE 15. Principal components plots of H_{1b} zone specimens. For explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 35.0%
P.C.2 - 15.7%
P.C.3 - 13.4%

A: Showing all analysed specimens. P.C.3 score ∝ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score as for A.





	S	C	T	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1					+	+	+				−		+
PC2				+								+	
PC3	−	+											

FIGURE 15. Principal components plots of H_{1b} zone specimens. For explanation see notes on pages 103-4 and comments on previous page.

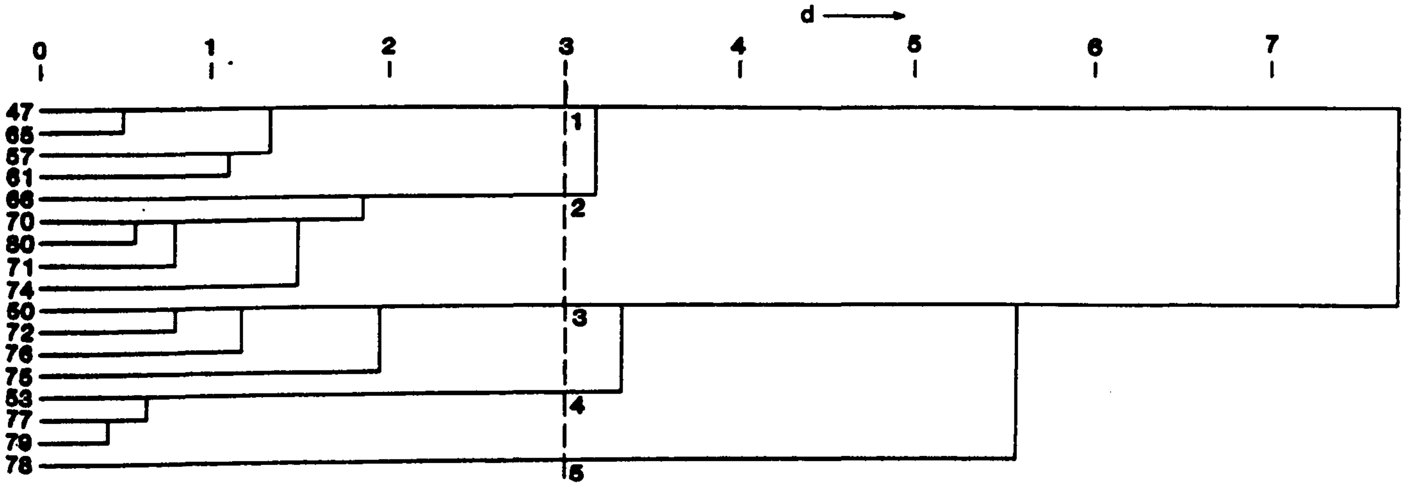
Variance explained: P.C.1 - 35.0%
P.C.2 - 15.7%
P.C.3 - 13.4%

A: Showing all analysed specimens. P.C.3 score ∝ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score as for A.

Analysis of H_{2a} zone goniatites.

8-10 mm size range - analysis code H2AX :

Dendrogram



Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
X 1	mean	4.00			11.0			.450	.438	2.03		.206	.039		.003	.094	.006
	s.d.				2.45			.057	.018	.255		.075	.010		.003	.019	.002
X 2	mean	5.00			15.4			.180	.427	2.10		.222	.037		.028	.074	.005
	s.d.				2.88			.084	.030	.261		.073	.009		.016	.012	.005
X 3	mean	4.00			10.2			.250	.416	2.19		.172	.042		.039	0	0
	s.d.				2.63			.208	.035	.109		.076	.005		.024	0	0
X 4	mean	3.00			15.6			.133	.487	2.04		.147	.034		.010	0	0
	s.d.				2.08			.153	.015	.036		.042	.008		.007	0	0
X 5	mean	1.00			15.0			.200	.311	1.35		.100	.005		.038	0	0
	s.d.				0			0	0	0		0	0		0	0	0

10-12 mm size range - analysis code H2AY :

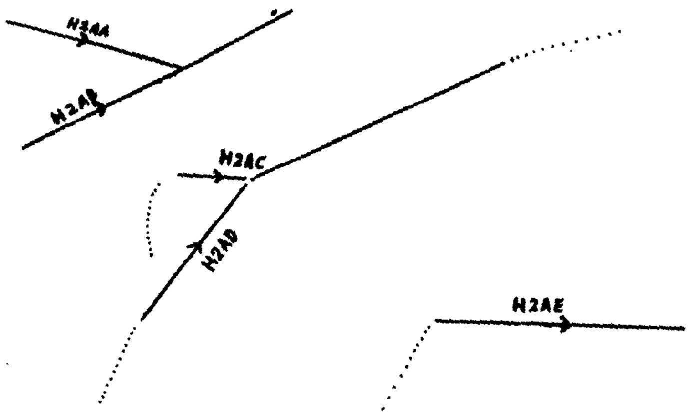
Means of character values for each cluster:

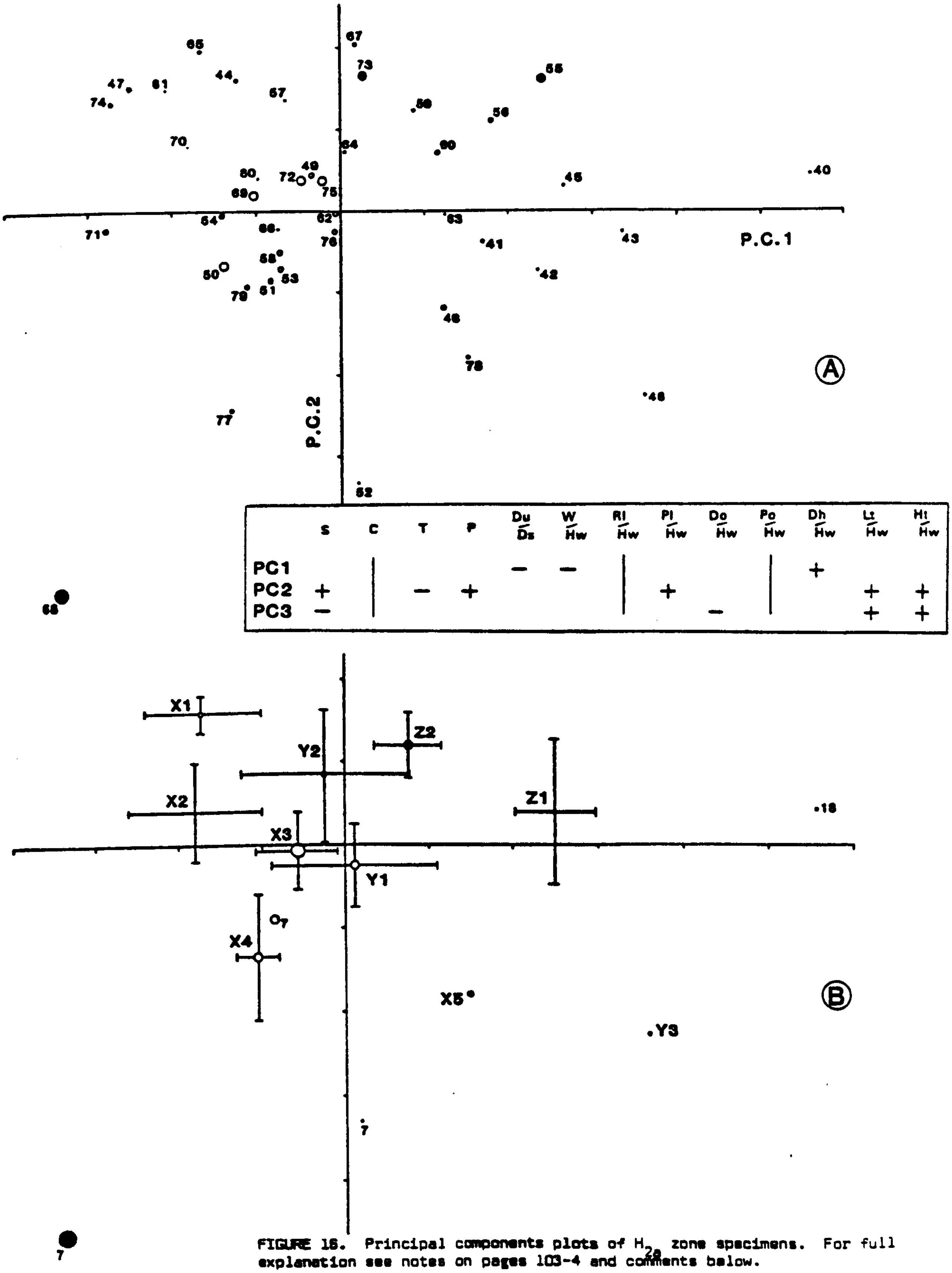
Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Y 1	mean	6.00			14.6			.350	.379	1.86		.183	.037		.022	0	0
	s.d.				2.16			.152	.059	.230		.092	.011		.014	0	0
Y 2	mean	5.00			11.6			.420	.371	1.74		.166	.026		.017	.076	.003
	s.d.				2.51			.179	.063	.291		.062	.016		.015	.053	.002
Y 3	mean	1.00			20.0			.100	.182	1.27		0	.018		.164	0	0
	s.d.				0			0	0	0		0	0		0	0	0

12-15 mm size range - analysis code H2AZ :

Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Z 1	mean	5.00			12.8			.680	.260	1.52		.145	.015		.079	.024	
	s.d.				3.27			.192	.020	.040		.079	.013		.055	.053	
Z 2	mean	3.00			8.66			.500	.314	1.61		.175	.020		.012	.074	
	s.d.				.577			.100	.027	.124		.069	.018		.013	.065	


H2AA
H2AB
H2AC
H2AD
H2AE



	S	C	T	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1		|			−	−	|			|	+		
PC2	+	|	−	+			|	+		|		+	+
PC3	−	|					|		−	|		+	+

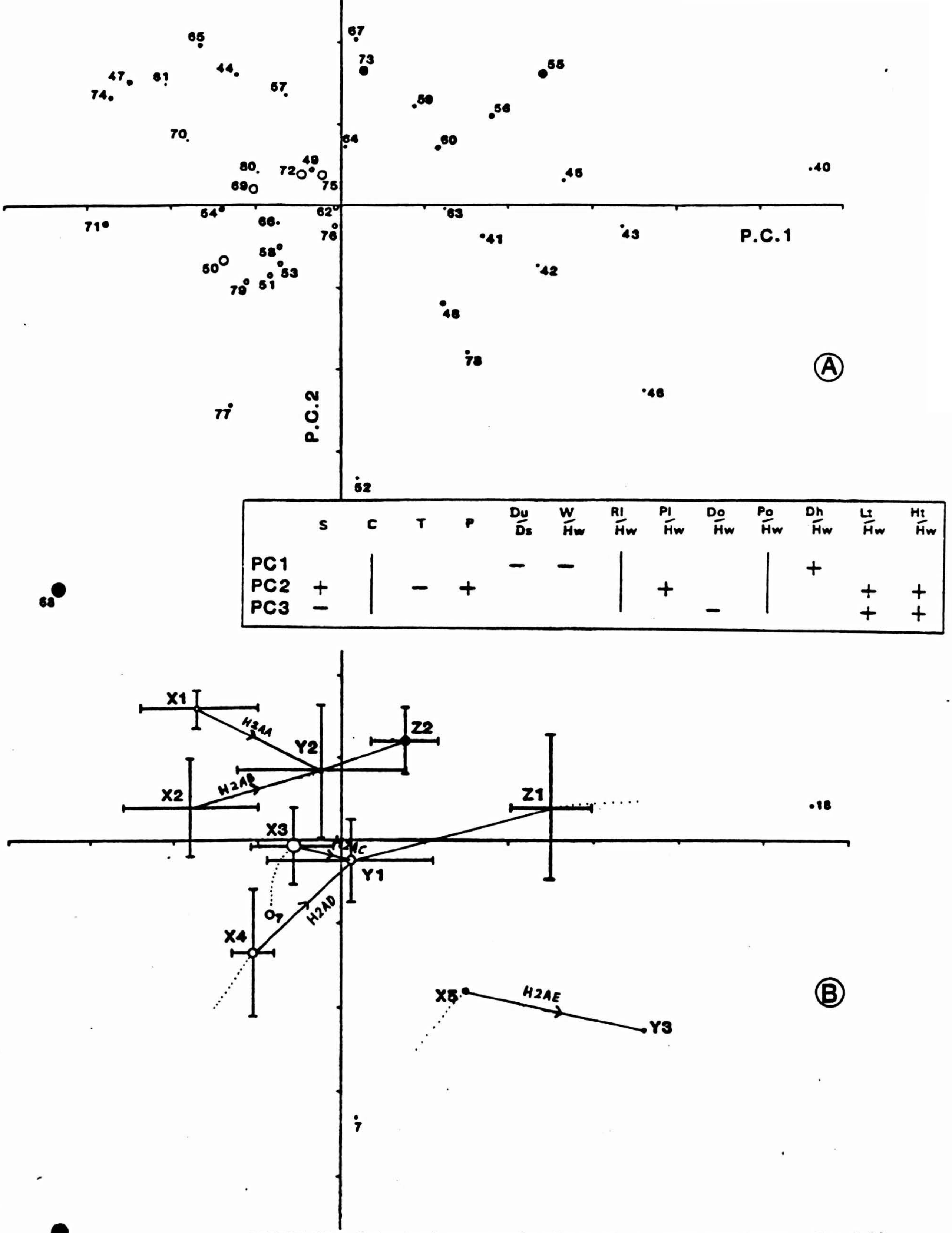
FIGURE 16. Principal components plots of H_{2a} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 32.8%
P.C.2 - 18.7%
P.C.3 - 12.8%

A: Showing all analysed specimens. P.C.3 score ≈ 1½ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ diam. of dots in mm.

Comments:

This fauna appears to show greater variation in younger specimens. The ontogenetic interpretation here is fairly straightforward, especially



	S	C	T	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1		|			−	−	|			|	+		
PC2	+	|	−	+			|	+		|		+	+
PC3	−	|					|		−	|		+	+

FIGURE 16. Principal components plots of H_{2a} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 32.8%
P.C.2 - 18.7%
P.C.3 - 12.8%

A: Showing all analysed specimens. P.C.3 score ≈ 1½ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ diam. of dots in mm.

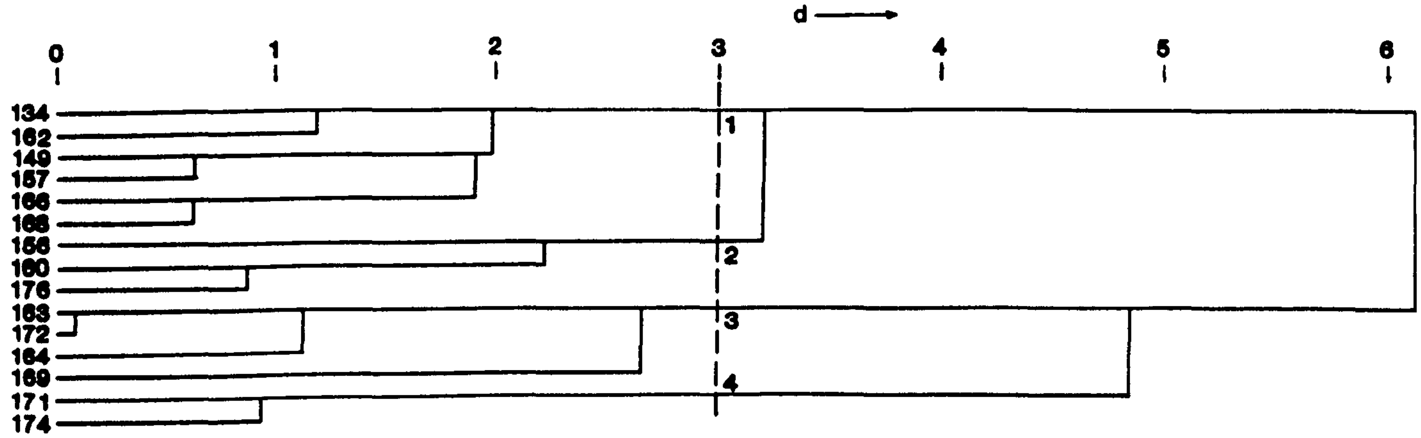
Comments:

This fauna appears to show greater variation in younger specimens. The ontogenetic interpretation here is fairly straightforward, especially when the P.C.3 scores of the clusters are noted.

Analysis of H_{2b} zone goniatites.

12-15 mm size range - analysis code H2BY :

Dendrogram



Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Y 1	mean	6.00			14.1		1.03	.817	.272	1.58		.065	.008	.003	.084	.065	.002
	s.d.				1.72		.052	.041	.030	.134		.024	.010	.004	.038	.052	.002
Y 2	mean	3.00			13.0		1.00	.900	.211	1.38		.039	.015	.004	.107	.015	0
	s.d.				.002		0	0	.041	.079		.056	.014	.004	.044	.026	.001
Y 3	mean	4.00			13.5		1.35	.825	.263	1.49		.054	.022	.020	.079	.136	.004
	s.d.				1.29		.058	.050	.011	.082		.013	.011	.006	.044	.122	.001
Y 4	mean	2.00			16.0		1.05	.600	.224	1.28		.053	.028	.007	.125	.058	.004
	s.d.				2.82		.071	0	.021	.075		.017	.005	.006	.017	.014	.001

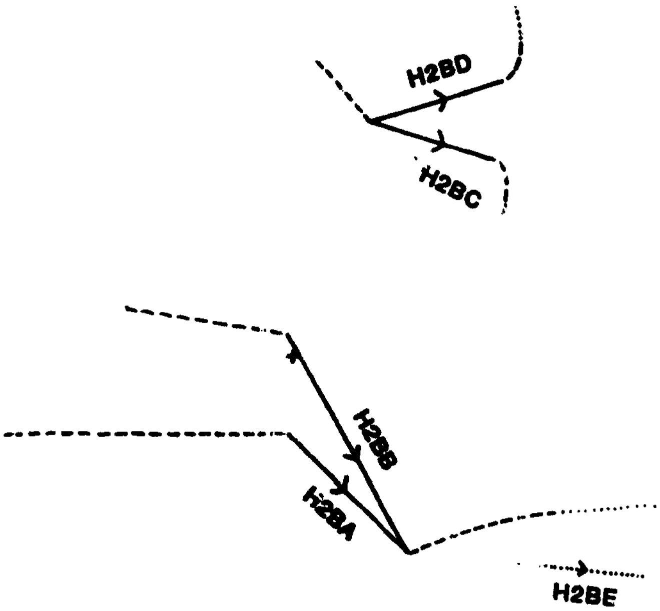
15-18 mm size range - analysis code H2BZ :

Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Z 1	mean	8.80			12.2		1.03	.762	.232			.086	.008	.001	.155	.006	0
	s.d.				3.32		.074	.091	.041			.063	.006	.002	.038	.017	.001
Z 2	mean	3.00			13.3		1.40	.767	.241			.034	.001	.001	.263	.111	.004
	s.d.				1.52		.361	.058	.041			.006	.002	.002	.065	.031	.001
Z 3	mean	3.00			13.0		1.53	.867	.231			.072	.019	.014	.171	.121	.004
	s.d.				1.00		.503	.058	.044			.049	.006	.010	.026	.059	.001

Comments:

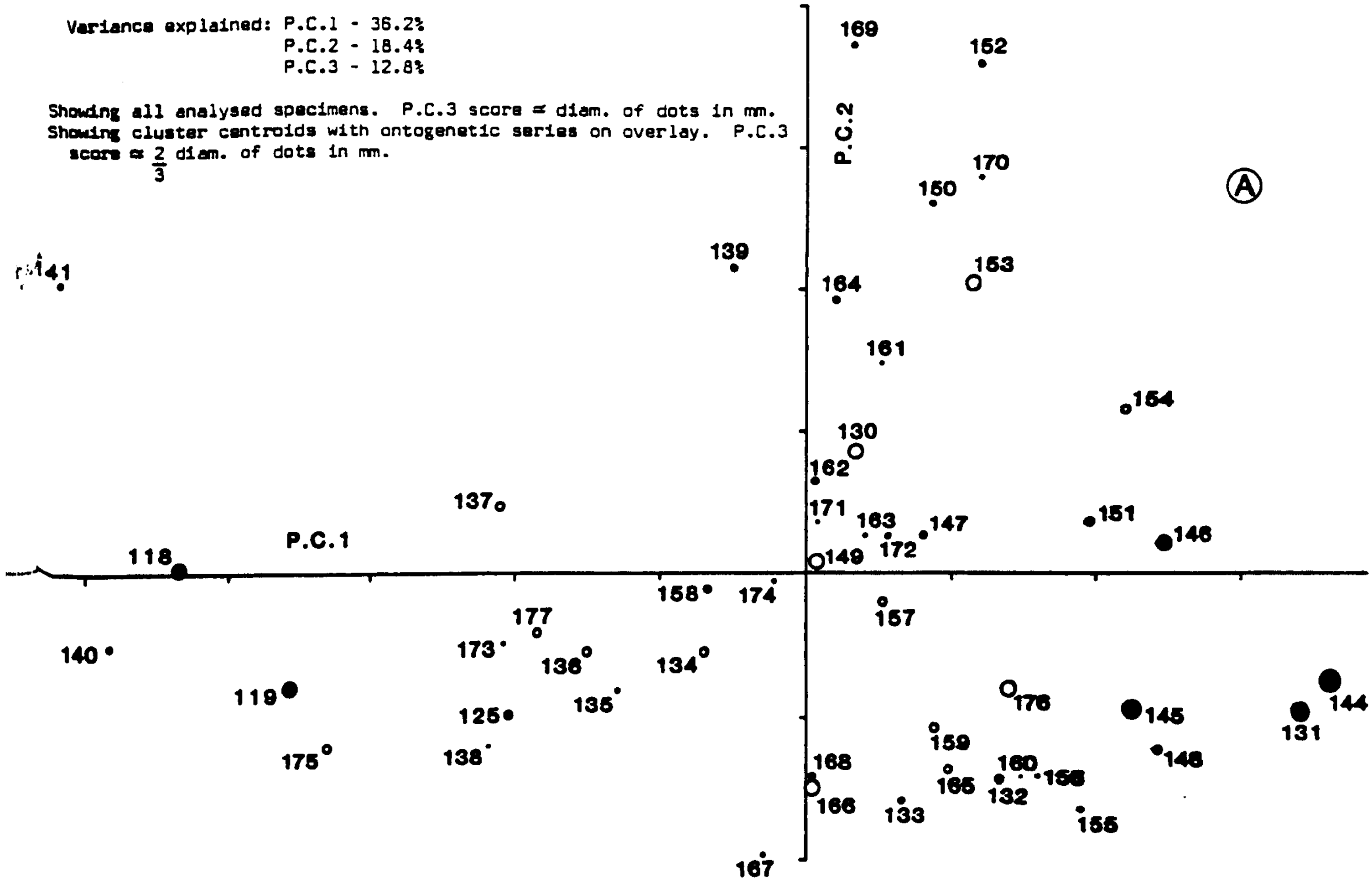
There is not a clear one-to-one ontogenetic relationship between clusters in these analyses. There appears to be a substantial increase in variation with age. The size range of analysis H2BY is the stage at which variation begins to increase, and this has resulted in difficulty in allocating cluster Y4 to the morphospecies represented by Z1, Z2 or Z3. The connection of Y4 to Z1 is made here on the basis of ontogeny observed in individual specimens. Particularly, the observed trends in degree of rib bifurcation link these two clusters.


H2BD
H2BC
H2BB
H2BA
H2BE

IGURE 17. Principal components plots of H_{2b} zone specimens. For full xplanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 36.2%
P.C.2 - 18.4%
P.C.3 - 12.8%

Showing all analysed specimens. P.C.3 score ≈ diam. of dots in mm.
Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ $\frac{2}{3}$ diam. of dots in mm.



	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1	│	│		│		+	−	−	│				+		−
PC2					+									+	+
PC3										+	+	+			

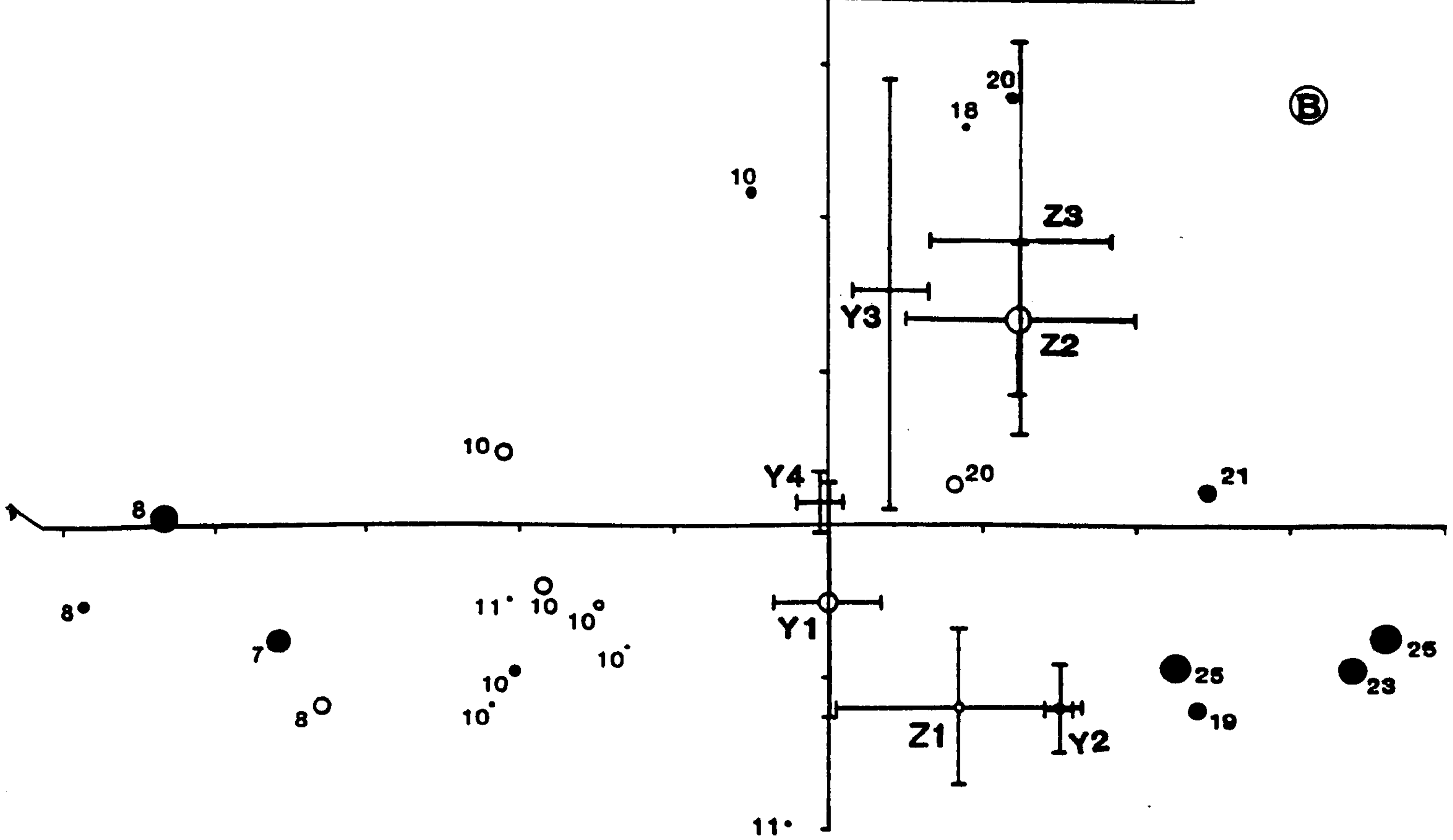
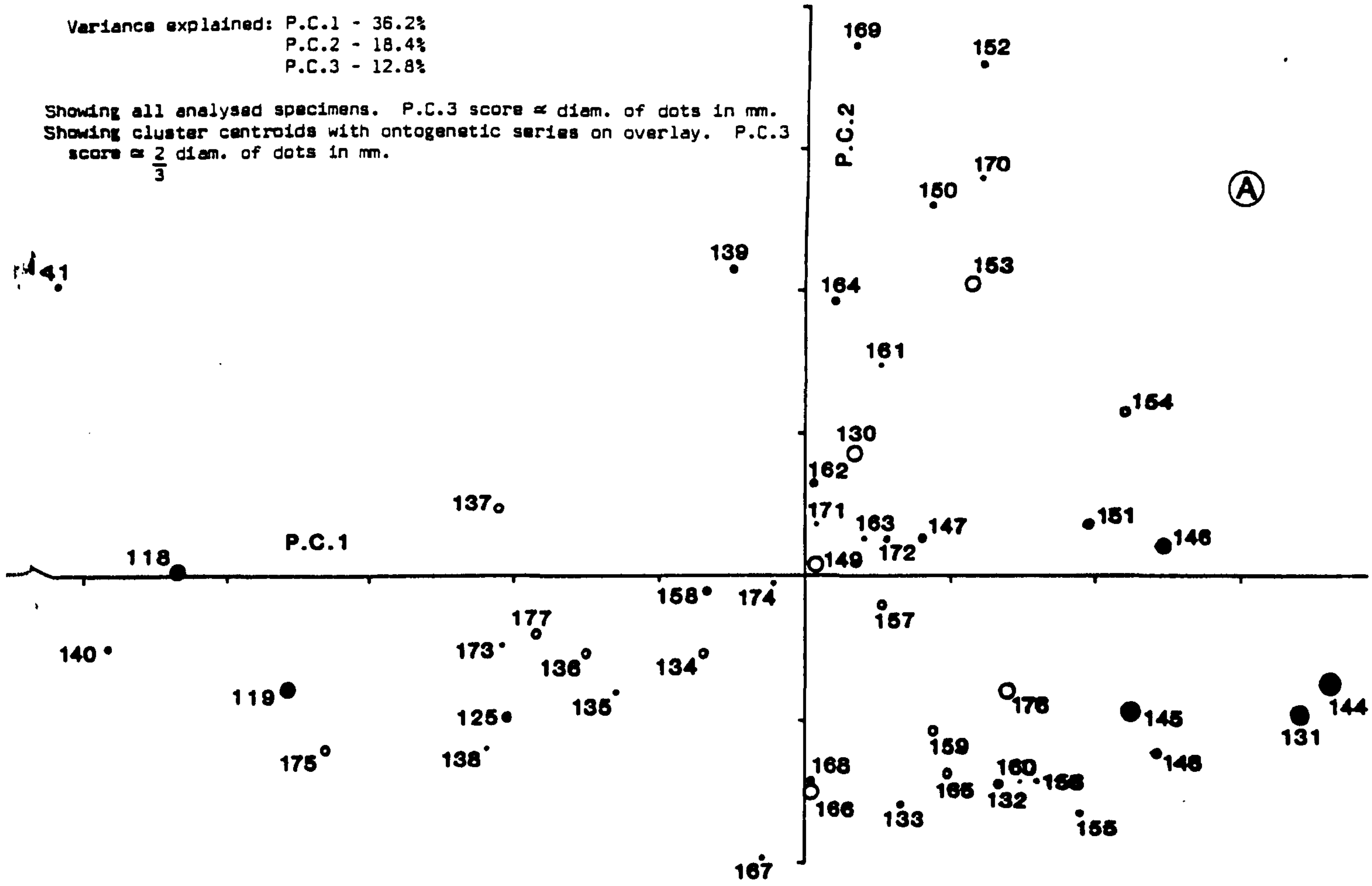


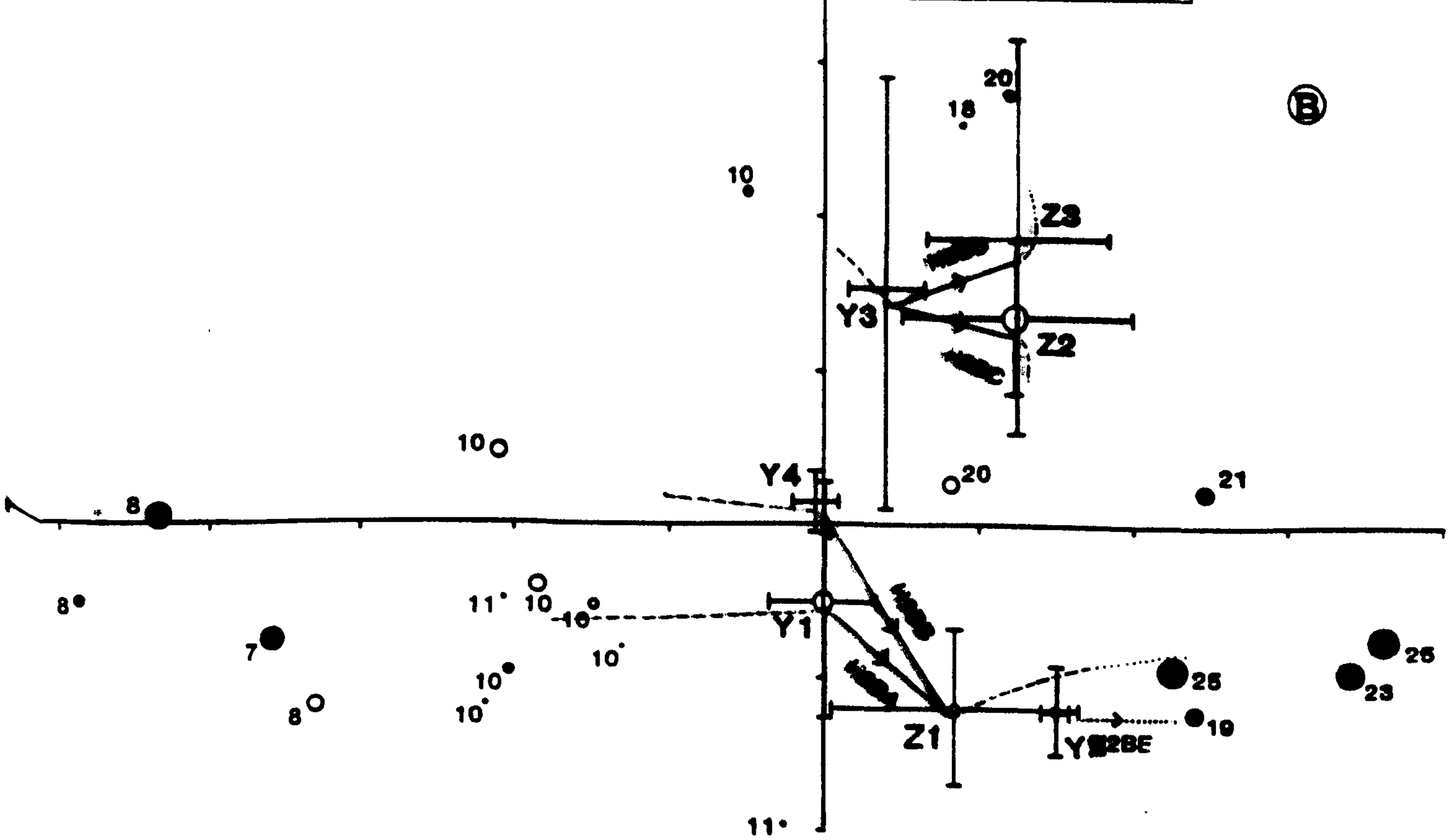
FIGURE 17. Principal components plots of H_{2b} zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 36.2%
P.C.2 - 18.4%
P.C.3 - 12.8%

Ⓐ Showing all analysed specimens. P.C.3 score ∝ diam. of dots in mm.
Ⓑ Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ∝ $\frac{2}{3}$ diam. of dots in mm.



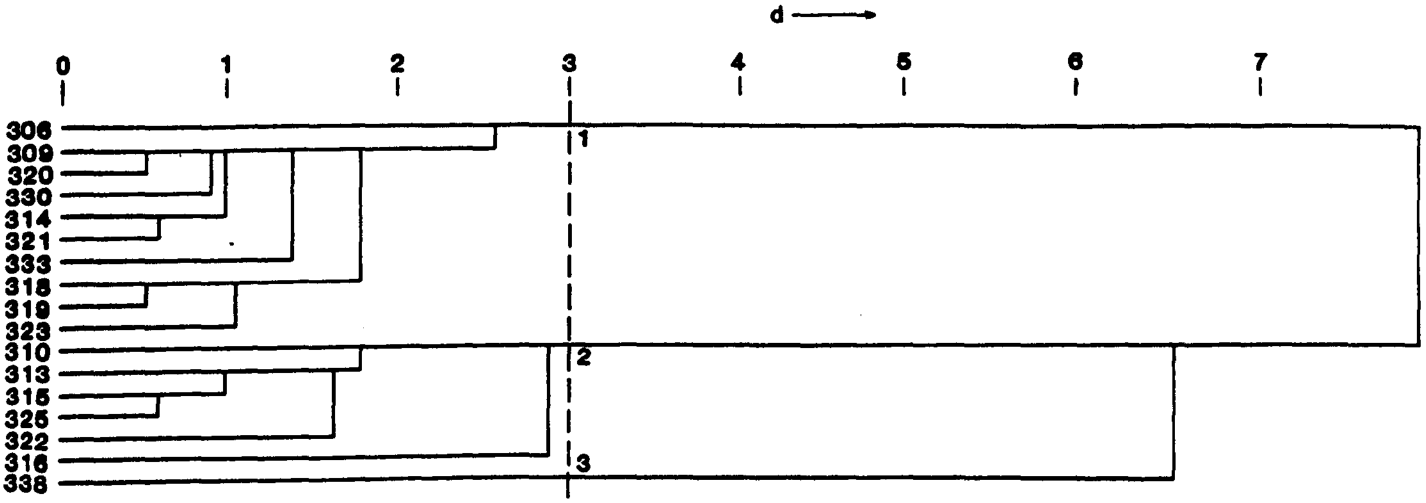
	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1	│	│		│		+	−	−	│				+		−
PC2	│	│		│	+				│					+	+
PC3	│	│		│					│	+	+	+			



Analysis of H_{2c} zone goniatites.

8-10 mm size range - analysis code H2CY :

Dendrogram



Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Y 1	mean	10.0		.125	13.5	8.10	2.15	.780	.411	1.45	.848	.397	.039	.004	.100	.350	.048
	s.d.			.098	3.27	2.51	.314	.103	.035	.091	.049	.089	.022	.003	.021	.051	.011
Y 2	mean	6.00		.183	21.8	8.50	2.23	.550	.348	1.31	.812	.378	.045	.008	.159	.249	.027
	s.d.			.075	5.81	1.51	.459	.138	.035	.104	.048	.044	.017	.011	.029	.067	.015
Y 3	mean	1.00		0	16.0	16.0	1.00	.300	.239	1.37	.848	0	0	0	.065	.054	.004
	s.d.			0	0	0	0	0	0	0	0	0	0	0	0	0	0

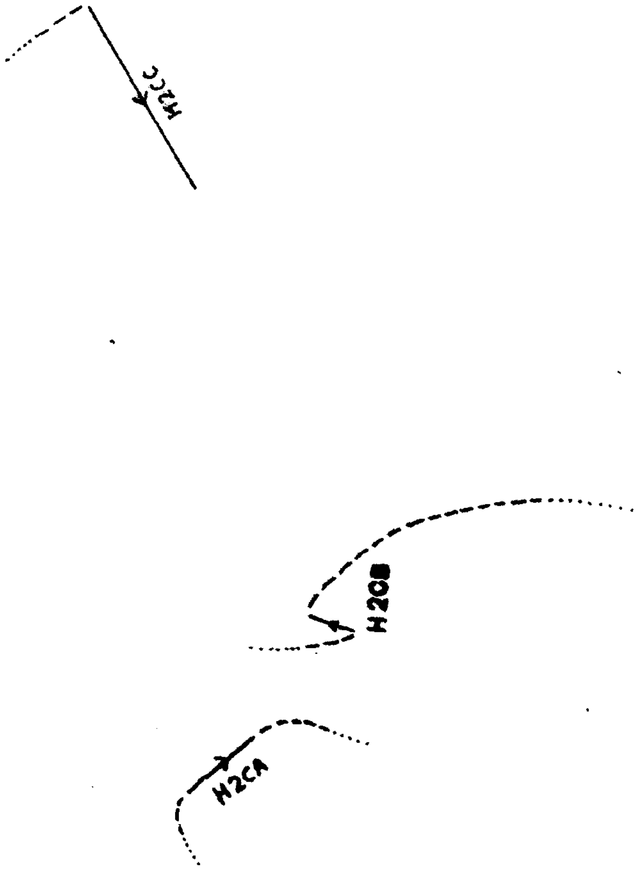
10-12 mm size range - analysis code H2CZ :

Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Z 1	mean	2.00			11.0	7.00	1.20	.500	.292	1.30	.779	.029	0	0	.030	.145	.003
	s.d.				0	1.41	.283	.283	.053	.112	.029	.015	0	0	.056	.049	.001
Z 2	mean	2.00			11.5	8.50	2.00	.850	.409	1.51	.766	.286	.032	.004	.118	.337	.052
	s.d.				.707	.707	0	.071	.042	.045	.004	.032	.008	.001	.020	.006	.018
Z 3	mean	6.00			14.3	8.16	1.98	.767	.342	1.24	.813	.325	.054	.004	.198	.289	.028
	s.d.				5.57	1.83	.299	.163	.026	.093	.027	.056	.023	.008	.042	.100	.005

Comments:

The selected linkages of Y1 to Z2 and Y2 to Z3 are justified by the observation that the characters which are consistant within each pair, namely the general shell shape and coarseness of ornament, are characters which are relatively conservative through the ontogeny of specimens.



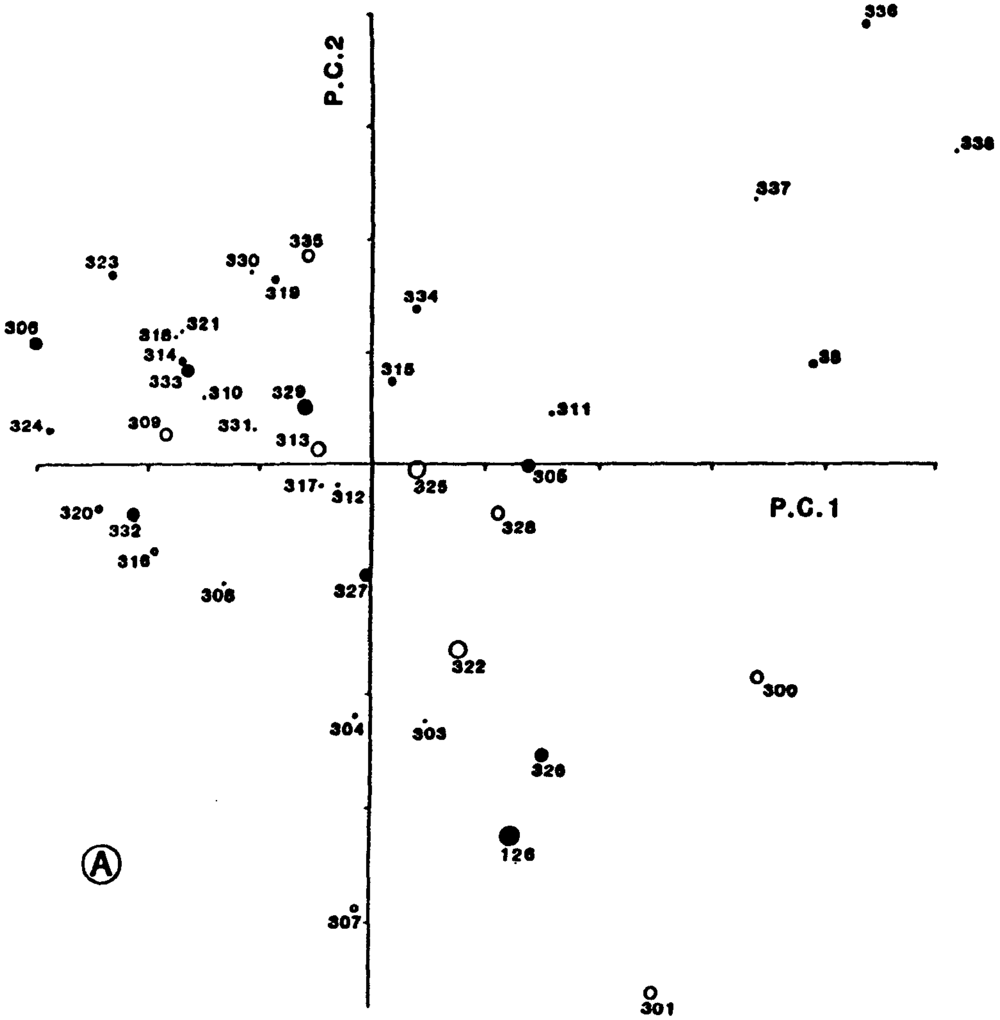
H2CC
H2CB
H2CA

FIGURE 18. Principal components plots of H_{2c} zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 27.8%
P.C.2 - 21.2%
P.C.3 - 14.0%

A: Showing all analysed specimens. P.C.3 ∝ 1½ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ∝ diam. of dots in mm.

	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
PC1							–			–				–	–
PC2	+							+					–		
PC3	+	–	–			+									



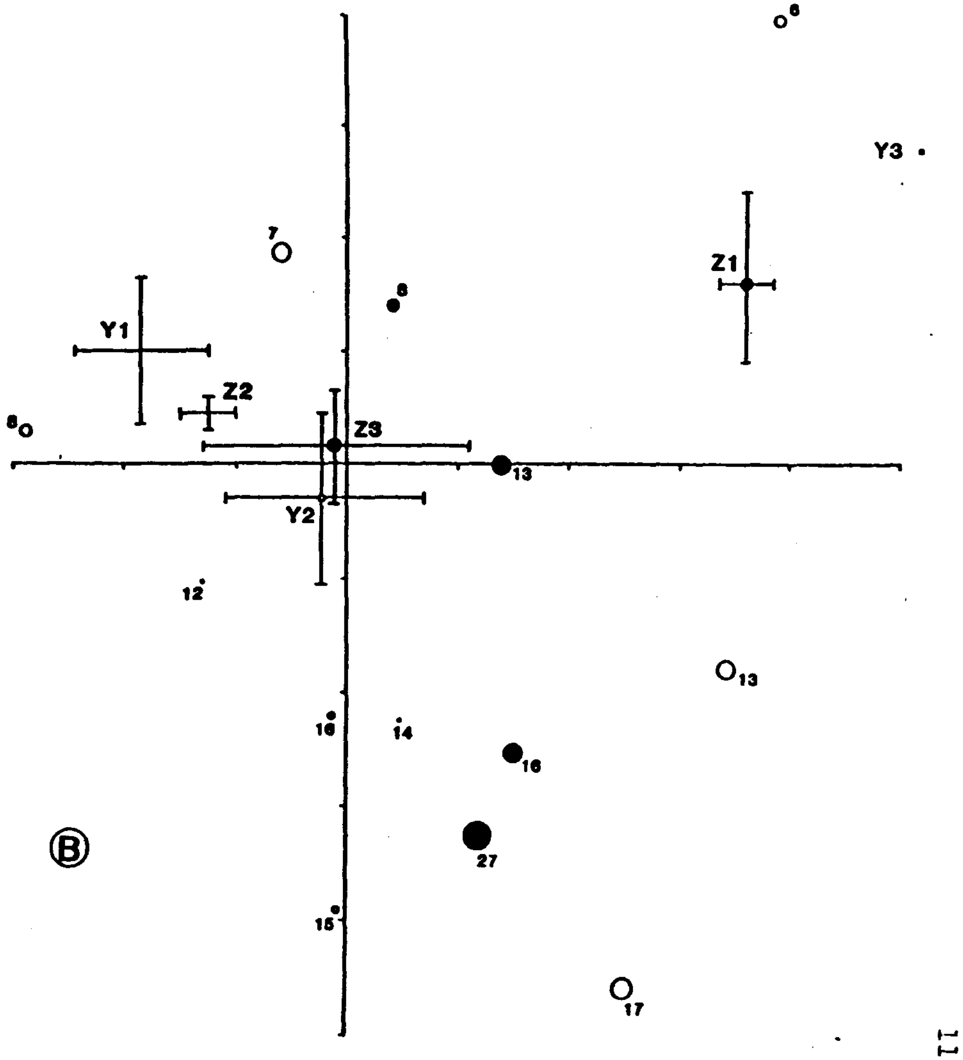
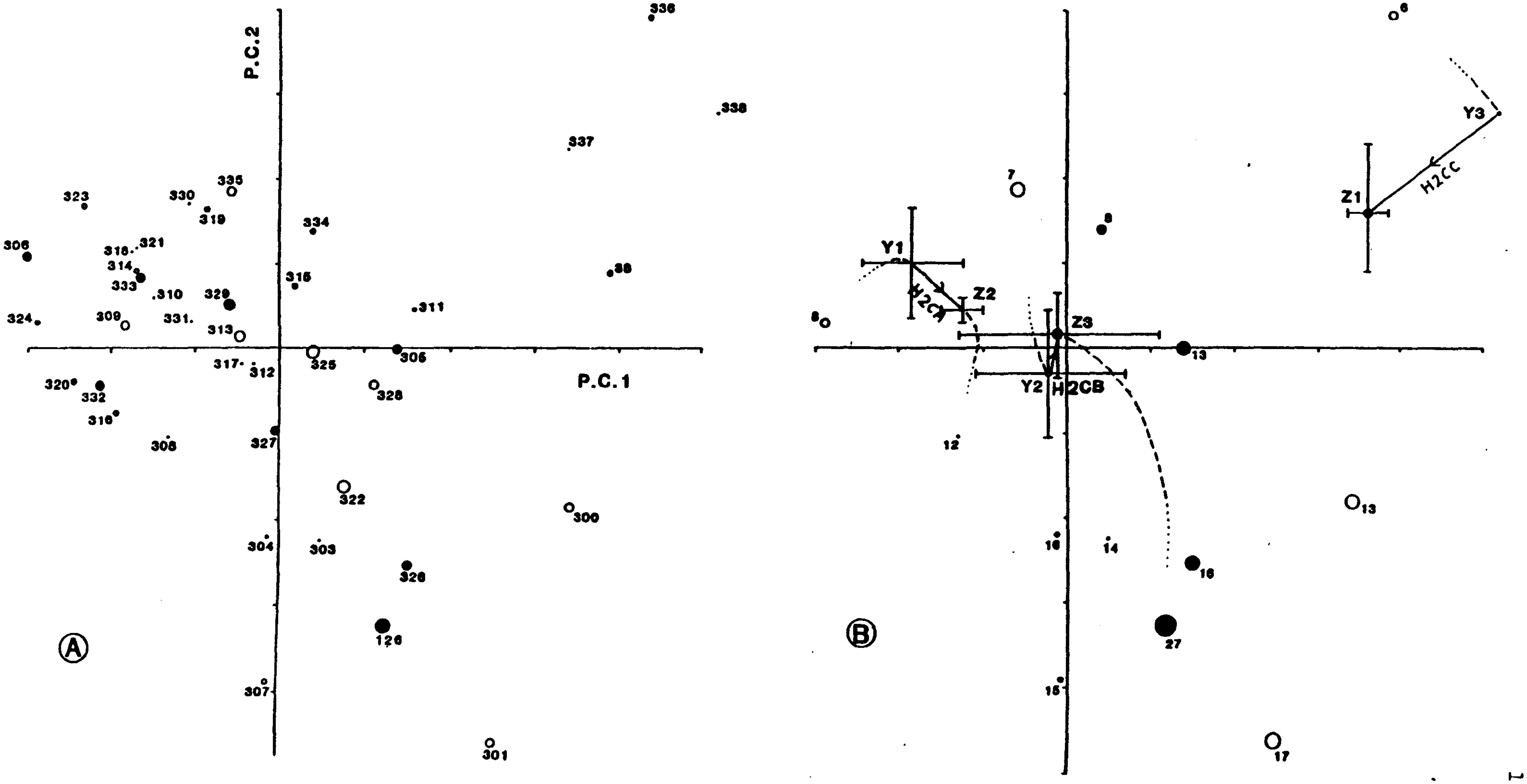


FIGURE 18. Principal components plots of H_{2c} zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 27.8%
P.C.2 - 21.2%
P.C.3 - 14.0%

A: Showing all analysed specimens. P.C.3 ≈ 1½ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ diam. of dots in mm.

	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1							−			−				−	−
PC2	+							+					−		
PC3	+	−	−			+									



Analysis of R_{1a} zone goniatites.

7-9 mm size range - analysis code HR1AX :

Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
X 1	mean	3.00		.800	.100	29.6	7.33	1.16	.200	.314	.875	.060	.015	.007	.067	.099	.022
	s.d.			0	0	1.52	1.52	.057	0	.034	.043	.045	.002	.005	.018	.038	.026
X 2	mean	6.00		.900	.050	12.8	13.0	1.01	.150	.255	.803	.110	.016	.013	.039	.095	.008
	s.d.			.063	.055	3.76	4.24	.041	.122	.039	.070	.076	.015	.009	.023	.021	.001
X 3	mean	2.00		.950	.250	22.5	27.5	1.00	0	.154	.819	0	.001	.001	.005	.146	.016
	s.d.			.071	.071	3.53	3.53	0	0	.045	.027	0	.002	.002	.008	.015	.022
X 4	mean	5.00		.950	.120	29.0	9.30	1.92	.380	.336	.831	.134	.028	.004	.063	.418	.018
	s.d.			.050	.084	6.32	2.38	.109	.349	.026	.109	.050	.017	.005	.033	.049	.009

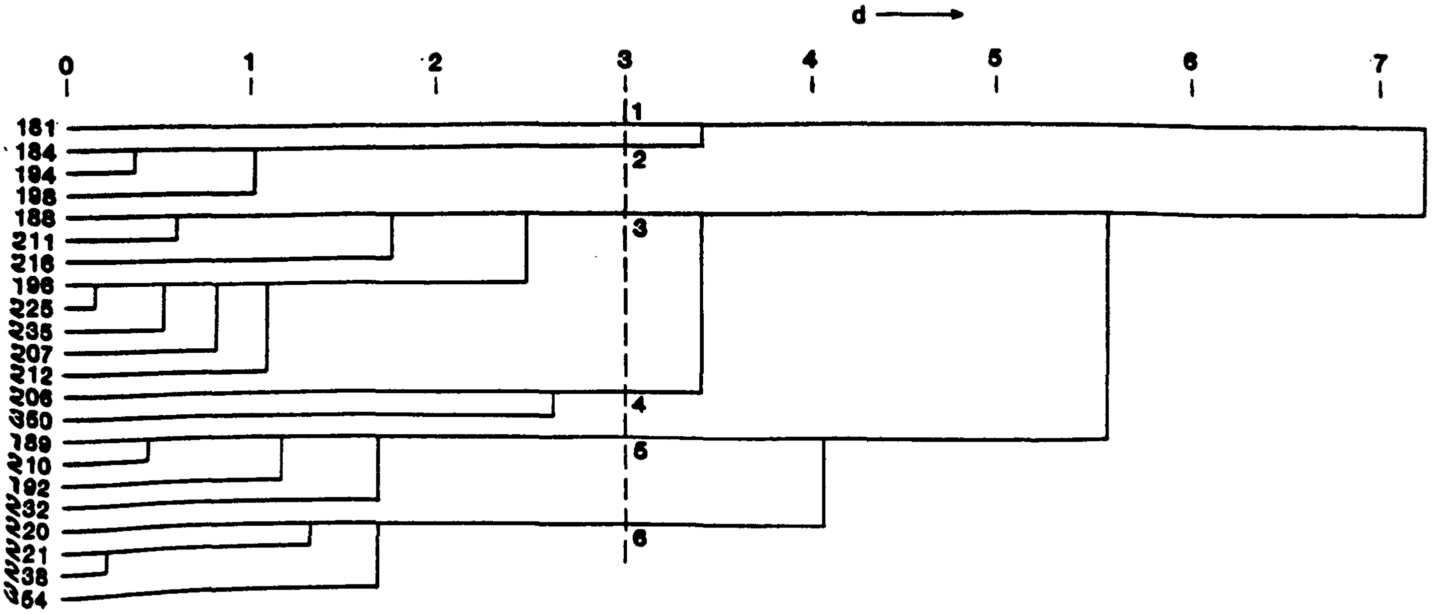
9-12 mm size range - analysis code HR1AY :

Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Y 1	mean	9.00	.911		22.0	11.6		.133	.223		.732	.070	.018	.009	.110	.128	.004
	s.d.		.074		8.53	4.72		.071	.040		.053	.025	.008	.008	.062	.054	.003
Y 2	mean	2.00	1.00		30.0	12.0		.150	.216		.784	.142	.011	.019	.131	.364	.007
	s.d.		0		7.07	5.66		.071	.057		.022	.011	.011	.001	.086	.056	.001
Y 3	mean	2.00	1.00		15.0	16.0		.400	.196		.737	.216	.047	.013	.262	.080	.003
	s.d.		0		.707	0		.424	.001		.077	.014	.001	.016	.077	.046	.001
Y 4	mean	5.00	.960		19.6	8.00		.040	.286		.862	.072	.032	.023	.076	.176	.022
	s.d.		.042		3.51	1.41		.055	.046		.055	.045	.015	.012	.039	.063	.014

12-16 mm size range - analysis code HR1AZ :

Dendrogram



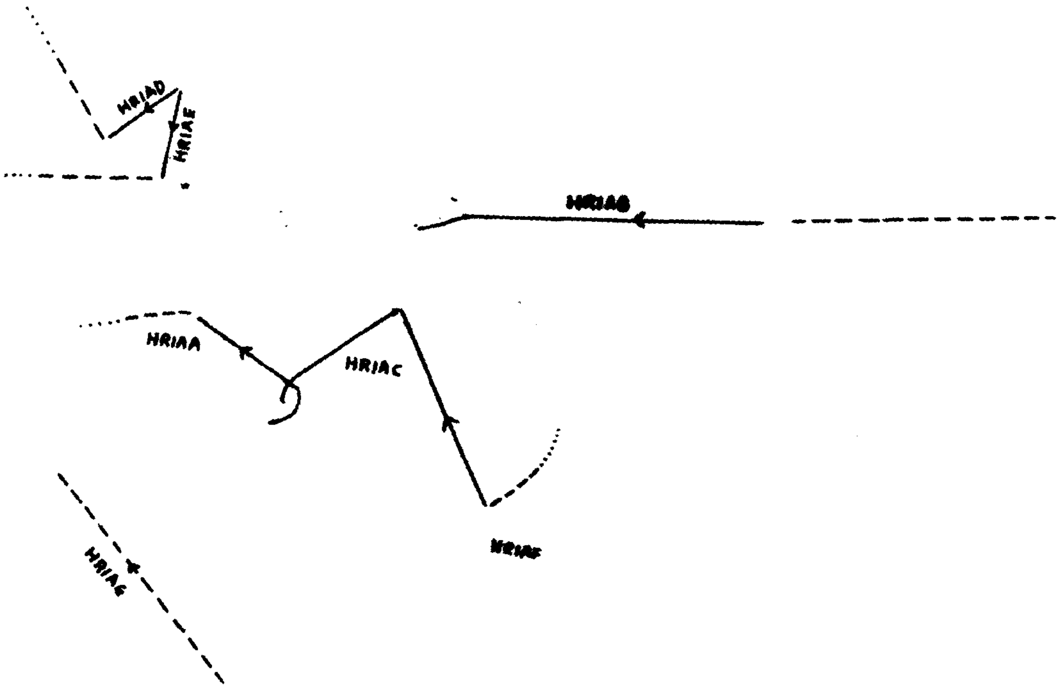
Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Z 1	mean	1.00			10.0	5.00			.336		.303	.033	.016	.003	.115	.131	.049
	s.d.				0	0			0		0	0	0	0	0	0	0
Z 2	mean	3.00			18.0	6.33			.239		.771	.023	.018	.021	.093	.085	.011
	s.d.				1.00	.577			.061		.065	.021	.006	.006	.044	.037	.007
Z 3	mean	8.00			18.2	9.75			.157		.717	.066	.020	.007	.244	.068	.003
	s.d.				3.77	4.16			.042		.106	.039	.006	.003	.074	.056	2.00
Z 4	mean	2.00			27.5	8.50			.196		.736	.176	.020	.004	.138	.206	.007
	s.d.				10.6	.707			.021		.037	.065	.006	.002	.073	.179	.007
Z 5	mean	4.00			19.0	6.37			.166		.763	.119	.038	.025	.381	.061	.002
	s.d.				3.36	2.81			.046		.054	.114	.007	.008	.055	.046	.001
Z 6	mean	4.00			16.0	16.7			.179		.797	.146	.045	.010	.235	.106	.003
	s.d.				2.94	2.06			.013		.068	.103	.006	.006	.148	.034	.001

Comments:

The ontogenetic transitions are confused here by P.C.1 being a direction of variation between as well as within morphospecies; morphological diversity is high. The most tenuous ontogenetic series of clusters is X1-Y4-Z2 - this however produces smoother ontogenetic curves for each character than the alternatives, and is therefore the most parsimonious solution.

Cluster Z1 comprises one anomalous specimen which is difficult to relate to any other.


HRIAD
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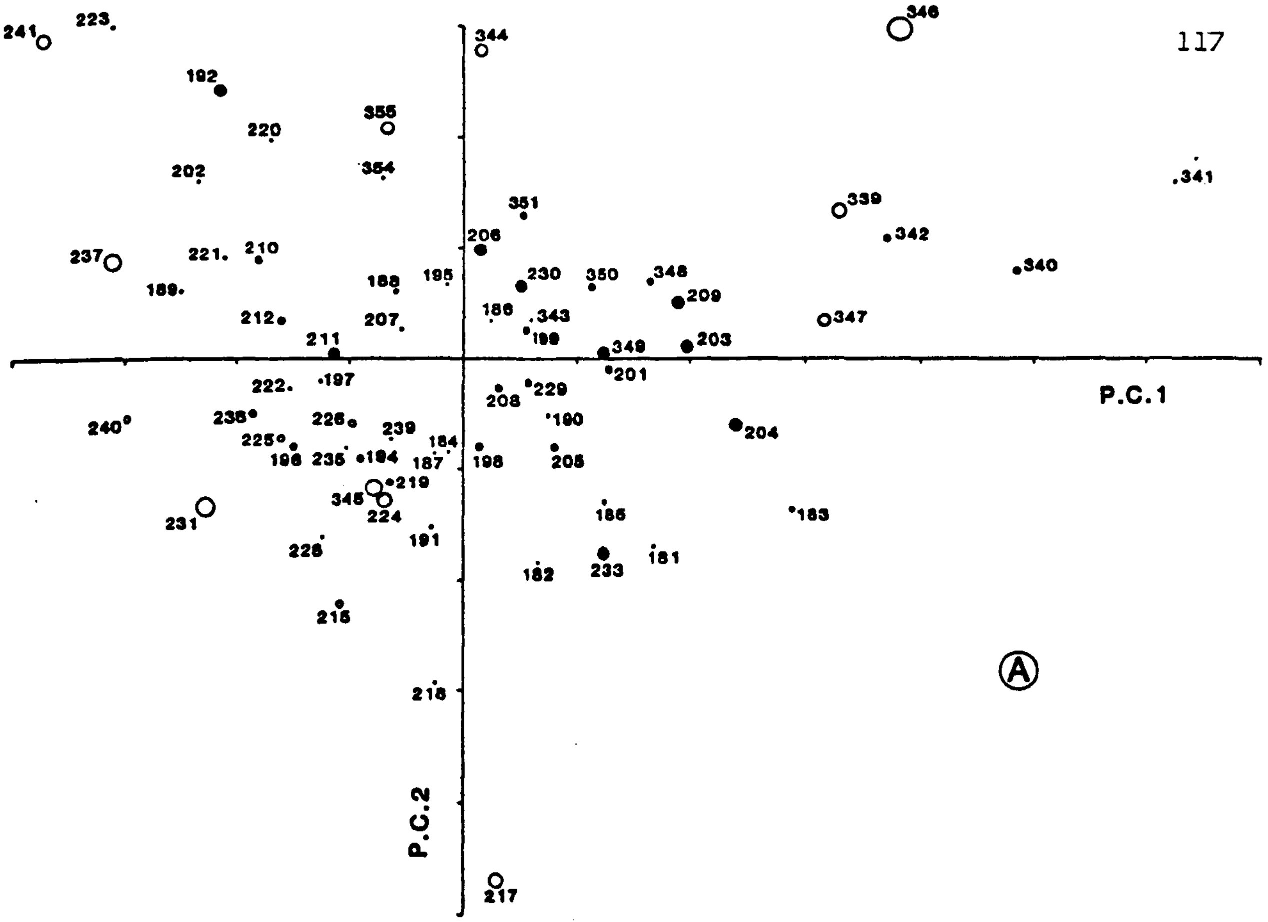


	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1			+		+		+						−	+	+
PC2	+									+	+		+		
PC3	+	−		−		−									

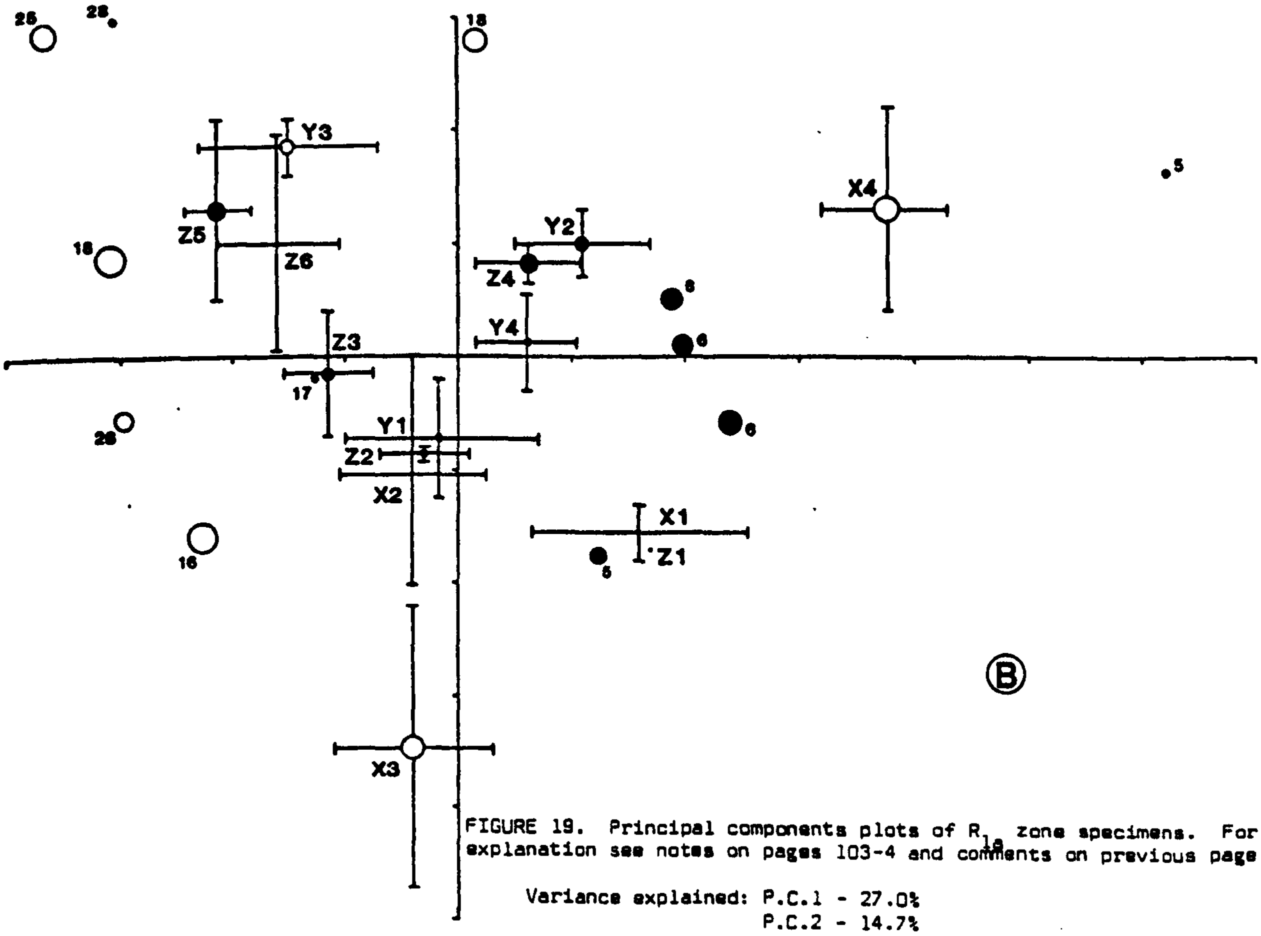
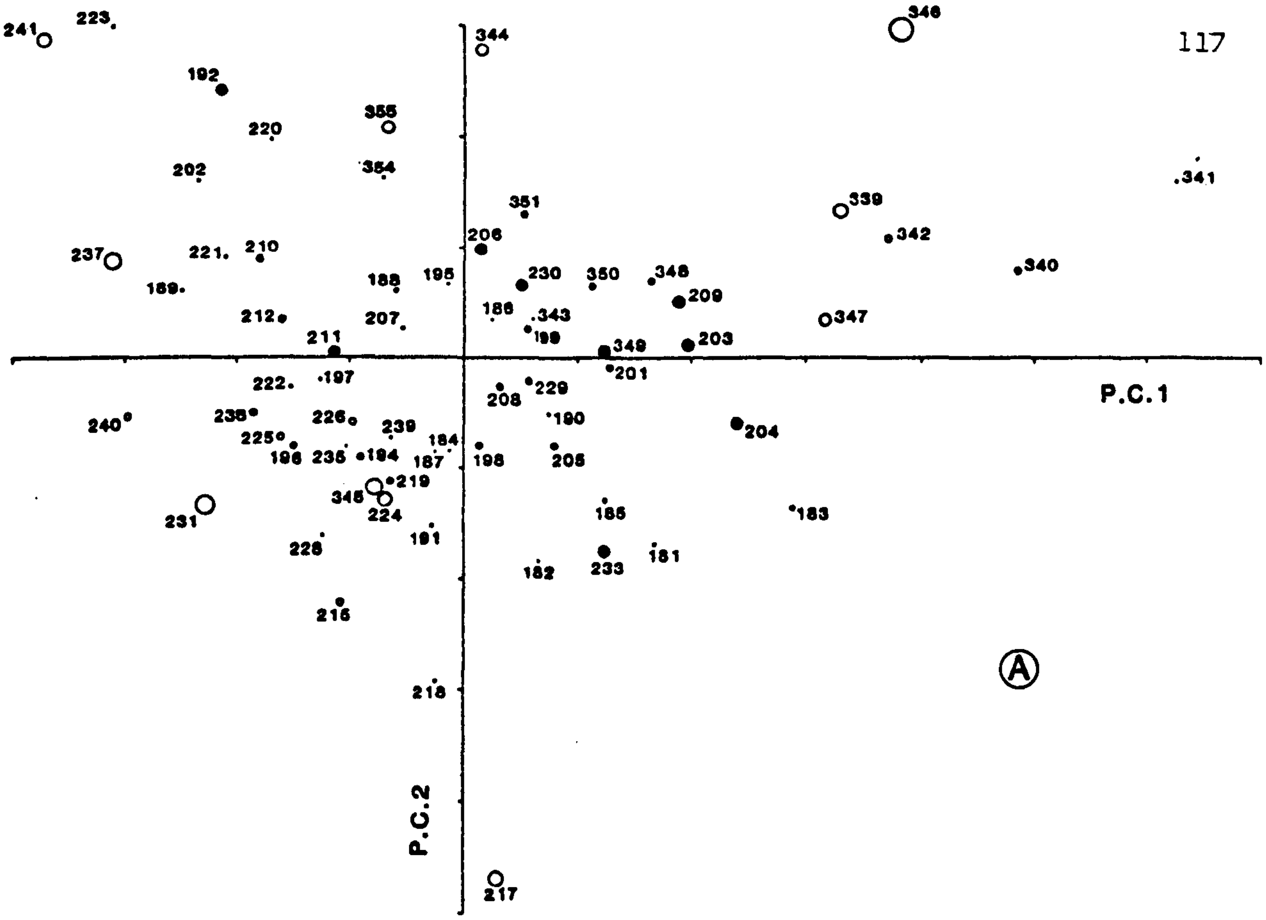


FIGURE 19. Principal components plots of R_{1a} zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 27.0%
P.C.2 - 14.7%
P.C.3 - 12.1%

A: Showing all analysed specimens. P.C.3 score ≃ 1½ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ 2 diam. of dots in mm.



	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1			+		+		+						−	+	+
PC2	+									+	+		+		
PC3	+	−		−		−									

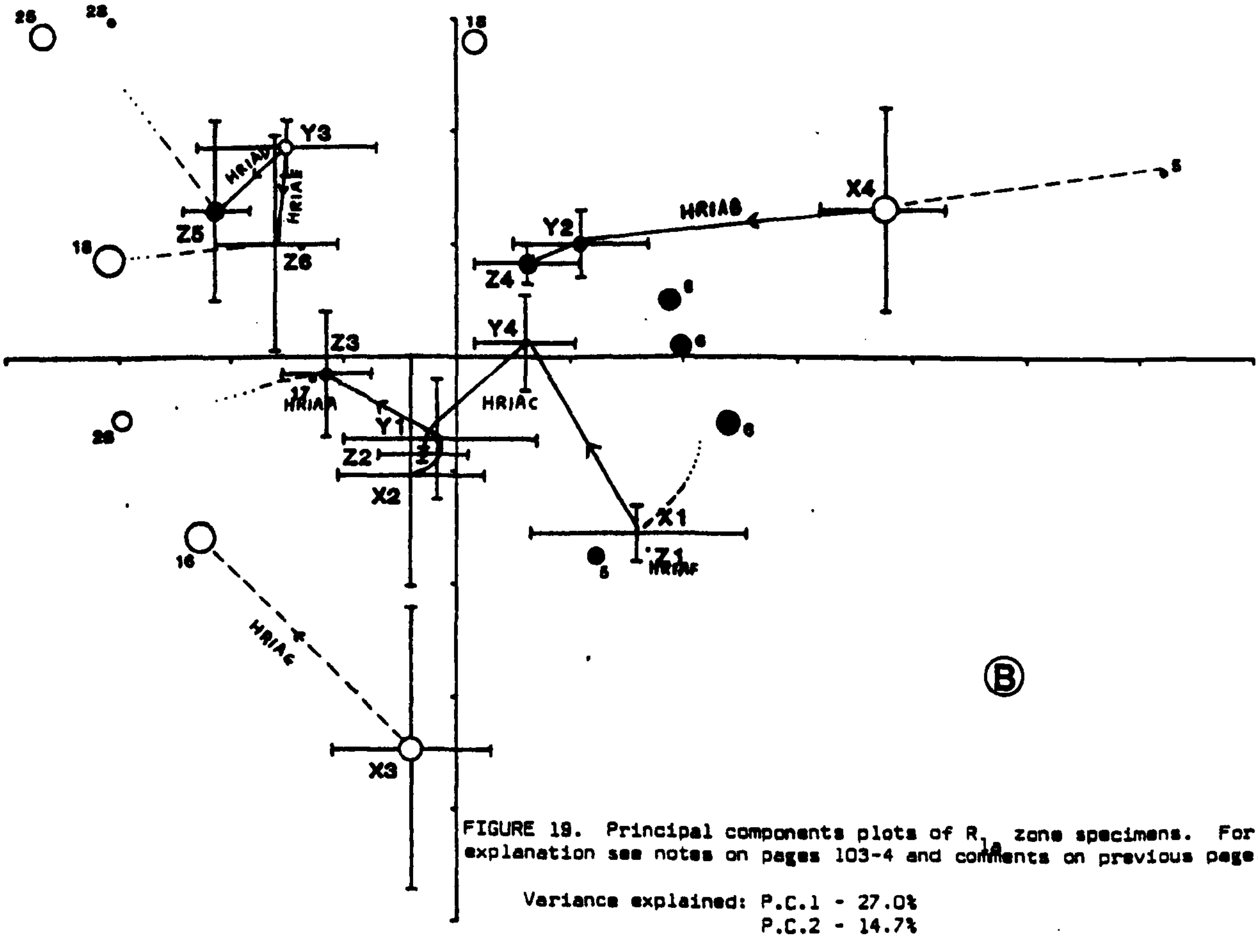


FIGURE 19. Principal components plots of R_{1a} zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 27.0%
P.C.2 - 14.7%
P.C.3 - 12.1%

A: Showing all analysed specimens. P.C.3 score ≃ 1½ diam. of dots in mm.
B:- Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ 2 diam. of dots in mm.

Analysis of R_{1b} zone goniatites.

7-9 mm size range - analysis code HR1BX :

Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
X 1	mean	5.00		.130	30.2		1.00	.180	.217			.026	.006	.005	.054	.054	.002
	s.d.			.120	2.86		0	.130	.044			.027	.005	.001	.032	.054	.002
X 2	mean	1.00		0	30.0		1.00	0	.096			.083	.027	.023	.250	0	0
	s.d.			0	0		0	0	0			0	0	0	0	0	0
X 3	mean	4.00		.175	23.7		1.47	.375	.264			.056	.017	.001	.077	.270	.010
	s.d.			.096	3.40		.126	.236	.013			.052	.025	.003	.038	.040	.005

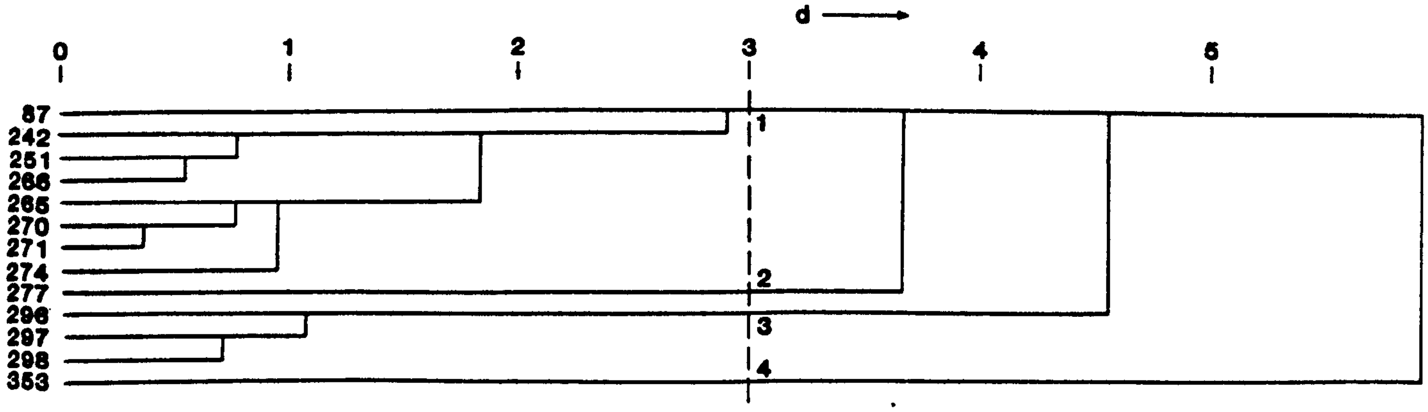
9-12 mm size range - analysis code HR1BY :

Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Y 1	mean	7.00	.864		19.3	8.71	1.32	.235	.238			.085	.018	.002	.143	.168	.006
	s.d.		.114		4.11	2.37	.386	.121	.029			.050	.015	.004	.087	.138	.003
Y 2	mean	1.00	.800		12.0	7.00	2.50	1.00	.218			.050	.008	.025	.117	.250	.010
	s.d.		0		0	0	0	0	0			0	0	0	0	0	0
Y 3	mean	5.00	.840		25.8	24.8	1.00	.120	.176			.027	.008	.003	.089	.064	.001
	s.d.		.055		5.72	16.7	0	.130	.043			.027	.008	.003	.057	.040	.001

12-16 mm size range - analysis code HR1BZ :

Dendrogram



Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Z 1	mean	8.00		.200	22.0		1.00	.112	.163		.747	.047	.027	.019	.151	.042	.001
	s.d.			.219	2.93		0	.125	.047		.066	.039	.013	.011	.049	.059	.001
Z 2	mean	1.00		.100	30.0		1.00	.100	.124		.576	.185	.033	.022	.413	.065	.003
	s.d.			0	0		0	0	0		0	0	0	0	0	0	0
Z 3	mean	3.00		.100	17.3		1.26	.167	.193		.759	.055	.017	.004	.186	.202	.004
	s.d.			0	4.61		.263	.058	.044		.047	.052	.011	.004	.037	.049	.001
Z 4	mean	1.00		0	7.00		1.98	.900	.133		.934	.066	.003	0	.098	0	0
	s.d.			0	0		0	0	0		0	0	0	0	0	0	0

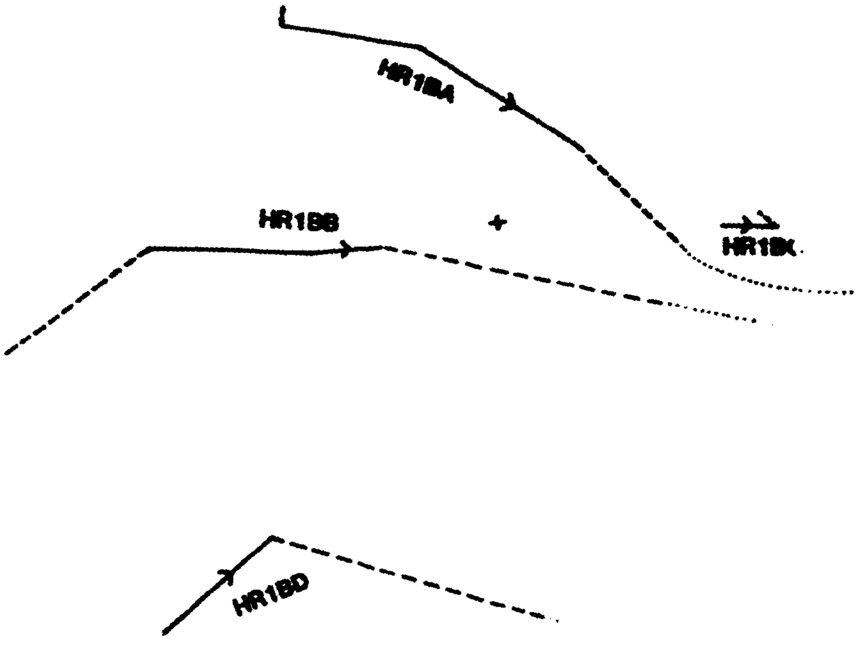
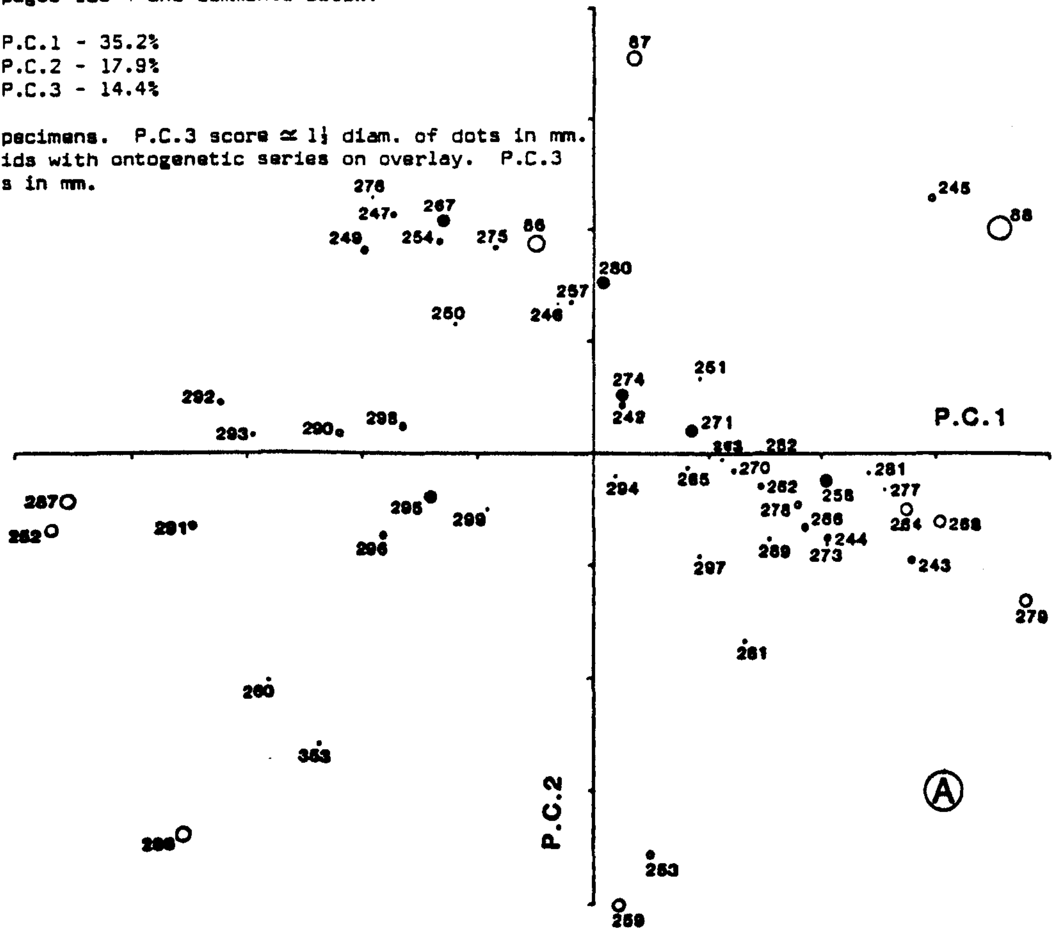

HR1BA
HR1BB
+
HR1BX
HR1BD

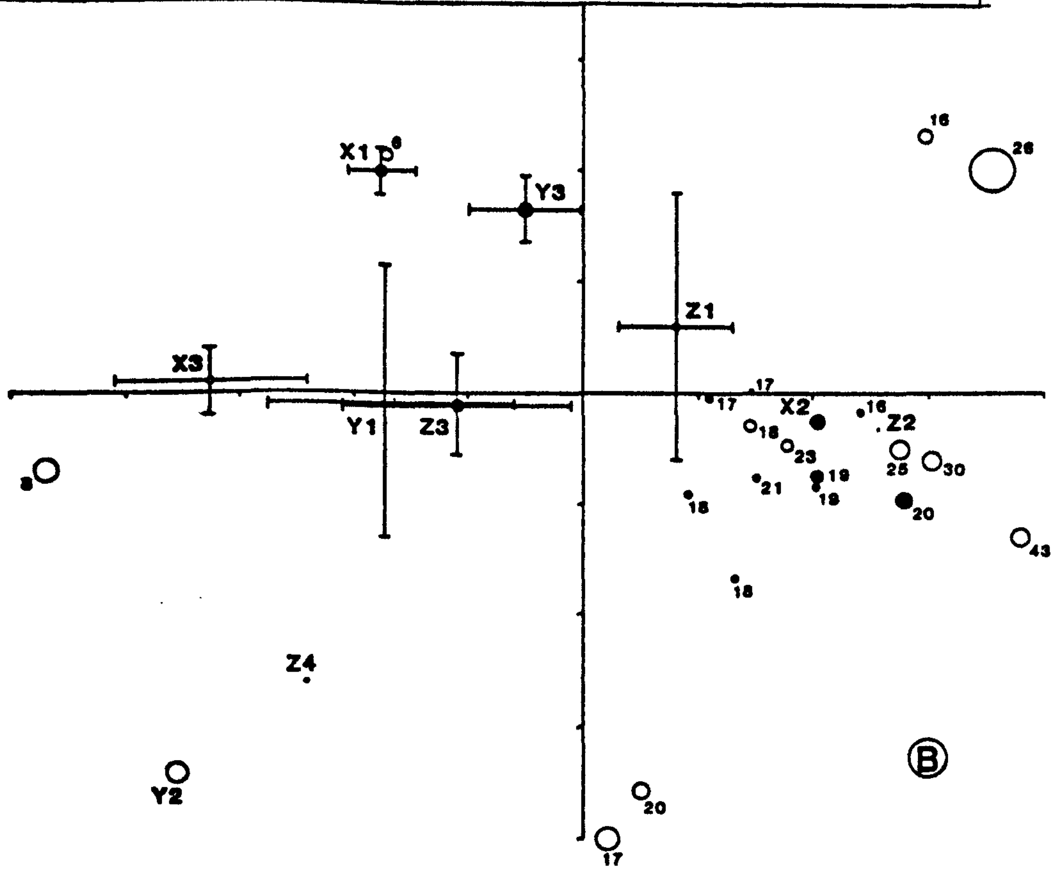
FIGURE 20. Principal components plots of R_{1b} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 35.2%
P.C.2 - 17.9%
P.C.3 - 14.4%

A: Showing all analysed specimens. P.C.3 score ≃ 1½ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score $\frac{2}{3}$ diam. of dots in mm.



	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1				|		–	–	|	|		+	+	+		–
PC2	–	+	+	|	–	–		|	|						
PC3	+	–		|				|	|	–					



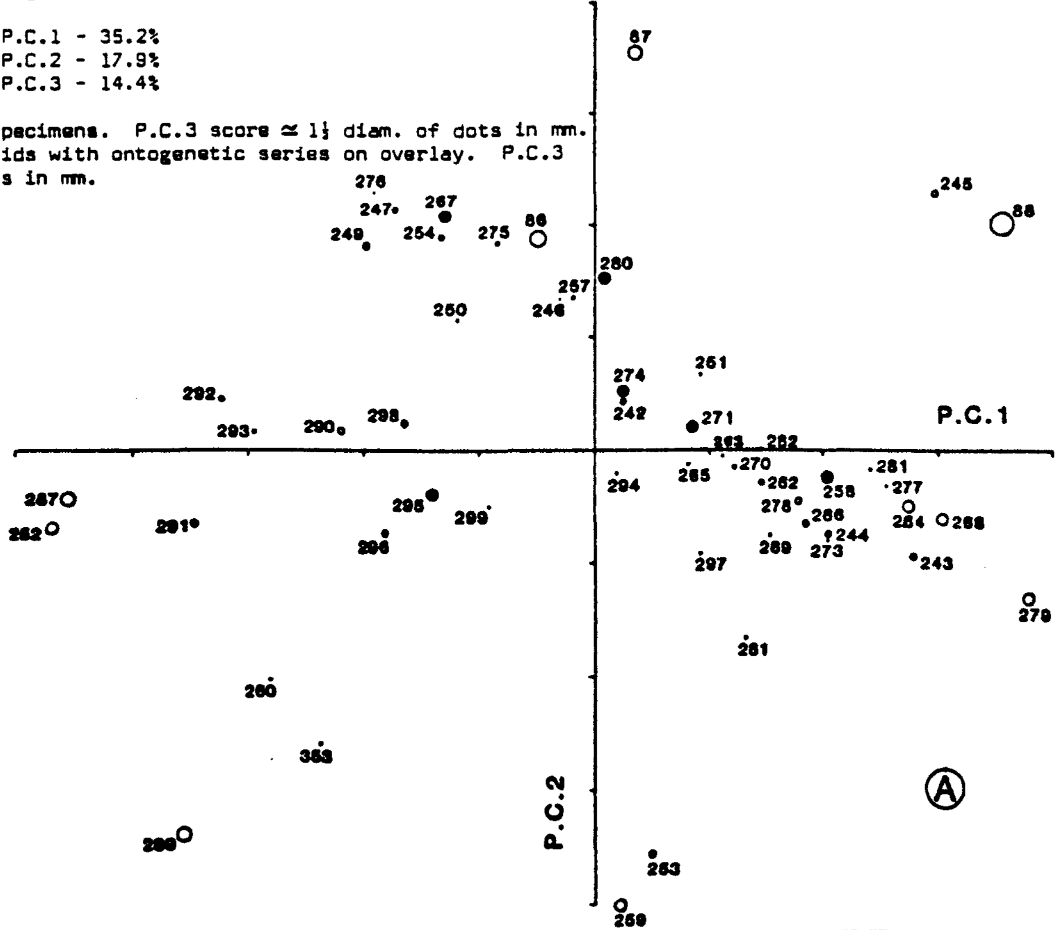
Comments:

Ontogenetic continua are quite clear from the principal components plot. It is apparent that morphospecies HR1BA and HR1BB become similar

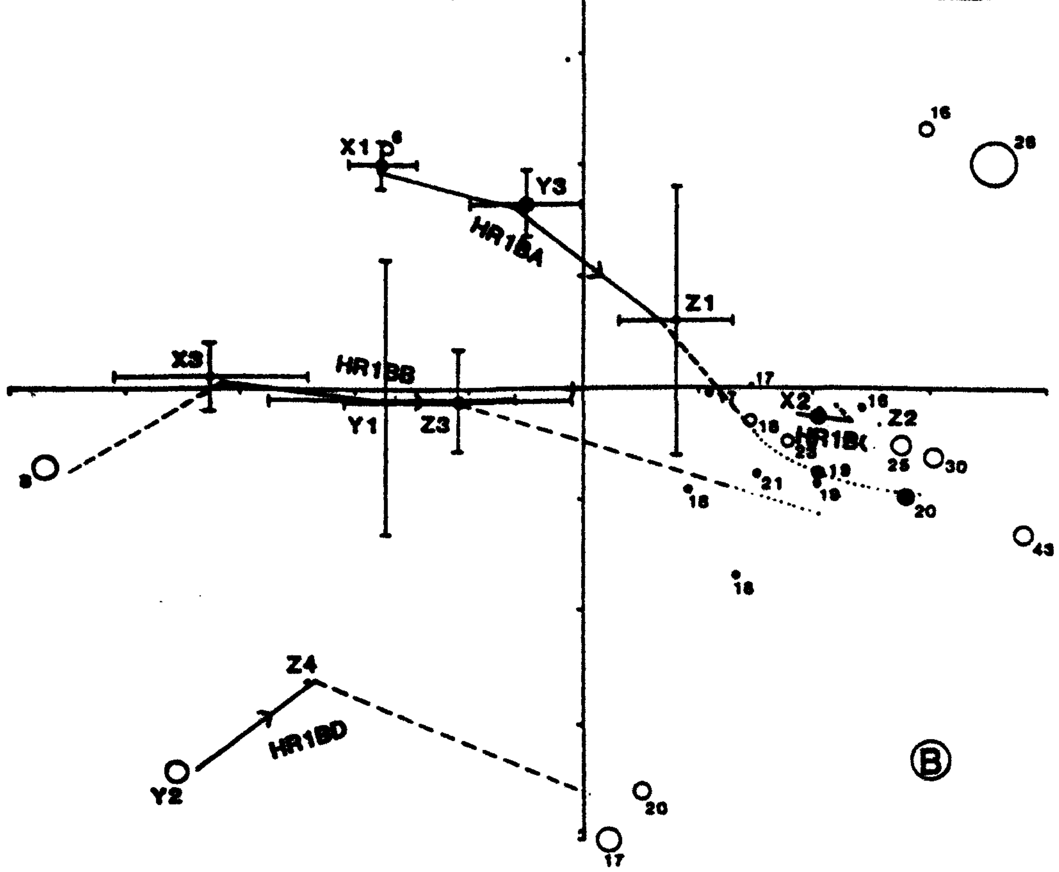
FIGURE 20. Principal components plots of R_{1b} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 35.2%
P.C.2 - 17.9%
P.C.3 - 14.4%

A: Showing all analysed specimens. P.C.3 score ≃ 1½ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score $\frac{2}{3}$ diam. of dots in mm.



	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1				│		−	−	│	│		+	+	+		−
PC2	−	+	+	│	−	−		│	│						
PC3	+	−		│				│	│	−					



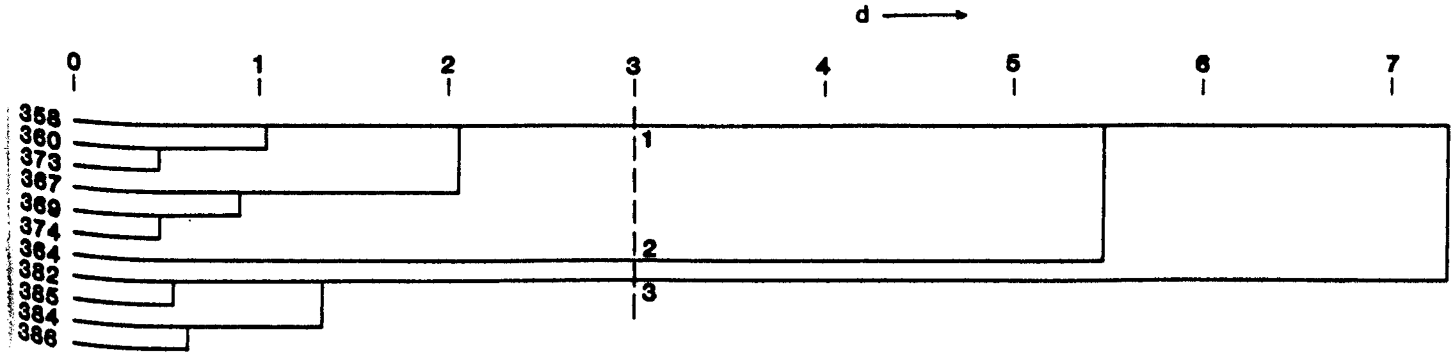
Comments:

Ontogenetic continua are quite clear from the principal components plot. It is apparent that morphospecies HR1BA and HR1BB become similar

Analysis of R_{1c} to Westphalian goniatites.

11-14 mm size range - analysis code HR1CGZ :

Dendrogram

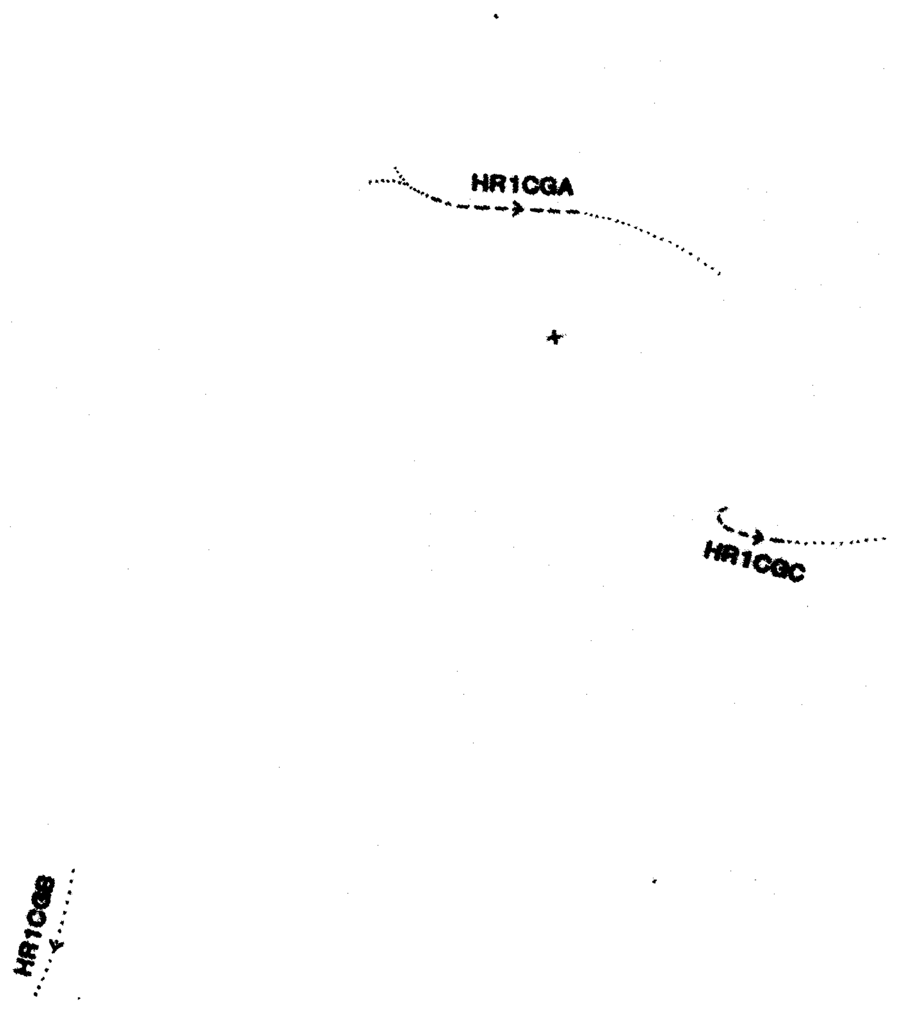


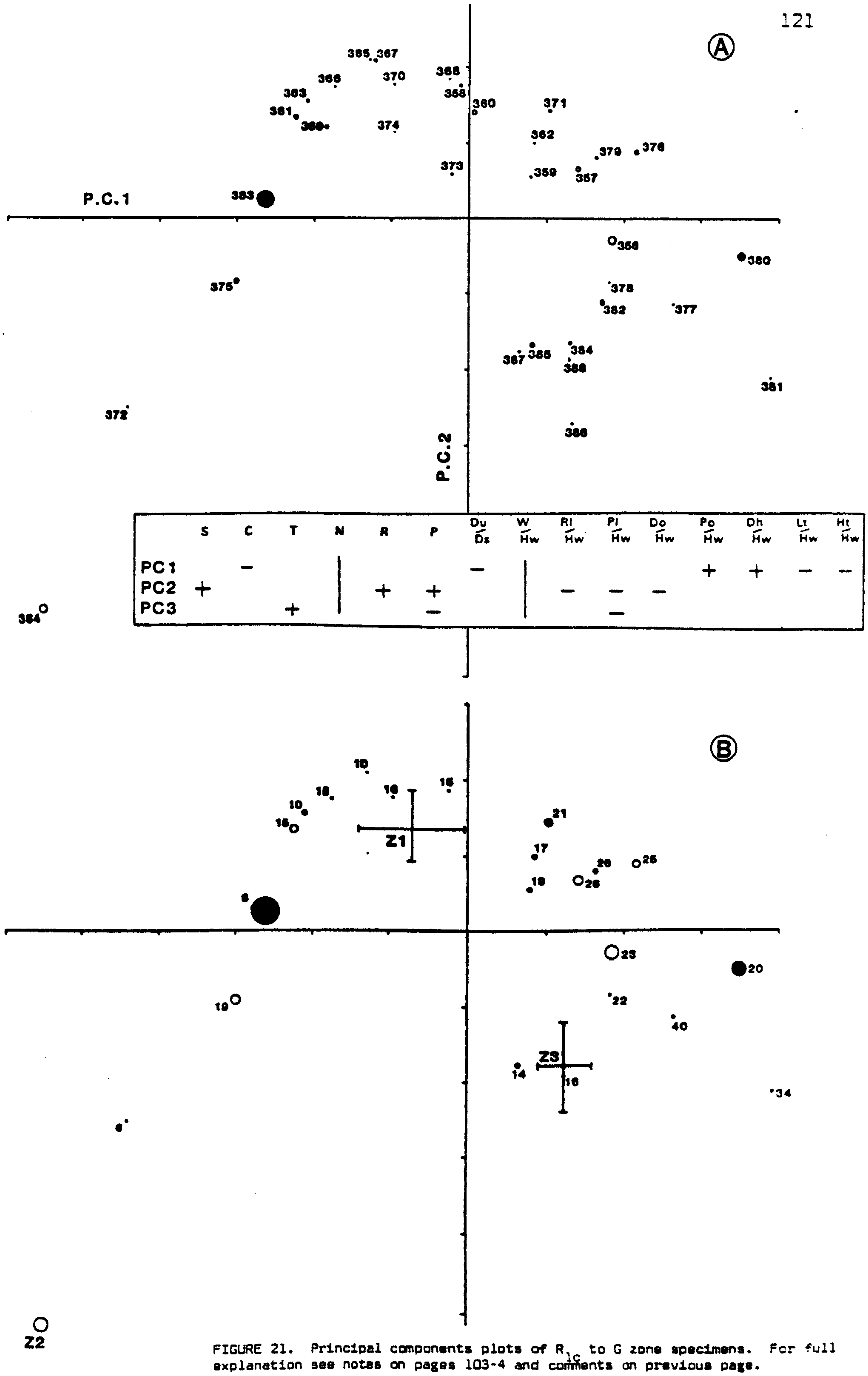
Means of character values for each cluster:

Cluster code		n	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Oh/Hw	Lt/Hw	Ht/Hw
Z 1	mean	6.00	.983		10.0		1.62	.917	.236		.677	.101	.021	.003	.163	.108	.004
	s.d.		.026		1.55		.354	.075	.062		.037	.067	.018	.003	.064	.129	.005
Z 2	mean	1.00	.700		13.0		1.00	.400	.442		.875	.300	.063	0	.063	.275	.008
	s.d.		0		0		0	0	0		0	0	0	0	0	0	0
Z 3	mean	4.00	.975		12.2		1.05	.175	.155		.718	.201	.071	.027	.347	.028	0
	s.d.		.050		3.20		.058	.050	.030		.053	.073	.019	.010	.058	.028	.001

Comments:

Many late Namurian and Westphalian specimens identified as Homoceratids are of various relatively large sizes, but without enough specimens at any particular size interval to allow analysis. Nevertheless, the ontogenetic trend around cluster Z1 is clear. For further notes regarding Z2 and Z3, see page 222.


HR1CGA
HR1CGC
HR1CGB

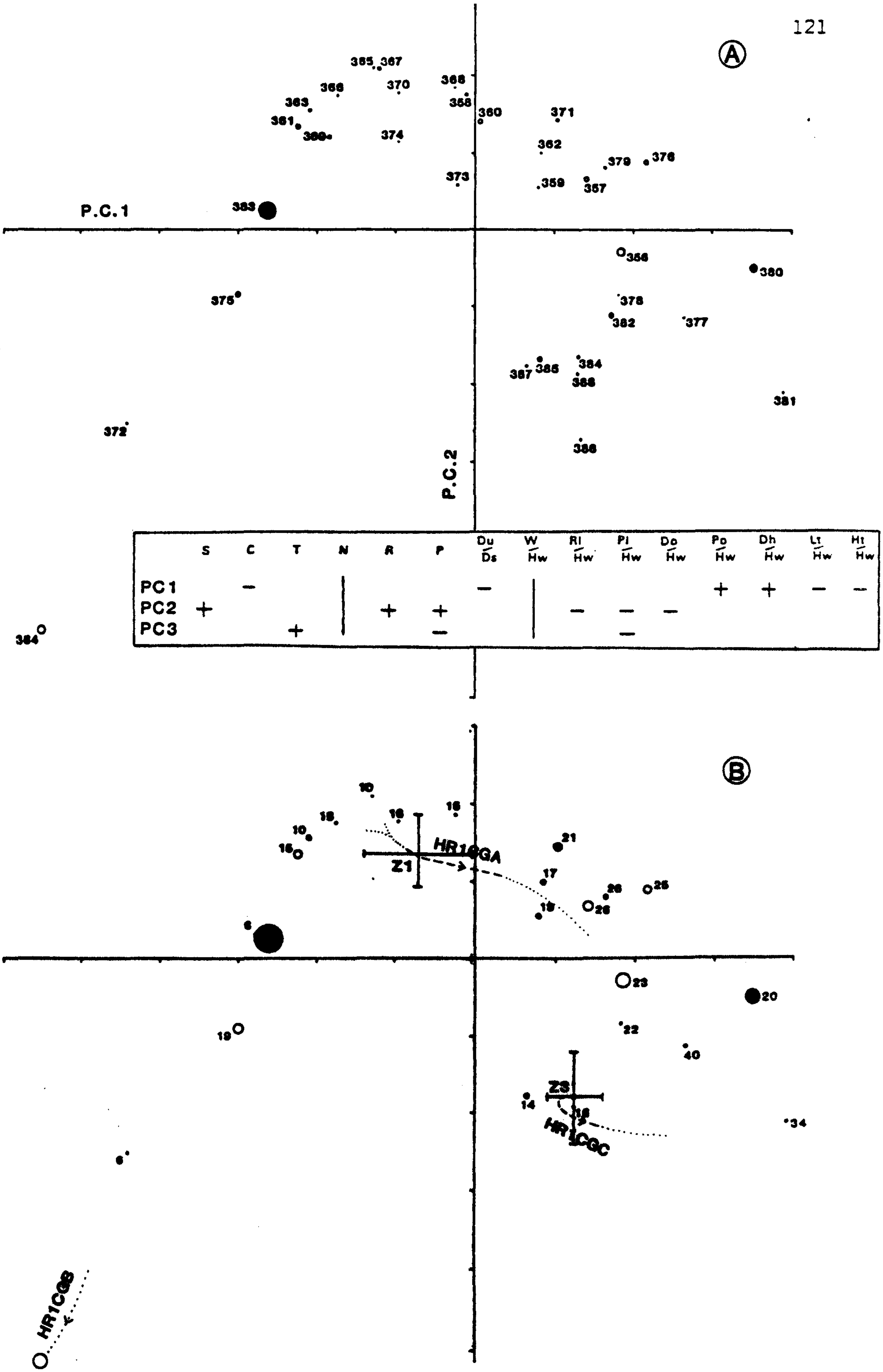


	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1		−		│			−	│				+	+	−	−
PC2	+			│	+	+		│	−	−	−				
PC3			+	│		−		│		−					

FIGURE 21. Principal components plots of R_{1c} to G zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 35.8%
P.C.2 - 23.4%
P.C.3 - 10.3%

A: Showing all analysed specimens. P.C.3 ≈ 1½ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ $\frac{2}{3}$ diam. of dots in mm.



	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1		−		│			−	│				+	+	−	−
PC2	+			│	+	+		│	−	−	−				
PC3			+	│		−		│		−					

FIGURE 21. Principal components plots of R_{1c} to G zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 35.8%
P.C.2 - 23.4%
P.C.3 - 10.3%

A: Showing all analysed specimens. P.C.3 ≈ 1½ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ 2 diam. of dots in mm.

4.1.2. ANALYSES OF SAMPLES OF RETICULOCERATIDAE s.l.

Samples were isolated from each of the following stratigraphic divisions:

R_{1a1}, R_{1a2}, R_{1b}, R_{1c}, R_{2a}, R_{2b}, R_{2c} to G.

Analysis of R_{1a1} zone goniatites.

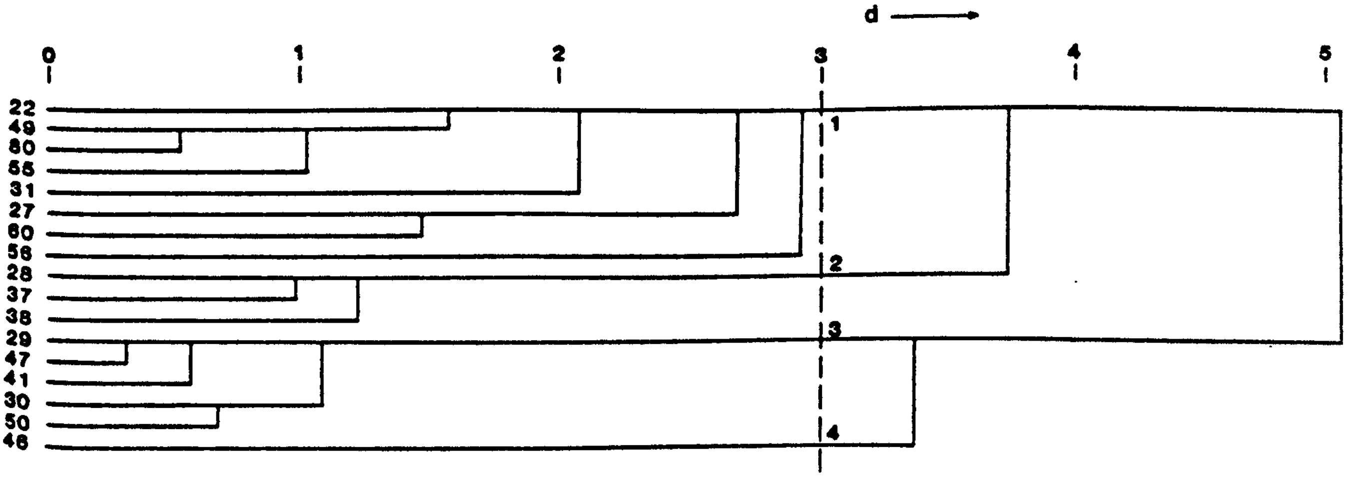
7-10 mm size range - analysis code R1A1X :

Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
X 1	mean	1.00	.900		50.0	1.30	.325		.844	.219	.094	0	.094	.156	.019
	s.d.		0		0	0	0		0	0	0	0	0	0	0
X 2	mean	2.00	.600		15.0	2.00	.422		.839	.339	.134	0	.241	.321	.045
	s.d.		0		5.65	.001	.031		.078	.076	.013	0	.013	.152	.013
X 3	mean	6.00	.883		30.5	1.39	.463		.843	.607	.027	0	.217	.391	.050
	s.d.		.683		4.93	.563	.033		.093	.203	.024	0	.074	.084	.026

10-13 mm size range - analysis code R1A1Y :

Dendrogram



Means of character values for each cluster:

Cluster ccde		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Y 1	mean	8.00	.850		24.6	1.13	.448	2.26	.874	.741	.044	0	.262	.425	.055
	s.d.		.096		3.66	.168	.039	.408	.037	.192	.034	0	.138	.145	.028
Y 2	mean	3.00	.300		19.6	1.53	.438	1.80	.771	.501	.041	0	.347	.442	.041
	s.d.		0		2.51	.251	.026	.234	.051	.229	.030	0	.100	.072	.023
Y 3	mean	5.00	.870		29.0	1.12	.406	1.65	.784	.414	.033	0	.211	.300	.031
	s.d.		.045		3.74	.084	.047	.242	.032	.143	.024	0	.037	.043	.007
Y 4	mean	1.00	.750		29.0	1.10	.314	1.26	.943	.377	.015	0	.415	.283	.113
	s.d.		0		0	0	0	0	0	0	0	0	0	0	0

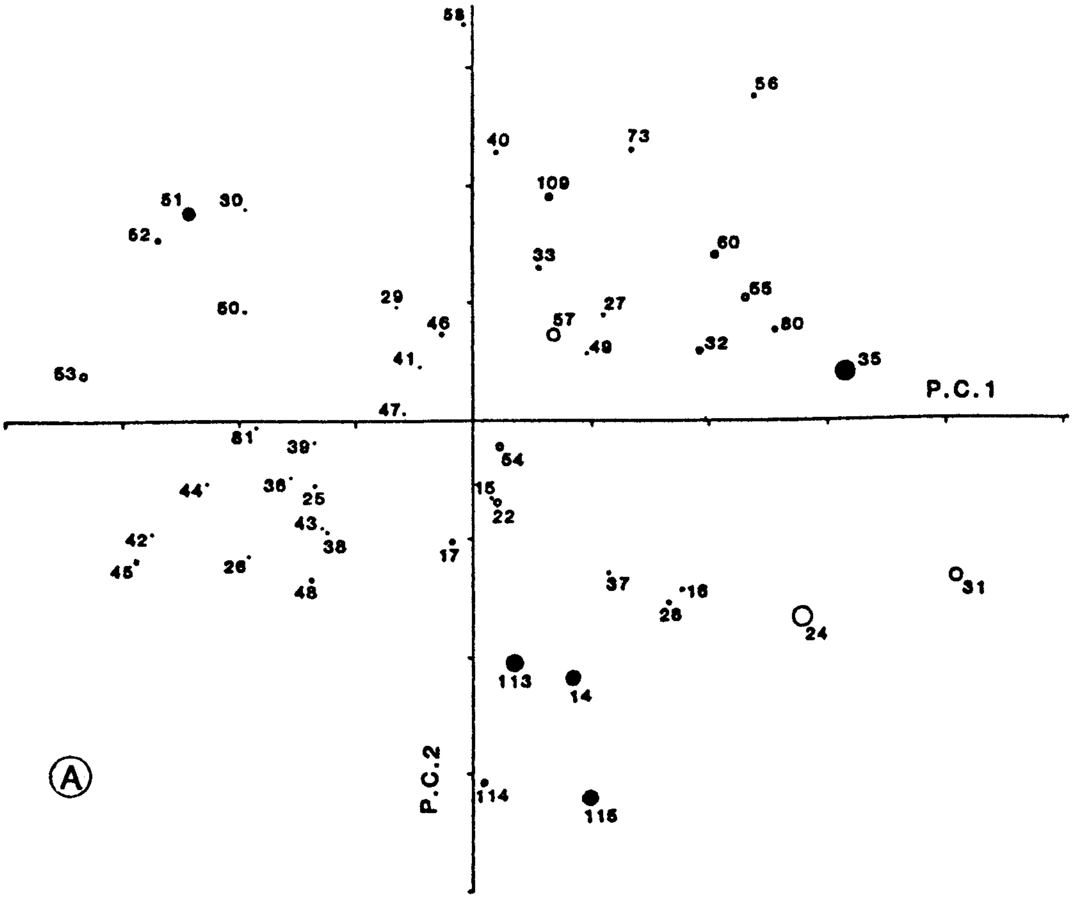
<u>13-17 mm size range - analysis code R1A1Z</u> :

Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Z 1	mean	4.00	.787		16.0	1.65	.399	1.87	.808	.451	.066	0	.275	.464	.049
	s.d.		.085		4.89	.311	.039	.242	.015	.170	.027	0	.038	.057	.013
Z 2	mean	3.00	.917		25.0	1.10	.439	1.95	.812	.651	.072	0	.559	.444	.045
	s.d.		.076		8.66	.100	.024	.214	.032	.150	.013	0	.183	.102	.016
Z 3	mean	9.00	.816		22.6	1.24	.344	1.41	.768	.389	.038	0	.308	.295	.027
	s.d.		.090		5.10	.124	.037	.121	.050	.099	.011	0	.116	.060	.013

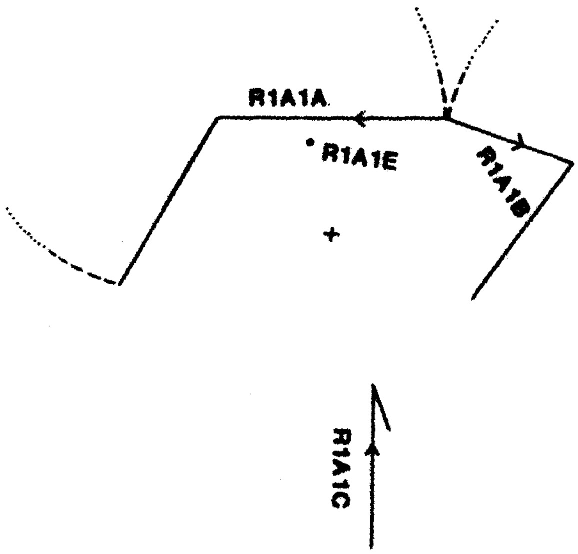
Comments:

The ontogenetic trends of these morphospecies show various directions in P.C. space, but these directions are quite unambiguous. Clusters X1 and Y4 are not linkable with any others, both being composed of anomalous single specimens. X1 is not present on the principal components plot: this analysis involved the character W/H_W, but the X1 specimen (no. 19) is laterally crushed.



	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1		|			+	+	+	+				+	+
PC2	+	|	+	–					–				
PC3		|		+				–			–		

FIGURE 22A. Description overleaf.


R1A1A
R1A1E
R1A1B
R1A1C

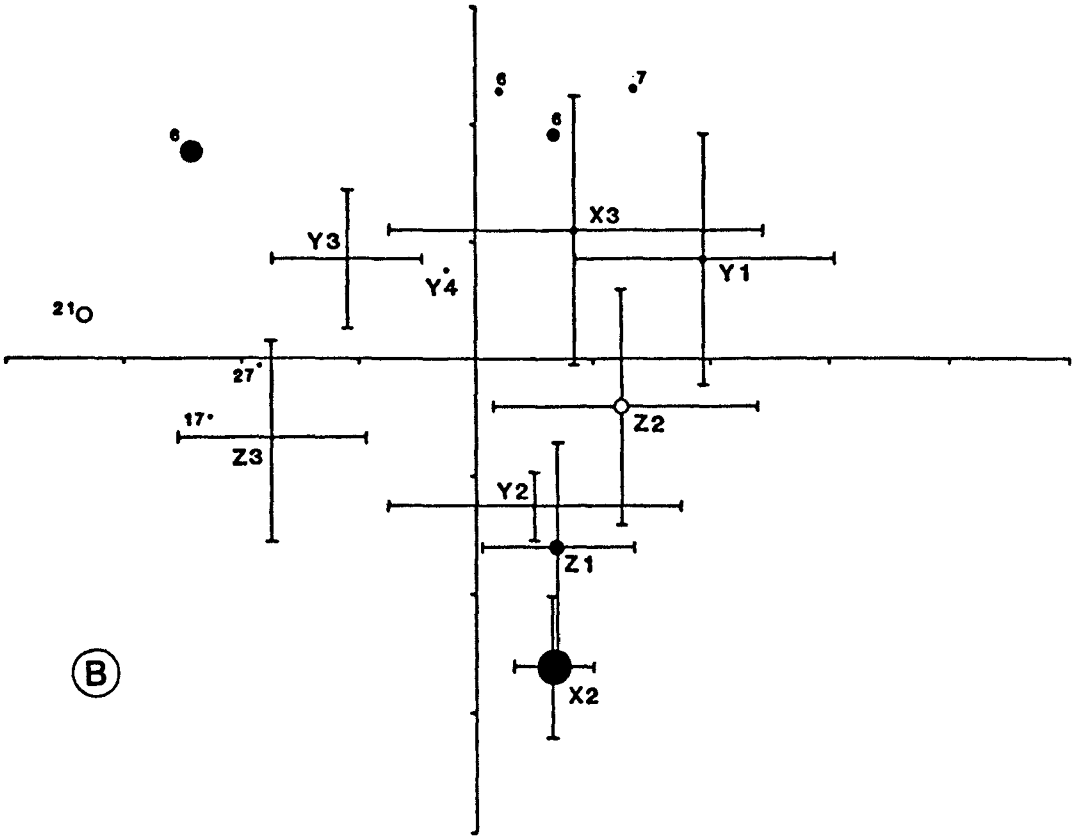


FIGURE 22. Principal components plots of R_{1a1} zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 26.6%
P.C.2 - 18.5%
P.C.3 - 10.0%

A: (Previous page) Showing all analysed specimens. P.C.3 score ≃ $1\frac{1}{3}$ diam. of dotes in mm.

B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ ½ diam. of dots in mm.

Analysis of R_{1a2} zone goniatites.

5-7 mm size range - analysis code R1A2U :

Means of character values for each cluster:

Cluster code		n	S	C	T	R	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
U 1	mean	5.00	.850		23.8	1.50	.374	1.70	.803	.364	.061		.192	.326	.035
	s.d.		.050		4.60	.223	.038	.191	.043	.072	.023		.046	.041	.015
U 2	mean	4.00	.962		30.2	1.57	.344	1.48	.855	.210	.104		.146	.314	.034
	s.d.		.048		4.57	.464	.007	.097	.022	.042	.008		.062	.050	.017
U 3	mean	5.00	.880		24.6	2.20	.369	1.82	.892	.226	.062		.121	.245	.056
	s.d.		.067		5.81	.245	.036	.066	.044	.032	.022		.010	.045	.018
U 4	mean	4.00	.787		17.0	1.50	.432	1.88	.950	.557	.061		.281	.416	.050
	s.d.		.025		4.96	.082	.016	.128	.024	.079	.046		.061	.036	.019
U 5	mean	5.00	.720		12.8	1.82	.443	1.81	.821	.673	.031		.287	.304	.086
	s.d.		.057		4.39	.109	.027	.100	.055	.125	.013		.121	.092	.013

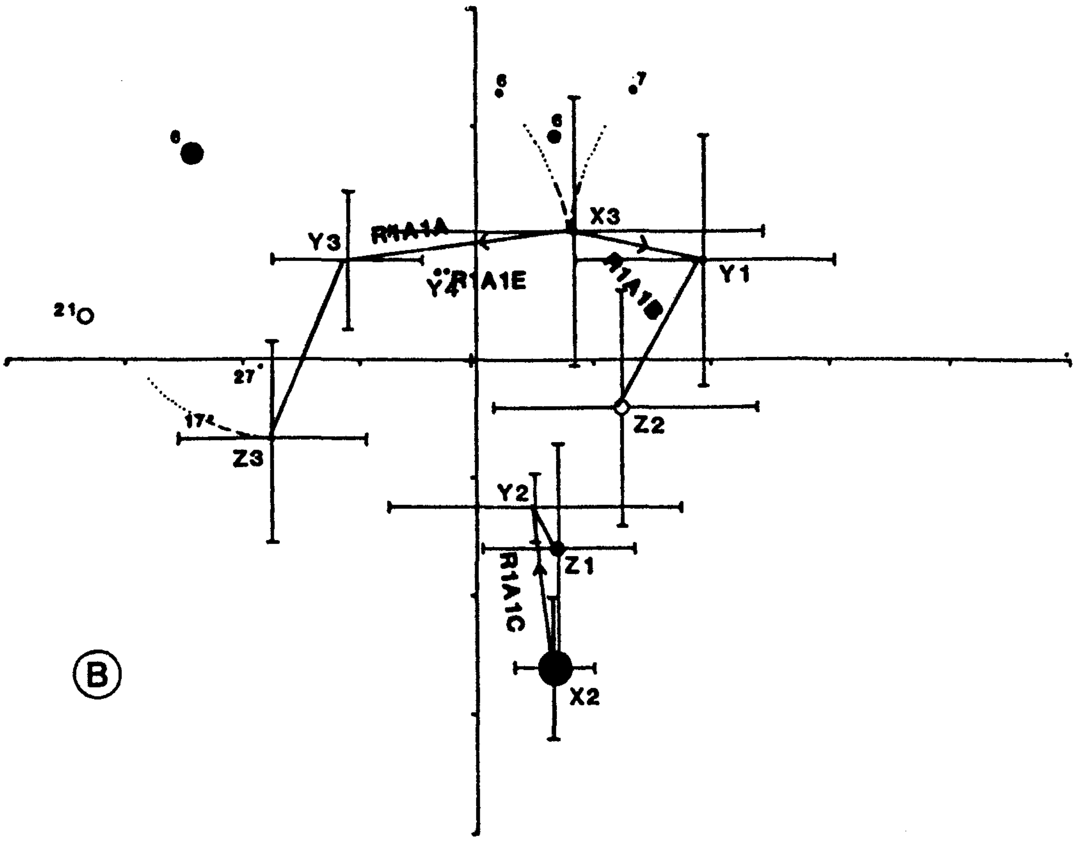


FIGURE 22. Principal components plots of R_{1a1} zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 26.6%
P.C.2 - 18.5%
P.C.3 - 10.0%

A: (Previous page) Showing all analysed specimens. P.C.3 score ≈ $1\frac{1}{3}$ diam. of dotes in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ ½ diam. of dots in mm.

Analysis of R_{1a2} zone goniatites.

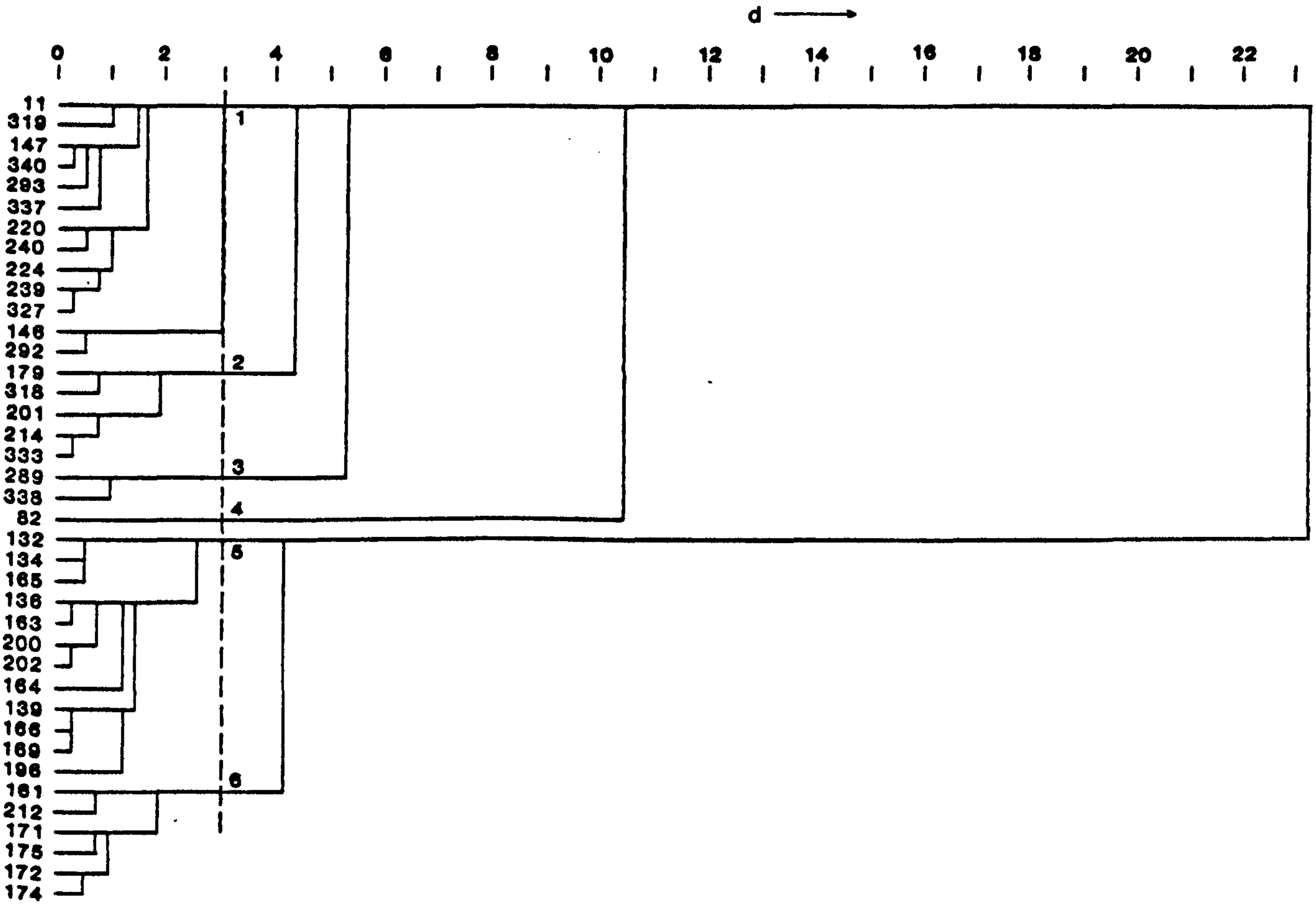
5-7 mm size range - analysis code R1A2U :

Means of character values for each cluster:

Cluster code		a	S	C	T	R	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
U 1	mean	5.00	.850		23.8	1.50	.374	1.70	.809	.364	.061		.192	.326	.035
	s.d.		.050		4.60	.223	.038	.191	.043	.072	.023		.046	.041	.015
U 2	mean	4.00	.962		30.2	1.57	.344	1.48	.855	.210	.104		.148	.314	.034
	s.d.		.048		4.57	.464	.007	.097	.022	.042	.008		.082	.050	.017
U 3	mean	5.00	.880		24.6	2.20	.369	1.82	.892	.226	.062		.121	.245	.056
	s.d.		.067		5.81	.245	.036	.066	.044	.032	.022		.010	.045	.018
U 4	mean	4.00	.787		17.0	1.50	.432	1.88	.850	.557	.061		.281	.416	.050
	s.d.		.025		4.98	.082	.016	.128	.024	.079	.046		.061	.036	.019
U 5	mean	5.00	.720		12.6	1.82	.443	1.81	.821	.673	.031		.287	.304	.086
	s.d.		.057		4.39	.109	.027	.100	.055	.125	.013		.121	.092	.013

7-9 mm size range - analysis code R1A2V :

Dendrogram



Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
V 1	mean	13.0	.842		22.6	1.31	.307		.849	.266	.064	.001	.138	.267	.028
	s.d.		.081		6.03	.395	.045		.046	.085	.019	.002	.030	.055	.012
V 2	mean	5.00	.720		21.4	1.30	.342		.792	.422	.075	0	.252	.259	.032
	s.d.		.027		2.41	.223	.111		.038	.165	.018	0	.043	.082	.015
V 3	mean	2.00	.850		17.0	1.85	.345		.912	.279	.082	.012	.176	.269	.039
	s.d.		.071		4.24	.212	.023		.009	.107	.006	.005	.071	.016	.011
V 4	mean	1.00	1.00		36.0	0	.253		.571	.429	.107	.007	.393	0	0
	s.d.		0		0	0	0		0	0	0	0	0	0	0
V 5	mean	12.0	.767		13.0	1.63	.437		.824	.644	.078	0	.304	.412	.069
	s.d.		.083		2.81	.274	.057		.042	.064	.020	0	.071	.074	.017
V 6	mean	6.00	.758		16.1	1.35	.451		.856	.563	.022	0	.316	.373	.057
	s.d.		.080		7.22	.234	.057		.031	.131	.014	0	.082	.060	.019

9-11 mm size range - analysis code R1A2W :

Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
W 1	mean	3.00	.967		38.3		.252		.814	.309	.096	.021	.241	.034	.003
	s.d.		.058		20.2		.056		.053	.190	.033	.010	.048	.059	.005
W 2	mean	9.00	.772		24.4		.266		.819	.234	.051	.003	.215	.184	.019
	s.d.		.071		7.65		.050		.050	.065	.019	.005	.072	.137	.019
W 3	mean	10.0	.780		12.5		.432		.814	.667	.076	0	.362	.416	.066
	s.d.		.063		4.67		.072		.034	.119	.057	0	.069	.102	.016

11-13 mm size range - analysis code R1A2X :

Means of character values for each cluster:

Cluster code		n	S	C	T	R	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
X 1	mean	5.00	.710		10.8	1.50	.458		.827	.705	.049	0	.354	.405	.054
	s.d.		.065		2.77	.339	.056		.018	.079	.034	0	.104	.082	.011
X 2	mean	6.00	.792		19.8	1.11	.203		.789	.249	.068	.004	.274	.143	.005
	s.d.		.037		1.94	.098	.045		.033	.078	.044	.003	.083	.122	.005
X 3	mean	4.00	.750		15.2	1.85	.302		.834	.239	.065	.003	.214	.242	.021
	s.d.		.071		2.21	.387	.094		.048	.089	.015	.005	.039	.031	.007
X 4	mean	1.00	.900		30.0	1.30	.171		.683	.365	.079	.032	.397	.143	.013
	s.d.		0		0	0	0		0	0	0	0	0	0	0

13-16 mm size range - analysis code R1A2Y :

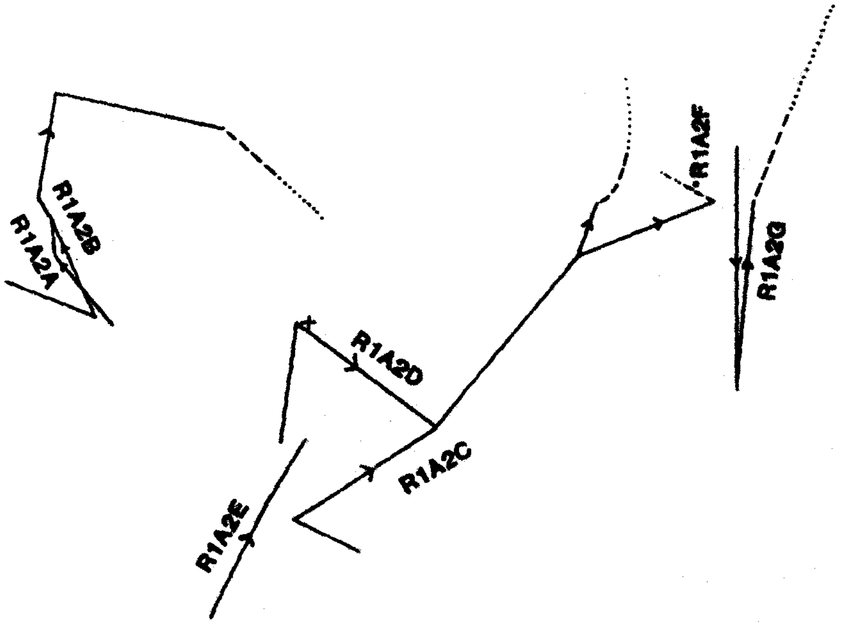
Means of character values for each cluster:

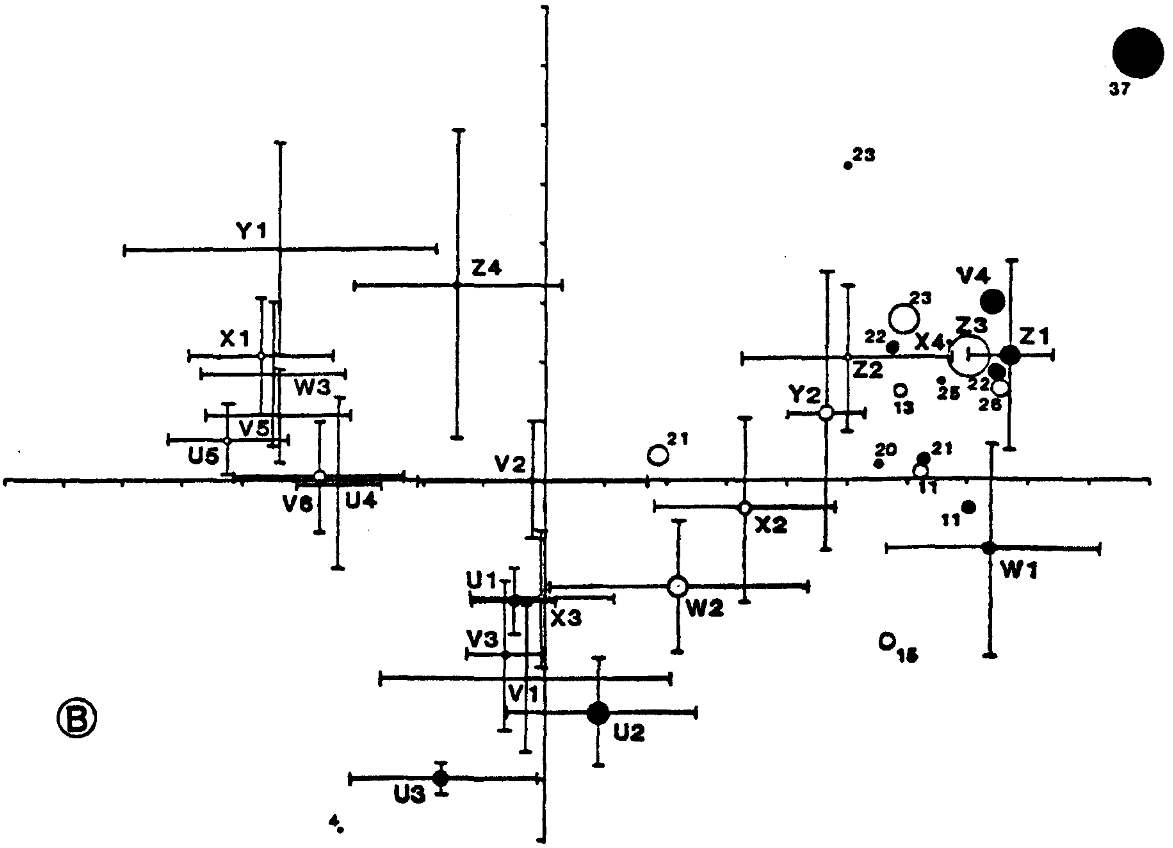
Cluster code		n	S	C	T	R	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
Y 1	mean	6.00	.756		11.5	1.73	.426	1.85	.857	.781	.114	0	.482	.385	.052
	s.d.		.049		2.66	.388	.075	.347	.038	.126	.048	0	.093	.101	.022
Y 2	mean	6.00	.733		20.5	1.03	.222	1.31	.794	.291	.084	.017	.312	.017	.002
	s.d.		.117		5.39	.082	.050	.182	.059	.196	.035	.009	.082	.042	.004

16-20 mm size range - analysis code R1A2Z :

Means of character values for each cluster:

Cluster code		n	S	C	T	R	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
Z 1	mean	4.00	.950	.150	40.7	1.00			.724	.406	.129	.016	.323	0	0
	s.d.		.058	.058	17.1	0			.061	.075	.071	.009	.024	0	0
Z 2	mean	7.00	.835	.628	22.2	.857			.737	.393	.060	.004	.465	0	0
	s.d.		.080	.157	11.5	.378			.073	.082	.037	.007	.153	0	0
Z 3	mean	2.00	.625	.775	25.5	1.35			.732	.175	.065	.029	.185	.087	.004
	s.d.		.318	.035	13.4	.495			.092	.117	.035	.013	.120	.120	.005
Z 4	mean	6.00	.775	.625	15.3	1.56			.793	.613	.110	.002	.480	.283	.027
	s.d.		.076	.189	3.82	.250			.071	.129	.042	.005	.154	.139	.016


R1A2B
R1A2A
R1A2F
R1A2G
R1A2D
R1A2C
R1A2E



	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1		│	+	−	−	│						−	−
PC2		│				│	−	+	+		+		
PC3	+	│				│			+				

FIGURE 23. Principal components plots of R_{1a2} zone specimens. For full explanation see notes on pages 103-4 and comments below.

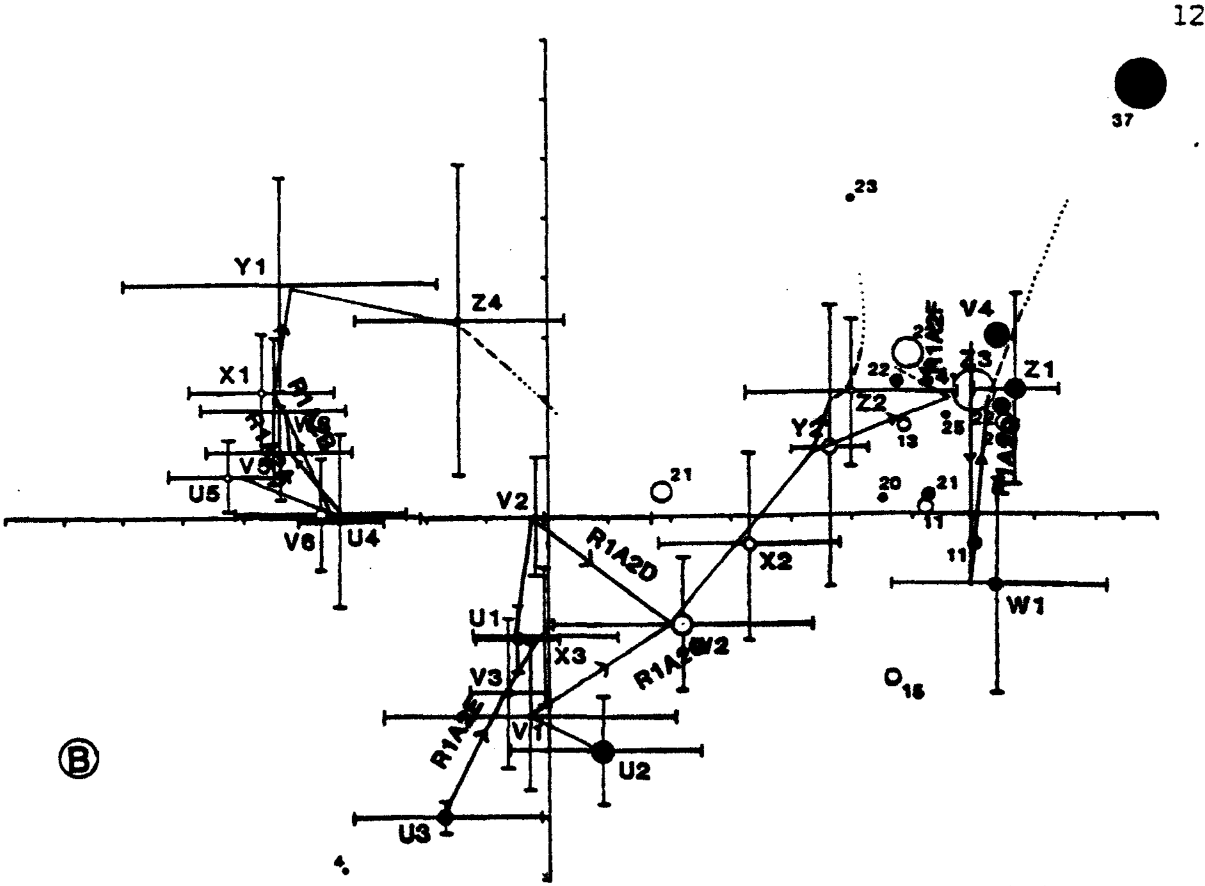
Variance explained: P.C.1 - 43.0%
P.C.2 - 17.7%
P.C.3 - 9.9%

A: (Overleaf) Showing all analysed specimens. P.C.3 score ≃ $\frac{2}{3}$ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ $\frac{2}{3}$ diam. of dots in mm.

Comments:

There is little evidence to decide which of the linkage alternativesU5-V6 and U4-V5 or U5-V5 and U4-V6 is to be preferred. The former is chosen here on the basis of parity of tubercle lengths, a character which appears to be relatively consistent through ontogeny of these morphospecies. Similarly the allocation of Z2 and Z3 to morphospecies R1A2D and R1A2C is somewhat tenuous, and is based on relative positions in P.C. space. P.C.3 is useful in identifying cluster Z1 as part of R1A2G. Cluster X4 is a single anomalous specimen.

Although the direction of ontogenetic change in morphospace appears to be less parallel to P.C.1 than is normal, this is deceptive as P.C.1 in this analysis accounts for a higher percentage of the total variation - 43% - than any other analysis here.



	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1		|	+	−	−	|						−	−
PC2		|				|	−	+	+		+		
PC3	+	|				|			+				

FIGURE 23. Principal components plots of R_{1a2} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 43.0%
P.C.2 - 17.7%
P.C.3 - 9.9%

A: (Overleaf) Showing all analysed specimens. P.C.3 score ≃ $\frac{2}{3}$ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ $\frac{2}{3}$ diam. of dots in mm.

Comments:

There is little evidence to decide which of the linkage alternativesU5-V6 and U4-V5 or U5-V5 and U4-V6 is to be preferred. The former is chosen here on the basis of parity of tubercle lengths, a character which appears to be relatively consistent through ontogeny of these morphospecies. Similarly the allocation of Z2 and Z3 to morphospecies R1A2D and R1A2C is somewhat tenuous, and is based on relative positions in P.C. space. P.C.3 is useful in identifying cluster Z1 as part of R1A2G. Cluster X4 is a single anomalous specimen.

Although the direction of ontogenetic change in morphospace appears to be less parallel to P.C.1 than is normal, this is deceptive as P.C.1 in this analysis accounts for a higher percentage of the total variation - 43% - than any other analysis here.

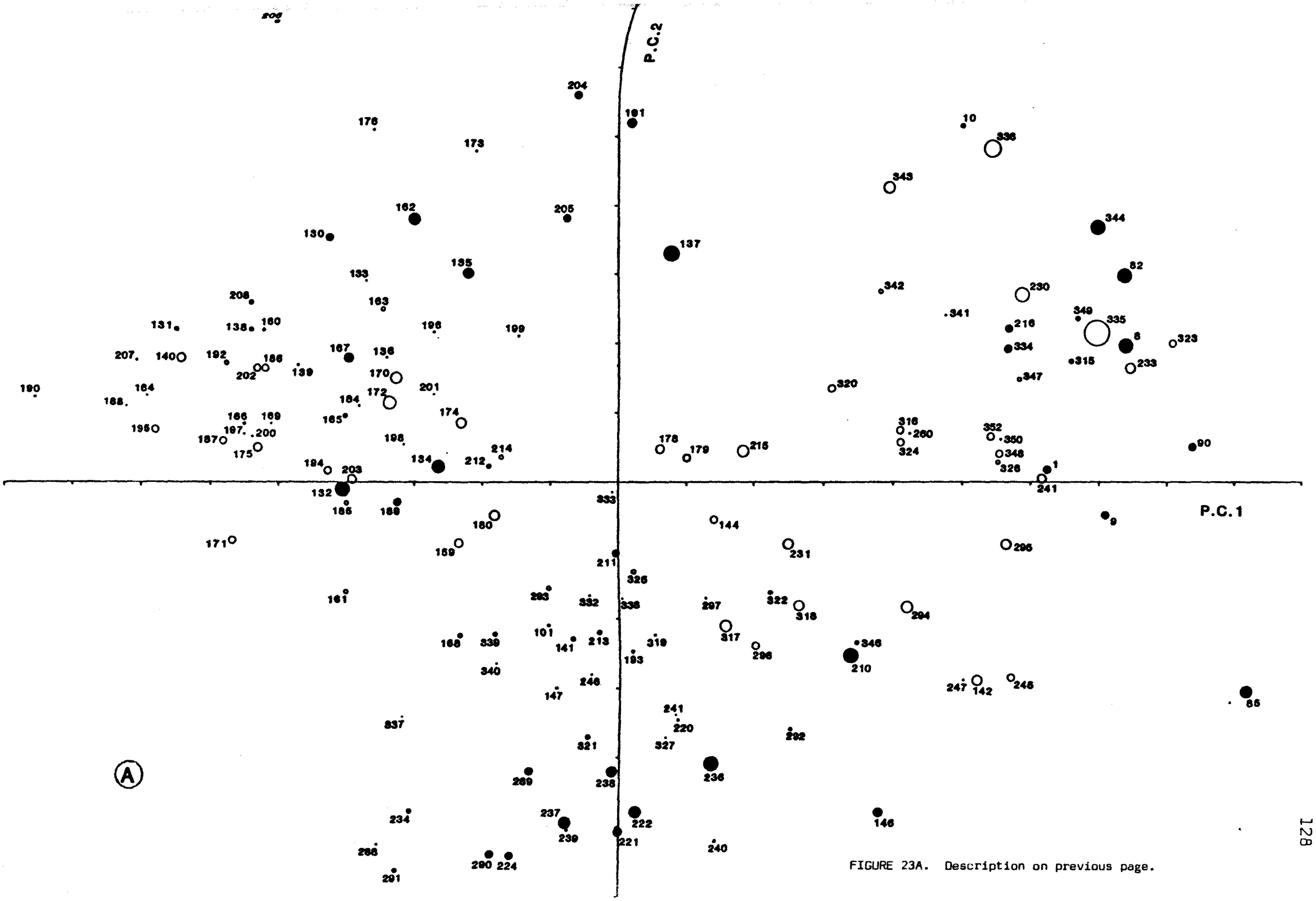


FIGURE 23A. Description on previous page.

Analysis of R_{1b} zone goniatites.

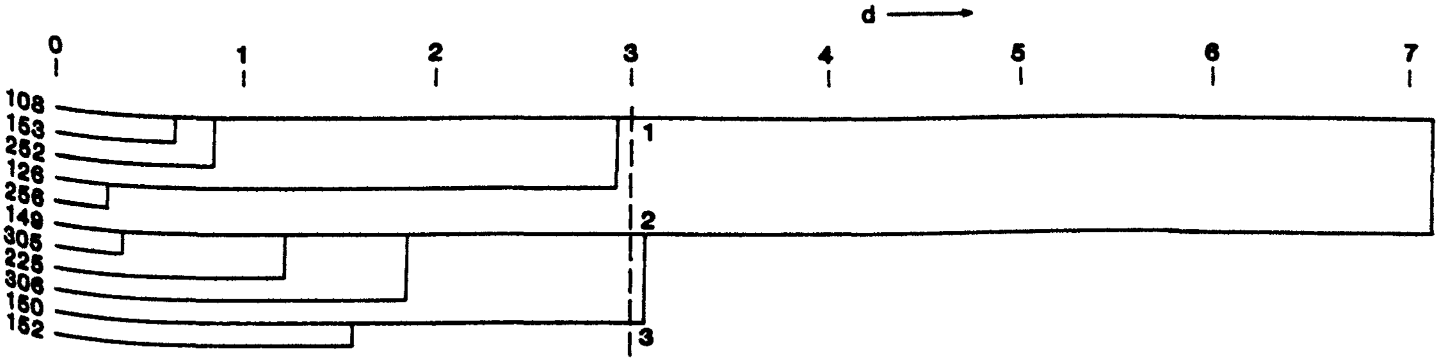
8-11 mm size range - analysis code R1BX :

Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
X 1	mean	3.00			18.0	1.13	.279		.820	.233	.094	.001	.140	.207	.017
	s.d.				3.46	.115	.026		.050	.073	.022	.001	.043	.027	.009
X 2	mean	4.00			17.0	1.75	.347		.869	.242	.113	.010	.202	.347	.031
	s.d.				2.00	.387	.023		.031	.056	.032	.005	.060	.030	.007
X 3	mean	5.00			17.6	1.44	.415		.869	.471	.084	0	.167	.357	.054
	s.d.				6.65	.329	.017		.044	.084	.029	0	.086	.027	.024

11-14 mm size range - analysis code R1BY :

Dendrogram

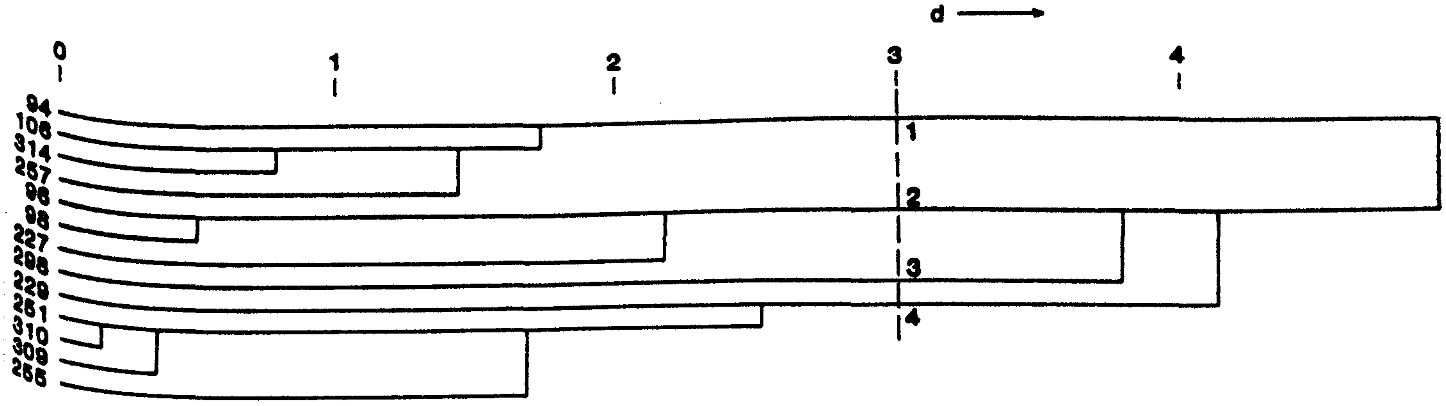


Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Y 1	mean	5.00			19.8	1.26			.772	.234	.070	.011	.188	.211	.012
	s.d.				4.49	.089			.032	.063	.027	.013	.039	.029	.006
Y 2	mean	4.00			16.0	1.37			.869	.293	.102	.003	.240	.289	.020
	s.d.				2.94	.150			.016	.088	.041	.005	.047	.047	.011
Y 3	mean	2.00			15.0	1.70			.877	.462	.062	0	.246	.384	.048
	s.d.				0	.141			.022	.340	.011	0	.034	.047	.011

17-21 mm size range - analysis code R1BZ :

Dendrogram



Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Z 1	mean	4.00	.825	.625	22.5				.714	.344	.110	.008	.420	0	0
	s.d.		.050	.189	8.50				.065	.074	.036	.006	.064	0	0
Z 2	mean	3.00	.667	.817	17.0				.817	.204	.121	.010	.267	0	0
	s.d.		.029	.189	3.60				.047	.037	.031	.017	.075	0	0
Z 3	mean	1.00	.750	.800	11.0				.833	.393	.143	.024	.321	.202	.012
	s.d.		0	0	0				0	0	0	0	0	0	0
Z 4	mean	5.00	.770	.500	14.0				.712	.231	.074	.008	.173	.054	.004
	s.d.		.076	.212	1.58				.053	.043	.012	.004	.066	.075	.005

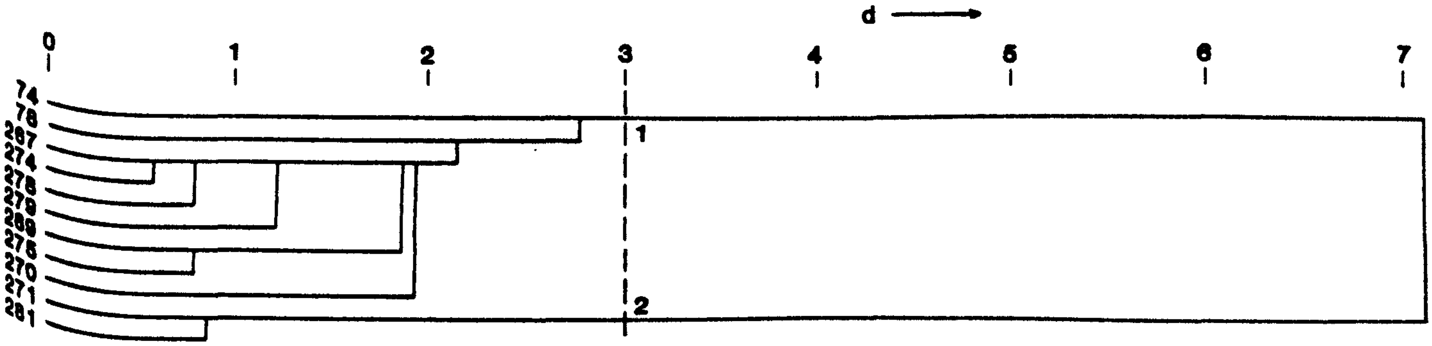
Comments:

Cluster Z1 is the only problem, being largely composed of crushed specimens in which the character Du/D_s, which is used in the principal components analysis, is not measurable. Also, it is distant in P.C. space from the Y clusters, indicating rapid morphological change at this stage in ontogeny, or else the unlikely occurrence of 4 specimens in the Z analysis of a morphospecies which is absent in other analyses. There is not enough observable ontogenetic change on the Z1 specimens to justify linkage with any of the Y clusters.

Analysis of R_{1c} zone goniatites.

12-15 mm size range - analysis code R1CZ :

Dendrogram

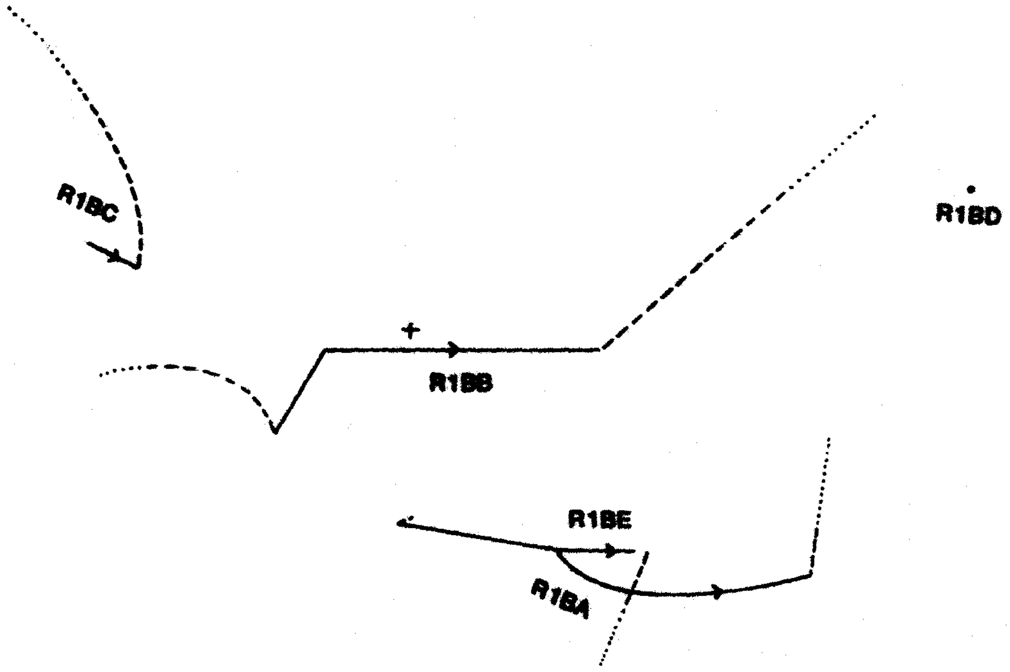


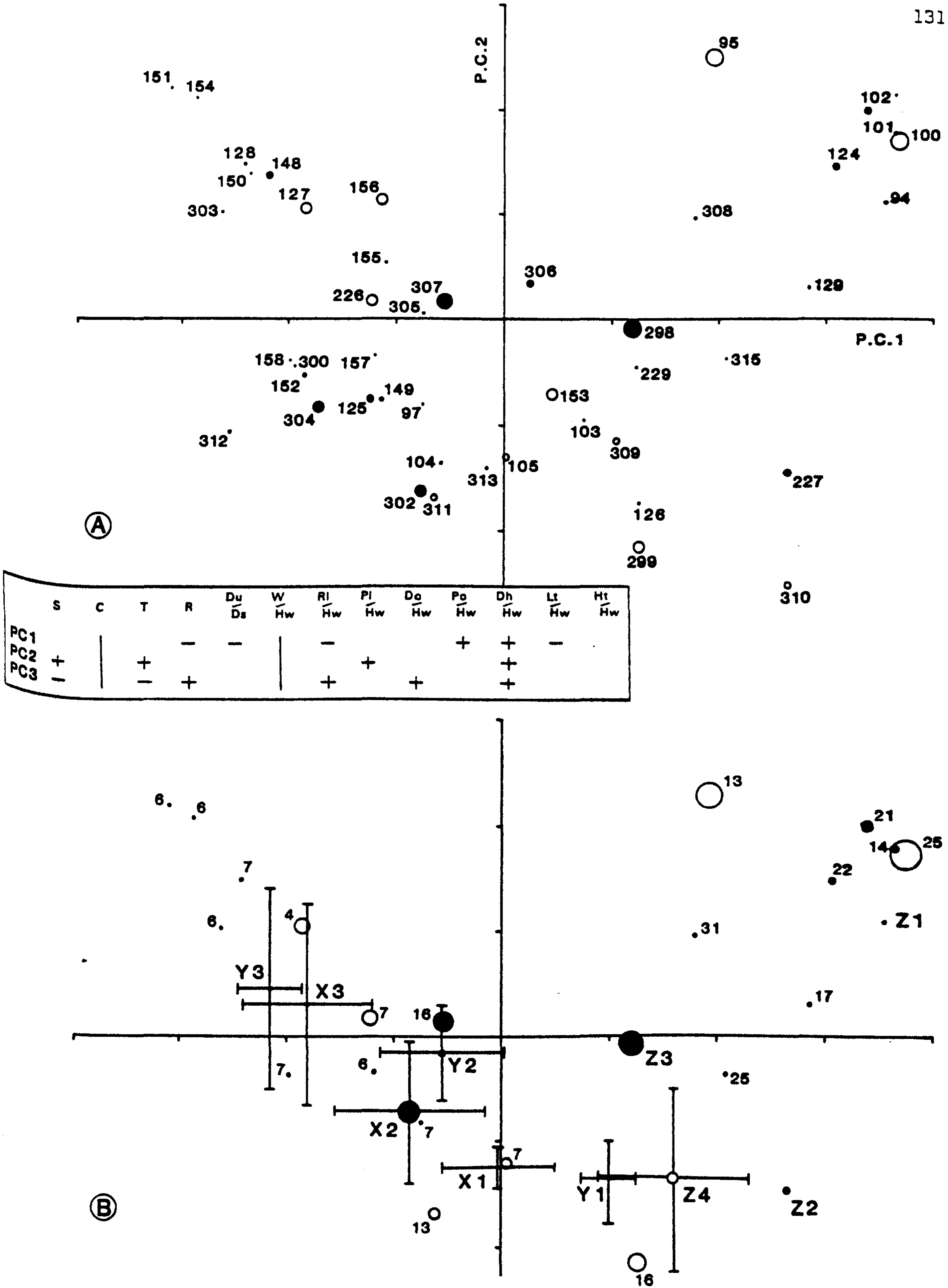
Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Z 1	mean	9.00	.634		21.1	1.03	.232		.734	.285	.077	.014	.298	.047	.004
	s.d.		.030		1.90	.070	.034		.070	.056	.027	.012	.119	.078	.006
Z 2	mean	2.00	.675		15.5	1.90	.307		.766	.220	.079	.005	.197	.257	.024
	s.d.		.035		.707	.141	.013		.006	.037	.039	.003	.063	.016	.002

Comments:

The ontogenetic trends are acceptably clear, given that it was only possible to analyse one size range. Unusually, P.C.2 is the dominant direction of ontogenetic change.


R1BC
R1BD
+
R1BB
R1BE
R1BA

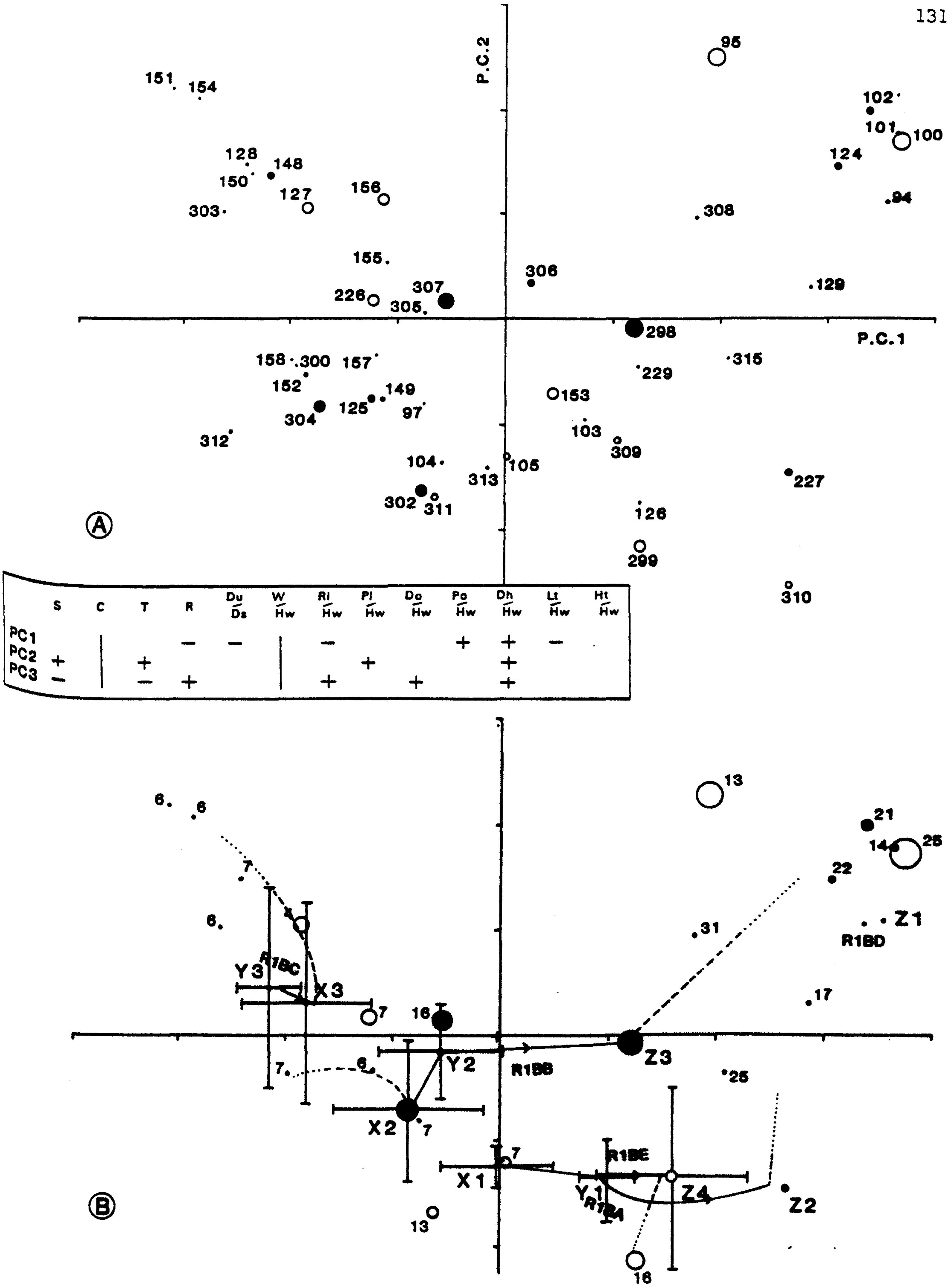


	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1		|		−	−	|	−			+	+	−	
PC2	+	|	+			|		+			+		
PC3	−	|	−	+		|	+		+		+		

FIGURE 24. Principal components plots of R_{1b} zone specimens. For full explanation see notes on pages 103-4 and comments near top of previous page.

Variance explained: P.C.1 - 36.7%
P.C.2 - 15.3%
P.C.3 - 11.6%

A: Showing all analysed specimens. P.C.3 score ∝ $\frac{2}{3}$ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ∝ ½ diam. of dots in mm.

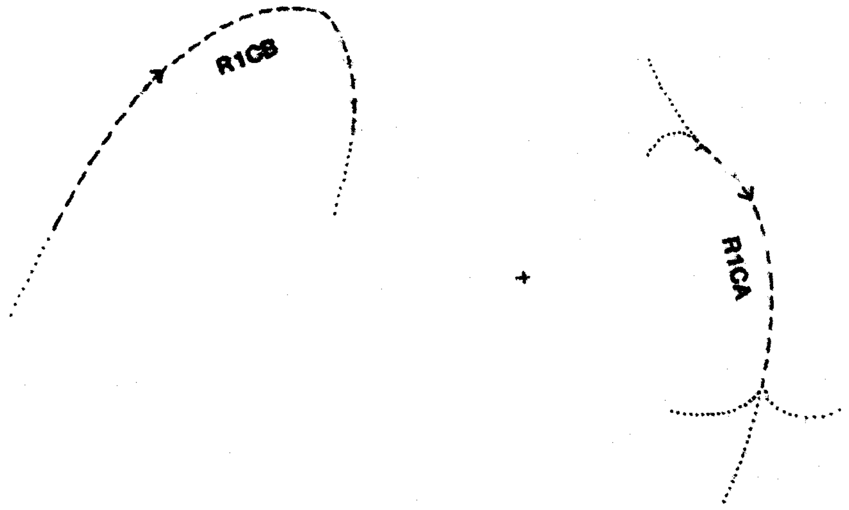


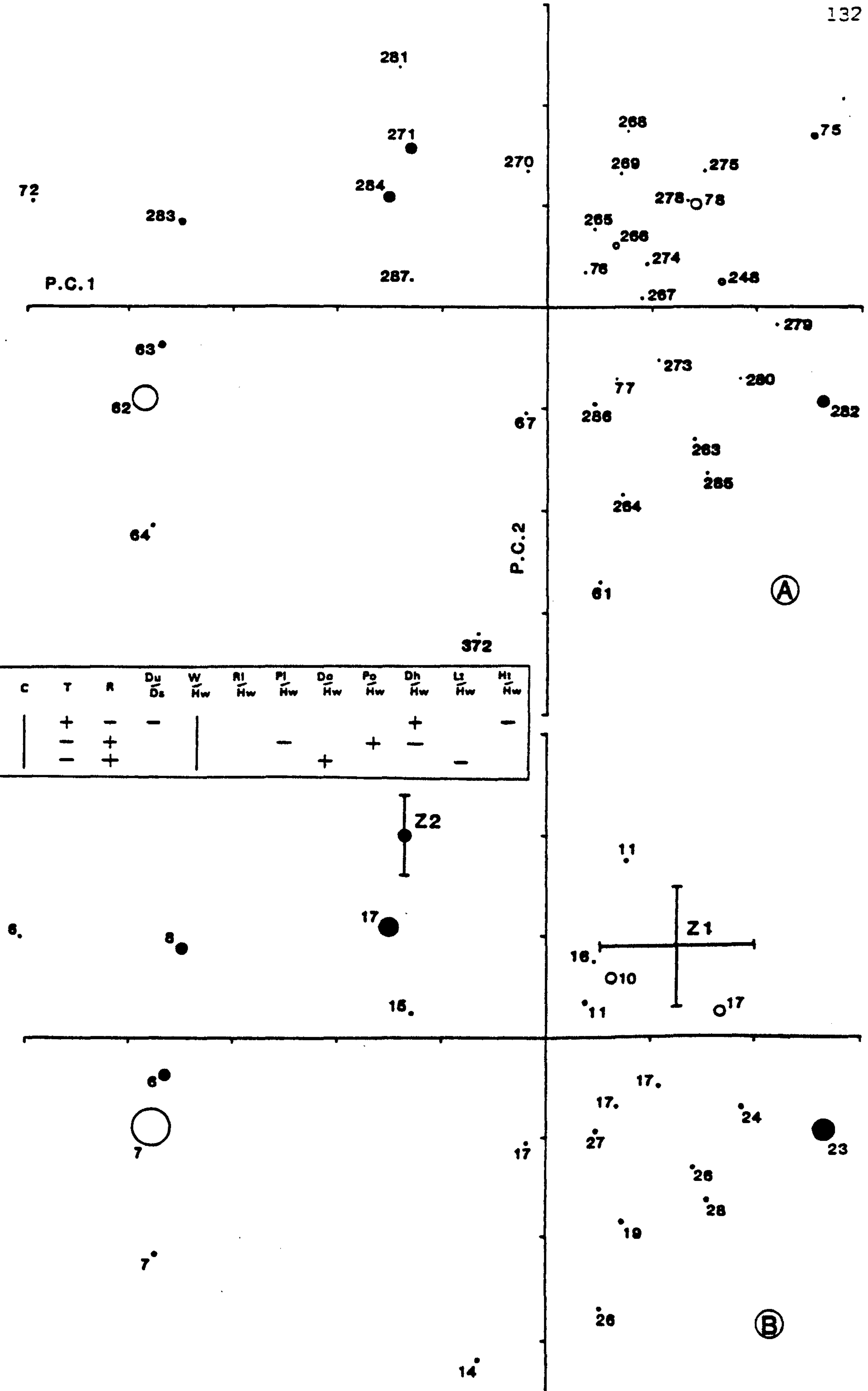
	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1		|		−	−	|	−			+	+	−	
PC2	+		+					+			+		
PC3	−		−	+			+		+		+		

FIGURE 24. Principal components plots of R_{1b} zone specimens. For full explanation see notes on pages 103-4 and comments near top of previous page.

Variance explained: P.C.1 - 36.7%
P.C.2 - 15.3%
P.C.3 - 11.6%

A: Showing all analysed specimens. P.C.3 score ≃ $\frac{2}{3}$ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ ½ diam. of dots in mm.


R1CB
R1CA

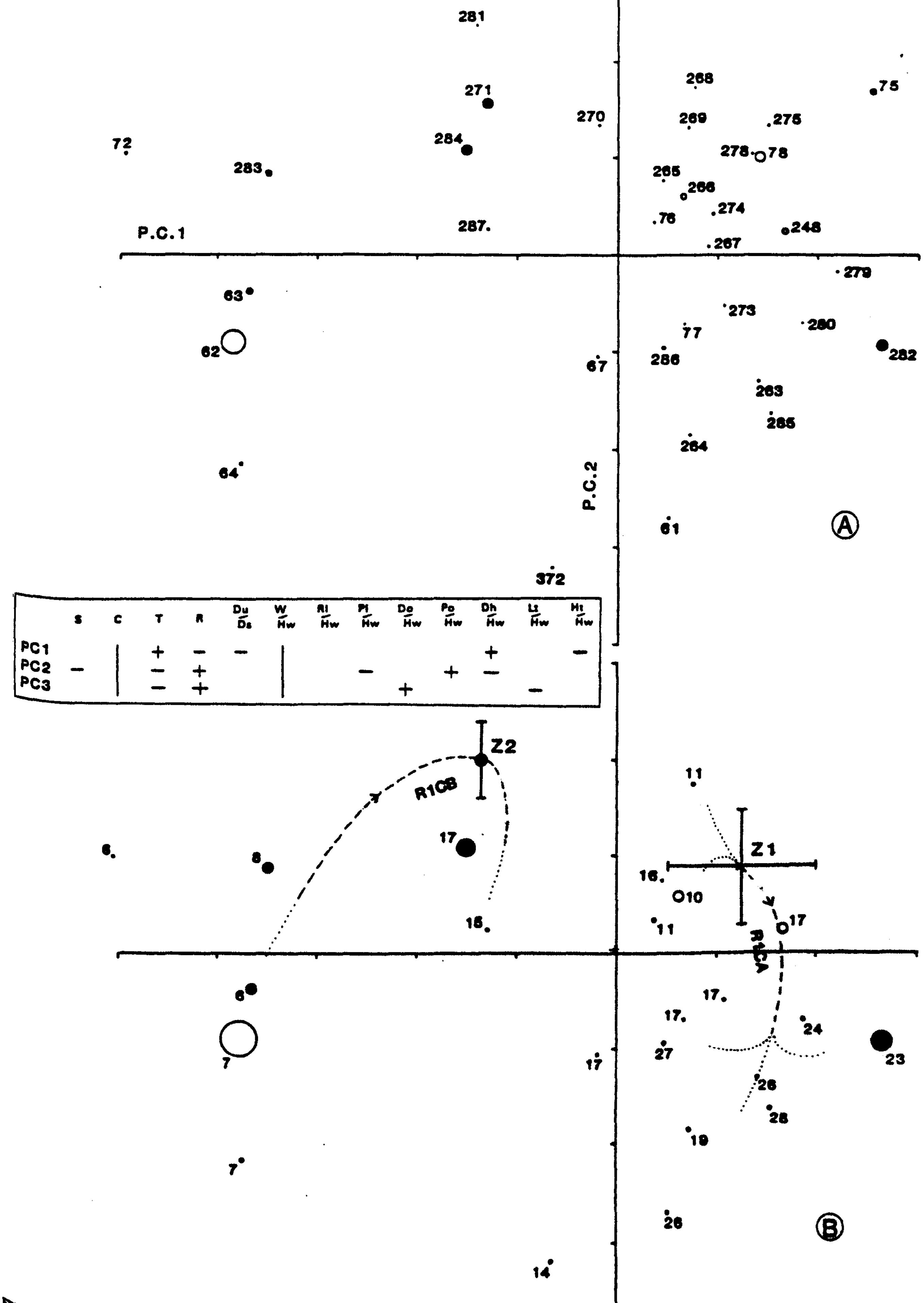


	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1		|	+	−	−	|					+		−
PC2	−	|	−	+		|		−		+	−		
PC3		|	−	+		|			+			−	

FIGURE 25. Principal components plots of R$_{1c}$ zone specimens. For full explanation see notes on pages 103-4 and comments at bottom of page 130.

Variance explained: P.C.1 - 35.3%
P.C.2 - 16.9%
P.C.3 - 10.4%

A: Showing all analysed specimens. P.C.3 score ≈ ¾ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ ½ diam. of dots in mm.



	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1		|	+	−	−	|					+		−
PC2	−	|	−	+		|		−		+	−		
PC3		|	−	+		|			+			−	

FIGURE 25. Principal components plots of R_{1c} zone specimens. For full explanation see notes on pages 103-4 and comments at bottom of page 130.

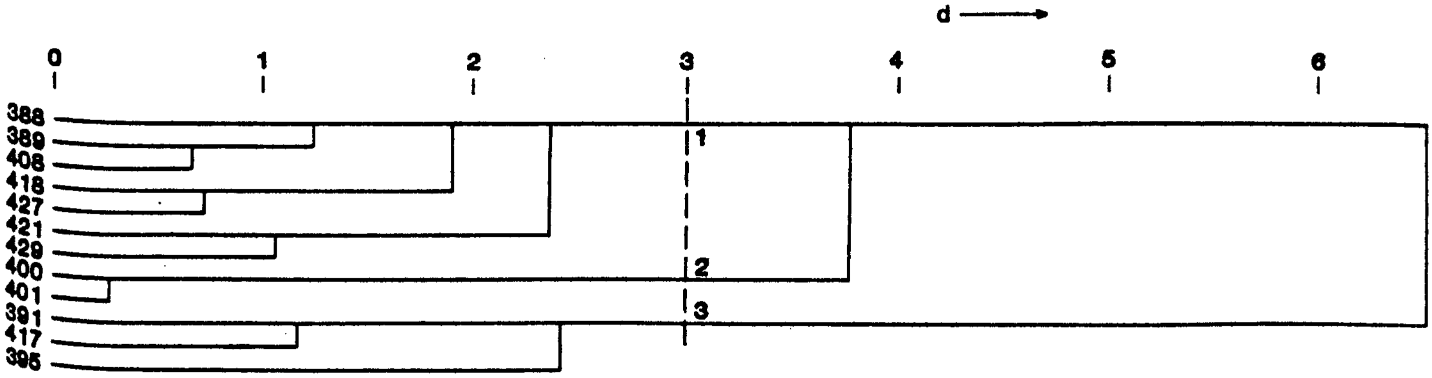
Variance explained: P.C.1 - 35.3%
P.C.2 - 16.9%
P.C.3 - 10.4%

A: Showing all analysed specimens. P.C.3 score ≃ ¾ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ ¼ diam. of dots in mm.

Analysis of R_{2a} zone goniatites

12-15 mm size range - analysis code R2AZ :

Dendrogram

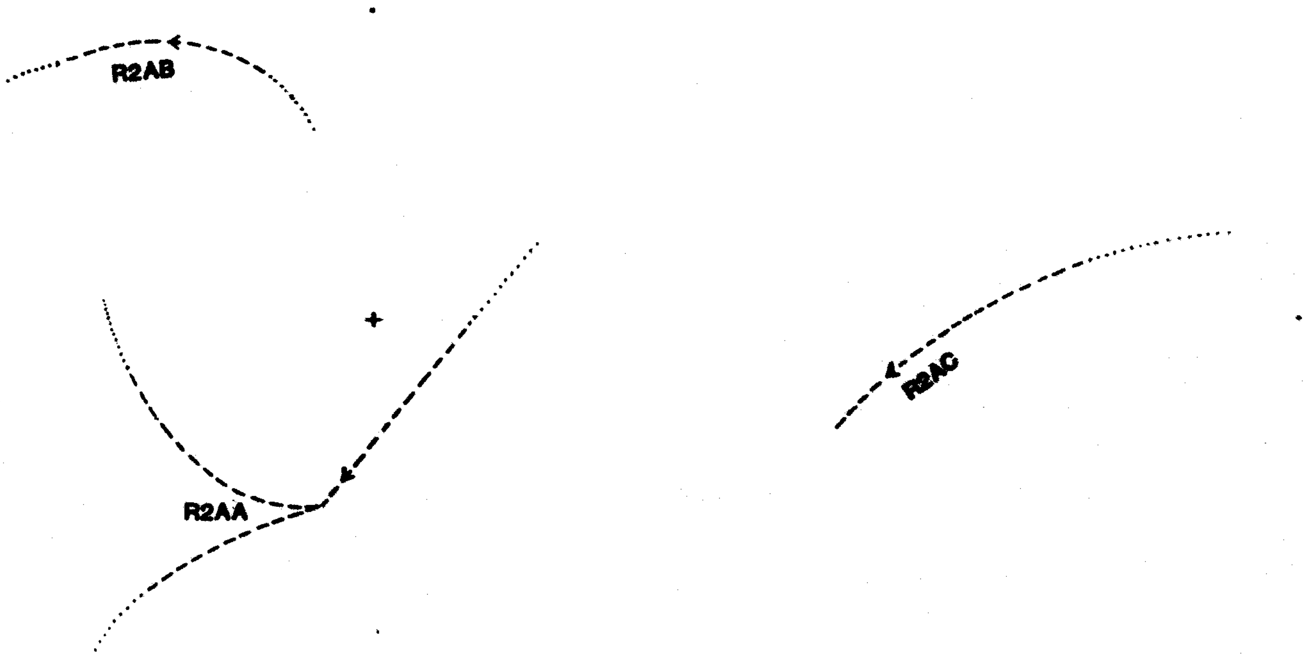


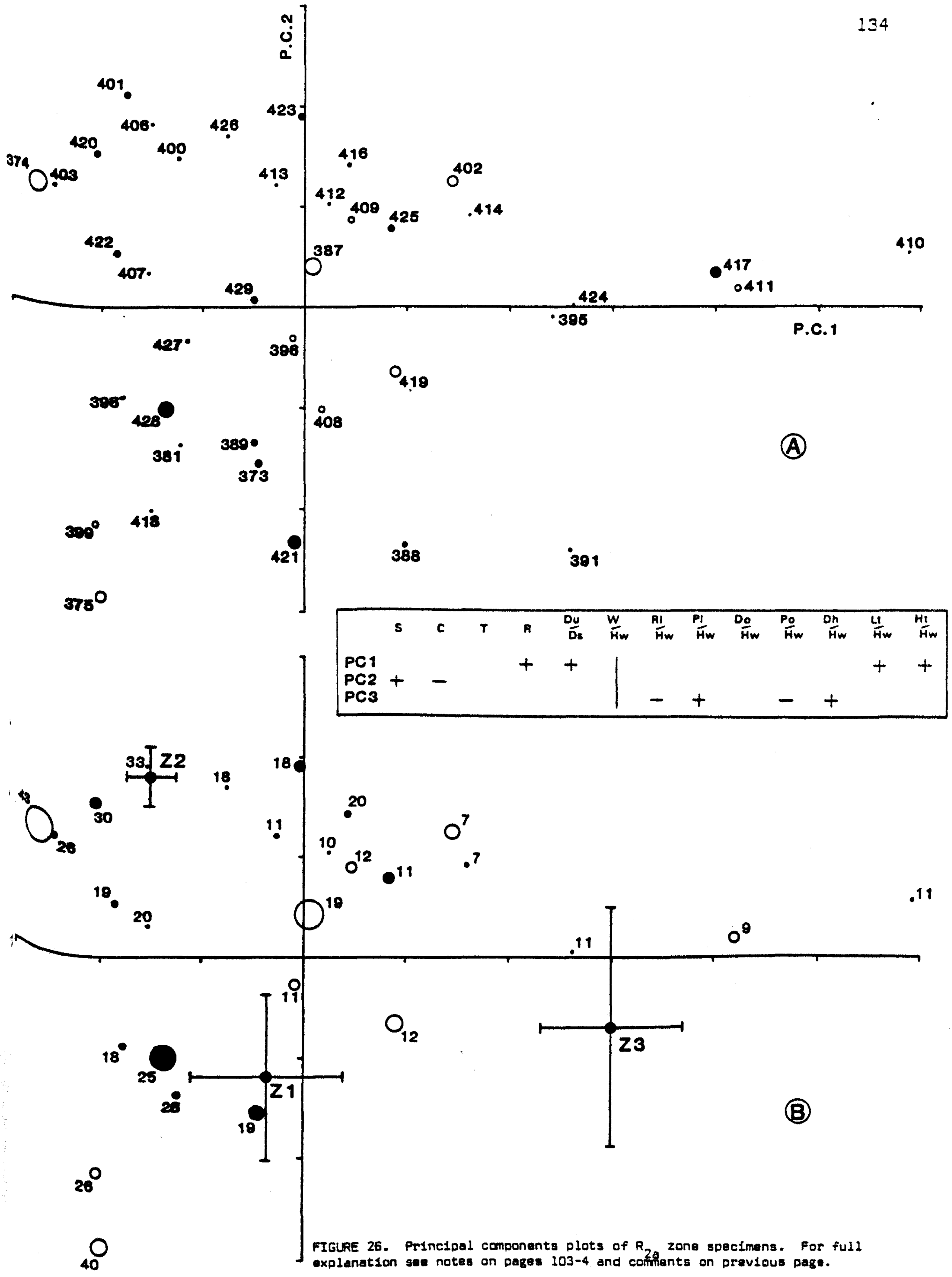
Means of character values for each cluster:

Cluster code		n	S	C	T	R	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
Z 1	mean	7.00	.636	.628	46.4	1.14	.267		.729	.438	.176		.527	.144	.011
	s.d.		.125	.197	12.6	.113	.041		.076	.106	.035		.084	.074	.012
Z 2	mean	2.00	.825	.300	35.5	1.00	.197		.803	.647	.274		.533	0	0
	s.d.		.035	.141	.707	0	.015		.047	.035	.007		.057	0	0
Z 3	mean	3.00	.767	.600	43.3	1.26	.412		.767	.725	.131		.417	.415	.040
	s.d.		.153	.100	10.4	.305	.053		.032	.163	.063		.097	.067	.017

Comments:

Only one size range was analysable, but clusters Z1 and Z2 lie quite clearly in ontogenetic series of smaller to larger specimens on the principal components plot. Larger specimens cannot be so easily allocated to R2AC. In addition, there is a group of points in the top right quadrant of the principal components plot which are of various sizes except the analysed size range 12-15mm. This may represent an additional morphospecies which by chance has escaped analysis.


R2AB
R2AA
R2AC

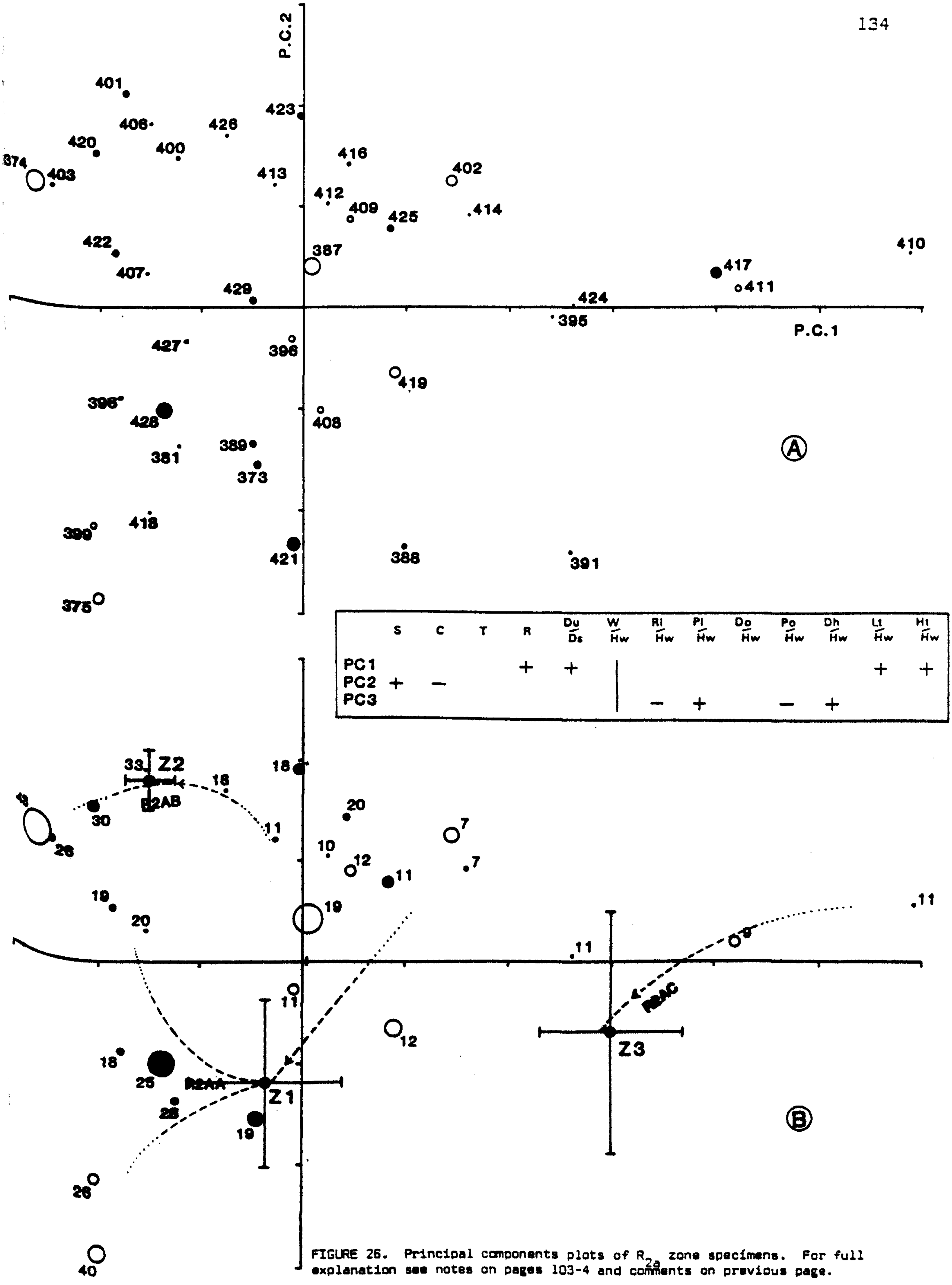


	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1				+	+							+	+
PC2	+	−											
PC3							−	+		−	+		

FIGURE 26. Principal components plots of R_{2a} zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 32.0%
P.C.2 - 16.4%
P.C.3 - 13.9%

A: Showing all analysed specimens. P.C.3 score $\propto$ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score $\propto \frac{2}{3}$ diam. of dots in mm.



	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1				+	+							+	+
PC2	+	−											
PC3							−	+		−	+		

FIGURE 26. Principal components plots of R_{2a} zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 32.0%
P.C.2 - 16.4%
P.C.3 - 13.9%

A: Showing all analysed specimens. P.C.3 score $\propto$ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score $\propto \frac{2}{3}$ diam. of dots in mm.

Analysis of R_{2b} zone goniatites

9-12 mm size range - analysis code R2BW :

Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
W 1	mean	5.00	.910	.320	21.6	1.30	.263		.821	.537	.243	.004	.548	.133	.002
	s.d.		.055	.084	4.39	.265	.025		.055	.052	.042	.004	.109	.097	.002
W 2	mean	5.00	.830	.320	22.6	1.50	.249		.700	.522	.170	.005	.588	.171	.010
	s.d.		.045	.109	4.72	.255	.042		.048	.023	.031	.001	.096	.040	.003
W 3	mean	5.00	.340	.240	22.3	1.32	.272		.733	.732	.246	0	.775	.143	.010
	s.d.		.042	.055	3.11	.192	.039		.077	.103	.054	0	.102	.057	.006
W 4	mean	2.00	.825	.400	18.0	1.60	.346		.854	.873	.291	0	.904	.224	.017
	s.d.		.035	0	2.32	.141	.015		.039	.012	.037	0	.108	.010	.016
W 5	mean	2.00	1.00	.100	20.0	1.00	.329		.823	.519	.341	.008	.531	0	0
	s.d.		0	0	1.41	0	.042		.032	.080	.083	.007	.026	0	0

12-15 mm size range - analysis code R2BX :

Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
X 1	mean	7.00	.879	.371	27.3	1.21	.230		.703	.513	.190	.002	.586	.095	.003
	s.d.		.057	.076	8.56	.122	.036		.037	.127	.035	.002	.131	.005	.002
X 2	mean	4.00	.925	.300	29.5	1.30	.283		.794	.712	.239	.002	.604	.105	.004
	s.d.		.029	0	4.20	.141	.019		.024	.162	.050	.002	.073	.039	.002
X 3	mean	3.00	.883	.167	17.6	1.36	.215		.738	.741	.190	0	.791	.123	.005
	s.d.		.029	.058	3.21	.379	.032		.049	.027	.007	0	.054	.053	.001
X 4	mean	6.00	.900	.350	19.3	1.00	.245		.742	.732	.229	.001	.637	0	0
	s.d.		.032	.105	4.54	0	.012		.024	.136	.047	.001	.083	0	0
X 5	mean	2.00	.950	.400	23.0	1.00	.248		.860	.532	.269	.022	.524	0	0
	s.d.		.071	.141	2.82	0	.026		.028	.011	.044	.003	.023	0	0
X 6	mean	1.00	.900	.400	31.0	1.00	.214		.843	.600	.186	.001	.871	0	0
	s.d.		0	0	0	0	0		0	0	0	0	0	0	0
X 7	mean	5.00	.800	.430	15.6	1.50	.281		.765	.718	.256	0	.671	.118	.008
	s.d.		.079	.148	2.70	.223	.051		.041	.127	.040	0	.147	.044	.005

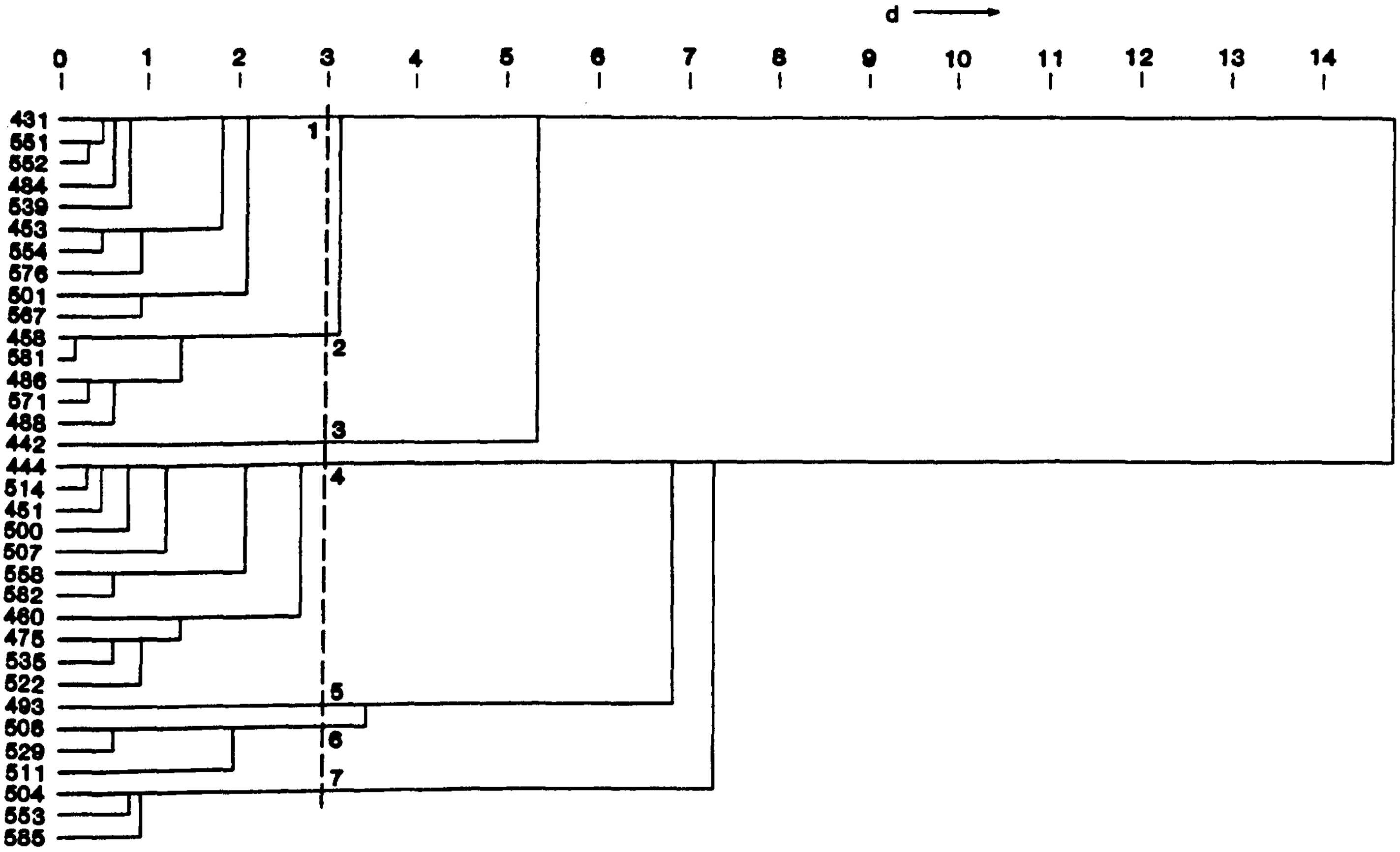
15-18 mm size range - analysis code R2BY :

Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Y 1	mean	10.0	.880	.340	24.7	1.00	.194		.725	.674	.232	.001	.670	0	0
	s.d.		.058	.107	2.62	0	.029		.058	.134	.075	.001	.132	0	0
Y 2	mean	5.00	.920	.520	24.4	1.00	.221		.836	.599	.248	.005	.646	0	0
	s.d.		.027	.045	5.59	0	.023		.041	.081	.052	.006	.094	0	0
Y 3	mean	3.00	.900	.367	20.0	1.36	.230		.682	.531	.200	.001	.736	.095	.003
	s.d.		.087	.116	7.00	.373	.029		.034	.110	.013	.002	.046	.045	.001
Y 4	mean	2.00	.825	.500	34.0	1.35	.303		.789	.549	.166	0	.472	.094	.005
	s.d.		.035	0	8.48	.212	.303		.023	.187	.107	0	.039	.004	.001
Y 5	mean	3.00	.900	.300	15.3	1.00	.269		.756	.864	.412	0	.884	.014	0
	s.d.		0	.100	2.31	0	.005		.043	.104	.084	0	.189	.024	.001
Y 6	mean	1.00	.850	.700	18.0	1.40	.363		.851	.821	.403	.022	.970	.179	.012
	s.d.		0	0	0	0	0		0	0	0	0	0	0	0
Y 7	mean	1.00	.700	.800	20.0	1.80	.188		.768	.829	.256	0	.610	.085	.002
	s.d.		0	0	0	0	0		0	0	0	0	0	0	0

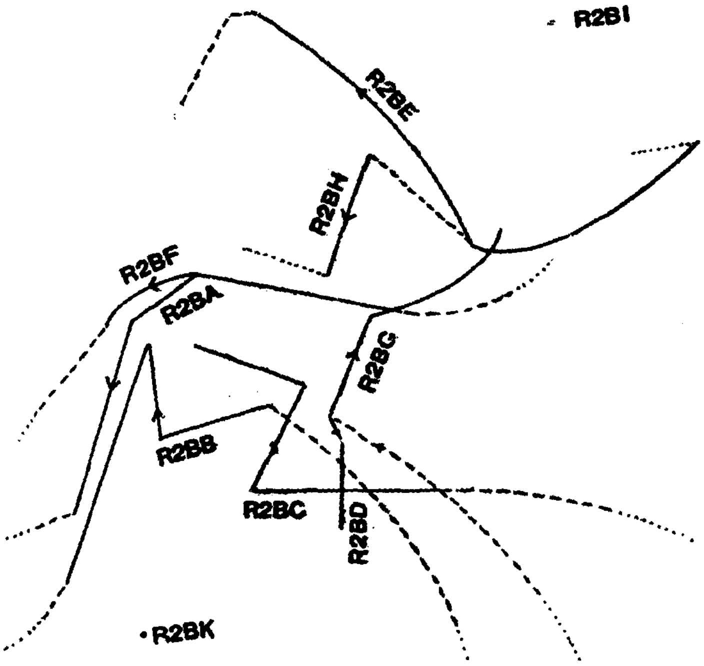
18-22 mm size range - analysis code R2BZ :

Dendrogram



Means of character values for each cluster:

Cluster code		n	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Z 1	mean	10.0	.920	.330	29.2		.166		.744	.495	.178	.001	.594	0	0
	s.d.		.048	.142	6.73		.028		.065	.060	.022	.002	.086	0	0
Z 2	mean	5.00	.950	.340	28.4		.176		.773	.730	.264	.005	.669	0	0
	s.d.		.035	.134	5.08		.019		.031	.128	.036	.001	.059	0	0
Z 3	mean	1.00	1.00	.100	25.0		.149		.745	.409	.209	.014	.545	0	0
	s.d.		0	0	0		0		0	0	0	0	0	0	0
Z 4	mean	11.0	.877	.463	19.6		.221		.696	.579	.217	0	.623	.019	.001
	s.d.		.068	.136	4.74		.037		.058	.082	.041	.001	.076	.027	.002
Z 5	mean	1.00	.900	.300	15.0		.225		.813	.625	.263	0	.950	.125	.010
	s.d.		0	0	0		0		0	0	0	0	0	0	0
Z 6	mean	3.00	.800	.633	17.3		.247		.669	.558	.231	0	.740	.112	.004
	s.d.		.050	.152	2.08		.055		.019	.030	.044	0	.153	.052	.001
Z 7	mean	3.00	.867	.367	19.0		.222		.701	.986	.366	0	.865	.020	0
	s.d.		.058	.116	2.64		.043		.040	.149	.018	0	.020	.034	.001


R2BI
R2BE
R2BH
R2BF
R2BA
R2BG
R2BB
R2BC
R2BD
R2BK

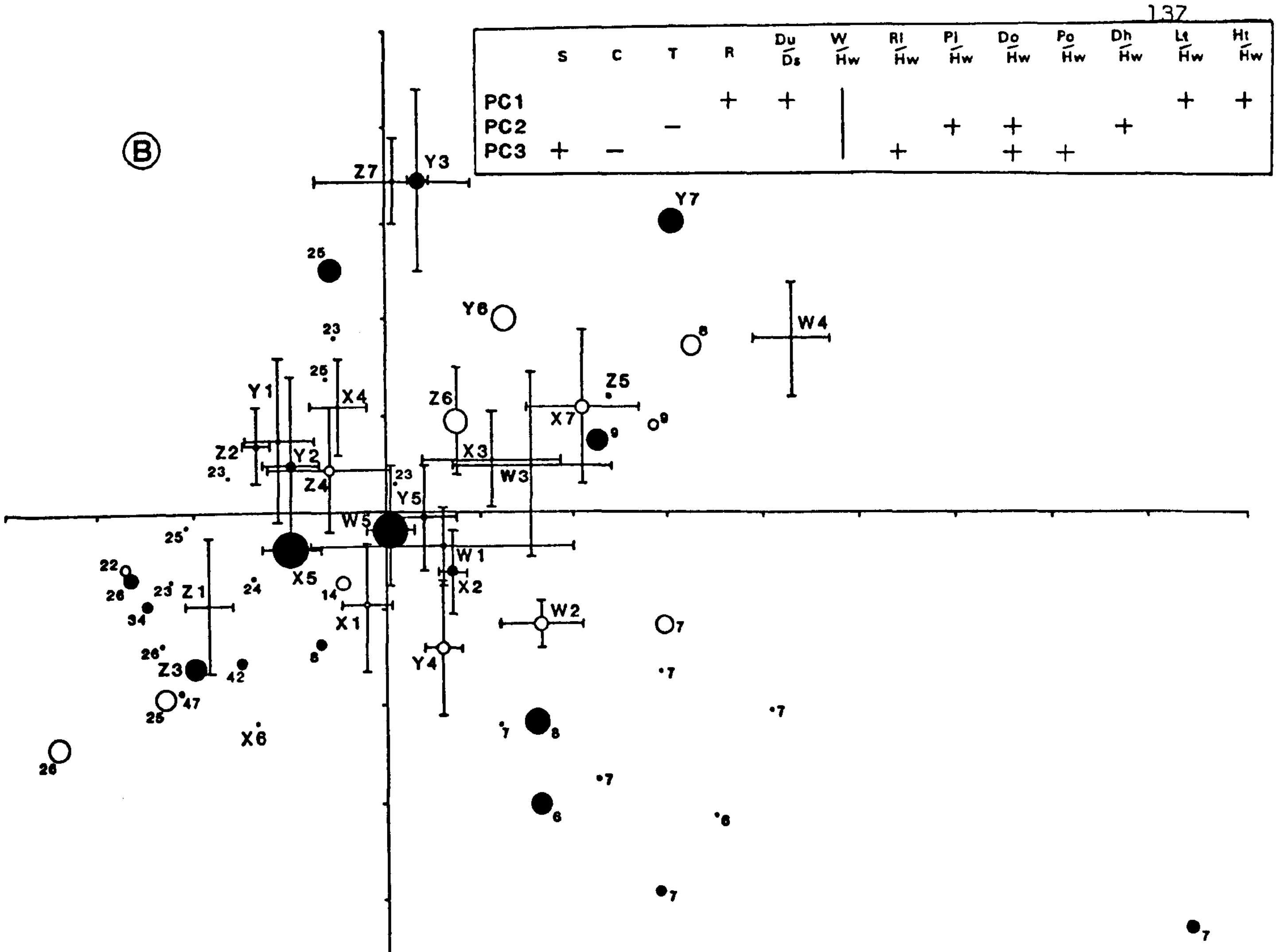


FIGURE 27. Principal components plots of R_{2b} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 25.9%
P.C.2 - 18.1%
P.C.3 - 14.6%

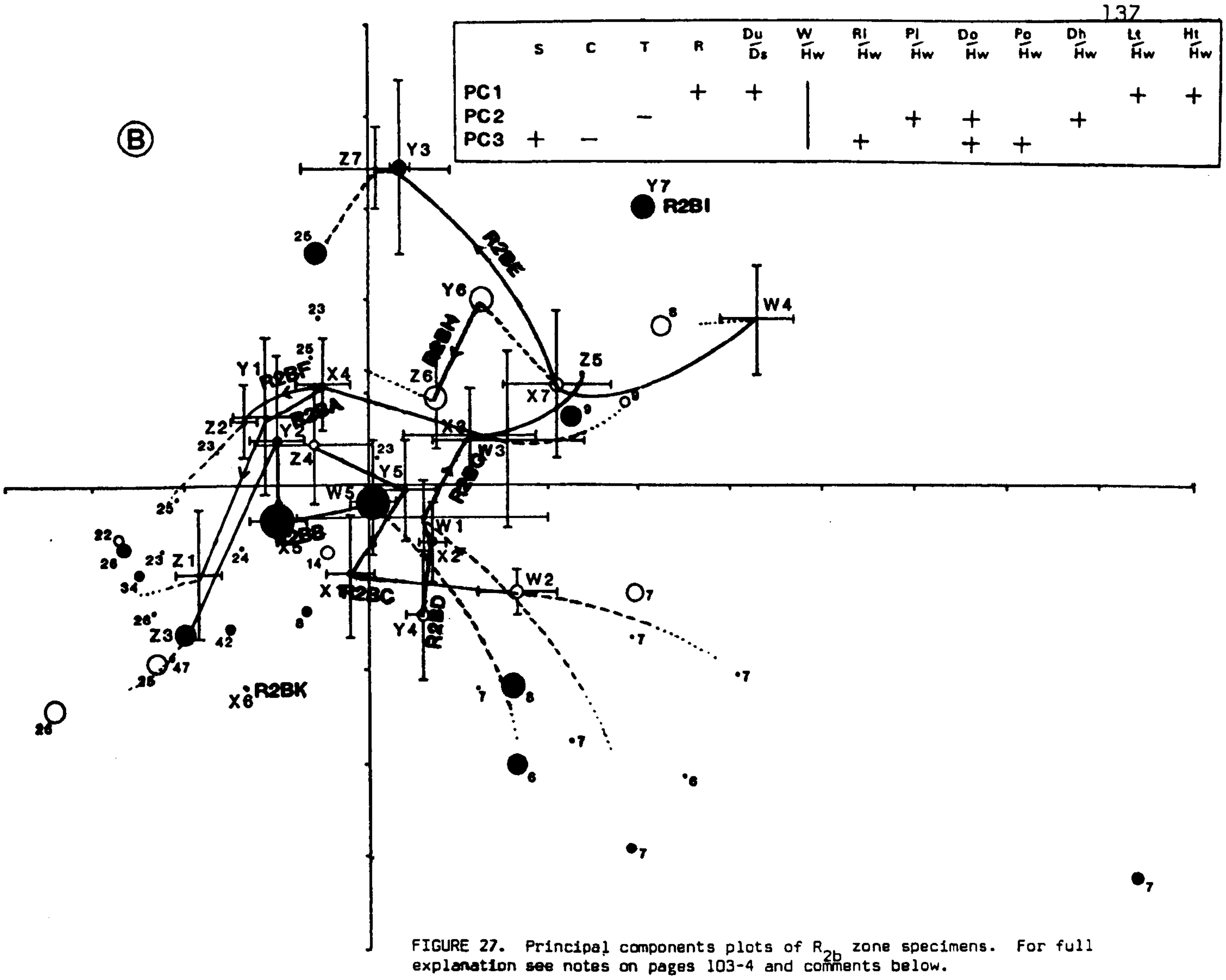
A: (Overleaf) Showing all analysed specimens. P.C.3 score $\simeq \frac{2}{3}$ diam. of dots in mm.

B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ diam. of dots in mm.

Comments:

The initial confusion here is eased when it is realised that the ontogenetic trend for most of the fauna is from the lower right quadrant of the P.C. plot to the lower left, via the centre. The links between clusters selected here are compatible with this trend and minimise crossing of ontogenetic lines. Curves for each morphospecies for each character are tolerably smooth, so the solution adopted here, though possibly not uniquely feasible, appears to be parsimonious. The most tenuous of the morphospecies in this respect are R2BD and R2BG, which cut across the dominant trend as constructed here. This anomalous trend in P.C. space is largely produced by the retention of strong plications in the postulated ontogeny, and this is compatible with the little information visible on individual specimens.

X6 and Y7 are anomalous specimens.



	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1				+	+	|						+	+
PC2			−			|		+	+		+		
PC3	+	−				|	+		+	+			

FIGURE 27. Principal components plots of R_{2b} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 25.9%
P.C.2 - 18.1%
P.C.3 - 14.6%

A: (Overleaf) Showing all analysed specimens. P.C.3 score $\simeq \frac{2}{3}$ diam. of dots in mm.

B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score $\simeq$ diam. of dots in mm.

Comments:

The initial confusion here is eased when it is realised that the ontogenetic trend for most of the fauna is from the lower right quadrant of the P.C. plot to the lower left, via the centre. The links between clusters selected here are compatible with this trend and minimise crossing of ontogenetic lines. Curves for each morphospecies for each character are tolerably smooth, so the solution adopted here, though possibly not uniquely feasible, appears to be parsimonious. The most tenuous of the morphospecies in this respect are R2BD and R2BG, which cut across the dominant trend as constructed here. This anomalous trend in P.C. space is largely produced by the retention of strong plications in the postulated ontogeny, and this is compatible with the little information visible on individual specimens.

X6 and Y7 are anomalous specimens.

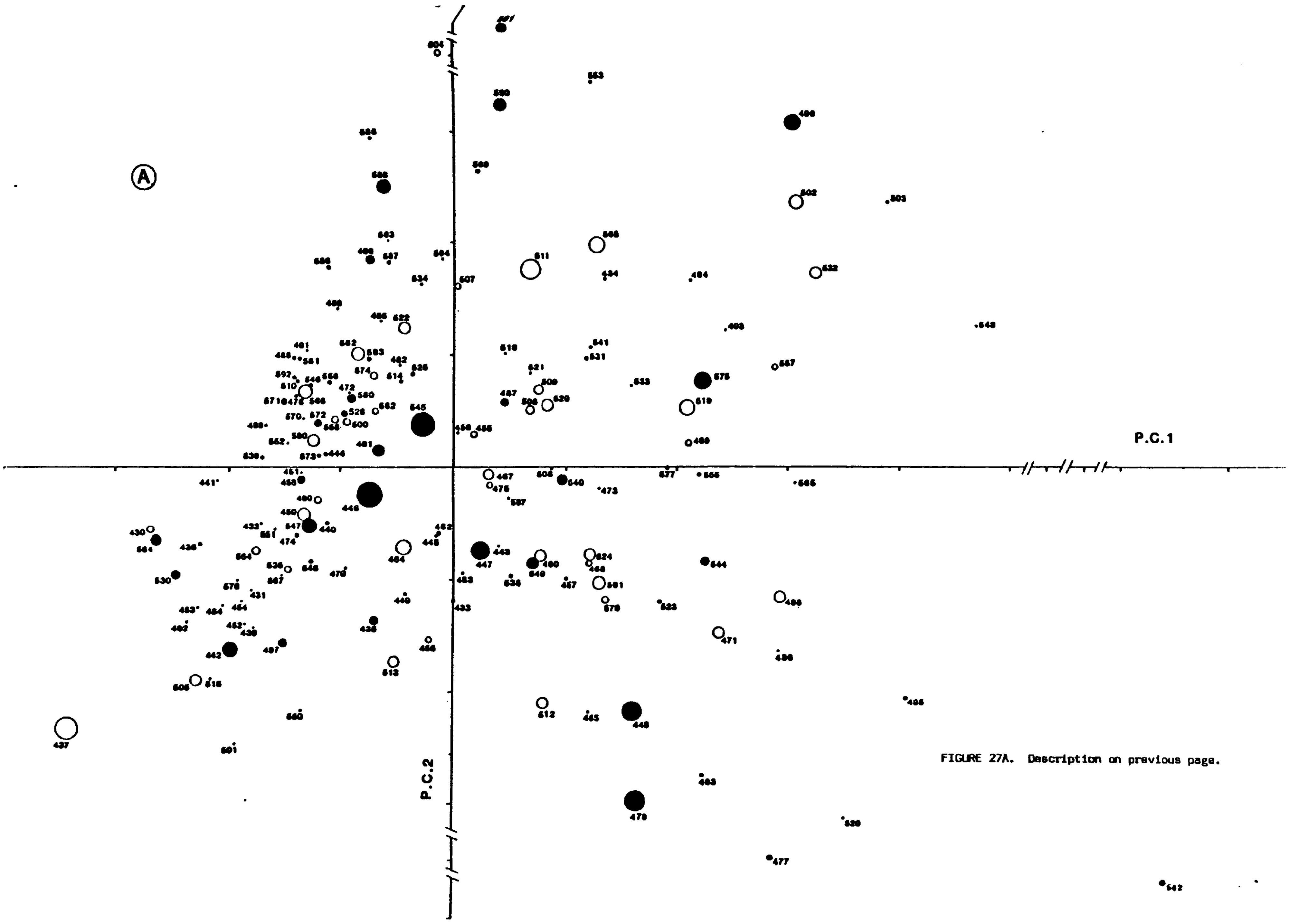
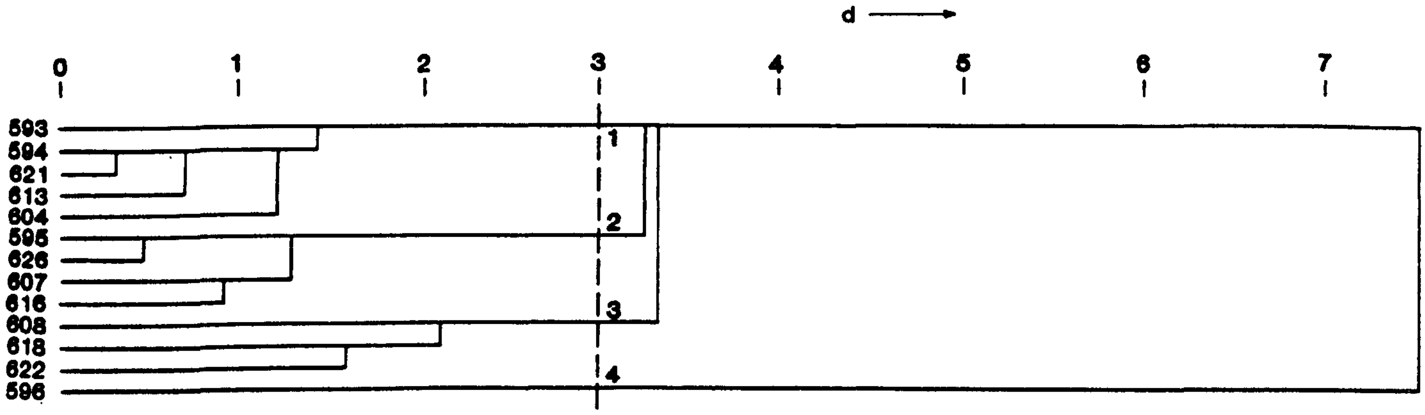


FIGURE 27A. Description on previous page.

Analysis of R_{2c} to G zone goniatites.

12-14 mm size range - analysis code R2CGZ :

Dendrogram

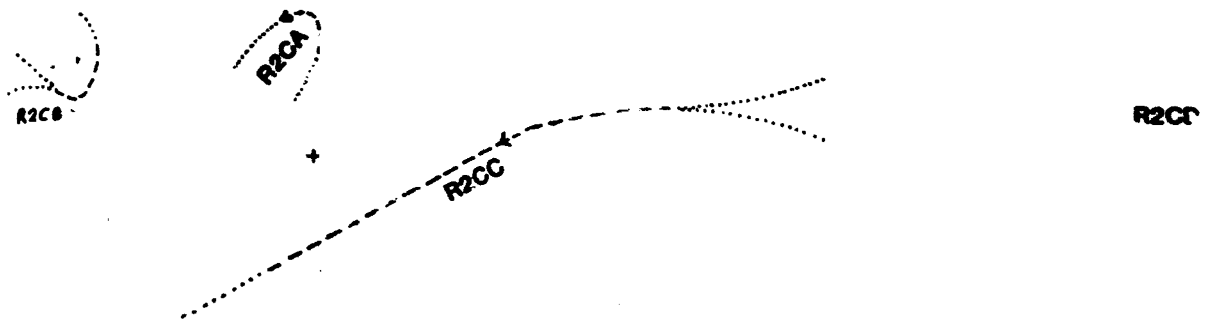


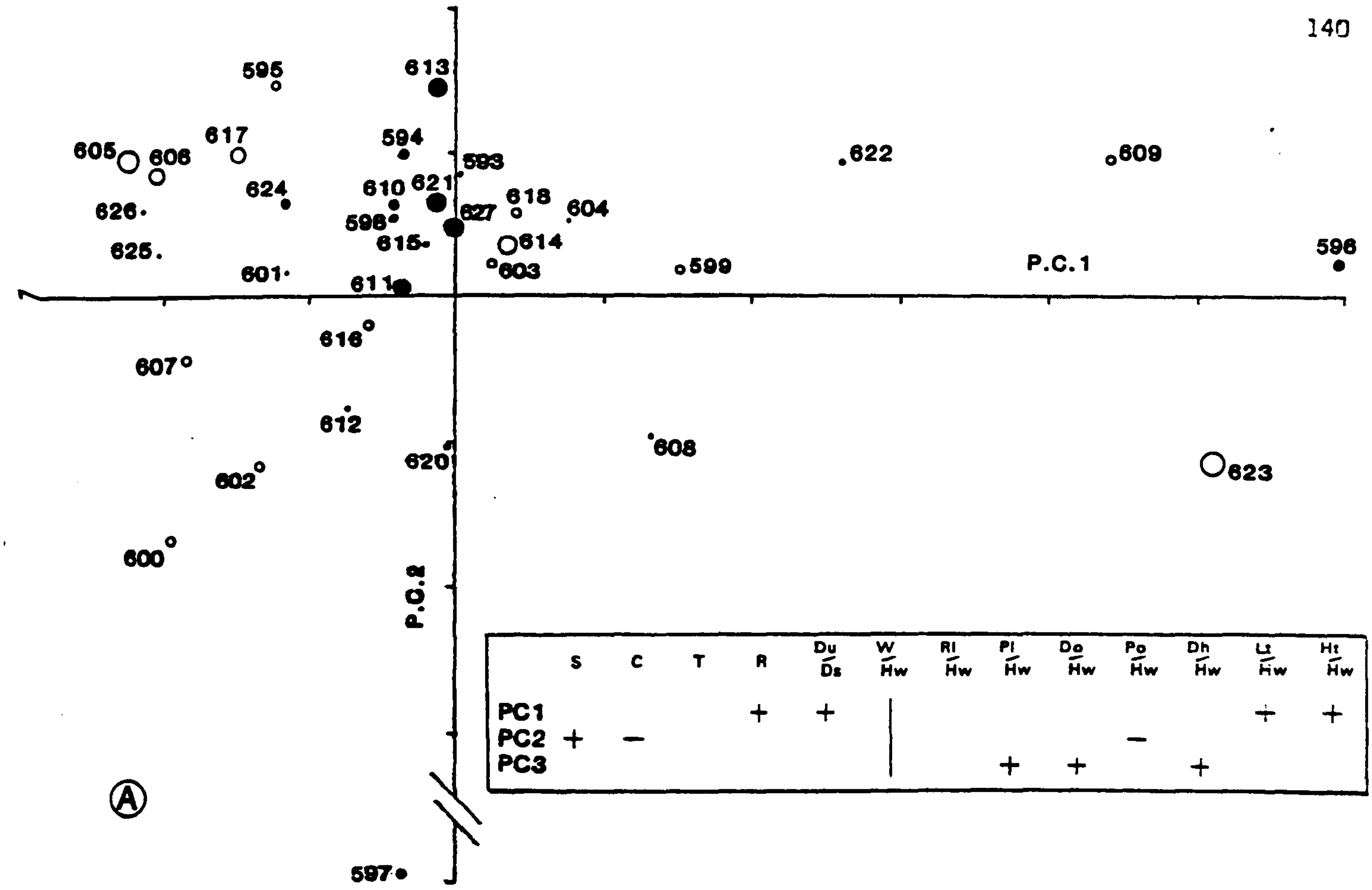
Means of character values for each cluster:

Cluster code		n	S	C	T	R	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
Z 1	mean	5.00		.160	26.6	1.00	.182		.763	.603	.327		.822	.013	.001
	s.d.			.055	4.33	0	.039		.031	.134	.028		.115	.029	.002
Z 2	mean	4.00		.100	25.0	1.00	.144		.716	.584	.193		.642	0	0
	s.d.			.082	3.36	0	.038		.069	.110	.041		.092	0	0
Z 3	mean	3.00		.167	17.3	1.40	.175		.729	.726	.262		.713	.080	.002
	s.d.			.115	2.31	.173	.023		.133	.163	.076		.029	.030	.001
Z 4	mean	1.00		.300	13.0	1.90	.225		.808	.865	.346		.962	.173	.010
	s.d.			0	0	0	0		0	0	0		0	0	0

Comments:

P.C.1 is the strongest direction of variation both within and between morphospecies. The interpretation here is that young representatives of one morphospecies are similar to old forms of another morphospecies.


R2CB
R2CA
R2CC
R2CD



	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1				+	+							+	+
PC2	+	−								−			
PC3								+	+		+		

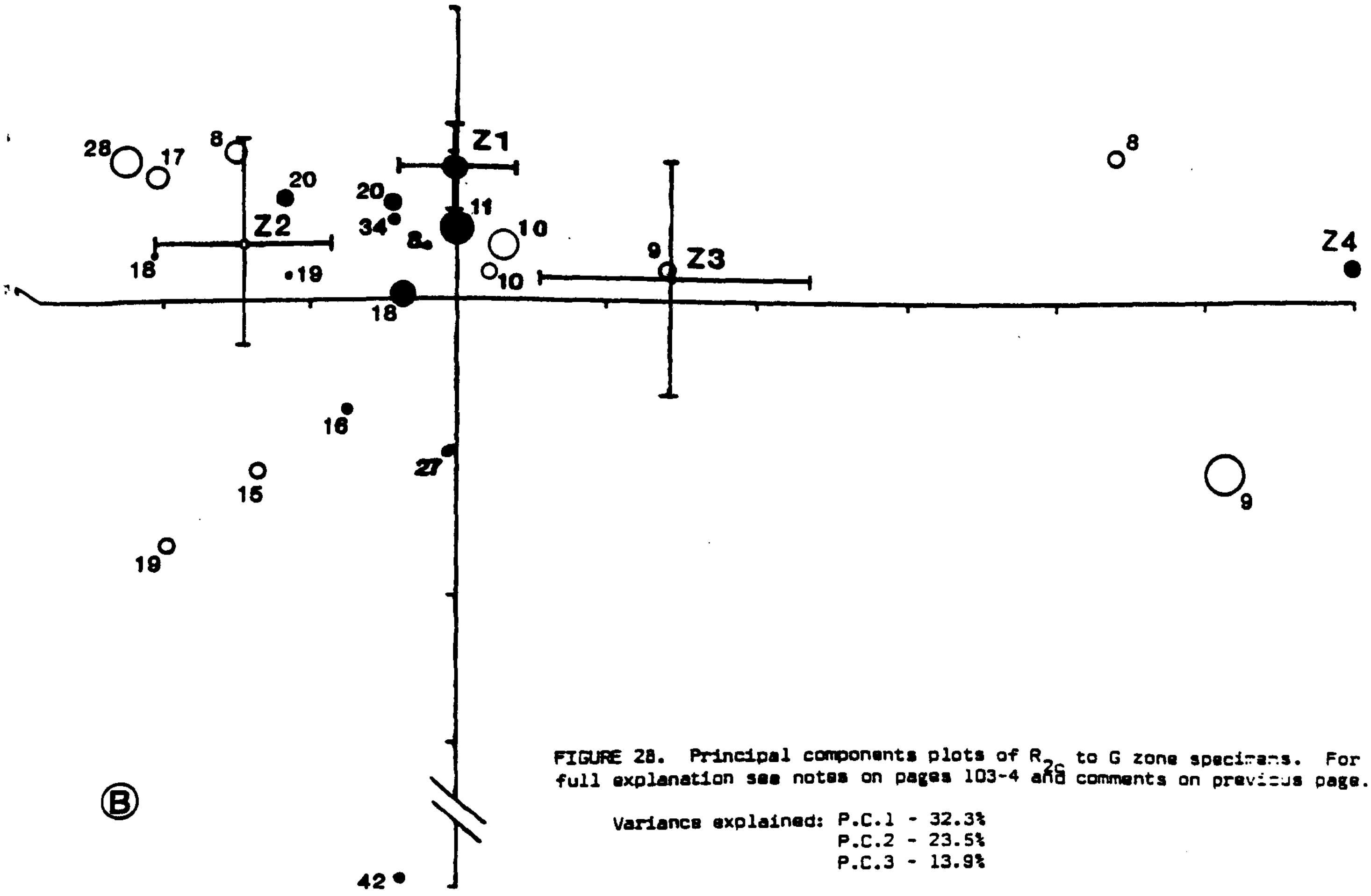
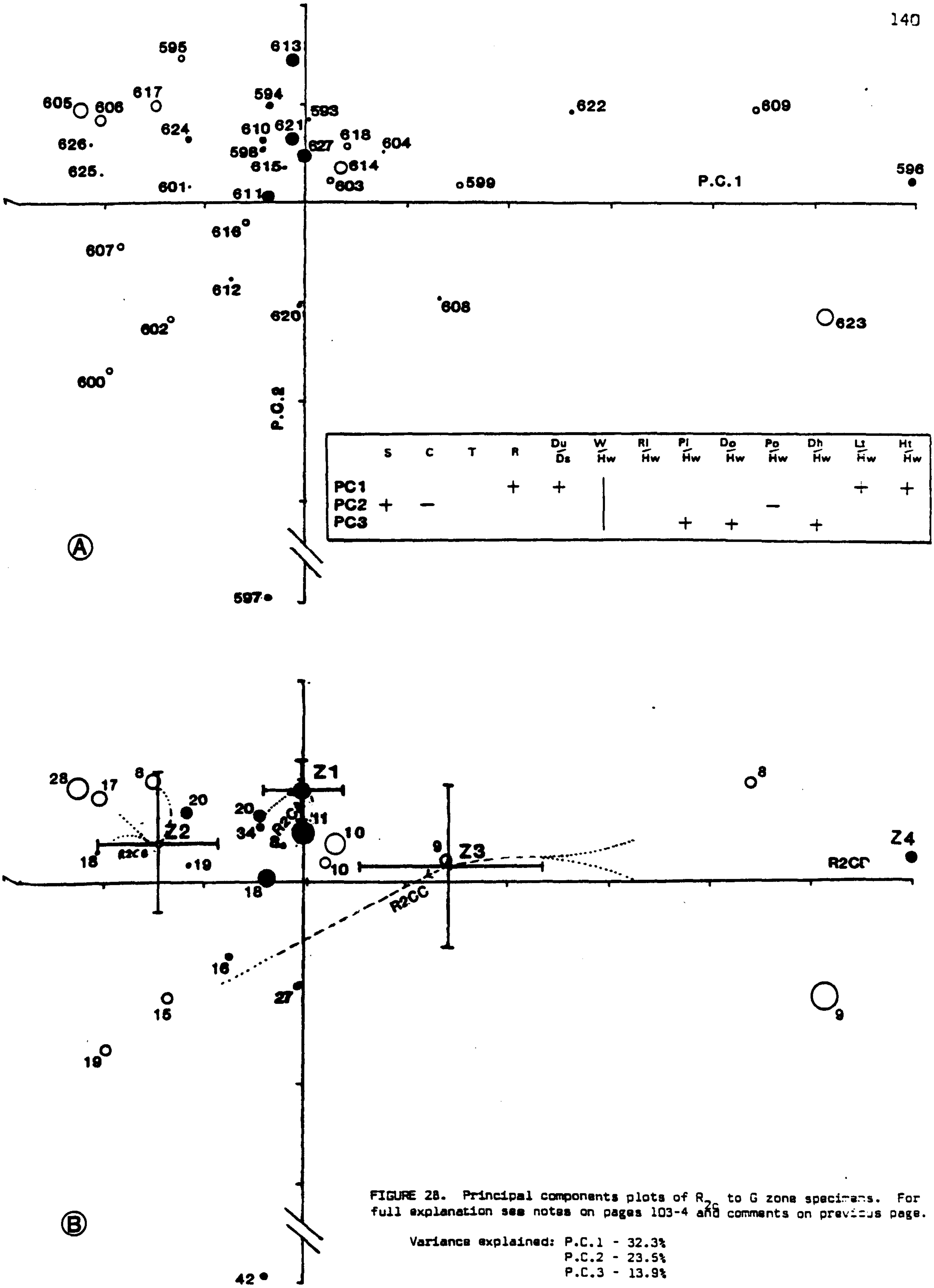


FIGURE 28. Principal components plots of R_{2c} to G zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 32.3%
P.C.2 - 23.5%
P.C.3 - 13.9%

A: Showing all analysed specimens. P.C.3 score ≈ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ $\frac{2}{3}$ diam. of dots in mm.



	S	C	T	R	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
PC1				+	+							+	+
PC2	+	−								−			
PC3								+	+		+		

FIGURE 28. Principal components plots of R_{2c} to G zone specimens. For full explanation see notes on pages 103-4 and comments on previous page.

Variance explained: P.C.1 - 32.3%
P.C.2 - 23.5%
P.C.3 - 13.9%

A: Showing all analysed specimens. P.C.3 score ≃ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ $\frac{2}{3}$ diam. of dots in mm.

4.1.3. ANALYSES OF SAMPLES OF GASTRIOCERATIDAE s.l.

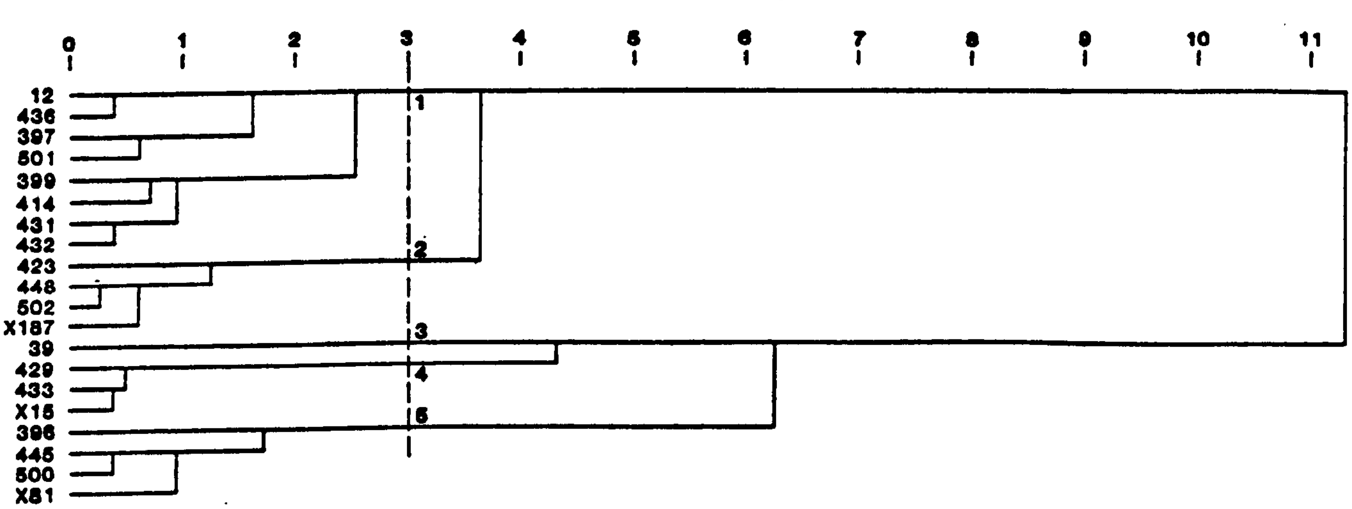
Samples were isolated from each of the following stratigraphic divisions:

G_{1a}, G_{1b}, G_{2a}, G_{2b}.

Analysis of G_{1a} zone goniatites.

9-12 mm size range - analysis code G1AW :

Dendrogram



Means of character values for each cluster:

Cluster code		n	R	S	C	T	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Do}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Ht}{Hw}$
W 1	mean	8.00		.825	.337	21.8	.337		.397		.122	.056
	s.d.			.103	.239	9.96	.035		.132		.042	.022
W 2	mean	4.00		.837	.362	24.0	.438		.557		.088	.068
	s.d.			.075	.125	8.48	.016		.180		.029	.022
W 3	mean	1.00		.100	0	35.0	.318		0		.096	0
	s.d.			0	0	0	0		0		0	0
W 4	mean	4.00		.800	.600	55.0	.297		.124		.035	.011
	s.d.			.100	.100	8.66	.031		.107		.011	.010
W 5	mean	4.00		.662	.950	40.5	.322		.440		.053	.084
	s.d.			.214	.058	8.23	.027		.155		.013	.036

11-14 mm size range - analysis code G1AX :

Means of character values for each cluster:

Cluster code		n	R	S	C	T	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Do}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Ht}{Hw}$
X 1	mean	6.00		.750	.567	24.5	.362		.376		.107	.049
	s.d.			.138	.265	10.7	.052		.116		.039	.021
X 2	mean	1.00		.100	0	35.0	.318		0		.096	0
	s.d.			0	0	0	0		0		0	0
X 3	mean	5.00		.700	.680	36.6	.272		.218		.028	.014
	s.d.			.158	.084	14.1	.027		.135		.011	.011
X 4	mean	3.00		.583	.900	46.6	.312		.384		.051	.087
	s.d.			.126	.100	5.77	.058		.069		.014	.006

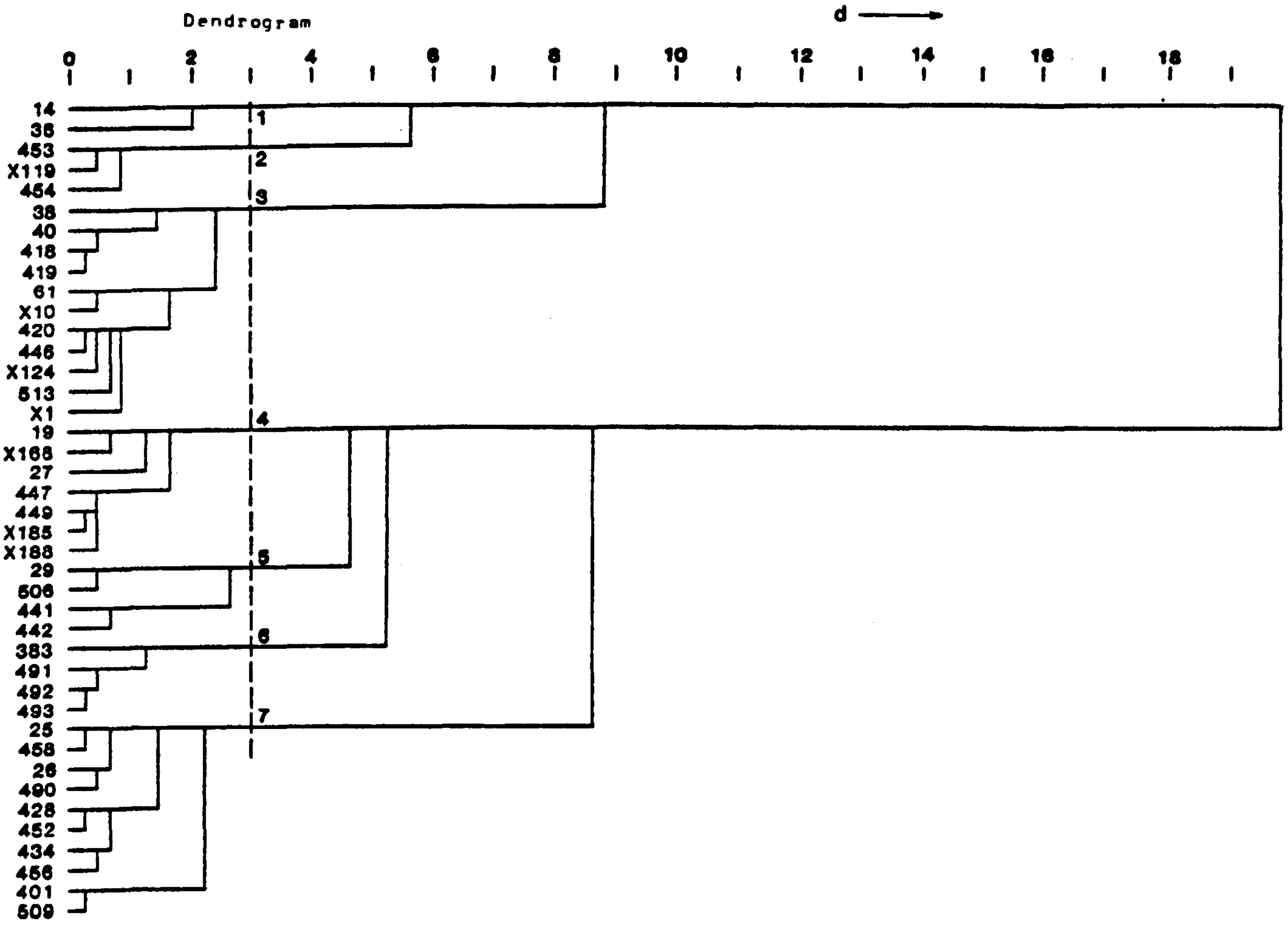
14-18 mm size range - analysis code G1AY :

Means of character values for each cluster:

Cluster code		n	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
Y 1	mean	2.00		.450	.900	50.0	.406		.452		.102	.062
	s.d.			.071	0	14.1	.008		.014		.009	.022
Y 2	mean	9.00		.531	.850	31.8	.375		.414		.063	.032
	s.d.			.128	.119	9.20	.068		.092		.010	.011
Y 3	mean	3.00		.483	.800	46.0	.250		.196		.030	.010
	s.d.			.029	.100	8.54	.032		.043		.013	.012
Y 4	mean	7.00		.579	.785	23.8	.315		.238		.037	.026
	s.d.			.081	.186	3.93	.045		.031		.019	.007
Y 5	mean	1.00		.900	.300	20.0	.288		.079		.016	.008
	s.d.			0	0	0	0		0		0	0

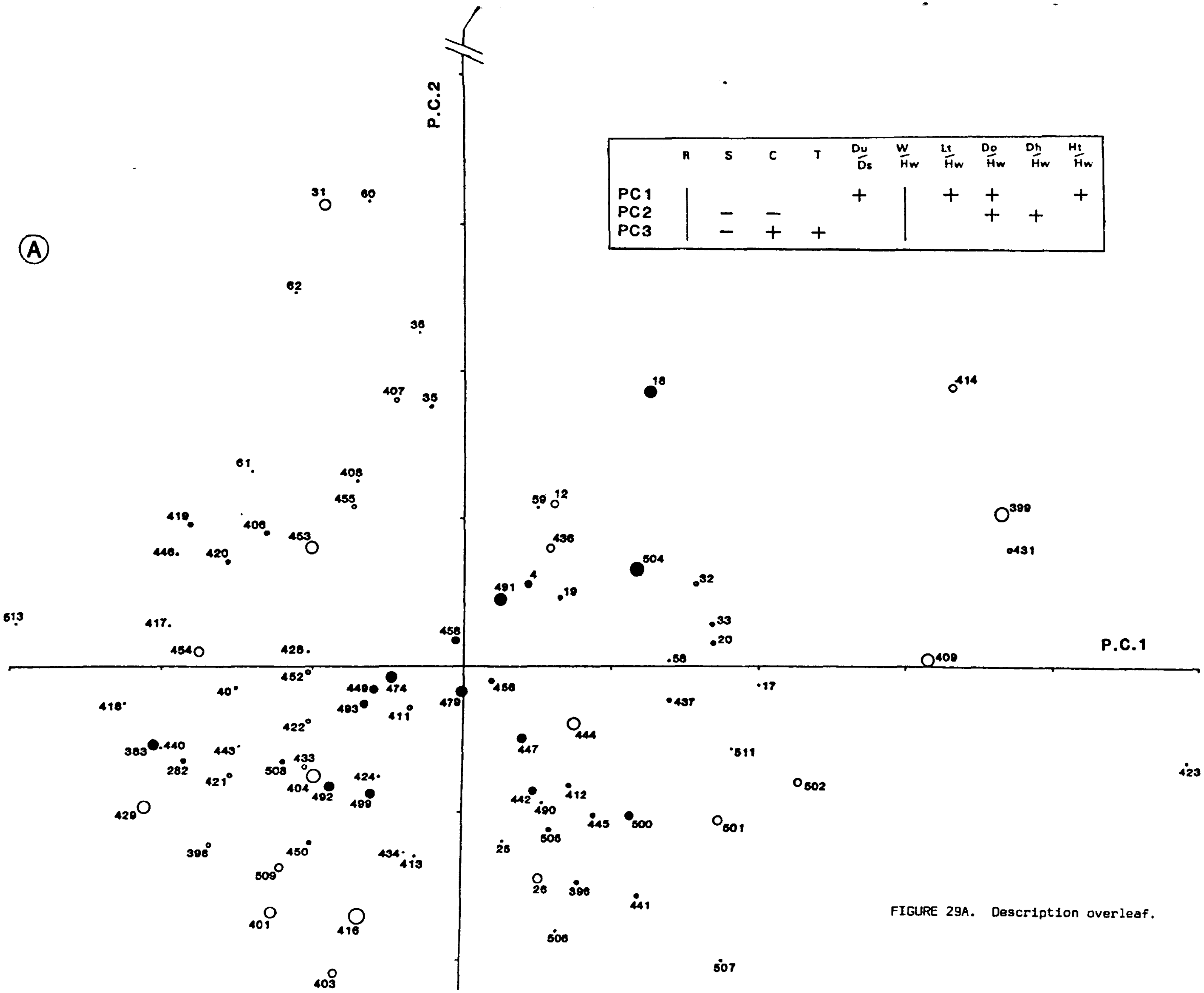
18-24 mm size range - analysis code G1AZ :

Dendrogram



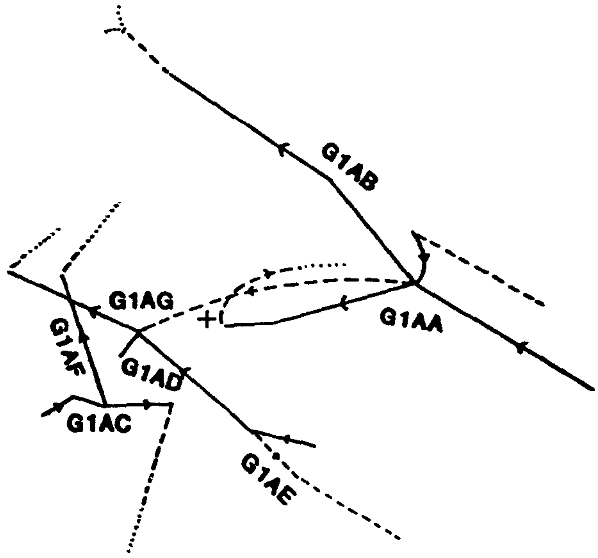
Means of character values for each cluster:

Cluster code		n	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
Z 1	mean	2.00		.550	.300	27.5	.260		.340		.124	.012
	s.d.			.212	.283	17.6	.049		.127		.006	.003
Z 2	mean	3.00		.767	.333	45.0	.280		.017		.056	0
	s.d.			.058	.153	8.66	.050		.023		.022	.001
Z 3	mean	11.0		.500	.745	40.2	.236		.158		.037	.014
	s.d.			.087	.175	11.6	.031		.084		.017	.008
Z 4	mean	7.00		.471	.929	27.3	.375		.374		.063	.031
	s.d.			.076	.076	3.69	.057		.039		.029	.011
Z 5	mean	4.00		.637	.850	35.0	.363		.511		.031	.062
	s.d.			.048	.100	8.16	.047		.119		.014	.031
Z 6	mean	4.00		.400	.900	55.0	.344		.283		.040	.047
	s.d.			0	.082	10.0	.032		.053		.013	.019
Z 7	mean	10.0		.720	.810	26.5	.336		.247		.034	.032
	s.d.			.079	:088	6.32	.061		.054		.011	.017



	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
PC1	|				+	|	+	+		+
PC2	|	−	−			|		+	+	
PC3	|	−	+	+		|				

FIGURE 29A. Description overleaf.


G1AB
G1AG
G1AA
G1AF
G1AD
G1AC
G1AE

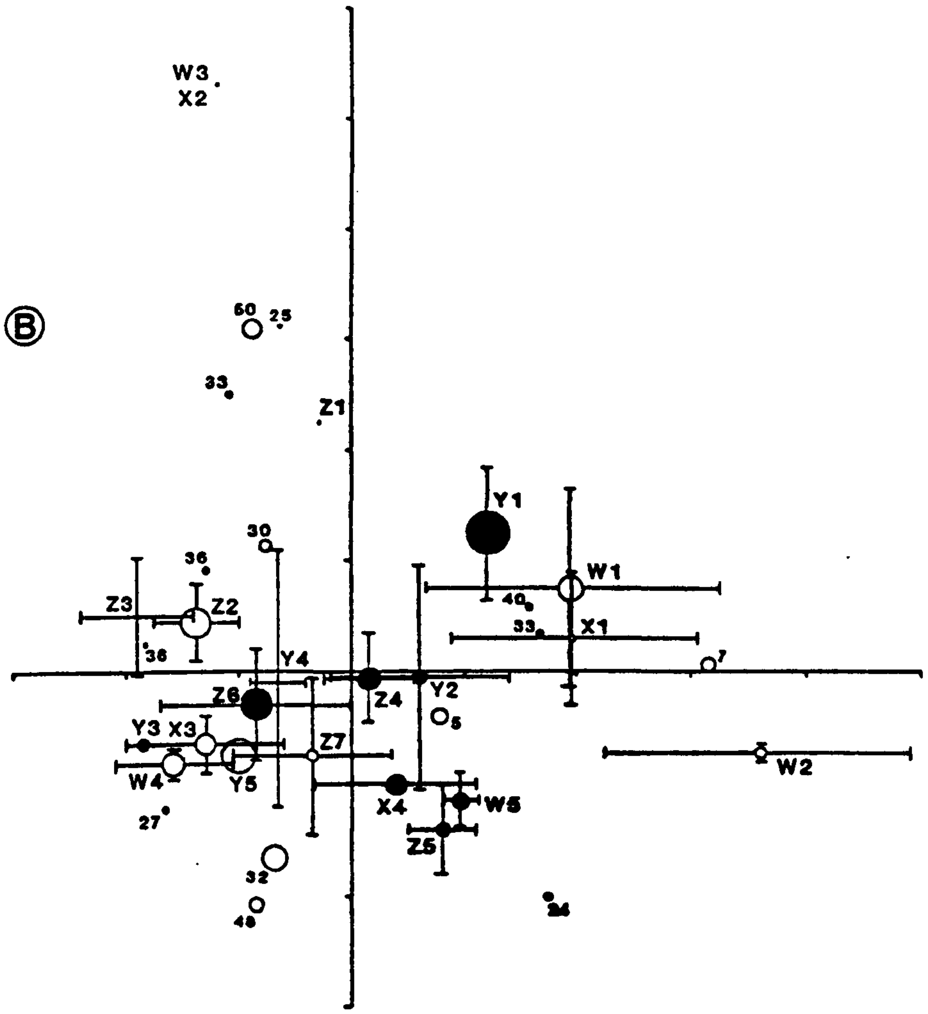


FIGURE 29. Principal components plots of G_{1a} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 30.3%
P.C.2 - 20.2%
P.C.3 - 16.9%

A: (Previous page) Showing all analysed specimens. P.C.3 score ≈ diam. of dots in mm.

B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ $\frac{2}{3}$ diam. of dots in mm.

Comments:

Rather difficult to interpret. The distribution of clusters in P.C. space does not appear to be very systematic, and P.C.1 is only vaguely correlated with ontogenetic change. The problem may be largely due to the effects of poor preservation in G_{1a} zone generally. The solution shown here gives weight to P.C.3 scores, this principal component being largely contributed to by ornamental characters, which are the least affected by the type of preservation in this zone, and are relatively consistent through ontogeny.

Note that in an attempt to aid cluster linkage, the size ranges of some analyses overlap by one millimetre. This is why clusters W3 and X2 are comprised of the same single specimen.

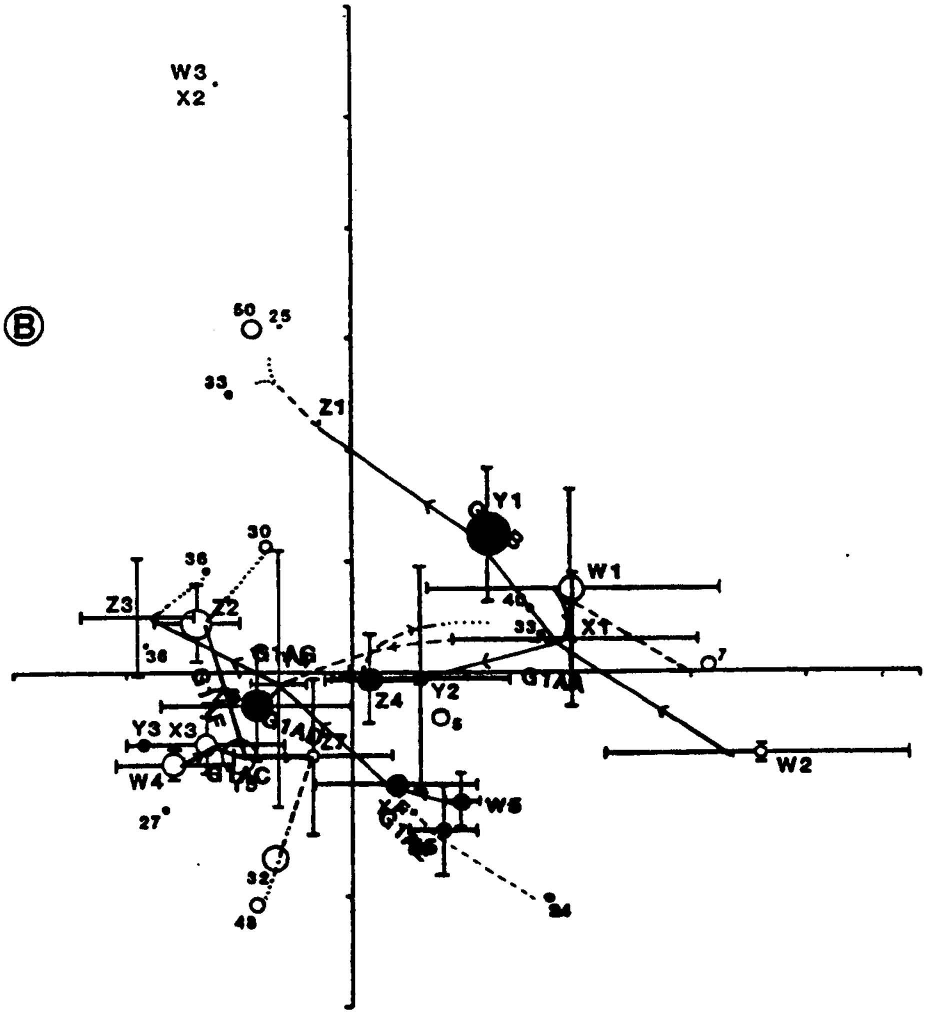


FIGURE 29. Principal components plots of G_{1a} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 30.3%
P.C.2 - 20.2%
P.C.3 - 16.9%

A: (Previous page) Showing all analysed specimens. P.C.3 score $\approx$ diam. of dots in mm.

B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score $\approx \frac{2}{3}$ diam. of dots in mm.

Comments:

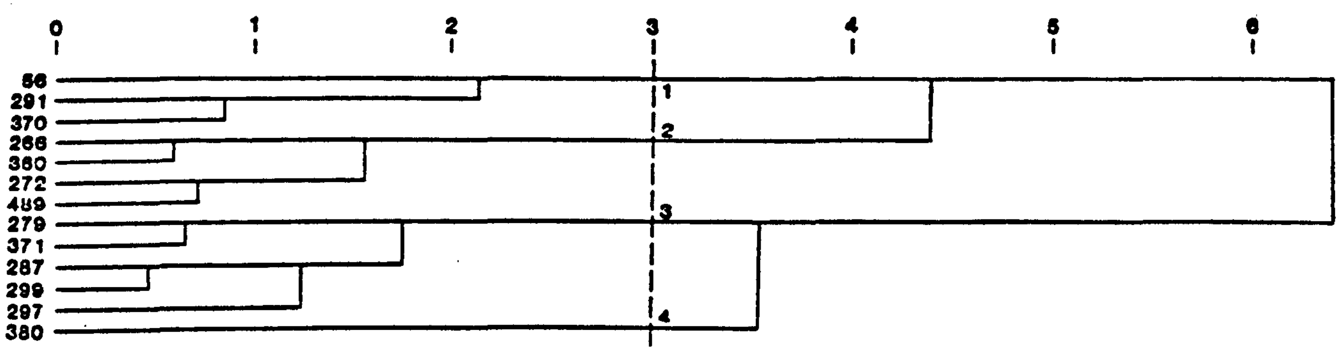
Rather difficult to interpret. The distribution of clusters in P.C. space does not appear to be very systematic, and P.C.1 is only vaguely correlated with ontogenetic change. The problem may be largely due to the effects of poor preservation in G_{1a} zone generally. The solution shown here gives weight to P.C.3 scores, this principal component being largely contributed to by ornamental characters, which are the least affected by the type of preservation in this zone, and are relatively consistent through ontogeny.

Note that in an attempt to aid cluster linkage, the size ranges of some analyses overlap by one millimetre. This is why clusters W3 and X2 are comprised of the same single specimen.

Analysis of G_{1b} zone goniatites.

9-12 mm size range - analysis code G1BW :

Dendrogram



Means of character values for each cluster:

Cluster code		n	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
W 1	mean	3.00		.367	.267	15.0	.307		.230		.135	.031
	s.d.			.058	.058	3.00	.048		.149		.011	.015
W 2	mean	4.00		1.00	.187	15.5	.325		.366		.085	.049
	s.d.			0	.193	2.08	.032		.130		.013	.009
W 3	mean	5.00		.900	.490	20.2	.302		.234		.049	.027
	s.d.			0	.219	4.08	.037		.052		.015	.010
W 4	mean	1.00		.800	.600	18.0	.442		.286		.057	.057
	s.d.			0	0	0	0		0		0	0

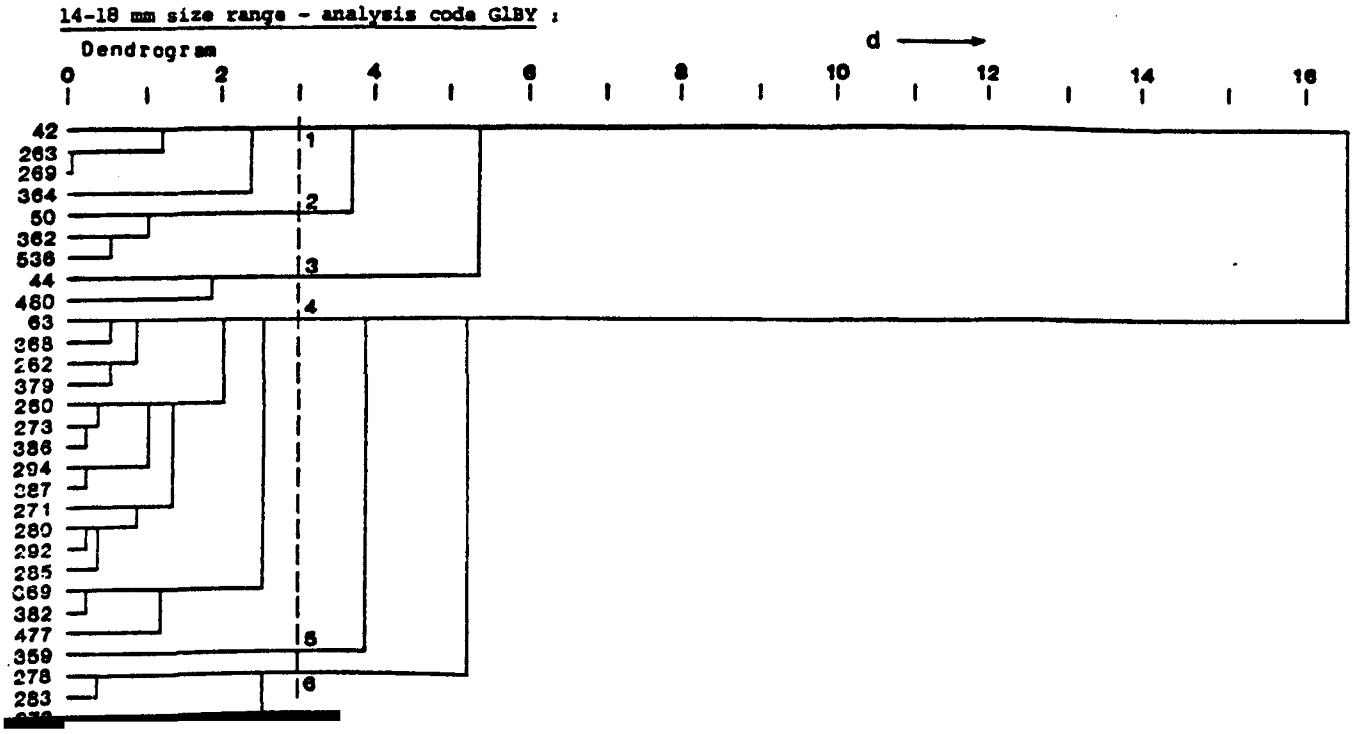
11-14 mm size range - analysis code G1BX :

Means of character values for each cluster:

Cluster code		n	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
X 1	mean	2.00		.350	.200	7.50	.363		.889		.020	.092
	s.d.			.212	.283	3.53	.016		.157		.004	.035
X 2	mean	1.00		.800	.700	16.0	.416		.469		.125	.125
	s.d.			0	0	0	0		0		0	0
X 3	mean	4.00		.900	.125	13.2	.318		.383		.124	.032
	s.d.			.082	.150	1.26	.044		.212		.021	.014
X 4	mean	7.00		.871	.350	16.1	.352		.244		.045	.048
	s.d.			.076	.281	5.01	.028		.031		.015	.009
X 5	mean	5.00		.800	.600	19.8	.263		.222		.054	.029
	s.d.			.141	.187	3.56	.025		.041		.011	.008

14-18 mm size range - analysis code G1BY :

Dendrogram



Means of character values for each cluster:

Cluster code		n	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
Y 1	mean	4.00		.700	.775	16.5	.377		.393		.039	.054
	s.d.			0	.126	3.11	.065		.142		.005	.016
Y 2	mean	3.00		.800	.300	11.6	.320		.316		.024	.053
	s.d.			0	.200	3.51	.025		.079		.009	.017
Y 3	mean	2.00		.750	.250	13.5	.348		.416		.129	.012
	s.d.			.071	.071	4.95	.034		.236		.006	.012
Y 4	mean	16.0		.856	.628	18.8	.281		.234		.048	.028
	s.d.			.051	.164	3.42	.036		.069		.026	.009
Y 5	mean	1.00		1.00	.100	25.0	.341		.068		.068	.007
	s.d.			0	0	0	0		0		0	0
Y 6	mean	3.00		.833	.900	30.3	.227		.181		.028	.019
	s.d.			.058	.100	2.52	.120		.029		.005	.009

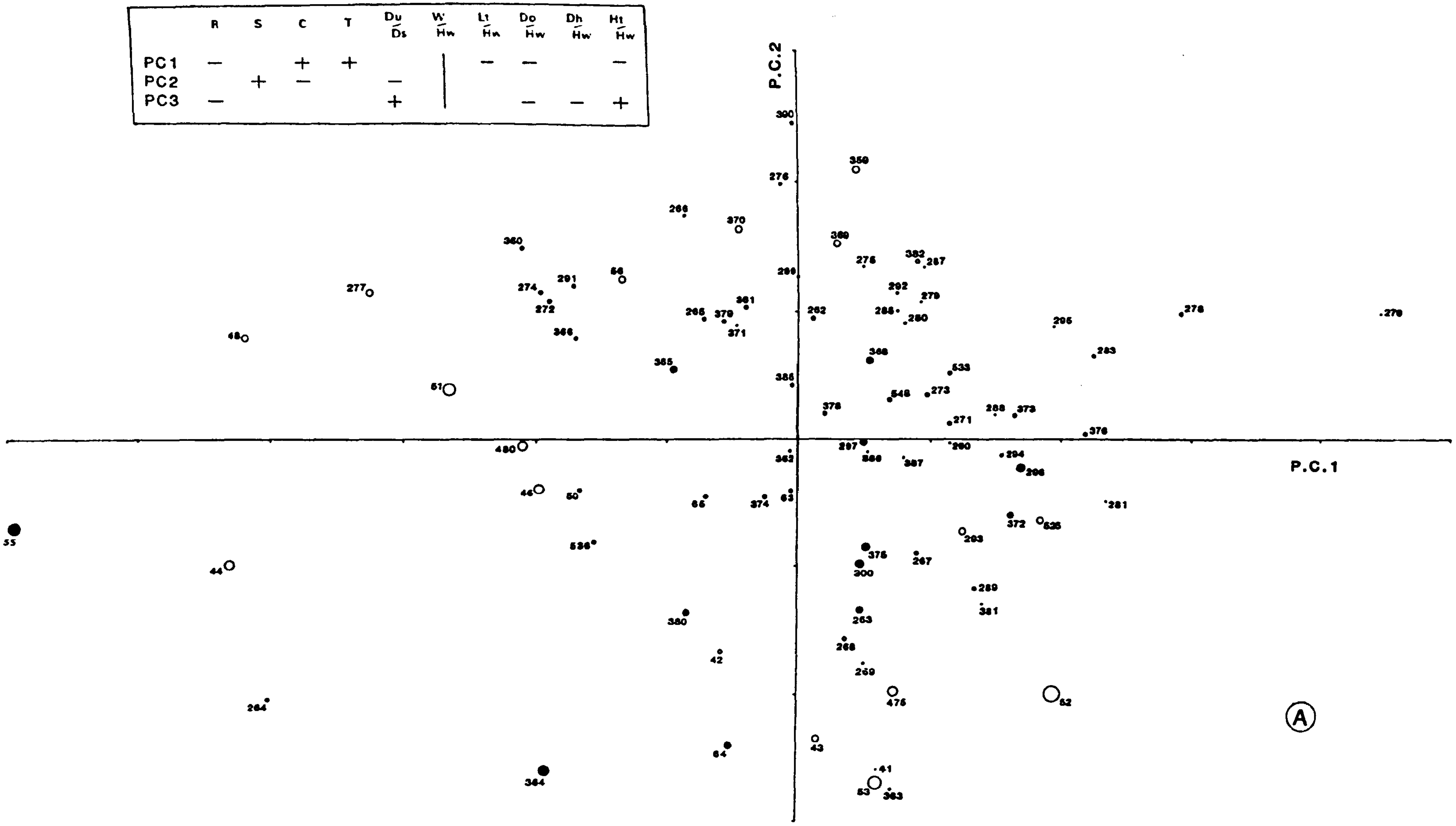
<u>18-24 mm size range - analysis code G1BZ</u> :

Means of character values for each cluster:

Cluster code		n	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
Z 1	mean	3.00		.700	.967	13.6	.299		.260		.057	.050
	s.d.			.100	.058	2.31	.034		.059		.040	.001
Z 2	mean	5.00		.800	.900	22.2	.380		.260		.028	.031
	s.d.			.071	.071	2.86	.025		.064		.011	.013
Z 3	mean	1.00		.300	.800	50.0	.271		0		.016	0
	s.d.			0	0	0	0		0		0	0
Z 4	mean	3.00		.800	.867	23.3	.223		.201		.022	.025
	s.d.			.100	.058	7.23	.018		.058		.017	.003
Z 5	mean	5.00		.860	.520	16.2	.317		.310		.060	.029
	s.d.			.055	.084	6.26	.050		.091		.038	.014

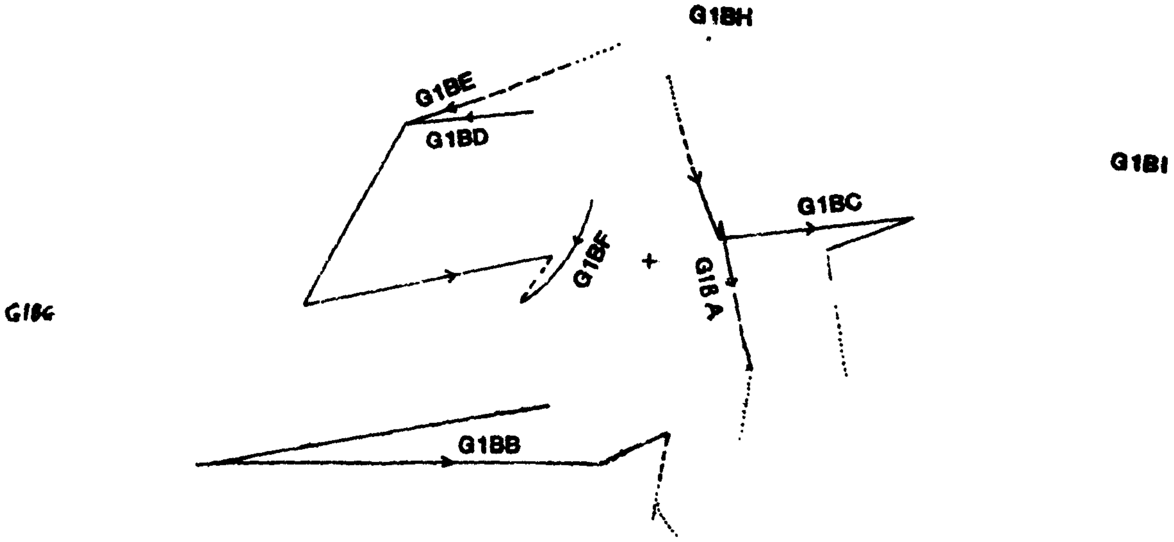
Comments:

The ontogenies here are easier to reconstruct than in G_{1a} zone largely because there is greater variation rather than within morphospecies. There is less of a general ontogenetic trend in P.C. space and morphospecies occupy fairly discrete morphologies, with little overlap.



	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
PC1	−		+	+			−	−		−
PC2		+	−		−					
PC3	−				+			−	−	+

FIGURE 30A. Description overleaf.


G1BH
G1BE
G1BD
G1BI
G1BC
G1BF
+
G1B A
G1BG
G1BB

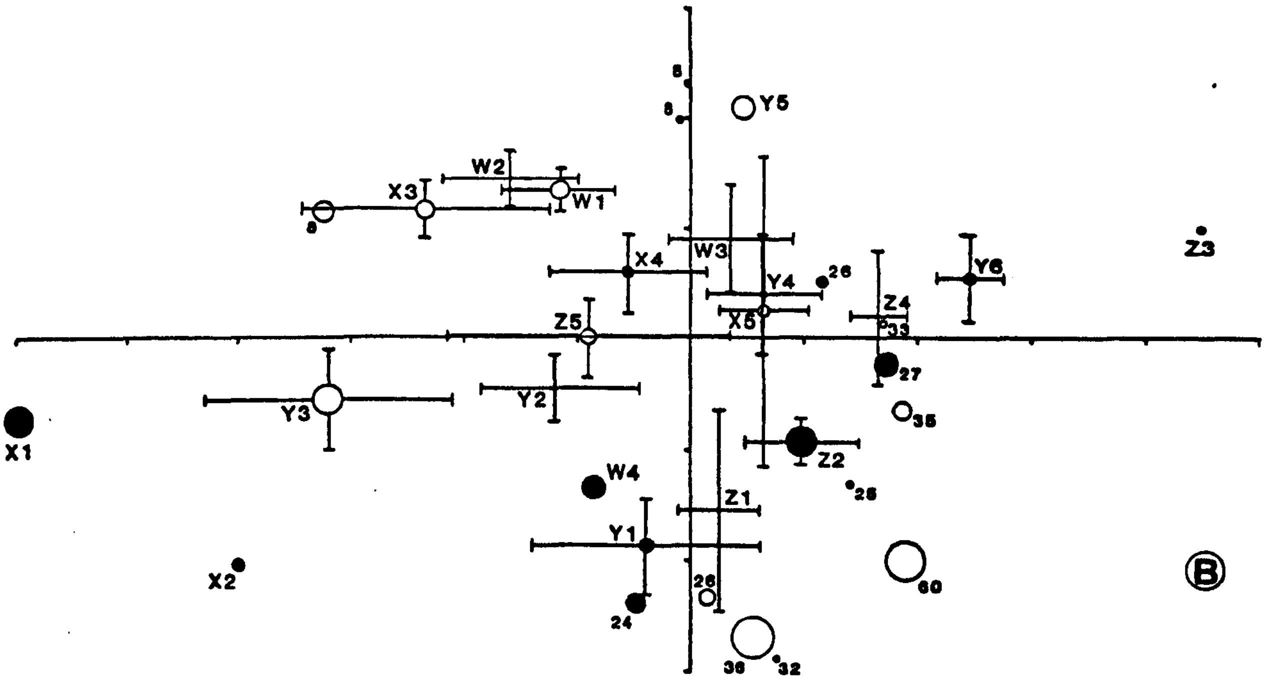


FIGURE 30. Principal components plots of G_{1b} zone specimens. For full explanation see notes on pages 103-4 and comments on page 145.

Variance explained: P.C.1 - 32.5%
P.C.2 - 17.5%
P.C.3 - 13.5%

A: (Previous page) Showing all analysed specimens. P.C.3 score $\approx 1\frac{1}{2}$ diam. of dots in mm.

B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score $\approx \frac{2}{3}$ diam. of dots in mm.

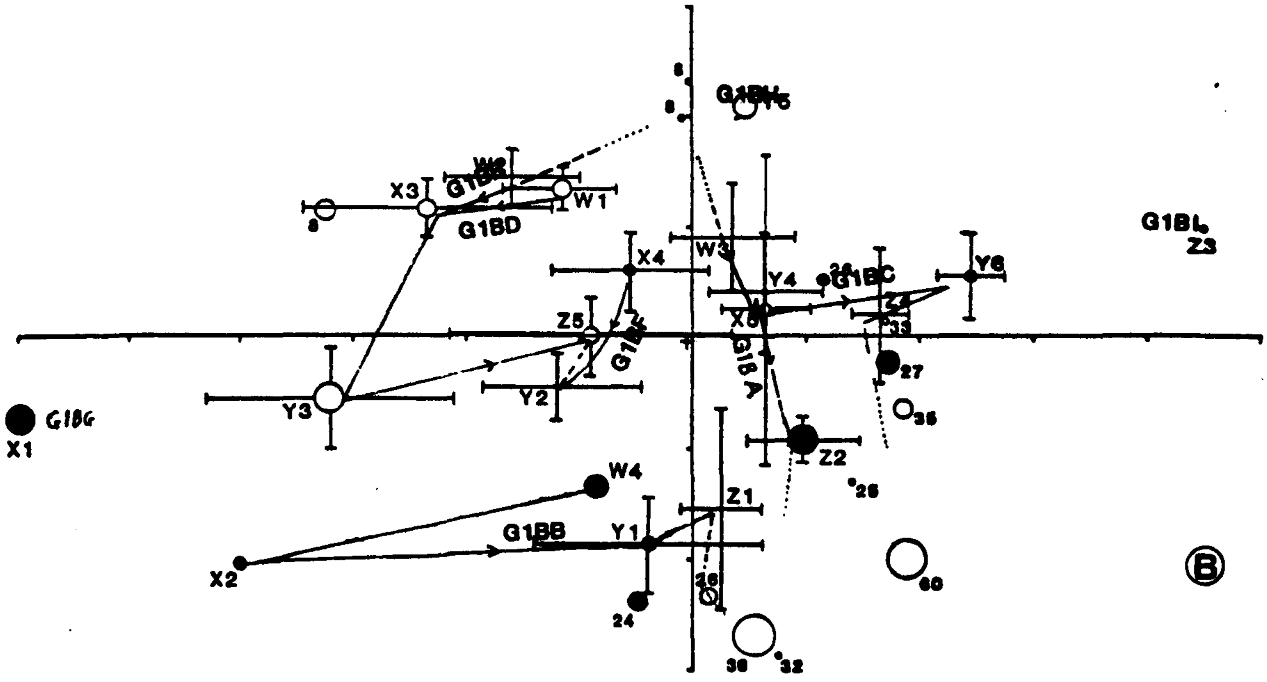


FIGURE 30. Principal components plots of G_{1b} zone specimens. For full explanation see notes on pages 103-4 and comments on page 145.

Variance explained: P.C.1 - 32.5%
P.C.2 - 17.5%
P.C.3 - 13.5%

A: (Previous page) Showing all analysed specimens. P.C.3 score ≃ 1½ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ $\frac{2}{3}$ diam. of dots in mm.

Analysis of G_{2a} zone goniatites (Subcrenatum Marine Band).

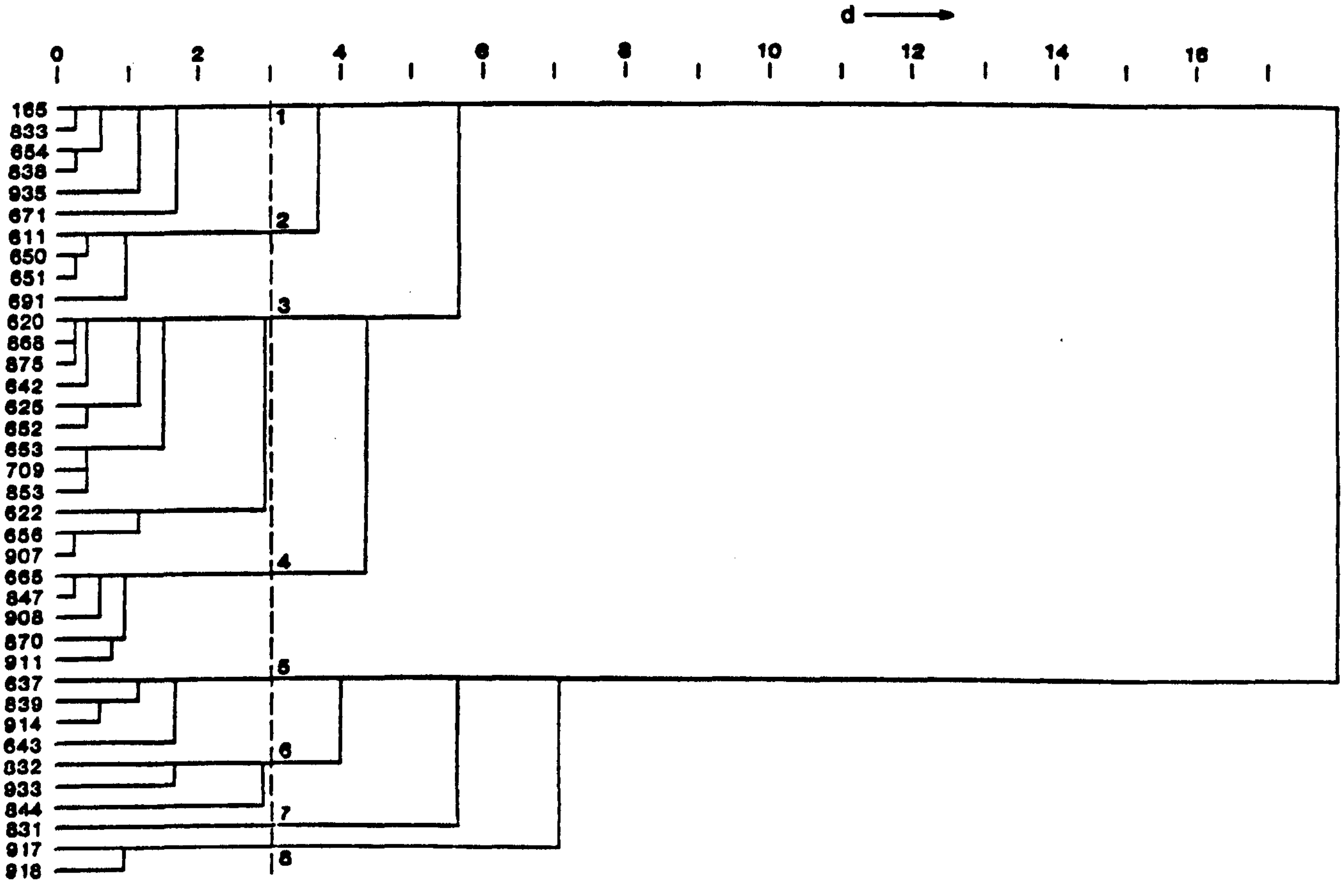
9-12 mm size range - analysis code G2AU :

Means of character values for each cluster:

Cluster code		n	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
U 1	mean	15.0	1.00		.020	21.5	.364	1.68	.260	.133	.053	.013
	s.d.		0		.041	2.87	.028	.281	.053	.021	.016	.008
U 2	mean	3.00	1.00		.267	17.6	.335	1.67	.241	.129	.056	.012
	s.d.		0		.058	.577	.034	.147	.016	.013	.006	.001
U 3	mean	4.00	1.25		.025	13.7	.392	1.71	.249	.098	.105	.016
	s.d.		.283		.050	3.86	.034	.152	.057	.027	.015	.010
U 4	mean	13.0	1.00		.031	21.0	.353	1.66	.105	.083	.056	.006
	s.d.		0		.048	5.45	.024	.153	.112	.018	.007	.007
U 5	mean	5.00	1.14		.040	22.6	.370	2.25	.374	.089	.055	.047
	s.d.		.219		.055	13.5	.024	.427	.069	.014	.015	.021
U 6	mean	1.00	1.00		0	30.0	.495	2.86	.333	.067	0	.067
	s.d.		0		0	0	0	0	0	0	0	0
U 7	mean	1.00	1.00		.100	75.0	.364	2.25	.375	.063	.038	.050
	s.d.		0		0	0	0	0	0	0	0	0
U 8	mean	2.00	2.00		.200	16.0	.359	1.84	.322	.091	.052	.026
	s.d.		0		.141	2.83	.088	.367	.102	.036	.002	.001

11-14 mm size range - analysis code G2AV :

Dendrogram

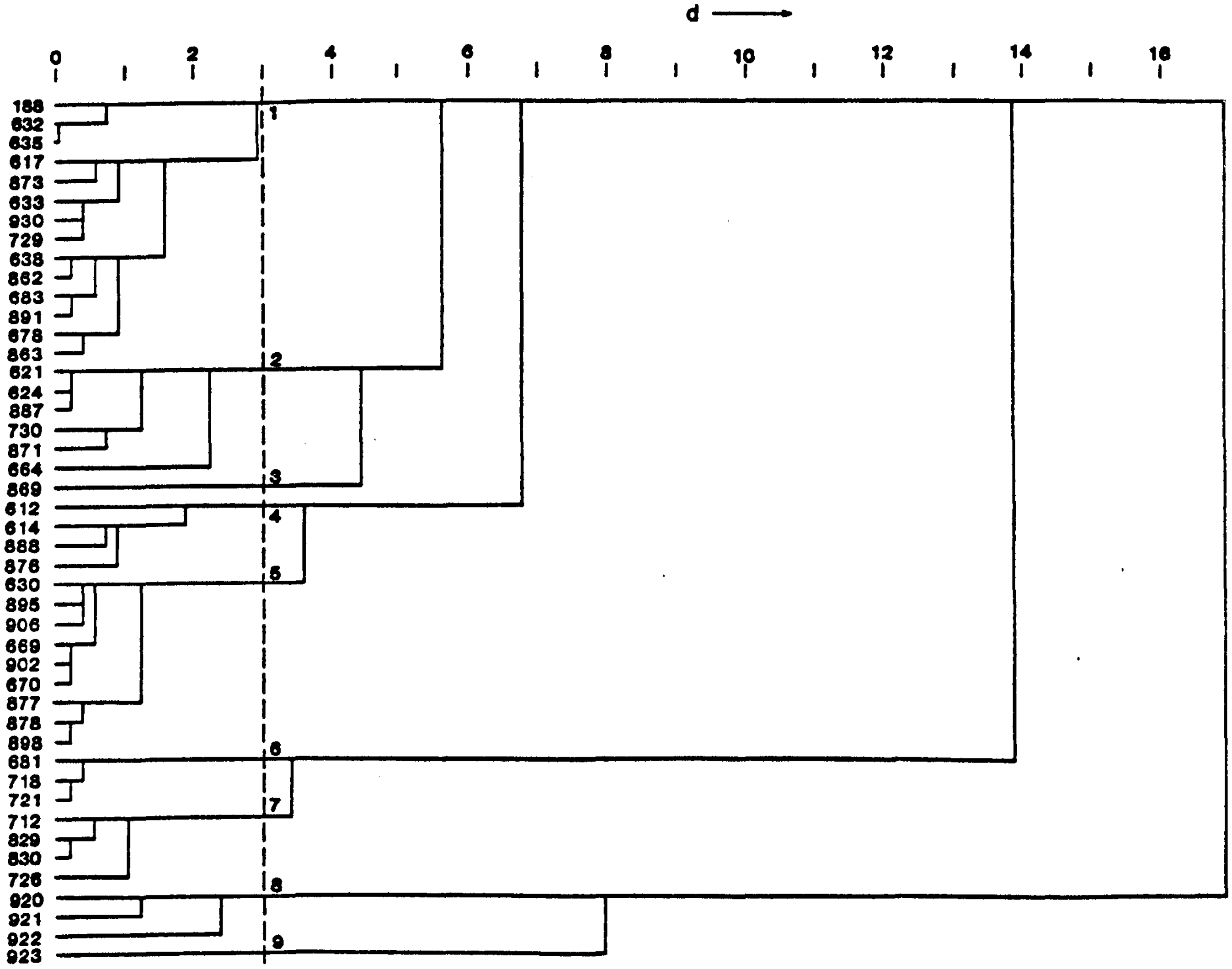


Means of character values for each cluster:

Cluster code		n	R	S	C	T	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Do}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Ht}{Hw}$
V 1	mean	6.00	1.08		.017	22.5	.334	1.65	.252	.179	.050	.015
	s.d.		.204		.041	9.85	.013	.115	.071	.026	.011	.007
V 2	mean	4.00	1.00		.012	21.0	.290	1.46	.021	.176	.044	.002
	s.d.		0		.025	5.88	.009	.103	.041	.039	.011	.004
V 3	mean	12.0	1.00		.083	22.5	.344	1.58	.135	.120	.064	.006
	s.d.		0		.072	3.98	.012	.110	.108	.033	.013	.005
V 4	mean	5.00	1.00		.260	22.6	.340	1.69	.239	.154	.052	.013
	s.d.		0		.055	6.69	.028	.117	.039	.033	.010	.006
V 5	mean	4.00	1.00		.050	21.0	.385	2.00	.271	.098	.052	.014
	s.d.		0		.058	4.24	.009	.179	.059	.032	.023	.003
V 6	mean	3.00	1.50		.133	22.3	.399	2.14	.368	.075	.062	.053
	s.d.		.500		.152	15.9	.019	.031	.046	.007	.015	.023
V 7	mean	1.00	1.00		.100	75.0	.364	2.25	.375	.063	.038	.050
	s.d.		0		0	0	0	0	0	0	0	0
V 8	mean	2.00	2.25		.050	15.5	.302	1.79	.241	.087	.054	.030
	s.d.		.353		.071	2.12	.008	.293	.012	.042	.006	.007

<u>14-18 mm size range - analysis code G2AW</u> :

Dendrogram



Means of character values for each cluster:

Cluster code		n	R	S	C	T	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Do}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Ht}{Hw}$
W 1	mean	14.0	1.00		.086	20.7	.312	1.59	.193	.176	.040	.008
	s.d.		0		.103	4.33	.033	.129	.108	.039	.010	.005
W 2	mean	6.00	1.00		.317	26.8	.321	1.36	.121	.121	.042	.005
	s.d.		0		.117	5.71	.040	.266	.065	.032	.010	.004
W 3	mean	1.00	1.00		.800	18.0	.346	1.64	.221	.294	.029	.015
	s.d.		0		0	0	0	0	0	0	0	0
W 4	mean	4.00	1.00		.125	34.2	.289	1.47	.078	.221	.087	.004
	s.d.		0		.096	12.6	.028	.156	.109	.066	.008	.005
W 5	mean	9.00	1.00		.189	20.0	.333	1.60	.045	.162	.068	.002
	s.d.		0		.078	4.47	.012	.081	.072	.031	.014	.003
W 6	mean	3.00	1.00		.100	39.3	.360	1.78	0	.106	.032	0
	s.d.		0		0	6.03	.021	.100	0	.014	.006	0
W 7	mean	4.00	1.00		.150	41.2	.381	1.99	.291	.077	.028	.033
	s.d.		0		.058	10.4	.017	.130	.024	.034	.007	.019
W 8	mean	3.00	1.66		.100	17.6	.291	1.59	.187	.248	.047	.058
	s.d.		.289		0	1.53	.020	.167	.074	.042	.015	.053
W 9	mean	1.00	1.50		.100	10.0	.443	2.39	.347	.020	.010	.143
	s.d.		0		0	0	0	0	0	0	0	0

18-24 mm size range - analysis code G2AX :

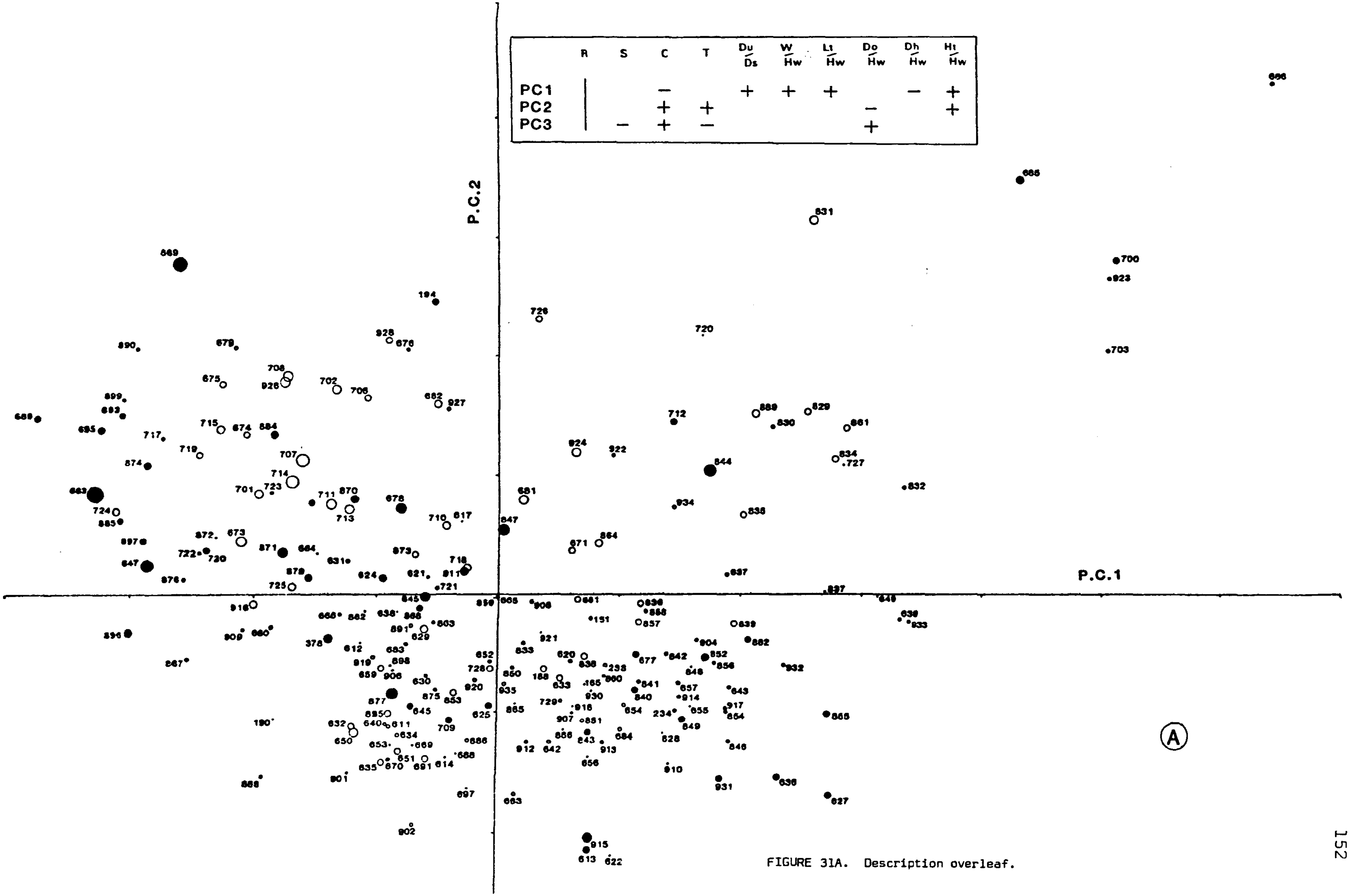
Means of character values for each cluster:

Cluster code		n	R	S	C	T	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Do}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Ht}{Hw}$
X 1	mean	5.00	1.00		.280	46.0	.335	1.65	.292	.178	.043	.019
	s.d.		0		.179	5.47	.029	.080	.060	.069	.024	.008
X 2	mean	1.00	1.20		.100	25.0	.385	1.80	.242	.161	.032	.040
	s.d.		0		0	0	0	0	0	0	0	0
X 3	mean	6.00	1.00		.183	38.5	.338	1.54	.020	.296	.030	.001
	s.d.		0		.194	7.47	.019	.163	.049	.078	.011	.002
X 4	mean	13.0	1.00		.231	24.4	.301	1.42	.087	.194	.032	.004
	s.d.		0		.149	6.43	.017	.120	.088	.050	.016	.004
X 5	mean	5.00	1.00		.560	21.0	.309	1.26	.042	.211	.054	.002
	s.d.		0		.230	5.43	.022	.074	.065	.060	.016	.003

23-28 mm size range - analysis code G2AY :

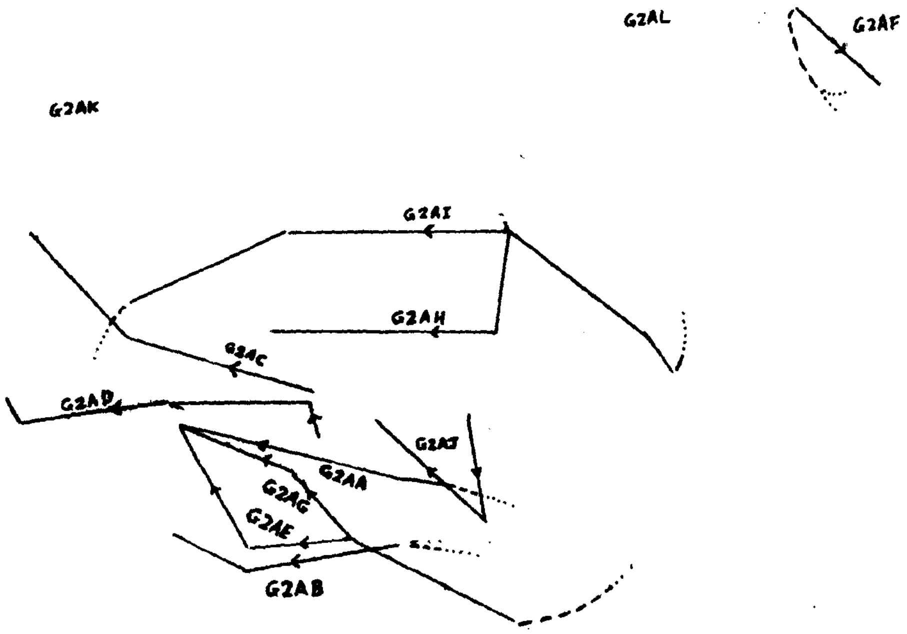
Means of character values for each cluster:

Cluster code		n	R	S	C	T	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Do}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Ht}{Hw}$
Y 1	mean	4.00	1.00		.175	37.0	.314	1.53	.225	.192	.031	.015
	s.d.		0		.096	12.4	.027	.085	.061	.063	.019	.013
Y 2	mean	3.00	1.00		.200	55.0	.294	1.36	.055	.173	.027	.003
	s.d.		0		.100	5.00	.007	.109	.095	.062	.003	.005
Y 3	mean	2.00	1.00		.450	37.5	.329	1.49	.119	.387	.030	.005
	s.d.		0		.071	3.53	.005	.211	.001	.016	.008	.001
Y 4	mean	7.00	1.00		.457	27.7	.301	1.29	.010	.032	.025	.001
	s.d.		0		.113	4.27	.026	.068	.037	.032	.025	.002



	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
PC1			−		+	+	+		−	+
PC2			+	+				−		+
PC3		−	+	−				+		

FIGURE 31A. Description overleaf.


G2AL
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G2AG
G2AE
G2AB

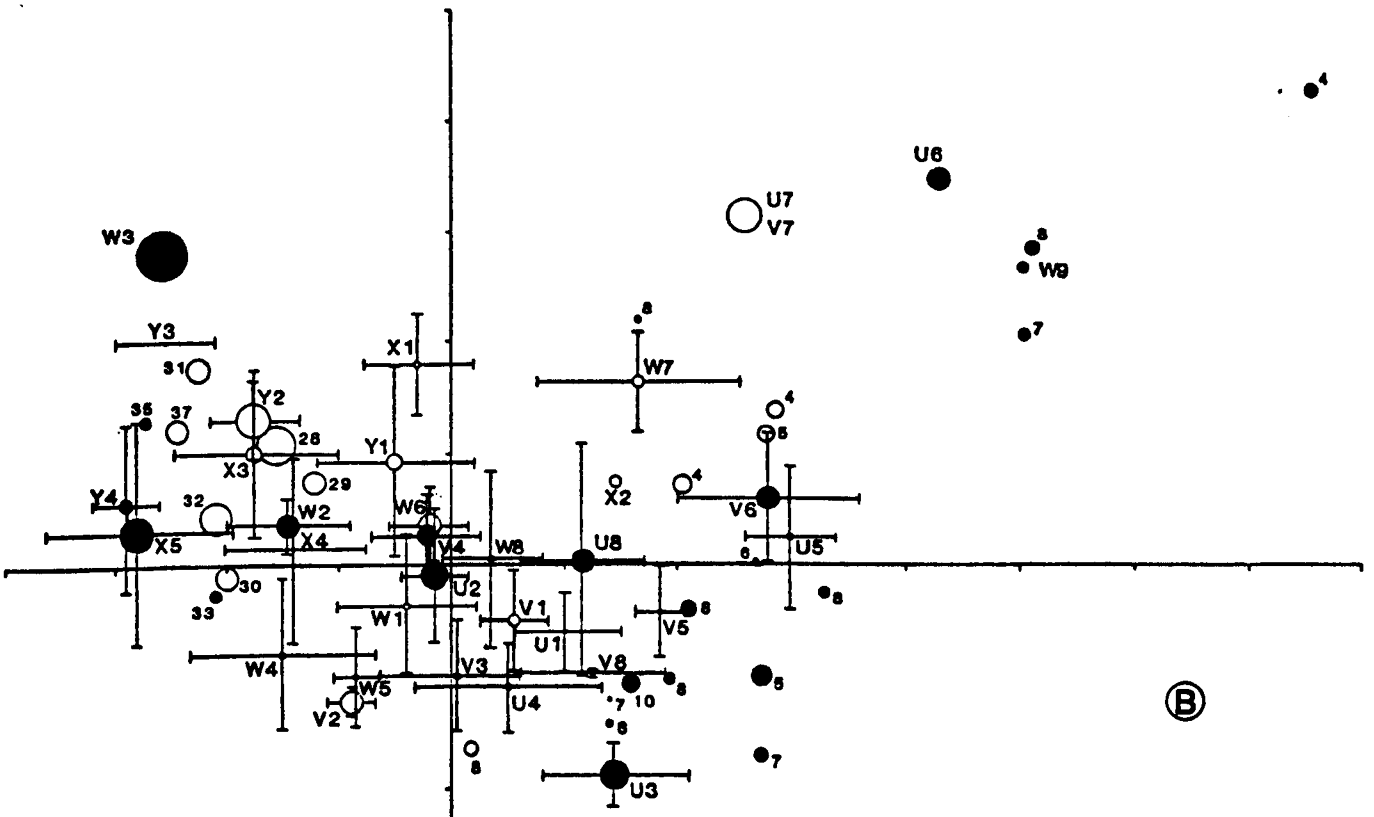


FIGURE 31. Principal components plots of G_{2a} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 37.5%
P.C.2 - 15.7%
P.C.3 - 13.2%

A: (Previous page) Showing all analysed specimens. P.C.3 score ≃ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ ½ diam. of dots in mm.

Comments:

Despite the congested appearance of the principal components plot, ontogenetic series of clusters can be resolved readily, given the strong ontogenetic trend in the approximate direction of P.C.1 which is observable on many specimens as well as being apparent on the plot.

U7 and V7 are represented by the same single specimen, for the reasons noted in G_{1a} zone. This specimen (831) and specimen 869 (W3) are anomalous.

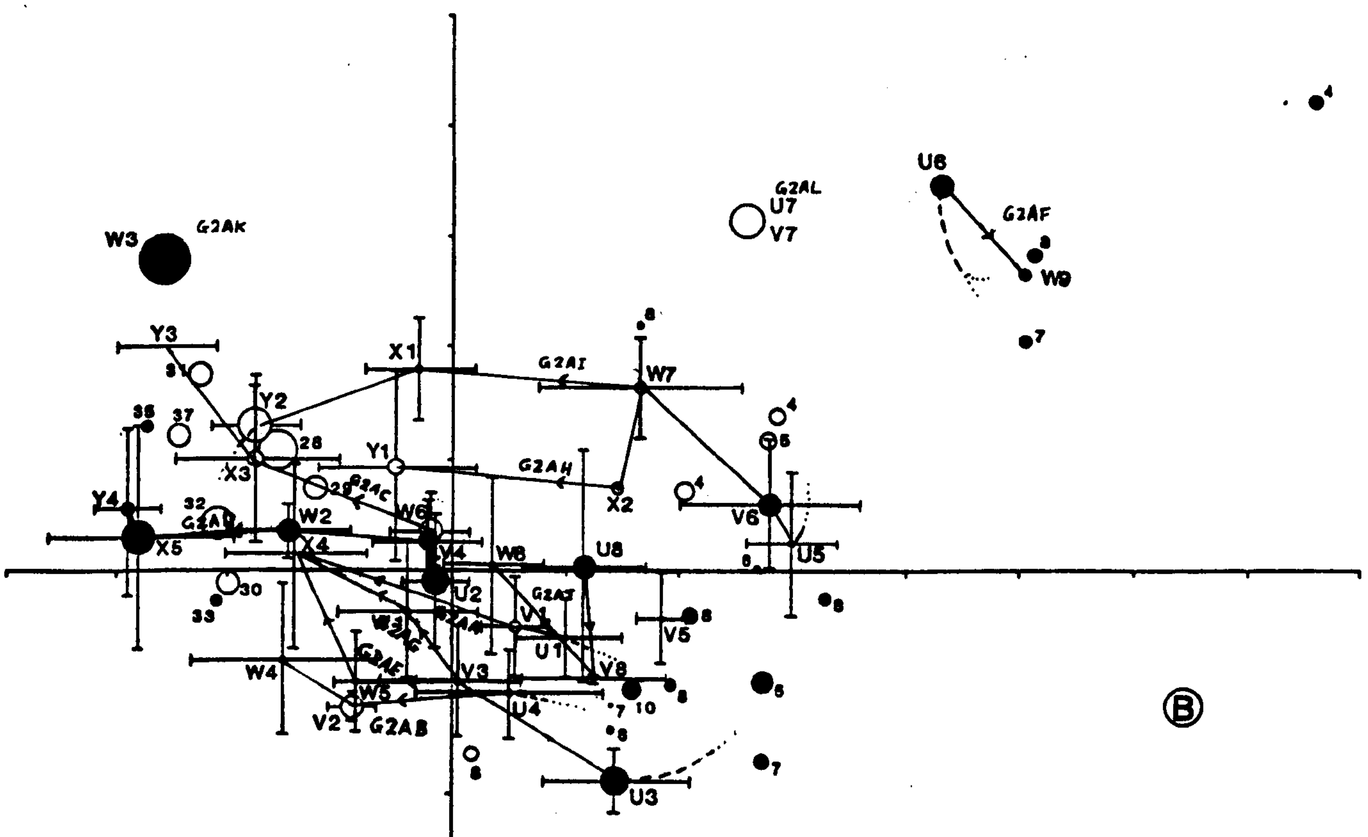


FIGURE 31. Principal components plots of G_{2a} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 37.5%
P.C.2 - 15.7%
P.C.3 - 13.2%

A: (Previous page) Showing all analysed specimens. P.C.3 score ≃ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ ½ diam. of dots in mm.

Comments:

Despite the congested appearance of the principal components plot, ontogenetic series of clusters can be resolved readily, given the strong ontogenetic trend in the approximate direction of P.C.1 which is observable on many specimens as well as being apparent on the plot.

U7 and V7 are represented by the same single specimen, for the reasons noted in G_{1a} zone. This specimen (831) and specimen 869 (W3) are anomalous.

Analysis of G_{2b} zone goniatites (Listeri Marine Band).

9-12 mm size range - analysis code G2BU :

Means of character values for each cluster:

Cluster code		n	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
U 1	mean	2.00	2.25		0	10.0	.494	2.32	.443	.008	.014	.121
	s.d.		.353		0	4.24	.052	.464	.028	.011	.021	.049
U 2	mean	2.00	1.35		.350	21.0	.512	2.97	.574	.037	.027	.235
	s.d.		.495		.353	12.7	.054	.345	.105	.047	.014	.045
U 3	mean	9.00	1.02		.117	42.0	.445	2.51	.388	.054	.023	.072
	s.d.		.067		.122	18.5	.023	.234	.083	.029	.014	.033
U 4	mean	8.00	1.00		.044	48.1	.356	1.99	.320	.030	.029	.045
	s.d.		0		.049	10.3	.032	.168	.054	.014	.018	.015
U 5	mean	6.00	1.00		.083	34.6	.372	2.08	.356	.105	.056	.046
	s.d.		0		.041	14.2	.024	.443	.049	.032	.011	.019
U 6	mean	4.00	1.50		.650	18.7	.402	2.04	.402	.072	.047	.056
	s.d.		.216		.129	6.84	.039	.125	.107	.041	.011	.024
U 7	mean	2.00	1.15		.550	19.0	.286	1.65	.178	.086	.052	.030
	s.d.		.071		.071	4.24	.038	.055	.064	.022	.006	.020

11-14 mm size range - analysis code G2BV :

Means of character values for each cluster:

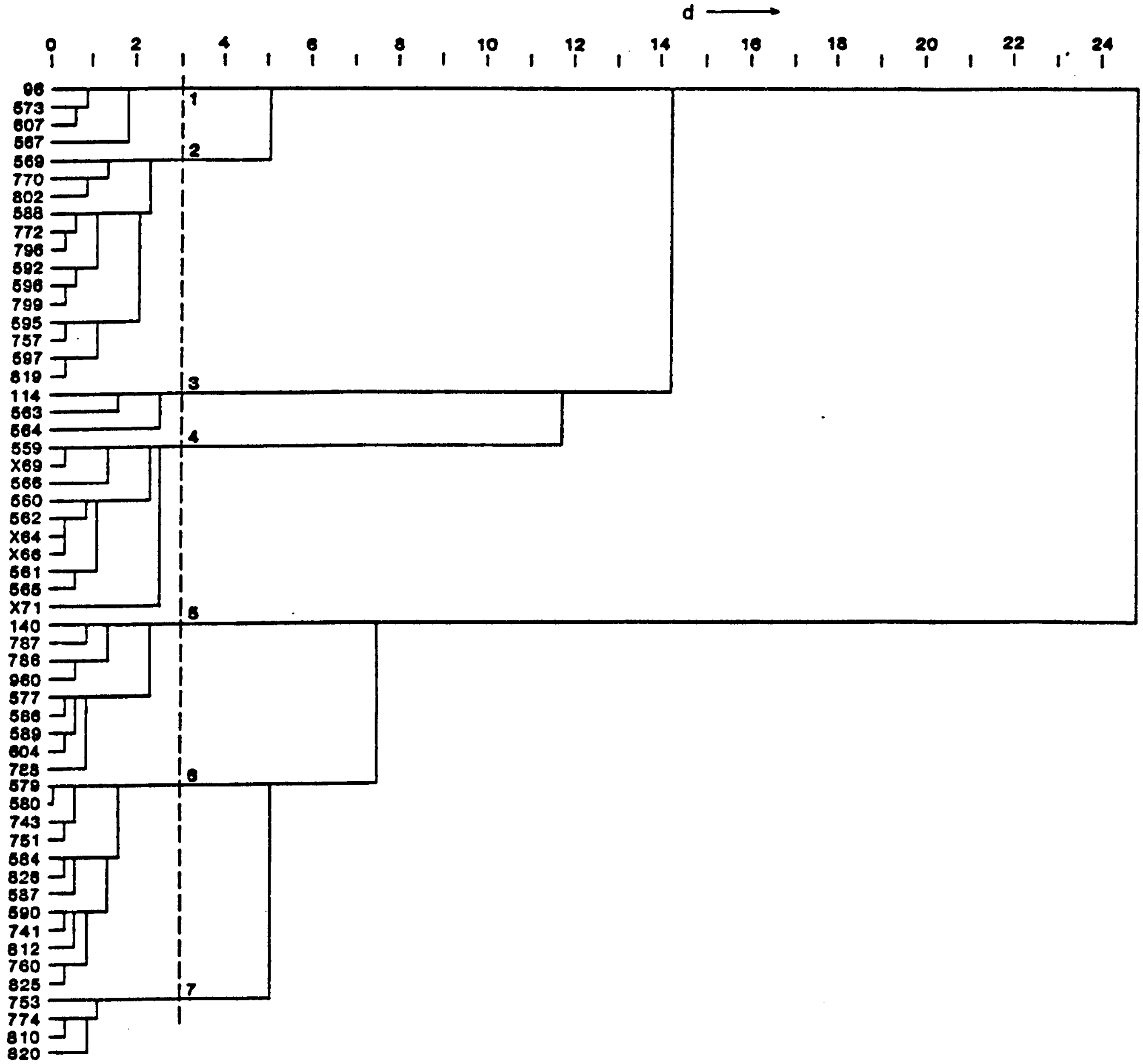
Cluster code		n	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
V 1	mean	2.00	2.75		0	6.50	.475	3.40	.548	.050	.007	.233
	s.d.		.353		0	.707	.035	.565	.049	.071	.010	.047
V 2	mean	21.0	1.00		.095	45.5	.387	2.19	.362	.072	.034	.044
	s.d.		0		.086	14.9	.031	.207	.044	.034	.019	.017
V 3	mean	1.00	1.00		.100	47.0	.379	2.18	.417	.292	.063	.052
	s.d.		0		0	0	0	0	0	0	0	0
V 4	mean	5.00	1.50		.140	13.2	.379	2.11	.377	.034	.022	.084
	s.d.		.412		.114	9.65	.016	.247	.092	.012	.017	.019
V 5	mean	5.00	1.00		.067	35.8	.320	1.91	.275	.049	.037	.035
	s.d.		0		.041	13.1	.027	.140	.054	.027	.011	.014
V 6	mean	6.00	1.50		.483	16.2	.384	2.05	.288	.078	.066	.049
	s.d.		.228		.214	7.01	.038	.144	.103	.033	.025	.023

14-18 mm size range - analysis code G2BW :

Means of character values for each cluster:

Cluster code		n	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
W 1	mean	4.00	1.25		.150	23.2	.441	2.72	.427	.068	.053	.064
	s.d.		.500		.100	13.8	.020	.238	.054	.024	.017	.020
W 2	mean	13.0	1.00		.146	39.6	.401	2.09	.407	.090	.028	.052
	s.d.		0		.066	10.7	.039	.261	.074	.049	.016	.013
W 3	mean	3.00	2.83		.233	9.33	.416	2.24	.436	.042	.013	.127
	s.d.		.763		.208	1.15	.058	.285	.032	.016	.011	.045
W 4	mean	10.0	1.52		.460	12.7	.371	1.76	.334	.078	.036	.044
	s.d.		.415		.151	4.69	.032	.197	.087	.042	.017	.011
W 5	mean	9.00	1.00		.128	49.4	.340	2.04	.374	.242	.027	.023
	s.d.		0		.090	9.50	.037	.179	.095	.069	.010	.008
W 6	mean	12.0	1.00		.108	43.7	.331	1.73	.226	.104	.030	.021
	s.d.		0		.051	12.9	.034	.154	.056	.042	.010	.009
W 7	mean	4.00	1.00		.050	48.2	.352	2.12	.327	.108	.069	.024
	s.d.		0		.057	17.2	.019	.238	.054	.044	.012	.007

Dendrogram

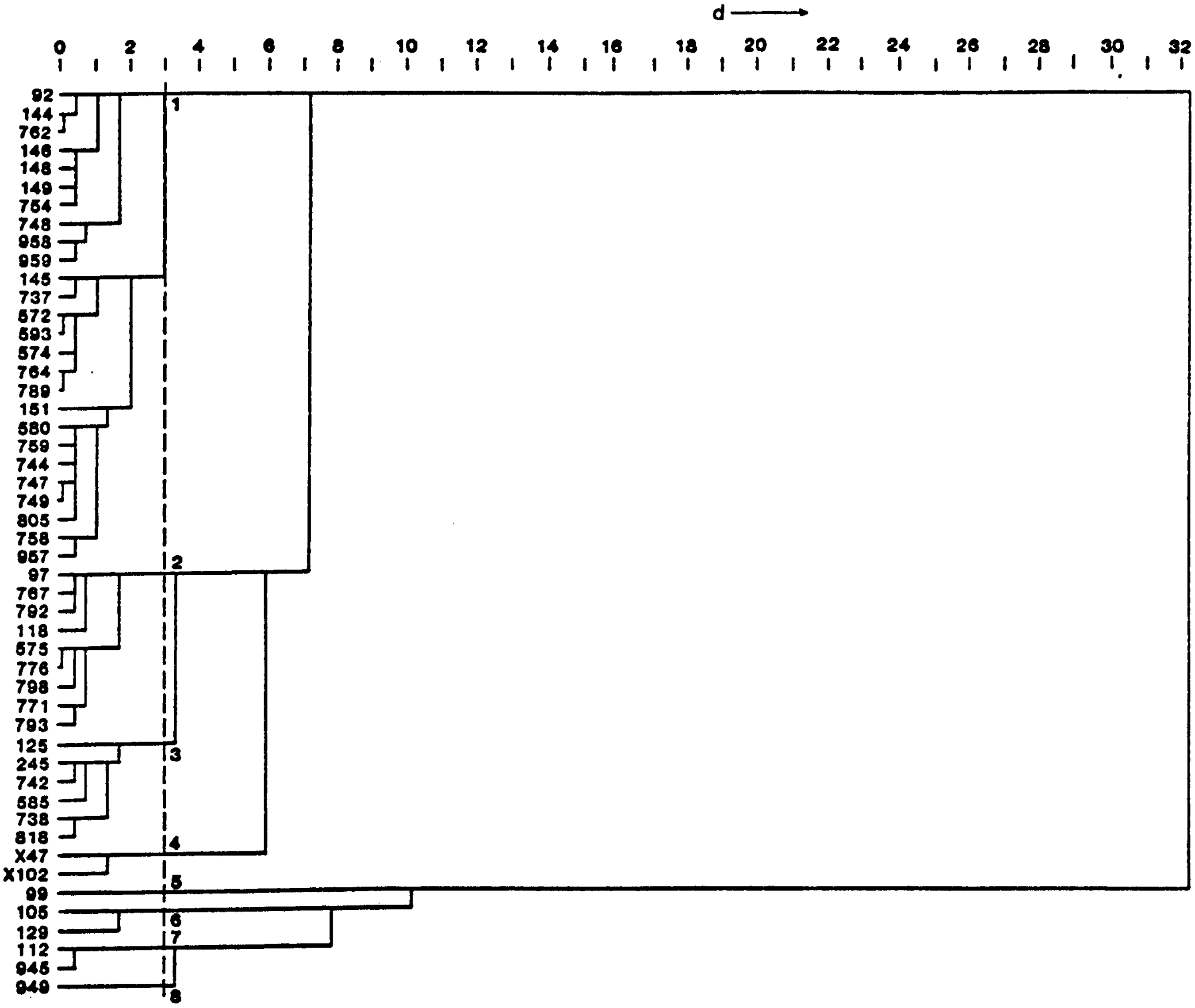


18-24 mm size range - analysis code G2BX :

Means of character values for each cluster:

Cluster code		n	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
X 1	mean	26.0	1.03		.165	52.2	.324	1.70	.267	.212	.023	.019
	s.d.		.196		.097	10.1	.026	.111	.110	.068	.013	.009
X 2	mean	9.00	1.00		.178	30.3	.347	1.75	.297	.111	.037	.033
	s.d.		0		.120	6.87	.016	.100	.060	.074	.021	.010
X 3	mean	6.00	1.16		.083	45.3	.397	2.13	.371	.155	.023	.029
	s.d.		.408		.098	14.5	.036	.088	.081	.081	.010	.011
X 4	mean	2.00	1.10		.725	14.0	.342	1.73	.304	.262	.018	.027
	s.d.		.141		.035	4.24	.013	.152	.213	.096	.024	.018
X 5	mean	1.00	1.00		.400	10.0	.459	2.97	.595	.238	.167	.190
	s.d.		0		0	0	0	0	0	0	0	0
X 6	mean	2.00	3.25		.100	12.0	.484	2.33	.350	.023	.015	.117
	s.d.		1.06		.141	2.82	.058	.018	.158	.011	.001	.009
X 7	mean	2.00	1.00		.300	28.0	.458	2.72	.476	.079	.004	.071
	s.d.		0		.141	2.82	.029	.101	0	.044	.006	.011
X 8	mean	1.00	1.00		.300	10.0	.545	2.35	.714	.143	0	.143
	s.d.		0		0	0	0	0	0	0	0	0

Dendrogram



<u>23-28 mm size range - analysis code G2BY</u> :

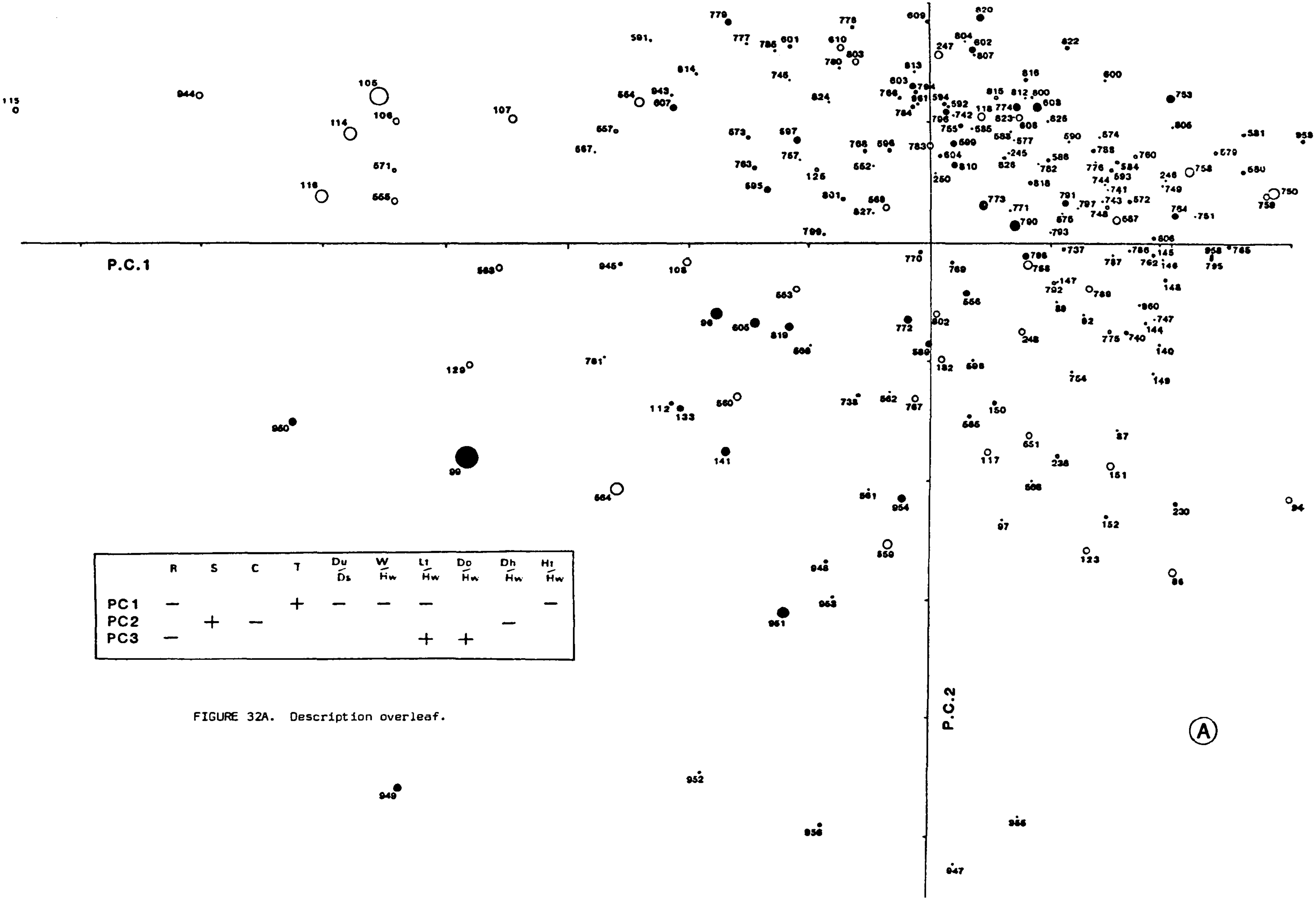
Means of character values for each cluster:

Cluster code		n	R	S	C	T	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Do}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Ht}{Hw}$
Y 1	mean	15.0	1.00		.246	41.3	.348	1.72	.283	.237	.022	.027
	s.d.		.026		.151	17.9	.028	.199	.085	.058	.016	.013
Y 2	mean	5.00	1.26		.760	17.6	.339	1.52	.397	.204	.011	.045
	s.d.		.279		.270	2.38	.029	.152	.093	.069	.007	.016
Y 3	mean	1.00	1.00		.200	6.00	.519	1.41	.205	.068	.027	.164
	s.d.		0		0	0	0	0	0	0	0	0
Y 4	mean	3.00	1.56		.567	8.83	.460	2.16	.369	.092	.045	.093
	s.d.		.115		.057	6.21	.039	.197	.055	.089	.050	.039

<u>28-33 mm size range - analysis code G2BZ</u> :

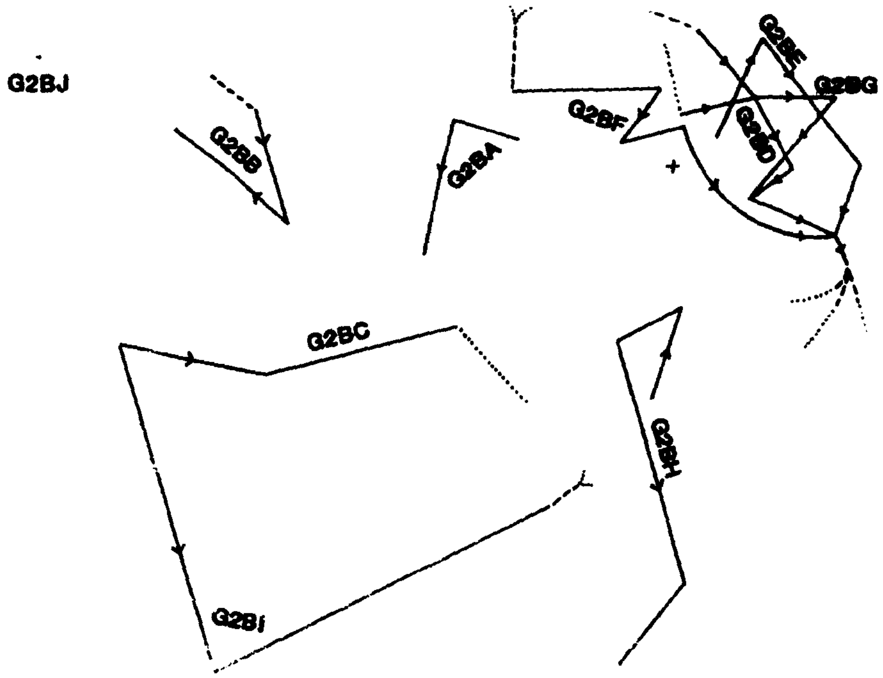
Means of character values for each cluster:

Cluster code		n	R	S	C	T	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Do}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Ht}{Hw}$
Z 1	mean	4.00	1.00		.200	28.2	.347	1.70	.193	.287	.021	.022
	s.d.		0		.115	15.1	.038	.213	.086	.076	.019	.013
Z 2	mean	8.00	1.11		.600	13.5	.383	1.78	.408	.205	.004	.054
	s.d.		.099		.219	6.16	.039	.139	.087	.118	.008	.011
Z 3	mean	2.00	2.00		.200	8.50	.574	2.97	.416	.069	0	.112
	s.d.		1.41		.141	2.12	.037	.086	.235	.044	0	.017



	R	S	C	T	Du/Ds	W/Hw	Lt/Hw	Do/Hw	Dh/Hw	Ht/Hw
PC1	−			+	−	−	−			−
PC2		+	−						−	
PC3	−						+	+		

FIGURE 32A. Description overleaf.


G2BJ
G2BB
G2BA
G2BF
G2BE
G2BG
G2BD
G2BC
G2BH
G2BI

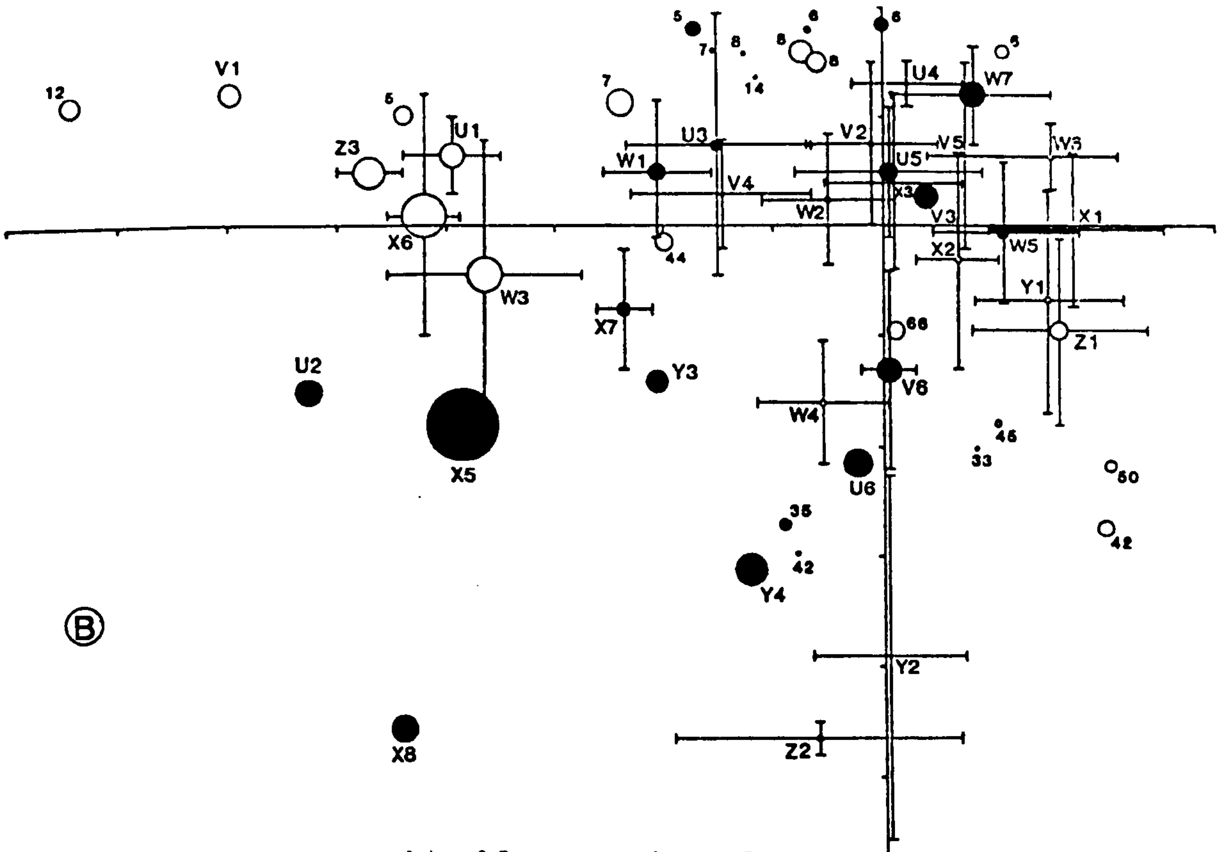


FIGURE 32. Principal components plots of G_{2b} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 34.5%
P.C.2 - 19.1%
P.C.3 - 10.7%

A: (Previous page) Showing all analysed specimens. P.C.3 score ≈ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≈ ½ diam. of dots in mm.

Comments:

Ontogenetic series are fairly obvious except for the set of four morphospecies which "bottleneck" into clusters Y1 and Z1. The chosen cluster connections are compatible with observed ontogenetic trends but other alternatives do exist. The ambiguity here may reflect a degree of artificiality in the choice of phenon line in some analyses.

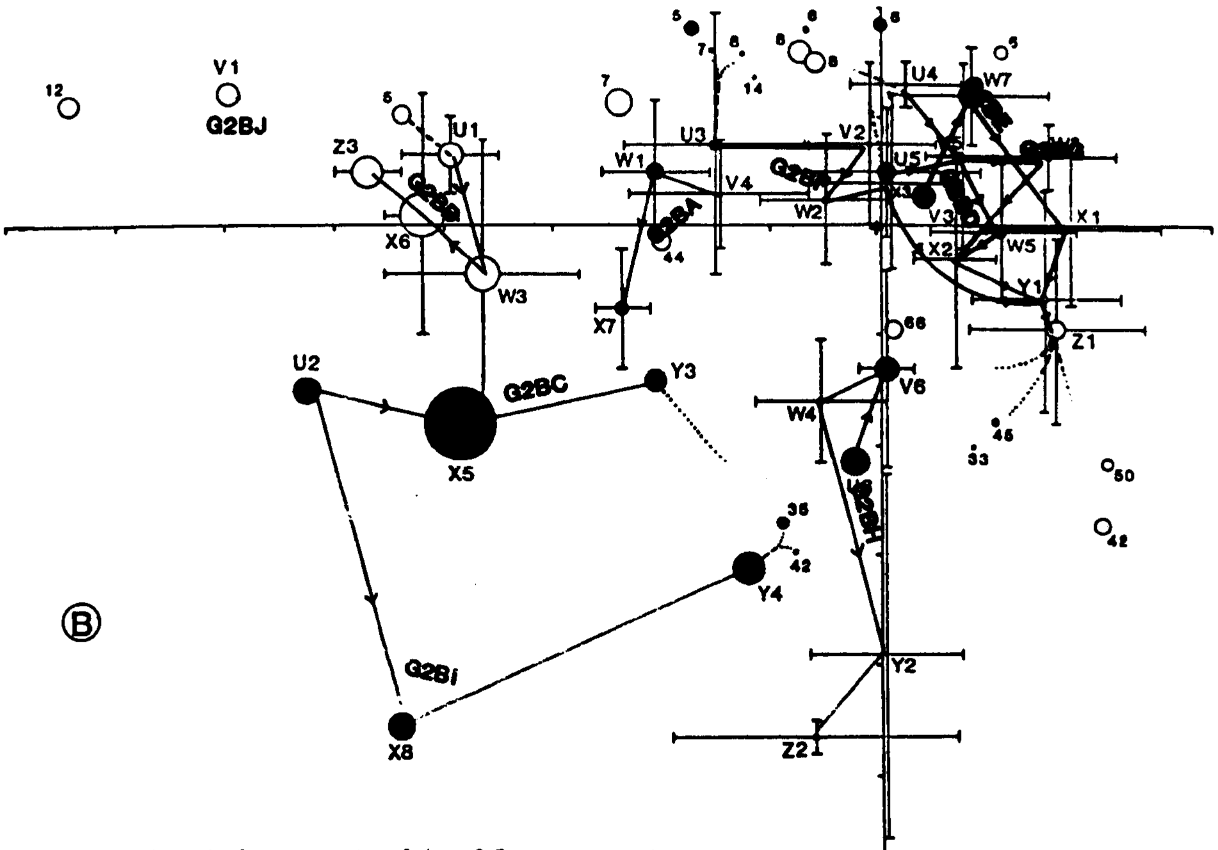


FIGURE 32. Principal components plots of G_{2b} zone specimens. For full explanation see notes on pages 103-4 and comments below.

Variance explained: P.C.1 - 34.5%
P.C.2 - 19.1%
P.C.3 - 10.7%

A: (Previous page) Showing all analysed specimens. P.C.3 score ≃ diam. of dots in mm.
B: Showing cluster centroids with ontogenetic series on overlay. P.C.3 score ≃ ½ diam. of dots in mm.

Comments:

Ontogenetic series are fairly obvious except for the set of four morphospecies which "bottleneck" into clusters Y1 and Z1. The chosen cluster connections are compatible with observed ontogenetic trends but other alternatives do exist. The ambiguity here may reflect a degree of artificiality in the choice of phenon line in some analyses.

4.1.4. GENERAL INTERPRETATION OF RESULTS

Dendrograms:

It is difficult to assess the success with which the phenon line at d = 3.0 has split off "natural" clusters. In many cases the data do not appear to be particularly ordered, in the manner illustrated in Figure 7b, but this may be due to the diffusing effects of poor preservation and error. Principal components plots generally show a large degree of compatibility between clusters recognised from different size ranges, and this is evidence in favour of the "naturalness" of clusters - the situation may well be similar to the theoretical distribution of morphospecies in morphospace shown in Figures 4 and 5. The relative difficulty with which ontogenetic series of clusters can be recognised in faunas typified by poor preservation indicates that the patterns recognised in the data for well preserved samples, at least, reflect the original composition of the population, and are not fabrications of the method. In the worst preserved samples, it may be that some of the results and interpretations of analyses are rather arbitrary; nevertheless it is contended here that these morphospecies definitions are the most accurate and objective that can be derived from the present data.

It is notable that the number of clusters differentiated at d = 3.0 is generally greater with larger sample sizes. Figure 33 shows that this is not likely to be due to simple

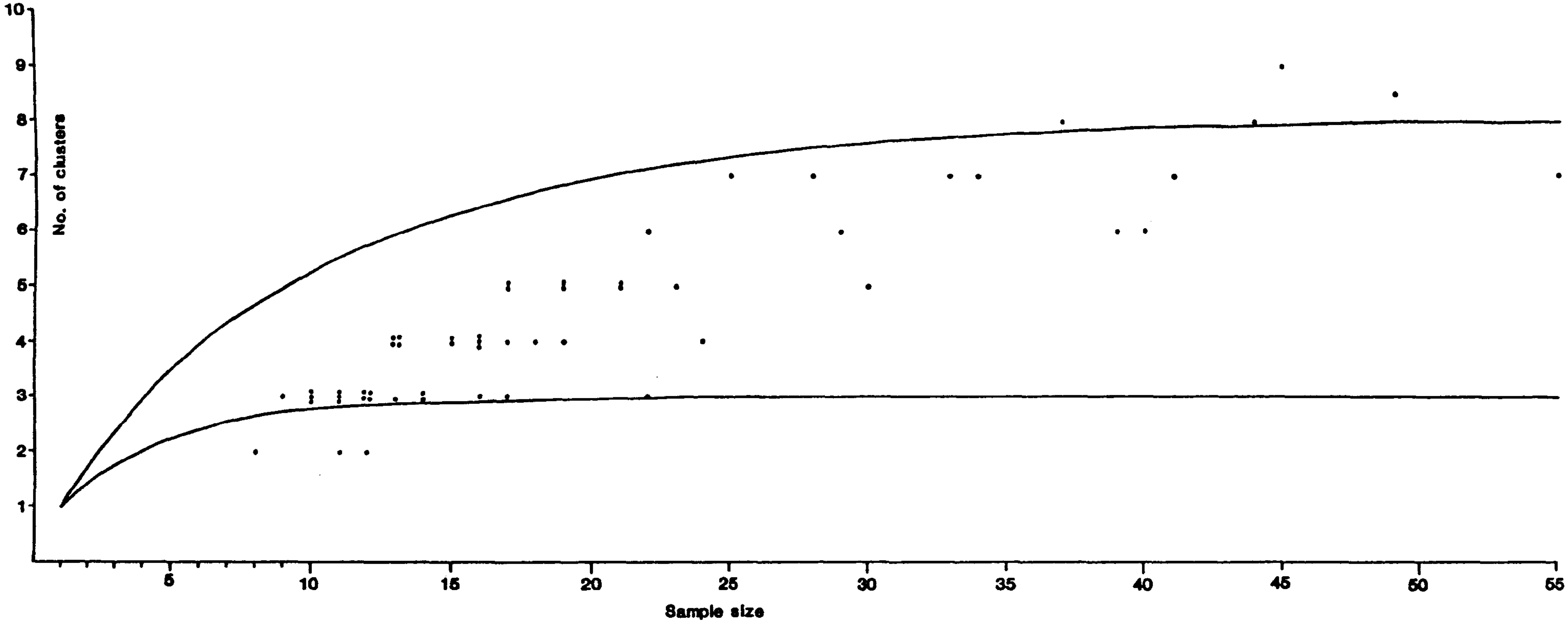


FIGURE 33. Graph comparing results of analyses with hypothetical rarefaction curves. Each dot represents a dendrogram resulting from the analyses presented in Section 4.1., with the number of specimens in the analysis ordinated against the nomber of clusters distinguished at d=3. The two curves are computer simulated rarefaction curves, showing the number of morphospecies which would be expected to be encountered by random sampling from two different populations. The top curve is for a population of 9 morphospecies with relative abundances as of clusters in analysis G2AW; the lower curve is for 3 morphospecies with relative abundances as for morphospecies in H_{1b} zone. The scatter of points is not closely related to the trend of either curve; it seems that the number of clusters recognised by analyses is probably not entirely dependent on rarefaction.

rarefaction (i.e. rarer morphospecies only being encountered in larger samples). Although this is uncertain whilst the "real" number and relative abundances of morphospecies in the samples are unknown, it seems probable that the use of this phenon line, though valid as a best compromise, resulted in oversplitting of large samples and possible lumping in small samples. More theoretical work is needed to resolve this.

Principal Components Plots:

There are striking parallels between the composition of the principal components in different analyses. With only two exceptions (H1A and G1B) the diameter of the umbilicus is a major contributor to P.C.1, and this is very frequently correlated positively with the size of tubercles or plications and the whorl width, and negatively with the depth of the hyponomic sinus. This consistent intercorrelation of a suite of shell characters suggests that there are functional restraints in goniatite morphology, and different morphotypes, occurring independently of taxonomy, may represent adaptations to different modes of life (see also Section 4.2.5.5).

As well as being of fairly consistent composition, P.C.1 is also very often the dominant direction of ontogenetic morphological change. This indicates that ontogeny is accompanied by anisometric growth of characters due possibly to changing functional constraints and changing mode of life.

P.C.2 and P.C.3 do not show the same degree of consistency between analyses. P.C.2, though, is often related to characters of the shell ornament.

Phenetic Continuity

The main source of difficulty in studying Silesian goniatites is the great range of phenetic variation within faunas. In response to this, Bisat (1924) deliberately allowed generous variation within species in order to accommodate all associated contemporary forms, whereas Ruzhentsev & Bogoslovskaya (1978) described many closely related forms from each fauna; and an intermediate approach is that of Haug (1896) who describes one species but many "varieties" from a fauna. In the present study, faunas have been split in an optimal manner using numerical criteria, but this does not imply that these faunas are in reality composed of forms which are phenetically isolated. If morphospecies were entirely distinct and discrete, then conventional palaeontological methods would no doubt have succeeded in recognising them, and the dendrograms in Sections 4.1.1,2&3 would show much clearer resolution between clusters. Instead, the evidence is that faunas are divisible into significant morphospecies, but that these are often part of a fairly continuous phenetic range, with a series of actual or potential intermediates - morphospecies are just peaks on a phenotype frequency distribution. The relationships between the morphospecies generated and the distribution of specimens in A-space is illustrated by two principal components plots of apparently typical samples in Figure 34 .

Continuity in the phenetic range of a fauna suggests that the morphospecies involved have a close phyletic relationship, and it is also likely that they share a common ancestor within that fauna - it is less feasible for two

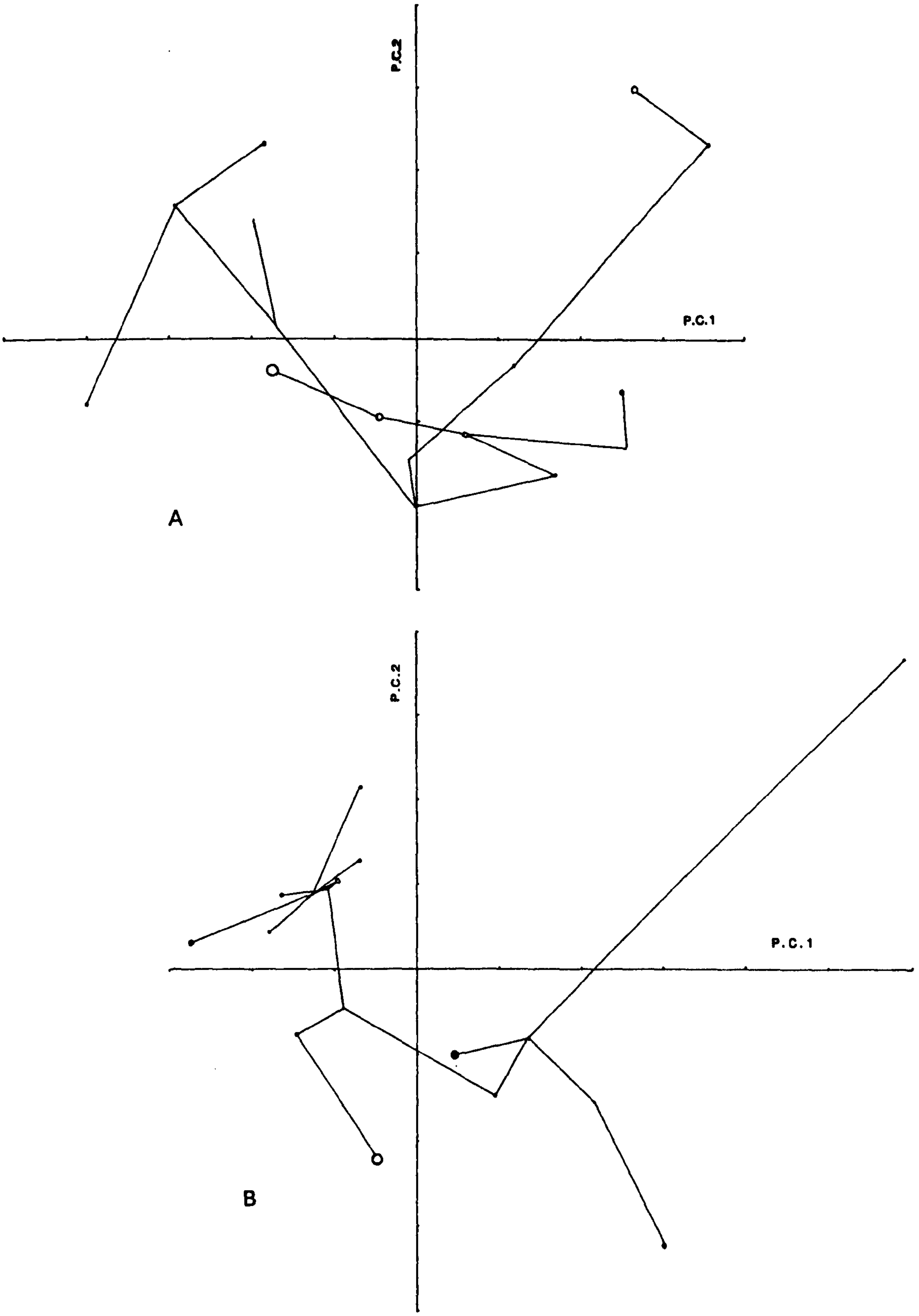


FIGURE 34. Principal components plots of Homoceratid specimens in A. R_{1a} zone (7-9 mm diam.) and B. H_{2c} zone (8-10 mm diam.), showing typical phenetic distribution within samples. Clusters are recognisable but are not always very isolated.

separate phyletic branches to merge into a phenetic continuum. Another inference is that the environment in which the fauna lived must have allowed a variety of modes of life comparable with the variety of form of the animals. Variation within faunas can incorporate vastly different shell shapes with different hydrodynamic and hydrostatic properties; these could not have occupied the same niche in the ecosystem. It seems possible, then, that much of the faunal variation is the result of radiation into the full range of ecological possibilities presented by the environment.

4.2. INTER-SPECIFIC ANALYSES

These use morphospecies and other authors' "species" as OTUs, and the data used is from the matrices of character values presented in Chapter 5, and from measurements made of published illustrations of overseas faunas. In addition, data for rarer British forms, for example *Gastrioceras depressum*, was measured from individual unanalysed specimens - these forms are only assumed to be valid morphospecies.

Results are here presented as dendrograms and principal components plots with superimposed minimum spanning trees, with histograms illustrating the contribution of each character to the principal components.

4.2.1. HOMOCERATIDAE *s.l.* AND HOMOCERATOIDES

Results are shown on Figures 35 - 40.

4.2.2. RETICULOCERATIDAE *s.l.*

Results are shown on Figures 41 - 47.

4.2.3. GASTRIOCERATIDAE *s.l.*

Results are shown on Figures 47 - 52.

4.2.4. ALL FAMILIES

Results are shown on Figures 53 - 57.

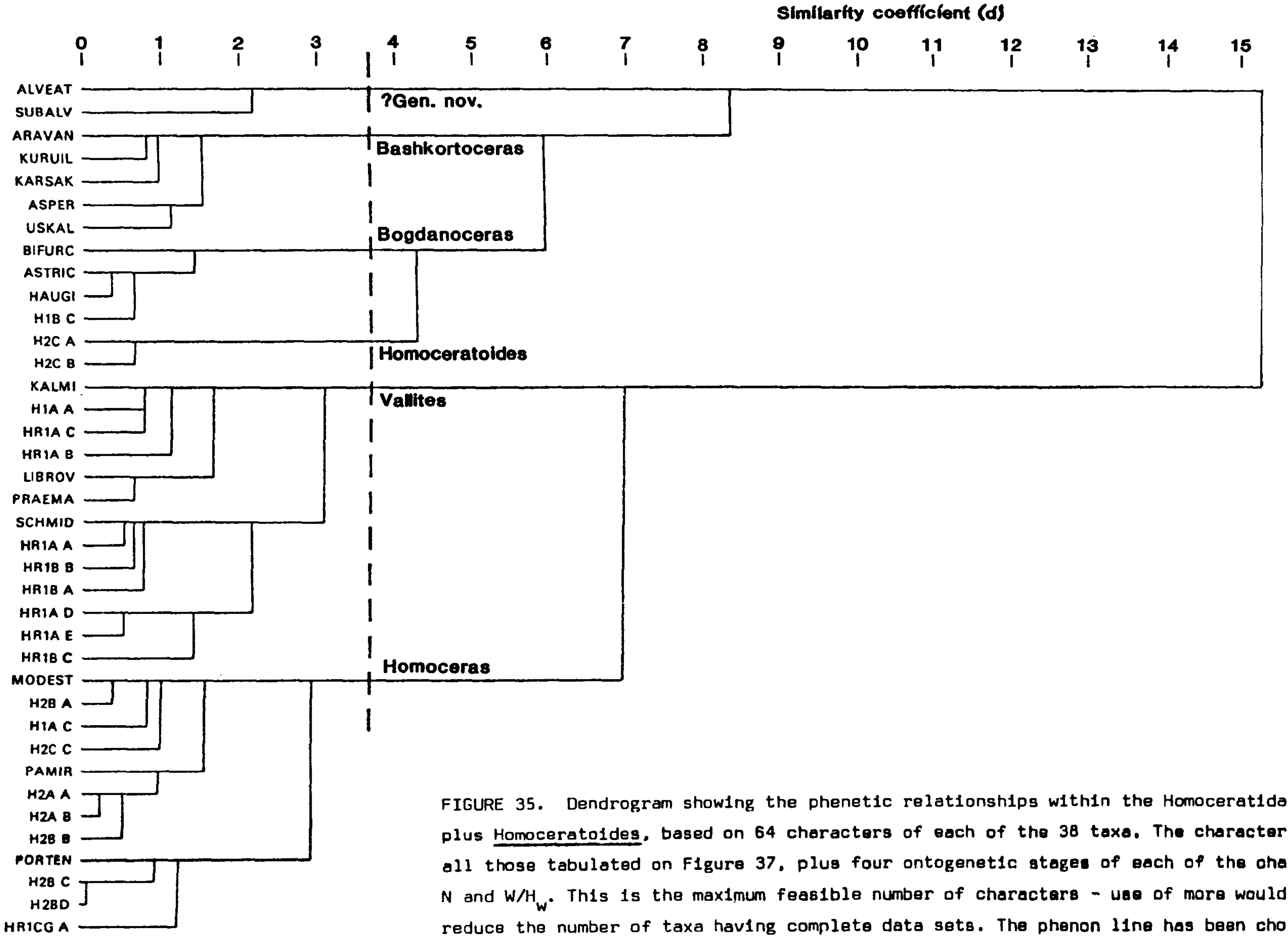


FIGURE 35. Dendrogram showing the phenetic relationships within the Homoceratidae *s.l.*, plus *Homoceratoides*, based on 64 characters of each of the 38 taxa. The characters include all those tabulated on Figure 37, plus four ontogenetic stages of each of the characters N and W/H_w. This is the maximum feasible number of characters - use of more would seriously reduce the number of taxa having complete data sets. The phenon line has been chosen according to the criteria cited in Section 3.1.3.5.b., and separates clusters which show a particularly high degree of similarity between their constituent taxa relative to the similarity between the clusters themselves. The clusters are interpreted as genera; the names given are explained in Section 4.2.5.2.B.

The key to the morphospecies codes is given in Table 5.

KEY TO SPECIES/MORPHOSPECIES CODES

Code	Species/Morphospecies	Source of Info.	Zone
ALVEAT	?Ba. alveatum (R&B,1978)	R&B,1978	Nm2a1
ARAVAN	Ba. aravanense (R&B,1978)	..	Nm2c2
ARTUM	H. artum (R&B,1971)	..	Nm2b3
ASPER	Ba. asperum (R&B,1971)	..	Nm2a1
ASSEL	H. asselicum R&B,1978	..	Nm2a2
ASTRIC	Bo. haugi astrictum (R&B,1978)	..	Nm2a2
BIFURC	Bo. bifurcum R&B,1971	..	Nm2b1
FERGAN	H. ferganensis (R&B,1978)	..	Nm2c2
HAUGI	Bo. haugi haugi (R&B,1978)	..	Nm2a2
INOST	H. inostranzewi (Karpinsky ,1889)	..	Nm2a2
KALMI	V. kalmiusi (Popov,1979)	Popov,1979	Nm2c2
KARSAK	Ba. karsaklense (R&B,1978)	R&B,1978	Nm2b3
KUGAR	H. kugarchense (R&B,1971)	..	Nm2b3
KURUIL	Ba. kuruilicum (R&B,1978)	..	Nm2b3
LIBROV	V. librovitchi (R&B,1978)	..	Nm2c1
MODEST	H. modestum (R&B,1978)	..	Nm2b1
PAMIR	H. pamiricum R&B,1978	..	Nm2a2
PORTEN	H. portentosus (R&B,1971)	..	Nm2b2
PRAEMA	V. praematurum (Haug,1898)	..	Nm2a1
SALAV	Ba. salavati (R&B,1971)	..	Nm2b2
SCHART	Ba. schartymense (R&B,1978)	..	Nm2a2
SCHMID	V. schmidti R&B,1978	..	Nm2b1
SUBALV	?Ba. subalveatum (R&B,1978)	..	Nm2a1
USKAL	Ba. uskalykense (R&B,1978)	..	Nm2b3
H1AA	V. lancastria sp. nov.	Analyses	H1a
H1AB	V. gillense sp. nov.	..	H1a
H1AC	H. subglobosum Bisat,1924	..	H1a
H1BA	H. diadema (Beyrich,1837)	..	H1b
H1BB	H. sp. aff. diadema	..	H1b
H1BC	Bo. beyrichianum (De Koninck,1843)	..	H1b
H2AA	H. browni sp.nov.	..	H2a
H2AB	H. browni sp.nov.	..	H2a
H2AC	H. smithii (Brown,1841)	..	H2a
H2AD	H. smithii (Brown,1841)	..	H2a
H2AE	H. gibsoni sp. nov.	..	H2a
H2BA	H. parundulatum sp. nov.	..	H2b
H2BB	H. sp. aff. parundulatum	..	H2b
H2BC	H. undulatum (Brown,1841)	..	H2b
H2BD	H. undulatum (Brown,1841)	..	H2b
H2BE	H. sp. aff. undulatum	..	H2b
H2CA	Htd. doolinense sp. nov.	..	H2c
H2CB	Htd. prereticulatum Bisat,1924	..	H2c
H2CC	V. eostriolatum (Bisat,1924)	..	H2c
HR1AA	V. mutabile (Bisat & Hudson,1943)	..	R1a
HR1AB	V. varicatum (Schmidt,1933)	..	R1a
HR1AC	V. magistrorum (Hodson,1957)	..	R1a
HR1AD	V. submagistrorum sp. nov.	..	R1a
HR1AE	V. henkei (Schmidt,1925)	..	R1a
HR1AF	V. sp. aff. magistrorum	..	R1a
HR1AG	V. sp. aff. henkei	..	R1a
HR1BA	V. striolatum (Phillips,1836)	..	R1b
HR1BB	V. varicatum (Schmidt,1933)	..	?R1b
HR1BC	V. sp. aff. striolatum	..	R1b
HR1BD	H. divaricatum (Hind,1905)	..	R1b
HR1CGA	H. fortelirifer (Ramsbottom,1958)	..	R2c

Abbreviations :

Ba. - Bashkortoceras
Bog.- Bogdanoceras
H. - Homoceras
Htd.- Homoceratoides
V. - Vallites
R&B - Ruzhentsev & Bogoslovskaya

TABLE 5. Key to species/morphospecies codes for the Homoceratidae. The generic names given are those resulting from the present taxonomic treatment, discussed in detail in Section 5.2.

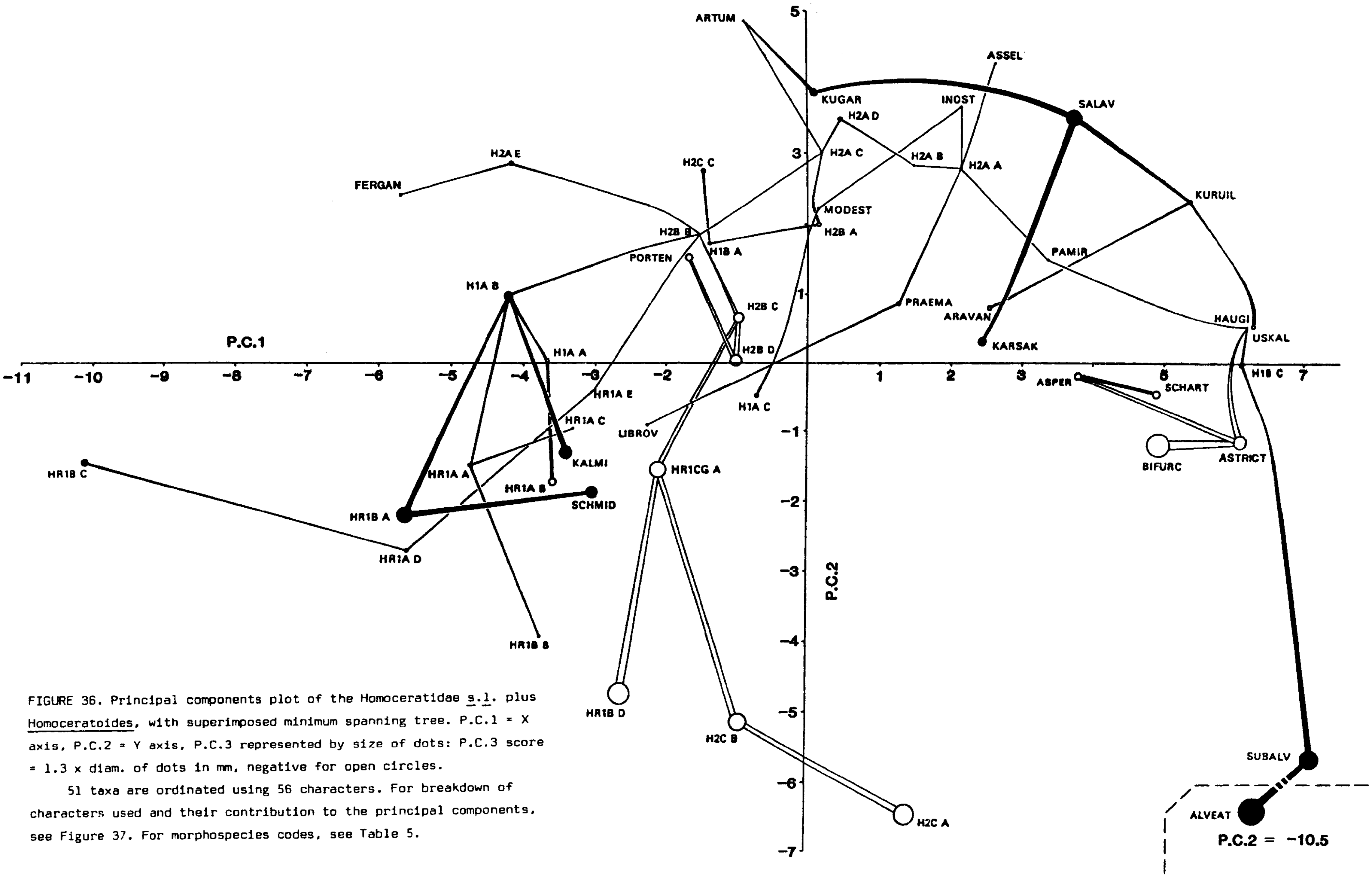


FIGURE 36. Principal components plot of the Homoceratidae s.l. plus Homoceratoides, with superimposed minimum spanning tree. P.C.1 = X axis, P.C.2 = Y axis, P.C.3 represented by size of dots: P.C.3 score = 1.3 x diam. of dots in mm, negative for open circles.

51 taxa are ordinated using 56 characters. For breakdown of characters used and their contribution to the principal components, see Figure 37. For morphospecies codes, see Table 5.

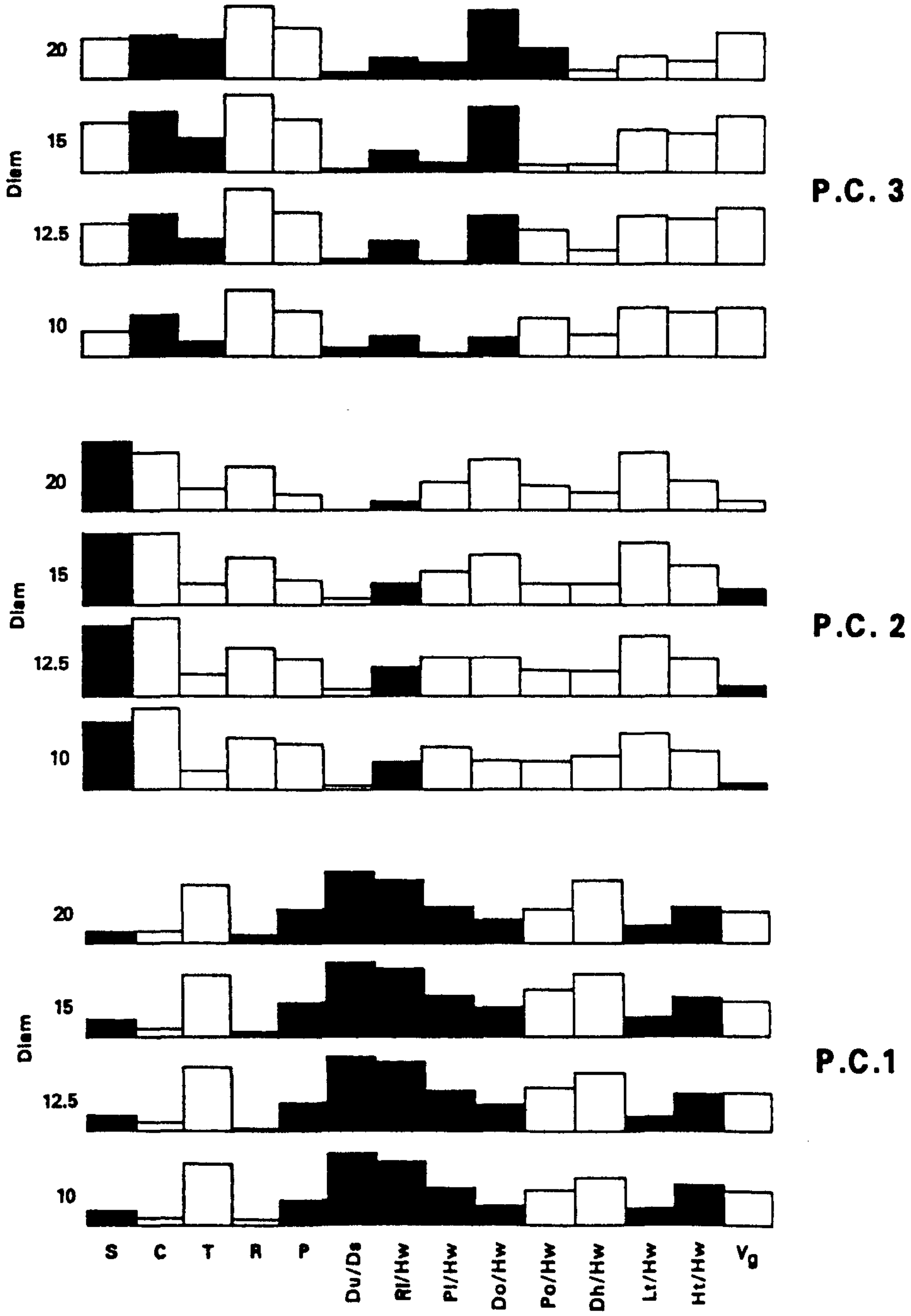


FIGURE 37. The relative contribution of each of the characters to the first 3 principal components of the plot shown on Figure 36. Positive contributions in black, negative in white.

Percentage of total variation: P.C.1 - 27.16%

P.C.2 - 16.88%

P.C.3 - 12.77%.

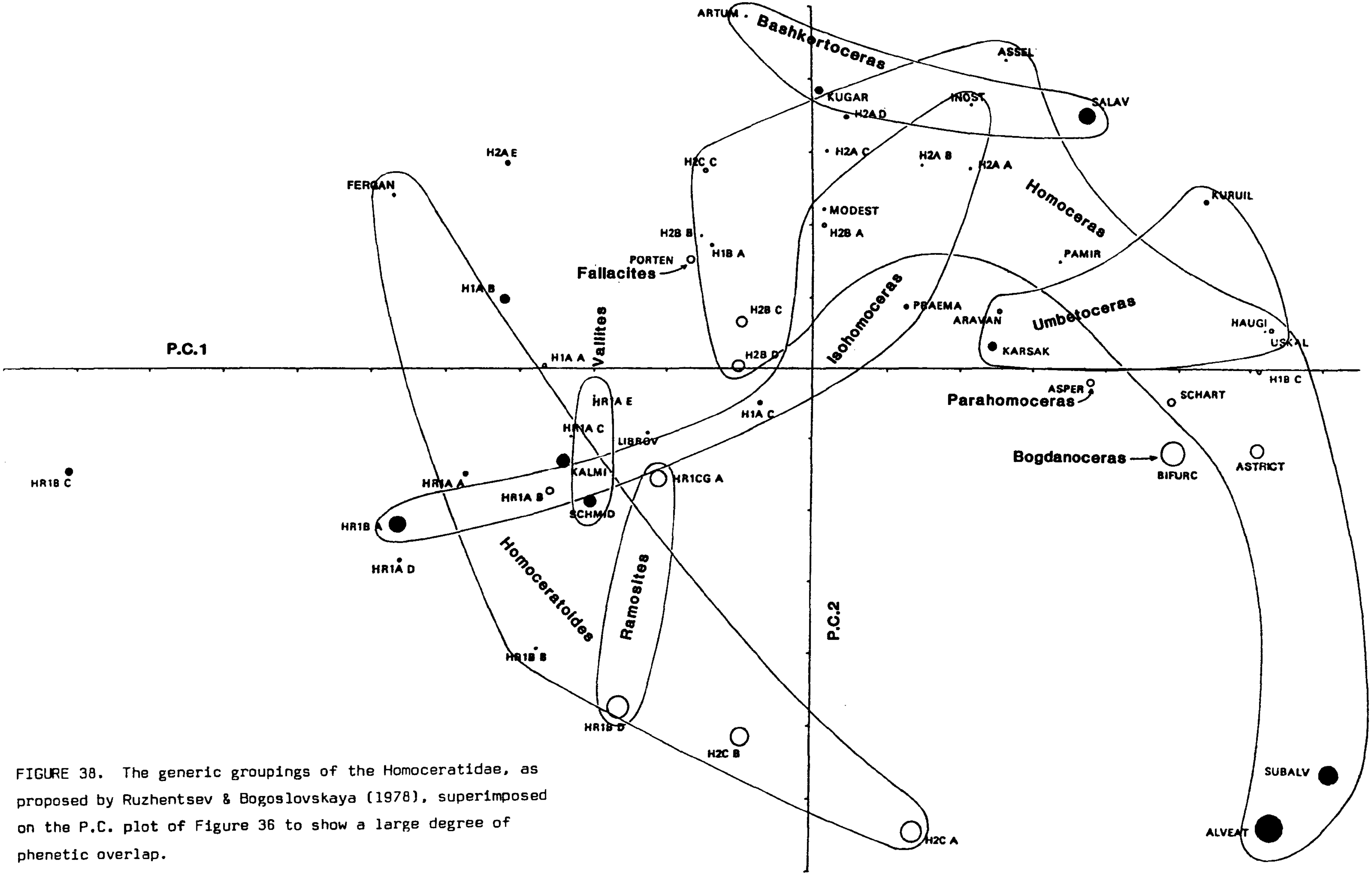


FIGURE 38. The generic groupings of the Homoceratidae, as proposed by Ruzhentsev & Bogoslovskaya (1978), superimposed on the P.C. plot of Figure 36 to show a large degree of phenetic overlap.

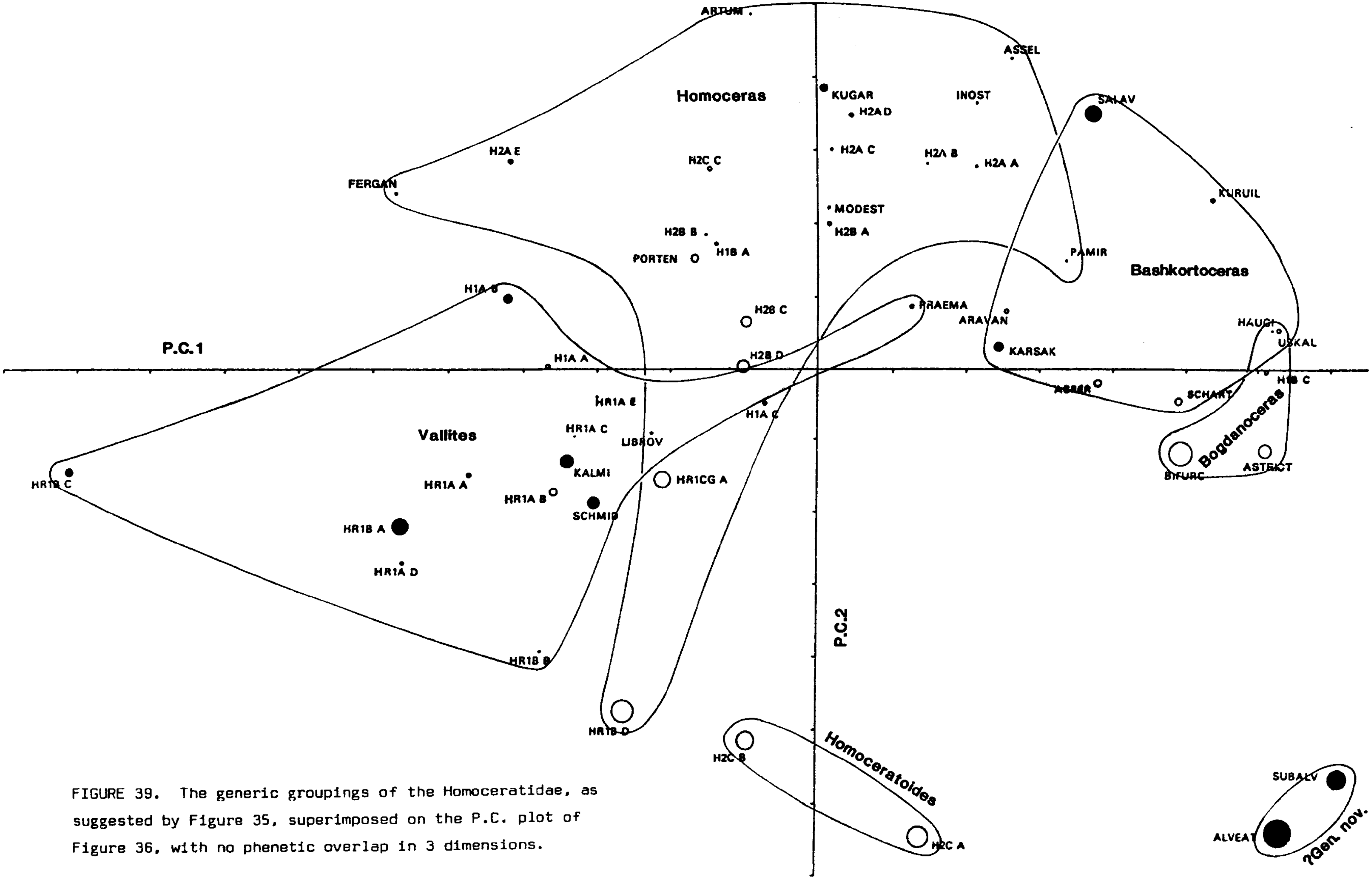


FIGURE 39. The generic groupings of the Homoceratidae, as suggested by Figure 35, superimposed on the P.C. plot of Figure 36, with no phenetic overlap in 3 dimensions.

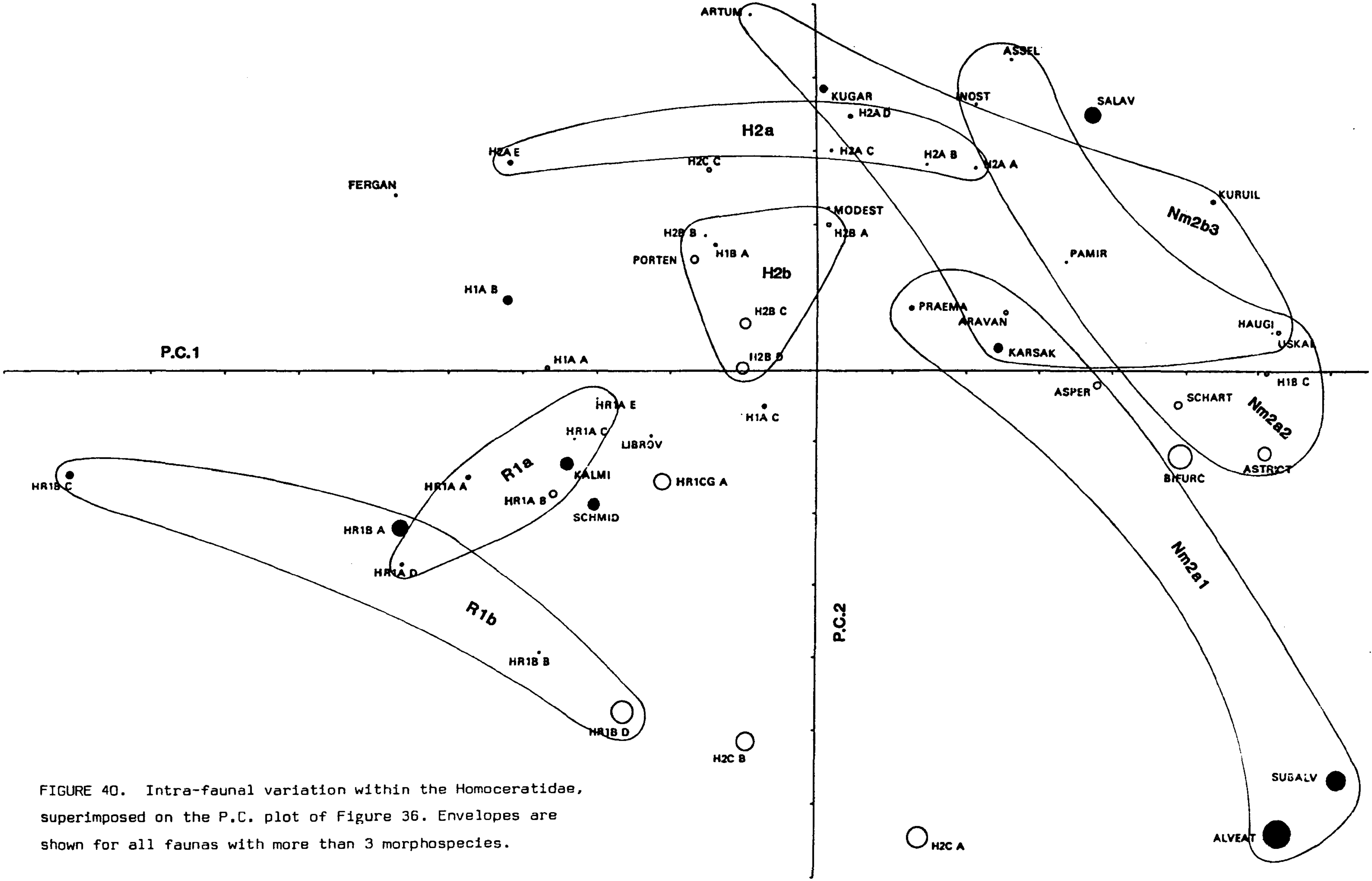


FIGURE 40. Intra-faunal variation within the Homoceratidae, superimposed on the P.C. plot of Figure 36. Envelopes are shown for all faunas with more than 3 morphospecies.

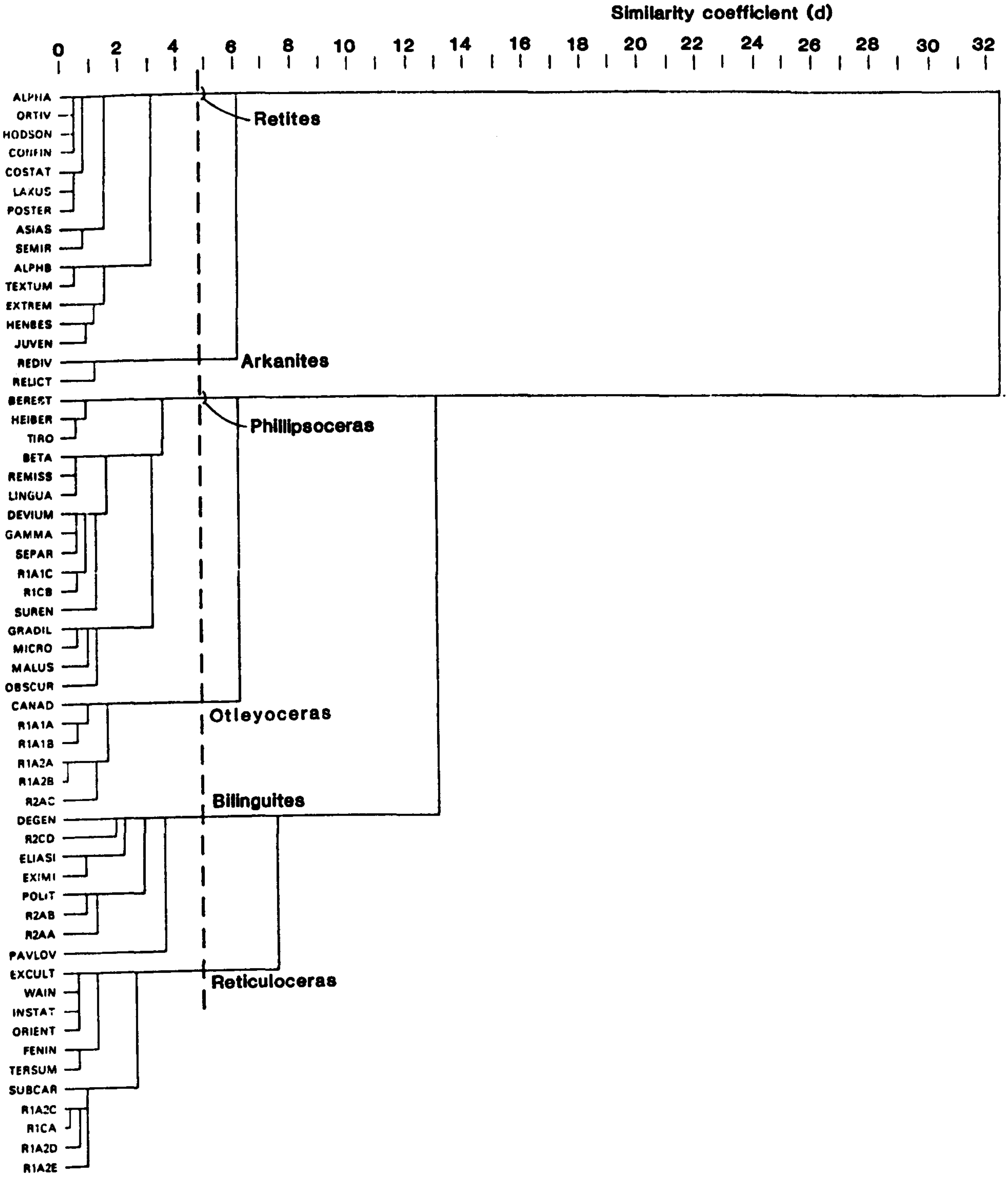


FIGURE 41. Dendrogram showing the phenetic relationships within the Reticuloceratidae _s.l._ based on 48 characters of each of 57 taxa. The characters include all those tabulated on Figure 43, plus four ontogenetic stages of the character W/H_w. This is the maximum feasible number of characters - use of more would seriously reduce the number of taxa having complete data sets. The phenon line has been chosen according to the criteria cited in Section 3.1.3.5.B., and exploits a clear gap between branches at low d. The clusters are interpreted as genera; the names given are explained in Section 4.2.5.3.B.

The key to the morphospecies codes is given in Table 6.

KEY TO SPECIES/MORPHOSPECIES CODES

Code	Species/Morphospecies	Source of Info.	Zone/ Form.
ALPHA	Re. alpharhipaeum (R&B,1975)	R&B,1978	Nm2b2
ALPHB	Re. alpharhipaeum (R&B,1975)	..	Nm2b2
ASIAS	P. asianus (R&B,1978)	..	Nm2b2
BEREST	P. berestovense (Popov,1979)	Popov,1979	Nm2c
BETA	P. betarhipaeum R&B,1978	R&B,1978	Nm2b3
CANAD	O. canadensis (Nassichuk,1975)	Nass.,1975	Hale
CONFIN	Re. confinis (R&B,1978)	R&B,1978	Nm2b2
COSTAT	Re. costatus (R&B,1975)	..	Nm2b2
DEGEN	B. degeneratus R&B,1978	..	Nm2c2
DEVIUM	P. devium (R&B,1978)	..	Nm2b3
ELIASI	B. eliasi M&S,1980	M&S,1980	Morrow
EXCULT	R. excultum R&B,1978	R&B,1978	Nm2b3
EXIMI	B. eximius R&B,1978	..	Nm2c2
EXTREM	Re. extremus R&B,1978	..	Nm2b3
FENIN	R. feninse Popov,1979	Popov,1979	Nm2c
GAMMA	Ph. gammarhipaeum R&B,1978	R&B,1978	Nm2b3
GRADIL	Ph. gradile R&B,1978	..	Nm2b3
HEIBER	Ph. heibergensis (Nassichuk,1975)	Nass.,1975	Hale
HENBES	Re. henbesti (Gordon,1965)	M&S,1980	Morrow
HODSON	Re. hodsoni (R&B,1975)	R&B,1978	Nm2b2
INSTAT	R. instatum R&B,1978	..	Nm2b2
JUVEN	Re. juvenilatus (R&B,1978)	..	Nm2b2
LAXUS	Re. laxus (R&B,1978)	..	Nm2b3
LINGUA	Ph. linguatum (R&B,1978)	..	Nm2b3
MALUS	Ph. malus (R&B,1978)	..	Nm2b3
MICRO	Ph. microreticulatum (Y F-Q,1978)	Y F-Q,1978	Nm2b3
OBSCUR	Ph. obscurus R&B,1978	R&B,1978	Nm2b3
ORIENT	R. orientale R&B,1978	..	Nm2b3
ORTIV	Re. ortivus R&B,1978	..	Nm2b2
PAVLOV	B. pavlovensis Popov,1979	Popov,1979	Nm2c
POLIT	B. politus R&B,1978	R&B,1978	Nm2c2
POSTER	Re. posterus (R&B,1975)	..	Nm2b3
REDIV	A. relictus redivivus M&S,1980	M&S,1980	Morrow
RELICT	A. relictus relictus (Q,M&W,1962)	..	Morrow
REMISS	Ph. remissum R&B,1978	R&B,1978	Nm2b3
SEMIR	Re. semiretia McCaleb,1964	M&S,1980	Morrow
SEPAR	Ph. separatum (R&B,1978)	R&B,1978	Nm2b2
SUREN	Ph. surenense (R&B,1978)	..	Nm2b2
SUBCAR	R. subcarinatus R&B,1978	..	Nm2b3
TERSUM	R. tersum Popov,1979	Popov,1979	Nm2c
TEXTUM	Re. textum (Gordon,1965)	M&S,1980	Morrow
TIRO	Ph. tiro (Gordon,1969)	..	Morrow
WAIN	R. wainwrighti Quinn,1966	..	Morrow
R1A1A	O. compressum (B&H,1943)	Analyses	R1a1
R1A1B	O. coronatum (B&H,1943)	..	R1a1
R1A1C	Ph. circumplicatile (Foord,1903)	..	R1a1
R1A1D	*	..	R1a1
R1A1E	*	..	R1a1
R1A2A	O. bouckaerti sp. nov.	..	R1a2
R1A2B	O. paucicrenulatum (B&H,1943)	..	R1a2
R1A2C	R. subreticulatum B&H,1943	..	R1a2
R1A2D	R. pulchellum (Foord,1903)	..	R1a2
R1A2E	R. samlesburyense B&H,1943	..	R1a2
R1A2F	*	..	R1a2
R1A2G	R. dubium B&H,1943	..	R1a2
R1BA	R. eoreticulatum Bisat,1928	..	R1b
R1BB	Ph. stubblefieldi (B&H,1943)	..	R1b
R1BC	Ph. nodosum (B&H,1943)	..	R1b
R1BD	*	..	R1b
R1BE	R. regularum B&H,1943	..	R1b
R1CA	R. reticulatum (Phillips,1836)	..	R1c
R1CB	Ph. coreticulatum (B&H,1943)	..	R1c
R2AA	B. gracile (Bisat,1924)	..	R2a
R2AB	B. involutum sp. nov.	..	R2a
R2AC	Ph. gracilingua sp. nov.	..	R2a
R2BA	B. bilingue (Salter,1864)	..	R2b
R2BB	B. filobilingue sp. nov.	..	R2b
R2BC	B. beta sp. nov.	..	R2b
R2BD	B. pulobilingue sp. nov.	..	R2b
R2BE	B. metabilingue (Wright,1927)	..	R2b
R2BF	B. sp. aff. bilingue	..	R2b
R2BG	B. sp. aff. pulobilingue	..	R2b
R2BH	B. sp. aff. metabilingue	..	R2b
R2BI	*	..	R2b
R2BJ	*	..	R2b
R2CA	B. superbilingue (Bisat,1924)	..	R2c
R2CB	B. sp. aff. superbilingue	..	R2c
R2CC	B. ruzhentsevi sp. nov.	..	R2c
R2CD	B. golcarensis sp. nov.	..	R2c

Abbreviations :

A. - Arkanites
B. - Bilinguites
O. - Otleyoceras
Ph. - Phillipsoceras
R. - Reticuloceras
Re. - Retites
B&H - Bisat & Hudson
M&S - Manger & Saunders
Nass.- Nassichuk
Q,M&W- Quinn, McCaleb & Webb
R&B - Ruzhentsev & Bogoslovskaya
Y F-Q- Yang Feng-Qing
* - Not formally described - represented by only one cluster of few anomalous specimens.

TABLE 6. Key to species/morphospecies codes for the Reticuloceratidae *s.l.* The generic names given are those resulting from the present work, discussed in detail in Section 5.2.

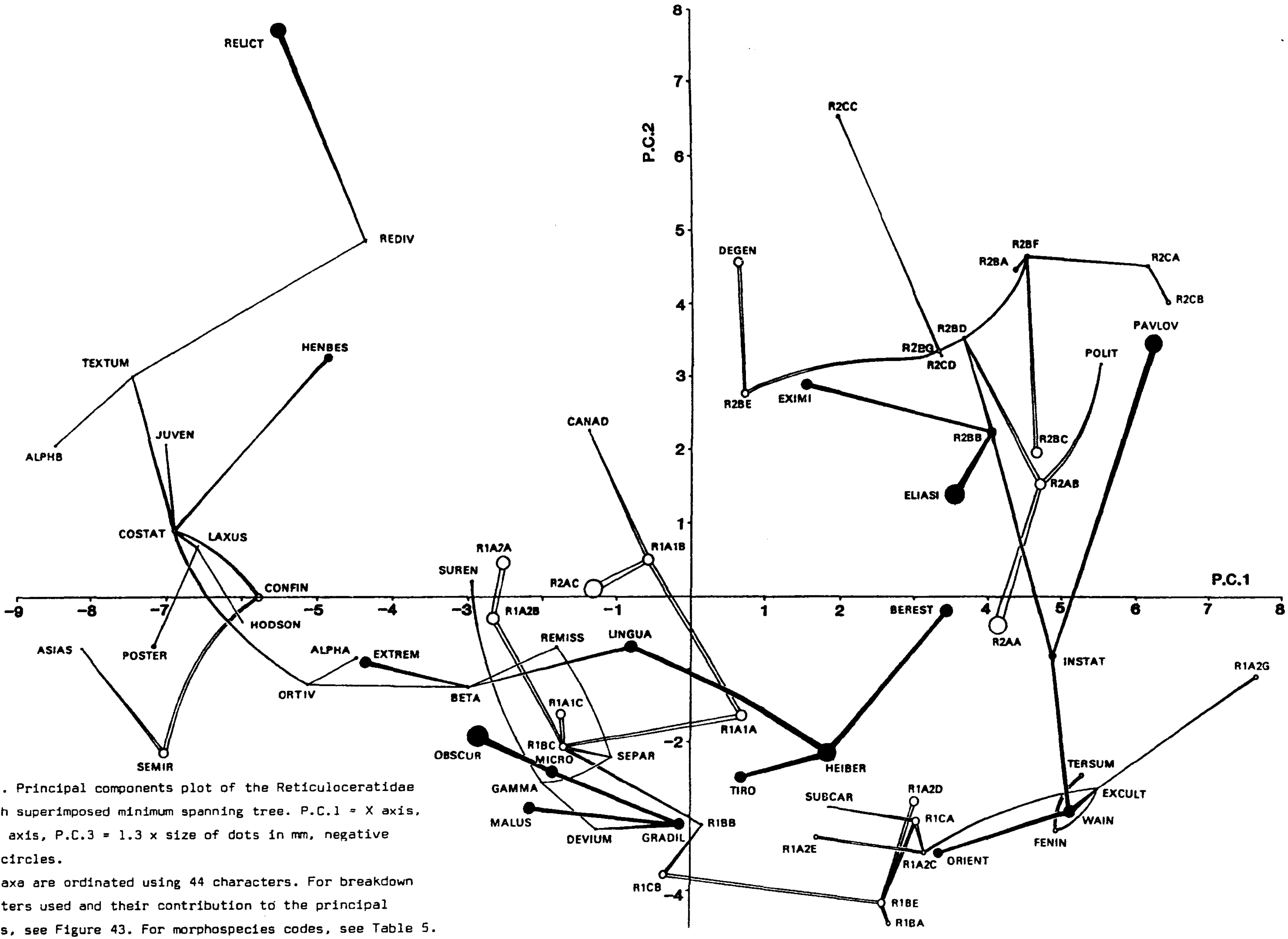


FIGURE 42. Principal components plot of the Reticuloceratidae *s.l.*, with superimposed minimum spanning tree. P.C.1 = X axis, P.C.2 = Y axis, P.C.3 = 1.3 x size of dots in mm, negative for open circles.

72 taxa are ordinated using 44 characters. For breakdown of characters used and their contribution to the principal components, see Figure 43. For morphospecies codes, see Table 5.

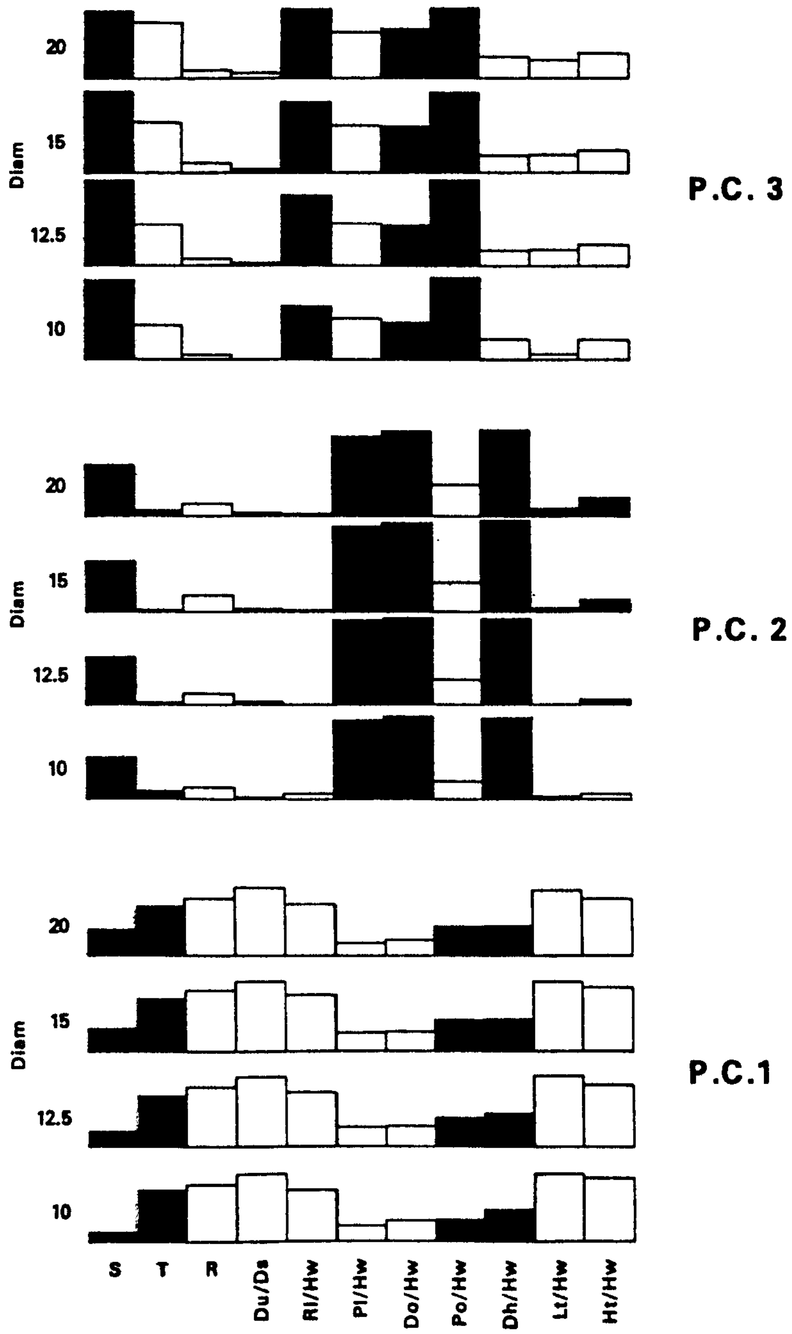


FIGURE 43. The relative contribution of each of the characters to the first 3 principal components of the plot shown on Figure 42. Positive contributions in black, negative in white.

Percentage of total variation: P.C.1 - 41.47%

P.C.2 - 18.62%

P.C.3 - 11.42%.

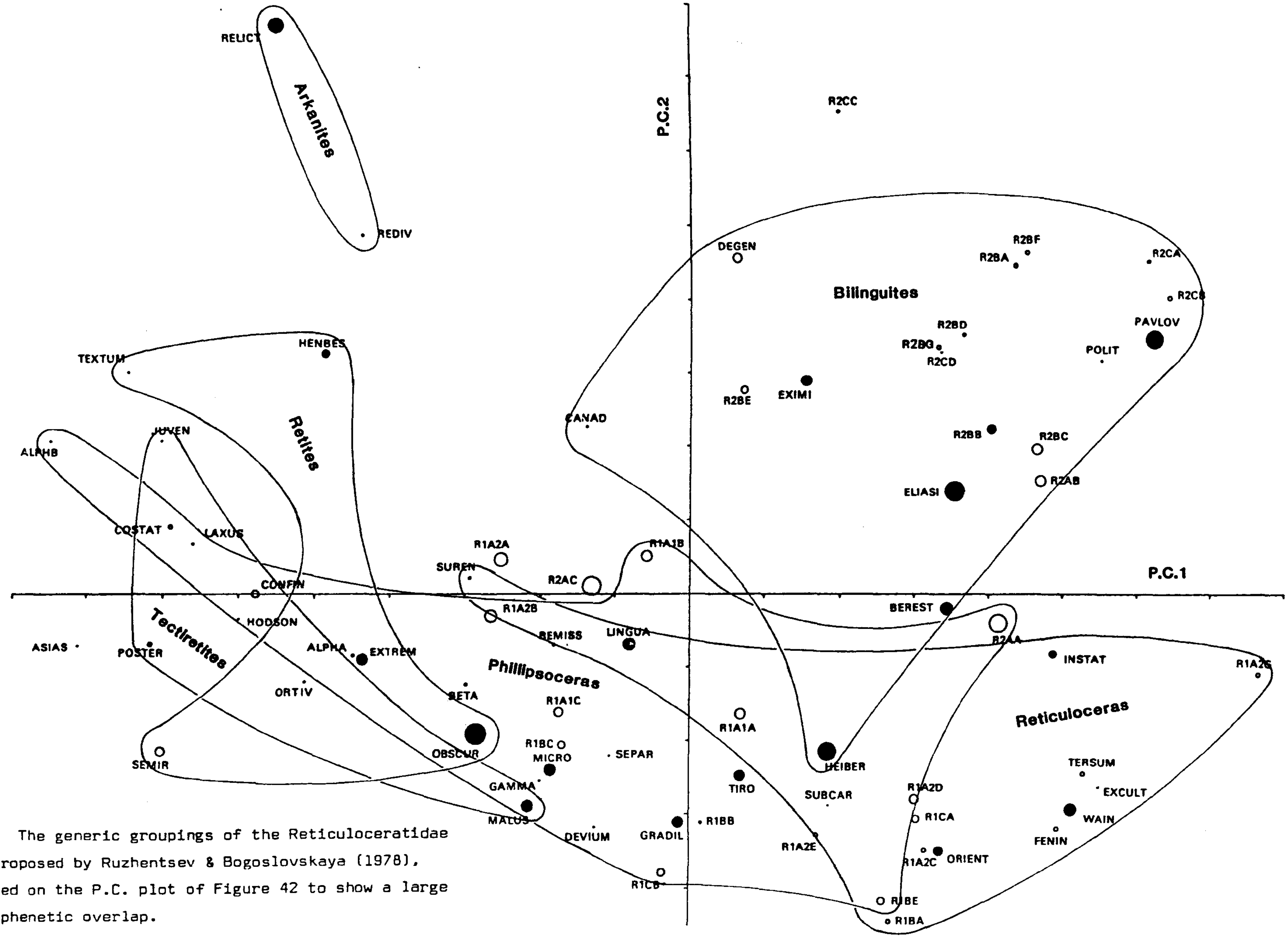


FIGURE 44. The generic groupings of the Reticuloceratidae s.l., as proposed by Ruzhentsev & Bogoslovskaya (1978), superimposed on the P.C. plot of Figure 42 to show a large degree of phenetic overlap.

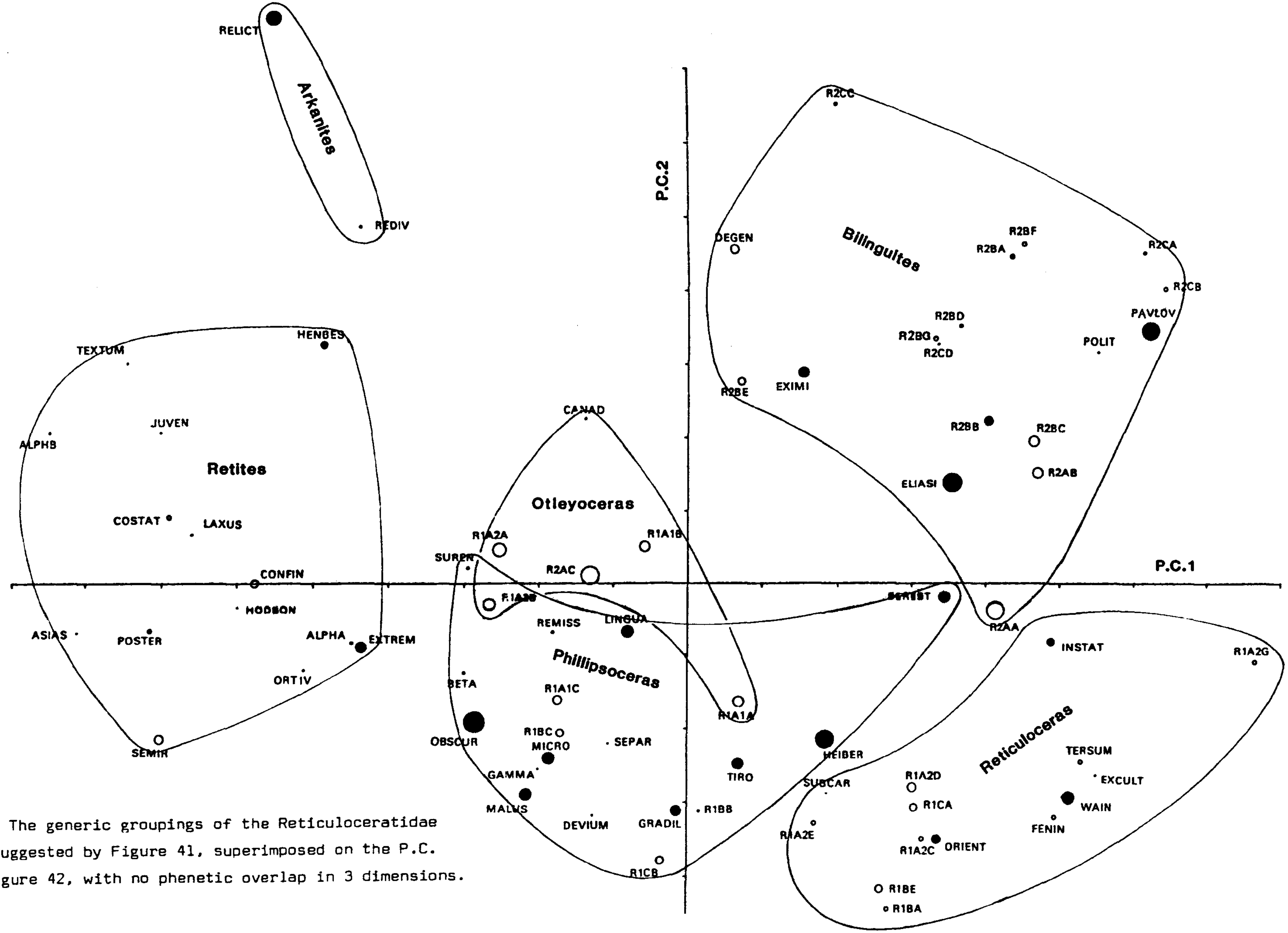


FIGURE 45. The generic groupings of the Reticuloceratidae s.l., as suggested by Figure 41, superimposed on the P.C. plot of Figure 42, with no phenetic overlap in 3 dimensions.

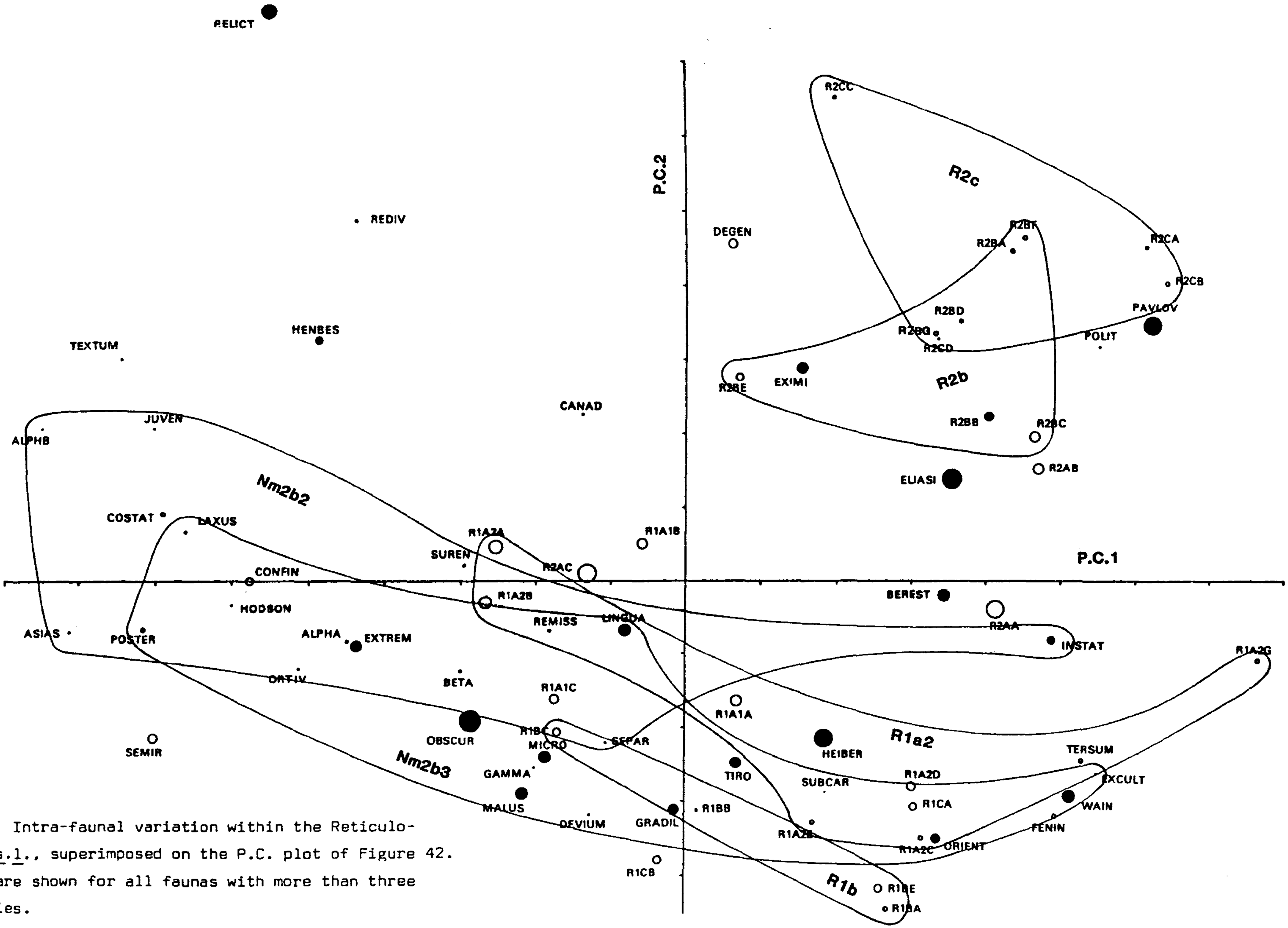


FIGURE 46. Intra-faunal variation within the Reticuloceratidae s.l., superimposed on the P.C. plot of Figure 42. Envelopes are shown for all faunas with more than three morphospecies.

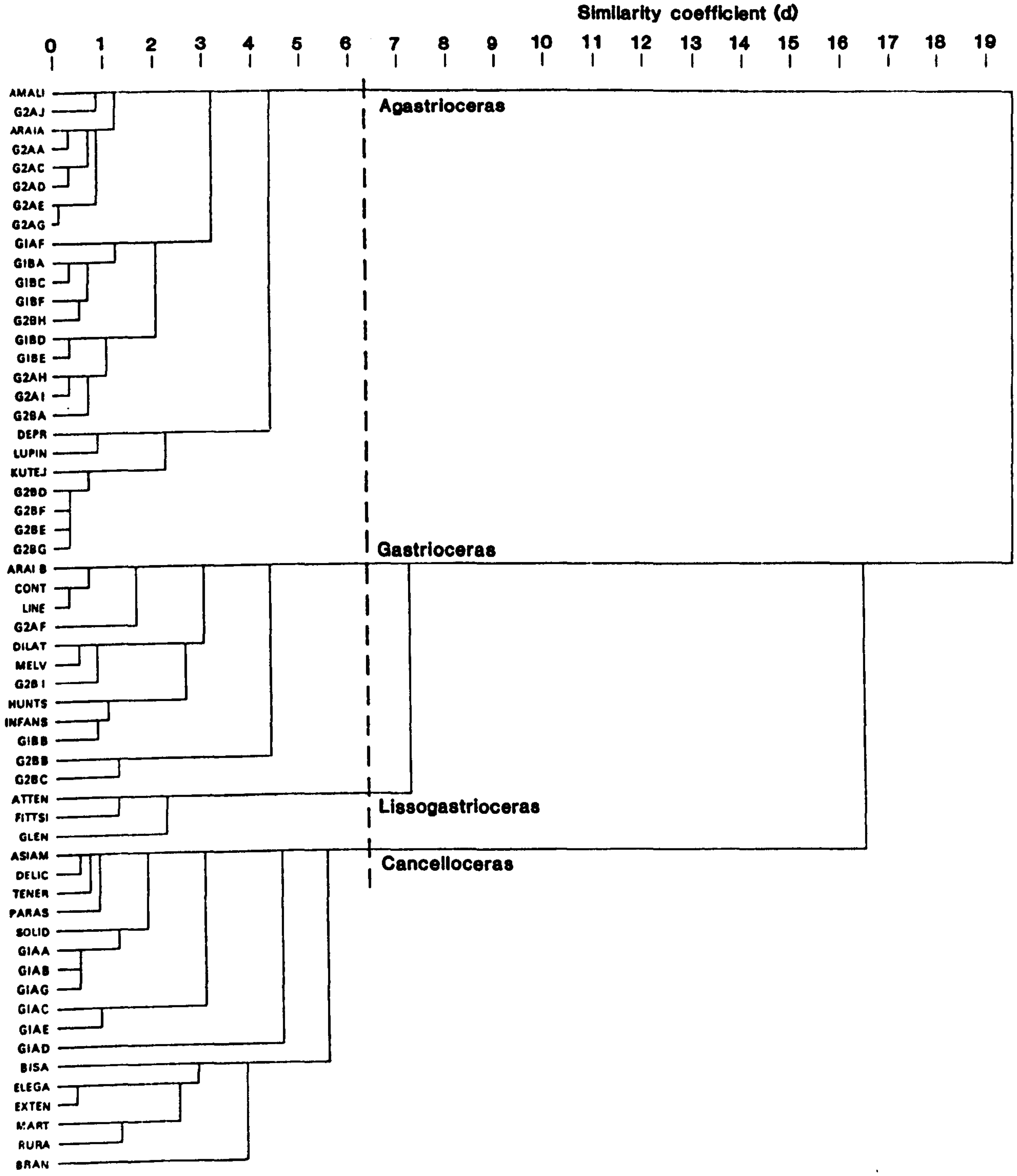


FIGURE 47. Dendrogram showing the phenetic relationships within the Gastrioceratidae s.l. based on 50 characters of each of 43 taxa. The characters include all those tabulated on Figure 49, plus five ontogenetic stages of the character W/H_w. This is the maximum feasible number of characters - use of more would seriously reduce the number of taxa having complete data sets. The phenon line has been chosen according to the criteria cited in Section 3.1.3.5.B.; there is no clear gap between branches at lower values of d. The clusters are interpreted as genera; the names given are explained in Section 4.2.5.4.B.

The key to the morphospecies codes is given in Table 7.

KEY TO SPECIES/MORPHOSPECIES CODES

Code	Species/Morphospecies	Source of Info.	Zone/ Form.
AMAL	A. amaliae (Schmidt,1938)	Specimens	W. A
ARAIA	G. araium McCaleb,1968	McC.,1968	Morrow
ARAIB	G. araium McCaleb,1968	McC.,1968	Morrow
ASIAM	C. asianum R&B,1978	R&B,1978	Nm2c2
ATTEN	L. attenuatum (McCaleb,1968)	McC.,1968	Nm2c2
BISA	C. bisati R&B,1978	R&B,1978	Nm2c2
BRAN	C. branneroides (Bisat,1940)	Specimens	G1a
CONT	G. contractum (R&B,1978)	..	Nm2c2
DELIC	C. delicatum Popov,1979	Popov,1979	Nm2c2
DEPR	A. depressum (Delepine,1937)	Specimens	W. C
DILAT	G. dilatatum (R&B,1978)	R&B,1978	Nm2c2
ELEGA	C. elegans R&B,1978	..	Nm2c2
EXTEN	C. extenuatum R&B,1978	..	Nm2c2
FITTSI	L. fittsi (Miller & Owen,1944)	McC.,1968	Morrow
GLEN	L. glenisteri (Nassichuk,1975)	Nass.,1975	Moscov
HUNTS	G. huntsvillense (M&S,1980)	M&S,1980	Morrow
INFANS	G. infans (Popov,1979)	Popov,1979	Nm2c2
KUTEJ	A. kutejnikovense (Popov,1979)	..	W.
LINE	G. lineatum Wright,1926	Specimens	R2c
LUPIN	A. lupinum (Popov,1979)	Popov,1979	W.
MART	C. martini (Schmidt,1925)	Specimens	G1a
MELV	G. melvillensis Nassichuk,1975	Nass.,1975	Bloyd
PARAS	C. parasianum R&B,1978	R&B,1978	Nm2c2
RURA	C. rurae (Schmidt,1925)	..	Nm2c2
SOLID	C. solidum Popov,1979	Popov,1979	Nm2c2
TENER	C. tenerum Popov,1979	..	Nm2c2
G1AA	C. crencellatum (Bisat,1924)	Analyses	G1a
G1AB	C. evansi sp. nov.	..	G1a
G1AC	A. sp. aff. carinatum	..	G1a
G1AD	C. cancellatoides sp. nov.	..	G1a
G1AE	C. sp. aff. cancellatoides	..	G1a
G1AF	A. carinatum (Schmidt,1925)	..	G1a
G1AG	C. sp. aff. evansi	..	G1a
G1BA	A. sp. aff. crenulatum	..	G1b
G1BB	G. pseudocrencellatum sp. nov.	..	G1b
G1BC	A. crenulatum (Bisat,1924)	..	G1b
G1BD	A. cumbriense (Bisat,1924)	..	G1b
G1BE	A. sp. B aff. cumbriense	..	G1b
G1BF	A. sp. A aff. cumbriense	..	G1b
G1BG	*	..	G1b
G1BH	*	..	G1b
G1BI	*	..	G1b
G2AA	A. sp. B aff. spiralis	..	G2a
G2AB	A. noncrenatum sp. nov.	..	G2a
G2AC	A. sp. aff. subcrenatum	..	G2a
G2AD	A. subcrenatum (Frech,1899)	..	G2a
G2AE	A. spiralis sp. nov.	..	G2a
G2AF	G. sp. aff. listeri	..	G2a
G2AG	A. sp. A aff. spiralis	..	G2a
G2AH	A. sp. aff. magrawi	..	G2a
G2AI	A. magrawi sp. nov.	..	G2a
G2AJ	A. calveri sp. nov.	..	G2a
G2AK	*	..	G2a
G2BA	A. belgiensis sp. nov.	..	G2b
G2BB	G. listeri (Sowerby,1812)	..	G2b
G2BC	G. sp. aff. weristerense	..	G2b
G2BD	A. circumnodosum (Foord,1903)	..	G2b
G2BE	A. retrorsum (Chalmers,1936)	..	G2b
G2BF	A. subcoronatum sp. nov.	..	G2b
G2BG	A. sp. aff. circumnodosum	..	G2b
G2BH	A. adleri Patteisky,1965	..	G2b
G2BI	G. weristerense Demanet,1943	..	G2b
G2BJ	*	..	G2b
G2BK	*	..	G2b

Abbreviations :

A. - Agastrioceras
C. - Cancelloceras
G. - Gastrioceras
L. - Lissogastrioceras
W. - Westphalian
M&S - Manger & Saunders
McC - McCaleb
Nass.- Nassichuk
R&B - Ruzhentsev & Bogoslovskaya
* - Not formally described - represented by only one cluster of few anomalous specimens.

TABLE 7. Key to species/morphospecies codes for the Gastrioceratidae s.l. The generic names given are those resulting from the present work, discussed in detail in Section 5.2.

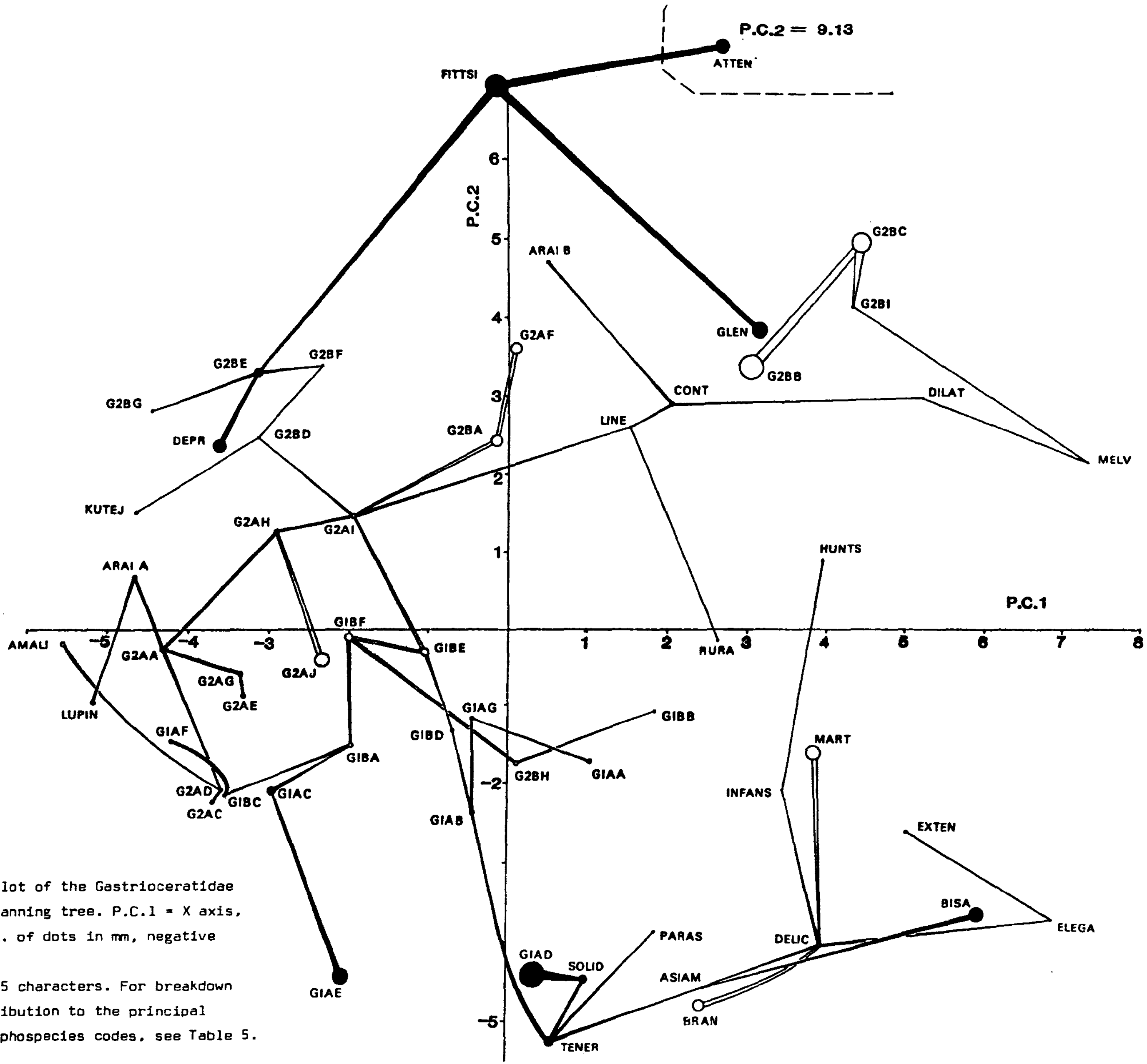


FIGURE 48. Principal components plot of the Gastrioceratidae s.l., with superimposed minimum spanning tree. P.C.1 = X axis, P.C.2 = Y axis, P.C.3 = 1.3 x diam. of dots in mm, negative for open circles.

57 taxa are ordinated using 45 characters. For breakdown of characters used and their contribution to the principal components, see Figure 49. For morphospecies codes, see Table 5.

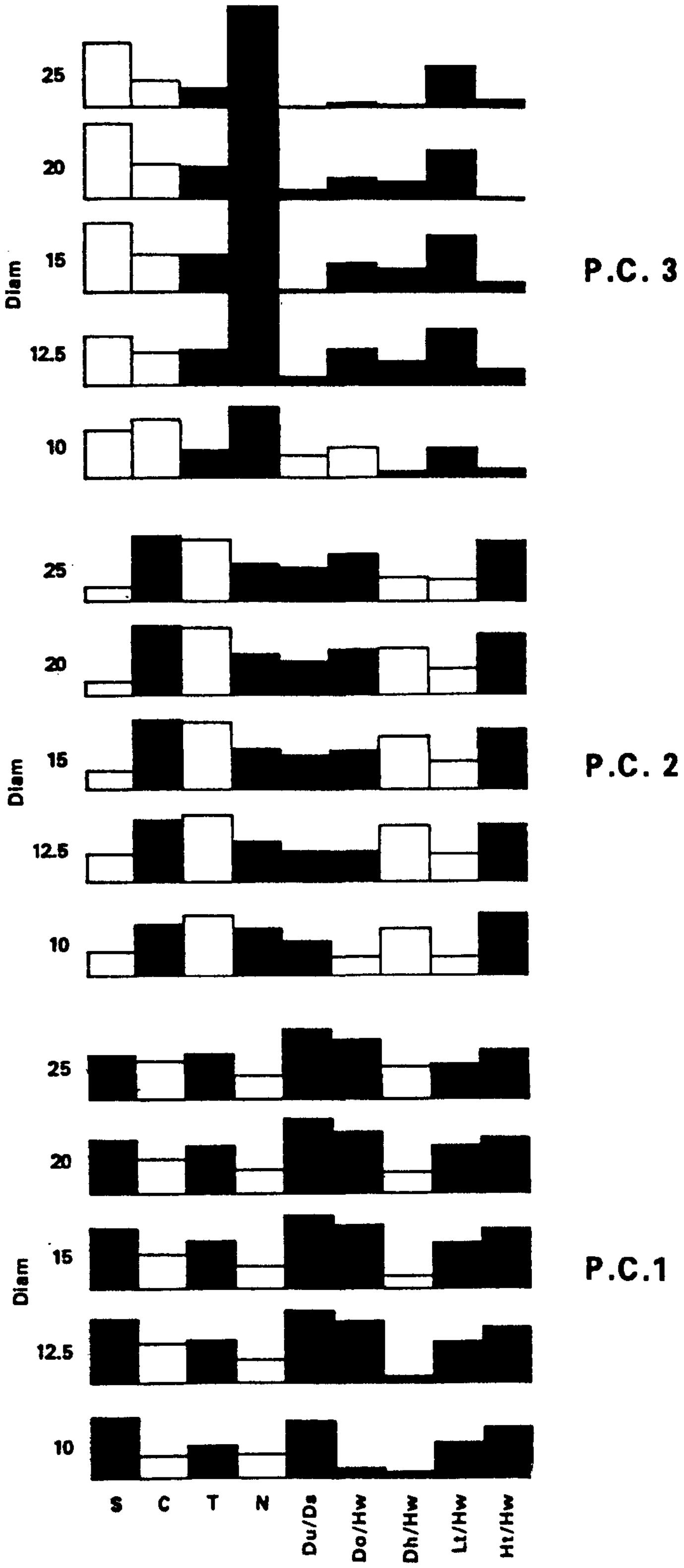


FIGURE 49. The relative contribution of each of the characters to the first 3 principal components of the plot shown on Figure 48. Positive contributions in black, negative in white.

Percentage of total variation: P.C.1 - 25.48%
P.C.2 - 22.43%
P.C.3 - 11.39%.

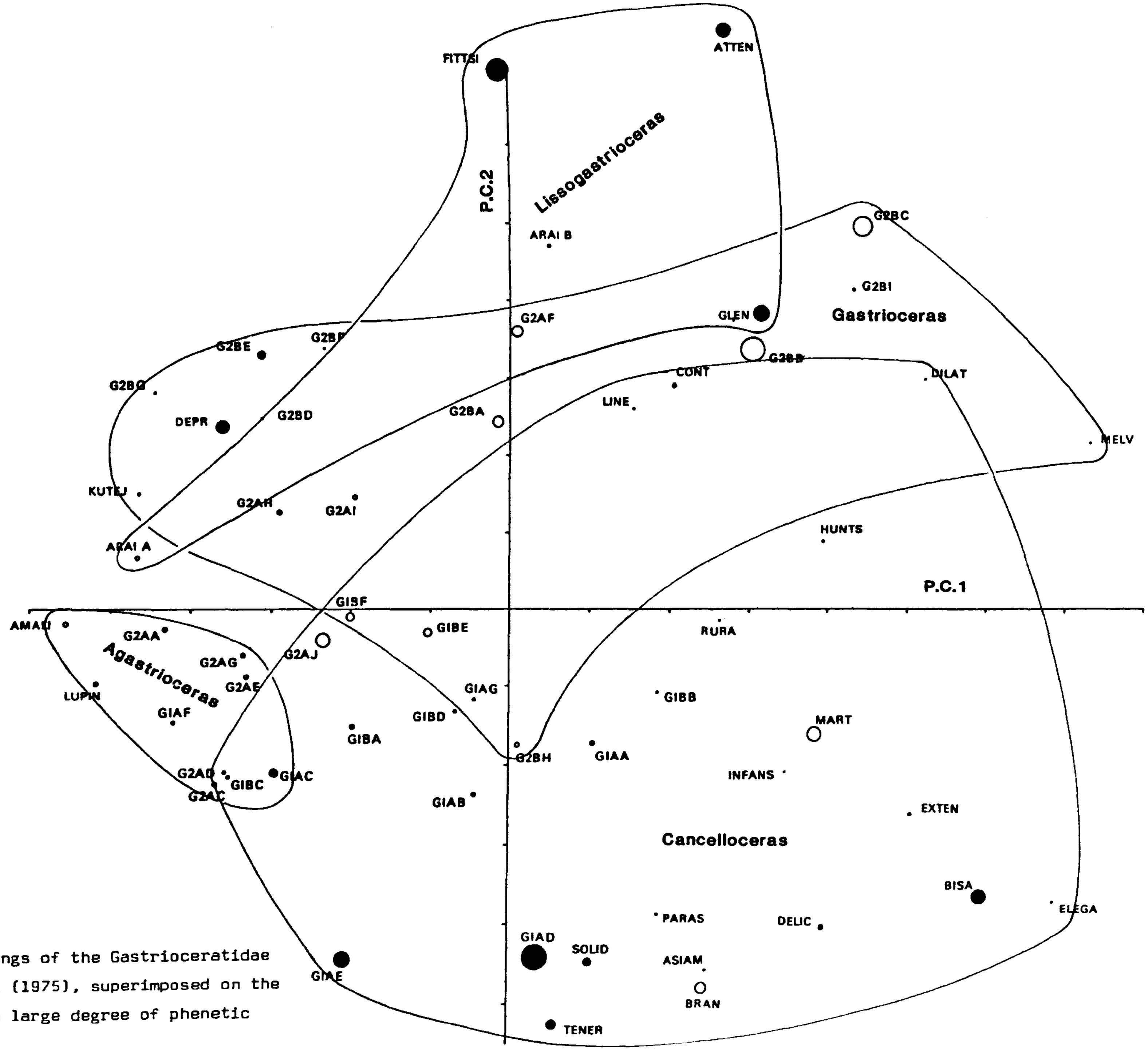


FIGURE 50. The generic groupings of the Gastrioceratidae *s.l.*, as summarised by Nassichuk (1975), superimposed on the P.C. plot of Figure 48 to show a large degree of phenetic overlap.

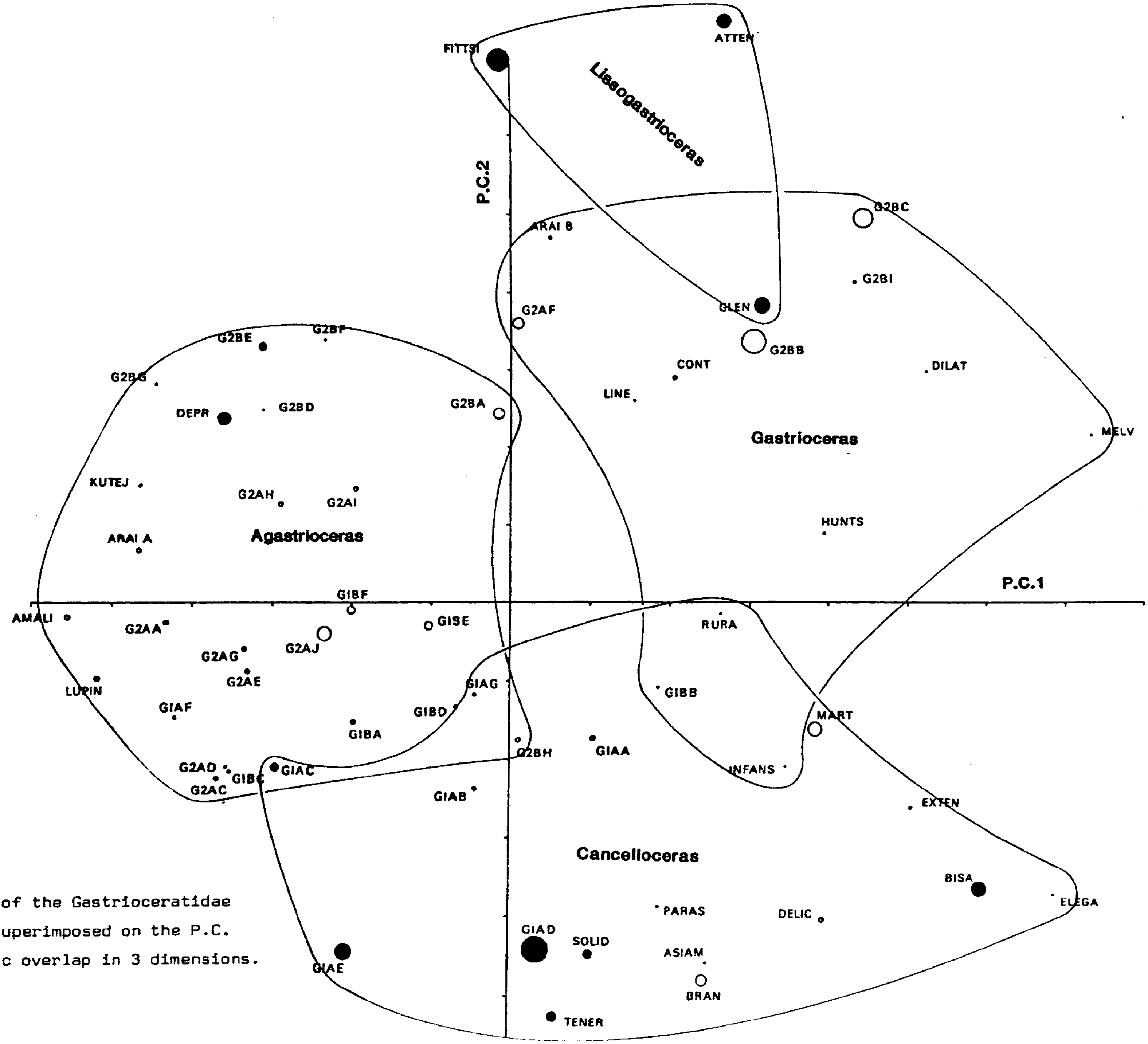


FIGURE 51. The generic groupings of the Gastrioceratidae *s.l.*, as suggested by Figure 47, superimposed on the P.C. plot of Figure 48, with no phenetic overlap in 3 dimensions.

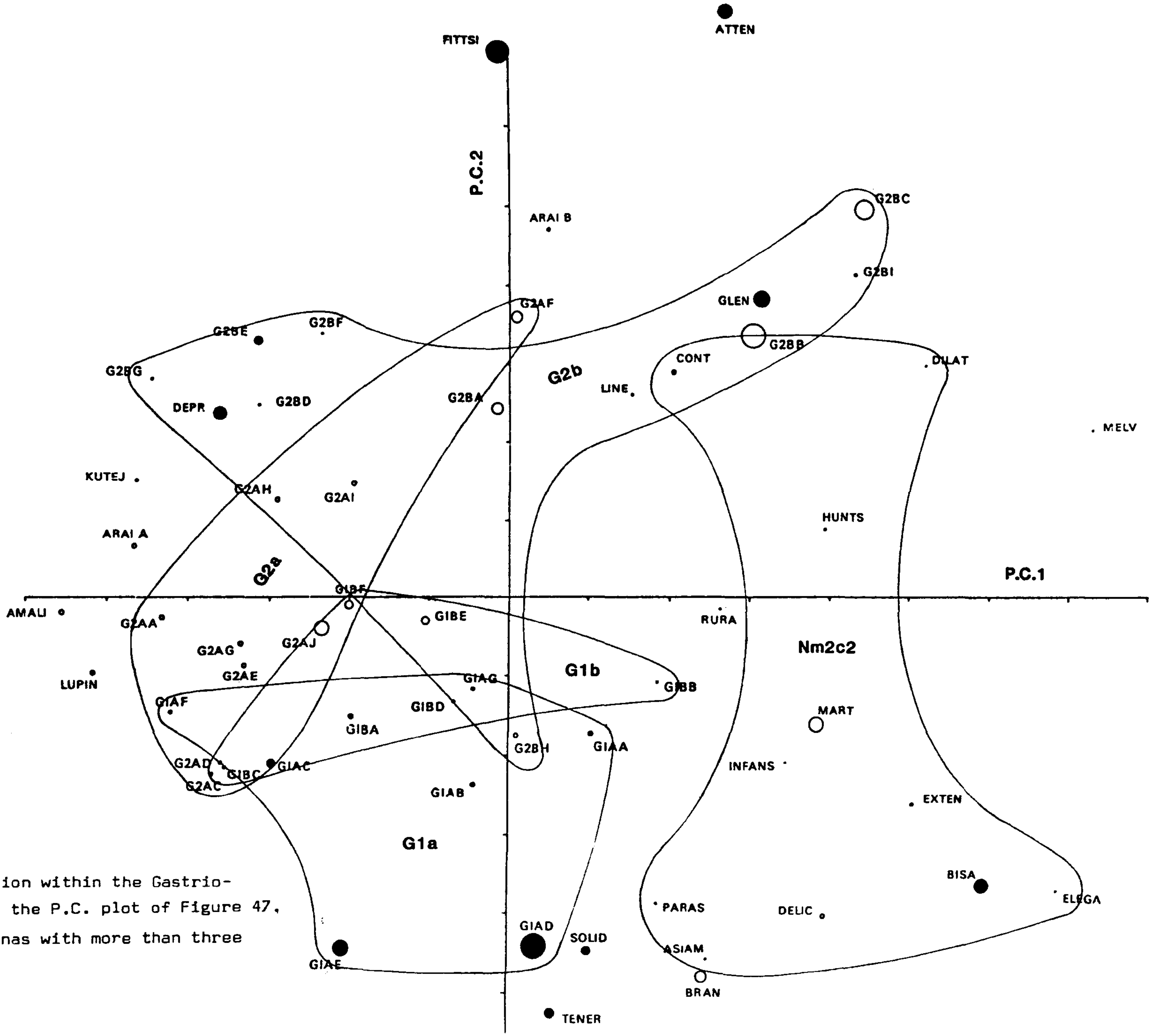


FIGURE 52. Intra-faunal variation within the Gastrioceratidae *s.l.*, superimposed on the P.C. plot of Figure 47. Envelopes are shown for all faunas with more than three morphospecies.

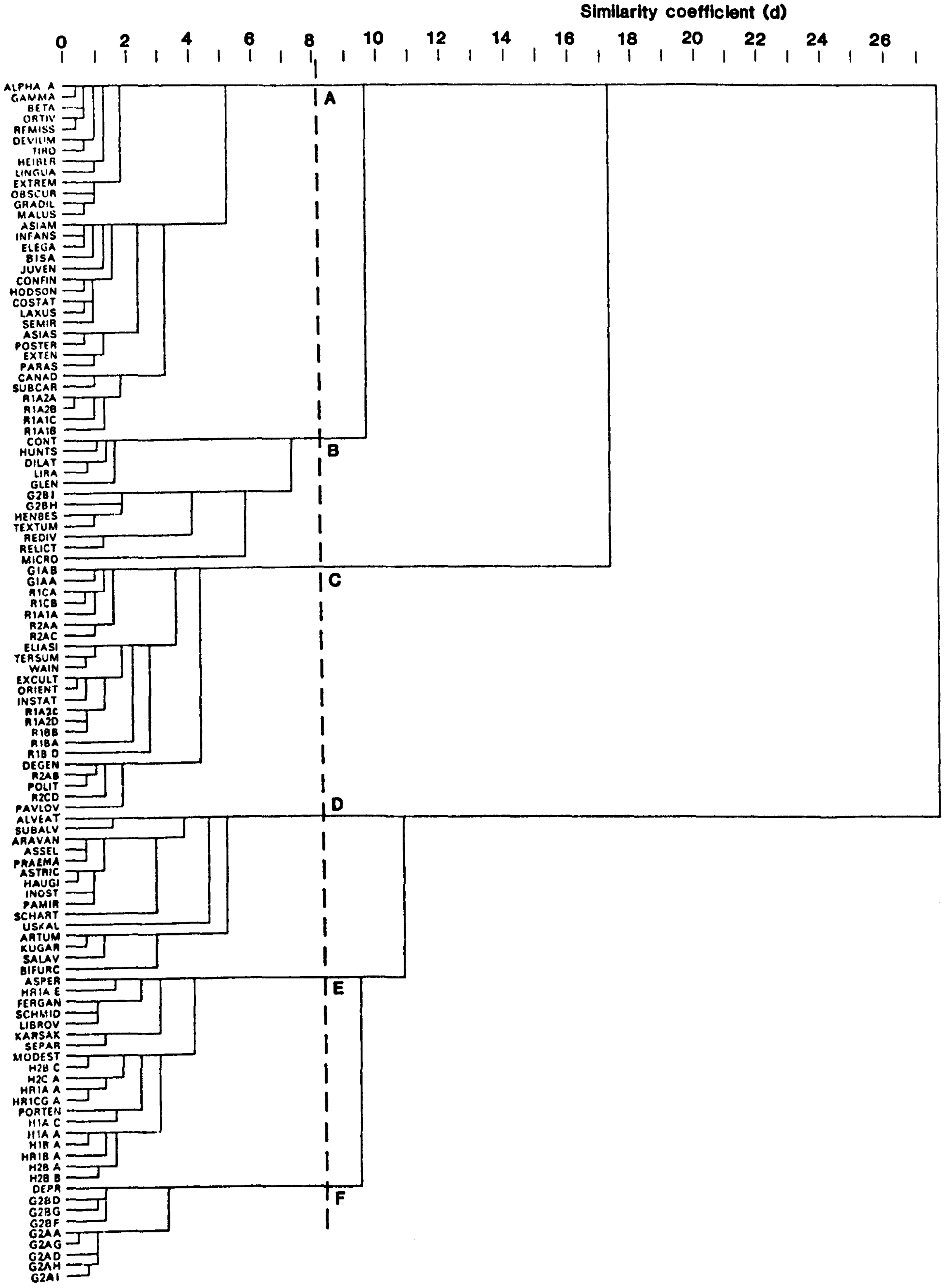


FIGURE 53. Dendrogram showing the phenetic relationships between taxa from the whole taxonomic scope of this study, based on 79 characters of each of 111 taxa. The characters used are tabulated on Figure 55. This is the maximum number of characters permitted by the CLUSTAN package. The phenon line has been chosen according to the criteria cited in Section 3.1.3.5.B., and is placed in the clearest gap between branches at relatively low d. The significance of the clusters is discussed in Sections 4.2.5.2.A. and 4.2.5.3.A.

Keys to the morphospecies codes are given in Tables 5, 6 & 7.

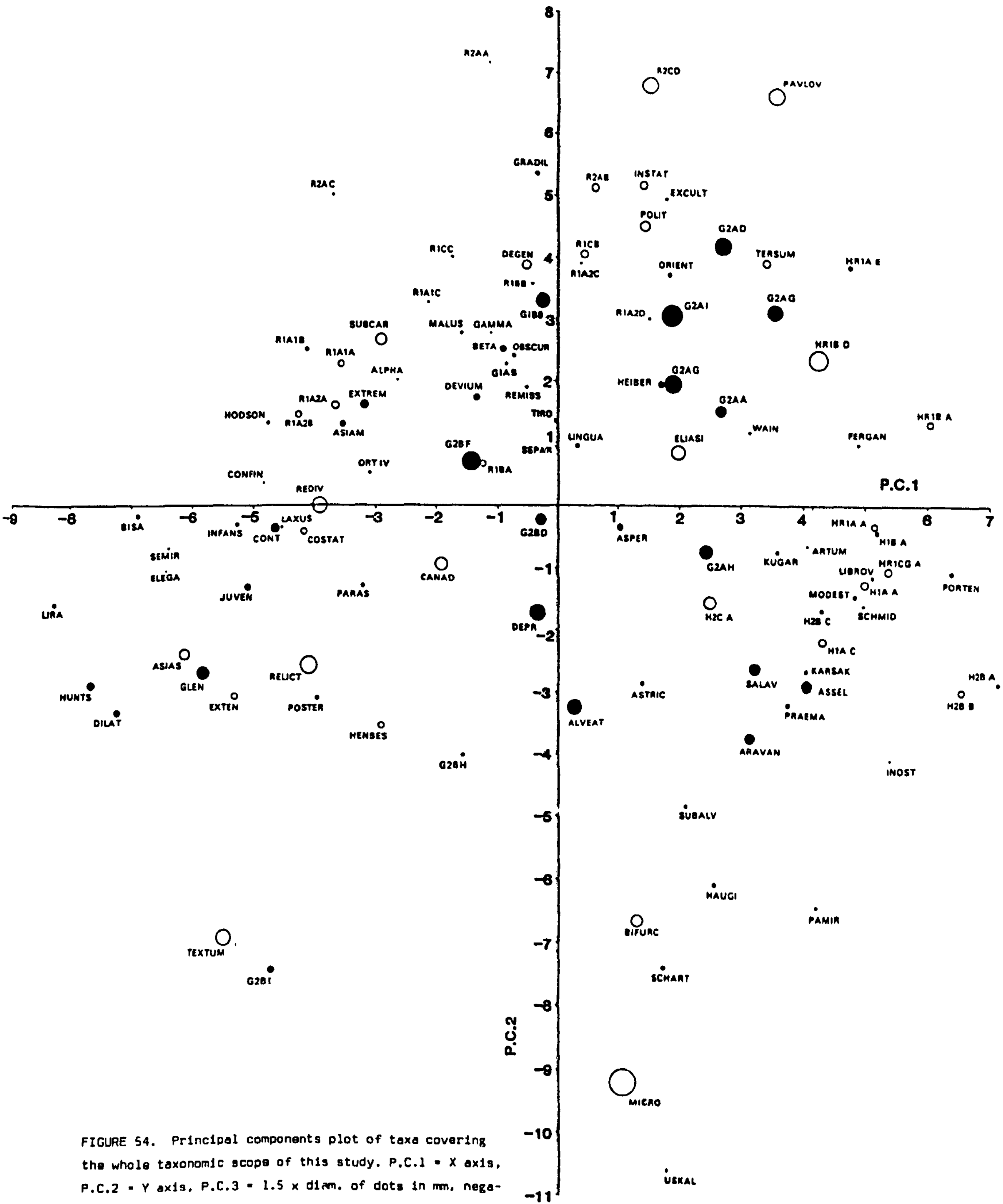


FIGURE 54. Principal components plot of taxa covering the whole taxonomic scope of this study. P.C.1 = X axis, P.C.2 = Y axis, P.C.3 = 1.5 x diam. of dots in mm, negative for open circles.

111 taxa are ordinated using 79 characters. for a breakdown of characters used and their contribution to the principal components, see Figure 55. For morpho-species codes, see Tables 5, 6 & 7.

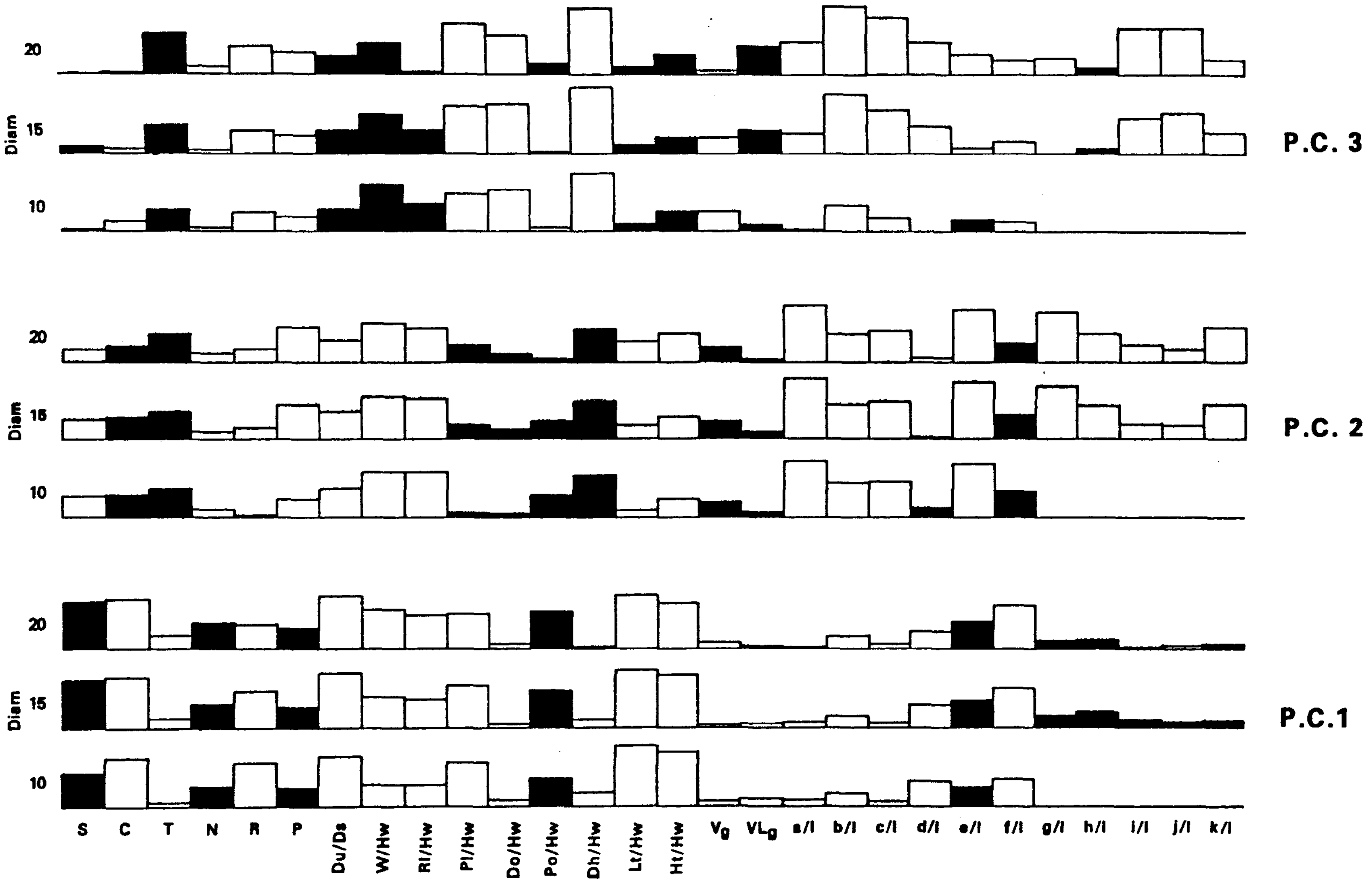


FIGURE 55. The relative contribution of each of the characters to the first 3 principal components of the plot shown on Figure 54. Positive contributions in black, negative in white. Percentage of total variation: P.C.1 - 17.96%

P.C.2 - 14.93%

P.C.3 - 8.92%.

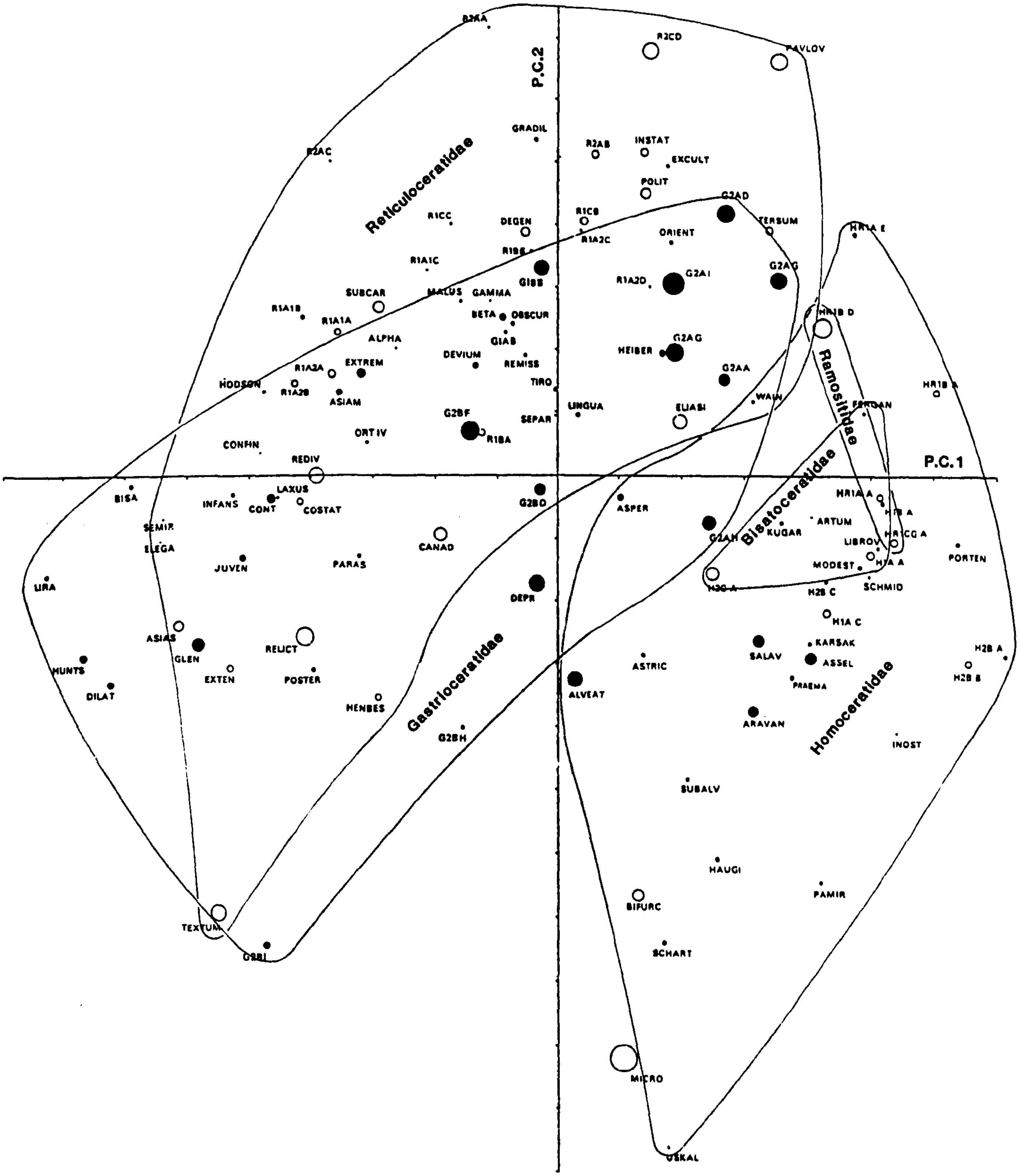


FIGURE 56. The familial groupings adopted by Ruzhentsev and Bogoslovskaya (1978) superimposed on the P.C. plot of Figure 54 to show the large degree of phenetic overlap.

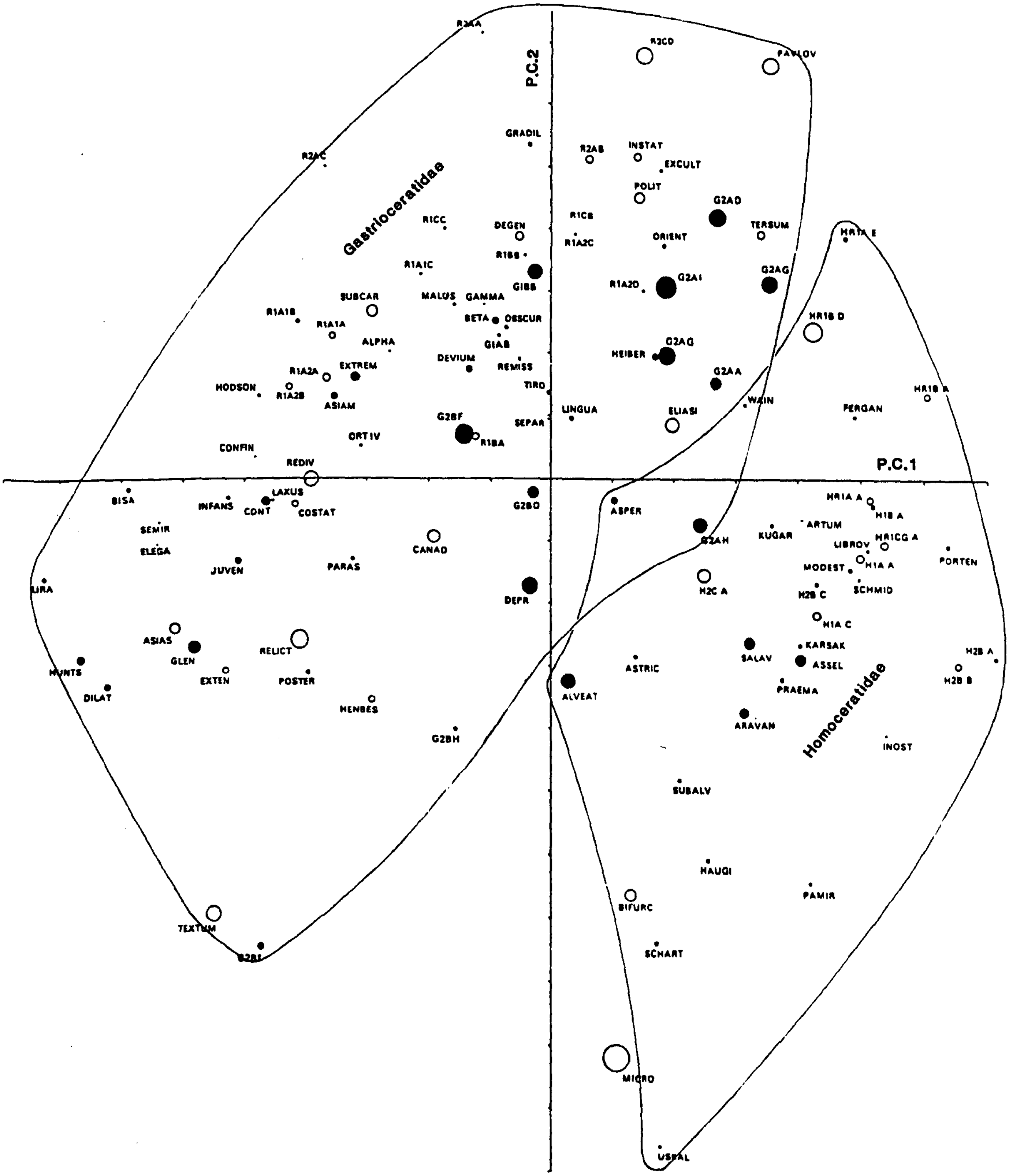


FIGURE 57. The familial groupings proposed by the present study, based on Figure 53, as discussed in Sections 4.2.5.2 and 4.2.5.3, superimposed on the P.C. plot of Figure 54, with no overlap in 3 dimensions.

4.2.5. DISCUSSION OF RESULTS OF INTER-SPECIFIC ANALYSES

This section will deal only with the evidence for taxonomic division - formal systematic treatment is to be found in Chapter 5.

4.2.5.1. General Observations

The following points apply generally to all analyses:

A. Established genera show a large and unacceptable degree of phenetic overlap (see Figures 38, 44 & 50). The monothetic criteria by which authors have distinguished genera seem not to be natural; they are not reinforced by the rest of the phenotype.

B. The relationships suggested when sutural details are included in analyses (Figure 53) are not always compatible with the relationships suggested when they are excluded (Figures 35, 41 & 47). Although the polythetic approach favours the inclusion of as many characters as possible, we have seen (Section 3.2.3.2., Figure 11) that sutural data may be empirically unreliable; and in this study sutural data has only been gleaned from a small, possibly unrepresentative, set of specimens, due to the relative infrequency of observation of sutures.

C. The amount of variation within faunas varies. For example, on Figure 40 the H_{2b} zone fauna can be seen to cover considerably less A-space than R_{1b} zone, even though the same number of morphospecies are recognised; R_{1a2} zone is more diverse than R_{1b} on Figure 46; and in all cases Russian faunas are apparently more varied than British. These differences in diversity in time and between regions may eventually be interpretable in terms of environmental parameters. Meanwhile, it is pertinent to note here that the area of morphospace spanned by a fauna is not closely correlated with the number of morphospecies recognised. This may reflect over-splitting of less diverse faunas (see Section 4.1.4.) and indicates that the finest taxonomic divisions in some faunas may be of little practical significance.

D. The directions in A-space of faunal diversities (Figs. 40, 46 & 52) show strong tendencies which are consistent with the character correlations noted on principal components plots of individual zones in Section 4.1.4. They also show a general parallelism with the diversity within previously recognised genera (Figs. 38, 44 & 50), certainly more so than with the new phenetic genera.(Figs. 39, 45 & 51). Previous authors appear to have stretched generic definitions to incorporate intra-faunal variation. The significance of this direction of diversity is discussed in Section 4.2.5.5., but the contention here is that, given the outstanding uncertainty as to its meaning, this phenomenon should not interfere with the phenetic taxonomic results.

4.2.5.2. Interpretation of the Homoceratidae s.l. and Homoceratoides

A. The Constitution of the Family

Ruzhentsev and Bogoslovskaya (1978) split those species referred to Homoceratoides in Britain between the Ramositidae (genus Ramosites), and the Bisatoceratidae (genus Homoceratoides), with none in the Homoceratidae. These species are, however, not sufficiently distinct in the present analyses to be separated from the Homoceratidae; for example, Figure 35 shows that type Homoceratoides (H2CB) is closer to Bogdanoceras than the latter is to Homoceras, and other Homoceratoides s.l. species are easily incorporated into Homoceras. In view of this, a numerical reappraisal of Russian Ramosites would be of interest.

When analysed with other families, the Homoceratidae cannot be split off as one exclusive cluster. Figure 53 shows that all Homoceratids are allocatable to two clusters (D & E), which they occupy almost exclusively, but that these are prevented from forming an integrated cluster at a higher level of the hierarchy by cluster F, formed entirely of species referable to Agastrioceras. As mentioned in Section 4.2.5.1.B, inferences based on this analysis may not be reliable if not compatible with other evidence. In view of the fact that these Agastrioceras species appear to be well integrated with typical Gastrioceratid s.l. forms in Figure 48, and that the division of Homoceratids into clusters D and E is not clearly related to clusters in Figure 35, it is preferred here to retain Agastrioceras in the Gastrioceratidae and to amalgamate clusters D and E as the Homoceratidae. Note also that the specimens in cluster F are distinguishable on Figure 54 as having large P.C.3 scores, but with respect to the first two principal components they are intermediate between the bulk of the Gastrioceratids and the Homoceratids - evidently cluster F is only marginally closer to D/E than it is to A/B/C.

Figure 57 shows the Homoceratidae, as defined here, as a well integrated group uniquely occupying a region of morphospace centred in the positive P.C.1, negative P.C.2 quadrant.

B. Generic Divisions

The phenon line shown on Figure 35 is here used to separate genera within the Homoceratidae. The genera distinguished are:

Bashkortoceras: This cluster includes the type species of three of Ruzhentsev and Bogoslovskaya's (1971,1978) genera, (*Bashkortoceras*, *Parahomoceras* and *Umbetoceras*) of which *Bashkortoceras* has precedence. The tightness of the cluster indicates the lack of significant differences between these genera.

Bogdanoceras: Includes three species previously regarded as belonging to *Homoceras*, but which are not typical of the latter genus in many respects.

Homoceras: Includes the type species *H. smithii* (H2AC/D) which has precedence over the type species of *Isohomoceras* and *Fallacites*, also present here. This cluster incorporates similar species previously referred to seven different genera, and consequently extends the range of *Homoceras* towards the top of the Namurian.

Homoceratoides: This analysis restricts the genus to the forms in H_{2c} zone. Figure 36, however, shows that other species (HR1BD, HR1CGA) previously allocated to this genus are in fact quite close, though necessarily separated.

Vallites: Includes the type species *V. henkei*, plus the type species of the consequently synonymous *Hodsonites*, and involute, discoidal forms previously included in *Isohomoceras* and *Homoceratoides*.

?*Gen. nov.*: This cluster is formed by two species previously included in *Homoceras* but which in this analysis appear to have been distinguished on the basis of characters which may be pathological.

More formal and detailed accounts of these taxonomic divisions is to be found in Section 5.2.

4.2.5.3. Interpretation of the Reticuloceratidae s.l.

A. The Constitution of the Family

The distribution of the Reticuloceratidae s.l. amongst the six clusters distinguished by the phenon line on Figure 53 is as follows: cluster A - 27 Reticuloceratids s.l. mixed with 6 Gastrioceratids s.l.; cluster B - 5 Reticuloceratids with 7 Gastrioceratids; cluster C - 21 Reticuloceratids with 2 Gastrioceratids; clusters D and F - none; cluster E - 1 Reticuloceratid amongst Homoceratids. The lone species in cluster E, Phillipsoceras separatum, is rather anomalously placed by the cluster analysis, as its nearest neighbours are all Reticuloceratids s.l. and it is well within typical Reticuloceratid morphospace in Figures 41 and 42. With this exception, the Reticuloceratidae s.l. are isolated by the first bifurcation of the dendrogram in Figure 53, and they plot in intimate association with Gastrioceratidae s.l. both in this figure and in Figure 54. Members of clusters A, B and C do show a definate affinity with each other regardless of previous familial designations - compare, for example, Cancelloceras extenuatum and Alurites costatus, both illustrated by Ruzhentsev and Bogoslovskaya (1978). Despite the generally higher stratigraphic occurrence of the Gastrioceratidae s.l. relative to the Reticuloceratidae s.l., the two previously recognised families show a remarkable degree of phenetic overlap (see Figure 56) and it is contended here that they are inseparable. All genera previously included in the Reticuloceratidae are therefore regarded here as belonging to the Gastrioceratidae, which has precedence.

B. Generic Divisions

Genera previously assigned to different families (ie. Reticuloceratidae and Gastrioceratidae) are here provisionally assumed to be distinct. Characters previously used to separate families are probably adequate to separate genera here. The distinctions should be apparent in the generic descriptions in Chapter 5. Nevertheless, further research may well show that certain genera, for example Alurites and Cancelloceras, are irresolvable.

The genera within the Reticuloceratidae s.l. are here separated by the phenon line shown on Figure 41, which resolves six genera:

Arkanites: Concept of genus unaltered.

Bilinguites: The type species, *B. superbilinguis*, is not included in the cluster analysis, due to missing character values, but its position on the principal components plot (Figure 42) leaves no doubt that it belongs with this cluster. All cluster members have previously been referred to this genus.

Phillipsoceras: Includes the type species *Ph. circumplicatile* (R1A1C) with many species previously recognised as *Phillipsoceras*, plus a few similar forms allocated in the past to *Bilinguites*, *Retites*, *Tectiretites* and *Reticuloceras*.

Reticuloceras: Composed of species mostly referred to this genus by previous authors, and so the definition of the genus is not greatly altered here.

Retites: Includes the type species *Re. semiretia*, which has precedence over the type species of *Tectiretites*, *Alurites* and *Quinnites* which are also in this cluster.

Otleyoceras gen. nov.: Composed of species previously allocated to *Phillipsoceras* and *Bilinguites*.

More formal and detailed accounts of these taxonomic divisions are to be found in Section 5.3.

4.2.5.4. Interpretation of the Gastrioceratidae *s.l.*

A. The Constitution of the Family

It was argued in the previous section that the Gastrioceratidae should incorporate all species hitherto placed in the Reticuloceratidae. The positions of members of the Gastrioceratidae *s.l.* in the dendrogram shown in Figure 53 have been described and interpreted in Sections 4.2.5. 2 & 3.

B. Generic Divisions

These are established for the Gastrioceratidae *s.l.* by the phenon line on Figure 47. The genera distinguished are:

Agastrioceras: This cluster consists largely of species previously referred to *Gastrioceras*, plus a few each from *Cancelloceras* and *Agastrioceras*. The latter genus is, however, the only one represented by its type species, *A. carinatum*.

Cancelloceras: Although the type species, *C. cancellatum*, is unanalysed, its morphology is apparently quite central with respect to this cluster. Similar morphospecies in the same stratigraphic level (G1AA, G1AB, G1AC) are included here. The concept of the genus is relatively unaltered.

Gastrioceras: Includes the type species *G. listeri* (G2BB) and various other coronate species previously referred to *Gastrioceras*, *Cancelloceras* and *Lissogastrioceras*.

Lissogastrioceras: Restricted here to three species. *L. fittsi* is the type species.

More formal and detailed taxonomic accounts are to be found in Section 5. 4.

4.2.5.5. The Significance of Intra-Faunal Variation

A. Style of Variation

The exact style of intra-faunal variation is shown by Figures 40, 46 and 52. It is immediately obvious that this variation is, in most cases, strongly linear or planar. Also, it is apparent that the main direction of elongation of the faunas in A-space is in the direction of the first principal component.

In all three analyses umbilical diameter is a major contributor to this component, and whorl width is also important. In the Reticuloceratidae s.l. and the Gastrioceratidae s.l. the size of the tubercles/plications is another important contributor to this direction of variation. We have, therefore, a series of faunas, each incorporating both relatively evolute, broad forms, usually with coarse ornament, and relatively involute, narrow forms. Other characters, although not constant within faunas, are certainly less variable, and vary in a less systematic manner.

This type of variation has two possible parallels in other ammonoid faunas: sexual dimorphism and intra-specific variation.

B. Sexual Dimorphism

Sexual dimorphism was suggested as an explanation for some of the variation encountered in Silesian goniatites by Demanet (1943) and by Ramsbottom & Calver (1962). The suggestion is that the more evolute, broad forms are female, the others male. This idea is not supported here for the following reasons:

1. Ammonoid sexual dimorphs have identical early whorls (see, for example, Kennedy & Cobban, 1976), whereas the morphospecies in Silesian faunas are often distinct down to

at least 5 mm diameter; they are only identical in the very earliest ontogeny, at which stage whole genera may be similar. An inter-specific analysis using only characters of morphospecies from growth stages up to 10 mm diameter failed to resolve faunas into significant pairs of morphospecies.

2. Sexual dimorphism should only be apparent when individuals approach maturity. Though rare and usually fragmentary, goniatite specimens do occur in the Silesian of considerably greater size (perhaps 50 - 100 mm diam.) than those dealt with in this study, so it is possible that the specimens analysed here are mostly immature. Fragmentation of the final whorl of most specimens prevents proper assessment of maturity according to the criteria of Kennedy & Cobban (1976). However, the forms cited as possible dimorphs in Silesian faunas by previous authors are all quite distinct down to at least 10 mm diameter, they are therefore distinct whilst probably immature and cannot be sexual dimorphs. Regrettably, too few good specimens exist of sufficiently large size to make objective judgements about the possibilities of sexual differentiation at later growth stages.

3. Variation between a sexually dimorphic pair should be discrete, not continuous.

4. Silesian goniatite faunas are essentially polymorphic, not dimorphic.

5. The features developed by classic dimorphic pairs, ie. apertural modifications in males, large size and loss of ornament in females, are not the features which particularly contribute to the main component of variation in Silesian goniatite faunas.

No evidence in favour of sexual dimorphism is forthcoming from this study. If present, it must only be manifested in larger sized specimens than are dealt with here, in which case its relationship with the variation in immature specimens would be an interesting complexity.

C. Intra-Specific Variation

Sexual dimorphism is obviously a type of intra-specific variation; this section discusses variation which does not fulfil the criteria for dimorphism as discussed above.

Intra-specific variation in ammonoids was reviewed by Kennedy & Cobban (op. cit., pp. 38-41) who cite many examples of faunas in which various forms have been described separately by earlier authors but amalgamated into one variable species by subsequent revisers. The basis for considering such forms conspecific is continuity of variation within populations. This is normally assessed subjectively. Kennedy & Cobban (op. cit., fig. 9 & plate 9) illustrate end members of apparently phenetically continuous populations of Triassic and Cretaceous ammonoids. These populations show variation particularly in the following characters: diameter of umbilicus, whorl width, strength of tuberculation. These are exactly the same characters as were cited above as contributing to the main component of Silesian intra-faunal goniatite variation. We conclude, then, that the type of intra-faunal variation discovered in the present study is also found in other ammonoid faunas, and may be widespread, and that many authors regard it as intra-specific in nature.

The exact genetic status of this variation cannot be known; the term "intra-specific variation" is used by authors regardless of the inapplicability of the biological species concept in palaeontology. Phenetic continuity of variation in a fauna does not prove that the members of that fauna were "actually or potentially interbreeding". The term "morphospecies" applied to significant peaks in the phenotypic frequency distribution, as used in this study, is a suitable term for this situation. It has the advantages of enabling concise and complete description of a phenetic continuum, whilst not assuming any genetic status.

The recurrence of the type of variation described above in several, possibly many, different ammonoid populations suggests the following:

1. The range of modes of life available to these ammonoid faunas must have been similar, or at least analogous. This only assumes that grossly different morphotypes could not have had identical ecological roles.
2. These ammonoids must have possessed great morphological flexibility. Whether attained by genuine intraspecific variability, or by evolutionary radiation, the amount of variation shown is no less remarkable.

It would be of great interest to compare the palaeoecology of these ammonoid faunas; perhaps the similarity in the ranges of phenetic variation would be found to be reflected in some common, parallel factor in the palaeoenvironment. This, though, is beyond the scope of the present study.

D. Inter-Faunal Variation Compared with Intra-Faunal Variation

It has been noted that intra-faunal variation is largely elongated in the direction of the first principal component of Figures 40, 46 and 52. This principal component also tends to differentiate British from Russian faunas; Russian forms are generally more evolute and coarsely ornamented. Within each province, however, inter-faunal differences are mainly in the direction of the second principal component. This component is particularly contributed to by the following characters: strength of crenulation and spiral ornament (especially Gastrioceratidae *s.l.*), strength of lingua and depth of hyponomic sinus (especially Reticuloceratidae *s.l.*). Overall shell shape is not so significant here.

The third principal component also separates faunas, but is especially notable for differentiating provinces - overseas faunas are frequently separated from British faunas by having strong positive values in this direction. The contribution of various characters to this component is, however, not so consistent over all families.

Comparison of successive faunas involves evolutionary considerations, and comparison of faunas in different provinces provides, in addition, stratigraphic information; these aspects are dealt with further in Chapters 6 and 7.

CHAPTER 5

SYSTEMATICS

5.1. INTRODUCTION

The use of a numerical methodology in this study has consequences not only with regard to the details of the taxonomic results produced, but also to the mode of presentation of these results. The attitude adopted here to the various aspects of systematic description are detailed below.

5.1.1. TAXA DESCRIBED

The only taxa described in detail here are those which are apparent in the results of the analyses given in Chapter 4. There are a few British taxa which escaped analysis by virtue of their rarity - only a brief account of these is given as they cannot be accorded the same objective status as analysed taxa.

Exclusively overseas taxa are not described here except for redefined genera and those morphospecies which yielded extensive data as a result of the author's visit to collections in Belgium and West Germany. Unless large collections of goniatite faunas have been studied by the author, then no statements as to the validity of morphospecies within those faunas can be made here.

5.1.2. SYNONYMY LISTS

Ideally, specimens would only be definitely included in the synonymy of a morphospecies if they could be shown to be a part of the appropriate cluster by analyses of the type described in Section 3.1.4. However, this is not often possible because of the uncertain accuracy of data derived from illustrations, and because it is too complicated a process to repeat for all the necessary specimens. Most synonymies have been established here either by the algorithm for identification described in Section 3.4., especially useful for difficult specimens, or by more subjective comparison of data, wherever the designation is fairly obvious.

Specimens which have been examined by the author are marked v.

Generic synonymies are established by the inclusion of type species in the clusters resulting from inter-specific analyses; these are explained in Section 4.2.5.

5.1.3. CHOICE OF HOLOTYPE

Where morphospecies have been recognised by this study which do not include any type specimens, then these require new names and a holotype must be designated. Previous authors have invariably regarded good preservation as an important criterion in choosing holotypes, but there is no necessary correlation between quality of preservation and typicality of form. The numerical approach of this study permits a genuine, definable concept of centrality or typicality of a specimen in a morphospecies, and this provides a criterion for choice of holotype which is independent of quality of preservation. The criteria used here in approximate order of importance are:

1. The specimen should be a member of the appropriate cluster in the results of the faunal analyses given in Section 4.1. Note that a fairly complete set of assessible characters is a prerequirement for

inclusion in these analyses.

2. The specimen should occupy a modal position within its cluster. Modality is essentially equivalent to typicality, and is here preferred to centrality (from the centroid or mean of a cluster) which need not be represented by specimens. Modal specimens occupy the densest part of a cluster.
3. The specimen should be well preserved, ie. it should show its features clearly.

Regrettably, existing holotypes must be retained whereever they fall within the range of a morphospecies, even though that morphospecies may be entirely redefined and the holotype may be atypical.

Numerical data of Holotypes of nearly all species/morphospecies mentioned here are to be found in Appendices 2, 3 & 4.

5.1.4. CHOICE OF SPECIMENS FOR ILLUSTRATION

Specimens illustrated in the plates have been chosen using the same criteria as dictated the choice of holotypes, only these have been applied less strictly. It is, therefore, not always the best preserved specimens that are illustrated, but all the relevant characters should be resolvable.

In addition, some specimens which do not fulfil the above criteria are illustrated in order to show features which are not apparent on other illustrations - particularly features of the later growth stages, which are often unanalysed.

All illustrated specimens are enlarged equally, for the sake of simplicity.

5.1.5. DESCRIPTIONS

A complete description of a goniatite morphospecies should include all characters at all ontogenetic stages.

This clearly involves a large amount of information; this can only be conveyed in words at excessive length, and this is quite impractical. In the past, authors have attempted description in prose, but these have always suffered from incompleteness and imprecision. At best, all descriptive terms used must be clearly defined, in which case the terms are merely imprecise substitutes for numerical values.

There has been a steady increase over the years in the amount of numerical data accompanying written descriptions, but these are usually restricted to general shell dimensions. Here the trend is continued to the extent that all character states at all growth stages are expressed numerically. It is contended here that, given such a complete numerical representation, written descriptions are superfluous. The notes accompanying the character value matrices in this chapter are intended only to summarise the general form of the morphospecies, particularly with regard to its position within the range of variation of its fauna, and to clarify occasional taxonomic difficulties.

All numerical values of external characters are means. Where these are derived from ontogenetic curves constructed from data output from analyses as described in Section 3.1.4, values of the matrix are enclosed in a box. Other values have been arrived at by ontogenetic extrapolation (< 5 mm diam.), are unanalysed characters, or are the result of averaging of measurements of a restricted number of well preserved specimens. An indication of the variation known for each analysed morphospecies can be found by referring to the data for the relevant clusters in Section 4.1. These data include standard deviations of each analysed character for each cluster.

Numerical values of characters of the suture line are derived from ontogenetic curves constructed from unanalysed data, and are only given where several specimens of a morphospecies yielded data. Sutural features do not vary a great deal within the genera treated in this study, and as they have been shown to be variable within morphospecies (Figure 11) they are probably best not used for specific identification. For this reason they are not illustrated here.

Line drawings of cross sections of specimens are a frequent accompaniment to goniatite descriptions - these are also not shown here. It is not practicable to prepare large numbers of sectioned specimens from each assemblage, and it is likely that individual preparations will not yield accurate data and may not be representative. Cross sections are, nevertheless, often the only means of obtaining information from the very early ontogenetic stages in association with the identifiable later stage. It is thought, though, that the information obtained by the methods adopted here for ontogenetic stages down to 5 mm diameter provides adequate account of early ontogeny.

5.1.6. THE PRACTICAL APPLICATION OF NUMERICAL DESCRIPTIONS - NOTES FOR USERS

The methodology used in this study is quite different from that used in orthodox palaeontology, and it is hoped that the approach will be adopted by subsequent workers in the field. Users of the systematic information in this thesis are particularly encouraged to regard goniatite morphology from a polythetic viewpoint; indeed, this is the only approach that can be used compatibly with the type of information given here. In addition, it will enable users to arrive at meaningful identifications without any previous knowledge or experience in the subject.

If possible, new specimens should be identified entirely objectively, as described in Section 3.4. Characters should be carefully and individually assessed (see Figure 8) and then compared with the appropriate data from the matrices of character values given here, using a suitable similarity coefficient and linkage algorithm. The increasing popularity of micro-computers renders this a feasible proposition, and the availability of excellent program packages means that this need not require any specialised statistical expertise.

If access to computing facilities is not possible, then a lesser degree of objectivity can be attained by mental comparison of data, considering similarity in each character equally. This is certainly preferable to visual comparison of specimens with illustrations, in which a few visually strong characters tend to dominate, regardless of their importance. Nevertheless, rough visual comparisons can succeed if new specimens are nearly identical to those illustrated, and may often be adequate in order to narrow down the field of possible designations of a new specimen.

To conclude, it is worth reiterating that it would be totally inappropriate to use the results of an objective methodology in a subjective manner.

5.2.	ORDER	GONIATITIDA Hyatt, 1884
	SUBORDER	GONIATITINA Hyatt, 1884
	SUPERFAMILY	GASTRIOCERATACEAE Hyatt, 1884
	FAMILY	HOMOCERATIDAE Spath, 1934

Characteristics

The principal components plot shown in Figure 57 gives an impression of the region of A-space occupied by the Homoceratidae, and from the histogram in Figure 55 can be derived the characters which particularly contribute to this position. These character states tend to be developed in the family but individually are not diagnostic. They are:

Shell shape	- usually involute and narrow, especially later growth stages.
Coarse ornament	- tubercles absent or weak, but strong ribbing often developed.
Fine ornament	- crenulation and spiral ornament weak, transverse ornament often quite widely spaced.
Apertural form	- hyponomic sinus and lingual projection both fairly weak, but umbilical projection sometimes developed.
Suture	- median saddle tall and wide at the expense of the lateral saddle. Both lateral and ventral lobes tend to develop a prominent prong.

Composition

The following genera can be included in this family:

Homoceras Hyatt, 1884 (incorporating _Isohomoceras_ Ruzhentsev & Bogoslovskaya, 1971, and _Fallacites_ R & B, 1971).

Vallites Ruzhentsev & Bogoslovskaya, 1971 (incorporating _Hodsonites_ Ramsbottom, 1977).

Bashkortoceras Ruzhentsev & Bogoslovskaya, 1971 (incorporating _Parahomoceras_ R & B, 1971, _Umbetoceras_ R & B, 1971).

Homoceratoides Bisat, 1924.

Bogdanoceras Ruzhentsev & Bogoslovskaya, 1971.

?_Gen_. _nov_.

Stratigraphic Distribution

Chokierian to Westphalian A

Genus **Homoceras** Hyatt, 1884

Ammonites: Beyrich, 1837 (pars.)

Goniatites: Brown, 1841 (pars.)

Glyphioceras: Karpinsky, 1889; Haug, 1898 (pars.); H. Schmidt, 1925 (pars.)

Isohomoceras: Ruzhentsev & Bogoslovskaya, 1978.

Homoceras: Hyatt, 1884; Bisat,1924 (pars.); H. Schmidt, 1925 (pars.); Delépine, 1941; Bisat & Hudson, 1943 (pars.); Patteisky, 1959 (pars.); Bouckaert, 1961 (pars.); Ruzhentsev & Bogoslovskaya, 1978 (pars.).

Type species: Goniatites smithii Brown, 1841, from H_{2a} zone at Millwood, near Todmorden, Yorkshire (see Opinion 1061, International Commission on Zoological Nomenclature).

Characteristics

The position in A-space of this genus is shown on Figure 39. The histograms on Figure 37 indicate that this position corresponds with possession of the following character states:

Shell shape	- variable, but mostly moderate for the family.
Coarse ornament	- some forms have bifurcating ribs, but more usually simple and featureless.
Fine ornament	- fairly widely spaced, crenulation and spiral ornament absent.
Apertural form	- most species lack apertural sinuosity.
Suture (Fig.54)	- normal Homoceratid.

Composition

H. smithii (Brown, 1841) (Goniatites), H. subglobosum Bisat, 1924, H. diadema (Beyrich, 1837) (Ammonites), H.undulatum (Brown, 1841) (Goniatites), H. eostriolatum Bisat,1928, H. divaricatum (Hind, 1905) (Glyphioceras), H. fortelirifer (Ramsbottom, 1958) (Homoceratoides), *H. asselicum* Ruzhentsev & Bogoslovskaya, 1978, *H. pamiricum* R & B, 1978, *H. inostranzewi* (Karpinsky, 1889) (*Glyphioceras*), *H. modestum* (R & B, 1971) (*Isohomoceras*), *H. portentosus* (R & B, 1971) (*Fallacites*), *H. artum* (R & B, 1971) (*Bashkortoceras*), *H. kugarchense* (R & B,1971) (*Bashkortoceras*), *H. ferganensis* (R & B, 1978) (*Homoceratoides*), *H. gibsoni* *sp. nov.*, *H. browni* *sp. nov.*, *H, parundulatum* *sp. nov.*.

Discussion

This genus is quite close in concept to *Isohomoceras*, of Ruzhentsev & Bogoslovskaya (1978), except that these authors use the monothetic criteria "absence of calyx stage" and "rounded umbilical margin" to distinguish *Isohomoceras* from type *Homoceras*. The taxonomic importance of a rounded umbilical margin is not confirmed by this study, and the validity of using the presence or absence of a calyx stage to differentiate the genera does not seem to be supported by Ruzhentsev & Bogoslovskaya's own illustrations - cross sections of species of "*Isohomoceras*" are shown which appear similar in early ontogeny to cross sections of species which they refer to *Homoceras*. When these characters are accorded the appropriate degree of taxonomic importance, the type species of *Homoceras*, *H. smithii* (Brown), is inseparable from the species referred in the past to *Isohomoceras*, so *Isohomoceras* must be included in the synonymy of *Homoceras*.

The inclusion here of higher Namurian species previously referred to *Homoceratoides* is the most tenuous element of this genus, as Figure 39 shows that these are indeed quite close to type *Homoceratoides*. However, the possession of coarse, bifurcating ribs, previously regarded as diagnostic of the latter genus, is here recognised to occur quite commonly in *Homoceras*, eg. *H. diadema*, and other characters confirm the affinity.

Stratigraphic Distribution

Chokierian to Westphalian A.

Homoceras subglobosum Bisat

Plate 1, 3 & 4

Homoceras striolatum var. *subglobosa* Bisat, 1924, p.110 (pars.).

Glyphioceras leodicense H. Schmidt, 1925, pl. xxiv, fig. 8.

v. *Homoceras leodicense* (Schmidt) Ramsbottom in Earp *et. al.* 1961, pl. xi, fig. 10.

v. *Homoceras subglobosum* Bisat; Ramsbottom in Earp *et. al.* 1961, pl. xi, fig. 13.

Lectotype: GSM 87319, chosen by Ramsbottom in Earp *et. al.*, 1961, p.207, from the *H. subglobosum* band at Gill Beck,Cowling, Yorkshire. For measurements, see Appendix 2, no. 5.

Stratigraphic Range: H_{1a} zone.

Code in Analyses: H1AC (Clusters Y1, Z3)

Matrix of Character values:

Diam	S	C	T	N	R	P	Du/De	W/Hw	Rl/Hw	Pl/Hw	Dg/Hw	Pg/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	.900	.100	19.0	8.00	1.00	.150	.370	2.00	1.00	.100	.020	0	.020	0	0
10	.900	.100	16.0	10.0	1.10	.270	.320	1.90	.950	.100	.028	.005	.020	.050	0
12.5	.900	.040	15.0	11.0	1.20	.500	.280	1.75	.850	.120	.032	.020	.020	.120	.003
15	.960	.020	13.0	12.0	1.60	.700	.260	1.55	.800	.100	.033	.024	.070	.200	.003
20															

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.140	.330	.280	.005	.190	.420	.020	.002	.030	.020	.002
15	.170	.350	.300	.010	.230	.380	.030	.001	.040	.020	.003
20	.190	.380	.330	.015	.260	.350	.040	0	.050	.020	.005

Discussion:

This morphosecies includes the more globose members of the H_{1a} zone fauna, and incorporates the uncommon subspherical young forms, such as specimen no. GSM 95364 (Plate I, 4), which have been referred to *H. leodicense* in the past. Specimens belonging to this morphospecies tend to have the strongest ornament amongst H_{1a} forms, and are more likely to show bifurcation of ribs.

The lectotype of *H. subglobosum* shows a markedly globose early ontogeny, which unfortunately does not agree with most of Bisat's original description; this forces *H. leodicense* (H. Schmidt) into junior synonymy.

Demanet (1941, pl. v, figs. 7-10) and Bouckaert (1961) both illustrate specimens named as *H. subglobosum* - these are ambiguous but may belong here.

Homoceras diadema (Beyrich)

Plate II, 1 & 2

Ammonites diadema Beyrich, 1837, pl. ii, figs.8, 9.

Glyphioceras beyrichianum var. *praematura* Haug, 1898, pl. i, figs. 12, 14, 23.

Homoceras beyrichianum (De Koninck) Patteisky, 1959, pl. ii, figs. 2, 9, 10, 12, 16, 17.

Holotype: The specimen figured by Beyrich (1837, pl. ii, figs. 8, 9) from the *B. beyrichianum* band at Chokier, Belgium. Measurements unobtainable due to poor illustration of holotype.

Stratigraphic Range: H_{1b} zone.

Code in Analyses: H1BA (Cluster Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	1.00	0	14.0	11.0	1.20	.500	.260		.850	.120	.002	.002	0	.080	.005
10	1.00	0	11.0	14.0	1.15	.600	.250		.820	.140	.013	.005	.030	.060	.005
12.5	1.00	.030	10.0	16.0	1.10	.600	.240		.780	.130	.020	.008	.070	.050	.003
15	1.00	.100	12.0	16.0	1.00	.400	.220		.700	.120	.025	.012	.110	.060	.002
20															

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.190	.280	.320	.090	.190	.430	.030	.003	.020	.020	.002
15	.210	.310	.330	.060	.260	.390	.035	.003	.030	.015	.004
20	.220	.340	.350	.030	.330	.340	.040	.001	.020	.015	.001

Discussion:

This morphospecies is fairly globose in shape, but is nevertheless the most discoidal, involute form in the H_{1b} zone assemblage. Bifurcation of ribs is often seen, but is only developed erratically.

Beyrich's (1837) illustration is not sufficiently clear to be certain, but it seems most likely that the type specimen of *H. diadema* is correctly assigned to this morphospecies.

Homoceras sp. aff. *diadema*

Plate II, 3.

Stratigraphic Range: H_{1b} zone.

Code in Analyses: H1BB (Cluster Z2)

Matrix of Character Values:

(See data for cluster H1BZ2, Section 4.1.1.)

Discussion:

This form is only represented by two poorly preserved specimens, and so a full systematic treatment is unjustified. Its most obvious feature is strong, bifurcating ornament on the flanks, otherwise it is similar to *H. diadema*.

The following are possibly equivalent:

Glyphioceras beyrichianum var. *irregularis* Haug, 1898, pl.i,fig. 8.
" " " *tenuistriata* " " " fig. 9.
" " " *biplex* " " " figs.13,19,20.
Homoceras diadema (Beyrich) Delépine, 1941, pl. i, figs. 10,11.
Homoceras beyrichianum (De Koninck) Patteisky, 1959, pl. ii, figs.8,16.

Homoceras smithii (Brown)

Plate II, 5, 6.

Goniatites smithii Brown, 1841, p. 218, pl. vii, figs. 34,35.

Homoceras diadema var. smithi (Brown) Bisat, 1924, pl. iv, figs. 3, 4.

Holotype: MM L10244, from the H. smithii band at Millwood, near Todmorden, Yorkshire. For measurements, see Appendix 2b.

Stratigraphic Range: H_{2a} zone.

Code in Analyses; H2AC & H2AD (Clusters X3, X4, Y1, Z1)

Matrices of Character Values:

H2AC

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Oh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5															
7.5	1.00	0	9.00		1.00	.200	.450	2.40	.950	.170	.040	0	.030	0	0
10	1.00	0	12.0		1.00	.400	.370	2.00	.910	.200	.040	0	.050	0	0
12.5	1.00	0	13.0		1.00	.550	.290	1.60	.830	.170	.030	.002	.080	.030	0
15	1.00	0	13.0		1.00	.700	.240	1.45	.800	.130	.010	.006	.120	.050	0
20															

H2AD

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Oh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5															
7.5	1.00	0	17.0		1.00	0	.520	2.20	.980	.120	.032	0	0	0	0
10	1.00	0	15.0		1.00	.200	.430	1.90	.950	.150	.032	0	.020	0	0
12.5	1.00	0	14.0		1.00	.500	.309	1.60	.870	.150	.023	.001	.050	.030	0
15	1.00	0	13.0		1.00	.700	.240	1.45	.800	.130	.010	.008	.100	.050	0
20															

Discussion:

Morphospecies H2AC and H2AD are here united under one name because: a) they are only distinct in one (H2AX) of three analyses; b) they are phenetically close and therefore difficult to distinguish in practice; c) the holotype of H. smithii cannot with certainty be attributed to one rather than the other.

H. smithii is more evolute than most other Homoceras species, and shows simple, distinctive ornament.

Homoceras browni sp. nov.

Plate II, 8.

Holotype: GSM Zi 4606, from the H. smithii band at the R. Aille, Phosphate Mine, Doolin, Co. Clare, Rep. of Ireland. For measurements, see Appendix 2, no. 47.

Stratigraphic Range: H_{2a} zone.

Code in Analyses: H2AA & H2AB. (Clusters X1, X2, Y2, Z2)

Matrices of Character Values:

H2AA	Diam	S	C	T	N	R	P	$\frac{Du}{De}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
	5															
	7.5	1.00	0	12.0	16.0	1.00	.500	.470	2.20	.990	.230	.050	0	0	.110	.009
	10	1.00	0	10.0	18.0	1.00	.400	.390	1.90	.940	.180	.030	0	.020	.090	.004
	12.5	1.00	0	9.00	21.0	1.00	.450	.330	1.65	.920	.180	.020	0	.020	.080	0
	15	1.00	0	8.00	23.0	1.00	.500	.280	1.50	.900	.200	.015	0	.010	.080	0
	20															

H2AB	Diam	S	C	T	N	R	P	$\frac{Du}{De}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
	5															
	7.5	1.00	0	17.0	21.0	1.00	.100	.460	2.30	.330	.260	.050	0	.040	.030	.008
	10	1.00	0	13.0	23.0	1.00	.300	.390	1.90	.900	.180	.030	0	.020	.075	.004
	12.5	1.00	0	10.0	26.0	1.00	.450	.330	1.65	.920	.180	.020	0	.015	.080	0
	15	1.00	0	8.00	29.0	1.00	.500	.280	1.50	.900	.200	.015	0	.015	.080	0
	20															

Discussion:

The two morphospecies H2AA and H2AB are both incorporated here for the same reasons as H2AC and H2AD in H. smithii. H. browni differs most from H. smithii in its tendency to possess a strong umbilical rim.

Homoceras gibsoni sp. nov.

Plate II, 7.

Homoceras cf. smithi H. Schmidt, 1925, pl. xxv, fig. 14.

Holotype: GSM Zi 4607x, from the H. smithii band at the River Aille, Phosphate mine, Doolin, Co. Clare, Rep. of Ireland. For measurements, see Appendix 2, no. 78.

Stratigraphic Range: H_{2a} zone.

Code in Analyses: H2AE (Clusters X5, Y3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	.350	.080	12.0		1.00	.200	.350	1.45	.850	.170	0	0	0	0	0
10	.980	0	18.0		1.00	.150	.240	1.30	.800	.050	.010	0	.120	0	0
12.5	1.00	0	22.0		1.00	.050	.150	1.20	.750	0	.022	0	.210	0	0
15	1.00	0	26.0		1.00	0	.120	1.10	.700	0	.030	0	.270	0	0
20															

Discussion:

A distinctly discoidal form - quite readily distinguishable from the much more common *H. smithii* & *H. browni*.

Homoceras undulatum (Brown)

Plate IV, 2, 3.

Goniatites undulatus Brown, 1841, p.213, pl. vii, figs. 1-4.

Homoceras diadema var. *undulatum* (Brown) Bisat, 1924, p. 105.

Homoceras undulatum (Brown) Bisat & Hudson, 1943, pl.xxvi, figs. 1, 2.

Holotype: MM L10241, from the *H. undulatum* band at Crosshills, Skipton, Yorkshire. For measurements, see Appendix 2b.

Stratigraphic Range: H_{2b} zone.

Code in Analyses: H2BC & H2BD (Clusters Y3, Z2, Z3)

Matrices of Character Values:

H2BC

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	1.00	0	17.0	14.0	1.10	.500	.290	1.80	.950	.150	.029	.018	0	.140	.010
10	1.00	0	15.0	14.0	1.20	.700	.280	1.65	.900	.100	.025	.021	.020	.140	.008
12.5	1.00	0	14.0	14.0	1.30	.800	.270	1.55	.850	.070	.025	.019	.060	.140	.006
15	1.00	0	13.0	14.0	1.40	.900	.260	1.40	.800	.050	.010	.009	.190	.120	.004
20															

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.230	.390	.350	.010	.290	.360	.030	.003	.030	.020	.002
15	.210	.420	.370	.040	.240	.380	.010	.001	.010	.030	.002
20	.250	.450	.390	.030	.220	.400	0	0	0	.010	0

H2BD

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	1.00	0	17.0	14.0	1.40	.500	.290	1.30	.950	.150	.020	.018	0	.140	.010
10	1.00	0	15.0	14.0	1.50	.700	.280	1.65	.900	.100	.025	.021	.020	.140	.008
12.5	1.00	0	14.0	14.0	1.55	.800	.270	1.50	.850	.070	.025	.021	.050	.140	.006
15	1.00	0	13.0	14.0	1.60	.800	.250	1.30	.800	.080	.020	.019	.140	.120	.004
20															

Discussion:

The two morphospecies H2BC and H2BD are here united in *H. undulatum* for the same reasons as were cited in the discussion of *H. smithii*. H_{2b} zone has less variation than any other Homoceratid fauna (see Fig. 40). *H. undulatum* is a rather typical member of the genus and,indeed, is morphologically central in the whole family.

Homoceras sp. aff. *undulatum*

Stratigraphic Range: H_{2b} zone.

Code in Analyses: H2BE (Cluster Y2)

Character Values: see data for cluster H2BY2 (Section 4.1.1.).

Discussion:

Incompletely known - only three specimens at one size range. Difficult to distinguish from other H_{2b} zone forms.

Homoceras parundulatum sp. nov.

Plate II, 1, 5.

Holotype: GSM Zi 4548 2076, from the *H. undulatum* band, River Aille, Doolin, Co. Clare, Rep. of Ireland. For measurements, see Appendix 2, no. 157.

Stratigraphic Range: H_{2b} zone.

Code in Analyses: H2BA (Clusters Y1, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	.380	0	14.0	14.0	1.00	.750	.400	2.20	.900	.200	.025	0	.010	.090	.010
10	1.00	.050	14.0	15.0	1.00	.800	.340	1.90	.850	.150	.013	0	.040	.080	.010
12.5	1.00	0	14.0	16.0	1.00	.800	.290	1.70	.820	.100	.010	.002	.070	.050	.005
15	1.00	0	13.0	19.0	1.05	.850	.260	1.50	.780	.100	.007	.001	.120	.030	0
20															

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.190	.360	.310	.010	.270	.380	.030	.002	.030	.020	.003
15	.210	.310	.330	.020	.320	.330	.030	.003	.010	.010	.002
20	.230	.270	.340	0	.370	.290	.030	.002	0	0	0

Discussion:

Generally more evolute and less discoidal than *H. undulatum*, and with simpler ornament - less likely to show bifurcating ribs.

Homoceras sp. aff. *parundulatum*

Plate II, 4.

Stratigraphic Range: H_{2b} zone.

Code in Analyses: H2BB (Clusters Y4, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	.980	0	16.0	24.0	1.00	.100	.311	1.750	.900	.120	.055	.002	.050	.090	.010
10	1.00	.050	16.0	24.0	1.00	.300	.280	1.50	.850	.030	.040	.004	.090	.080	.010
12.5	1.00	0	16.0	24.0	1.10	.500	.250	1.40	.820	.070	.030	.006	.120	.050	.005
15	1.00	0	15.0	26.0	1.10	.600	.220	1.30	.780	.080	.025	.005	.160	.030	0
20															

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.190	.350	.360	.010	.250	.390	.030	.002	.025	.020	.007
15	.230	.340	.380	.040	.280	.350	.030	.003	.020	.020	.008
20	.250	.320	.400	.030	.320	.320	.030	.002	.010	.020	.006

Discussion:

Only analytically separable from *H. parundulatum* at one size range, at which it is represented by two specimens (cluster H2BY4). Difficult to distinguish in practice.

Homoceras eostriolatum Bisat

Plate IV, 6.

Homoceras striolatum (Phillips) Bisat, 1924, pl. vii, figs. 6-9(pars.).

Homoceras eostriolatum Bisat, 1928, p. 131.

Homoceras eostriolatum Bisat; Bisat & Hudson, 1943, pl. xxv, fig. 3.

Vallites eostriolatum (Bisat) Ramsbottom, 1977, p. 288.

Lectotype: BM C25748, from the *H. eostriolatum* band at Pendle Water, east of Rough Lee, Forest of Pendle, Lancashire. For measurements, see Appendix 2b.

Stratigraphic Range: H_{2c} zone.

Code in Analyses: H2CC (Clusters Y3, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	1.00	0	17.0	15.0	1.10	.200	.250	1.40	.870	0	0	0	.050	.070	.003
10	1.00	0	13.0	12.0	1.10	.400	.260	1.30	.820	0	0	0	.080	.080	0
12.5	1.00	0	8.00	5.00	1.00	.500	.300	1.25	.750	.050	0	0	.110	.170	0
15	1.00	0	6.00	4.00	1.00	.400	.310	1.20	.700	.050	0	0	.150	.200	0
20															

Discussion:

Previously placed in Vallites on the basis of its slightly raised umbilical rim, but this character is here shown to be also common in Homoceras. In all respects it is quite typical of Homoceras, and is the only member of the genus in H_{2c} zone.

Homoceras divaricatum (Hind)

Plate VI, 6.

Glyphioceras divaricatum Hind, 1905, pl. vi, fig. 6.

Glyphioceras divaricatum Hind, 1918, pl. xvi, figs. 2-6.

Homoceratoides divaricatum (Hind) Bisat, 1924, p. 113.

Homoceratoides complanatum Delépine, 1941, pl. vii, fig. 9.

Homoceratoides divaricatum Demanet, 1943, pl. v, figs. 22, 23.

Holotype: The specimen figured by Hind (1905, pl. vi, fig. 6) from the Upper Namurian, Rep. of Ireland. For measurements see Appendix 2b.

Stratigraphic Range: R_{1b} to Westphalian A.

Code in Analyses: HR1BD (Clusters Y2, Z4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	.800	.050	15.0	6.00	2.80	1.00	.290		.750	.050	.010	.016	.140	.330	.020
10	.800	.100	13.0	6.50	2.60	1.00	.220		.700	.050	.010	.025	.120	.270	.010
12.5	.870	0	9.00	8.00	2.20	.950	.170		.850	.050	.007	.017	.110	.120	.005
15	.950	0	7.00	9.00	1.80	.900	.120		.930	.050	.005	0	.080	0	0
20															

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.190	.380	.330	.030	.220	.400	.020	0	.040	.020	.001
15	.130	.430	.400	.050	.210	.420	.010	.002	.060	.030	0
20	.180	.490	.480	.080	.200	.430	.010	.002	.070	.040	0

Discussion:

This form becomes extremely involute and discoidal and has very characteristic sinuous ribbing on the flanks, forming pronounced ocular and hyponomic sinuses, in later ontogeny.

H. divaricatum is not analysed on Figure 35, due to an incomplete character set; it is here included in Homoceras rather than Homoceratoides because its nearest neighbour in the A-space of the Figure 36 analysis is a member of the Homoceras cluster (code HR1CGA). Its inclusion here is, nevertheles, marginal.

Specimens allocatable to this morphospecies occur occasionally in most marine horizons from R_{1b} to G_2 zones. Unfortunately, it is particularly rare in the size ranges analysed and does not contribute to any clusters in the R_{1c} to G zone analysis. The many larger specimens known from this interval can only tentatively be included in this morphospecies. The morphospecies HR1CGC is dominated by specimens referred to Homoceratoides kitchini (Bisat, 1929) which is now referred to Politoceras on the basis of sutural characters; this morphospecies is therefore not further considered here.

Homoceras fortelirifer (Ramsbottom)

Plate VI, 7, 8.

v. Homoceratoides fortelirifer Ramsbottom, 1958, pl. 11, figs. 1-8.

Holotype: GSM Zh 563, from the B. superbilingue horizon at Pears House Clough, south end of Strines Reservoir, Sugworth, Yorkshire. For measurements, see Appendix 2, no. 370.

Stratigraphic Range: R_{2c} zone.

Code in Analyses: HR1CGA (Cluster Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	1.00	0	10.0	5.00	1.40	1.00	.290	1.20	.700	.080	.040	.013	.120	.290	.012
10	1.00	0	10.0	7.00	1.50	1.00	.270	1.10	.700	.080	.030	.015	.140	.180	.010
12.5	.980	0	10.0	10.0	1.60	.900	.240	1.05	.680	.100	.020	.003	.160	.110	.002
15	.960	.050	9.00	10.0	1.80	.900	.220	1.00	.680	.080	.020	.004	.170	.140	.008
20															

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.120	.300	.300	.020	.250	.400	.020	.002	.010	.010	.001
15	.180	.340	.350	.030	.300	.370	.030	.003	.010	.010	.002
20	.220	.360	.400	.050	.360	.320	.030	.005	.020	.015	.002

Discussion:

This morphospecies clusters on Figure 35 with *Homoceras*, but Figure 39 shows it to be intermediate between this genus and *Homoceratoides*. Its coarse bifurcating ornament placed it in *Homoceratoides* in the original description; this combination of characters is allowed in *Homoceras* in the present analysis and overall resemblance is to unambiguous *Homoceras* forms.

Genus Vallites Ruzhentsev and Bogoslovskaya, 1971

Goniatites: Phillips, 1836 (pars.)

Glyphioceras: Haug, 1898 (pars.)

Eumorphoceras: H. Schmidt, 1925 (pars.)

Homoceras: Bisat, 1924 (pars.); H. Schmidt, 1934; Demanet, 1941 (pars.); Bisat & Hudson, 1943 (pars.); Stubblefield in Stephens et al., 1953 (pars.); Hodson, 1957; Patteisky, 1959 (pars.); Bouckaert, 1961 (pars.).

Homoceratoides: Schmidt, 1933; Bisat & Hudson, 1943 (pars.); Bouckaert, 1961 (pars.); Ruzhentsev & Bogoslovskaya, 1978 (pars.); Popov, 1979 (pars.).

Hodsonites: Ramsbottom, 1977.

Isohomoceras: Ruzhentsev & Bogoslovskaya, 1978 (pars.).

Vallites: Ruzhentsev & Bogoslovskaya, 1971; R & B, 1978.

Type species: Homoceras henkei H. Schmidt, 1934, from R_{1a} zone, Gerlingsen, West Germany.

Characteristics

The position in A-space of this genus is shown on Figure 39. The histogram on Figure 37 indicate that this position corresponds with possession of the following character states:

Shell shape - mostly involute and discoidal.

Coarse ornament - ribbing not usually present, but there are a variety of structures on the umbilical margin.

Fine ornament - striae spaced closer than in other Homoceratids; some species develop crenulation and associated spirals.

Apertural form - a strong hyponomic sinus, and some species develop pronounced sinuosity on the flanks.

Suture - this genus has lower lobes and saddles than other Homoceratids, and the lateral saddle is wide, at the expense of the median saddle. The lobes tend not to have strong prongs. (Information from Fig. 54).

Composition

V. henkei (H.Schmidt, 1934) (*Homoceras*), *V. magistrorum* (Hodson, 1957) (*Homoceras*), *V. striolatum* (Phillips,1836) (*Goniatites*), *V. varicatum* (Schmidt, 1933) (*Homoceratoides*), *V. mutabile* (Bisat & Hudson, 1943) (*Homoceratoides*), *V. praematurum* (Haug, 1898) (*Glyphioceras*), *V. demaneti* (Bouckaert, 1961) (*Homoceratoides*), *V. schmidti* Ruzhentsev & Bogoslovskaya, 1971, *V. librovitchi* (R & B,1978) (*Homoceratoides*), *V. kalmiusi* (Popov, 1979) (*Homoceratoides*), *V. submagistrorum sp. nov.*, *V. gillense sp. nov.*, *V. lancastria sp. nov.*.

Discussion

Best recognised, not by a crenulate umbilical rim as cited in the type description, but by being the most involute, discoidal and finely ornamented of the Homoceratidae.

Stratigraphic Distribution

Chokierian, topmost Alportian and Kinderscoutian (H_1, H_{2c}, R_{1a}, R_{1b}).

Vallites lancastria sp. nov.

Plate I, 1,2,5,6.

Homoceras striolatum var. *subglobosa* Bisat, 1924, p. 110 (pars.)

Homoceras subglobosum Bisat; Patteisky, 1959, pl. ii, fig. 1.

Holotype: GSM 82854, from the *H. subglobosum* band at Samlesbury Bottoms, Lancashire. For measurements, see Appendix 2, no. 16.

Stratigraphic Range: H_{1a} zone.

Code in Analyses: H1AA (Clusters Y3, Z2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Oh/Hw	Lt/Hw	Ht/Hw
5															
7.5	.930	0	34.0	6.00	2.00	0	.150	1.70	.800	.030	.010	0	0	.150	.010
10	.900	.020	24.0	6.00	1.70	.200	.160	1.50	.800	.030	.010	.002	.060	.130	.010
12.5	.980	.080	15.0	6.00	1.30	.400	.160	1.30	.800	.050	.012	.009	.140	.110	.010
15	1.00	0	12.0	6.00	1.10	.300	.160	1.20	.780	.080	.025	.016	.210	.090	.010
20															

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.200	.370	.340	.030	.190	.400	.015	0	.020	.010	.001
15	.200	.400	.390	.030	.260	.360	.020	.001	.030	.015	.004
20	.200	.420	.430	0	.330	.320	.025	0	.035	.020	.006

Discussion:

This is the commonest form in H_{1a} zone and is fairly central with respect to the range of variation in the fauna. It possesses, when young, a slight umbilical ridge, which may be divided into perceptible tubercles. The slight umbilical structures visible on specimen no. GSM 82852 (Plate I, 1) are not normal at this size.

Much of Bisat's (1924) description of *H. striolatum* var. *subglobosa* seems to apply to this morphospecies. Although quite close to typical *Homoceras*, the shell shape and fine ornament place it in *Vallites*.

Vallites gillense sp. nov.

Plate I, 7.

Holotype: GSM 59999, from the *H. subglobosum* band at Fairborough Wood, Cliffe Park Station, Staffordshire. For measurements, see Appendix 2, no. 25.

Stratigraphic Range: H_{1a} zone.

Code in Analyses: H1AB (Clusters Y2, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	.970	0	28.0		1.00	0	.200	1.40	.800	.020	.005	0	.020	0	0
10	.920	.100	23.0		1.00	.130	.170	1.40	.790	.060	.023	.007	.050	0	0
12.5	.900	.100	20.0		1.00	.400	.160	1.20	.790	.100	.030	.005	.100	0	0
15	.950	.100	18.0		1.00	.250	.160	1.15	.770	.120	.030	.010	.120	0	0
20															

Discussion:

This is the most extremely discoidal member of the fauna. It is more likely than other H_{1a} zone forms to show crenulation and spiral ornament, albeit slight, but it is particularly notable for its lack of structure on the umbilical margin. This is quite a rare form, but it shows a clear similarity with type *Vallites*.

Vallites magistrorum (Hodson)

Plate V, 2, 3.

v. *Homoceras sp. nov.* A. Stubblefield in Stephens *et al.* 1953, pl. vii, fig. 7.

v. *Homoceras magistrorum* Hodson, 1957, pl.C, fig.1; pl.D, figs.2,3,6 (pars.)

Homoceras magistrorum Hodson; Patteisky, 1959, pl. 5, fig. 1.

Hodsonites magistrorum (Hodson) Ramsbottom, 1977, p. 288.

Holotype: GSM 86909, from the *V. magistrorum* band at River Aille, near Lisdoonvarna, Co. Clare, Rep. of Ireland. For measurements, see Appendix 2, no. 195.

Stratigraphic Range: R_{1a1} zone.

Code in Analyses: HR1AC (Clusters X1, Y4, Z2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Oh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5															
7.5	.800	.100	30.0	7.50	1.10	.250	.320	1.55	.900	.080	.020	.007	.060	.100	.020
10	.950	.080	21.0	8.50	1.15	.200	.291	1.35	.350	.090	.030	.021	.080	.170	.020
12.5	1.00	.050	18.0	7.00	1.10	.100	.250	1.20	.800	.050	.025	.024	.090	.110	.015
15	1.00	.020	17.5	6.00	1.10	.050	.220	1.15	.700	.020	.015	.021	.095	.070	.010
20															

Discussion:

Ramsbottom (1977) placed this species in a new genus on the basis of presence of bifurcation and intercalation of striae. These are monothetic criteria which are not confirmed as important here. *V. magistrorum* differs from the type *Vallites* in being stouter and in possessing quite widely spaced plications at the umbilical edge when young, with little sign of associated crenulation. In *V. henkei*, these plications are so closely spaced as to form an umbilical ridge, which is crenulate. Bifurcation and intercalation of striae in *V. magistrorum* may simply be the consequence of wide spacing of plications.

Vallites sp. aff. *magistrorum*

Plate V, 1.

v. *Homoceras magistrorum* Hodson, 1957, pl. D , fig. 6 .

Stratigraphic Range: R_{1a1} zone

Code in Analyses: HR1AF (Cluster Z1)

Character Values: see data for cluster HR1AZ1 (Section 4.1.1.).

Discussion:

Only represented by one specimen. Generally like *V. magistrorum* but more evolute, broad and coarsely ornamented.

Vallites submagistrorum sp. nov.

Plate V, 4.

v. *Homoceras magistrorum* Hodson, 1957, pl. D, 5.

Holotype: GSM 71452, from the *V. magistrorum* band at Backstone Beck, Ilkley, Yorkshire. For measurements, see Appendix 2, no. 189.

Stratigraphic Range: R_{1a1} zone

Code in Analysis: HR1AD (Clusters Y3, Z5)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	1.00	.100	14.0	18.0	1.00	.600	.220	1.20	.800	.300	.050	.003	.230	.120	.010
10	1.00	.100	15.0	16.0	1.00	.500	.200	1.10	.750	.230	.045	.015	.290	.100	.010
12.5	.950	.100	17.0	10.0	1.10	.200	.180	1.05	.750	.150	.040	.022	.350	.090	.005
15	.900	.100	18.0	6.00	1.05	.100	.160	1.00	.730	.100	.045	.025	.380	.070	.002
20															

Discussion:

This morphospecies is found in association with *V. magistrorum*, and the range of variation between the two may well be continuous; nevertheless they do form significantly separate clusters. *V. submagistrorum* has approximately the same ornament as *V. magistrorum*, and approximately the same involute, discoidal shape as *V. henkei*.

Vallites henkei (Schmidt)

Plate IV, 7, 8.

Eumorphoceras subreticulatum Schmidt, 1925, pl. xxv, figs. 4,5,6.

Homoceras henkei Schmidt, 1934, p. 456.

v. Homoceras henkei Schmidt; Bisat & Hudson 1943, pl. xxv,figs. 5,7.

v. Homoceras aff. eostriolatum Bisat & Hudson 1943, pl. xxv, fig. 6.

v. Homoceras henkei Schmidt; Stubblefield in Stephens et al., 1953, pl. vi, fig. 9.

v. Homoceras henkei Schmidt; Hodson, 1957, pl. C, 2; pl. E, 4, 5.

Homoceras henkei Schmidt; Patteisky, 1959, pl.i, 23.

Homoceras henkei Schmidt; Bouckaert, 1961.

Vallites henkei (Schmidt), Ruzhentsev & Bogoslovskaya, 1971.

Vallites henkei (Schmidt); R & B, 1978, pl. xiv, figs. 8-10.

Holotype: The specimen illustrated by H. Schmidt (1925, pl. xxv, fig.4) from R_{1a} zone, Gerlingsen, W. Germany.

Stratigraphic Range: R_{1a} and topmost H_{2c} zones.

Code in analyses: HR1AE (Clusters Y3, Z6)

Matrix of Character Values:

		S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
Diam	5															
	7.5	1.00	.100	14.0	19.0	1.00	.600	.220	1.40	.830	.300	.050	.003	.160	.140	.010
	10	1.00	.050	15.0	17.0	1.00	.500	.200	1.30	.800	.230	.045	.007	.200	.130	.010
	12.5	1.00	.020	16.0	16.0	1.00	.200	.190	1.25	.800	.150	.045	.009	.220	.110	.005
	15	1.00	0	16.0	16.0	1.00	.200	.170	1.15	.800	.150	.055	.010	.250	.090	.002
	20															

		a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
Diam	10	.070	.210	.240	.040	.200	.390	.010	0	.020	.020	0
	15	.090	.250	.260	.030	.210	.380	.020	0	.010	.030	0
	20	.110	.290	.290	.010	.230	.370	.020	0	.010	.030	0

Discussion:

This morphospecies is involute and discoidal with sinuous simple ornament on the flanks and venter. The most notable feature, however, is the ornamentation on the umbilical shoulder, which takes the form of a crenulate spiral ridge. This feature is maximally developed in this morphospecies, and it is therefore not diagnostic or typical of the genus.

Vallites sp. aff. henkei

Stratigraphic Range: R_{1a} zone.

Code in Analyses: HR1AG (Cluster X3)

Character Values: see data for cluster HR1AX3 (Section 4.1.1).

Discussion:

This form is represented by a few poorly preserved specimens (GSM EWJ 3460, 3442 & 3437) from the Knott Copy borehole, near Settle, Yorkshire. It is particularly notable for its extremely tight umbilicus, even in smallspecimens; otherwise it seems to resemble V. henkei.

Vallites mutabile (Bisat & Hudson)

Plate IV, 9; V, 8.

v. Homoceratoides mutabile Bisat & Hudson, 1943, pl. xxv, fig. 2.

Holotype: GSM SH 3256, from R_{1a1} zone, Lumbutts Clough, Woodhouse, Todmorden, Yorkshire. For measurements, see Appendix 2, no. 345.

Stratigraphic Range: R_{1a} zone.

Code in Analyses: HR1AA (Clusters X2, Y1, Z3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	.880	.050	13.0	14.0	1.05	.150	.260	1.40	.830	.120	.015	.013	.040	.100	.010
10	.900	.120	22.0	12.0	1.10	.200	.220	1.25	.750	.070	.018	.010	.120	.120	.005
12.5	.900	.100	20.0	10.0	1.10	.150	.180	1.15	.730	.060	.020	.007	.200	.080	.005
15	.900	.080	18.0	9.00	1.10	.120	.160	1.10	.730	.060	.022	.008	.290	.080	.008
20															

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.190	.300	.320	.030	.220	.400	.030	0	.030	.030	.002
15	.220	.350	.370	.040	.240	.390	.030	0	.020	.020	.002
20	.210	.350	.340	.050	.240	.340	.020	.001	.010	.010	.002

Discussion:

This morphospecies appears to have few characters which justify its original inclusion in Homoceratoides. It shows typical Vallites ornament with a low umbilical ridge divided into short plications or nodes.

Vallites varicatum (H. Schmidt)

Plate V, 5, 6.

Homoceratoides varicatum H. Schmidt, 1933, figs. 73, 74.

Homoceratoides varicatum H. Schmidt; Bisat & Hudson, 1943, pl.xxv,fig.1

Homoceratoides varicatus H. Schmidt; Hodson, 1957, pl. E, 1,2,3.

Homoceratoides varicatus H. Schmidt; Bouckaert, 1961.

Holotype: The specimen figured by H. Schmidt (1933, fig. 73) from R_{1a1} zone, east of Neheim, near Arnsberg, W. Germany. For measurements, see Appendix 2b.

Stratigraphic Range: R_{1a} zone.

Code in Analyses: HR1AB (Clusters X4, Y2, Z4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5															
7.5	1.00	.100	30.0	9.50	2.00	.400	.350	1.30	.830	.150	.030	.002	.080	.410	.025
10	.350	0	30.0	11.0	1.20	.200	.240	1.20	.790	.150	.015	.018	.120	.380	.010
12.5	1.00	0	28.0	11.0	1.00	.150	.200	1.10	.750	.170	.015	.011	.130	.280	.005
15	1.00	0	26.0	7.00	1.00	.200	.190	1.00	.720	.200	.021	.003	.150	.170	.005
20															

Discussion:

V. varicatum shows typical Vallites characters, except its distinctive long bifurcating plications, which are not sufficient to justify inclusion in Homoceratoides.

Vallites sp. aff. varicatum

Plate V, 7.

Stratigraphic Range: ?R_{1b} zone.

Code in analyses: HR1BB (Clusters X3, Y1, Z3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5															
7.5	.300	.150	24.0	9.00	1.55	.400	.270	1.30	.820	.050	.015	.001	.060	.280	.010
10	.800	.130	20.0	9.00	1.35	.350	.240	1.15	.780	.080	.020	.002	.130	.180	.005
12:5	.850	.120	18.0	9.00	1.30	.250	.210	.900	.760	.070	.018	.003	.170	.170	.003
15	.900	.080	17.0	3.50	1.35	.150	.180	.750	.740	.060	.015	.005	.200	.210	.003
20															

Discussion:

This morphospecies is composed of specimens from a locality in Ireland which are doubtfully attributed to R_{1b} zone; a R_{1a} age now seems more likely. This uncertainty prohibits confidence as to its status.

Vallites striolatum (Phillips)

Plate VI, 1, 2.

Goniatites striolatus Phillips, 1836, pl. xix, figs. 15-18.

Glyphioceras striolatum (Phillips) Haug, 1898, pl. i, figs. 26,27.

Homoceras striolatum (Phillips) Bisat, 1924, pp. 107,108 (pars.)

Homoceras striolatum (Phillips) Demanet, 1941, pl. xvii, fig. 9.

Homoceras striolatum (Phillips) Bisat & Hudson, 1943, pl.xxvii,fig.1.

Homoceras moorei Bouckaert, 1961.

Homoceras striolatum (Phillips) Bouckaert, 1961.

Vallites striolatum (Phillips) Ramsbottom, 1977, p. 288.

Lectosyntypes: The specimens illustrated by Phillips (1836, pl. xix, figs. 14-18) from R_{1b} zone, Kulkeagh, near Enniskillen, Rep. of Ireland. For measurements, see Appendix 2b.

Stratigraphic Range: R_{1b} zone.

Code in Analyses: HR1BA (Clusters X1, Y3, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
6															
7.5	.850	.100	30.0	25.0	1.00	.150	.230	1.40	.830	.030	.005	0	.059	.050	.004
10	.820	.150	26.0	25.0	1.00	.120	.190	1.30	.780	.030	.010	.003	.080	.060	.003
12.5	.850	.200	24.0	22.5	1.00	.080	.170	1.20	.760	.020	.020	.011	.130	.050	.002
15	.880	.180	21.0	21.0	1.00	.080	.140	1.10	.740	.030	.028	.022	.130	.060	.001
20															

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.170	.310	.250	0	.210	.390	.010	0	.040	.035	0
15	.180	.320	.260	.030	.230	.390	.020	0	.035	.025	0
20	.190	.330	.280	.060	.240	.390	.025	.001	.030	.020	.001

Discussion:

V. striolatum differs from species of Vallites in R_{1a} zone by showing more consistent crenulation on the umbilical margin, when preservation allows, and by having a less prominent umbilical rim.

Cluster HR1BZ1 includes one specimen (no. 87, Plate VI,5) which has been included in Homoceras spiraloides Bisat & Hudson. Although this specimen, the holotype, cannot be separated on this evidence from V. striolatum, nevertheless Figure 20 shows two other specimens referred to H. spiraloides (nos. 245 & 88, Plate VI,4) plotting distant from V. striolatum. These specimens were not included in cluster analyses, being too large, so their significance is not known. It seems likely, though, that H. spiraloides is distinct from V. striolatum but is poorly founded.

Vallites sp. aff. striolatum

Plate VI, 3.

Stratigraphic Range: R_{1b} zone.

Code in Analyses: HR1BC (Clusters X2, Z2)

Matrix of Character Values:

Diam mm	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	1.00	0	30.0		1.00	0	.100	1.10	.750	.070	.026	.020	.240	0	0
10	.350	.030	30.0	6.00	1.00	0	.110	1.050	.650	.100	.028	.021	.310	.010	0
12.5	.950	.080	30.0	6.50	1.00	0	.110	1.00	.620	.150	.030	.022	.370	.040	0
15	.900	.070	30.0	7.00	1.00	.200	.130	1.10	.600	.180	.035	.022	.410	.070	.002
20															

Discussion:

Only known with certainty from two poorly preserved specimens. Apparently much more smoothly ornamented than V. striolatum.

Genus Bogdanoceras Ruzhentsev & Bogoslovskaya, 1971.

Goniatites: De Koninck, 1843 (pars.)

Glyphioceras: Haug, 1898 (pars.)

Homoceras: H. Schmidt, 1924 (pars.); Delepine, 1941 (pars.); Patteisky, 1959 (pars.); Ruzhentsev & Bogoslovskaya, 1971 (pars.), 1978 (pars.)

Bogdanoceras: Ruzhentsev & Bogoslovskaya, 1971, 1978.

Type species: Bogdanoceras bifurcum Ruzhentsev & Bogoslovskaya, 1971, from Nm_2b_1 and Nm_2b_2 zones of the Southern Urals.

Characteristics

The position in A-space of this genus is shown on Figure 39. The histograms on Figure 37 indicate that this position corresponds with possession of the following character states:

Shell shape	- includes the most evolute and broad Homoceratids.
Coarse ornament	- some forms have tubercles, and strong ribbing is more likely to be developed than in other genera, sometimes showing strong bifurcation.
Fine ornament	- striae quite widely spaced.
Apertural form	- lingua and ocular sinus usually strong, but hyponomic sinus particularly weak.
Suture	- lobes and saddles are particularly tall compared to other Homoceratids, and the median saddle is wide. The lobes tend to have terminal prongs. (From Fig.54).

Composition

B. bifurcum Ruzhentsev & Bogoslovskaya, 1971; B. beyrichianum (De Koninck, 1843) (Goniatites); B. haugi (R & B, 1978) (Homoceras).

Discussion

An extreme and aberrant group amongst Homoceratids. Ruzhentsev and Bogoslovskaya (1978) appear to have overlooked the similarity between B. bifurcum and B haugi astrictum, which they place in different genera.

Stratigraphic Distribution

Chokierian (H_{1b}) and Kinderscoutian (R_1) in the U.S.S.R.

Bogdanoceras beyrichianum (De Koninck)

Plate II, 4.

Goniatites beyrichianum De Koninck, 1843.

Glyphioceras beyrichianum var. *crenata* Haug, 1898, pl. i, figs. 1, 4, 5, 17, 18.

Glyphioceras beyrichianum var. *coronata* Haug, 1898, pl. i, figs. 2, 15, 16.

Homoceras beyrichianum (De Koninck), H. Schmidt, 1924, pl. xxv, fig.1.

Homoceras beyrichianum (De Koninck), Patteisky, 1959, pl. ii, fig. 3 (pars.).

Homoceras coronatum coronatum (Haug), Ruzhentsev & Bogoslovskaya, 1978, pl. xv, figs. 1, 2, 3.

Homoceras coronatum nudum (Haug), Ruzhentsev & Bogoslovskaya, 1978, pl. xvi, figs. 1, 2.

Lectotype: The specimen figured by Haug (1898, pl. i, fig. 2), from the *B. beyrichianum* band near Liege, Belgium. For measurements, see Appendix 2b.

Stratigraphic Range: H_{1b} zone.

Code in Analyses: H1BC (Cluster Z3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	1.00	0	7.00	11.5	1.00	.800	.480	2.35	.900	.650	.030	0	0	.110	.035
10	1.00	0	6.00	13.0	1.00	.900	.480	2.20	.910	.680	.040	0	0	.090	.025
12.5	1.00	0	8.00	14.0	1.00	1.00	.470	2.05	.960	.730	.045	.001	0	.080	.015
15	1.00	0	10.0	16.0	1.00	.800	.450	1.90	1.00	.750	.040	.001	0	.060	.005
20															

Discussion:

This morphospecies is quite evolute and coronate, and is remarkable in that, for much of its ontogeny, it has no hyponomic sinus, and the ribs arch forward to what is, in effect, a lingua situated on the venter. This is quite different from the apertural form of *Homoceras* species.

As Haug (1898) and Ruzhentsev & Bogoslovskaya (1978) illustrate, this morphosecies is highly variable and its limits are difficult to define. It may incorporate the two species here referred to ?*Gen*. *nov*., both of which differ in possessing ventral grooves. Analysis using larger samples than were available here may result in a refinement of the taxonomic divisions in this fauna.

Genus Homoceratoides Bisat, 1924.

Homoceratoides: Bisat, 1924

Type species: Homoceratoides prereticulatum Bisat, 1924, from H_{2c} zone, Holden Beck, Silsden, Yorkshire.

Characteristics:

The position in A-space of this genus is shown on Figure 39. The histograms on Figure 37 indicate that this position crresponds with possession of the following character states:

Shell shape	- average Homoceratid.
Coarse ornament	- strong bifurcating ribs and plications.
Fine ornament	- may show faint crenulation and spirals.
Apertural form	- strong lingua and hyponomic sinus notable even in small specimens.
Suture	- lateral saddle narrower than most Homoceratids; all lobes and saddles tend to become particularly tall in later ontogeny. The lateral lobe tends to be inflated. (Information from Fig. 54.)

Composition

Htd. prereticulatum Bisat, 1924; Htd. doolinense sp. nov.

Discussion

The present analysis restricts the genus to the distinctive forms in H_{2c} zone - no other species previously allocated to Homoceratoides has comparable early growth stages. Attention is drawn, however, to similarities with Russian species of Brevikites, unanalysed here. This demands further study.

Stratigraphic Distribution

Topmost Alportian (H_{2c} zone).

Homoceratoides prereticulatum Bisat

Plate IV, 1, 3, 4.

Homoceratoides prereticulatum Bisat, 1924, pl. 1, fig. 3.

Lectotype: BM C25749, from H_{2c} zone, Holden Beck, Silsden, Yorkshire.

For measurements, see Appendix 2b.

Stratigraphic Range: H_{2c} zone.

Code in Analyses: H2CB (Clusters Y2, Z3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5															
7.5	.920	.120	24.0	8.00	2.30	.600	.350	1.40	.850	.380	.050	.004	.130	.260	.030
10	.980	.150	18.0	8.00	2.10	.700	.340	1.30	.800	.350	.050	.005	.170	.280	.030
12.5	1.00	.080	13.0	9.00	1.90	.700	.270	1.15	.770	.180	.050	.004	.200	.280	.020
15	1.00	0	12.0	11.0	1.80	.500	.170	.950	.700	.050	.040	.003	.210	.230	0
20															

Discussion:

The distinctive ribbing, with prominent furcations, of the young specimens make the H_{2c} zone species quite distinct from Homoceratid forms from other horizons. Within this fauna, however, two morphospecies of Homoceratoides are recognised in the cluster analysis. Htd. prereticulatum differs from Htd. doolinense by having finer ornament and by being slightly more involute, although these differences are only clear on young specimens. Most published illustrations referred to this species, for example those of Bouckaert (1961), are of poorly preserved, older specimens and cannot be definately allocated to one or other morphospecies.

Homoceratoides doolinense sp. nov.

Plate IV, 2, 5.

Holotype: GSM LZ3035 G, from the Htd. prereticulatum band at Phosphate Mine, River Aille, Doolin, Co. Clare, Rep. of Ireland. For measurements, see Appendix 2, no. 332.

Stratigraphic Range: H_{2c} zone.

Code in Analyses: H2CA (Clusters Y1, Z2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5															
7.5	.930	.130	15.0	8.00	2.10	.750	.420	1.45	.830	.420	.060	.007	.090	.380	.045
10	.930	.100	12.0	8.00	2.05	.800	.410	1.50	.780	.330	.035	.004	.110	.340	.050
12.5	.920	.120	11.0	9.00	1.90	.300	.320	1.45	.750	.270	.040	.005	.160	.310	.040
15	.900	.150	10.0	10.0	2.00	1.00	.210	1.30	.770	.280	.050	.008	.260	.250	.020
20															

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.110	.320	.320	.020	.210	.380	.010	.002	.010	.020	.003
15	.180	.410	.430	.020	.280	.310	.010	.002	0	.020	.003
20	.240	.460	.490	.020	.320	.250	.010	.001	0	.020	.002

Discussion:

More evolute and with stronger tubercles and ribs than *Htd. preretículatum*.

Genus *Bashkortoceras* Ruzhentsev & Bogoslovskaya, 1971

Homoceras: Delepine, 1941 (pars.); Ruzhentsev & Bogoslovskaya, 1971 (pars.), 1978 (pars.).

Bashkortoceras: R & B, 1971 (pars.), 1978 (pars.).

Umbetoceras: R & B, 1971, 1978.

Parahomoceras: R & B, 1971, 1978.

Type species: *Bashkortoceras salavati* R & B, 1971, from Nm_2b_2 zone of the Southern Urals.

Characteristics

The position in A-space of this genus is shown on Figure 39. The histograms on Figure 36 indicate that this position corresponds with possession of the following character states:

Shell shape - evolute and broad.

Coarse ornament - plications, tubercles and ribs not well developed, but likely to possess a ventral groove.

Fine ornament - simple, widely spaced.

Apertural form - tendency to have a strong ocular sinus, otherwise simple.

Suture - lobes and saddles lower than any other analysed genus; ventral saddle also narrow. Terminal prongs on lobes not well developed. (Information from Fig. 54).

Composition

B. salavati Ruzhentsev & Bogoslovskaya, 1971; *B. asperum* (R & B,1971) (*Parahomoceras*); *B. africanum* (R & B, 1971) (*Parahomoceras*); *B. schartymense* (R & B, 1978) (*Homoceras*); *B. uskalykense* (R & B, 1971) (*Umbetoceras*); *B. aravanense* (R & B, 1978) (*Umbetoceras*); *B. kuruilicum* (R & B, 1978) (*Umbetoceras*); *B. karsaklense* (R & B, 1978) (*Umbetoceras*).

Discussion

Ruzhentsev and Bogoslovskaya's (1971) division of these species into various genera was monothetically based, particularly with reference to presence of systems of "intra-ventral ridges". This criterion is not supported here, and is outweighed by similarities which reinforce the coherence of the genus.

Stratigraphic Distribution

Russian Nm_2a_1 to Nm_2c_2; unknown in Britain.

?Gen. nov.

Homoceras: Ruzhentsev & Bogoslovskaya, 1971(pars.), 1978 (pars.).

Characteristics

The position in A-space of this possible genus is shown on Figure 39. The histograms on Figure 37 indicate that this position corresponds with possession of the following character states:

Shell shape - evolute and broad.

Coarse ornament - moderately strong ribs; may have bifurcating plications. Strong ventral groove.

Fine ornament - suggestion of spiral ornament, otherwise normal.

Apertural form - aperture arches forward to form a relatively strong ocular sinus.

Suture - similar to Bogdanoceras.

Composition

?Homoceras alveatum Ruzhentsev & Bogoslovskaya, 1971; ?Homoceras subalveatum R & B, 1971.

Discussion

Two species represented by only three known specimens. The ventral groove is critical in separating this group from Bogdanoceras and Bashkortoceras, and until this is shown not to be pathological, generic status is doubtful.

Stratigraphic Distribution

Russian Nm_2a_1 zone.

5. 3. FAMILY GASTRIOCERATIDAE Hyatt, 1884

Characteristics

For reasons explained in Section 4.2.5.3, the Reticuloceratidae Librovitch (1957), cannot be separated from the Gastrioceratidae. Consequently, this forms a large and varied taxon. The principal components plot of Figure 57 gives an impression of this variety, and the histogram of Figure 52 suggests the following generalisations about the character states present in the family:

Shell shape	- very variable, but tends to be more evolute than the Homoceratidae.
Coarse ornament	- tubercles and plications often strong, and these may show bifurcation. Ribbing usually weak.
Fine ornament	- more delicate than most Homoceratids, with crenulation of striae and associated spiral ornament very common.
Apertural form	- both the lingua and hyponomic sinus tend to be strong.
Suture	- the lateral saddle is usually wide at the expense of the median saddle, but both tend to be rather short compared to the Homoceratids. Most forms do not develop significant prongs on the lobes in the size range analysed here.

Composition

The following genera can be included in this family:

Phillipsoceras Ruzhentsev and Bogoslovskaya, 1975.

Retites McCaleb, 1964 (incorporating Alurites Ruzhentsev & Bogoslovskaya, 1975; Tectiretites R & B, 1975; Quinnites Manger & Saunders, 1980).

Reticuloceras Bisat, 1924.

Bilinguites Librovitch, 1946.

Arkanites McCaleb, Quinn & Furnish, 1964.

Otleyoceras gen. nov.

Gastrioceras Hyatt, 1884.

Agastrioceras C. Schmidt, 1938.

Lissogastrioceras Gordon, 1965.

Cancelloceras Ruzhentsev & Bogoslovskaya, 1969.

Stratigraphic Distribution

Kinderscoutian to basal Westphalian C.

Genus Phillipsoceras Ruzhentsev & Bogoslovskaya, 1975

Gastrioceras: Foord, 1903 (pars.)

Reticuloceras: Bisat, 1924 (pars.); Bisat & Hudson, 1943 (pars.); Hodson, 1957; Bouckaert, 1961 (pars.).

Eumorphoceras: H. Schmidt, 1925 (pars.).

Phillipsoceras: Ruzhentsev & Bogoslovskaya, 1975 (pars.), 1978(pars.).

Type species: Gastrioceras circumplicatile Foord, 1903, from R_{1a} zone, Lisdoonvarna, Co, Clare, Rep, of Ireland.

Characteristics

The position in A-space of this genus is shown on Figure 45, and the histogram on Figure 43 indicates that this position corresponds with possession of the following character states:

Shell shape - variable but moderate.

Coarse ornament - rather average for the family.

Fine ornament - striae fairly widely spaced.

Apertural form - less sinuosity than most Reticuloceratids s. l.

Suture - particularly small median saddle. Lobes simple. (information from Fig. 54).

Composition

Ph. circumplicatile (Foord, 1903) (Gastrioceras); Ph. coreticulatum (Bisat & Hudson, 1943) (Reticuloceras); Ph. nodosum (B & H,1943) (Reticuloceras); Ph. stubblefieldi (B & H, 1943) (Reticuloceras); Ph. tiro (Gordon, 1968) (Reticuloceras); Ph. devium (Ruzhentsev & Bogoslovskaya) (Reticuloceras); Ph. surenense (R & B,1978) (Reticuloceras); Ph. microreticulatum (Yang Feng-qing, 1979) (Reticuloceras); Ph. heibergensis (Nassichuk, 1975) (Bilinguites); Ph. berestovense (Popov, 1979) (Bilinguites); Ph. malus (Ruzhentsev & Bogoslovskaya, 1978) (Tectiretites); Ph. obscurus (R & B, 1978) (Retites); Ph. betarhipaeum R & B, 1978; Ph. remissum R & B, 1978; Ph. linguatum R & B, 1978; Ph. gammarhipaeum R & B, 1978; Ph. separatum R & B, 1978; Ph. gradile R & B, 1978.

Discussion

Phillipsoceras, as defined here, is quite close to the original generic concept, except for the removal of some finely ornamented morphospecies, here placed in Otleyoceras gen. nov.

Stratigraphic Distribution

Kinderscoutian (R_1) in Britain and the South Urals, apparently higher Namurian elsewhere.

Phillipsoceras circumplicatile (Foord)

Plate VII, 1, 8.

Gastrioceras circumplicatile Foord, 1903, pl. xix, figs. 12, 13.

Eumorphoceras inconstans (Phillips) H. Schmidt, 1925, pl.xxv,figs.7,8.

Reticuloceras circumplicatile (Foord) Bisat & Hudson, 1943, pl. xxv, figs. 1, 2.

v. Reticuloceras circumplicatile (Foord) Hodson, 1957, pl. A, pl. B, figs. 1, 2, 4.

Reticuloceras compressum (Bisat & Hudson) Bouckaert, 1961.

Phillipsoceras circumplicatile (Foord) Ruzhentsev & Bogoslovskaya, 1975, p. 55.

Phillipsoceras circumplicatile (Foord) R & B, 1978, p. 245.

Lectotype: GSE 4803K, from the Ph. circumplicatile band, Lisdoonvarna, Co. Clare, Rep. of Ireland. For measurements, see Appendix 3b.

Stratigraphic Range: R_{1a1} zone.

Code in Analyses: R1A1C (Clusters X2, Y2, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5	.950	.150	13.0	8.00	2.30	.300	.420	1.90	.900	.350	.130	0	.070	.330	.055
7.5	.830	.380	14.0	8.00	2.20	.250	.420	1.75	.860	.340	.150	0	.180	.330	.047
10	.800	.650	17.0	8.50	1.70	.200	.430	1.75	.790	.410	.080	0	.310	.380	.040
12.5	.780	.820	19.0	9.00	1.60	.200	.420	1.80	.770	.520	.040	0	.350	.440	.042
15	.760	.700	16.0	9.00	1.60	.200	.390	1.85	.800	.470	.060	0	.250	.450	.047
20	.680	.400	12.0	9.00	1.80	.200	.340	1.90	.840	.350	.100	0	.150	.400	.055

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.120	.250	.300	.010	.140	.490	.010	0	.010	.015	0
15	.150	.310	.320	.020	.190	.450	.010	0	.010	.010	0
20	.170	.360	.340	.020	.230	.410	0	0	.010	.010	.001

Discussion :

Quite evolute and with distinctive coarse ornament, which most readily distinguishes it from *Otleyoceras coronatum*. Bisat and Hudson's (1943) *Reticuloceras umbilicatum* is an old age form which may belong here. In addition, and more importantly, there is a possibility that the type specimens of *Ph. inconstans* (Phillips, 1841) may be conspecific. This would make *Ph. circumplicatile*, the type species of the genus, a junior synonym of *Ph. inconstans*, and potentially change the type of the genus. In view of the importance of this problem, a conservative approach is adopted here pending examination and analysis of Phillips' type material.

Phillipsoceras stubblefieldi (Bisat & Hudson)

Plate X, 2, 4.

v. *Reticuloceras stubblefieldi* Bisat & Hudson, 1943, pl.xxix, fig. 1.

Phillipsoceras stubblefieldi (Bisat & Hudson) Ruzhentsev & Bogoslovskaya, 1978, p. 245.

Holotype: GSM 63084, from R_{1b} zone, Earle's cement works, near Hope, Derbyshire. For measurements, see Appendix 3, no. 307.

Stratigraphic Range: R_{1b} zone.

Code in Analyses: R1BB (Clusters X2, Y2, Z3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
6	.770	.350	16.0	8.00	1.30	.300	.420		.860	.190	.070	0	.120	.370	.070
7.5	.700	.530	16.5	8.00	1.80	.300	.370		.860	.220	.100	.006	.180	.360	.040
10	.710	.630	16.5	8.00	1.60	.300	.340		.870	.280	.110	.007	.220	.310	.025
12.5	.750	.680	15.0	8.00	1.40	.200	.310		.870	.330	.105	.006	.260	.250	.015
15	.760	.730	13.0	8.00	1.40	.200	.280		.850	.380	.120	.013	.290	.220	.010
20	.740	.800	11.0	8.00	1.20	.200	.240		.820	.400	.150	.026	.330	.180	.010

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.070	.230	.210	.035	.100	.350	.010	0	.020	.025	.001
15	.130	.290	.280	.030	.150	.320	.010	0	.015	.020	.002
20	.200	.350	.360	.030	.190	.300	.010	0	.010	.020	.001

Discussion:

Approximately central to the range of variation in R_{1b} zone.

Phillipsoceras nodosum (Bisat & Hudson)

Plate X, 1.

v. *Reticuloceras nodosum* Bisat & Hudson, 1943, pl. xxix, fig. 5.

Phillipsoceras nodosum (Bisat & Hudson) Ruzhentsev & Bogoslovskaya, 1978, p. 245.

Holotype: GSM 63088, from R_{1b} zone, Swint Clough, Alport Valley, Derbyshire. For measurements, see Appendix 3, no. 148.

Stratigraphic Range: R_{1b} zone.

Code in Analyses: R1BC (Clusters X3, Y3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
6	1.00	0	16.0	7.00	1.90	.400	.580		.850	.540	.100	0	.120	.430	.110
7.5	.800	.550	17.0	6.00	1.60	.350	.440		.860	.490	.090	0	.160	.330	.070
10	.760	.620	16.0	6.00	1.60	.350	.410		.870	.470	.075	0	.210	.360	.050
12.5	.760		14.0	7.00	1.60	.300	.380		.870	.450	.055	0	.280	.370	.030
15	.760		13.0	6.00	1.40	.300	.350		.870	.430	.040		.310	.310	.020
20															

Discussion:

The most evolute and coarsely ornamented of the R_{1b} zone fauna; it is consequently rather typical of its genus.

Phillipsoceras coreticulatum (Bisat & Hudson)

Plate XI, 4, 5.

Eumorphoceras reticulatum (Phillips) H. Schmidt, 1925, pl. xxv, figs. 16, 17, 19, 20.

Reticuloceras eoreticulatum Bisat, 1924, p.131 (pars.).

Reticuloceras reticulatum (Phillips) Bisat, 1924, pl. iv, fig.1 (pars.).

v. *Reticuloceras coreticulatum* Bisat & Hudson, 1943, pl. xxvii, fig. 2.

Phillipsoceras coreticulatum (Bisat & Hudson) Ruzhentsev & Bogoslovskaya, 1978, p. 245.

Holotype: GSM FOR 1820, from R_{1c} zone, Gevelsberg, Westphalia, West Germany. For measurements, see Appendix 3, no. 62.

Stratigraphic Range: R_{1c} zone.

Code in Analyses: R1CB (Cluster Z2)

Matrix of Character Values:

		S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
Diam	5	1.00	.100	12.0	7.00	1.60	.200	.500	2.00	.840	.300	.130	0	.160	.400	.090
	7.5	.830	.400	13.0	7.06	1.50	.200	.440	1.75	.810	.270	.110	0	.170	.350	.050
	10	.760	.550	14.0	7.00	1.70	.200	.390	1.50	.790	.240	.080	.003	.170	.320	.030
	12.5	.690	.660	15.0	7.00	1.80	.200	.340	1.35	.770	.230	.070	.005	.170	.270	.025
	15	.660	.720	15.0	7.00	1.30	.200	.310	1.25	.770	.260	.080	.006	.210	.220	.020
	20	.740	.730	15.0	7.00	1.20	.200	.290	1.20	.790	.380	.130	.004	.350	.080	.005

		a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
Diam	10	.040	.250	.240	.060	.160	.380	0	0	.050	.040	.001
	15	.100	.330	.300	.030	.180	.420	.020	0	.030	.020	.002
	20	.170	.400	.360	.010	.190	.460	0	0	.020	.010	.001

Discussion:

Includes the most evolute and coarsely ornamented specimens in R_{1c} zone, which show clear affinities with *Ph. circumplicatile*.

Otleyoceras *gen.* *nov.*

Reticuloceras: Bisat, 1924 (pars.); Bisat & Hudson, 1943 (pars.); Stubblefield in Stephens *et al.*, 1953 (pars.); Patteisky, 1959 (pars.); Bouckaert, 1961 (pars.); Ramsbottom in Earp *et al.*, 1961 (pars.).

Phillipsoceras: Ruzhentsev & Bogoslovskaya, 1975 (pars.), 1978(pars.).

Bilinguites: ?Nassichuk, 1975 (pars.).

Type species: *Reticuloceras* *coronatum* Bisat & Hudson, 1943, from R_{1a1} zone, Otley, Yorkshire.

Characteristics

The position of this genus in A-space is shown on Figure 43, and the histogram on Figure 43 indicates that this position corresponds with possession of the following character states:

Shell shape	- average Reticuloceratid *s.l.*
Coarse ornament	- fairly strong tubercles/plications.
Fine ornament	- striae dense, spiral ornament developed.
Apertural form	- not greatly sinuous, but tends to arch forward to the lingua.
Suture	- average amongst the Gastrioceratidae (from Fig.54).

Composition

O. *coronatum* (Bisat & Hudson, 1943) (*Reticuloceras*); *O.* *compressum* (Bisat & Hudson, 1943) (*Reticuloceras*); *O.* *paucicrenulatum* (Bisat & Hudson, 1943) (*Reticuloceras*); ?*O.* *canadensis* (Nassichuk, 1975) (*Bilinguites*); *O.* *bouckaerti* *sp.* *nov.*, *O.* *gracilingua* *sp.* *nov.*

Discussion

The finer ornament most readily distinguishes this genus from *Phillipsoceras* , to which it is nevertheless phenetically close. The genus may be exclusively N. W. European.

Stratigraphic Distribution

Kinderscoutian (R_{1a}) to Lower Marsdenian (R_{2a}).

Otleyoceras coronatum (Bisat & Hudson)

Plate VII, 3, 7.

v. *Reticuloceras coronatum* Bisat & Hudson, 1943, pl. xviii, fig. 3.

v. *Reticuloceras coronatum* Bisat & Hudson; Stubblefield in Stephens *et al.*, 1953, pl. vi, fig. 11.

Phillipsoceras coronatum (Bisat & Hudson) Ruzhentsev & Bogoslovskaya, 1978, p. 245.

Holotype: GSM Da 2031, from R_{1a1} zone, Storris House, Otley, Yorkshire.

For measurements, see Appendix 3, no. 56.

Stratigraphic Range: R_{1a1} zone.

Code in Analyses: R1A1B (Clusters X3, Y1, Z2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	29.0	7.00	1.70	.300	.510	1.70	.890	.520	.010	0	.160	.330	.080
7.5	.930	.150	30.0	7.00	1.50	.200	.480	1.85	.860	.600	.020	0	.200	.360	.060
10	.860	.500	27.0	7.00	1.30	.200	.460	2.10	.860	.680	.040	0	.240	.400	.055
12.5	.860	.670	25.0	8.00	1.20	.200	.390	2.20	.860	.710	.050	0	.330	.420	.050
15	.910	[illegible]	25.0	8.00	1.10	.100	.340	1.95	.810	.650	.070	0	.560	.430	.045
20	.980	.680	24.0	8.00	1.00	.100	.290	1.60	.780	.550	.090	0	.700	.440	.030

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.100	.260	.310	.070	.180	.460	.005	0	.040	.020	.001
15	.160	.340	.300	.090	.230	.440	0	0	.040	.020	0
20	.210	.390	.300	.110	.260	.420	0	0	.040	.030	0

Discussion:

Retains a coronate shape to a later ontogenetic stage than any other R_1 zone species. Chosen as the type for the genus because of its characteristic association of this shell shape with closely spaced delicate striae. The holotype is regrettably an atypically extreme example of this morphology.

Otleyoceras compressum (Bisat & Hudson)

Plate VII 2, 4, 5, 6.

v. *Reticuloceras compressum* Bisat & Hudson, 1943, pl.xxx, fig.6 (pars.)

v. *Reticuloceras compressum* Hodson, 1957, pl. 8, figs. 3, 5.

Reticuloceras circumplicatile (Foord) Patteisky, 1959, pl.i, figs. 29, 30, 31, 33.

Holotype: GSM 63093, from R_{1a1} zone, Samlesbury Bottoms, near Blackburn, Lancashire. For measurements, see Appendix 3, no. 52.

Stratigraphic Range: R_{1a1} zone.

Code in Analyses: R1A1A (Clusters X3, Y3, Z3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Ou/De	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Oh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	33.0	9.00	1.30	.300	.530	1.90	.870	.340	.030	0	.050	.440	.060
7.5	.930	.150	32.0	9.00	1.10	.250	.490	1.85	.850	.480	.030	0	.160	.380	.050
10	.900	.680	30.0	9.00	1.10	.200	.430	1.75	.820	.480	.030	0	.200	.340	.040
12.5	.870	.850	27.0	9.00	1.70	.200	.390	1.60	.780	.400	.030	0	.210	.310	.030
15	.820	.700	23.0	9.00	1.25	.200	.340	1.40	.770	.380	.040	0	.310	.290	.030
20	.870	.600	.270	9.00	1.20	.200	.290	1.30	.760	.350	.040	0	.310	.220	.015

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.100	.280	.260	.010	.140	.490	0	0	.020	.040	0
15	.140	.340	.260	.010	.190	.490	.010	0	.030	.040	.001
20	.130	.390	.270	.010	.230	.480	.010	0	.040	.030	.003

Discussion:

Includes the most involute members of the genus and of the R_{1a1} zone fauna.

Otleyoceras paucicrenulatum (Bisat & Hudson)

Plate VIII, 1, 2.

v. Reticuloceras paucicrenulatum Bisat & Hudson, 1943, p. 427.

v. Reticuloceras paucicrenulatum Bisat & Hudson; Ramsbottom in Earp et al., 1961, pl. xi, fig. 3.

Reticuloceras gulincki Bouckaert, 1961.

Phillipsoceras paucicrenulatum (Bisat & Hudson) Ruzhentsev & Bogoslovskaya, 1978, p. 245.

Holotype: GSM 71074, from R_{1a2} zone, Lumbutts Clough, Woodhouse, Yorkshire. For measurements, see Appendix 3, no. 181.

Stratigraphic Range: R_{1a2} zone

Code in Analyses: R1A2B (Clusters U5, V6, W3, X1, Y1, Z4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.730	.130	13.0	8.00	2.00	.300	.440	1.80	.820	.660	.020	0	.250	.310	.055
7.5	.750	.260	16.0	8.00	1.50	.300	.460	1.80	.850	.580	.030	0	.320	.360	.065
10	.710	.360	14.0	8.00	1.40	.300	.460	1.80	.640	.600	.050	0	.360	.390	.065
12.5	.720	.450	11.0	8.00	1.60	.300	.450	1.80	.840	.700	.060	0	.380	.400	.055
15	.750	.530	12.0	8.00	1.70	.300	.410	1.80	.850	.740	.090	.001	.480	.370	.050
20	.780	.640	18.0	8.00	1.50	.300	.350	1.60	.810	.550	.100	.003	.470	.230	.015

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.090	.340	.360	.060	.180	.450	.010	0	.040	.030	.003
15	.150	.380	.390	.030	.170	.440	.015	.001	.030	.010	.002
20	.200	.420	.430	.015	.130	.440	.015	0	.025	0	0

Discussion:

The coarse ornament of this morphospecies makes it the closest of its genus to *Phillipsoceras*. Its inclusion in *Otleyoceras* here is largely contributed to by the strong forward arching of striae towards the lingua.

Otleyoceras bouckaerti *sp. nov.*

Plate VIII, 3, 4.

Reticuloceras aff. *circumplicatile* Bisat & Hudson, 1943, pl.xxiv,fig.4.

Reticuloceras paucicrenulatum (Bisat & Hudson) Bouckaert, 1961.

Holotype: GSM LZ 1893, from R_{1a2} zone at Roughlee, Pendle, Lancashire.

For measurements, see Appendix 3, no. 173.

Stratigraphic Range: R_{1a2} zone.

Code in Analyses: R1A2A (Clusters U4, V5, W3, X1, Y1, Z4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.830	.130	18.0	10.0	1.50	.200	.420	1.85	.870	.530	.060	0	.250	.440	.055
7.5	.770	.260	14.0	10.0	1.60	.200	.430	1.90	.830	.620	.070	0	.300	.410	.065
10	.770	.360	12.0	10.0	1.60	.200	.430	1.30	.810	.670	.090	0	.360	.400	.065
12.5	.770	.450	11.0	16.0	1.60	.200	.430	1.85	.810	.740	.100	0	.380	.400	.055
15	.780	.530	12.0	10.0	1.70	.200	.410	1.80	.810	.760	.110	.001	.480	.370	.050
20	.780	.640	18.0	10.0	1.50	.200	.350	1.60	.780	.550	.100	.003	.470	.230	.015

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.130	.310	.290	.040	.150	.430	.010	0	.040	.030	.004
15	.170	.340	.360	.070	.180	.400	.010	0	.025	.025	.003
20	.210	.330	.400	.030	.210	.370	.015	0	.015	.020	.001

Discussion:

This morphospecies is a more involute contemporary of _O. paucicrenulatum_. As is frequently the case, the more involute form is also narrower, has reduced coarse ornament and a stronger hyponomic sinus.

Otleyoceras gracilingua _sp. nov._

Plate XII, 3.

Reticuloceras gracile Bisat; Bouckaert, 1961.

Holotype: GSM Z1 5268 from the R_{2a} zone at Sabden Brook, east of Whalley, Lancashire. For maesurements, see Appendix 3, no. 417.

Stratigraphic Range: R_{2a} zone.

Code in Analyses: R2AC (Cluster Z3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Do}$	$\frac{W}{Hw}$	$\frac{Wl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5	.330	.270	18.0	9.00	1.30	.100	.430	1.70	.930	.500	.120	0	.080	.460	.110
7.5	.760	.360	22.0	9.00	1.70	.100	.420	1.60	.380	.530	.130	0	.230	.480	.090
10	.740	.430	30.0	9.00	1.70	.100	.410	1.55	.840	.580	.150	0	.340	.460	.070
12.5	.730	.520	37.0	9.00	1.60	.100	.400	1.50	.800	.660	.140	0	.400	.450	.055
15	.760	.600	42.0	9.00	1.30	.100	.400	1.40	.770	.720	.130	0	.420	.420	.040
20	.820	.640	41.0	6.00	1.00	.100	.390		.730	.630	.100	0	.460	.280	.010

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.070	.310	.300	.110	.220	.480	.010	0	.030	.010	0
15	.110	.260	.250	.060	.200	.420	.010	0	.030	.020	0
20	.150	.270	.270	.030	.180	.360	0	0	.030	.040	0

Discussion:

An evolute form with strong plications when young, but with closely spaced, fine striae. This morphospecies shows a clear similarity with other _Otleyoceras_ species, despite its occurence with _Bilinguites_ _spp_. in R_{2a} zone.

This morphospecies was described by Bisat & Ramsbottom (unpublished MS) who first used the specific name _gracilingua_.

Genus Reticuloceras Bisat

Goniatites: Phillips, 1836 (pars.).

Glyphioceras: Foord & Crick, 1897 (pars.); Haug, 1898 (pars.).

Glyphioceras (Beyrichoceras): Foord, 1903 (pars.).

Reticuloceras: Bisat, 1924 (pars.); 1928 (pars.); Bisat & Hudson, 1943 (pars.); Patteisky, 1959 (pars.); Bouckaert. 1961 (pars.); Quinn, 1966 (pars.); Ruzhentsev & Bogoslovskaya, 1978 (pars.); Popov, 1979 (pars.); Manger & Saunders, 1980.

Eumorphoceras: H. Schmidt, 1925 (pars.).

Tectiretites: Ruzhentsev & Bogoslovskaya, 1978 (pars.).

Type species: Goniatites reticulatus Phillips, 1836, from R_{1c} zone of Yorkshire.

Characteristics

The position in A-space of this genus is shown on Figure 45, and the histogram on Figure 43 indicates that this position corresponds with possession of the following character states:

Shell shape	- moderately to strongly involute.
Coarse ornament	- generally weak.
Fine ornament	- closely spaced with fairly prominent spirals.
Apertural form	- lingual projection weak. Rather featureless except for frequent development of a projection near the umbilical shoulder.
Suture	- average; central to the range of variation in the family. (Information from Figure 54.)

Composition

R. reticulatum (Phillips, 1836) (Goniatites); R. pulchellum (Foord, 1903) (Glyphioceras (Beyrichoceras)); R. dubium Bisat & Hudson, 1943; R. samlesburyense Bisat & Hudson, 1943; R. eoreticulatum Bisat, 1928; R. regularum Bisat & Hudson, 1943; R. subcarinatus (Ruzhentsev & Bogoslovskaya, 1978) (Alurites); R. excultum R & B, 1978; R. instatum R & B, 1978; R. orientale R & B, 1978; R. feninse Popov, 1979; R. tersum Popov, 1979; R. wainwrighti Quinn, 1966.

Discussion

The definition of the genus presented here differs little from that of Ruzhentsev & Bogoslovskaya (1978).

Stratigraphic Distribution

Kinderscoutian (R_{1a2} to R_{1c} zones).

Reticuloceras *pulchellum* (Foord)

Plate VIII, 5, 6; IX, 3, 4.

Glyphioceras (*Beyrichoceras*) *pulchellum* Foord, 1903, pl.xix, fig. 5.

Reticuloceras *pulchellum* (Foord) Bisat & Hudson, 1943, pl.xxviii,fig.8.

v. *Reticuloceras* aff. *pulchellum* Bisat & Hudson, 1943, pl.xxix,figs.4,6.

v. *Reticuloceras* *todmordenense* Bisat & Hudson, 1943, pl. xxiii, figs.1-5.

v, *Reticuloceras* *adpressum* Bisat & Hudson, 1943, p. 420.

Reticuloceras *adpressum* Bisat & Hudson, Bouckaert, 1961.

Holotype: GSE 3450c, from R_1 zone, Rathcahill, near Abbeyfield, Co. Limerick, Rep. of Ireland. For measurements, see Appendix 3b.

Stratigraphic Range: R_{1a2} zone and possibly R_{1a1}.

Code in Analyses: R1A2D (Clusters U1, V2, W2, X2, Y2, Z2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Pe/Hw	Dh/Hw	Lz/Hw	Ht/Hw
5	.900		25.0	8.00	1.70	.400	.390	1.80	.820	.380	.060	0	.170	.350	.040
7.5	.740		22.0	8.00	1.40	.400	.350	1.70	.800	.400	.070	.001	.230	.280	.035
10	.720		20.0	8.50	1.20	.350	.280	1.60	.780	.330	.070	.003	.250	.200	.015
12.5	.740		20.0	9.00	1.10	.300	.240	1.45	.780	.300	.070	.004	.270	.100	.005
15	.780	.650	20.0	11.0	1.00	.200	.240	1.30	.780	.280	.080	.004	.330	.020	.002
20.	.860	.550	24.0		1.00	.200	.240	1.20	.710	.140	.050	.004	.500	0	0

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.130	.310	.320	.010	.160	.330	.010	.001	.010	.010	.001
15	.180	.330	.360	.020	.190	.370	.010	0	.010	.010	0
20	.220	.360	.410	.025	.220	.360	.010	0	.005	0	0

Discussion:

A rather finely ornamented, moderately involute form. *R.* *subreticulatum* is similar but has shorter plications and a stronger hyponomic sinus, with still finer ornament and develops a tighter umbilicus.

There is no evidence forthcoming from this study to separate type *R.*

todmordenense and R. adpressum from R. pulchellum. The anomalous cluster R1A2X4, composed of one specimen, may be similar to the former but does not include type material.

Reticuloceras subreticulatum (Foord)

Plate IX, 1, 2.

Glyphioceras (Beyrichoceras) subreticulatum Foord, 1903, pl. xlix, figs. 6, 7.

Reticuloceras subreticulatum (Foord) Bisat & Hudson, 1943, pl.xxvi, fig. 3.

v. Reticuloceras aff. pulchellum Bisat & Hudson, 1943, pl.xxviii,figs. 2, 5, 6.

v. Reticuloceras subreticulatum (Foord) Ramsbottom in Earp et al., 1961, pl. xi, fig. 2.

Reticuloceras subreticulatum (Foord) Bouckaert, 1961.

Lectotype: GSE 845C, from R_{1a2} zone, Foynes Island, Limerick, Rep. of Ireland. For measurements, see Appendix 3b.

Stratigraphic Range: R_{1a2} zone and possibly R_{1a1}.

Code in Analyses: R1A2C (Clusters U2, V1, W2, X2, Y2, Z3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.80		32.0	12.0	1.80	.300	.360	1.50	.860	.230	.120	0	.130	.350	.035
7.5	.850		24.0	12.0	1.70	.250	.310	1.50	.850	.250	.070	.001	.140	.280	.030
10	.780		23.0	11.0	1.50	.250	.240	1.40	.820	.240	.050	.003	.210	.200	.015
12.5	.760		23.0	10.0	1.20	.200	.200	1.35	79.0	.260	.070	.007	.260	.100	.005
15	.710	.830	24.0	9.00	1.20	.200	.220	1.30	.780	.310	.030	.021	.290	.040	.002
20	.550	.600	29.0	8.00	1.30	.150	.200	1.20	.730	.420	.050	.033	.110	.100	.002

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.090	.250	.290	.045	.140	.410	.010	0	.025	.015	.001
15	.150	.300	.330	.040	.160	.400	.015	.001	.020	.010	.003
20	.200	.380	.360	.030	.180	.410	.020	.001	.010	.005	.006

Discussion:

An attractive morphospecies, with the finest ornament and the most involute, discoidal form of the R_{1a} zone fauna, except for the rare and poorly known R. dubium.

Reticuloceras samlesburyense Bisat & Hudson

Plate VIII, 6, 8.

v. *Reticuloceras samlesburyense* Bisat & Hudson, 1943, pl. xxiv, fig. 3.

Reticuloceras todmordenense var. *uhlenbruchense* Patteisky, 1959, pl. 3, figs. 13-18; pl. 4, figs. 1-7, 9-15, 17-22.

Reticuloceras umbilicatum Bisat & Hudson; Patteisky, 1959,pl.4,figs.8,16.

Reticuloceras todmordenense Bisat & Hudson; Bouckaert, 1961.

Phillipsoceras samlesburyense (Bisat & Hudson) Ruzhentsev & Bogoslovskaya, 1978, p. 245.

Holotype: GSM 63085, from R_{1a2} zone, Samlesbury Bottoms, near Blackburn, Lancashire. For measurements, see Appendix 3, no. 328.

Stratigraphic Range: R_{1a2} zone.

Code in Analyses: R1A2E (Clusters U3, V3, X3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Oh}{Hw}$	$\frac{Lz}{Hw}$	$\frac{Ht}{Hw}$
5	.900	.360	28.0	9.00	2.30	.300	.400	1.90	.910	.230	.040	0	.120	.260	.065
7.5	.870	.400	18.0	9.00	2.00	.300	.350	1.70	.910	.260	.080	.012	.160	.260	.040
10	.780	.450	24.0	8.50	1.80	.250	.260	1.40	.820	.240	.050	.003	21.0	.190	.020
12.5	.740	.600	25.0	8.00	1.80	.200	.200	1.20	.830	.220	.080	.001	.220	.250	.020
15	.700	.700	26.0	7.00	1.80	.200	.170	1.10	.780	.230	.150	0	.400	0	0
20															

Discussion:

Somewhat more evolute and coarse than other R_{1a2} *Reticuloceras* species.

Reticuloceras dubium Bisat & Hudson

Plate IX, 5.

v. *Reticuloceras dubium* Bisat & Hudson, 1943, p. 421.

Holotype: GSM WE 1108, from R_{1a2} zone, Bottom Beck, Spofforth Haggs, Yorkshire. For measurements, see Appendix 3, no. 90.

Stratigraphic Range: R_{1a2} zone.

Code in Analyses: R1A2G (Clusters V4, W1, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	.050	32.0		1.10	.200	.280		.750	.500	.100	0	.200	0	0
7.5	1.00	.150	35.0		1.00	.100	.260		.560	.450	.110	.006	.380	0	0
10	.960	.200	38.0		1.00	.100	.250		.810	.320	.100	.020	.250	.030	.002
12.5	.980	.200	39.0		1.00	.100	.210		.760	.320	.100	.022	.260	.020	0
15	.960	.170	400		1.00	.100	.200		.740	.350	.110	.020	.230	0	0
20	.980	.120	40.0		1.00	.100	.190		.710	.430	.140	.013	.360	0	0

Discussion:

An aberrant form, with very atypical ornament and an extremely involute, discoidal shape.

Reticuloceras eoreticulatum Bisat

Plate X, 3.

Reticuloceras eoreticulatum Bisat, 1928, p. 131 (pars.).

v. Reticuloceras eoreticulatum Bisat; Bisat & Hudson, 1943, p. 418.

Reticuloceras regularum Bisat & Hudson; Bouckaert, 1961.

Lectotype: GSM 71069, from R_{1b} zone, Pendle Water, east of Rough Lee, Pendle, Lancashire. For measurements, see Appendix 3, no. 101.

Stratigraphic Range: R_{1b} zone.

Code in Analyses: R1BA (Clusters X1, Y1, Z2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.930	.100	13.0	9.00	1.20	.200	.370		.920	.170	.110	0	.110	.260	.040
7.5	.760	.450	16.0	9.00	1.10	.200	.310		.860	.220	.100	0	.120	.230	.020
10	.670	.650	19.0	9.00	1.20	.200	.270		.790	.220	.090	.005	.160	.210	.010
12.5	.640	.750	21.0	9.00	1.30	.200	.255		.760	.210	.080	.011	.200	.180	.010
15	.630	.800	21.0	9.00	1.20	.200	.240		.770	.200	.090	.012	.240	.030	.005
20	.690	.820	16.0	9.00	1.00	.200	.190		.830	.210	.125	.010	.300	0	0

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.130	.290	.380	.059	.160	.450	.010	0	.030	.030	.001
15	.180	.330	.430	.105	.210	.410	.030	.003	.025	.030	.003
20	.230	.390	.510	.140	.250	.380	.030	.006	.020	.030	.001

Discussion:

The position of this morphospecies with respect to the R_{1b} zone fauna is analogous to that of R. pulchellum in R_{1a2}. Note that only one cluster (R1BZ2) separates R. eoreticulatum from R. regularum, and that the Lectotype of the former is too large to have been included in any sample for cluster analysis. The taxonomic distinction between the two must be regarded as slight.

Reticuloceras regularum Bisat & Hudson

Plate X, 5, 6.

v. Reticuloceras regularum Bisat & Hudson, 1943, p. 416.

v. Reticuloceras moorei Bisat & Hudson, 1943, p. 413.

Phillipsoceras regularum (Bisat & Hudson) Ruzhentsev & Bogoslovskaya, 1978, p. 245.

Holotype: GSM 71061, from R_{1b} zone at Shewbroad Clough, Todmorden, Yorkshire. For measurements, see Appendix 3, no. 258.

Stratigraphic Range: R_{1b} zone.

Code in Analyses: R1BE (Clusters X1, Y1, Z4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Da	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.920	.100	13.0	10.0	1.20	.400	.370		.920	.170	.110	0	.110	.260	.040
7.5	.760	.440	16.0	10.0	1.10	.300	.310		.860	.220	.100	0	.120	.230	.020
10	.700	.650	19.0	10.0	1.20	.300	.270		.790	.240	.090	.005	.160	.210	.010
12.5	.680	.700	19.0	9.00	1.30	.300	.255		.750	.240	.080	.011	.180	.190	.010
15	.690	.660	18.0	9.00	1.20	.300	.240		.730	.240	.090	.009	.180	.120	.005
20	.790	.440	13.0	9.00	1.00	.200	.190		.710	.250	.125	.007	.180	.030	.001

Discussion:

The holotypes of both R. regularum and R. moorei are included in clusters allocated to this morphospecies, but that of R. regularum is more central, and therefore more representative.

R. regularum is moderately involute but is noticeably narrow. Ornament is rather typical of the assemblage, but the lingua and hyponomic sinus are weak.

Reticuloceras reticulatum (Phillips)

Plate XI, 1, 2, 3, 6.

Goniatites reticulatus Phillips, 1836, pl. xix, figs. 26, 27.

Glyphioceras reticulatum (Phillips) Haug, 1898, pl.i, figs.38,39,41,42.

Reticuloceras reticulatum (Phillips) Bisat, 1924, pl.iv, fig. 2.

Eumorphoceras reticulatum (Phillips) H. Schmidt, 1925, pl.xxv, fig.18.

Reticuloceras reticulatum (Phillips) Bisat & Hudson, 1943, p.411 (pars.)

Reticuloceras reticulatum (Phillips) Patteisky, 1959, pl.vi,fig.25.

Lectotype: The specimen figured by Phillips (1836, pl.xix, fig. 26), probably from High Green Wood, Todmorden, Yorkshire (see Bisat & Hudson 1943, p. 411). For measurements, see Appendix 3b.

Stratigraphic Range: R_{1c} zone.

Code in Analyses: R1CA (Cluster Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{De}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5	1.00	0	14.0	9.00	1.70	.300	.520	2.00	.920	.540	.100	0	.030	.700	.050
7.5	.930	.360	18.0	8.00	1.40	.300	.380	1.70	.860	.420	.080	0	.120	.200	.030
10	.760	.640	21.0	8.00	1.20	.250	.300	1.40	.800	.340	.070	.004	.180	.130	.020
12.5	.700	.700	21.0	9.00	1.05	.200	.240	1.30	.750	.300	.070	.009	.250	.080	.010
15	.680	.670	20.0	10.0	1.00	.160	.210	1.20	.740	.300	.080	.011	.310	.040	0
20	.720	.620	20.0		1.00	.100	.180	1.05	.760	.390	.100	-.037	.360	0	0

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.050	.280	.280	.020	.100	.440	.010	0	.040	.020	0
15	.120	.370	.340	0	.160	.410	.020	0	.040	.030	0
20	.130	.430	.330	0	.210	.390	.020	0	.030	.040	0

Discussion:

The commonest morphospecies in the R_{1c} zone fauna. It shows a well developed sinuous aperture and good reticulate ornament. The shell shape is the most discoidal in R_{1c} zone. R. davisi (Foord & Crick, 1897) is probably an old age form of this morphospecies.

Genus *Bilinguites* Librovitch, 1946.

Goniatites: Salter, 1864.

Glyphioceras (*Beyrichoceras*): Foord, 1903.

Reticuloceras: Bisat, 1924 (pars.); Wright, 1926; Demanet, 1941 (pars.); Patteisky, 1959 (pars.); Popov, 1979 (pars.).

Eumorphoceras: H. Schmidt, 1925 (pars.).

Reticuloceras (*Bilinguites*): Librovitch, 1946.

Bilinguites: Nassichuk, 1975; Ruzhentsev & Bogoslovskaya, 1978; Popov, 1979; Manger & Saunders, 1980.

Type species: *Reticuloceras superbilingue* Bisat, 1924, from R_{2c} and G zones, N. England.

Characteristics

The position in A-space of this genus is shown on Figure 45, and the histogram on Figure 43 indicates that this position corresponds with possession of the following character states:

Shell shape - generally involute.

Coarse ornament - plications and ribs slight or absent.

Fine ornament - striae closely spaced. Crenulation and associated spirals weak.

Apertural form - lingual projection and/or ocular sinus strongly developed. Hyponomic sinus also prominent.

Suture - generally rather flat, with a small median saddle. Terminal prongs on lobes only weak. (From fig.54).

Composition

B. superbilingue (Bisat, 1924) (*Reticuloceras*); *B. bilingue* (Salter, 1864) (*Goniatites*); *B. gracile* (Bisat, 1924) (*Reticuloceras*); *B. metabilingue* (Wright, 1926) (*Reticuloceras*); *B. degeneratus* Ruzhentsev & Bogoslovskaya, 1978; *B. eximius* R & B, 1978; *B. pavlovensis* Popov, 1979; *B. eliasi* Manger & Saunders, 1980; *B. involutum sp. nov.*; *B. beta sp. nov.*; *B. pulobilingue sp. nov.*; *B. filobilingue sp. nov.*; *B. golcarensis sp. nov.*; *B. ruzhentsevi sp. nov.*

Discussion

This genus is extreme amongst the Gastrioceratidae in many of its characters, and so is quite distinct. As used here, Bilinguites differs little from the original description.

Stratigraphic Distribution

Marsdenian to Westphalian A (R_{2a} to G_2 zones).

Bilinguites gracile (Bisat)

Plate XII, 1, 2.

Reticuloceras reticulatum mut. gracile Bisat, 1924, p. 51.

Reticuloceras reticulatum mut. α Bisat, 1924, pl. ii, figs. 1, 2, 6.

Phillipsoceras gracile (Bisat) Ruzhentsev & Bogoslovskaya, 1978, p.245.

Lectotype: BMC 25753, from R_{2a} zone immediately above the Kinderscout Grit, Rake Dike, Holme, Yorkshire. For measurements, see Appendix 3b.

Stratigraphic Range: R_{2a} zone.

Code in Analyses: R2AA (Cluster Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Oo/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.920	.100	37.0	8.00	1.60	.200	.350	1.60	.900	.400	.130	0	.330	.440	.040
7.5	.790	.270	38.0	8.00	1.30	.200	.300	1.40	.840	.430	.150	0	.390	.320	.025
10	.720	.500	42.0	8.00	1.20	.200	.270	1.30	.780	.430	.160	0	.440	.250	.015
12.5	.680	.630	44.0	8.00	1.20	.200	.270	1.20	.750	.430	.170	0	.500	.180	.010
15	.630	.640	44.0	8.00	1.20	.100	.270		.730	.420	.170	0	.530	.150	.010
20	.550	.580	.420	8.00	1.10	.100	.240		.690	.390	.160	.001	.500	.080	.005

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.070	.260	.250	.020	.120	.430	0	0	.030	.050	0
15	.090	.260	.260	.020	.140	.420	.010	0	.030	.030	.001
20	.120	.300	.330	.030	.160	.390	.020	0	.010	.010	.003

Discussion:

An involute form with very fine, strongly crenulate striae and prominent spirals. There are strong plications on the umbilical margin when young. This is the average R_{2a} zone morphology.

Bilinguites involutum sp. nov.

Plate XII, 4.

Reticuloceras reticulatum (Bisat) Demanet, 1941, pl.xvii,figs.13,14.

Holotype: GSM Da 855, from R_{2a} zone, just above the Kinderscout Grit, Rag Clough, Holme, Yorkshire. For measurements, see Appendix 3, no. 400.

Stratigraphic Range: R_{2a} zone.

Code in Analyses: R2AB (Cluster Z2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.360	.200	41.0	7.00	1.40	.300	.340	1.60	.860	.700	.030	.004	.070	.300	.015
7.5	.810	.220	40.0	7.00	1.20	.200	.290	1.40	.840	.700	.140	.003	.220	.200	.010
10	.790	.230	38.0	7.50	1.15	.200	.250	1.30	.820	.680	.200	.003	.360	.100	.005
12.5	.800	.240	37.0	8.00	1.10	.100	.220	1.20	.810	.660	.250	.002	.460	.040	0
15	.820	.230	35.0	8.00	1.10	.100	.200	1.10	.800	.830	.270	.002	.540	0	0
20	.870	.230	35.0	8.00	1.10	.100	.170		.770	.540	.260	.002	.630	0	0

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.070	.250	.280	.080	.130	.420	0	0	.020	.010	0
15	.130	.300	.260	.070	.190	.420	.030	0	.020	.020	.001
20	.130	.350	.360	.060	.240	.410	.020	0	.010	.020	.001

Discussion:

The most extremely involute member of the fauna, with relatively weak plication when young. Crenulation and spiral ornament is only weakly developed, in comparison with the other R_{2a} zone species; consequently this morphospecies is closest of the zone to R_{2b} forms.

Bilinguites bilingue (Salter)

Plate XIII, 1, 2.

Goniatites bilinguis Salter, 1864, p. 60, fig.14.

v. Reticuloceras reticulatum mut. β Bisat, 1924, pl. vii, fig. 2.

Reticuloceras bilingue (Salter) Demanet, 1941, pl.xviii, figs.1-4.

Reticuloceras bilingue (Salter) Patteisky, 1959, pl. vi, fig. 19.

Reticuloceras bilingue (Salter) Bouckaert, 1961.

Bilinguites bilinguis (Salter) Ruzhentsev & Bogoslovskaya, 1978,p.283.

Lectotype: GSM 30831, from R_{2b} zone, Pule Moss, Diggle, Lancashire. For measurements, see Appendix 3, no. 489.

Stratigraphic Range: R_{2b} zone.

Code in Analyses: R2BA (Clusters W3, X4, Y1, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	19.0		1.50	.100	.320		.870	.500	.230	0	.600	.240	.020
7.5	.950	.130	22.0		1.40	.100	.300		.810	.600	.250	0	.750	.210	.015
10	.940	.230	22.0		1.30	.100	.280		.740	.740	.250	0	.760	.140	.010
12.5	.910	.280	20.0		1.10	.100	.260		.750	.740	.240	0	.720	.030	0
15	.910	.440	22.0		1.00	.100	.230		.790	.620	.230	.004	.640	0	0
20	.910	.380	29.0		1.00	.100	.170		.750	.500	.180	.003	.580	0	0

Discussion:

This is central with respect to the variation within the fauna. Bisat (1924) and subsequent authors have recognised early and late forms of this basic morphospecies, and these have been named. In this study, the R_{2b} zone is regarded as a unit, and the relationships between morphospecies here defined and the stratigraphically early or late forms is investigated separately in Chapter 7.

B. bilingue is not distinguished here from *R. bilinguoides* Bisat & Ramsbottom (unpublished MS).

Bilinguites *sp.* aff. *bilingue*

Stratigraphic Range: R_{2b} zone.

Code in Analyses: R2BF (Clusters W3, X4, Z2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	19.0		1.50	.200	.320		.870	.500	.230	0	.600	.240	.020
7.5	.950	.130	22.0		1.40	.200	.300		.810	.600	.250	0	.750	.210	.015
10	.940	.230	22.0		1.30	.100	.280		.740	.740	.250	0	.760	.140	.010
12.5	.910	.280	20.0		1.10	.100	.260		.740	.740	.240	0	.720	.030	0
15	.900	.300	23.0		1.00	.100	.210		.730	.700	.230	0	.670	0	0
20	.950	.300	28.0		1.00	.100	.160		.780	.720	.260	.001	.720	.010	0

Discussion:

Not distinguished in analyses from *B. bilingue* when young, and difficult to separate in practice even in later growth stages.

Bilinguites filobilingue sp. nov.

Plate XIII, 3, 4, 5.

Holotype: GSM AT 3110, from the R_{2b} zone at Buckstone House, Marsden, Yorkshire. For measurements, see Appendix 3, no. 546.

Stratigraphic Range: R_{2b} zone.

Code in Analyses: R2BB (Clusters W5, X5, Y2, Z3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Oh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5	1.00	.110	23.0		2.10	.200	.390		.810	.400	.100	0	0	.340	.020
7.5	1.00	.120	21.0		1.40	.100	.370		.820	.440	.240	.002	.250	.230	.010
10	1.00	.120	20.0		1.00	.100	.330		.840	.520	.330	.009	.520	0	0
12.5	.950	.300	23.0		1.00	.100	.270		.850	.560	.290	.015	.470	0	0
15	.950	.440	25.0		1.00	.100	.220		.840	.540	.250	.019	.460	0	0
20	1.00	.100	25.0		1.00	.100	.150		.750	.400	.210	.014	.530	0	0

Discussion:

Particularly notable for a slight umbilical projection on the aperture, which is not developed to the same extent in other contemporary forms, and for the very slight plications, although this criterion is difficult to use reliably. Otherwise it is close to B. bilingue.

Bilinguites metabilingue (Wright)

Plate XIII, 6-8.

v. Reticuloceras reticulatum early mut.γ Wright, 1926,pl.xii,figs.1,2,6.
Reticuloceras reticulatum mut. metabilingue Wright, 1927, p. 114.
Reticuloceras eometabilingue Ramsbottom, 1969, p.75.

Holotype: GSM 37920, from R_{2b} zone above the Helmshore Grit, Witton Farm, Longworth Valley, Egerton, Lancashire. For measurements, see Appendix 3, no. 592.

Stratigraphic Range: R_{2b} zone.

Code in Analyses: R2BE (Clusters W4, X7, Y3, Z7)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Oh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5	1.00	0	19.0		2.00	.200	.460		.940	.900	.280	.001	.020	.420	.050
7.5	.900	.200	19.0		1.80	.200	.410		.910	.900	.280	.001	.120	.320	.030
10	.830	.400	18.0		1.70	.200	.350		.850	.380	.280	0	.280	.230	.015
12.5	.800	.420	17.0		1.60	.100	.300		.790	.760	.270	0	.560	.150	.010
15	.360	.380	13.0		1.50	.100	.260		.720	.600	.210	0	.720	.100	.005
20	.870	.360	20.0			.100	.220		.710	.980	.360	0	.840	.060	0

Discussion:

Spirals and crenulation are relatively strong. The lingua is strong but does not project greatly from the aperture because of the arching back of the ocular sinus on the flanks.

The type material of B. eometabilingue (Ramsbottom, 1969) is included in this morphospecies. The stratigraphic use of this previously recognised species is investigated in Chapter 7.

Bilinguites sp. ~~aff.~~ metabilingue

Stratigraphic Range: R_{2b} zone.

Code in Analyses: R2BH (Clusters Y6, Z6)

Character Values: see data for clusters R2BY6 & Z6, Section 4.1.2.

Discussion:

Manifested as a distinct form only in the few poorly preserved specimens forming two clusters.

Bilinguites beta sp. nov.

Plate XII, 5; XIII, 9.

Reticuloceras reticulatum mut.β, Bisat, 1924, pl. iii, fig. 9.

Reticuloceras (cf.?) bilingue Patteisky, 1959, pl. vi, fig. 22.

Holotype: BMC 25756, from R_{2b} zone in the Saltaire boring, Yorkshire.

For measurements, see Appendix 3b.

Stratigraphic Range: R_{2b} zone.

Code in Analyses: R2BC (Clusters W2, X1, Y5, Z4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Dw/Ds	W/Hw	Ml/Hw	Pl/Hw	Do/Hw	Po/Hw	Oh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	24.0		2.00	.100	.350		.700	.520	.160	0	.460	.360	.020
7.5	.900	.200	23.0		1.70	.100	.300		.680	.520	.160	0	.540	.260	.012
10	.850	.300	22.0		1.50	.100	.250		.700	.510	.170	0	.580	.180	.010
12.5	.880	.350	26.0		1.20	.100	.240		.700	.510	.180	.002	.600	.120	.003
15	.900	.370	25.0		1.10	.100	.230		.700	.520	.200	.001	.600	.080	.001
20	.880	.500	18.0		1.00	.100	.220		.680	.580	.210	.001	.630	.020	.005

Discussion:

Moderately evolute, and with strong plications, but especially notable for its pronounced crenulation and spiral ornament.

First named by Bisat & Ramsbottom (1969, unpublished MS) whose holotype is adopted here.

Bilinguites pulobilingue sp. nov.

Plate XII, 6.

Reticuloceras reticulatum mut.β Bisat, 1924, pl.iii, fig. 7.

Eumorphoceras bilingue (Salter) H. Schmidt, 1925, pl. xxv, fig.22.

Reticuloceras bilingue (Salter) Demanet, 1941, pl. xviii, fig.5.

Holotype: GSM AT 3618, from R_{2b} zone at Pule Hill, Marsden, Yorkshire.

For measurements, see Appendix 3, no. 467.

Stratigraphic Range: R_{2b} zone.

Code in Analyses: R2BD (Clusters W1, X2, Y4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	De/Hw	Pe/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.960	.150	20.0		1.50	.200	.310		.820	.540	.230	.009	.420	.260	.020
7.5	.920	.230	20.0		1.40	.200	.270		.820	.540	.240	.006	.480	.180	.010
10	.900	.340	23.0		1.30	.100	.260		.820	.550	.240	.002	.560	.140	.005
12.5	.930	.320	28.0		1.30	.100	.280		.790	.680	.240	.001	.600	.100	.005
15	.920	.360	24.0		1.30	.100	.280		.770	.800	.230	.001	.720	.090	.005
20	.810	.640	17.0		1.30	.100	.240		.670	.560	.230	0	.750	.120	0

Discussion:

Particularly evolute in early ontogeny, and striae are coarsely spaced. Lingua strongly projected.

First named by Bisat & Ramsbottom (1969, unpublished MS) whose holotype is adopted here.

Bilinguites sp. aff pulobilingue

Stratigraphic Range: R_{2b} zone.

Code in Analyses: R2BG (Clusters W1, X3, Z5)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Oh/Hw	Lt/Hw	Ht/Hw
5	.960	.150	20.0		1.50	.200	.310		.920	.540	.230	.009	.420	.260	.020
7.5	.920	.230	20.0		1.40	.100	.270		.820	.540	.240	.006	.480	.180	.010
10	.900	.250	20.0		1.30	.100	.260		.920	.550	.240	.002	.560	.140	.005
12.5	.880	.200	18.0		1.40	.100	.230		.760	.680	.200	.001	.740	.130	.008
15	.880	.240	15.0		1.50	.100	.230		.760	.800	.200	0	.810	.120	.010
20	.900	.270	15.0		1.80	.100	.220		.800	.620	.260	0	.750	.160	.010

Discussion:

Not distinguished in analysis from B. pulobilingue when young, and postulated later ontogeny is anomalous; consequently the validity of the morphospecies is uncertain. The anomalous specimen forming cluster R2BY7 (no. 496, Plate XII, 7) may be related to this form.

Bilinguites superbilingue (Bisat)

Plate XIV, 2.

Reticuloceras reticulatum mut.γ Bisat, 1924, pl. v, figs. 6, 7.

Reticuloceras reticulatum mut. superbilingue Bisat, 1924, p. 51.

Eumorphoceras superbilingue (Bisat) H, Schmidt, 1925, pl.xxv,fig.26.

Reticuloceras superbilingue Bisat; Demanet, 1941, pl.xviii, fig. 7.

Reticuloceras (Bilinguites) superbilinguis (Bisat) Librovitch, 1946, p. 79.

Reticuloceras superbilingue superbilingue Bisat; Patteisky, 1959, pl. ix, figs. 19-33.

Bilinguites superbilinguis (Bisat) Ruzhentsev & Bogoslovskaya, 1978, pl. xxxvii, fig. 5.

Lectotype: BMC C25763, from R_{2c} zone from a borehole at Brow Grains, Meltham, Yorkshire. For measurements, see Appendix 3b.

Stratigraphic Range: R_{2c} to G_{2a} zones.

Code in Analyses: R2CA (Cluster Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Oh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	24.0		1.50	.100	.230		.810	.740	.220	.005	.470	.120	.015
7.5	.980	.080	24.0		1.20	.100	.220		.790	.700	.220	.003	.630	.070	.005
10	.950	.130	25.0		1.10	.100	.200		.780	.640	.240	.002	.730	.040	0
12.5	.940	.170	26.0		1.00	.100	.180		.770	.610	.290	.002	.780	0	0
15	.940	.220	33.0		1.00	.100	.160		.750	.590	.240	.002	.770	0	0
20.	.950	.230	43.0		1.00	.100	.160		.720	.570	.220	.001	.730	0	0

Discussion:

Highly involute and also distinguishable from R_{2b} zone morphospecies by its almost complete lack of crenulation, except on the lingua.

Bilinguites sp. aff. superbilingue

Plate XIV, 1.

Stratigraphic Range: R_{2c} ?to G_{2a} zones.

Code in Analyses: R2CB (Cluster Z2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	De/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	27.0		1.30	.100	.290		.840	.820	.300	0	.520	.040	.010
7.5	.970	.120	24.0		1.10	.100	.220		.800	.740	.270	0	.640	.010	.002
10	.960	.170	22.0		1.00	.100	.170		.750	.650	.240	0	.740	0	0
12.5	.950	.130	25.0		1.00	.100	.150		.720	.600	.200	0	.660	0	0
15	.950	.130	29.0		1.00	.100	.130		.720	.540	.180	0	.630	0	0
20.	.950	.170	36.0		1.00	.100	.120		.720	.480	.160	.001	.580	0	0

Discussion:

In practice, not distinguishable from B. superbilingue - they are separated largely by the persistence of slight plications, which are generally difficult to discern.

Bilinguites golcarensis sp. nov.

Plate XIV, 4.

Reticuloceras superbilingue Bisat; Bouckaert, 1961.

Holotype: GSM AT 3518, from R_{2c} zone at Heath House Wood, near Golcar, Yorkshire. For measurements, se Appendix 3, no. 618.

Stratigraphic Range: R_{2c} zone.

Code in Analyses: R2CC (Cluster Z3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	De/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	12.0		2.00	.100	.390		.860	.880	.340	0	.500	.180	.010
7.5	.980	0	12.0		1.80	.100	.340		.840	.880	.340	0	.670	.160	.007
10	.340	.170	12.0		1.80	.100	.290		.920	.860	.340	0	.740	.140	.007
12.5	.910	.270	13.0		1.80	.100	.230		.800	.850	.330	0	.950	.120	.007
15	.900	.270	16.0		1.90	.100	.190		.790	.900	.300	0	.900	.120	.007
20.	.900	.150	27.0		1.70	.100	.140		.720	.560	.260	0	.780	.110	0

Discussion:

Somewhat more evolute and generally more coarsely ornamented than B. superbilingue.

Bilinguites ruzhentsevi sp. nov.

Plate XIV, 3.

Holotype: GSM Ze 2023, from R_{2c} zone at River Ogden, ¾ mile north of Helmshore, Lancashire. For measurements, see Appendix 3, no. 596.

Stratigraphic Range: R_{2c} zone.

Code in Analyses: R2CD (Cluster Z4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Oh/Hw	Lt/Hw	Ht/Hw
5	.960	.080	17.0		2.40	.200	.290	1.30	.940	.150	.270	.002	.300	.400	.025
7.5	.900	.250	17.0		2.10	.100	.270	1.10	.880	.300	.270	.002	.430	.300	.012
10	.900	.230	17.0		1.70	.100	.210	1.00	.800	.540	.270	.002	.580	.200	.008
12.5	.930	.150	18.0		1.50	.100	.180	.900	.740	.700	.260	.002	.630	.100	.003
15	.960	.100	18.0		1.30	.100	.160	.800	.700	.820	.250	.001	.750	.040	.001
20	1.00	.050	20.0		1.00	.100	.120							0	0

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.090	.260	.220	.040	.180	.440	.010	0	.030	.040	0
15	.080	.310	.230	.050	.210	.410	0	0	.020	.050	0
20	.070	.400	.300	.050	.230	.400	0	0	.020	.050	0

Discussion:

Very much more evolute and coarser than the rest of the R_{2c} fauna.

Genus *Retites* McCaleb, 1964

Retites: McCaleb, 1964; McCaleb, 1968; Ruzhentsev & Bogoslovskaya, 1978 (pars.); Manger & Saunders, 1980.

Gastrioceras (*Branneroceras*): Gordon, 1965 (pars.).

Branneroceras: Gordon, 1968 (pars.).

Phillipsoceras: Ruzhentsev & Bogoslovskaya, 1975 (pars.); 1978 (pars.).

Alurites: Ruzhentsev & Bogoslovskaya, 1975 (pars.); 1978 (pars.).

Tectiretites: Ruzhentsev & Boboslovskaya, 1975 (pars.); 1978 (pars.).

Reticuloceras: Saunders, manger & Gordon, 1977 (pars.).

Quinnites: Manger & Saunders, 1980.

Type species: *Re. semiretia*, McCaleb, 1964, from the Hale Formation, Arkansas, U.S.A.

Characteristics

The position in A-space of this genus is shown on Figure 45, and the histograms on Figure 43 indicates that this position corresponds with possession of the following character states:

Shell shape - the most evolute of the Reticuloceratidae *s.l.*

Coarse ornament - tubercles/plications particularly strong and with prominent bifurcation.

Fine ornament - spirals conspicuous, striae widely spaced.

Apertural form - lingua and ocular sinus quite pronounced but umbilical projection not so. Hyponomic sinus weaker than other Reticuloceratidae *s.l.*

Suture - lateral saddle quite broad. Someforms have notably tall lobes and saddles. Terminal prongs on lobes not well developed.

Composition

Re. semiretia McCaleb, 1964; *Re. henbesti* (Gordon, 1965) (*Gastrioceras*); *Re. textum* (Gordon, 1965) (*Gastrioceras*); *Re. alpharhipaeum* (Ruzhentsev & Bogoslovskaya, 1975) (*Phillipsoceras*); *Re. costatus* (R & B, 1975) (*Alurites*); *Re. asianus* (R & B, 1978) (*Alurites*); *Re. hodsoni* (R & B,1975) (*Tectiretites*); *Re. confinis* (R & B, 1978) (*Tectiretites*); *Re. juvenilatus* (R & B, 1978) (*Tectiretites*); *Re. laxus* (R & B, 1978) (*Tectiretites*); *Re. posterus*

(R & B, 1975) (Tectiretites); Re. ortivus R & B, 1978.

Discussion

The genera proposed by previous authors which are here amalgamated were distinguished on monothetic criteria, and each itself incorporated a large variation in other characters. Tectiretites was distinguished by its hood-shaped whorl cross section in later ontogeny; Alurites by its wide umbilicus and narrow whorls; Quinnites by its "Gastrioceratid" suture. The present study shows that these features are not so significant when all morphological characters are considered.

Stratigraphic Range

Throughout R_1 zone in U.S.A. and U.S.S.R.; probably into R_2 in U.S.A.; unknown in Europe.

Genus *Arkanites* McCaleb, Quinn & Furnish, 1964

Eumorphoceras: Quinn, McCaleb & Webb, 1962 (pars.).

Arkanites: McCaleb, Quinn & Furnish, 1964; Ruzhentsez & Bogoslovskaya, 1978; Manger & Saunders, 1980.

Type species: *Eumorphoceras relictus* Quinn, McCaleb & Webb, 1962, from the Hale Formation, Arkansas, U.S.A.

Characteristics

The position in A-space of this genus is shown on Figure 45, and the histograms on Figure 43 indicate that this position corresponds with possession of the following character states:

Shell shape - evolute.

Coarse ornament - strong plications.

Fine ornament - widely spaced with weak spiral striae.

Apertural form - particularly deep ocular sinus and pronounced lingua formed close to the venter.

Suture - similar to *Retites*, but with a particularly high median saddle and a strong convexity of the lateral lobes. (Information from Fig. 54.)

Composition

A. relictus Quinn, McCaleb & Webb, 1962.

Discussion

A very distinctive genus, apparently combining the aperture shape of *Bilinguites* with the shell shape and ornament of *Retites*.

Stratigraphic Range

Near top of Halian, U.S.A.; $?R_{2c}$ and $?G_{1a}$ equivalents.

Genus Cancelloceras Ruzhentsev & Bogoslovskaya, 1971.

Gastrioceras: Bisat, 1923, 1924 (pars.), 1940; H. Schmidt, 1925; Demanet, 1941; Patteisky, 1959; Bouckaert, 1961; Ramsbottom & Calver, 1962 (pars.).

Cancelloceras: Ruzhentsev & Bogoslovskaya, 1971, 1978 (pars.); Popov 1979.

Type species: Gastrioceras cancellatum Bisat, 1923, from G_{1a} zone of Meanwood, near Leeds, Yorkshire.

Characteristics

The position in A-space of this genus is shown on Figure 51; the histograms on Figure 49 show that this posiyion corresponds with possession of the following character states:

Shell shape	- variable, most quite evolute.
Coarse ornament	- tubercles show more bifurcation than most Gastriocer-atidae s.l.
Fine ornament	- strong crenulation and spiral; transverse striae usually widely spaced.
Apertural form	- fairly deep ocular sinus.
Suture	- ventral saddle narrow, lateral saddle low.(From Fig.54)

Composition

C. cancellatum (Bisat, 1923) (Gastrioceras); C. crencellatum (Bisat, 1924) (Gastrioceras); C. branneroides (Bisat, 1940) (Gastrioceras); C. rurae (Schmidt, 1925) (Gastrioceras); C. martini (Schmidt, 1925) (Gastrioceras); C. asianum Ruzhentsev & Bogoslovskaya, 1978; C. parasianum R & B, 1978; C. bisati R & B, 1978; C. elegans R & B, 1978; C. extenuatum R & B, 1978; C. delicatum Popov, 1979; C. tenerum Popov, 1979; C. solidum Popov, 1979; C. cancellatoides sp. nov.; C. evansi sp. nov.

Discussion

As used here, Cancelloceras is close to the original definition, but with some finely ornamented, Gastrioceras-like forms excluded.

Stratigraphic Range

Yeadonian (G_{1a}) in Europe, Nm_2c_2 zone in the U.S.S.R.

Cancelloceras cancellatum (Bisat)

v. Gastrioceras cancellatum Bisat, 1923, pl. viii, figs. 1, 2.

v. Gastrioceras cancellatum Bisat; Ramsbottom & Calver, 1962, pl.xiv, figs. 4, 5.

Cancelloceras cancellatum (Bisat) Ruzhentsev & Bogoslovskaya, 1978, p. 290.

Lectotype: BMC 25767, from the C. cancellatum band, Meanwood,Leeds, Yorkshire. For measurements, see Appendix 4b.

Stratigraphic Range: C. cancellatum horizon, G_{1a} zone.

Discussion:

The lectotype of C. cancellatum regrettably represents a rare form which is not apparent in analyses. It is relatively evolute, with very strong tubercles, and yet has exceptionally fine ornament, like C. evansi. The name G. cancellatum has been used in the past to describe many other commoner forms in G_{1a} zone.

Cancelloceras branneroides (Bisat)

v. Gastrioceras branneroides Bisat, 1940, fig. 2.

Cancelloceras branneroides (Bisat) Ruzhentsev & Bogoslovskaya, 1978, p. 290.

Holotype: GSM 62441, from below the C. cancellatum horizon, Minera Mill, near Wrexham, N. Wales. For measurements, see Appendix 4, no. 15.

Stratigraphic Range: C. branneroides horizon, below C. cancellatum horizon, G_{1a} zone.

Discussion:

Not present in analyses. Most specimens are poorly preserved, but it is apparent that the species has coarse ornament and strong spirals. Large tubercles bifurcate and give rise to ribs. It is probably quite evolute.

Cancelloceras crencellatum (Bisat)

Plate XIV, 8.

v. Gastrioceras cancellatum var. crencellatum Bisat, 1924, pl.iv, fig.6.

Gastrioceras cancellatum Bisat; Demanet, 1941, pl. xviii, fig. 13.

v. Gastrioceras cancellatum crencellatum Bisat; Patteisky, 1959, pl. xi, figs. 3-6, 8-10; pl. xii, fig. 20; pl. xiii, fig. 5.

v. Gastrioceras crencellatum Bisat; Ramsbottom & Calver, 1962, pl. xiv, figs. 6, 7.

Cancelloceras crencellatum (Bisat) Ruzhentsev & Bogoslovskaya, 1978, p. 290.

Lectotype: GSM RE 4330, from the C. crencellatum horizon, G_{1a} zone at Royshaw Brickworks, Blackburn, Lancashire. For measurements, see Appendix 4, no. 27.

Stratigraphic Range: G_{1a} zone.

Code in Analyses: G1AA (Clusters W2, X1, Y2, Z4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.950	.230	27.0	5.80	1.00	.300	.480	1.70			.120	0	.040	.800	.090
7.5	.830	.500	28.0	8.40	1.00	.300	.450	1.65			.090	0	.060	.550	.060
10	.690	.760	28.0	8.50	1.00	.300	.425	1.60	.920	.200	.065	0	.070	.450	.045
12.5	.520	.840	32.0	8.50	1.00	.200	.405	1.60	.890	.180	.053	0	.080	.430	.045
15	.470	.890	37.0	8.50	1.00	.200	.363	1.55	.880	.150	.040	0	.100	.400	.045
20	.660	.860	38.0	8.50	1.00	.100	.315	1.55	.820	.100	.030	.005	.110	.400	.050

Discussion:

Evolute, with long tubercles stretched across the flanks and a characteristically cancellate ornament, which is coarser than C. cancellatum. This morphospecies is probably not equivalent to C. martini (H. Schmidt, 1925), despite the contention of Bisat (1940) to this effect; the latter is more extremely evolute, to an extent not found on British specimens.

Cancelloceras cancellatoides sp. nov.

Plate XIV, 5.

Gastrioceras cancellatum crencellatum Bisat; Patteisky, 1959, pl. xii, fig. 2.

Holotype: GSM ARS 623, from the C. cancellatum horizon, G_{1a} zone. For measorements, see Appendix 4b.

Stratigraphic Range: C. cancellatum , G_{1a} zone.

Code in Analyses: G1AD (Clusters W5, X4, Y4, Z6)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Pe/Hw	Oh/Hw	Lt/Hw	Ht/Hw
5	1.00	.200	21.0	6.00	1.00	.200	.400				.090			.330	.060
7.5	.820	.400	21.0	6.50	1.00	.100	.360				.070	0		.300	.050
10	.650	.780	21.0	7.20	1.00	.100	.325		.800	.150	.050	0		.250	.040
12.5	.550	.980	22.0	7.80	1.00	.100	.295		.760	.110	.035	0		.220	.033
15	.460	.830	26.0	8.70	1.00	.100	.250		.710	.070	.035	.005		.170	.028
20	.480	.760	26.0	9.50	1.00	.100	.225		.680	.050	.037	.008		.150	.022

Discussion:

This morphospecies has coarser ornament and larger tubercles than C. evansi. It is the morphospecies most often identified as C. cancellatum by virtue of its relative abundance.

Cancelloceras sp. aff. cancellatoides

Stratigraphic Range: G_{1a} zone.

Code in Analyses: G1AE (Clusters W5, X4, Z5)

Character Values: see data for cluster G1AZ5, Section 4.1.3.

Discussion:

Only distiguished in later ontogeny, when it retains a more evolute shape than C. cancellatoides.

Cancelloceras evansi sp. nov.

Plate XIV, 6.

Gastrioceras cancellatum Bisat; Demanet, 1941, pl.xviii, figs.10,11.

Holotype: GSM LZB 1621, from the C. cancellatum marine band, at Glyn Neath Bank, South Wales. For measurements, see Appendix 4b.

Stratigraphic Range: C. cancellatum horizon, G_{1a} zone.

Code in Analyses: G1AB (Clusters W1, X1, Y1, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Oh/Hw	Lt/Hw	Ht/Hw
5	.380	.620	40.0	6.00	1.00	.200	.400		.900	.290	.085	0	.050	.350	.120
7.5	.750	.820	48.0	6.70	1.00	.100	.350		.840	.250	.070	0	.070	.320	.075
10	.580	.320	52.0	7.00	1.00	.100	.315		.820	.220	.060	0	.090	.300	.045
12.5	.510	.810	53.0	7.50	1.00	.100	.300		.800	.200	.057	0	.130	.260	.022
15	.450	.800	52.0	8.00	1.00	.200	.255	1.65	.770	.150	.050	.010	.230	.220	.013
20	.430	.800	53.0	8.50	1.00	.100	.250	1.50	.730	.120	.047	.020	.240	.200	.015

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.130	.230	.190	0	.180	.380	.021	0	.042	.033	0
15	.170	.300	.290	.040	.200	.410	.023	0	.042	.038	0
20	.160	.300	.330	.070	.210	.360	.035	0	.013	.017	0

Discussion:

This morphospecies has extremely fine transverse striae, and this tends to emphasise the spiral ornament, which is consequently often dominant. Tubercles are quite small, and the shell is involute compared to most other *Cancelloceras* species. It is perhaps the commonest element of the fauna. *C. evansi* is probably the same form as that called *Gastrioceras sp. nov.* by Heptonstall (1964, unpublished thesis).

Cancelloceras sp. aff. *evansi*

Stratigraphic Range: G_{1a} zone.

Code in Analyses: G1AG (Clusters W1, X1, Y4, Z3)

Character Values: see data for cluster G1AZ3, Section 4.1.3.

Discussion:

Distinct only at one ontogenetic stage and the ontogeny is difficult to reconstruct. The cluster consists largely of poorly preserved specimens which nevertheless show characteristic fine ornament.

Genus *Agastrioceras* Schmidt, 1938.

Ammonites: von Buch, 1832; Beyrich, 1884.

Glyphioceras: Frech, 1902.

Eumorphoceras: C. Schmidt, 1924 (pars.).

Gastrioceras: Haug, 1898 (pars.); Foord, 1903; Wedekind, 1914; C. Schmidt, 1924 (pars.); H. Schmidt, 1924 (pars.); Chalmers, 1936 (pars.); Delepine, 1937; Demanet, 1943; Ramsbottom & Calver, 1962 (pars.); Patteisky, 1965 (pars.); Popov, 1979.

Agastrioceras: Schmidt in Kukuk, 1938; Patteisky, 1959, 1965; Ramsbottom & Calver, 1962; Nassichuk, 1975.

Type species: *Glyphioceras subcrenatum* var. *carinata* Frech, from G_{1a} zone of West Germany.

Characteristics

The position in A-space of this genus is shown on Figure 51, and the histograms on Figure 49 indicate that this position corresponds with possession of the following character states:

Shell shape - the most involute of the Gastrioceratidae *s.l.*

Coarse ornament - tubercles small or absent.

Fine ornament - striae closely spaced, crenulation usually weak.

Apertural shape - relatively deep hyponomic sinus and shallow ocular sinus.

Suture - ventral saddle wide relative to outer saddle; all saddles low; lateral lobe simple.(From Fig.54.)

Composition

A. carinatum (Frech, 1902) (*Glyphioceras*); *A. crenulatum* (Bisat,1924) (*Gastrioceras*); *A. cumbriense* (Bisat, 1924) (*Gastrioceras*); *A. subcrenatum* (Beyrich, 1884) (*Ammonites*); *A. circumnodosum* (Foord, 1903) (*Gastrioceras*); *A. retrorsum* (Chalmers, 1936) (*Gastrioceras*); *A. amaliae* (Schmidt, 1938) (*Gastrioceras*); *A. adleri* Patteisky, 1965; *A. depressum* (Delepine, 1937) (*Gastrioceras*); *A. lupinum* (Popov, 1979) (*Gastrioceras*); *A. kutejnikovense* (Popov, 1979) (*Gastrioceras*); *A. magrawi sp. nov.*; *A. calveri sp. nov.*; *A. noncrenatum sp. nov.*; *A. spiralis sp. nov.*; *A. belgiensis sp. nov.*; *A. subcoronatum sp. nov.*

Discussion

The original generic definition of Agastrioceras, which only encompassed forms without tubercles, is here expanded to include forms with small tubercles, if associated with fairly involute shell shape and fine ornament. There is no objective discrete boundary between possession of small tubercles and absence of tubercles.

Stratigraphic Range

Yeadonian (G_{1a} zone) to Westphalian C.

Agastrioceras carinatum (Frech)

Plate XIV, 7.

Glyphioceras subcrenatum var. carinata Frech, 1902, pl.xlvi.b, figs.1,2.

Eumorphoceras carinatum (Frech) C. Schmidt, 1924, pl.xiv, figs. 1,2.

v. Agastrioceras carinatum (Frech) Patteisky, 1959, pl. x, figs. 1-12; pl. xi, figs. 26-29; pl. xii, figs. 1-3, 14-17; pl. xiii, figs.4,22.

v. Agastrioceras carinatum (Frech) Ramsbottom & Calver, 1962, pl.xiv,fig.8.

Agastrioceras carinatum (Frech) Patteisky, 1965, pl. iii, fig. 11.

Holotype: The specimen figured by Frech (1902, pl. xlvi.b, fig.2) from Essen, West Germany. For measurements, see Appendix 4b.

Stratigraphic Range: C. crencellatum horizon, G_{1a} zone.

Code in Analyses: G1AF (Clusters W4, X3, Y5, Z2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5	.940	.300	41.0	7.50	1.00	.200	.340	1.65	.950	.200	.095	0	.010	.270	.025
7.5	.850	.410	44.0	8.00	1.00	.100	.295	1.70	.780	.180	.070	.003	.060	.160	.015
10	.880	.510	45.0	8.50	1.00	.100	.280	1.78	.720	.150	.060	.008	.070	.130	.010
12.5	.790	.580	46.0	8.50	1.00	.100	.275	1.65	.660	.100	.060	.010	.080	.100	.005
15	.700	.650	47.0	8.50	1.00	.100	.270	1.40	.630	.140	.067	.016	.140	.050	0
20	.710	.760	48.0	8.50	1.00	.100	.260	1.30	.610	.160	.072	.020	.230	.040	0

Discussion:

This is the most involute member of the G_{1a} fauna, and is also recognisable by its early loss of tubercles during ontogeny. There is a strong hyponomic sinus, but the ornament is variable, with spirals sometimes prominent.

Agastrioceras sp, aff. carinatum

Stratigraphic Range: G_{1a} zone.

Code in Analyses: G1AC (Clusters W4, X3, Y5, Z7)

Character Values: see data for cluster G1AZ7, Section 4.1.3.

Discussion:

Separate from A. carinatum only at larger sizes, when it becomes less involute.

Agastrioceras crenulatum (Bisat)

Plate XV, 5.

v. Gastrioceras crenulatum Bisat, 1924, pl. v, figs. 1, 4.

Gastrioceras cumbriense Bisat; Delépine, 1941, pl. vii, figs. 18-21.

v. Gastrioceras crenulatum Bisat; Ramsbottom & Calver, 1962, pl. xv, fig.3.

Cancelloceras crenulatum (Bisat) Ruzhentsev & Bogoslovskaya, 1978, p.290.

Lectotype: BMC 25764, from the A. cumbriense horizon, Withins Scar, Haworth, Yorkshire. For measurements, see Appendix 4b.

Stratigraphic Range: G_{1b} zone.

Code in Analyses: G1BC (Clusters W3, X5, Y6, Z4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Oh/Hw	Lt/Hw	Ht/Hw
5	.960	.280	19.0	7.30	1.00	.200	.400	1.90			.075	0	.070	.320	.031
7.5	.900	.500	21.0	7.70	1.00	.200	.330	1.70			.050	0	.060	.250	.030
10	.850	.610	22.0	8.00	1.00	.100	.295	1.50	.900	.090	.035	0	.062	.220	.025
12.5	.850	.700	23.0	7.80	1.00	.100	.290	1.40	.730	.060	.030	.002	.068	.200	.020
15	.810	.820	23.5	7.50	1.00	.100	.280	1.30	.610	.040	.025	.004	.090	.180	.022
20	.740	.870	22.0	7.30	1.00	.100	.270	1.20			.020	.005	.100	.170	.028

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.120	.220	.230	.020	.190	.400	.021	.002	.028	.034	0
15	.100	.200	.230	.010	.180	.330	.015	.001	.020	.040	.002
20	.080	.180	.230	0	.170	.360	.010	0	.020	.040	.004

Discussion:

Moderately involute, but particularly distinctive because its strong crenulation is not associated with any great development of spiral ornament, as is usually the case.

Agastrioceras *sp*. aff. *crenulatum*

Stratigraphic Range: G_{1b} zone.

Code in Analyses: G1BA (Clusters W3, X5, Y4, Z2)

Character Values: see data for clusters G1BY4 & G1BZ2, Section 4.1.3.

Discussion:

Represented by poorly preserved specimens. Apparently more evolute than *A. crenulatum* in later growth stages.

Agastrioceras *cumbriense* (Bisat)

Plate XV, 1, 2.

v. *Gastrioceras* *crenulatum* var. *cumbriense* Bisat, 1924, pl. v, fig.2.
Gastrioceras *cumbriense* Bisat; Patteisky, 1959, pl. xiii, fig. 14.
Gastrioceras *cumbriense* Bisat; Bouckaert, 1961.
v. *Gastrioceras* *cumbriense* Bisat; Ramsbottom & Calver, 1962, pl.xv,fig.1.
Cancelloceras *cumbriense* (Bisat) Ruzhentsev & Bogoslovskaya, 1978,p.290.

Lectotype: Specimen figured by Bisat (1924, pl. v, fig. 2) from the *A. cumbriense* band, Bigrigg, Cumbria. For measurements, see Appendix 4b.

Stratigraphic Range: G_{1b} zone.

Code in analyses: G1BD (Clusters W1, X3, Y3, Z5)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5	.920	0	13.0	8.00	1.20	.500	.450	2.35			.090	0	.070	.550	.100
7.5	.880	.160	12.5	7.70	1.20	.400	.400	1.90	.850	.300	.080	0	.070	.500	.105
10	.850	.240	10.5	7.50	1.60	.400	.370	1.85	.820	.200	.075	.001	.070	.450	.105
12.5	.800	.360	10.0	7.30	1.90	.400	.370	1.80	.800	.220	.070	.002	.075	.450	.105
15	.710	.640	8.50	6.80	2.00	.400	.410	1.70	.780	.150	.055	.005	.080	.450	.100
20	.710	.760	8.00	6.60	2.00	.400	.430	1.60			.030		.080	.400	.085

Discussion:

Rather evolute and coarsely ornamented; Figure 51 shows it to be only marginally includable in *Agastrioceras*.

Agastrioceras *sp*. A aff. *cumbriense*

Stratigraphic Range: G_{1b} zone.

Code in Analyses: G1BF (Clusters W1, X4, Y2, Z5)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.950	.090	14.0	7.50	1.00	.200	.340		.850	.200	.100	0	.120	.420	.065
7.5	.940	.240	15.0	7.50	1.00	.100	.325		.820	.190	.080	0	.090	.350	.050
10	.950	.440	16.5	7.50	1.00	.100	.325		.790	.150	.060	0	.080	.250	.035
12.5	.960	.600	16.5	7.50	1.00	.100	.325		.780	.120	.047	0	.080	.200	.025
15	.980	.760	17.0	7.50	1.00	.100	.330		.750	.100	.030	.010	.070	.230	.020
20	.985	.860	18.0	7.50	1.00	.100	.335		.730	.070	.020	.010	.060	.180	.015

Discussion:

Distinguished only in analyses G1BX and G1BY, when it is somewhat intermediate between A. cumbriense and A. crenulatum.

Agastrioceras sp. B aff. cumbriense

Stratigraphic Range: G_{1b} zone.

Code in Analyses: G1BE (Clusters W2, X3, Y3, Z5)

Character Values: see data for cluster G1BW2, Section 4.1.3.

Discussion:

Distinct only in analysis of smallest specimens. Very close to A. cumbriense; possibly a fabrication resulting from poor preservation.

Agastrioceras subcrenatum (Beyrich)

Plate XVI, 1.

Ammonites carbonarius von Buch, 1832, pl. ii, fig. 9, iv.

Ammonites subcrenatus Schlotheim; Beyrich, 1884, pp. 213-4.

Glyphioceras subcrenatus Schlotheim; Frech, 1902, pl. xlvi,b, fig. 5.

Gastrioceras langenbrahmi Wedekind, 1914, figs. 4, 5.

Gastrioceras carbonarium von Buch = subcrenatum Schlotheim; C. Schmidt, 1924, pl. xvi, fig. 2.

Gastrioceras cumbriense Bisat; Demanet, 1943, pl. viii, figs.2,6,11.

Agastrioceras subcrenatum (Frech) Patteisky, 1965, pl. iii, figs. 14, 17, 18; pl.iv, figs. 2-16.

Lectotype: The specimen figured by von Buch (1832, pl. ii, fig. 9, iv), from the Subcrenatum Marine Band, West Germany. For measurements, see Appendix 4b.

Stratigraphic Range: Basal Westphalian A.

Code in Analyses: G2AD (Clusters U2, V4, W2, X5, Y4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	20.0	8.00	1.00	.200	.390	1.70	.940	0	.080	.010	.030	.140	.010
7.5	1.00	0	20.0	8.00	1.00	.200	.340	1.60	.920	0	.055	.010	.090	.100	.005
10	1.00	0	21.0	8.00	1.00	.200	.290	1.50	.900	0	.045	.015	.170	.060	.002
12.5	1.00	0	23.0	8.00	1.00	.200	.270	1.40	.880	0	.038	.020	.210	.040	.001
15	.320	.200	36.0	8.00	1.00	.100	.255	1.30	.850	.130	.032	.040	.280	.020	0
20	.860	.300	44.0	8.00	1.00	.100	.250	1.20	.800	.250	.035	.060	.310	0	0

Discussion:

A moderately involute morphospecies with fine ornament, reduced tubercles and a fairly sinuous aperture. Older specimens may show almost smooth shell surfaces. Despite the variety of morphology present in G_{2a} zone, and the taxonomic splitting of the fauna advocated here, most published illustrations labelled A. subcrenatum show smooth, poorly crenulate specimens which best fit this morphospecies.

The complex synonymy of A. subcrenatum is dealt with in detail by Ramsbottom and Calver (1962).

Agastrioceras sp. aff. subcrenatum

Plate XVII, 3.

Stratigraphic Range: G_{2a} zone.

Code in Analyses: G2AC (Clusters U2, V4, W6, X3, Y3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	19.0	9.30	1.00	.300	.390	1.90			.075		.060	.370	.030
7.5	1.00	0	22.0	9.10	1.00	.200	.370	1.65	.900	.040	.060	.005	.100	.260	.020
10	.950	.100	24.0	8.80	1.00	.200	.340	1.55	.880	.035	.050	.003	.125	.150	.010
12.5	.880	.300	25.0	8.70	1.00	.200	.320	1.45	.840	.030	.040	.010	.160	.100	.005
15	.860	.400	26.0	8.40	1.00	.200	.305	1.35	.660	.020	.030	.015	.210	.050	.002
20	.860	.400	26.0	7.80	1.00	.200	.305	1.25	.600	.010	.020	.020	.240	.020	.001

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.180	.290	.250	0	.220	.410	.004	.002	.006	.004	0
15	.090	.250	.210	0	.210	.380	.003	.002	.004	.003	.001
20	.080	.210	.180	0	.200	.350	.002	.002	.002	.002	.002

Discussion:

Becomes broader than A. subcrenatum in later ontogeny, and has finer ornament.

Agastrioceras magrawi sp. nov.

Plate XVII, 1, 2.

Gastrioceras cumbriense Bisat; Demanet, 1943, pl. viii, fig. 10.

Holotype: GSM LZB 1359, from the Subcrenatum Marine Band at Windmill Inn, Wrightington, Lancashire. For measurements, see Appendix 4, no. 830.

Stratigraphic Range: G_2 zone, probably only G_{2a}.

Code in Analyses: G2AI (Clusters U5, V6, W7, X1, Y2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lz/Hw	Ht/Hw
5	1.00	0	22.0	9.20	1.50	.200	.420	2.40	.930	.120	.065	.004	.015	.400	.070
7.5	1.00	.050	22.0	9.00	1.40	.200	.380	2.30	.900	.100	.060	.010	.060	.370	.055
10	.950	.150	23.0	8.80	1.30	.200	.365	2.10	.850	.090	.060	.020	.100	.360	.045
12.5	.850	.300	26.0	8.60	1.20	.100	.355	1.90	.780	.070	.060	.030	.150	.340	.035
15	.840	.400	33.0	8.30	1.00	.100	.335	1.70	.600	0	.055	.040	.250	.200	.020
20	.900	.450	39.0	7.70	1.00	.100	.325	1.50	.550	0	.045	.050	.380	.120	.010

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.120	.270	.290	.010	.220	.360	.010	0	.010	.006	0
15	.110	.250	.270	0	.210	.350	.015	0	0	.003	0
20	.100	.230	.230	0	.200	.330	.010	.001	0	0	0

Discussion:

Much broader than *A. subcrenatum*, and with crenulation only strong on the tubercles. Ornament is much finer, but the diameter of the umbilicus is rather variable; specimens from the Embury Shale of Devon are more involute than those illustrated here. Fragments of older specimens are very similar to those of *A. subcrenatum*.

Agastrioceras sp. aff. *magrawi*

Stratigraphic Range: G_{2a} zone.

Code in Analyses: G2AH (Clusters U1, V5, W7, X2, Y1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lz/Hw	Ht/Hw
5	1.00	.050	20.0	9.00	1.20	.200	.415	2.50			.085		.060	.450	.060
7.5	1.00	.050	20.0	8.80	1.20	.200	.400	2.25	.930	.130	.055	.003	.080	.360	.045
10	1.00	.050	22.0	8.70	1.10	.200	.380	2.05	.900	.120	.045	.007	.100	.310	.035
12.5	1.00	.100	24.0	8.60	1.10	.200	.370	1.90	.870	.110	.035	.010	.110	.270	.030
15	1.00	.150	30.0	8.70	1.10	.200	.340	1.70	.810	.090	.030	.030	.150	.230	.025
20	.960	.200	38.0	9.50	1.00	.200	.315	1.60	.750	.080	.030	.050	.200	.220	.020

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.190	.380	.340	.040	.220	.330	.030	.001	.015	.015	0
15	.200	.320	.300	.030	.240	.340	.023	.002	.010	.005	0
20	.210	.270	.230	.020	.250	.310	.016	.003	.005	0	0

Discussion:

Early ontogeny uncertain. Specimens allocated here are poorly preserved; features appear to be similar to *A. magrawi* but less extreme.

Agastrioceras calveri *sp. nov.*

Plate XV, 6, 7.

Holotype: GSM CL 194, from the Embury Shale, probably G_{2a} zone, Hescott quarry, near Hartland, Devon. For measurements, see Appendix 4, no.921.

Stratigraphic Range: Embury Shale, probably G_{2a} zone.

Code in Analyses: G2AJ (Clusters U8, V8, W8)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.920	.200	14.0	9.30	2.20	.400	.380	2.05	.950	.150	.065	.010	.030	.380	.060
7.5	.940	.200	15.0	9.20	2.10	.400	.340	1.85	.900	.120	.055	.015	.080	.320	.045
10	.980	.150	16.0	9.10	2.00	.300	.310	1.70	.860	.100	.050	.020	.150	.240	.030
12.5	1.00	.100	17.0	9.00	1.70	.300	.295	1.60	.820	.080	.045	.026	.220	.180	.020
15	1.00	.100	20.0	9.00	1.00	.300	.275	1.45	.770	.070	.035	.030	.320	.020	.010
20	1.00	.100	24.0	9.00	1.00	.300	.260	1.30		.050	.025		.400	0	.005

Discussion:

Rather broad and with distinctive sinuous, coarse striae. Possibly restricted to South West England.

Agastrioceras spiralis *sp. nov.*

Plate XVI, 4, 5.

Holotype: GSM LZB 1435, from the Subcrenatum Marine Band, Heaton House, Upholland, Lancashire. For measurements, see Appendix 4, no. 877.

Stratigraphic Range: G_{2a} zone.

Code in Analyses: G2AE (Clusters U3, V3, W5, X4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.900	.100	16.0	10.0	1.00	.300	.360	1.85			.030		.080	.400	.040
7.5	.880	.200	18.0	9.50	1.00	.200	.345	1.75	.900	.040	.070	.005	.120	.270	.025
10	.880	.250	20.0	9.20	1.00	.200	.335	1.62	.870	.035	.063	.003	.150	.160	.015
12.5	.870	.350	21.0	9.00	1.00	.200	.328	1.53	.840	.030	.056	.010	.170	.070	.005
15	.860	.500	24.0	9.00	1.00	.100	.317	1.35	.660	.020	.045	.015	.210	.030	0
20	.860	.550	27.0	9.00	1.00	.100	.310	1.20	.600	.010	.035	.020	.240	.010	0

Discussion:

Shows the strongest ornament of G_{2a} zone morphospecies. Striae considerably coarser than A. subcrenatum. This is the most abundant morphospecies in collections from bullions in Lancashire, and occurs commonly crushed in shale elsewhere, but seems to have eluded description previously.

Cluster G2AW3 (specimen no. 869, Plate XVI, 6) is a related but anomalous single specimen with particularly well developed crenulation and tubercles

Agastrioceras sp. A. aff. spiralis

Plate XVI, 2.

Stratigraphic Range: G_{2a} zone.

Code in Analyses: G2AG (Clusters U3, V3, W1, X4)

Character Values: see data for cluster G2AW1, Section 4.1.3.

Discussion:

Distinct only in one analysis, when it is similar but with smaller tubercles.

Agastrioceras sp. B aff. spiralis

Stratigraphic Range: G_{2a} zone.

Code in Analyses: G2AA . (Clusters U1, V1, X4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	21.0	7.70	1.00	.200	.375	1.90	.900	0	.065	.020	.010	.320	.040
7.5	1.00	0	21.0	7.80	1.00	.200	.350	1.75	.870	0	.055	.020	.090	.300	.020
10	.980	.020	21.0	8.00	1.00	.200	.330	1.65	.860	.030	.050	.018	.140	.250	.015
12.5	.920	.100	21.0	8.10	1.00	.100	.320	1.60	.850	.090	.045	.015	.180	.210	.010
15	.870	.230	24.0	8.20	1.00	.100	.300	1.45	.780	.060	.050	.017	.220	.120	.005
20	.840	.400	29.0	8.00	1.00	.100	.285	1.35	.730	.040	.075	.020	.240	.020	.002

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.160	.290	.330	.060	.210	.390	.023	.001	.013	.025	.001
15	.140	.250	.290	.050	.200	.370	.020	.001	.009	.020	.003
20	.120	.210	.250	.040	.190	.350	.017	.001	.006	.016	.004

Discussion:

Intermediate between A. spiralis and A. subcrenatum.

Agastrioceras noncrenatum sp. nov.

Plate XVI, 3.

Holotype: GSM LZB 1484, from the Subcrenatum Marine Band at Heaton House, Upholland, Lancashire. For measurements, see Appendix 4, no. 912.

Stratigraphic Range: G_{2a} zone.

Code in Analyses: G2AB (Clusters U4, V2, W4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5	1.00	0	36.0	7.60	1.00	.200	.460	2.50	.900	.160	.070	0	.060	.200	.025
7.5	.960	0	36.0	7.70	1.00	.100	.420	2.05	.870	.140	.050	.005	.080	.160	.020
10	.950	.050	37.0	7.80	1.00	.100	.385	1.90	.830	.120	.035	.008	.100	.140	.015
12.5	.950	.100	38.0	8.00	1.00	.100	.360	1.80	.790	.100	.025	.012	.110	.120	.010
15	.950	.100	45.0	8.20	1.00	.100	.325	1.60	.770	.070	.020	.013	.140	.070	.005
20	.950	.200	55.0	8.50	1.00	.100	.300	1.35	.770	.050	.025	.013	.170	.050	0

Discussion:

Crenulation in this morphospecies is amongst the weakest of the G_{2a} zone fauna, otherwise its morphology is average.

Agastrioceras circumnodosum (Foord)

Gastrioceras listeri (Martin) Haug, 1898, pl. i, fig. 28.

Gastrioceras circumnodosum Foord, 1903, pl. xlix, fig. 10.

v. Gastrioceras normalis Chalmers, 1936, pl. ii, figs. 7, 8.

v. Gastrioceras retrorsum Chalmers, 1936, pl. ii, figs. 4, 6.

Gastrioceras circumnodosum Foord; Ramsbottom & Calver, 1962, pl. xv, figs. 6-8.

Gastrioceras circumnodosum Foord; Patteisky, 1965, pl. viii, figs. 7, 10.

Gastrioceras listeri (Martin) Popov, 1979, pl. xi, figs. 4-6.

Lectotype: Specimen figured by Foord (1903, pl. xlix, fig. 10), from the Listeri Marine Band, Firoda, Kilkenny, Rep. of Ireland. For measurements, see Appendix 4b.

Stratigraphic Range: Listeri Marine Band, G_{2b}.

Code in Analyses: G2BD (Clusters U5, V5, W5, X2, Y1, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Oh/Hw	Lt/Hw	Ht/Hw
5	.970	0	43.0	7.20	1.00	.300	.530	2.75	.970		.070	0	.060	.470	.110
7.5	.950	.080	48.0	7.50	1.00	.200	.480	2.50	.950	.250	.055	0	.080	.420	.080
10	.940	.100	48.0	8.20	1.00	.100	.440	2.25	.880	.220	.045	.001	.110	.370	.060
12.5	.940	.150	48.0	9.00	1.00	.100	.390	2.05	.600	.200	.037	.002	.140	.360	.050
15	.940	.200	51.0	10.0	1.00	.100	.352	1.85	.300	0	.030	.020	.220	.330	.040
20.	.920	.250	57.0	10.0	1.00	.100	.336	1.70	.750	0	.025	.030	.300	.290	.030

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.180	.400	.410	.030	.220	.390	.016	0	.010	.009	0
15	.160	.390	.410	.020	.200	.390	.012	0	.007	.009	0
20	.140	.380	.410	.010	.180	.390	.008	0	.004	.009	0

Discussion:

Moderately involute. Ornament is very fine with crenulation strong only around the umbilical rim.

Agastrioceras sp. ~~aff.~~ circumnodosum

Plate XVIII, 3.

Stratigraphic Range: G_{2b} zone.

Code in Analyses: G2BG (Clusters U4, V5, W6, X2, Y1, Z1)

Character Values: see data for clusters G2BU4 & G2BW6, Section 4.1.3.

Discussion:

Ontogeny almost inseparable from A. circumnodosum.

Agastrioceras retrorsum (Chalmers)

Plate XVIII, 4, 5.

Gastrioceras circumnodosum Foord; H. Schmidt, pl. xxvi, figs. 12,13.

v. Gastrioceras retrorsum Chalmers, 1936, pl. ii, fig. 3.

Gastrioceras listeri (Martin) Demanet, 1943, pl. viii, fig. 14.

Holotype: GSM 96455, from the Listeri Marine Band, Ravenhead Quarry, Upholland, Lancashire. For measurements, see Appendix 4, no. 146.

Stratigraphic Range: Listeri Marine Band, G_{2b}.

Code in Analyses: G2BE (Clusters V3, W7, X1, Y1, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	47.0	8.00	1.00	.200	.395	2.20			.050	0	.002	.400	.070
7.5	1.00	.060	49.0	8.20	1.00	.100	.355	2.05	.920	.150	.032	0	.030	.325	.050
10	.980	.120	52.9	8.50	1.00	.100	.343	1.93	.900	.100	.025	0	.055	.260	.040
12.5	.960	.200	54.0	8.60	1.00	.100	.330	1.85	.880	.080	.018	.010	.125	.220	.030
15	.920	.290	58.0	8.80	1.00	.100	.310	1.67	.840	.040	.012	.024	.215	.160	.023
20	.880	.300	61.0	9.00	1.00	.100	.305	1.55	.860	.020	.010	.035	.270	.130	.025

Discussion:

Similar to A. circumnodosum but more involute and with weaker tubercles - consequently it approaches A. subcrenatum in shape.

Of the specimens which Calmers (1936) illustrated, only the holotype belongs to this morphospecies.

Agastrioceras subcoronatum sp. nov.

Plate XVIII, 3.

Holotype: GSM LZB 1112, from the Listeri Marine Band, Ravenhead Brickworks, Shore, Lancashire. For measurements, see Appendix 4, no. 757.

Stratigraphic Range: G_{2b} zone.

Code in Analyses: G2BF (Clusters U3, V2, W2, X3, Y1, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	36.0	6.20	1.00	.300	.485	2.40	.920	.010	.065	0	.020	.440	[illegible]
7.5	.960	.100	32.0	7.30	1.00	.200	.440	2.20	.890	.020	.060	0	.040	.370	.060
10	.900	.120	31.0	8.30	1.00	.200	.415	2.10	.880	.030	.055	0	.055	.330	.050
12.5	.880	.150	30.0	8.80	1.00	.100	.395	2.00	.870	.050	.045	.001	.075	.320	.040
15	.890	.120	31.0	9.20	1.00	.100	.370	1.85	.860	.150	.035	.004	.115	.310	.030
20	.920	.100	35.0	9.30	1.00	.100	.350	1.75	.830	.180	.027	.007	.160	.280	.030

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.160	.310	.330	.050	.200	.360	.030	0	.025	.010	0
15	.140	.290	.330	.020	.180	.330	.022	0	.010	0	0
20	.130	.280	.330	0	.170	.310	.018	0	.005	0	0

Discussion:

Evolute and broad; intermediate between A. circumnodosum and Gastrioceras coronatum.

Agastrioceras adleri Patteiský

Plate XVII, 5, 6.

v. Gastrioceras crenulatum Bisat; Demanet, 1943, pl. vi, figs. 5, 22.

v. Gastrioceras crenulatum var. weristerense Demanet, 1943, pl. vii, figs. 5, 11, 14.

Gastrioceras weristerense Demanet; Bouckaert, 1961, fig. 4.

v. Agastrioceras adleri Patteisky, 1965, pl. v, figs. 5-11.

Holotype: Specimen figured by Patteisky (1965, pl. v, fig. 5) from the Listeri Marine Band, Essen, West Germany. For measurements, see Appendix 4b.

Stratigraphic Range: Listeri Marine Band, G_{2b}.

Code in Analyses: G2BH (Clusters U6, V6, W4, Y2, Z2)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	De/Hw	Pe/Hw	Dh/Hw	Lt/Hw	Ht/Hw
6	.840	.300	16.0	9.00	1.40	.300	.450	2.55	.990	.100	.073	.005	.035	.430	.075
7.5	.800	.500	16.0	8.70	1.30	.300	.405	2.10	.980	.050	.057	.010	.070	.430	.060
10	.810	.650	16.0	8.50	1.30	.200	.365	1.90	.940	.020	.047	.015	.105	.400	.045
12.5	.720	.800	16.0	8.30	1.40	.200	.350	1.70	.930	0	.035	.020	.140	.390	.040
16	.820	.800	16.0	8.00	1.40	.200	.335	1.60	.900	0	.025	.030	.190	.370	.040
20	.810	.850	17.0	7.70	1.40	.200	.330	1.60	.850	0	.017	.035	.230	.350	.040

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.290	.360	.420	.070	.280	.400	.045	0	.020	.010	.003
16	.250	.340	.390	.050	.260	.390	.034	.001	.010	.020	.008
20	.210	.330	.380	.030	.230	.390	.025	.002	0	.025	.018

Discussion:

Moderately evolute, striae quite widely spaced and crenulate in young specimens. Spiral ornament often conspicuous.

Patteisky (1965) erroneously included this species in Agastrioceras on the basis of absence of tubercles. The type specimens, though crushed, do, in fact, have tubercles, but A. adleri is retained in the genus here on the basis of other shell characters, though only marginally.

This morphospecies occurs in England as well as continental Europe.

Agastrioceras belgiensis sp. nov.

Plate XVII, 4.

v. *Gastrioceras crenulatum* Bisat; Demanet, 1943,pl.vi,figs.2,9,10,16,18.

v. *Gastrioceras crenulatum* var. *weristerense* Demanet, 1943, pl. vii, figs. 3,6,7,15,18.

Gastrioceras weristerense Demanet; Bouckaert, 1961, figs.1,2,3,5.

Holotype: Specimen figured by Demanet (1943, pl.vii, fig.7) from the Listeri Marine Band, Werister, Belgium. For measurements see App. 4b.

Stratigraphic Range: Listeri Marine Band, G_{2b}.

Code in Analyses: G2BA (Clusters V4, W1, X7)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.960	.330	22.0	5.80	1.40	.400	.445	2.50	.980	.250	.030	0	.010	.370	.100
7.5	.900	.430	20.0	6.00	1.40	.300	.425	2.25	.950	.200	.027	0	.030	.360	.080
10	.850	.500	18.0	6.30	1.40	.200	.410	2.10	.880	.100	.026	0	.050	.370	.075
12.5	.820	.550	17.0	6.80	1.80	.200	.400	2.05	.820	.050	.025	0	.080	.380	.070
15	.780	.600	15.0	7.70	2.50	.200	.390	1.95	.710	0	.017	.002	.140	.390	.070
20	.760	.600	14.0	8.80	2.50	.200	.385	1.90	.680	0	.010	.003	.200	.400	.070

Discussion:

Intermediate between *A. adleri* and *Gastrioceras weristerense* in most characters; it is consequently close to inclusion in *Gastrioceras* (see Figure 51. It occurs in England as well as continental Europe.

Genus *Gastrioceras* Hyatt, 1884

Ammonites: Sowerby, 1825; Beyrich, 1884.

Gastrioceras: Hyatt, 1884; Foord & Crick, 1897 (pars.); Haug, 1898; Wedekind, 1914; C. Schmidt, 1924; Wright, 1927; Chalmers, 1936 (pars.); Demanet, 1943 (pars.); Ramsbottom & Calver, 1962 (pars.); Patteisky, 1965 (pars.); McCaleb, 1968 (pars.); Nassichuk, 1975 (pars.).

Lissogastrioceras: Gordon, 1965 (pars.); Nassichuk, 1975 (pars.).

Cancelloceras: Ruzhentsev & Bogoslovskaya, 1971, 1978 (pars.); Manger & Saunders, 1980.

Type species: *Ammonites listeri*, Sowerby, 1812, from Westphalian A of England.

Characteristics

The position in A-space of this genus is shown on Figure 51, and the histograms of Figure 49 show that this position corresponds with possession of the following character states:

Shell shape - evolute.
Coarse ornament - strong tubercles, often bifurcating.
Fine ornament - widely spaced, usually poorly crenulate.
Apertural form - hyponomic sinus relatively weak, ocular sinus strong.
Suture - lobes and saddles tall; ventral saddle large; prongs on lobes well developed. (Information from Fig. 54).

Composition

G. listeri (Sowerby, 1825) (*Ammonites*); *G. lineatum* Wright, 1927; *G. coronatum* Foord & Crick, 1897; *G. weristerense* Demanet, 1943; *G. araium* McCaleb, 1968; *G. melvillensis* Nassichuk, 1975; *G. contractum* (Ruzhentsev & Bogoslovskaya, 1978) (*Cancelloceras*); *G. dilatatum* (R & B, 1978) (*Cancelloceras*); *G. infans* (Popov, 1979) (*Cancelloceras*); *G. huntsvillense* (Manger & Saunders, 1980) (*Cancelloceras*); *G. pseudocrencellatum sp. nov.*

Discussion

The genus Gastrioceras is restricted here to the more coronate, coarsely ornamented species of the Gastrioceratidae s.l.

Stratigraphic Range

Marsdenian (R_{2b} zone) to Westphalian A.

Gastrioceras pseudocrencellatum sp. nov.

Plate XV, 3, 4.

Gastrioceras crenulatum Bisat; Patteisky, 1959, pl. xii, figs. 6, 7.

Gastrioceras crenulatum Bisat; Bouckaert, 1961.

Holotype: GSM JS 468, from the A. cumbriense band, Blue Scar Clough, Stanbury Moor, Yorkshire. For measurements, see Appendix 4, no. 41.

Stratigraphic Range: G_{1b} zone.

Code in Analyses: G1BB (Clusters W4, X2, Y1, Z1)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5	.860	.400	14.0	8.00	2.20	.300	.410	1.90	.920	.180	.130	.010	.030	.520	.085
7.5	.750	.680	14.0	8.30	2.00	.200	.375	1.90	.880	.150	.100	.010	.050	.450	.055
10	.700	.750	16.0	8.30	1.30	.200	.372	1.85	.840	.120	.080	.010	.075	.350	.050
12.5	.680	.830	17.5	8.00	1.00	.200	.370	1.80	.800	.100	.060	.010	.070	.300	.040
15	.740	.890	21.5	7.50	1.00	.200	.370	1.60	.780	.170	.025	.002	.060	.260	.030
20	.850	.910	25.0	7.00	1.00	.200	.365	1.50			.020		.060	.230	.025

Discussion:

Quite evolute, with the best developed cancellate ornament in G_{1b} zone. Only marginally included in Gastrioceras rather than Cancelloceras.

Gastrioceras sp. aff. listeri

Stratigraphic Range: Subcrenatum Marine Band (G_{2a} zone).

Code in Analyses: G2AF (Clusters U6, W9)

Matrix of Character Values:

Diam	S	C	T	N	R	P	$\frac{Du}{Ds}$	$\frac{W}{Hw}$	$\frac{Rl}{Hw}$	$\frac{Pl}{Hw}$	$\frac{Do}{Hw}$	$\frac{Po}{Hw}$	$\frac{Dh}{Hw}$	$\frac{Lt}{Hw}$	$\frac{Ht}{Hw}$
5	.960	0	34.0	6.70	1.50	.200	.490	2.80			.042		.045	.400	.170
7.5	.940	.050	22.0	7.20	1.40	.300	.460	2.55	.980	.250	.030	0	.060	.370	.160
10	.950	.100	16.0	7.60	1.30	.400	.440	2.35	.360	.200	.020	0	.080	.360	.150
12.5	.970	.100	10.0	8.00	1.20	.600	.420	2.20	.920	.160	.013	0	.090	.350	.140
15	1.00	.100	6.00	8.50	1.10	.700	.390	1.95	.880	.120	.008	0	.130	.340	.120
20	1.00	.100		8.80	1.00	.600	.375	1.80	.850	.080	.005	0	.150	.330	.110

Discussion:

A rare form known only from poor specimens. It is distinctly coronate when young and resembles *G. listeri*, although not quite so morphologically extreme. The morphospecies is certainly the most evolute and coarsest of G_{2a} zone, and its recognition is important to avoid stratigraphic confusion with the Listeri Marine Band (G_{2b} zone). It has been recorded from Devon and South Wales.

This morphospecies may be equivalent to *G. carbonarium* recorded from the same horizon in Belgium and West Germany, which also has very strong tubercles (see Patteisky, 1965). *G. carbonarium*, however, has only been described as large specimens which are not easily comparable with British material.

Gastrioceras listeri (Sowerby)

Plate XVIII, 1, 2.

Ammonites listeri Sowerby, 1825.

Gastrioceras listeri (Martin) Foord & Crick, 1897.

Gastrioceras listeri (Martin) Haug, 1898, pl. i, figs. 29-31.

Gastrioceras kahrsi Wedekind, 1914, figs. 7, 8.

Gastrioceras listeri (Martin) H. Schmidt, 1924, pl. xxvi, fig. 11.

v. *Gastrioceras listeri* (Martin) Chalmers, 1936, pl. ii, figs. 1, 2.

v. *Gastrioceras listeri* (Martin) Demanet,1943,pl.viii,fig.15;pl.ix.fig.8.

v. *Gastrioceras listeri* (Sowerby) Ramsbottom & Calver,1962,pl.xv,fig. 9.

v. *Gastrioceras listeri* (Sowerby) Patteisky, 1965, pl. v, figs. 12-17; pl. vi, figs. 1-5.

v. *Gastrioceras listeri coronatum* Foord & Crick; Patteisky, 1965, pl. vi, figs. 1-5.

Lectotype: BM 439096, from the Listeri Marine Band, north of Halifax, Yorkshire. For measurements, see Appendix 4b.

Stratigraphic Range: Listeri Marine Band (G_{2b} zone).

Code in Analyses: G2BB (Clusters U1, W3, X6, Z3)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	1.00	0	16.0	4.00	2.40	.300	.550	2.30	.990	.400	.050	0	.005	.520	.160
7.5	.960	0	11.0	4.50	2.30	.700	.500	2.60	.980	.400	.025	0	.020	.490	.140
10	.920	.100	9.00	5.20	2.40	.600	.460	2.35	.960	.420	.022	0	.030	.530	.180
12.5	.910	.200	9.00	6.20	2.70	.600	.450	2.40	.950	.450	.020	0	.045	.500	.140
15	.860	.400	10.0	7.80	3.10	.600	.460	2.30	.930	.220	.015	0	.060	.420	.115
20	.830	.300	10.0	9.20	3.50	.600	.495	2.40	.910	.150	.010	0	.065	.390	.110

Discussion:

Quite a distinctive morphospecies: very coronate, with coarse ornament and crenulate only around the umbilicus.

Gastrioceras coronatum Foord & Crick

v. *Gastrioceras coronatum* Foord & Crick, 1897, p.236.

Holotype: BM 97356, from the Listeri Marine Band, locality unknown. For measurements, see Appendix 4b.

Stratigraphic Range: Listeri Marine Band (G_{2b} zone).

Discussion:

The holotype is of a rare form not present in analyses. The specimens usually referred to this species are extreme forms of *G. listeri*; the true *G. coronatum* has closely spaced striae, and does not have ribs or tubercles developed to the same extent.

This appears to be a case where the chosen type specimen does not correspond with the popular concept of the species.

Gastrioceras weristerense Demanet

v. *Gastrioceras crenulatum* var. *weristerense* Demanet, 1943, pl.vii, figs. 1,2,13.

v. *Gastrioceras crenulatum* Bisat; Demanet, 1943, pl. vi, fig. 3.

v. *Gastrioceras weristerense* Demanet; Patteisky, 1965, pl. ix, fig. 1.

Lectotype (here chosen): the specimen figured by Demanet (1943, pl. vii, fig. 1) from the Listeri Marine Band, Werister, Belgium. For measurements, see Appendix 4b.

Stratigraphic Range: Listeri Marine Band (see Ramsbottom & Calver, 1962).

Code in Analyses: G2BI (Clusters U2, X8, Y4)

Matrix of Character Values:

Diam	S	C	T	N	R	P	Du/Ds	W/Hw	Rl/Hw	Pl/Hw	Do/Hw	Po/Hw	Dh/Hw	Lt/Hw	Ht/Hw
5	.980	.300	26.0	6.50	1.80	.400	.560	3.30			.030	0	.025	.600	.260
7.5	.920	.400	24.0	7.50	1.80	.300	.525	2.80			.025	0	.040	.550	.230
10	.860	.450	21.0	7.50	1.80	.300	.505	2.65	.980	.250	.023	0	.065	.500	.200
12.5	.820	.500	19.0	7.50	1.80	.300	.490	2.55	.960	.220	.020	0	.080	.460	.180
15	.800	.500	16.0	7.50	1.80	.300	.460	2.40	.930	.170	.017	0	.100	.430	.140
20	.790	.550	13.0	7.50	1.80	.300	.440	2.30	.920	.120	.013	0	.100	.390	.110

Diam	a/l	b/l	c/l	d/l	e/l	f/l	g/l	h/l	i/l	j/l	k/l
10	.230	.380	.400	.050	.260	.370	.028	.003	.005	.020	.002
15	.260	.350	.340	.030	.230	.370	.032	.001	.015	.030	.004
20	.280	.330	.300	.020	.210	.370	.036	0	.020	.040	.005

Discussion:

Similar in shape to *G. listeri*, but striae are fine, delicate and extensively crenulate, and spiral ornament is visible.

Gastrioceras sp. aff. *weristerense*

Stratigraphic Range: Listeri Marine Band (G_{2b} zone).

Code in Analyses: G2BC (Clusters U2, X5, Y3)

Character Values: see data for clusters G2BX5 & G2BY3, Section 4.1.3.

Discussion:

Only two specimens; apparently less crenulate than *G. weristerense*.

Genus Lissogastrioceras Gordon, 1965

Gastrioceras: Miller & Owen, 1944 (pars.); McCaleb, 1968 (pars.).

Gastrioceras (Lissogastrioceras): Gordon, 1965; Nassichuk, 1975.

Type species: Gastrioceras fittsi Miller & Owen, 1944, from the Bloyd formation, Arkansas, U.S.A.

Characteristics:

The position in A-space of this genus is shown on Figure 51, and the histograms of Figure 49 indicate that this position corresponds to possession of the following character states:

Shell shape - evolute and particularly broad, some nearly coronate.
Coarse ornament - tubercles very strong. Little sign of bifurcation.
Fine ornament - striae very fine and close. Crenulation and spirals weak.
Apertural form - hyponomic sinus quite shallow, ocular sinus deep.
Suture - median saddle large, terminal prongs on lobes quite well developed.

Composition

L. fittsi (Miller & Owen, 1944) (Gastrioceras); L. attenuatum (McCaleb 1968) (Gastrioceras); L. glenisteri (Nassichuk, 1975) (Gastrioceras (Lissogastrioceras)).

Discussion

Gordon (1965) distinguished Lissogastrioceras on the basis of a monothetic criterion - absence of striae on the venter. Here the concept of the genus is changed slightly to incorporate other characters. The general shell shape is quite distinctive. Note that Gastrioceras araium McCaleb (1968) has had to be excluded from Lissogastrioceras because of this.

The genus is not present in Britain.

Stratigraphic Range

Topmost Namurian and Westphalian.

PLATE I

PLATE I

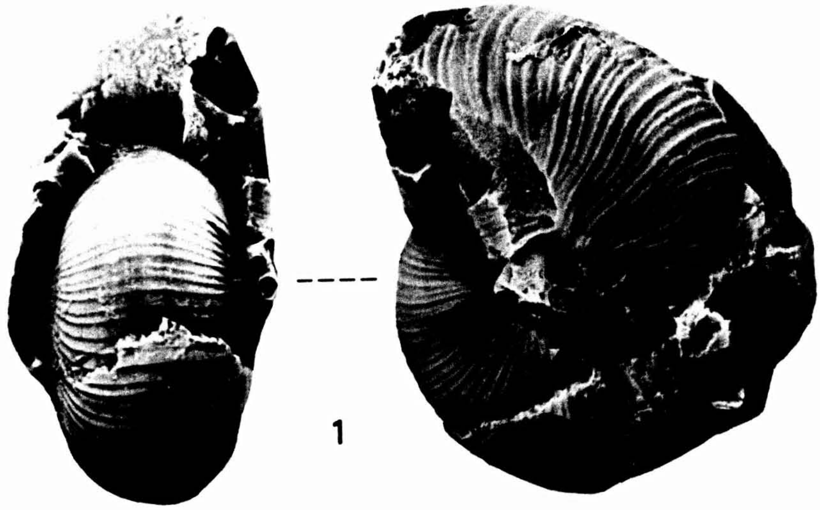
H_{1a} zone Homoceratids

1. *Vallites lancastria sp. nov.* (code H1AA). Spec. no. GSM 82852, from the *H. subglobosum* band at Samlesbury Bottoms, near Blackburn, Lancashire. (IM).
2. *Vallites lancastria sp. nov.* (code H1AA). Holotype. Spec. no. GSM 82854, horizon and locality as for 1. above.
3. *Homoceras subglobosum* Bisat (code H1AC). Spec. no. GSM Zi 4536, from the *H. subglobosum* band, Lisdoonvarna, Co. Clare, Rep. of Ireland. (IM).
4. *Homoceras subglobosum* Bisat (code H1AC). Spec. no. GSM 95364, from the *H. subglobosum* band at Gill Beck, Cowling, Yorkshire. (IM).
5. *Vallites lancastria sp. nov.* (code H1AA). Spec. no. GSM 59993, from the *H. subglobosum* band at Fairborough Wood, Staffordshire.
6. *Vallites lancastria sp. nov.* (code H1AA). Spec. no. GSM LZ 1973, horizon and locality as for 4. above.
7. *Vallites gillense sp. nov.* (code H1AB). Holotype. Spec. no. GSM 59999, horizon and locality as for 5. above.

All photographs X3 magnification.

All specimens in this and the following plates are complete or fragmentary casts, except where the following abbreviations are used:

IM - Internal Mould
EM - External Mould
LC - Laterally Crushed
VLC - Ventro-Laterally Crushed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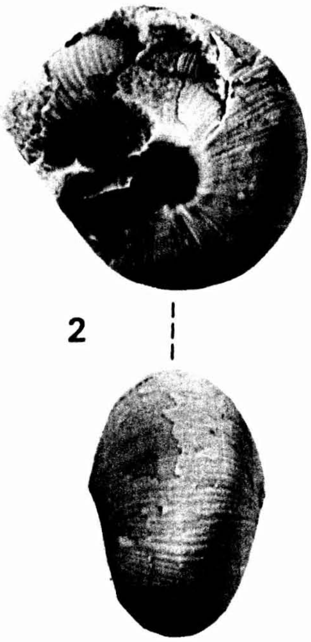
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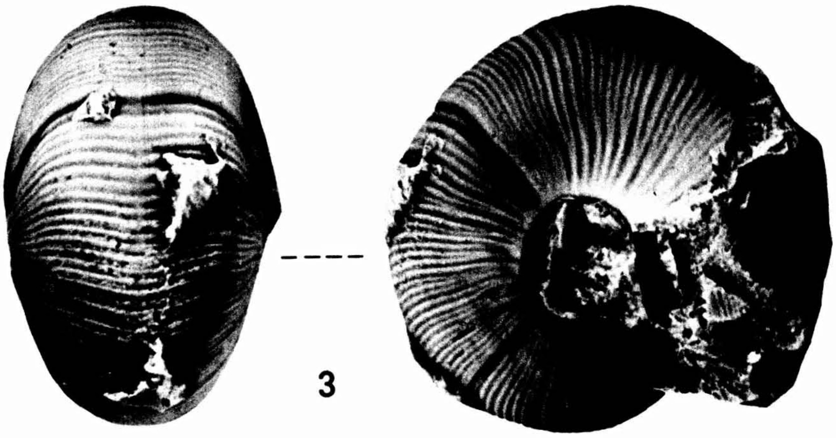
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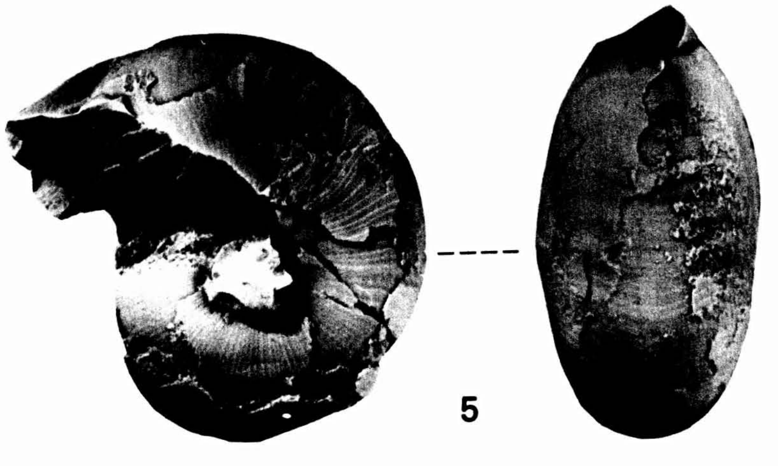
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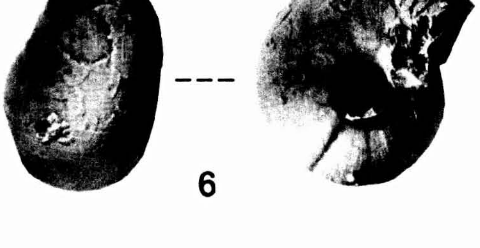
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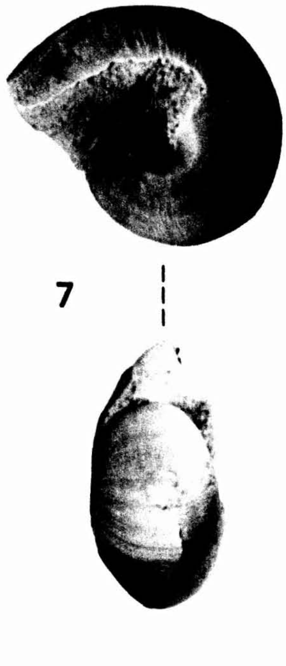
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PLATE II

H_{1b} & H_{2a} zone Homoceratids

1. *Homoceras diadema* (Beyrich) (code H1BA). Spec. no. GSM 50614, from the *B. beyrichianum* band, Lisdoonvarna, Co. Clare, Rep. of Ireland.

2. *Homoceras diadema* (Beyrich) (code H1BA). Spec. no. GSM 50613, horizon and locality as for 1. above.

3. *Homoceras sp.* aff. *diadema* (code H1BB). Spec. no. GSM Ze 1964, from the *B. beyrichianum* band at Mam Tor, Castleton, Derbyshire. (IM).

4. *Bogdanoceras beyrichianum* (De Koninck) (code H1BC). Spec. no. GSM 26296, from the *B. beyrichianum* band at Tenby, Pembrokeshire.

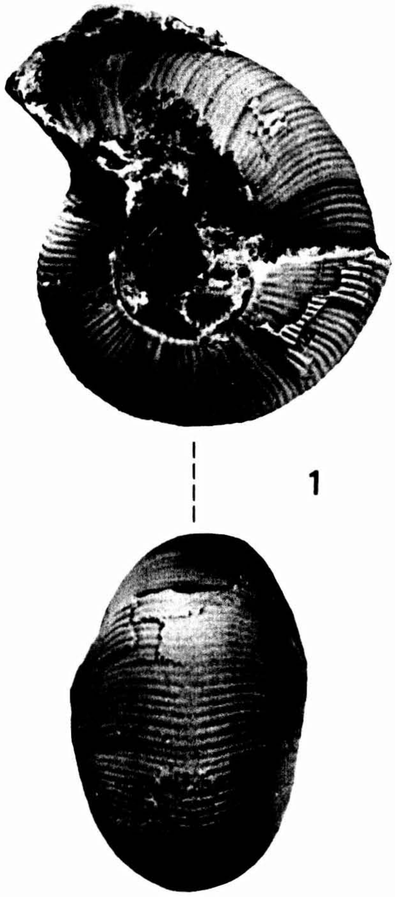
5. *Homoceras smithii* (Brown) (code H2AC/D). Spec. no. GSM Zi 4603, from the *H. smithii* band at River Aille, Phosphate Mine, Doolin, Co. Clare, Rep. of Ireland.

6. *Homoceras smithii* (Brown) (code H2AC/D). Spec. no. GSM Zi 4596, horizon and locality as for 5. above.

7. *Homoceras gibsoni sp. nov.* (code H2AE). Spec. no. GSM Zi 4607x, horizon and locality as for 5. above.

8. *Homoceras gibsoni sp. nov.* (code H2AE). Holotype. Spec. no. GSM Zi 4606, horizon and locality as for 5. above.

For notes, see Plate I.



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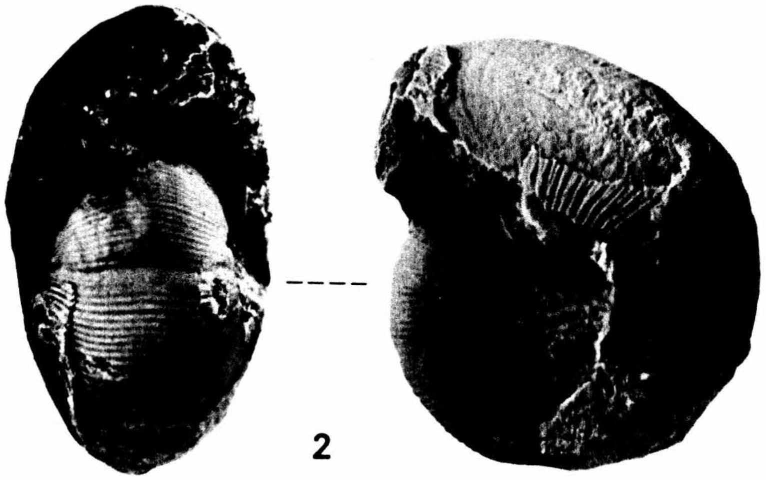

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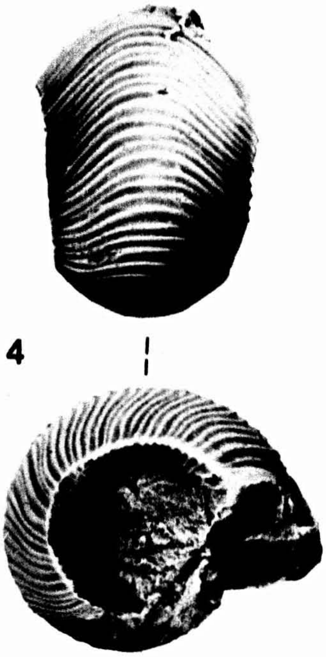

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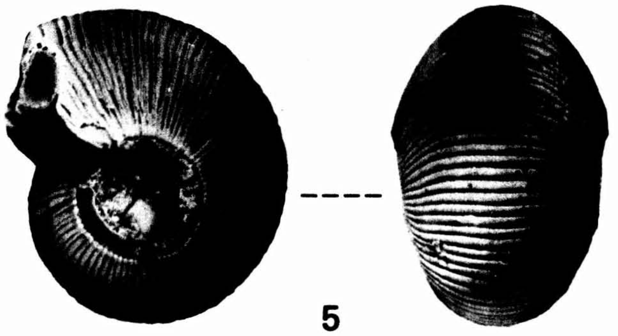

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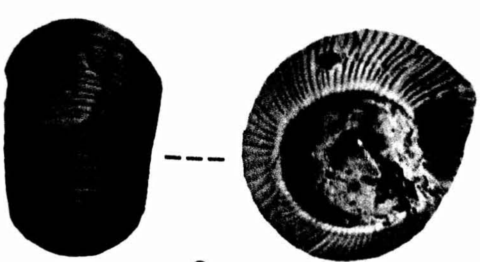

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PLATE III

PLATE III

H_{2b} zone Homoceratids

1. Homoceras parundulatum sp. nov. (code H2BA). Spec. no. GSM Zi 4548 2217, from the H. undulatum band, River Aille, Doolin, Co. Clare, Rep. of Ireland.

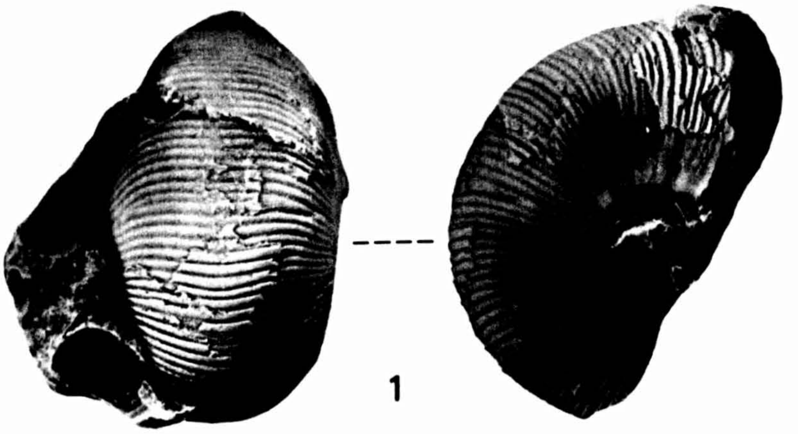
2. Homoceras sp. aff. undulatum (code H2BC). Spec. no. GSM Zi 4548 2154, horizon and locality as for 1. above. (IM).

3. Homoceras undulatum (Brown) (code H2BD). Spec. no. GSM Zi 4548 2152, horizon and locality as for 1. above. (IM).

4. Homoceras sp. aff. parundulatum (code H2BB). Spec. no. GSM Zi 4548 K43/30, horizon and locality as for 1. above.

5. Homoceras parundulatum sp. nov. (code H2BA). Holotype. Spec. no. GSM Zi 4548 2076, horizon and locality as for 1. above. (IM).

For notes, see Plate I.



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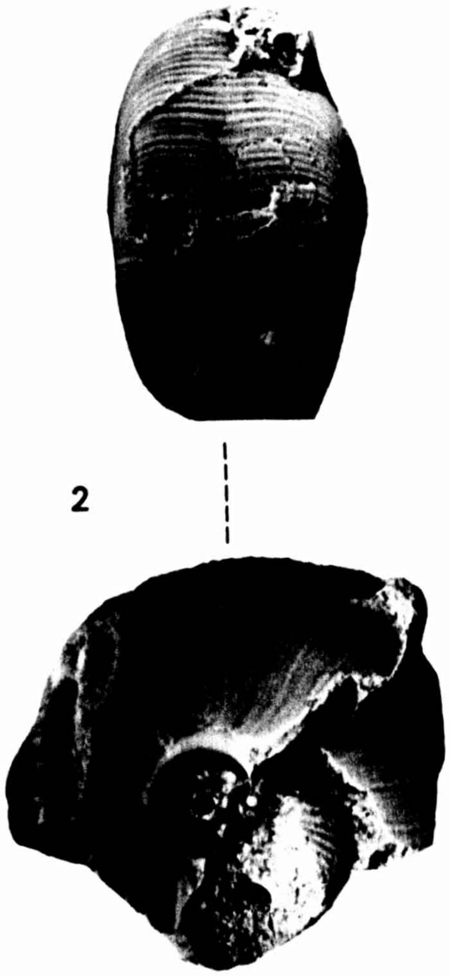

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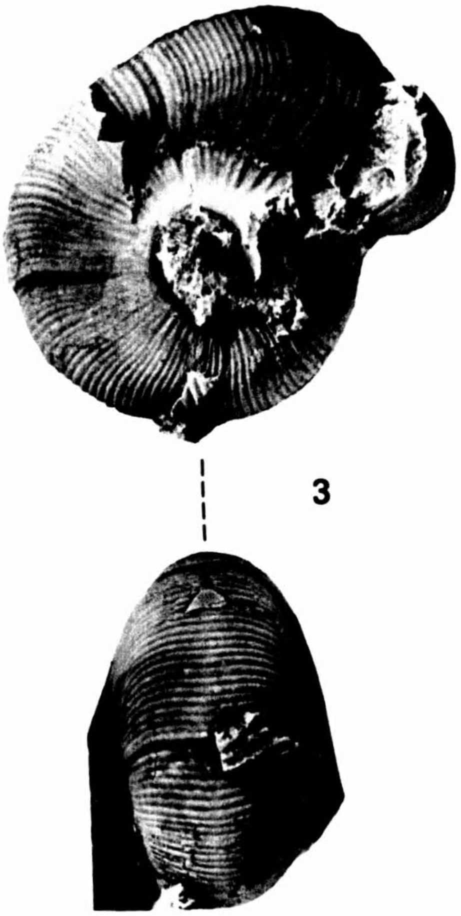

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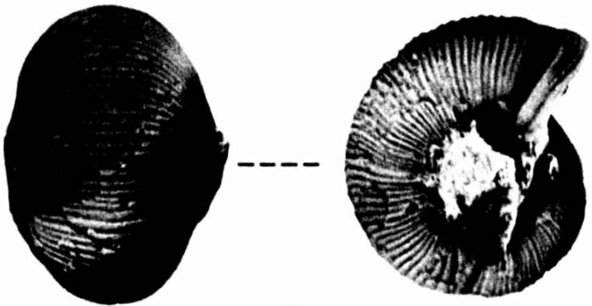

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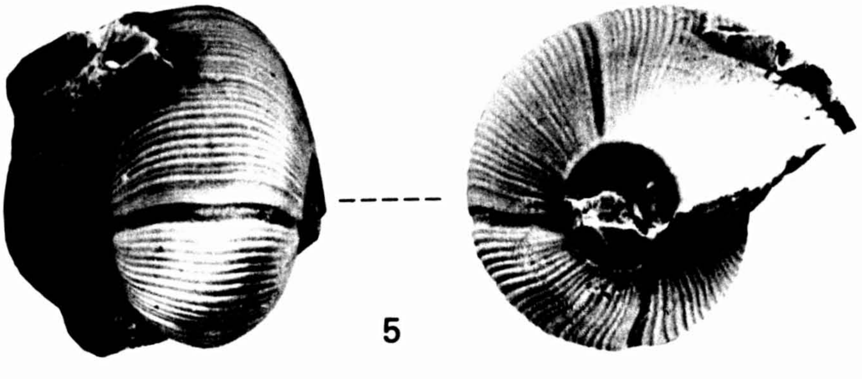

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PLATE IV

PLATE IV

H_{2c} & R_{1a} zone Homoceratids

1. *Homoceratoides prereticulatum* Bisat (unanalysed specimen). Spec. no. GSM Zi 4669, from the *Htd. prereticulatum* band, Holden Beck, Silsden, Yorkshire.

2. *Homoceratoides doolinense sp. nov.* (code H2CA). Spec. no. GSM LZ 3034R, from the *Htd. prereticulatum* band, Phosphate Mine, River Aille, Doolin, Co. Clare, Rep. of Ireland.

3. *Homoceratoides prereticulatum* Bisat (code H2CB). Spec. no. GSM LZ 3034 Z, horizon and locality as for 2. above. (IM).

4. *Homoceratoides prereticulatum* Bisat (code H2CB). Spec. no. GSM LZ 3034P, horizon and locality as for 2. above. (IM).

5. *Homoceratoides doolinense sp. nov.* (code H2CA). Holotype. Spec. no. GSM LZ 3035G, horizon and locality as for 2. above. (IM).

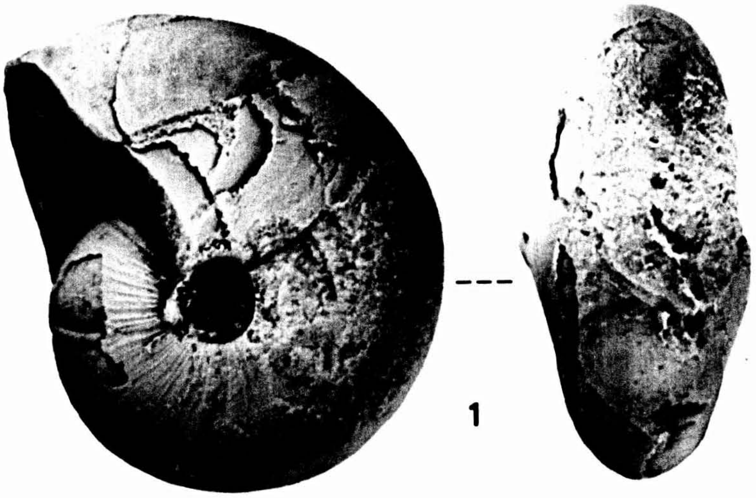
6. *Homoceras eostriolatum* Bisat (code H2CC). Spec. no. GSM 6050, from ?H_{2c} zone, Samlesbury Bottoms, near Blackburn, Lancashire.

7. *Vallites henkei* (Schmidt) (code HR1AE). Spec. no. GSM 86934, from R_{1a} zone, River Aille, Batlyteig Bridge, near Lisdoonvarna, Co. Clare, Rep. of Ireland.

8. *Vallites henkei* (Schmidt) (unanalysed specimen). Spec. no. GSM 73342, from R_{1a} zone, Saunders Brick Pit, Pinhoe, Exeter, Devon.

9. *Vallites mutabile* (Bisat & Hudson) (code HR1AA). Spec. no. GSM 86913, from R_{1a} zone, River Aille, Phosphate Mine, near Roadford, Co. Clare, Rep. of Ireland.

For notes, see Plate I.



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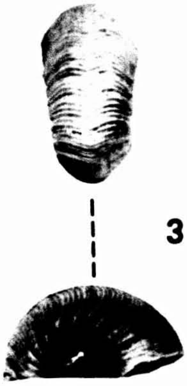

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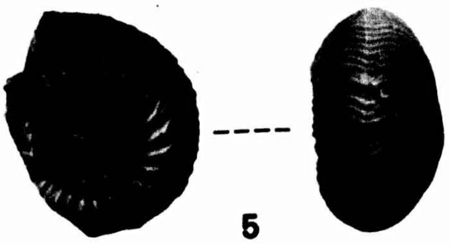

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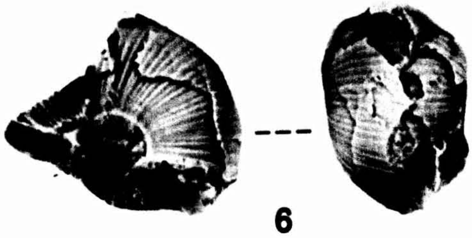

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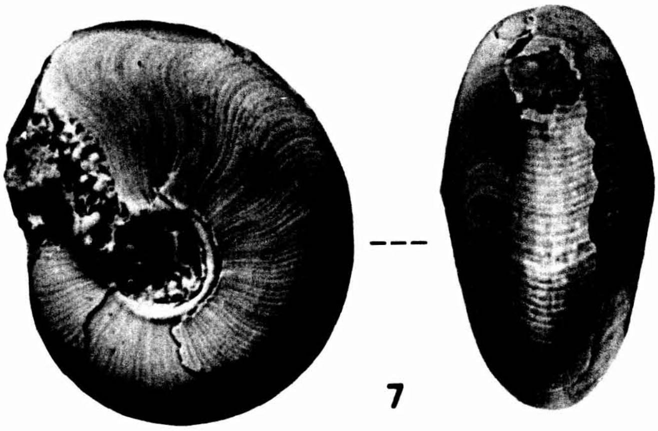

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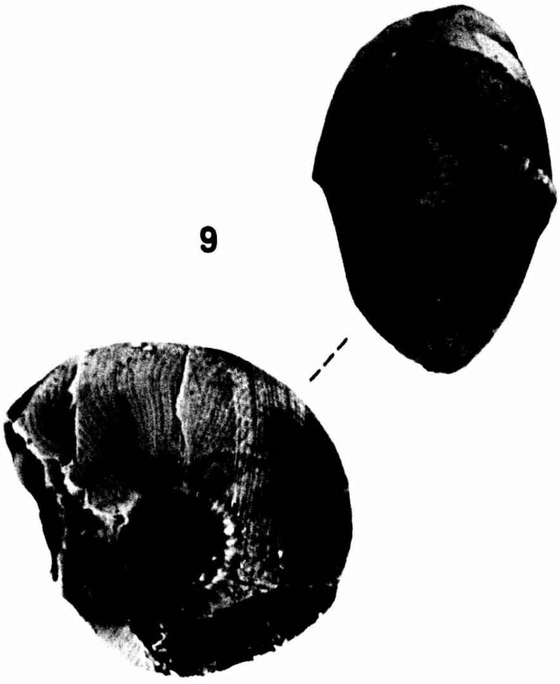

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PLATE V

R_{1a} zone Homoceratids

1. *Vallites* *sp.* aff. *magistrorum* (Hodson) (code HR1AF). Spec. no. GSM 71458, from R_{1a} zone, Backstone Beck, Ilkley Station, Yorkshire.

2. *Vallites* *magistrorum* (Hodson) (code HR1AC). Spec. no. GSM 86911, from R_{1a} zone, River Aille, Ballyteig Bridge, near Lisdoonvarna, Co. Clare, Rep. of Ireland.

3. *Vallites* *magistrorum* (Hodson) (code HR1AC). Spec. no. GSM 71454, horizon and locality as for 1. above.

4. *Vallites* *submagistrorum* *sp.* *nov.* (code HR1AD). Holotype. Spec. no. GSM 71452, horizon and locality as for 1. above.

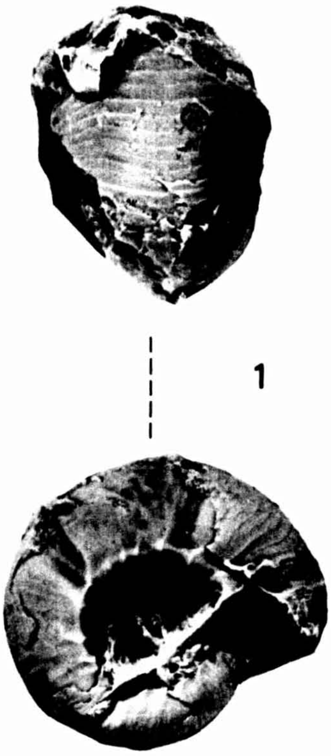
5. *Vallites* *varicatum* (H. Schmidt) (code HR1AB). Spec. no. GSM 90012, horizon and locality as for 1. above.

6. *Vallites* *varicatum* (H. Schmidt) (code HR1AB). Spec. no. GSM Zi 4684, from R_1 zone, Ballshanny House, Kilfenora, Co. Clare, Rep. of Ireland.

7. *Vallites* *varicatum* (H. Schmidt) (code HR1BB). Spec. no. GSM Zi 4667, from R_1 zone, Kilmoon River, Lisdoonvarna, Co. Clare, Rep. of Ireland.

8. *Vallites* *mutabile* (Bisat & Hudson) (code HR1AA). Holotype. Spec. no. GSM SH 3256, from R_{1a} zone, Lumbutts Clough, Woodhouse, Todmorden, Yorkshire. (LC).

For notes, see Plate I.



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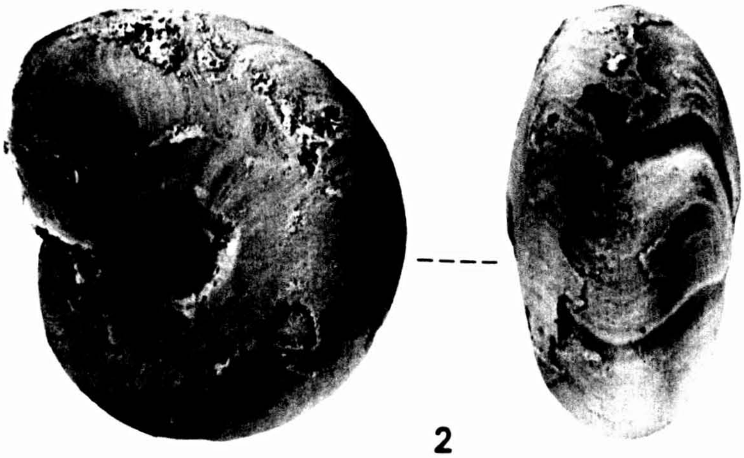

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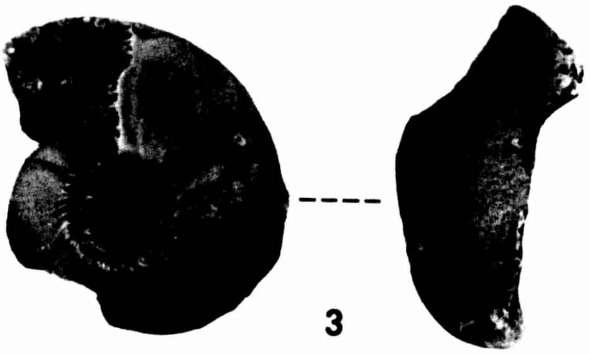

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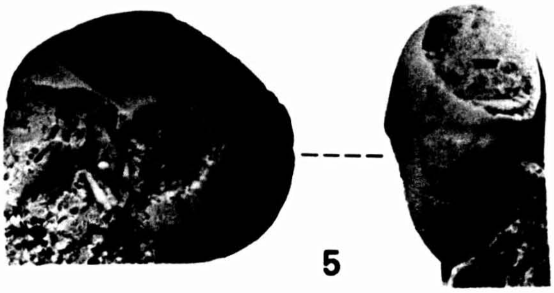

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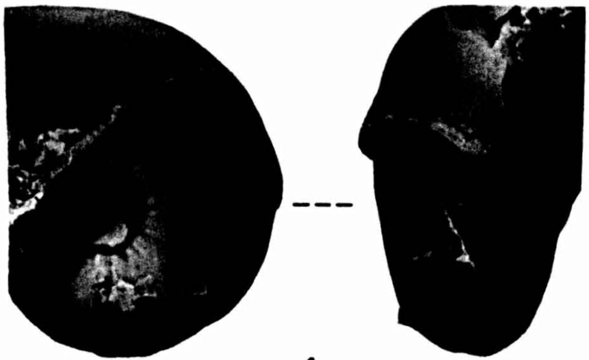

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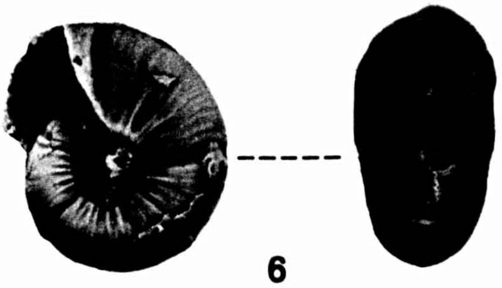

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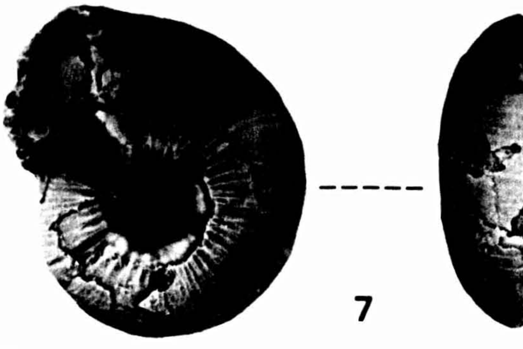

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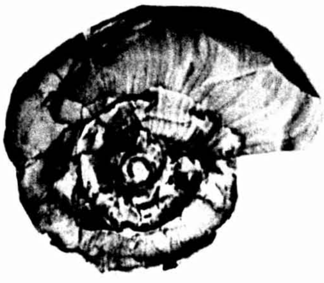

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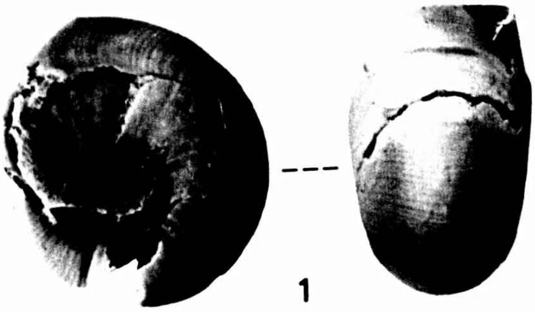
PLATE VI

PLATE VI

R_{1b} to R_{2c} zone Homoceratids

1. Vallites striolatum (Phillips) (code HR1BA). Spec. no. GSM Z1 6049, from R_{1b} zone, Samlesbury Bottoms, near Blackburn, Lancashire. (IM).
2. Vallites striolatum (Phillips) (code HR1BA). Spec. no. GSM Z1 6060, horizon and locality as for 1. above.
3. Vallites sp. aff. striolatum (code HR1BC). Spec. no. GSM 30814, from R_{1b} zone, Todmorden, Yorkshire.
4. Homoceras spiraloides (Bisat & Hudson). Spec. no. GSM 63089, from the Ph. nodosum band, Swint Clough, Alport Valley, Derbyshire. See note, p.232 .
5. Vallites striolatum (Phillips) (code HR1BA). Spec. no. GSM 63090, horizon and locality as for 4. above. See note, p. 232.
6. Homoceras fortelirifer (Ramsbottom) (code HR1CGA). Spec. no. GSM IPS 734, from the R_{2c} zone, Rocher End Brook, Bradfield, Yorkshire. (LC).
7. Homoceras fortelirifer (Ramsbottom) (code HR1CGA). Spec. no. GSM LZ 3601, from R_{2c} zone, Pears House Clough, Strines, Sugworth, Yorkshire. (LC).
8. Homoceras divaricatum (Hind) (code HR1BD). Spec. no. GSM 59849, from R_{1b} zone, Fairborough Wood, Cliffe Park Station, Staffs. (LC).

For notes, see Plate I.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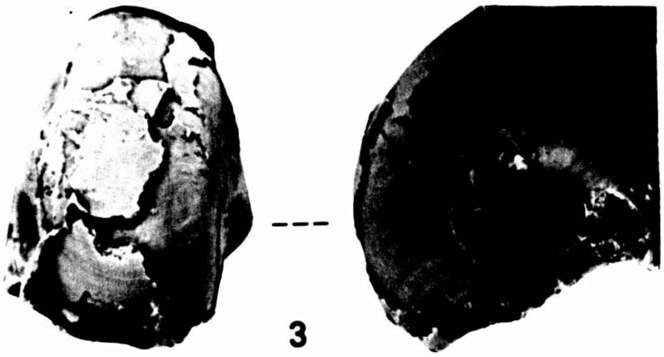
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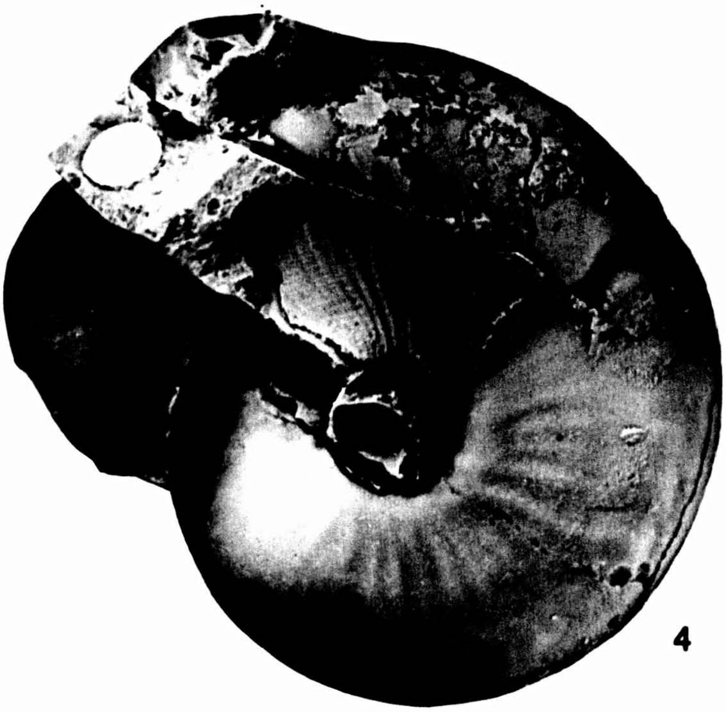
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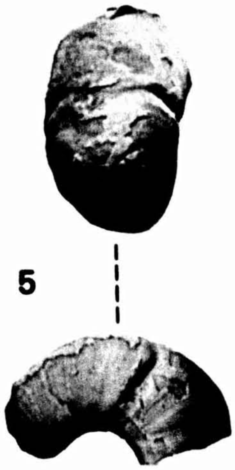
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PLATE VII

PLATE VII

R_{1a1} zone Gastrioceratids

1. Phillipsoceras circumplicatile (Foord) (code R1A1C). Spec. no. GSM Zi 4695, from the Ph. circumplicatile band, Ballyshanny House, near Kilfenora, Co. Clare, Rep. of Ireland. (IM).

2. Otleyoceras compressum (Bisat & Hudson) (code R1A1A). Spec. no. GSM 95231, from the Ph. circumplicatile band, Lisdoonvarna, Co. Clare, Rep. of Ireland.

3. Otleyoceras coronatum (Bisat & Hudson) (code R1A1B). Spec. no. GSM Zi 4702A, horizon and locality as for 1. above.

4. Otleyoceras compressum (Bisat & Hudson) (code R1A1A). Spec. no. GSM Zi 4691, horizon and locality as for 1. above.

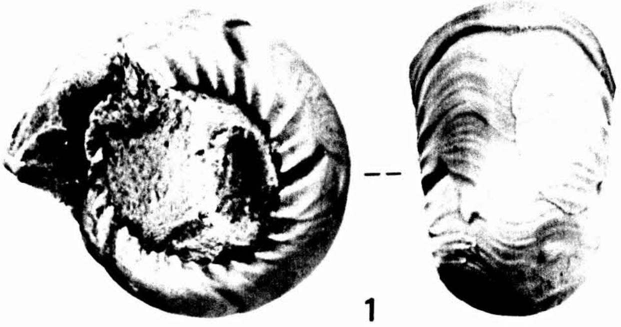
5. Otleyoceras compressum (Bisat & Hudson) (code R1A1A). Holotype. Spec. no. GSM 63093, from R_{1a1} zone, Samlesbury Bottoms, Lancashire.

6. Otleyoceras compressum (Bisat & Hudson) (code R1A1A). Spec. no. GSM Zi 4698, horizon and locality as for 1. above.

7. Otleyoceras coronatum (Bisat & Hudson) (code R1A1B). Holotype. Spec. no. GSM Da 2031, from R_{1a1} zone, Storris House, Otley, Yorkshire.

8. Phillipsoceras circumplicatile (Foord) (code R1A1C). Spec. no. GSM 59986, from R_{1a1} zone, Spring Wood, Staffordshire.

For notes, see Plate I.



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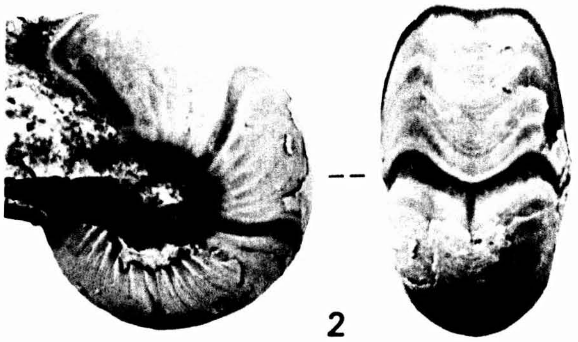

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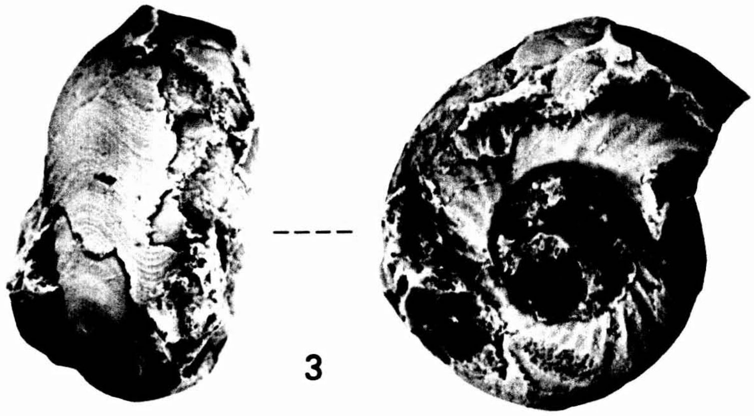

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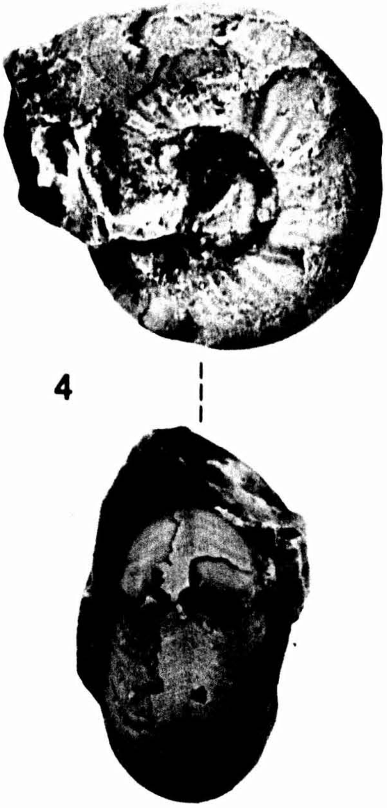

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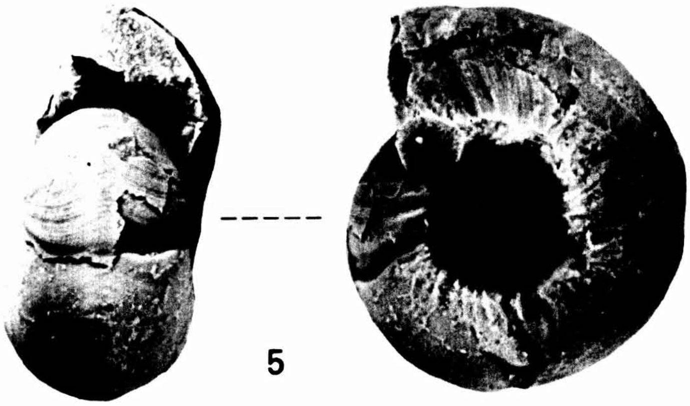

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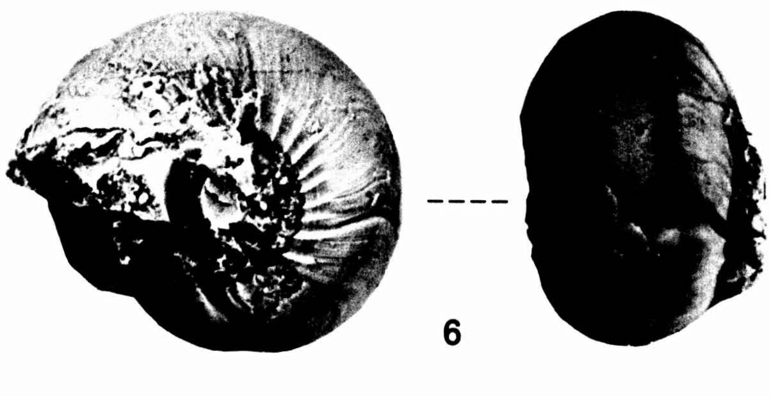

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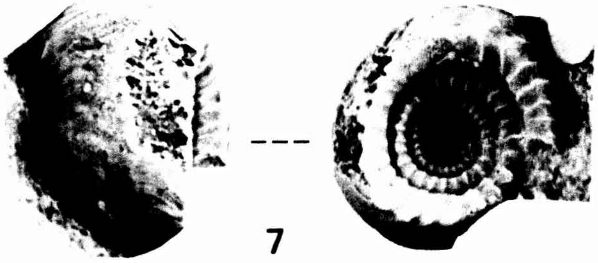

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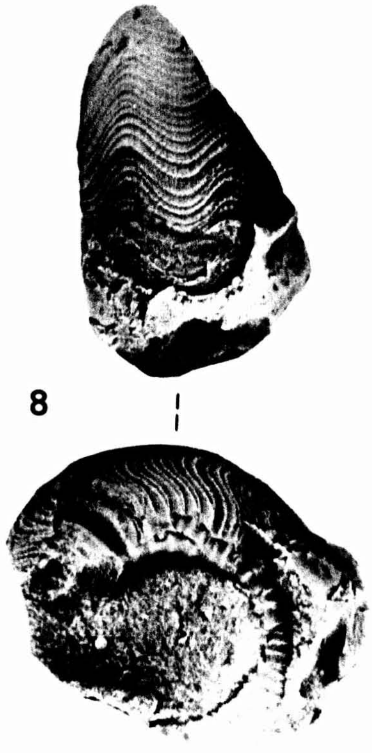

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PLATE VIII

PLATE VIII

R_{1a2} zone Gastrioceratids

1. _Otleyoceras_ _paucicrenulatum_ (Bisat & Hudson) (code R1A2B). Spec. no. GSM LZ 1893, from R_{1a2} zone, Roughlee, Pendle, Lancashire.

2. _Otleyoceras_ _paucicrenulatum_ (Bisat & Hudson) (code R1A2B). Spec. no. GSM LZ 1892, horizon and locality as for 1. above. (IM).

3. _Otleyoceras_ _bouckaerti_ _sp._ _nov._ (code R1A2A). Soec. no. GSM LZ 1948, horizon and locality as for 1. above. (IM).

4. _Otleyoceras_ _bouckaerti_ _sp._ _nov._ (code R1A2A). Holotype. Spec. no. GSM LZ 1954, horizon and locality as for 1. above.

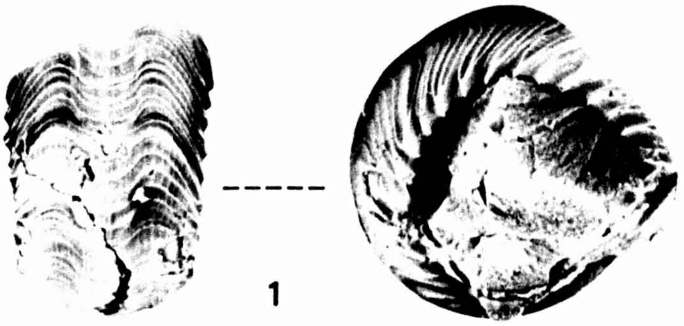
5. _Reticuloceras_ _pulchellum_ (Foord) (code R1A2D). Spec. no. GSM Z1 6021, horizon and locality as for 1. above. (IM).

6. _Reticuloceras_ _samlesburyense_ Bisat & Hudson (code R1A2E). Spec. no. GSM 63086, from R_{1a2} zone, Alport Bridge, Ashop Valley, Derbyshire.

7. _Reticuloceras_ _pulchellum_ (Foord) (code R1A2D). Spec. no. GSM Z1 6011, horizon and locality as for 1. above. (IM).

8. _Reticuloceras_ _samlesburyense_ Bisat & Hudson (code R1A2E). Holotype. Spec. no. GSM 63085, from R_{1a2} zone, Samlesbury Bottoms, near Blackburn, Lancashire. (IM).

For notes, see Plate I.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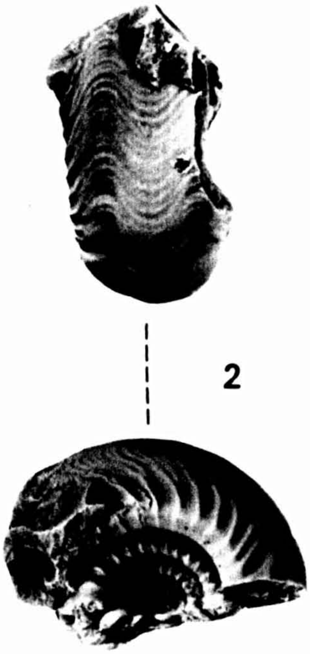
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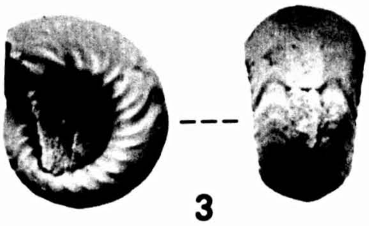
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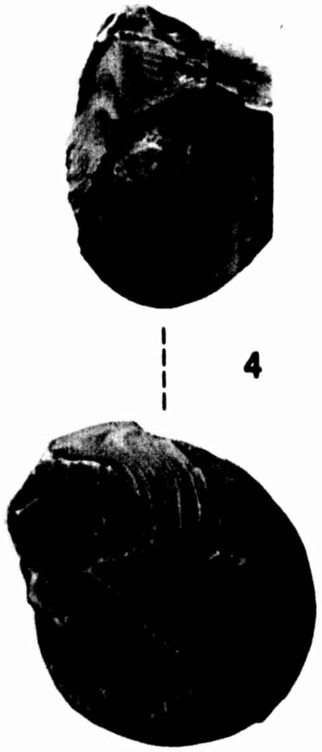
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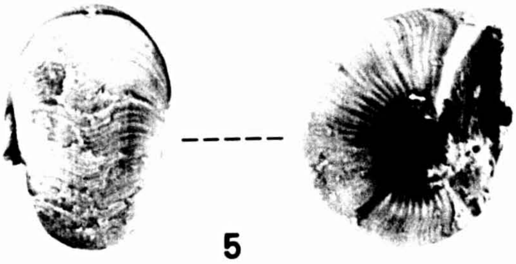
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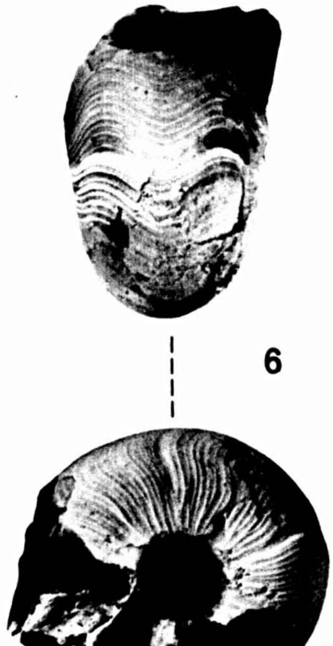
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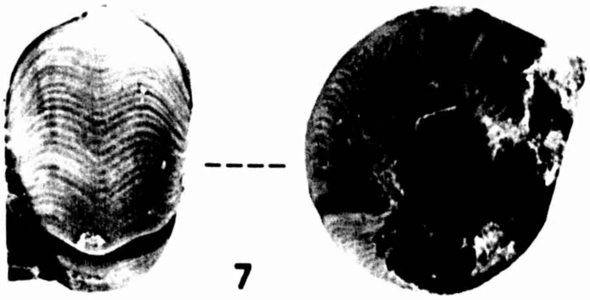
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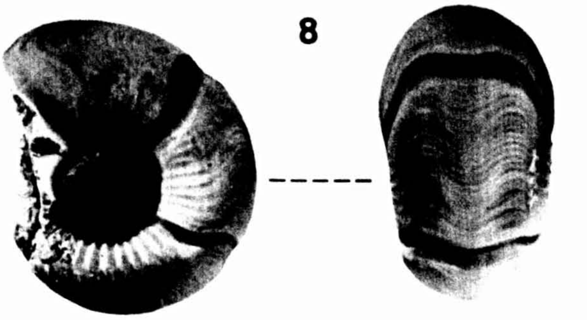
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PLATE IX

PLATE IX

R_{1a2} zone Gastrioceratids

1. Reticuloceras subreticulatum (Foord) (code R1A2C). Spec. no. GSM 85386, from the R_{1a2} zone, Blakes Bridge, Slieve Elva, Co. Clare, Rep. of Ireland.

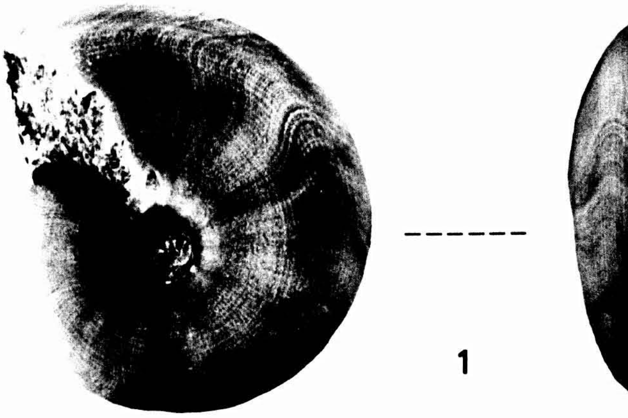
2. Reticuloceras subreticulatum (Foord) (code R1A2C). Spec. no. GSM LZ 1988, horizon and locality as for 1. above.

3. Reticuloceras pulchellum (Foord) (code R1A2D). Spec. no. GSM 83930, from R_{1a2} zone, Roughlee, Pendle, Lancashire.

4. Reticuloceras pulchellum (Foord) (code R1A2D). Spec. no. GSM 71132, from R_{1a2} zone, Lumbutts Clough, Woodhouse, Todmorden, Yorkshire. (LC).

5. Reticuloceras dubium Bisat & Hudson (code R1A2G). Holotype. Spec. no. GSM WE 1108, from R_{1a2} zone, Bottom Beck, Spofforth Haggs, Yorkshire. (LC).

For notes, see Plate I.



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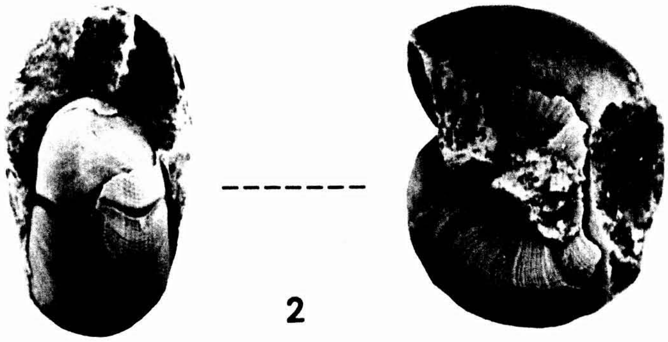

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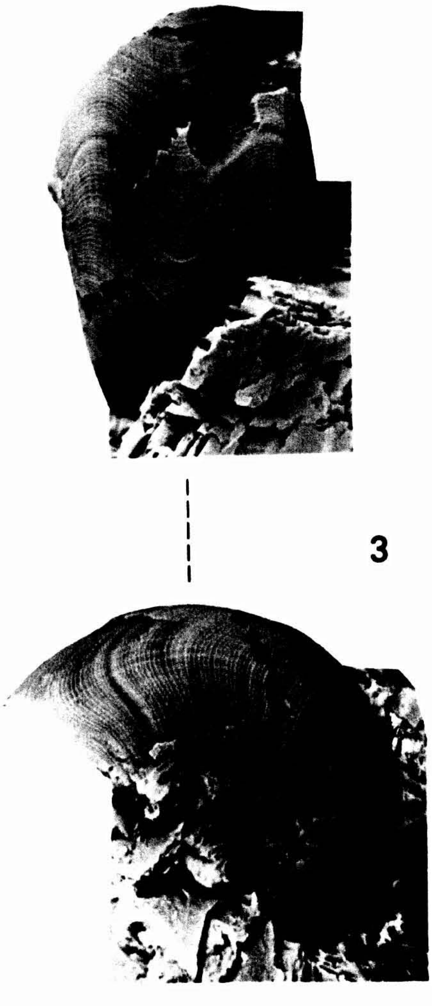

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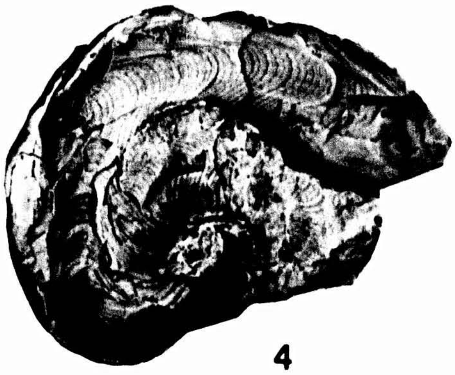

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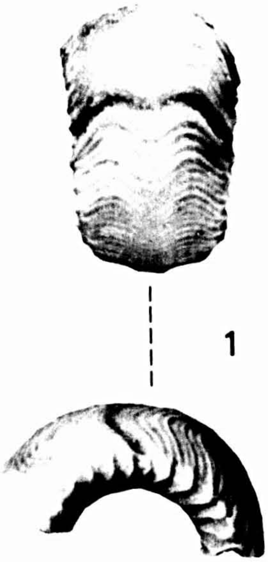
PLATE X

PLATE X

R_{1b} zone Gastrioceratids

1. Phillipsoceras nodosum (Bisat & Hudson) (code R1BC). Spec. no. GSM 71120, from R_{1b} zone, Swint Clough, Alport Valley, Derbyshire. (IM).
2. Phillipsoceras stubblefieldi (Bisat & Hudson) (code R1BB). Spec. no. GSM 89948, from R_{1b} zone, Cliffs of Moher, near O'Brien's Tower, Co. Clare, Rep. of Ireland.
3. Reticuloceras eoreticulatum Bisat (code R1BA). Spec. no. GSM 71069, from R_{1b} zone, Roughlee, Pendle, Lancashire.
4. Phillipsoceras stubblefieldi (Bisat & Hudson) (code R1BB). Spec. no. GSM 71117, horizon and locality as for 1. above. (IM).
5. Reticuloceras regularum Bisat & Hudson (code R1BD). Spec. no. GSM 73340, from R_{1b} zone, Saunders Brick Pit, Pinhoe, near Exeter, Devon.
6. Reticuloceras regularum Bisat & Hudson (code R1BD). Spec. no. GSM 71057, from R_{1b} zone, Samlesbury Bottoms, near Blackburn, Lancashire.

For notes, see Plate I.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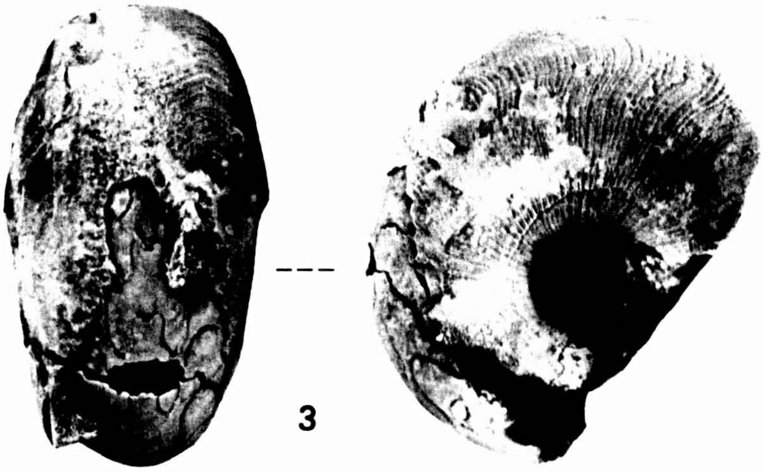
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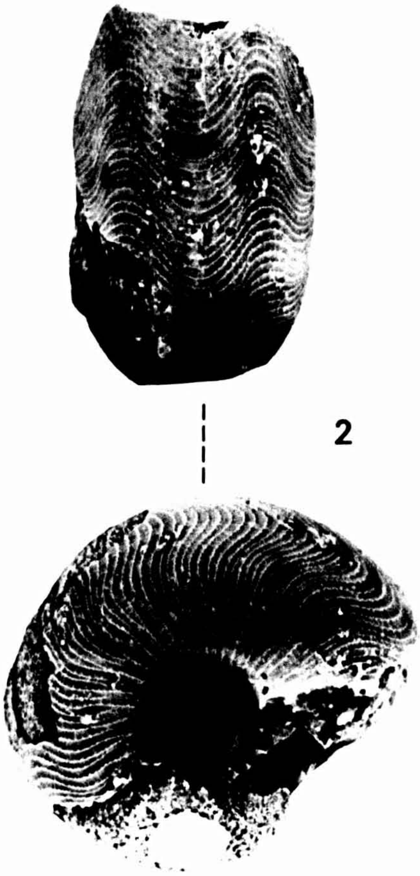
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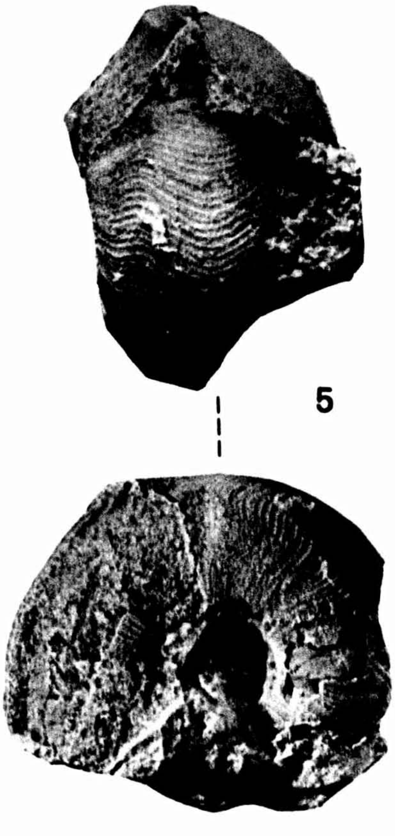
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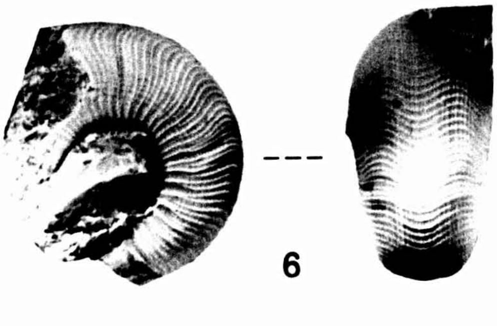
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PLATE XI

PLATE XI

R_{1c} zone Gastrioceratids

1. Reticuloceras reticulatum (Phillips) (code R1CA). Spec. no. GSM 52158, from R_{1c} zone, Crimsworth Dene, Hebden Bridge, Yorkshire. (IM).
2. Reticuloceras reticulatum (Phillips) (code R1CA). Spec. no. GSM 62446, horizon and locality as for 1. above.
3. Reticuloceras reticulatum (Phillips) (code R1CA). Spec. no. GSM 71104, horizon and locality as for 1. above. (IM).
4. Phillipsoceras coreticulatum (Bisat & Hudson) (code R1CB). Spec. no. GSM 52159, horizon and locality as for 1. above.
5. Phillipsoceras coreticulatum (Bisat & Hudson) (code R1CB). Spec. no. GSM T2818, from R_{1c} zone, Shell Brook, Mare Knowles, N. Staffs.
6. Reticuloceras reticulatum (Phillips) (code R1CA). Spec. no. GSM LZ 340, from R_{1c} zone, Ponden Clough, Stanbury, Yorkshire. (LC).

For notes, see Plate I.

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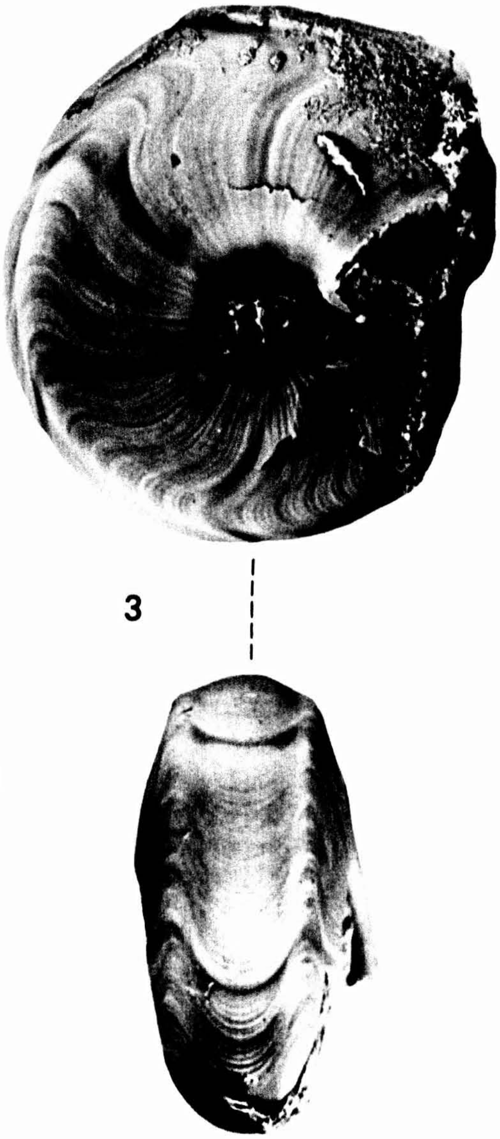

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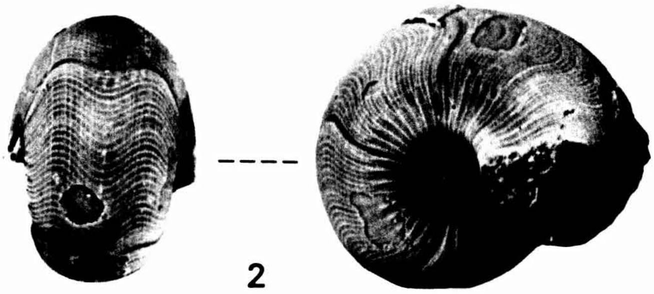

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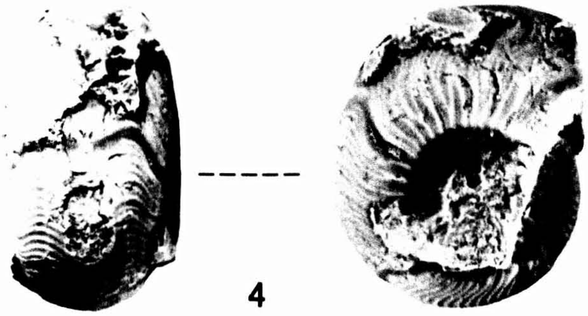

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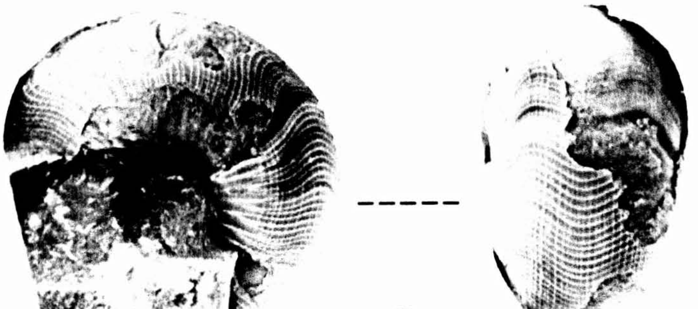

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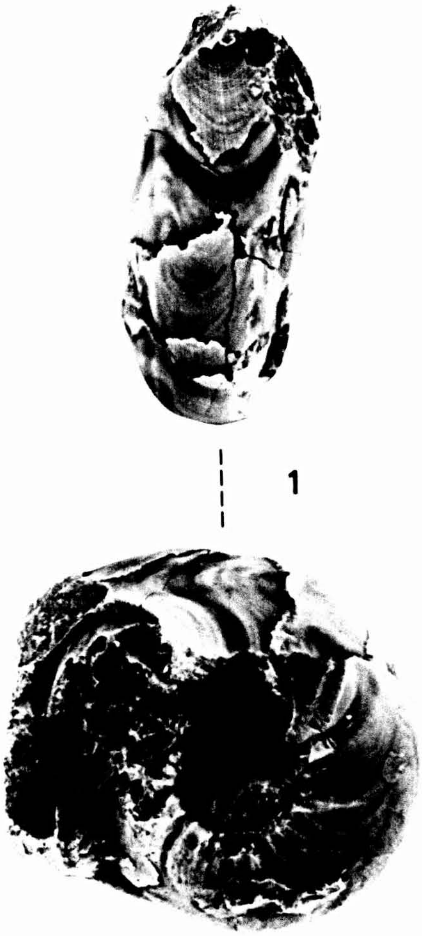
PLATE XII

PLATE XII

R_{2a} and R_{2b} zone Gastrioceratids

1. Bilinguites gracile (Bisat) (code R2AA). Spec. no. GSM 30806, from R_{2a} zone, Felt House Wood, S.W. of Leek, Staffordshire.
2. Bilinguites gracile (Bisat) (code R2AA). Spec. no. GSM Zl 5256, from R_{2a} zone, Star Wood, Oakamoor, Staffordshire.
3. Otleyoceras gracilingua sp. nov. (code R2AC). Holotype. Spec. no. GSM Zl 5268, from R_{2a} zone, Sabden Brook, east of Whalley, Lancashire.
4. Bilinguites involutum sp. nov. (code R2AB). Holotype. Spec. no. GSM Da 855, from R_{2a} zone, Rag Clough, Holme, Yorkshire. (LC).
5. Bilinguites beta sp. nov. (code R2BC). Spec. no. GSM AT 3103, from R_{2b} zone, Linsgreave Clough, Rishworth, Yorkshire. (LC).
6. Bilinguites pulobilingue sp. nov. (code R2BD). Spec. no. GSM RE 4593, from R_{2b} zone, Wittenstall Clough, Cornholme, Yorkshire. (LC).
7. Bilinguites sp. aff. beta (code R2BG). Spec. no. GSM Da 2286, from R_{2b} zone, High Cote, Riddlesden, Yorkshire. (EM).

For notes, see Plate I.



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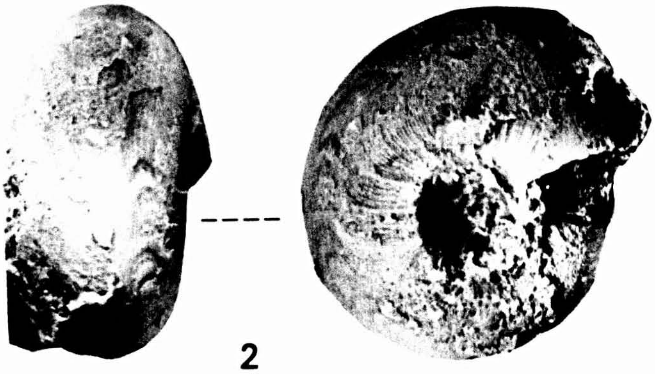

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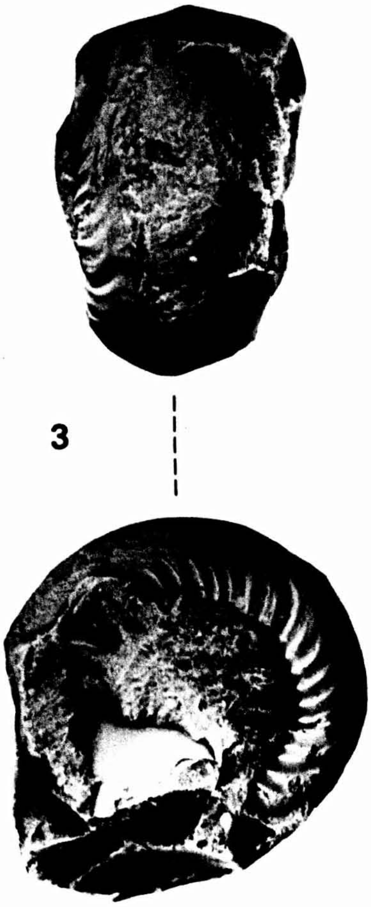

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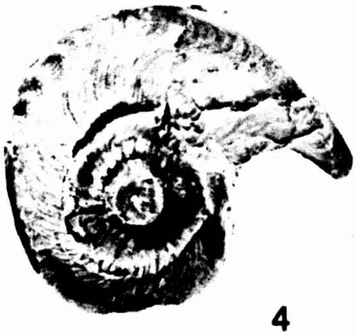

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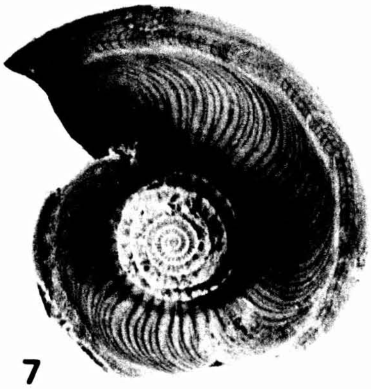

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PLATE XIII

PLATE XIII

R_{2b} zone Gastrioceratids

1. Bilinguites bilingue (Salter) (code R2BA). Spec. no. GSM AT 3076, from R_{2b} zone, Dean Clough, Scammonden, Yorkshire. (EM).
2. Bilinguites bilingue (Salter) (code R2BA). Spec. no. GSM 50265A, from R_{2b} zone, Wakefield Waterworks Tunnel, Barkisland, Yorkshire.
3. Bilinguites filobilingue sp. nov. (code R2BB). Spec. no. GSM AT 3103, from R_{2b} zone, Linsgreave Clough, Rishworth, Yorkshire. (LC).
4. Bilinguites filobilingue sp. nov. (code R2BB). Spec. no. GSM AT 3195, from R_{2b} zone, Mansergh House, Slaithwaite, Yorkshire. (EM).
5. Bilinguites filobilingue sp. nov. (code R2BB). Holotype. Spec. no. GSM AT 3110, from R_{2b} zone, Buckstone House, Marsden, Yorkshire. (EM).
6. Bilinguites metabilingue (Wright) (code R2BE). Spec. no. GSM 37931, from R_{2b} zone, Higher Hempshaws, Belmont, Lancashire. (LC).
7. Bilinguites metabilingue (Wright) (code R2BE). Spec. no. GSM Ze 1908, from R_{2b} zone, Beeley, Derbyshire. (LC).
8. Bilinguites metabilingue (Wright) (code R2BE). Spec. no. GSM 37930, horizon and locality as for 6. above. (LC).
9. Bilinguites beta sp. nov. (code R2BC). Spec. no. GSM Re 4574, from R_{2b} zone, Wittenstall Clough, Cornholme Station, Yorkshire. (LC).

For notes, see Plate I.


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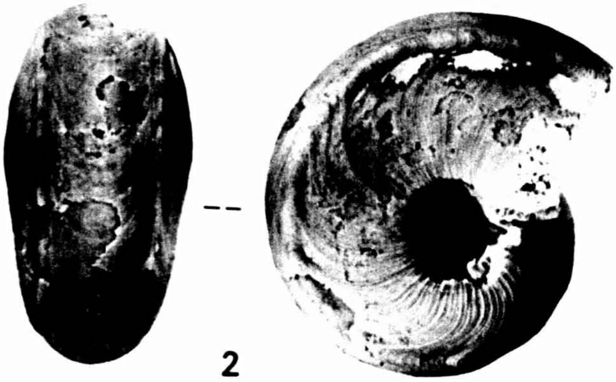
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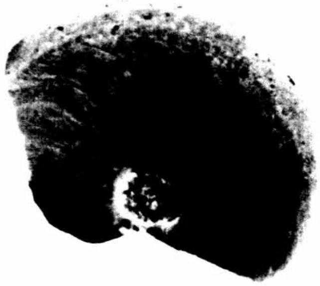
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PLATE XIV

PLATE XIV

R_{2c} & G_{1a} zone Gastrioceratids

1. *Bilinguites* *sp*. aff. *superbilingue* (code R2CB). Spec. no. GSM AT 3136C, from R_{2c} zone, Gospat Clough, Stainland, Yorkshire. (LC).

2. *Bilinguites* *superbilingue* (Bisat) (code R2CA). Spec. no. GSM AT 3136B, horizon and locality as for 1. above. (LC).

3. *Bilinguites* *ruzhentsevi* *sp*. *nov*. (code R2CD). Holotype. Spec. no. GSM Ze 2023, from R_{2c} zone, River Ogden, north of Helmshore, Lancashire. (IM).

4. *Bilinguites* *golcarensis* *sp*. *nov*. (code R2CC). Holotype. Spec. no. GSM AT 3518, from R_{2c} zone, Heath House Wood, Golcar, Yorkshire. (LC).

5. *Cancelloceras* *cancellatoides* *sp*. *nov*. (code G1AB). Holotype. Spec. no. GSM ARS 623, from the *C*. *cancellatum* band, Orchard Farm, Derbyshire. (LC).

6. *Cancelloceras* *evansi* *sp*. *nov*. (code G1AD). Holotype. Spec. no. GSM LZB 1621, from the *C*. *cancellatum* band, Glyn Neath Bank, South Wales.

7. *Agastrioceras* *carinatum* (Frech) (code G1AE). Spec. no. GSM ARS 707, from the *C*. *crencellatum* horizon, Orchard Farm, Derbyshire. (LC).

8. *Cancelloceras* *crencellatum* (Bisat) (code G1AA). Lectotype. Spec. no. GSM RE 4330, from the *C*. *crencellatum* horizon, Royshaw Brickworks, Blackburn, Lancashire. (VLC).

For notes, see Plate I.


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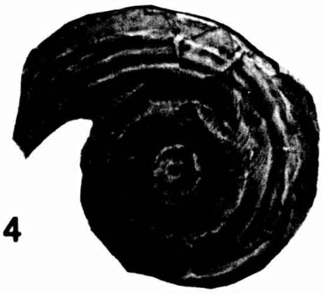
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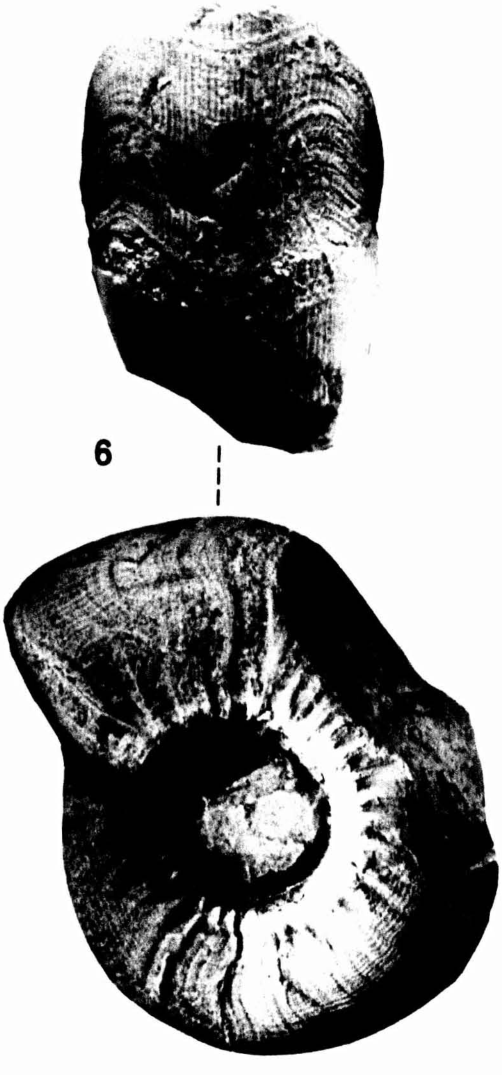
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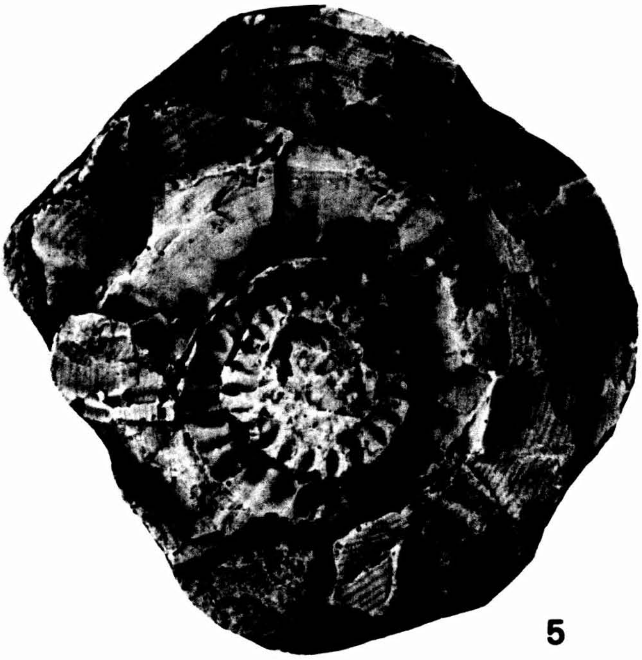
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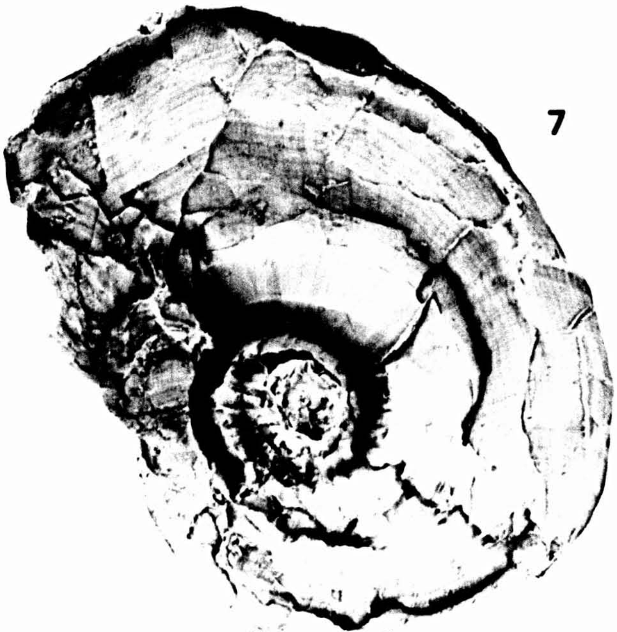
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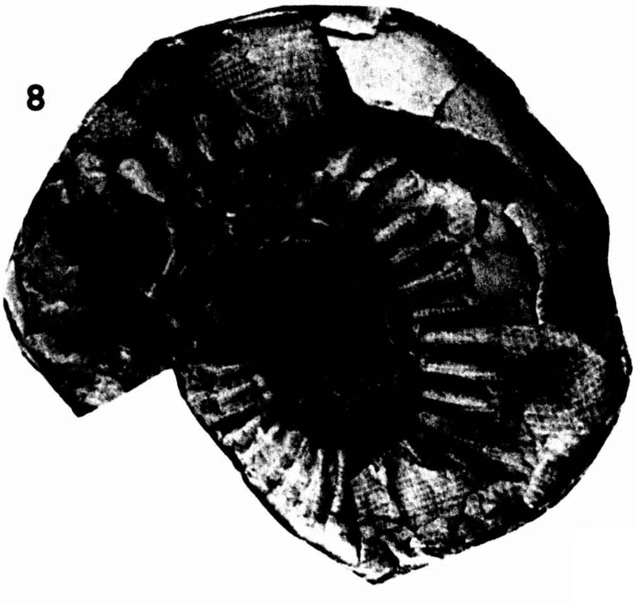
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PLATE XV

PLATE XV

G_{1b} & G_{2a} zone Gastrioceratids

1. Gastrioceras sp. aff. cumbriense (unanalysed specimen). Spec. no. GSM ARS 327, from the A. cumbriense band, Withins Scar, Haworth, Yorkshire. (VLC).

2. Agastrioceras cumbriense (Bisat) (code G1BD). Spec. no. GSM RE 3169, from the A. cumbriense band, Bigrigg, Cumbria. (LC).

3. Gastrioceras pseudocrencellatum sp. nov. (code G1BB). Holotype. Spec. no. GSM JS 468, from the A. cumbriense band, Blue Scar Clough, Stanbury Moor, Yorkshire. (LC).

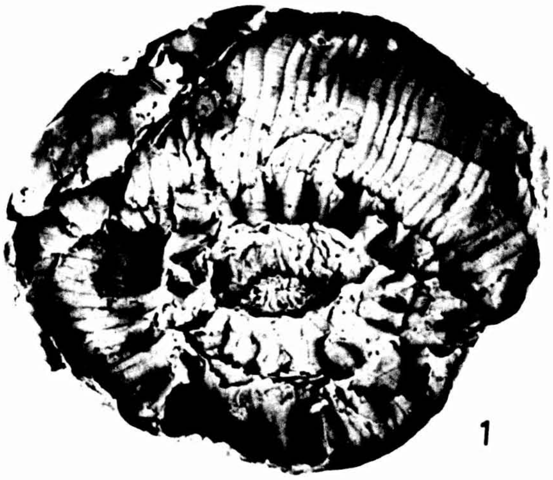
4. Gastrioceras pseudocrencellatum sp. nov. (code G1BB). Spec. no. GSM ARS 386, horizon and locality as for 1. above. (LC).

5. Agastrioceras crenulatum (Bisat) (code G1BC). Spec. no. GSM ARS 379, horizon and locality as for 1. above. (LC).

6. Agastrioceras calveri sp. nov. (code G2AJ). Holotype. Spec. no. GSM CL 194, from G_{2a} zone, Hescott Quarry, Hartland, Devon.

7. Agastrioceras calveri sp. nov. (code G2AJ). Spec. no. GSM ARS 1910, from G_{2a} zone, Embury Cove, near Hartland, Devon.

For notes, see Plate I.



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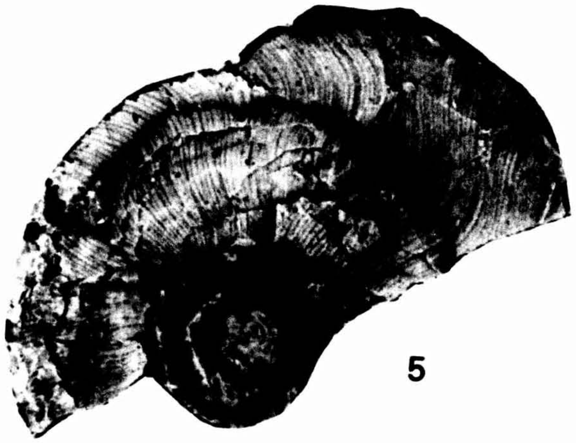

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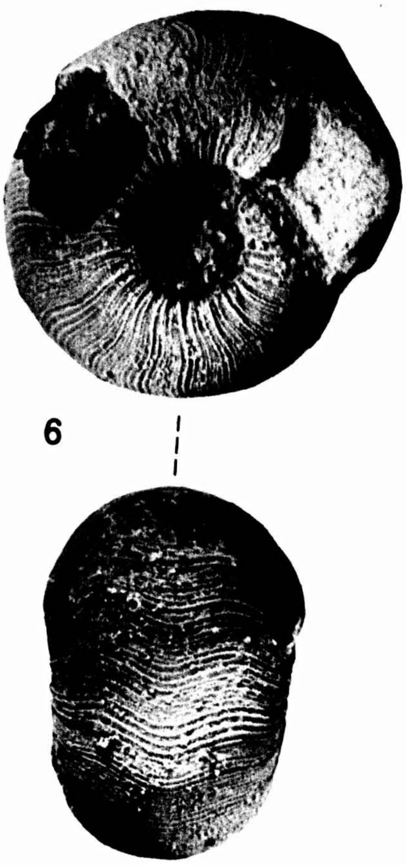

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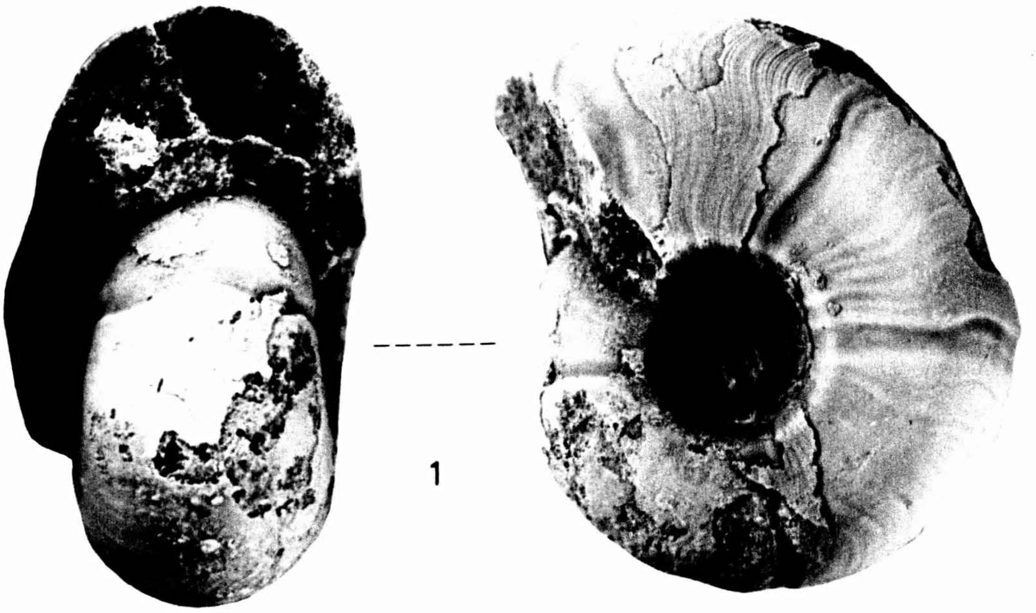
PLATE XVI

PLATE XVI

Subcrenatum Marine Band Gastrioceratids

1. *Agastrioceras subcrenatum* (Beyrich) (code G2AD). Spec. no. GSM LZB 1459, from the Subcrenatum Marine Band, Heaton House, Upholland, Lancashire.
2. *Agastrioceras sp.* A aff. *spiralis* (code G2AG). Spec. no. GSM LZB 1407, horizon and locality as for 1. above.
3. *Agastrioceras noncrenatum sp. nov.* (code G2AB). Holotype. Spec. no. GSM LZB 1484, horizon and locality as for 1. above.
4. *Agastrioceras spiralis sp. nov.* (code G2AE). Holotype. Spec. no. GSM LZB 1435, horizon and locality as for 1. above.
5. *Agastrioceras spiralis sp. nov.* (code G2AE). Spec. no. GSM LZB 1429, horizon and locality as for 1. above.
6. *Agastrioceras ?spiralis sp. nov.* (code G2AK). Spec. no. GSM LZB 1420, horizon and locality as for 1. above. See page .

For notes, see Plate I.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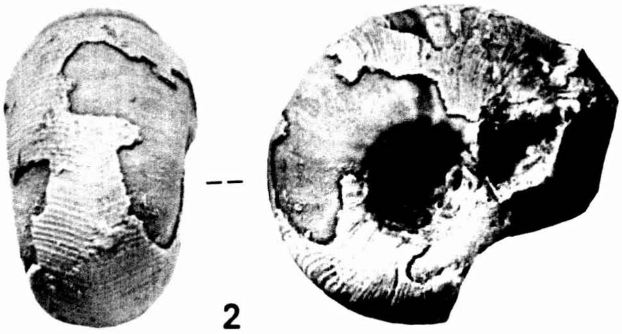
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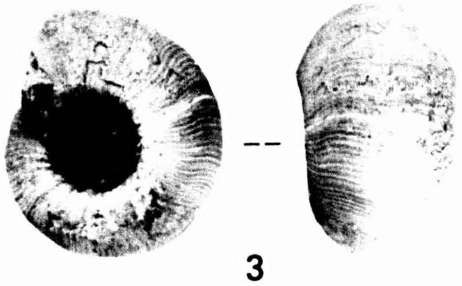
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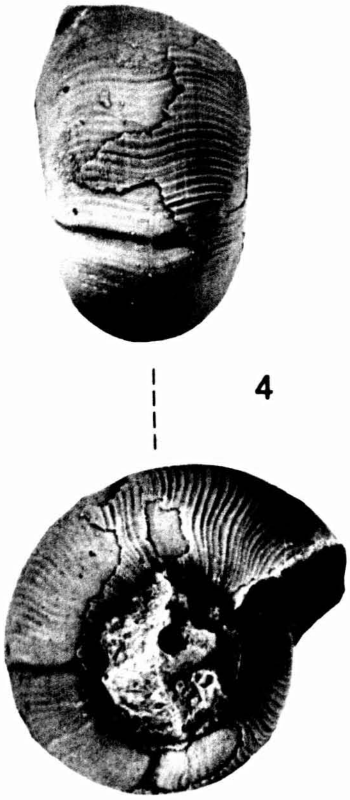
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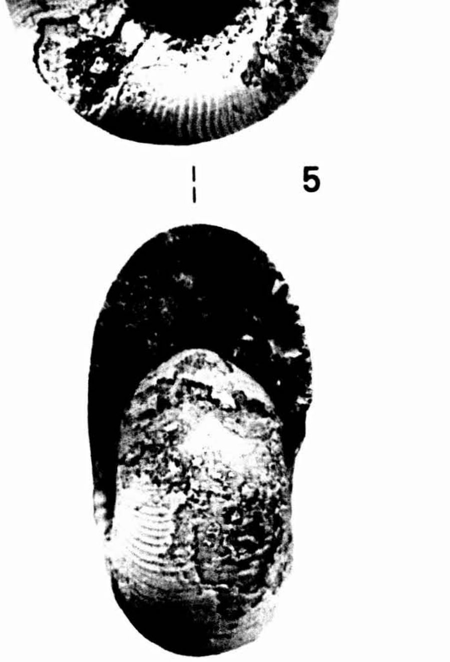
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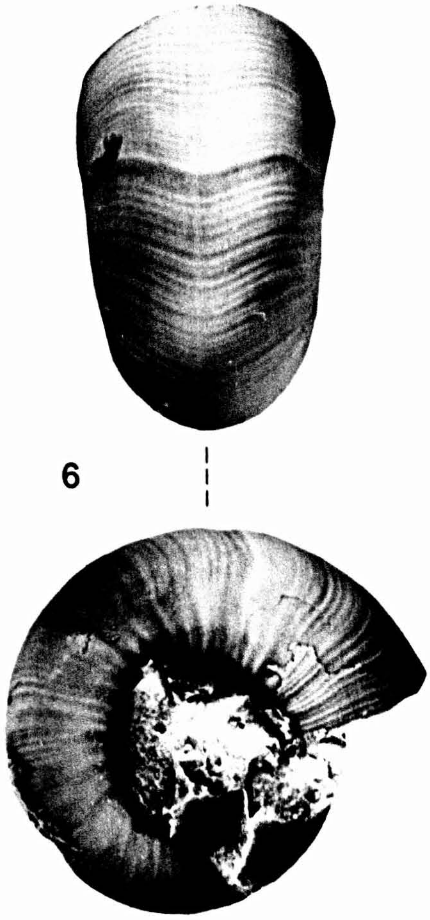
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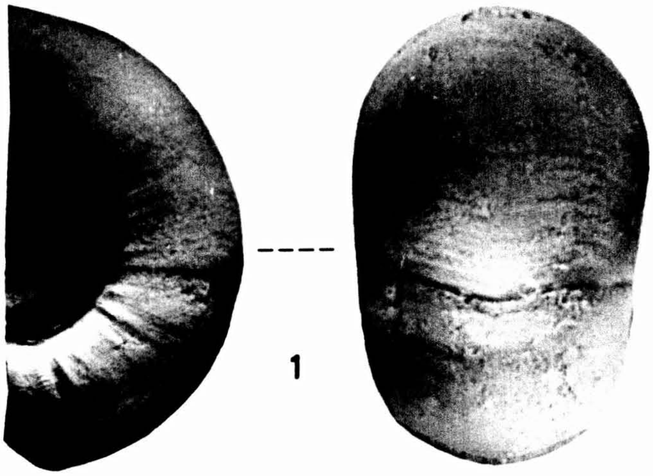
PLATE XVII

PLATE XVII

Subcrenatum & Listeri Marine Band Gastrioceratids

1. Agastrioceras magrawi sp. nov. (code G2AI). Spec. no. GSM LZB 658, from the Subcrenatum Marine Band, Heaton House, Upholland, Lancashire.
2. Agastrioceras magrawi sp. nov. (code G2AI). Holotype. Spec. no. GSM LZB 1359, horizon and locality as for 1. above.
3. Agastrioceras sp. aff. subcrenatum (code G2AK). Spec. no. GSM LZB 974, horizon and locality as for 1. above.
4. Agastrioceras belgiensis sp. nov. (code G2BA). Spec. no. GSM LZB 429, from the Listeri Marine Band, Shore, Lancashire.
5. Agastrioceras adleri Patteisky (code G2BH). Spec. no. GSM LZB 424, horizon and locality as for 4. above.
6. Agastrioceras adleri Patteisky (code G2BH). Spec. no. GSM FOR 2185, from the Listeri Marine Band, Werister, Belgium.

For notes, see Plate I.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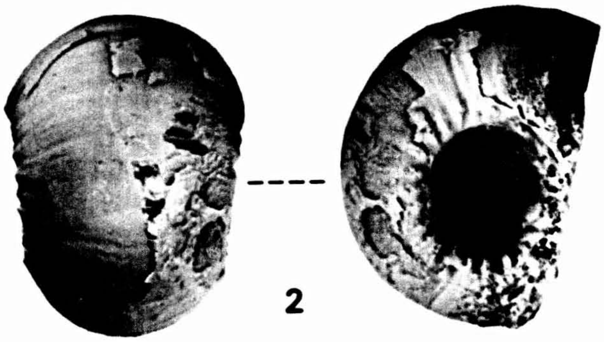
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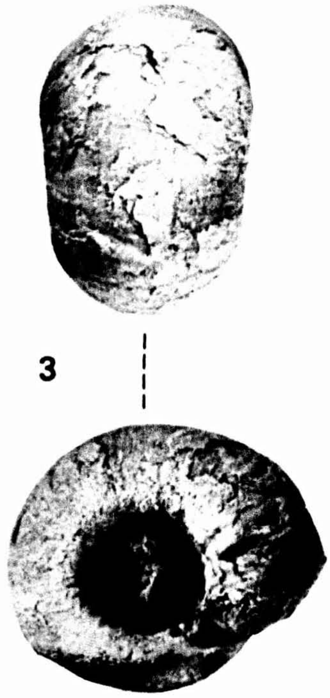
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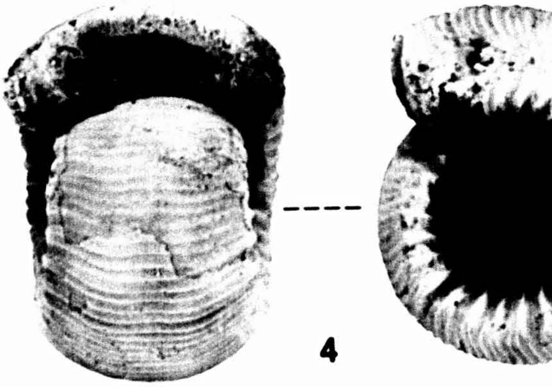
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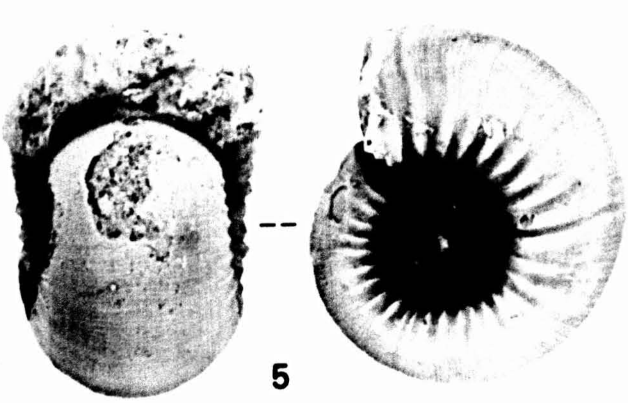
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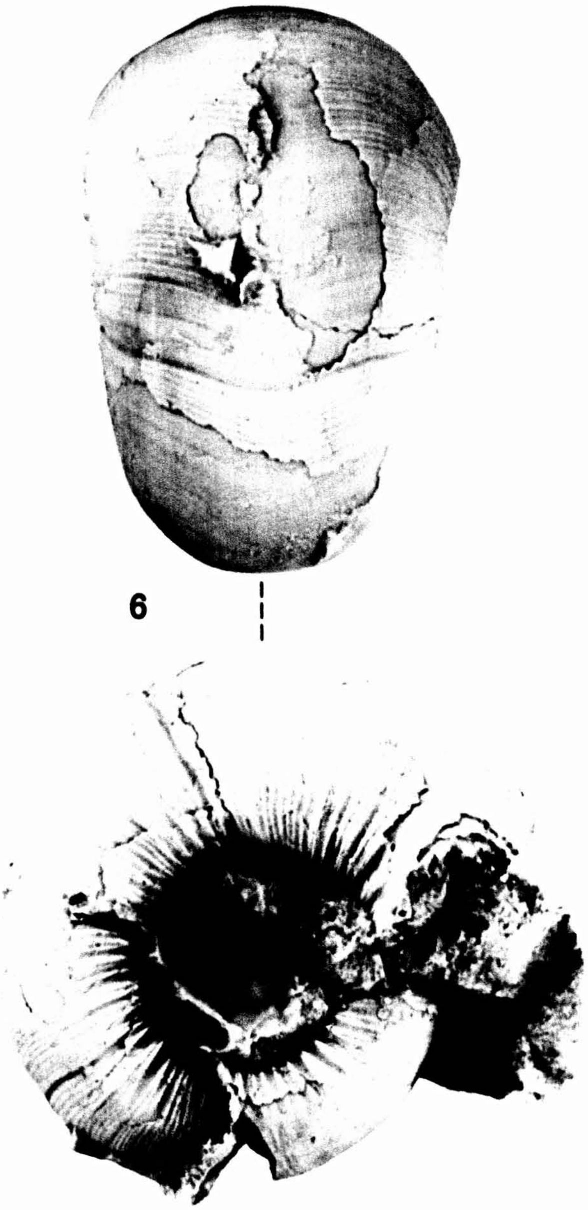
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PLATE XVIII

PLATE XVIII

Listeri Marine Band Gastrioceratids

1. Gastrioceras listeri (Sowerby) (code G2BB). Spec. no. GSM ARS 1920, from the Listeri Marine Band, Mouth Mill, Clovelly, Devon. (IM).

2. Gastrioceras listeri (Sowerby) (code G2BB). Spec. no. GSM LZB 426, from the Listeri Marine Band, Shore, Lancashire.

3. Agastrioceras sp. aff. circumnodosum (code G2BF). Spec. no. GSM LZB 1112, from the Listeri Marine Band, Ravenhead Brickworks, Shore, Lancashire.

4. Agastrioceras retrorsum (Chalmers) (code G2BE). Spec. no. GSM LZB 1093, horizon and locality as for 3. above.

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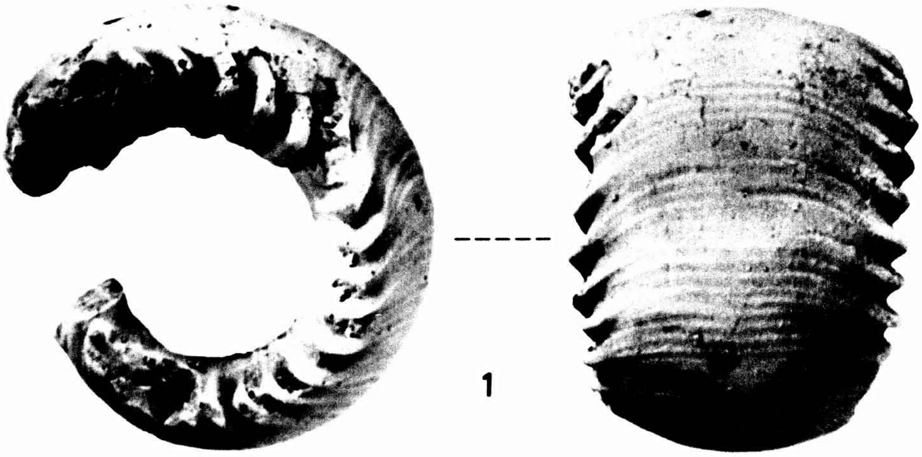
For notes, see Plate I.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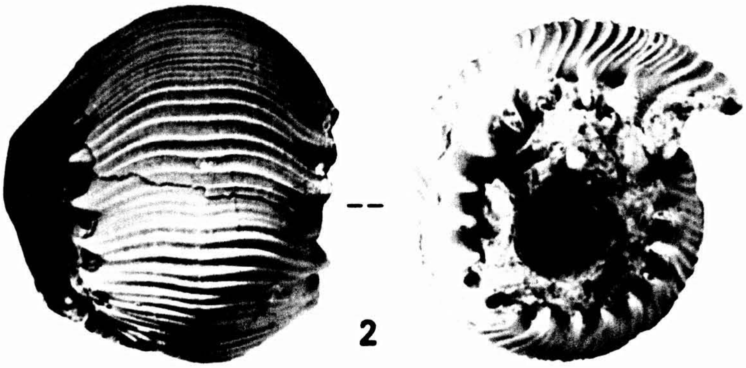
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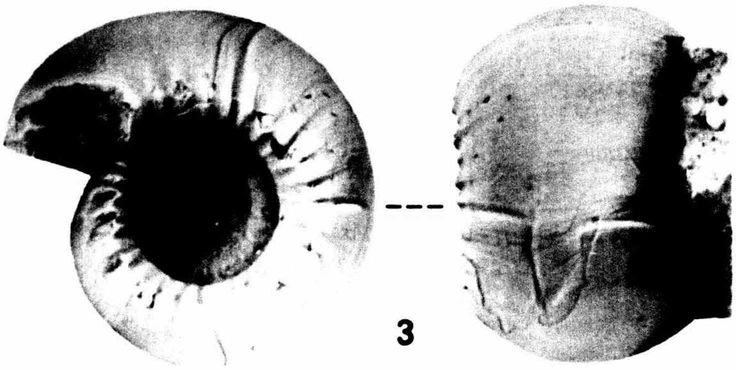
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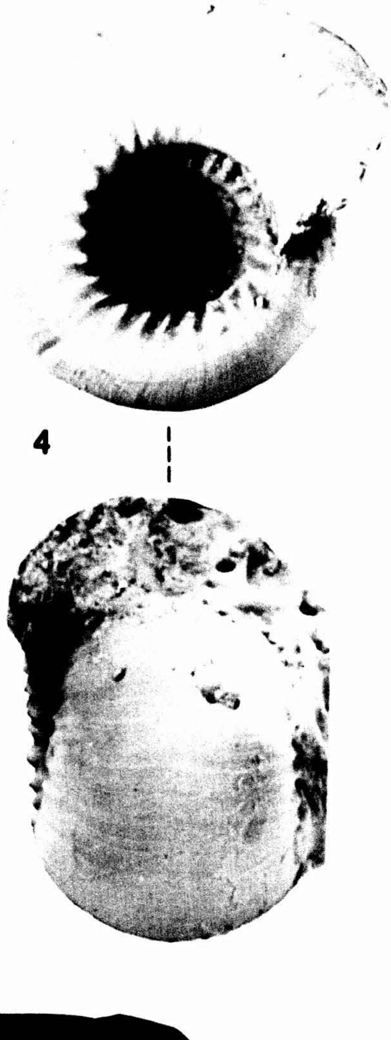
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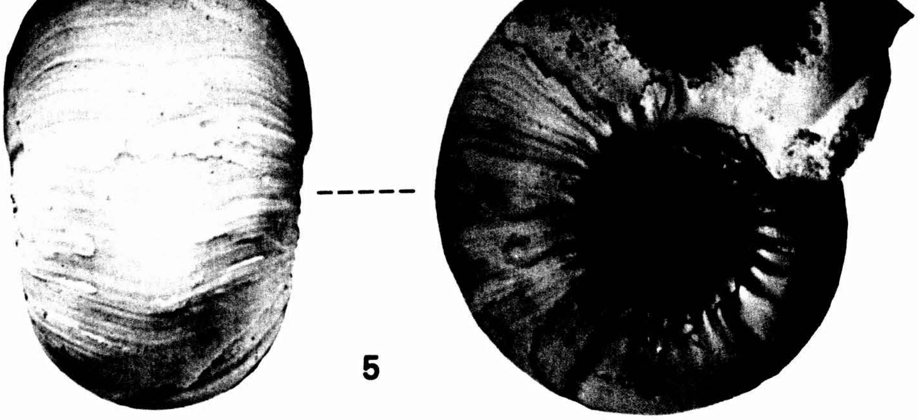
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CHAPTER 6

PHYLOGENY

6.0. INTRODUCTION

The phylogenetic lineages constructed here are the result of the application of the algorithm described in Section 3.3.2., as applied to the minimum spanning trees shown in Figures 36, 42 & 48. Although this algorithm is objective, it does not necessarily arrive at the truth, but can only suggest the most likely interpretation. Its results must be regarded as speculative, though interesting, and should not take precedence over phenetic information in devising taxonomic structure.

In all three phylogenetic reconstructions which follow, lineages depart markedly from the lines on the minimum spanning tree, suggesting that convergence is an important complication.

6.1. PHYLOGENY OF THE HOMOCERATIDAE

Figure 58 shows the result of the phylogenetic interpretation of Figure 36.

Note, firstly, that the origins of this family must necessarily be outside the scope of this study.

The earliest forms are of H_{1a} zone age in Britain; the earliest Russian forms are well linked with the British H_{1b} zone fauna. It is reasonable, then, to regard the British H_{1a} zone morphospecies as ancestral to the whole family. The Homoceras smithii (H2A) and H. undulatum (H2B) faunas are readily derivable from the H_1 zone forms, together with the bulk of the genus Homoceras, right through to the Upper Namurian. The derivation of the dominantly Russian forms to the right of Figure 58 is, however, rather tenuous.

The Vallites species of R_{1a} zone may have evolved rapidly from the H. undulatum fauna, or slower but cryptically from the more discoidal H_{1a} zone morphospecies. V. varicatum, previously included in Homoceratoides, can be placed in a transitional series with type Vall-

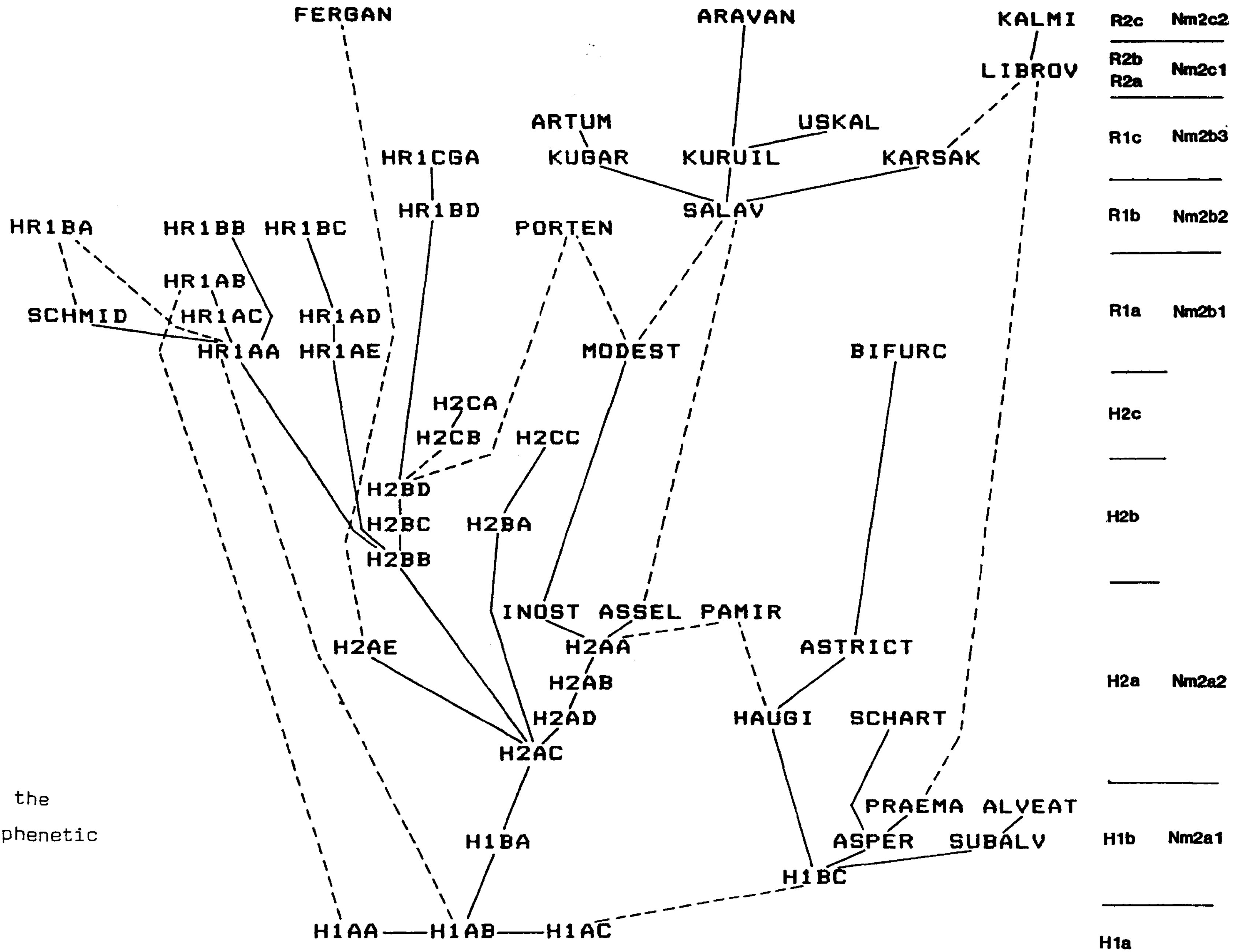

FIGURE 58. Phylogeny of the Homoceratidae, based on phenetic evidence.

ites, but the origin of true *Homoceratoides* is still not ascertained with any confidence.

Of the Homoceratid genera, *Bogdanoceras*, *Homoceratoides* and ?*Gen. nov*. are monophyletic according to the present scheme; *Homoceras* is very nearly so; but *Vallites* and *Bashkortoceras* are polyphyletic from at least two ancestral morphospecies.

6.2. PHYLOGENY OF THE RETICULOCERATIDAE *s.l*.

Figure 59 shows the results of the phylogenetic interpretation of Figure 42.

The origin of this group is not clear from this study; the earliest forms are quite different from the Homoceratidae. Ruzhentsev and Bogoslovskaya (1978) derive this group from the Surenitidae; this hypothesis is compatible with the evidence of this study.

Once again, the earliest forms appear to be British - there are no Russian Reticuloceratids contemporary with *Vallites henkei*. The first Russian species are closest to R_{1b} or R_{1a2} zone morphospecies, from which they diversify largely by becoming more evolute and developing coarser ornament. Several lineages are recognisable, each originating in a British morphospecies and terminating in Russian or American forms. Interestingly, American species occur in several branches and can usually be derived from Russian faunas, for example *Retites semiretia*, *Arkanites*, *Reticuloceras wainwrighti* and *Phillipsoceras tiro*. This points to a geographical connection.

Notice that the coarser, more evolute lineages (to the right of Figure 59) become extinct in Europe in R_{1c} times, whereas the more discoidal, involute stock, derived from *R. pulchellum* (R1A2D), developed and proliferated as the *Bilinguites* assemblages.

According to this scheme, *Bilinguites*, *Reticuloceras* and *Arkanites* are monophyletic, as are the bulk of *Retites* and *Phillipsoceras*, but *Otleyoceras* is notably not so.

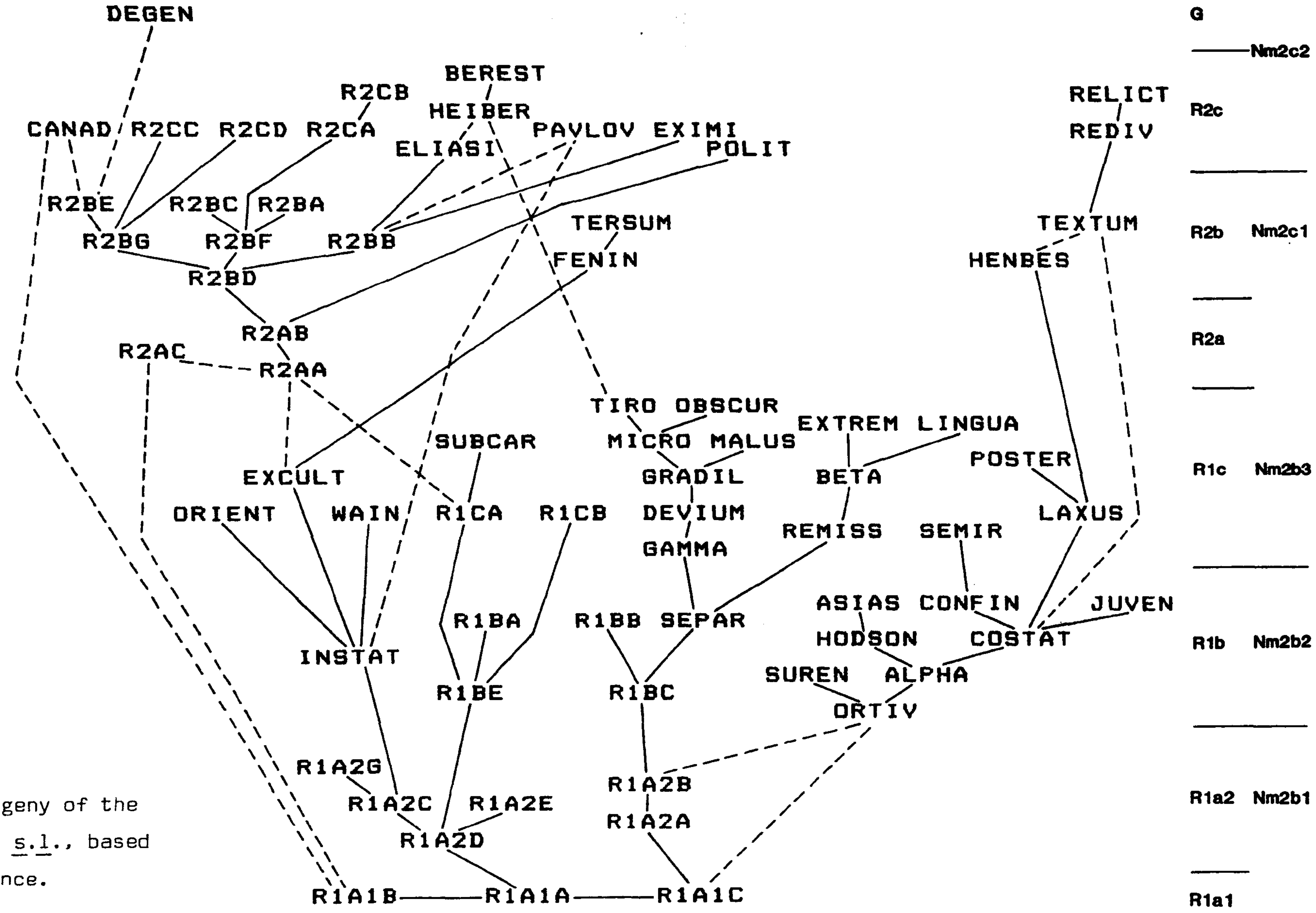

FIGURE 59. Phylogeny of the Reticuloceratidae *s.l.*, based on phenetic evidence.

6.3. PHYLOGENY OF THE GASTRIOCERATIDAE *s.l.*

Figure 60 shows the result of the phylogenetic interpretation of Figure 48.

The origin of the Gastrioceratidae *s.l.* is again problematic. The earliest forms are from British R_{2b} zone, but these are rare and as yet poorly known. *Gastrioceras lineatum* from R_{2c} zone is quite common and well known, but this species does not elucidate the situation - it is similar to Westphalian forms and does not suggest an ancestor outside its genus.

It is not possible to determine which of the Russian Nm_2c_2 and British G_{1a} zone Gastrioceratidae *s.l.* are earliest. The Russian species are, however, rather peripheral and could not have directly given rise to the bulk of the genus *Gastrioceras*. The Russian faunas show conspicuous radiation away from the central *Cancelloceras delicatum*, which is probably the local ancestor.

Development of the Westphalian diverse faunas from the British Upper Namurian morphospecies can be traced with some confidence - there are several linear transitional series spanning G_{1a} to G_{2b} zones which are readily observed on Figure 48.

The genus *Lissogastrioceras*, from North America, seems to have evolved from the smoothly ornamented elements of the Listeri Marine Band fauna.

According to this scheme, *Agastrioceras* and *Lissogastrioceras* are monophyletic and *Cancelloceras* is very nearly so. *Gastrioceras*, in contrast, is seriously polyphyletic, with five different ancestors in other genera.

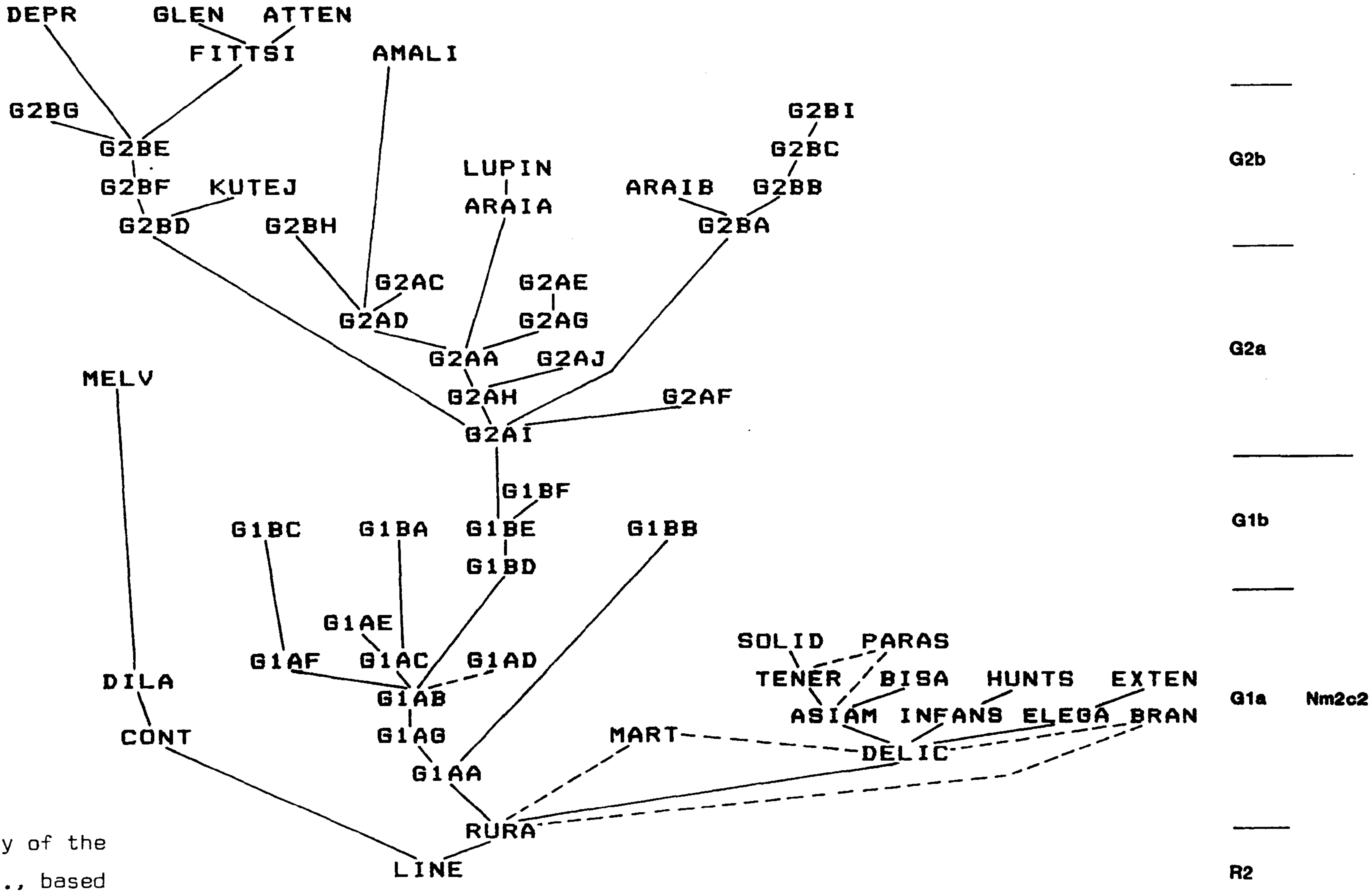

FIGURE 60. Phylogeny of the Gastrioceratidae s.l., based on phenetic evidence.

6.4. GENERAL OBSERVATIONS

It was noted in Section 4.2.5.5. that fairly continuous variation within faunas suggests that the morphospecies involved have common ancestors within that fauna. If this is so, then it is inevitable that the above phylogenies are incorrect. True phylogenetic lineages would span the ranges of intra-faunal variation, and connections between faunas would only number one per pair of successive faunas. Also, given the rapid radiation within the fauna, it would be difficult to establish the true ancestral form.

The two alternative possibilities of evolutionary progression are illustrated in Figure 61.

If phylogeny proceeds as in Figures 58, 59 & 60 , then evolution must occur in the phases between preserved faunas, in which case the punctuated equilibria model of Eldredge and Gould (1972) would apply. However, if evolutionary radiation occurs within the period of the preserved fauna, then the phylogenetic progression from fauna to fauna is likely to be dictated simply by the particular element of the fauna which survives the transition, which would be determined by the environmental change; and evolutionary rates could be gradual. There seems to be no decisive evidence on this point forthcoming from this study.

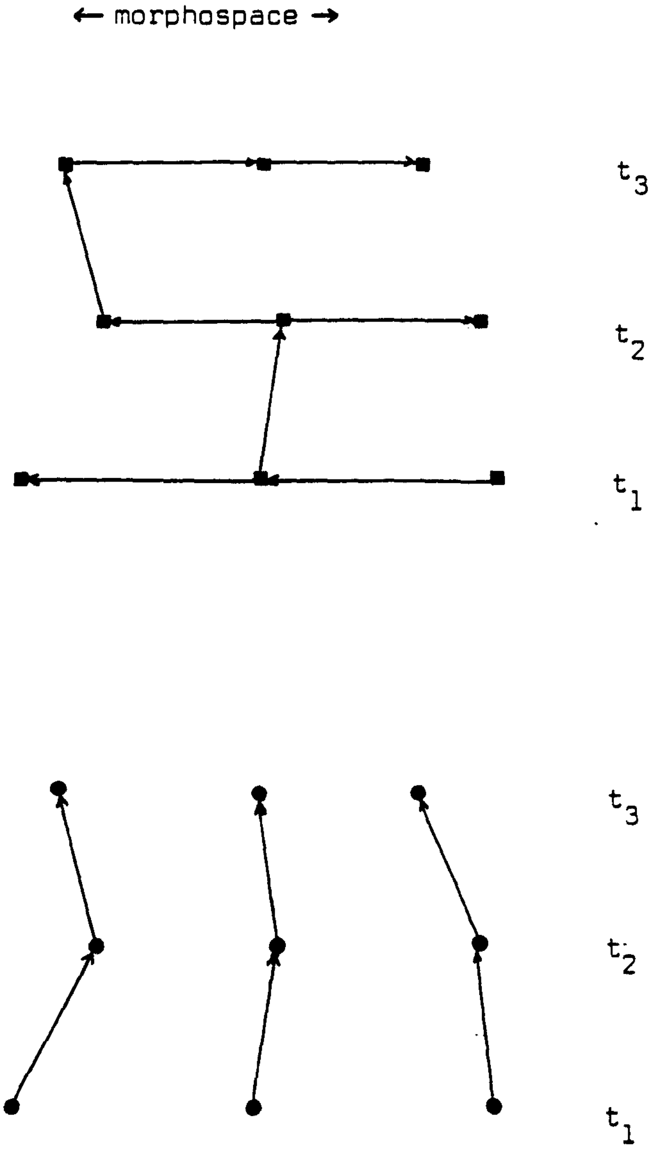

FIGURE 61. Alternative possibilities of modes of evolution between faunas.

CHAPTER 7

STRATIGRAPHIC INFERENCES AND APPLICATIONS

7.0. INTRODUCTION

The scope for numerical methods in biostratigraphic work is vast. Subjective correlation based on shared species or overall faunal resemblance could be replaced by a subjective scheme whereby biostratigraphic comparisons are given an objective numerical measure of resemblance. In the present study it has not been possible to develop all the possible means of numerical biostratigraphy, nor to apply them to all horizons at all locations. Nevertheless, it would be of interest to a) investigate the phenetic relationships between distant but possibly contemporaneous faunas, and b) assess the detailed succession of phenotypes in a sequence at individual localities.

It is only possible here to give examples of the applications of numerical methods to stratigraphic problems within that part of the Silesian considered here.

7.1. INTERNATIONAL CORRELATION

7.1.1. Britain - U.S.S.R.

The correlation of the Silesian of the southern Urals, U.S.S.R., with the British succession has been summarised by Ruzhentsev & Bogoslovskaya (1978). The correlation is aided by the occurrence of species common to both regions, for example *Vallites henkei* and *Bilinguites superbilingue*, which suggest not only stratigraphic correlation but also a palaeogeographical connection. However, widespread species are not dominant in their respective assemblages - provincialism dominates the species distributions. Interchange of forms did take place, though, and so there are definite similarities between faunas of the two provinces, independent of shared species. The positions of the various faunas on Figures 40, 46 & 52 show that Russian faunas are separated from the nearest British forms in a systematic manner - usually in the direction of the third principal component. This parallel development of faunas suggests correlations which support those of Ruzhentsev & Bogoslovskaya (1978):

Russian zone	British zone
Nm_{2a1}	H_{1b}
Nm_{2a2}	H_2
Nm_{2b1}	R_{1a}
Nm_{2b2}	R_{1b}
Nm_{2b3}	R_{1c}
Nm_{2c1}	$R_{2b/c}$
Nm_{2c2}	$R_{2c/G1}$

7.1.2. Europe - U.S.A.

The North American Silesian succession is not complete - there are large unconformities particularly towards the base, and no goniatites referable to H zone occur. The lowest record in the North American mid-continent of goniatites included in this study is of a fauna including <u>Retites semiretia</u>, <u>Phillipsoceras tiro</u> and <u>R. wainwrighti</u>, which occurs between two unconformities in the Lower Morrowan. Manger & Saunders (1980) correlate this fauna with the R_{1a} zone of Britain and Nm_{2b1} zone of the U.S.S.R. However, the phenetic affinities of this assemblage are with species from the Russian Nm_{2b3} zone (see Figure 42) which correlates with the British R_{1c} zone. The subsequent fauna of the N. American mid-continent, above an unconformity, is dominated by "*Quinnites*" *henbesti*, and Manger & Saunders' (*op. cit.*) correlation of this with the R_{2b} zone is compatible with the evidence from the present study. Consequently, it seems likely that the unconformity at the base of the Lower Morrowan is greater than previously thought, and that the unconformity separating the *R. semiretia* and "*Q.*" *henbesti* faunas is less so.

7.2. CORRELATION WITHIN BRITAIN

The bulk of the data used in the faunal analyses in this study were from Britain, but there was no further geographical restriction. Consequently, specimens from diverse localities were numerically compared. Samples were prepared comprising specimens from a restricted stratigraphic interval, but the quality of the original stratigraphic designation is often open to doubt. The faunal analyses therefore provided a reassessment of the stratigraphic designations - if specimens from diverse localities are from the same horizon, then those specimens should mix well in clusters. If stratigraphic levels are confused between localities, then specimens from different localities will be from different horizons and will plot in different clusters, with little mixing.

For example, faunas from the Westphalian A of Devon are geographically distant from the well known faunas of the north of England, so the precise correlation is not certain. An assemblage collected at Mouth Mill, Clovelly, has been correlated with the Listeri Marine Band; these specimens (nos. 571 - 610) were therefore included in that analysis. The results (page 158) shows that these specimens are well integrated phenetically with the north England specimens - the correlation appears sound.

Contrastingly, specimens from the Embury shale of Devon have been identified as belonging to the Subcrenatum Marine Band, but when incorporated in the appropriate analysis (page 153) the Embury shale specimens (nos.916-936) are not entirely integrated with typical north England Subcrenatum Marine Band forms. There is some affinity, but the correlation clearly cannot be regarded as exact and certain. The discrepancy may be due to the local Culm facies; the cyclicity which determines the persistence of marine bands elsewhere (see Section 1.2.) may well be locally disrupted in effect.

7.3. STRATIGRAPHICAL RESOLUTION

Two major complications occur when using goniatite faunas for correlation in the Silesian. Firstly, the variation within faunas means that more than one form is characteristic of each horizon. Secondly, this same variation results in phenetic overlap between horizons, so that not all specimens in a fauna are stratigraphically diagnostic.

7.3.1. The Problem of Variation Within Faunas

The first problem is illustrated by Figure 62, which shows the result of the application of the algorithm for identification, described in Section 3.4., to a fauna from the H_{1b} zone at Gill Beck, Cowling, Yorkshire. The morphospecies from this zone isolated by analysis in Section 4.1.

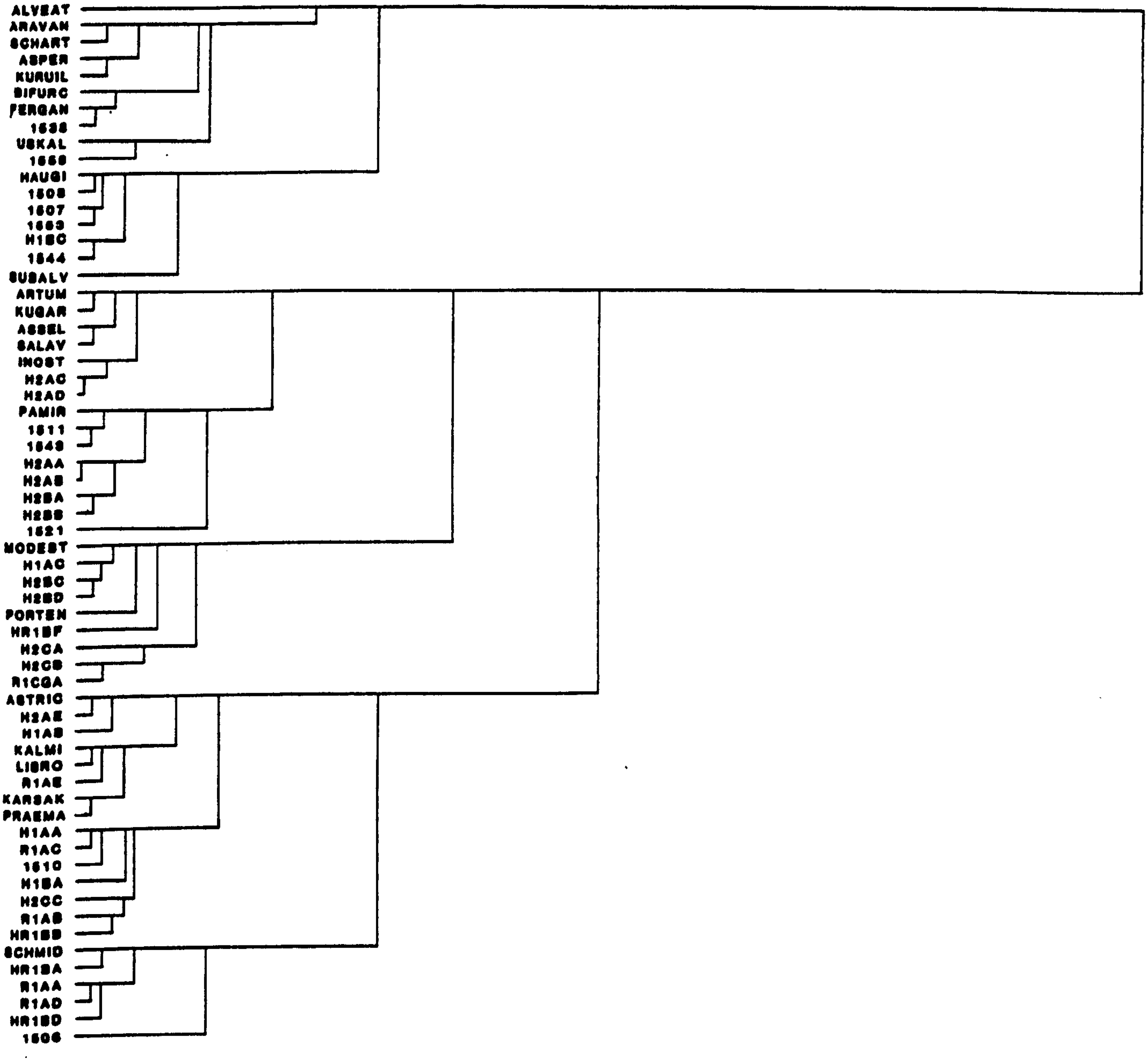

FIGURE 62. Variation within the H_{1b} zone fauna at Gill Beck, Cowling. Branches labelled with 4-figure numbers are specimens from the fauna which are provisionally identified by closeness to established species.

(page 109) are diverse; so there is no particular point in A-space which corresponds to that particular stratigraphic level. Figure 62 shows that the analysed specimens are correspondingly scattered over the range of Homoceratid forms, and many are identified by the algorithm as Russian forms, which is interesting but possibly deceptive. Nevertheless, it is obvious that many of the new specimens are phenetically close to the morphospecies *Bogdanoceras beyrichianum* (H1BC), and this gives a good stratigraphic designation.

The important points here are that a) not all the identifications suggested by Figure 62 need be correct - some are contradictory; b) nevertheless the bulk of the analysed specimens suggest the correct biostratigraphic designation; and C) one particular element (H1BC) of the fauna provides the best correlation - other morphospecies (H1BA & H1BB) appear to have been useless in this analysis.

7.3.2. The Problem of Phenetic Overlap

This difficulty is well illustrated by Figure 63, which shows the distribution in A-space of specimens from detailed horizons in R_2 zone, compared with the standard data from Reticuloceratid *s.l.* morphospecies. The relevant morphospecies definitions resulted from analyses of each of the relatively crude divisions, R_{1c}, R_{2a}, R_{2b}, R_{2c}; the specimens with which they are ordinated were collected from apparently distinct horizons within those zones.

It is notable that the specimens from the precise horizons do tend to occupy a fairly diagnostic region of A-space, although there is some overlap. However, it is

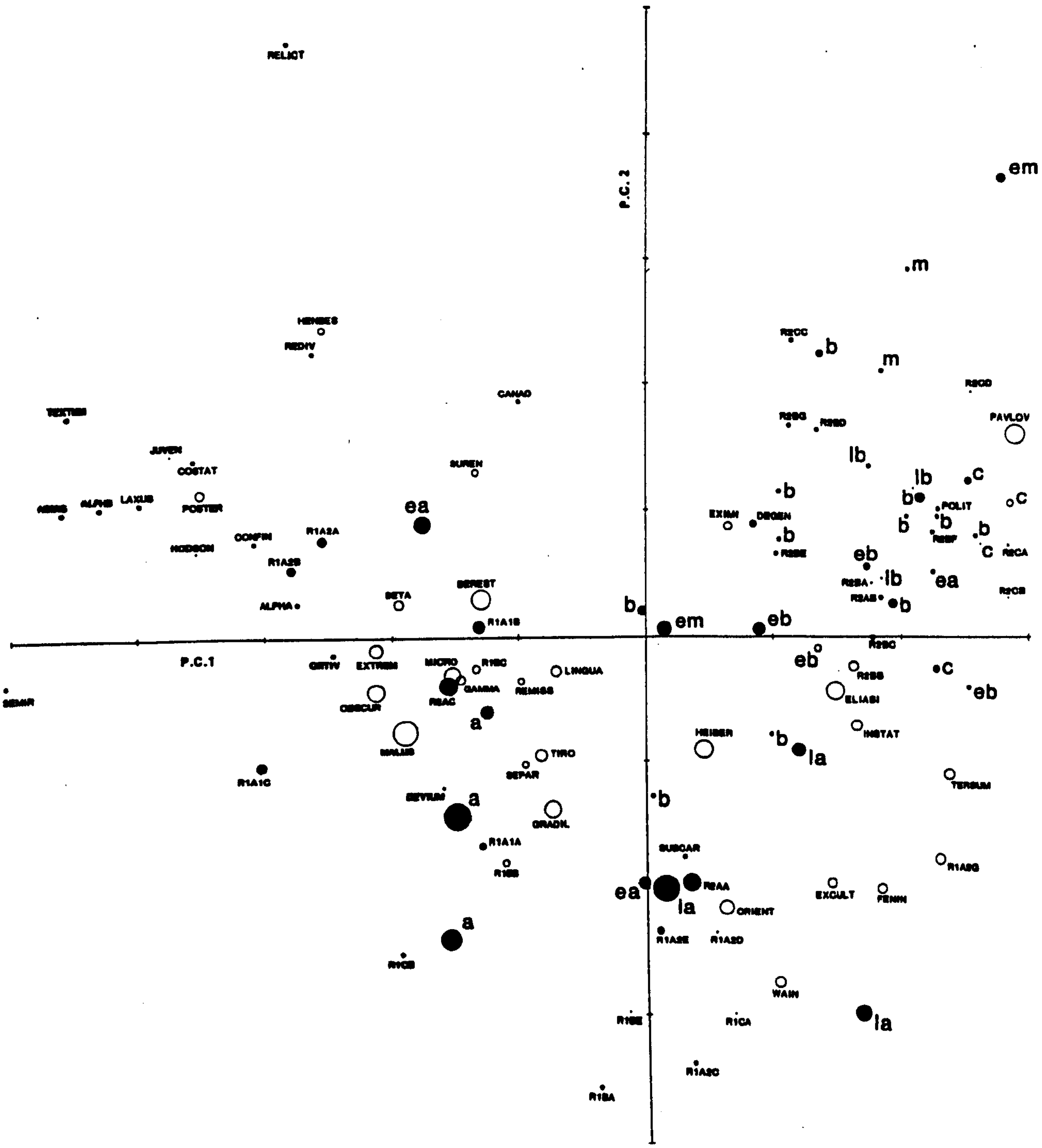

FIGURE 63. Comparison of forms supposedly characteristic of restricted bands within R_2 zone with the established morphospecies ordinated on a principal components plot. P.C.3 indicated by size of dots.

The points labelled with larger letters are specimens which were previously identified as the following stratigraphically significant forms: ea - early gracile; a - gracile; la - late gracile; em - eometabilingue; m - metabilingue; eb - early bilingue; b - bilingue; lb - late bilingue; c - superbilingue.

also apparent that these regions do not fit in well with the phenetic faunal transition from R_{1c} to R_{2c}. This suggests either that the faunal transition based on the morphospecies is not entirely accurate, or that the recognised zonal subdivisions characterised by forms such as B. metabilingue are not entirely valid. It seems likely that the detailed subdivisions are recognised not by overall phenetic criteria but by the occurrence of certain possibly unrepresentative diagnostic forms.

This and related problems would be elucidated by a detailed study of the phenetic range of whole faunas from successive horizons; new specimens could then be easily allocated to one or other horizon, with an attached probability.

It is clear that similar but more detailed and exhaustive studies than have been possible here would yield much information of practical and theoretical interest.

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APPENDIX 1

Example of CLUSTAN 1C output.

APPENDICES 2, 3 & 4

(Data files)

are inside back cover.

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 CCCCC  LL        U     UU  SSSSS  TTTTTT  AAAAA  NN     N        II    CCCCC
CC    C LL        U     UU SS     S   TT   A     AA NNN    N       III   CC    C
CC      LL        U     UU SSS        TT   A     AA N NN   N      IIII   CC
CC      LL        U     UU  SSSSS     TT   A     AA N  NN  N        II   CC
CC      LL        U     UU      SSS   TT   AAAAAAAA N   NNN         II   CC
CC    C LL        U     UU S     SS   TT   A     AA N    NN         II   CC    C
 CCCCC  LLLLLLL  UUUUU     SSSSS      TT   A     AA N     N      IIIIII  CCCCC

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JANUARY 1978


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COMPUTER CENTRE
UNIVERSITY COLLEGE LONDON
19 GORDON STREET
LONDON WC1H 0AH

========================================================================




PROCEDURE FILE
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R1A ZONE    12-15MM


NUMBER OF CASES =    22
NUMBER OF BINARY VARIABLES =     0
NUMBER OF NUMERIC VARIABLES =    16

FILE DATA MATRIX


READ AND FILE RAW NUMERIC DATA
REPLACE NUMERIC DATA BY STANDARD SCORES
INPUT DATA FORMAT(F4.0,10X,2F3.0,2F4.0,2F3.0,7F5.0,2F4.0)
RAW DATA FILED
NUMERIC MEANS FILED
NUMERIC VARIANCES FILED
STANDARD SCORES FILED
FILE COMPLETE
JOB ENDS
```

```
PROCEDURE CORREL
================

F1A ZONE   12-15MM

NUMBER OF CASES =    22
NUMBER OF BINARY VARIABLES =     0
NUMBER OF NUMERIC VARIABLES =    10

CALCULATION OF COEFFICIENT MATRIX AND K-LINKAGE LISTS

USE NUMERIC DATA
THE FOLLOWING NUMERIC VARIABLES ARE MASKED FROM THE COEFFICIENT CALCULATION
   1    2    3    6    7    9
STANDARD SCORES SELECTED
SELECT COEFFICIENT NUMBER  1
COEFFICIENT IS DISSIMILARITY TYPE
FILE  10 K-LINKAGE LISTS
DISK FILE USES   151 RECORDS

COEFFICIENTS AND K-LINKAGE LISTS CALCULATED AND FILED
JOB ENDS
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PROCEDURE HIERARCHY
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R1A ZONE    12-15MM


NUMBER OF CASES =     22
NUMBER OF BINARY VARIABLES =      0
NUMBER OF NUMERIC VARIABLES =    16


STANDARD SCORES FILED
NUMERIC COEFFICIENT CALCULATED
THE FOLLOWING VARIABLES WERE USED TO COMPUTE COEFFICIENTS
   4    5    8   10   11   12   13   14   15   16
COEFFICIENT NUMBER  1 CALCULATED
 10 K-LINKAGE LISTS FILED
```

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PROCEDURE TREE
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TREE INPUT PARAMETERS

NUMBER OF INDIVIDUALS=  22
SUBTREE PARAMETER K=    0 CLUSTERS
TRANSFORMATION SELECTED= 0
TYPE OF TREE REQUIRED = 1
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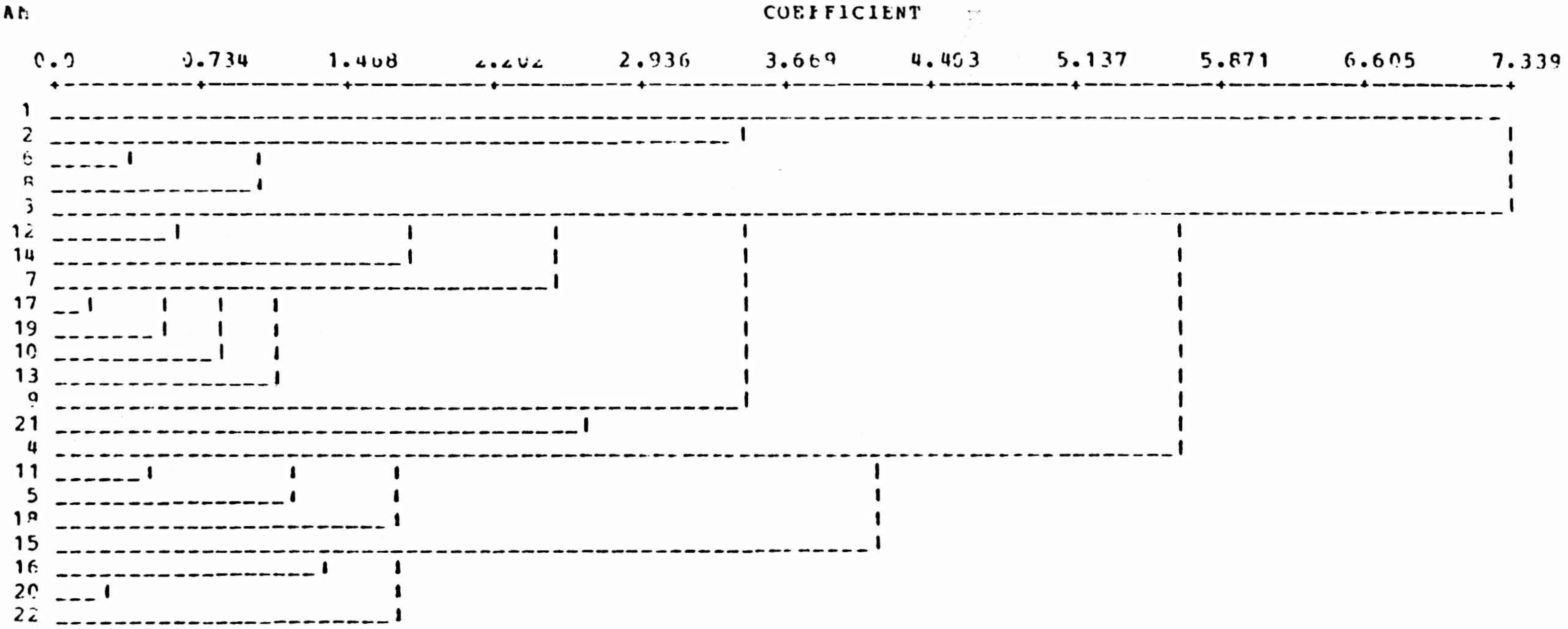
DENDROGRAM



PROCEDURE COMPLETE

```
WARDS METHOD


OUTPUT CLASSIFICATIONS FOR     2 TO    8 CLUSTERS


CYCLE    1 NOW  FUSE  POINTS    7   17  AT  COEFFICIENT    0.159 -   21  CLUSTERS  AND  NEW  CLUSTER  CODE  IS    7
CYCLE    2 NOW  FUSE  POINTS   16   20  AT  COEFFICIENT    0.248 -   20  CLUSTERS  AND  NEW  CLUSTER  CODE  IS   16
CYCLE    3 NOW  FUSE  POINTS    2    6  AT  COEFFICIENT    0.382 -   19  CLUSTERS  AND  NEW  CLUSTER  CODE  IS    2
CYCLE    4 NOW  FUSE  POINTS    4   11  AT  COEFFICIENT    0.467 -   18  CLUSTERS  AND  NEW  CLUSTER  CODE  IS    4
CYCLE    5 NOW  FUSE  POINTS    7   19  AT  COEFFICIENT    0.532 -   17  CLUSTERS  AND  NEW  CLUSTER  CODE  IS    7
CYCLE    6 NOW  FUSE  POINTS    3   12  AT  COEFFICIENT    0.582 -   16  CLUSTERS  AND  NEW  CLUSTER  CODE  IS    3
CYCLE    7 NOW  FUSE  POINTS    7   10  AT  COEFFICIENT    0.827 -   15  CLUSTERS  AND  NEW  CLUSTER  CODE  IS    7
CYCLE    8 NOW  FUSE  POINTS    2    8  AT  COEFFICIENT    1.041 -   14  CLUSTERS  AND  NEW  CLUSTER  CODE  IS    2
CYCLE    9 NOW  FUSE  POINTS    7   13  AT  COEFFICIENT    1.110 -   13  CLUSTERS  AND  NEW  CLUSTER  CODE  IS    7
CYCLE   10 NOW  FUSE  POINTS    4    5  AT  COEFFICIENT    1.174 -   12  CLUSTERS  AND  NEW  CLUSTER  CODE  IS    4
CYCLE   11 NOW  FUSE  POINTS   15   16  AT  COEFFICIENT    1.305 -   11  CLUSTERS  AND  NEW  CLUSTER  CODE  IS   15
CYCLE   12 NOW  FUSE  POINTS   15   22  AT  COEFFICIENT    1.659 -   10  CLUSTERS  AND  NEW  CLUSTER  CODE  IS   15
CYCLE   13 NOW  FUSE  POINTS    4   18  AT  COEFFICIENT    1.690 -    9  CLUSTERS  AND  NEW  CLUSTER  CODE  IS    4
 WARDS  METHOD  GROUP   14  FUSE  POINTS    3   14  AT  COEF     1.772    8  CLUSTERS
    1     2     3     4     4     2     7     2     9     7     4     3     7     3    15    15     7     4     7    15
   21    15
 WARDS  METHOD  GROUP   15  FUSE  POINTS    3    7  AT  COEF     2.516    7  CLUSTERS
    1     2     3     4     4     2     3     2     9     3     4     3     3     3    15    15     3     4     3    15
   21    15
 WARDS  METHOD  GROUP   16  FUSE  POINTS    9   21  AT  COEF     2.615    6  CLUSTERS
    1     2     3     4     4     2     3     2     9     3     4     3     3     3    15    15     3     4     3    15
    9    15
 WARDS  METHOD  GROUP   17  FUSE  POINTS    3    9  AT  COEF     3.433    5  CLUSTERS
    1     2     3     4     4     2     3     2     3     3     4     3     3     3    15    15     3     4     3    15
    3    15
 WARDS  METHOD  GROUP   18  FUSE  POINTS    1    2  AT  COEF     3.438    4  CLUSTERS
    1     1     3     4     4     1     3     1     3     3     4     3     3     3    15    15     3     4     3    15
    3    15
 WARDS  METHOD  GROUP   19  FUSE  POINTS    4   15  AT  COEF     4.084    3  CLUSTERS
    1     1     3     4     4     1     3     1     3     3     4     3     3     3     4     4     3     4     3     4
    3     4
 WARDS  METHOD  GROUP   20  FUSE  POINTS    3    4  AT  COEF     5.636    2  CLUSTERS
    1     1     3     3     3     1     3     1     3     3     3     3     3     3     3     3     3     3     3     3
    3     3
CYCLE   21 NOW  FUSE  POINTS    1    3  AT  COEFFICIENT    7.339 -    1  CLUSTERS  AND  NEW  CLUSTER  CODE  IS    1
JOB ENDS
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PROCEDURE RESULT
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R1A ZONE    12-15MM


NUMBER OF CASES =     22
NUMBER OF BINARY VARIABLES =      0
NUMBER OF NUMERIC VARIABLES =     16


STANDARD SCORES FILED
NUMERIC COEFFICIENT CALCULATED
THE FOLLOWING VARIABLES WERE USED TO COMPUTE COEFFICIENTS
  4   5   8  10  11  12  13  14  15  16
COEFFICIENT NUMBER   1 CALCULATED
 10 K-LINKAGE LISTS FILED


NUMERIC MEANS AND STANDARD DEVIATIONS

   1       220.8636        45.5166
   2         0.9568         0.0584
   3         0.0386         0.0435
   4        18.2273         5.0421
   5         9.6136         4.6852
   6         1.0500         0.0913
   7         0.1136         0.0834
   8         0.1856         0.0566
   9         1.0294         0.4452
  10         0.7532         0.0797
  11         0.0929         0.0812
  12         0.0276         0.0124
  13         0.0123         0.0093
  14         0.2313         0.1199
  15         0.0916         0.0702
  16         0.0061         0.0105


RAW NUMERIC DATA

S   1          181.0000         0.8000         0.0500        10.0000         5.0000         1.2000         0.2000         0.3360
                 1.5570         0.8030         0.0330         0.0160         0.0030         0.1150         0.1310         0.0490

S   2          184.0000         0.9000         0.1000        18.0000         6.0000         1.3000         0.1000         0.2180
                 1.2500         0.7220         0.0420         0.0140         0.0280         0.1250         0.1250         0.0140

S   3          188.0000         0.9500         0.0500        24.0000         7.0000         1.1000         0.1000         0.1560
                 1.0540         0.8350         0.1490         0.0230         0.0090         0.3110         0.1890         0.0030

S   4          189.0000         0.9000         0.1000        16.0000         7.0000         1.2000         0.0000         0.1460
                 1.0640         0.8330         0.0640         0.0450         0.0260         0.4230         0.0640         0.0010

S   5          192.0000         1.0000         0.0000        17.0000         3.5000         1.0000         0.0000         0.1270
                 1.0620         0.7760         0.2840         0.0370         0.0310         0.3580         0.1110         0.0020

S   6          194.0000         1.0000         0.0500        17.0000         6.0000         1.0000         0.0000         0.1920
                 1.3020         0.7460         0.0000         0.0160         0.0160         0.1110         0.0790         0.0030

S   7          196.0000
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S  8         198.0000      7.0000      0.1000     19.0000      7.0000      1.0000      0.1000      0.3090
               1.5170      0.8450      0.0260      0.0260      0.0210      0.0430      0.0520      0.0170

S  9         206.0000      1.0000      0.0000     35.0000      8.0000      1.0000      0.1000      0.2110
               1.1430      0.7620      0.2220      0.0240      0.0050      0.1900      0.0790      0.0020

S 10         207.0000      0.9000      0.0500     16.0000      6.0000      1.0000      0.2000      0.2240
               0.0000      0.7620      0.0950      0.0320      0.0030      0.1430      0.0790      0.0030

S 11         210.0000      1.0000      0.0500     16.0000      5.0000      1.0000      0.1000      0.1570
               1.0860      0.7290      0.1000      0.0430      0.0140      0.3140      0.0710      0.0030

S 12         211.0000      1.0000      0.0000     19.0000      6.0000      1.1000      0.1000      0.1370
               1.1390      0.6250      0.0560      0.0140      0.0080      0.3190      0.0830      0.0060

S 13         212.0000      1.0000      0.0000     14.0000      6.0000      1.0000      0.1000      0.1220
               1.0770      0.6770      0.0620      0.0150      0.0050      0.3230      0.0460      0.0030

S 14         216.0000      1.0000      0.0000     16.0000     15.0000      1.0000      0.0000      0.0900
               0.0000      0.5500      0.0380      0.0130      0.0030      0.1500      0.0000      0.0000

S 15         220.0000      1.0000      0.0000     17.0000     15.0000      1.0000      0.3000      0.1880
               1.0170      0.8980      0.1020      0.0510      0.0050      0.4410      0.1360      0.0030

S 16         221.0000      1.0000      0.0000     12.0000     15.0000      1.0000      0.1000      0.1800
               1.3080      0.7690      0.1080      0.0460      0.0150      0.2460      0.0770      0.0020

S 17         225.0000      0.9000      0.1000     16.0000     16.0000      1.0000      0.2000      0.1810
               1.0920      0.7630      0.0310      0.0230      0.0110      0.2770      0.0770      0.0030

S 18         232.0000      1.0000      0.0000     23.0000     10.0000      1.0000      0.1000      0.2330
               1.3710      0.7140      0.0290      0.0290      0.0290      0.4290      0.0000      0.0000

S 19         235.0000      0.9000      0.1000     24.0000     10.0000      1.0000      0.2000      0.1550
               1.0630      0.7380      0.0630      0.0190      0.0060      0.2130      0.0380      0.0010

S 20         238.0000      0.9000      0.1000     16.0000     18.0000      1.0000      0.1000      0.1600
               1.2540      0.7760      0.0750      0.0450      0.0150      0.1190      0.0750      0.0030

S 21         349.9998      1.0000      0.0000     20.0000      9.0000      1.2000      0.2000      0.1810
               1.0140      0.7100      0.1300      0.0160      0.0020      0.0870      0.3330      0.0120

S 22         353.9998      1.0000      0.0000     19.0000     19.0000      1.0000      0.2000      0.1870
               0.0000      0.7400      0.2990      0.0370      0.0040      0.1340      0.1340      0.0030


VARIABLE MINIMUM VALUE      MAXIMUM VALUE

   1           181.0000        353.9998
   2             0.8000          1.0000
   3             0.0000          0.1000
   4            10.0000         35.0000
   5             3.5000         19.0000
   6             1.0000          1.3000
   7             0.0000          0.3000
   8             0.0900          0.3360
   9             0.0600          1.5570
  10             0.5500          0.8980
  11             0.0000          0.2990
  12             0.0130          0.0510
  13             0.0020          0.0310
  14             0.0430          0.4410
  15             0.0000        [illegible]
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```
NUMERIC STANDARD SCORES

S  1     -0.8758 -2.6872  0.2615 -1.6317 -0.9847  1.6430  1.0361  2.6574  1.1850  0.6254 -0.7380 -0.9401 -0.9965 -0.9700
          0.5616  4.0636
S  2     -0.8099 -0.9736  1.4120 -0.0451 -0.7713  2.7384 -0.1636  0.5726  0.4955 -0.3914 -0.6272 -1.1017  1.6777 -0.8865
          0.4761  0.7455
S  3     -0.7220 -0.1168  0.2615  1.1449 -0.5579  0.5477 -0.1636 -0.5228  0.0552 -1.4835  0.6910 -0.3746 -0.3550  0.6651
          1.3882 -0.2973
S  4     -0.7000 -0.9736  1.4120 -0.4417 -0.5579  1.6430 -1.3633 -0.6995  0.0777  1.0020 -0.3561  1.4029  1.4637  1.5994
         -0.3932 -0.4869
S  5     -0.6341  0.7400 -0.8891 -0.2434 -1.3049 -0.5477 -1.3633 -1.0351  0.0732  0.3116  2.3541  0.7565  1.9987  1.0572
          0.2766 -0.3921
S  6     -0.5902  0.7400  0.2615 -0.2434 -0.7713 -0.5477 -1.3633  0.1132  0.6122 -0.0901 -1.1446 -0.9401  0.3935 -1.0033
         -0.1794 -0.2973
S  7     -0.5463 -0.9736 -0.8891 -0.0451  0.5093 -0.5477 -1.3633  0.1309  0.5561  0.3743 -0.7011 -0.2938 -0.0340 -0.1191
         -0.7922 -0.3921
S  8     -0.5023  0.7400  1.4120  0.1533 -0.5579 -0.5477 -0.1636  2.1803  1.0951  1.1526 -0.8243 -0.1322  0.9288 -1.5706
         -0.5642  1.0299
S  9     -0.3266  0.7400 -0.8891  3.3266 -0.3444 -0.5477 -0.1636  0.4489  0.2551  0.1107  1.5903 -0.2938 -0.7829 -0.3443
         -0.1794 -0.3921
S 10     -0.3046 -0.9736  0.2615 -0.4417 -0.7713 -0.5477  1.0361  0.6786 -2.3121  0.1107  0.0258  0.3526 -0.9969 -0.7364
         -0.1794 -0.2973
S 11     -0.2387  0.7400  0.2615 -0.4417 -0.9847 -0.5477 -0.1636 -0.5051  0.1271 -0.3035  0.0874  1.2413  0.1799  0.6901
         -0.2934 -0.2973
S 12     -0.2167  0.7400 -0.8891 -0.0451 -0.7713  0.5477 -0.1636 -0.8585  0.2461 -1.6090 -0.4547 -1.1017 -0.4620  0.7318
         -0.1224 -0.0129
S 13     -0.1947  0.7400 -0.8891 -0.8384 -0.7713 -0.5477 -0.1636 -1.1235  0.1069  1.5543 -0.3808 -1.0209 -0.7829  0.7652
         -0.6497 -0.2973
S 14     -0.1069  0.7400 -0.8891 -0.4417  1.1497 -0.5477 -1.3633 -1.6888 -2.3121 -2.5505 -0.6764 -1.1825 -0.9969 -0.6780
         -1.3052 -0.5817
S 15     -0.0190  0.7400 -0.8891 -0.2434  1.1497 -0.5477  2.2358  0.0426 -0.0279  1.8179  0.1120  1.8876 -0.7829  1.7496
          0.6329 -0.2973
S 16      0.0030  0.7400 -0.8891 -1.2351  1.1497 -0.5477 -0.1636 -0.0988  0.6257  0.1986  0.1859  1.4837  0.2869  0.1229
         -0.2079 -0.3921
S 17      0.0909 -0.9736  1.4120 -0.4417  1.3631 -0.5477  1.0361 -0.0811  0.1406  0.1986 -0.7627 -0.3746 -0.1410  0.3815
         -0.2079 -0.2973
S 18      0.2447  0.7400 -0.8891  0.9466  0.0825 -0.5477 -0.1636  0.8376  0.7672 -0.4918 -0.7873  0.1102  1.7847  1.6495
         -1.3052 -0.5817
S 19      0.3106 -0.9736  1.4120  1.1449  0.0825 -0.5477  1.0361 -0.5405  0.0755 -0.1906 -0.3685 -0.6978 -0.6759 -0.1524
         -0.7637 -0.4869
S 20      0.3765 -0.9736  1.4120 -0.4417  1.7900 -0.5477 -0.1636 -0.4521  0.5044  0.2864 -0.2206  1.4029  0.2869 -0.9366
         -0.2364 -0.2973
S 21      2.8371  0.7400 -0.8891  0.3516 -0.1310  1.6430  1.0361 -0.0811 -0.0346 -0.5420  0.4569 -0.9401 -1.1039 -1.2035
          3.4403  0.5559
S 22      2.9250  0.7400 -0.8891  0.1533  2.0034 -0.5477  1.0361  0.0249 -2.3121 -0.0901  2.5389  0.7565 -0.8899 -0.8115
          0.6044 -0.2973


 10 K-LINKAGE LISTS - (NEAREST NEIGHBOURS)

S  1          1.907   8    2.615   2    2.752  10    3.062   6    3.495   7    3.561  21    3.710  17    3.951  13    4.029  12
              4.161  11
S  2          0.381   6    0.822   8    0.950   7    1.166  10    1.169  12    1.251  17    1.279  19    1.378  11    1.458   3
              1.466  18
S  3          0.581  12    0.875  19    1.018  11    1.126  21    1.235  10    1.277   9    1.381   6    1.386   7    1.402  17
              1.458   2
S  4          0.467  11    0.846  16    0.973  18    0.999   5    1.074   7    1.078  15    1.217  17    1.241  13    1.398  20
              1.558  10
S  5          0.995  11    0.999   4    1.695   3    1.717  16    2.071  18    2.096   2    2.129  10    2.152  13    2.179   7
              2.185  12
S  6          0.381   2    0.386   7    0.545  10    0.600  19    0.739  17    0.752  12    0.929   8    0.972  11    0.991  13
              1.342  20
S  7          0.158  17    0.30    19    0.386   6    0.431  1     0.634  20    0.636  16    0.719  11    0.720  13    0.877  1
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              0.932  18
S  8          0.822   2   0.929   6   1.101  10   1.113   7   1.697  17   1.805  19   1.895  20   1.907   1   1.985  18
              2.001  16
S  9          1.041  19   1.277   3   1.751  10   1.850   7   1.866  22   2.233  11   2.246  12   2.281   6   2.390  17
              2.405  18
S 10          0.481   7   0.545   6   0.584  11   0.690  19   0.827  17   0.863  16   1.006  13   1.035  12   1.072  20
              1.101   8
S 11          0.467   4   0.584  10   0.602  16   0.719   7   0.834  12   0.934  19   0.948  17   0.972   6   0.995   5
              1.018   3
S 12          0.581   3   0.589  19   0.762   6   0.834  11   0.877   7   0.948  14   0.952  17   1.035  10   1.118  13
              1.169   2
S 13          0.724   7   0.896  17   0.905  19   0.991   6   1.006  10   1.043  11   1.118  12   1.241   4   1.509  16
              1.679  15
S 14          0.948  12   1.156  19   1.399  17   1.476   7   1.670   6   1.982  20   2.001   3   2.058  10   2.183  11
              2.210  16
S 15          0.830  16   1.078   4   1.160  17   1.250  20   1.272  11   1.405   7   1.630  10   1.679  13   1.827  22
              1.997  19
S 16          0.248  20   0.529  17   0.602  11   0.636   7   0.830  15   0.846   4   0.863  10   1.175  22   1.354  19
              1.374   6
S 17          0.158   7   0.529  16   0.570  19   0.570  20   0.739   6   0.827  10   0.896  13   0.948  11   0.952  12
              1.160  15
S 18          0.932   7   0.973   4   1.155  11   1.172  17   1.246  19   1.438   6   1.466   2   1.503  12   1.590  16
              1.854  10
S 19          0.306   7   0.570  17   0.589  12   0.600   6   0.690  10   0.875   3   0.905  13   0.934  11   1.041   9
              1.156  14
S 20          0.248  16   0.570  17   0.634   7   1.072  10   1.083  11   1.091  22   1.196  19   1.250  15   1.342   6
              1.398   4
S 21          1.126   3   1.796  10   1.888   2   1.968   6   2.034  12   2.099  22   2.180  19   2.269  17   2.434   7
              2.615   9
S 22          1.091  20   1.175  16   1.563  10   1.568  17   1.727   7   1.756   3   1.796  19   1.827  15   1.866   9
              2.006  11
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WARDS METHOD GROUP   14 FUSE POINTS    3   14 AE COEF    1.772    8 CLUSTERS


CLASSIFICATION ARRAY

  1    2    3    4    4    2    5    2    6    5    4    3    5    3    7    7    5    4    5    7    8    7


CLUSTER    1 NUMBER OF CASES =      1

CASE NUMBERS
  1


CLUSTER DIAGNOSIS OF MEANS, STANDARD DEVIATIONS AND F-RATIO
       VAR   F-RATIO      T              MN-ORIG         STD-ORIG             VAR    F-RATIO       T             MN-ORIG        STD-ORIG

        12     0.0       -0.9401         0.0160          0.0                  16     0.0         4.0636         0.0490         0.0
        10     0.0        0.6254         0.8030          0.0                   2     0.0        -2.6872         0.8000         0.0
        14     0.0       -0.9700         0.1150          0.0                   3     0.0         0.2615         0.0500         0.0
         9     0.0        1.1850         1.5570          0.0                   4     0.0        -1.6317        10.0000         0.0
        11     0.0       -0.7380         0.0330          0.0                   5     0.0        -0.9847         5.0000         0.0
        13     0.0       -0.9969         0.0030          0.0                   6     0.0         1.6430         1.2000         0.0
        15     0.0        0.5616         0.1310          0.0                   7     0.0         1.0361         0.2000         0.0
         1     0.0       -0.8758       181.0000          0.0                   8     0.0         2.6574         0.3360         0.0


CLUSTER    2 NUMBER OF CASES =      3

CASE NUMBERS
  2    6    8


CLUSTER DIAGNOSIS OF MEANS, STANDARD DEVIATIONS AND F-RATIO
       VAR   F-RATIO      T              MN-ORIG         STD-ORIG             VAR    F-RATIO       T             MN-ORIG        STD-ORIG

         5   0.0152     -0.7001          6.3333          0.5774                1    0.0251     -0.6341        192.0000         7.2111
         4   0.0393     -0.0451         18.0000          1.0000               11    0.0682     -0.8653          0.0227         0.0212
         9   0.1011      0.7343          1.3563          0.1415               14    0.1339     -1.1535          0.0930         0.0439
        12   0.2698     -0.7247          0.0187          0.0064               15    0.2767     -0.0892          0.0853         0.0369
        13   0.4159      1.0001          0.0217          0.0060                3    0.4413      1.0285          0.0833         0.0289
         7   0.4797     -0.5635          0.0667          0.0577               16    0.4883      0.4927          0.0113         0.0074
        10   0.6699      0.2237          0.7710          0.0652                2    0.9788      0.1688          0.9667         0.0577
         8   1.1781      0.9554          0.2397          0.0614                6    3.5993      0.5477          1.1000         0.1732


CLUSTER    3 NUMBER OF CASES =      3

CASE NUMBERS
  3   12   14


CLUSTER DIAGNOSIS OF MEANS, STANDARD DEVIATIONS AND F-RATIO
       VAR   F-RATIO      T              MN-ORIG         STD-ORIG             VAR    F-RATIO       T             MN-ORIG        STD-ORIG

        16   0.0809     -0.2973          0.0030          0.0030                1    0.1076     -0.3435        205.0000        14.9332
        13   0.1183     -0.
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       11   0.5386  -0.1467       0.0810      0.0596        14   0.6327  -0.2396      0.2600     0.0953
        4   0.6818   0.2194      19.3333      4.1633         5   1.1085  -0.0598      9.3333     4.9329
       15   1.8225  -0.0132       0.0907      0.0947         9   2.0308  -0.6702      0.7310     0.6345


CLUSTER    4 NUMBER OF CASES =     4

CASE NUMBERS
  4   5  11  18


CLUSTER DIAGNOSIS OF MEANS, STANDARD DEVIATIONS AND F-RATIO
      VAR  F-RATIO     T            MN-ORIG     STD-ORIG         VAR  F-RATIO     T            MN-ORIG    STD-ORIG

       16   0.0150  -0.4395       0.0015      0.0013         9   0.1144   0.2613      1.1458     0.1506
        1   0.1893  -0.3320     205.7500     19.8053        14   0.2108   1.2490      0.3810     0.0550
       12   0.3373   0.8777       0.0385      0.0072         5   0.3597  -0.6913      6.3750     2.8100
       15   0.4284  -0.4288       0.0615      0.0459         4   0.4458  -0.0451     18.0000     3.3665
       10   0.4560   0.1295       0.7635      0.0538         7   0.4797  -0.7634      0.0500     0.0577
       13   0.6638   1.3568       0.0250      0.0076         8   0.6753  -0.3505      0.1658     0.0465
        2   0.7341   0.3116       0.9750      0.0500         6   1.1998   0.0000      1.0500     0.1000
        3   1.2135  -0.0261       0.0375      0.0479        11   1.9583   0.3245      0.1192     0.1136


CLUSTER    5 NUMBER OF CASES =     5

CASE NUMBERS
  7  10  13  17  19


CLUSTER DIAGNOSIS OF MEANS, STANDARD DEVIATIONS AND F-RATIO
      VAR  F-RATIO     T            MN-ORIG     STD-ORIG         VAR  F-RATIO     T            MN-ORIG    STD-ORIG

        6   0.0000  -0.5477       1.0000      0.0001        16   0.0072  -0.3542      0.0024     0.0009
       15   0.0909  -0.5186       0.0552      0.0212        11   0.0995  -0.4374      0.0574     0.0256
        1   0.1127  -0.1288     215.0000     15.2807        13   0.1751  -0.5262      0.0074     0.0039
       12   0.2631  -0.4069       0.0226      0.0063        14   0.3267   0.0278      0.2346     0.0685
       10   0.4514   0.4095       0.7858      0.0535         8   0.4659  -0.1871      0.1750     0.0386
        4   0.5822  -0.1244      17.6000      3.8471         2   0.5873  -0.6309      0.9200     0.0447
        5   0.8200   0.0825      10.0000      4.2426         7   1.1514   0.3163      0.1400     0.0894
        9   1.3202  -0.2866       0.9018      0.5116         3   1.3238   0.2615      0.0500     0.0500


CLUSTER    6 NUMBER OF CASES =     1

CASE NUMBERS
  9


CLUSTER DIAGNOSIS OF MEANS, STANDARD DEVIATIONS AND F-RATIO
      VAR  F-RATIO     T            MN-ORIG     STD-ORIG         VAR  F-RATIO     T            MN-ORIG    STD-ORIG

       12   0.0      -0.2938       0.0240      0.0            16   0.0     -0.3921      0.0020     0.0
       10   0.0       0.1107       0.7620      0.0             2   0.0      0.7400      1.0000     0.0
       14   0.0      -0.3443       0.1900      0.0             3   0.0     -0.8891      0.0000     0.0
        9   0.0       0.2551       1.1430      0.0             4   0.0      3.3266     35.0000     0.0
       11   0.0       1.5963       0.2220      0.0             5   0.0     -0.3444      8.0000     0.0
       13   0.0      -0.7829       0.0050      0.0             6   0.0     -0.5477      1.0000     0.0
       15   0.0      -0.1794       0.0790      0.0             7   0.0     -0.1636      0.1000     0.0
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CLUSTER    7 NUMBER OF CASES =      4

CASE NUMBERS
 15  16  20  22


CLUSTER DIAGNOSIS OF MEANS, STANDARD DEVIATIONS AND F-RATIO
       VAR    F-RATIO       T              MN-ORIG        STD-ORIG          VAR    F-RATIO      T              MN-ORIG         STD-ORIG

         6     0.0000    -0.5477            1.0000          0.0001           16     0.0022    -0.3210          0.0028           0.0005
         8     0.0527    -0.1209            0.1787          0.0130            5     0.1936     1.5232         16.7500           2.0616
        12     0.2192     1.3827            0.0447          0.0058           15     0.2359     0.1982          0.1055           0.0341
         4     0.3409    -0.4417           16.0000          2.9439           13     0.4225    -0.2748          0.0098           0.0061
         2     0.7341     0.3116            0.9750          0.0500           10     0.7368     0.5532          0.7972           0.0684
         7     1.3193     0.7362            0.1750          0.0957            3     1.3238    -0.3138          0.0250           0.0500
        14     1.5360     0.0311            0.2350          0.1486           11     1.6102     0.6540          0.1460           0.1030
         9     1.8755    -0.3024            0.8947          0.6097            1     1.9997     0.8214        258.2498          64.3655


CLUSTER    8 NUMBER OF CASES =      1

CASE NUMBERS
 21


CLUSTER DIAGNOSIS OF MEANS, STANDARD DEVIATIONS AND F-RATIO
       VAR    F-RATIO       T              MN-ORIG        STD-ORIG          VAR    F-RATIO      T              MN-ORIG         STD-ORIG

        12     0.0        -0.9401           0.0160         0.0              16     0.0         0.5559          0.0120          0.0
        10     0.0        -0.5420           0.7100         0.0               2     0.0         0.7400          1.0000          0.0
        14     0.0        -1.2035           0.0870         0.0               3     0.0        -0.8891          0.0000          0.0
         9     0.0        -0.0346           1.0140         0.0               4     0.0         0.3516         20.0000          0.0
        11     0.0         0.4569           0.1300         0.0               5     0.0        -0.1310          9.0000          0.0
        13     0.0        -1.1039           0.0020         0.0               6     0.0         1.6430          1.2000          0.0
        15     0.0         3.4403           0.3330         0.0               7     0.0         1.0361          0.2000          0.0
         1     0.0         2.8371         349.9998         0.0               8     0.0        -0.0811          0.1810          0.0
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KEY TO LOCALITIES

1. Tunnel, Doveholes Station, Derbyshire.
2. Alport Borehole, Derbyshire.
3. Gill Beck, Cowling, Lancashire.
4. R. Noe, Harrop Farm, Derbs.
5. Rowley Wood, Low House, Ben Rhyddings, Yorks.
6. R. Darwen, Samlesbury Bottoms, Lancs.
7. Kilmoon River, Lisdoonvarna, Co. Clare, Ireland.
8. Fairborough Wood, Staffordshire.
9. Blacksmiths Arms, Leek, Staffs.
10. Primrose Hill, Middleton, Ilkley, Yorks.
11. New Grange Farm, Staffs.
12. Pendle Water, Rough Lee, Pendle, Lancs.
13. Rough Lee, Pendle, Lancs.
14. R. Aille, Phosphate Mine, Doolin, Co. Clare, Ireland.
15. Grains Clough, Lee House, Edale, Derbs.
16. Heber's Gill, Netherwood House, Ilkley, Yorks.
17. Swint Clough, Alport Valley, Derbs.
18. Swartha Beck, Silsden, Yorks.
19. Lumb Beck, Throstle Nest, Addingham, Yorks.
20. North Sands, Tenby, Pembrokeshire.
21. Mam Tor, Derbs.
22. Washburn Valley Reservoir, Yorks.
23. Cronagort Stream, Roadford, Co. Clare, Ireland.
24. Brunthwaite Beck, Silsden, Yorks.
25. Knott House, Eastburn, Sutton, Yorks.
26. Shell Brook, Greasley Hollow, Staffs.
27. Slieve Elva, Lisdoonvarna, Co. Clare, Ireland.
28. Barland Common, Bishopston, Glamorgan.
29. Backstone Beck, Ilkley, Yorks.
30. Earle's Cement Works, Hope, Derbs.
31. R. Aille, Ballyteige Bridge, Co. Clare, Ireland.
32. Emde Brickworks, Neheim, W. Germany.
33. Cahermaynalem, Noughavel, Co. Clare, Ireland.
34. Knott Copy Borehole, Settle, Yorks.
35. Ballyshanny House, Kilfenora, Co. Clare, Ireland.
36. Railway Cutting, Storris House, Ilkley, Yorks.
37. Pen-y-cae, Wrexham, N. Wales.
38. Foynes Island, Co. Limerick, Ireland.
39. Crimsworth Dene, Hebden Bridge, Yorks.
40. West Edge, Ashover, Derbs.
41. Dinckley, Blackburn, Lancs.

42. Pencaedrain Tunnel, Glyn Neath, Glamorgan.
43. Woodhouse, Lumbutt's Clough, Todmorden, Yorks.
44. Saunder's Brick Pit, Pinhoe, Exeter, Devon.
45. Woodford Park, Nab's Head, Lancs.
46. Throckley Borehole, Northumberland.
47. Shore Brook, Higher House, Belmont, Lancs.
48. Westfield Mills Borehole, Yeadon, Yorks.
49. Gevelsberg, Westphalia, W. Germany.
50. Clarkesham Farm, Cheshire.
51. Rocher End Brook, Bradfield, Yorks.
52. Pears House Clough, Strines Res., Bugworth, Yorks.
53. Hollingbrook Farm, Holcombe Brook, Lancashire.
54. Horsforth Waterworks Borehole, Yorks.
55. Roebuck Low, Oldham, Lancs.
56. Fair Oak Colliery, Cannock, Staffs.
57. Pow Gill, Bolton New Houses, Wigton, Cumbria.
58. Maltby Main Colliery, Doncaster, Yorks.
59. Cefn Coed Colliery, Crinant, S. Wales.
60. Fforchorky Stream, S. Wales.
61. Holden Beck, Silsden, Yorks.
62. Mareknowles Farm, Wrexham, Cheshire.
63. Jack Bridge, Todmorden, Yorkshire.
64. Gevelsberg, Westphalia, W. Germany.
65. Sicklinghall Waterworks, Sicklinghall, Yorks.
66. Sabden Brook, nr. R. Calder, Lancs.
67. Ponden Clough, Stanbury, Yorkshire.
68. Bottom Beck, Spofforth Haggs, Yorks.
69. Dingle Brook, Rushton James, Rushton Hall, Staffs.
70. Spring Wood, Staffs.
71. Ivy Tower, Tenby, Pembrokeshire.
72. Shell Brook, Nettlebeds Farm, Hugbridge, Staffs.
73. Co. Kerry, Ireland.
74. Porter's Farm, Horton, Staffs.
75. Fisherstreet Bay, Co. Clare, Ireland.
76. Killbarryowen Lodge, Oughterard Township, S. Clare, Ireland.
77. Glenruin River, Blakes Bridge, Co. Clare, Ireland.
78. Gate Cote, R. Darwen, Lancs.
79. O'Brien's Tower, Cliff of Moher, Co. Clare, Ireland.
80. Ewood Hall, Todmorden, Yorks.
81. Shewbroad Clough, Todmorden, Yorks.
82. Sewer Trench, Pen-y-fai, Glamorgan.
83. Shell Brook, Mareknowles, Staffs.
84. Crag Hill, White House, Eggleston, Co. Durham.
85. Trumfleet Borehole, 8 m. N.E. of Doncaster, Yorks.
86. The Coombes, Leek, Staffs.
87. Horse Hay Clough, Bailings, Yorks.
88. Bankfield Mills Borehole, Mold Green, Huddersfield, Yorks.
89. Foster Clough, Mytholmroyd, Yorks.
90. Holme Woods, Holme, Yorks.

91. Bull's Clough, Rishworth, Halifax, Yorks.
92. Kirk Lane Dyeworks Borehole, Yeadon, Yorks.
93. Felt House Wood, Leek, Staffs.
94. Quarmby Clough Mills B.H., Longwood, Huddersfield, Yorks.
95. Load Clough, Luddenden, Yorks.
96. Rag Clough, Grinding Stone Hole, Oxenhope, Yorks.
97. Star Wood, Oakamoor, N. Staffs.
98. Alum Bray, Nab's Head, Lancs.
99. Mount Road, Pule Hill, Marsden.
100. Linsgreave Clough, Way Stone, Rishworth, Yorks.
101. Tom Clough, Buckstones House, Marsden, Yorks.
102. Lench Holes, Blackwood, Rishworth, Yorks.
103. Wittenstall Clough, Cornholme, Yorks.
104. Forestone Edge, Dobcross, Yorks.
105. Short Scar, Hardhead Clough, Marsden, Yorks.
106. Fairweather Green B.H., Four Lane Ends, Bradford, Yorks.
107. Kitchen Clough, Mansergh House, Slaithwaite, Yorks.
108. High Cote, Riddlesden, Yorks.
109. Pule Moss, Diggle, Yorks.
110. Ramsden Clough, Holmbridge, Yorks.
111. Phoenix Mills B.H., Yorks.
112. Clark Bridge Mill B.H., Yorks.
113. Hodge Clough, Stubbins Stn., Ramsbottom, Lancs.
114. Black Sike, Lower Res., Upperthong, Holmfirth, Yorks.
115. Pembrokeshire.
116. Red Lane Dike, Lower Montson Place, Stainland, Yorks.
117. Rake Dike, Holme, Yorks.
118. Hooley Hey Farm, Taxal, Cheshire.
119. R. Derwent, Beeley, Derbs.
120. Great Clough, Deanhead, Scammonden, Yorks.
121. Netherends Beck, Parsonage Triangle, Sowerby, Yorks.
122. Grouse Inn, Glossop-Hayfield Road, Derbs.
123. Grane B.H., Haslingden, Lancs.
124. Wakefield Waterworks Tunnel, Ripponden, Yorks.
125. Haigh Gutter, Slaithwaite, Yorks.
126. Borehole, Feniscowles Rlwy. Stn., Blackburn, Lancs.
127. Nan Scar Beck, Sunny Bank, Yorks.
128. Mould Greave, Hoyle Sark, Marsh, Oxenhope, Yorks.
129. Hewenden, Yorks.
130. Butterly Clough, Marsden, Yorks.
131. R. Tonge, Mill Hill, Tonge Moor Rd., Bolton, Yorks.
132. Wittons Farm, Hall Wood, Longworth Valley, Egarton, Yorks.
133. Gospat Clough, Outlane Church, Stainland, Yorks.
134. R. Ogden, Helmshore, Lancs.
135. Thom Borehole, Cwmgorse, S. Wales.
136. Normanton B.H., Southwell, Notts.
137. Chatsworth Park, Chesterfield, Derbs.
138. No. 2 B.H., Withnel Fold, Chorley, Lancs.

139. Eagle Stone, 8 m. W.N.W. of Chesterfield, Derbs.
140. N.W. Helmshore Stn., Lancs.
141. Heath House Wood, Golcar, Lancs.
142. Moss Borehole, Doncaster, Yorks.
143. New House Farm, Upper Cotton, Derbs.
144. Warden's Tower, Knypersley Res., Staffs.
145. Cribden Clough, Rawtenstall, Lancs.
146. Minera Mill, Wrexham, N. Wales.
147. Stowell Bank Borehole.
148. Eakring Borehole, Eakring, Notts.
149. Yeadon Brick & Tile Works, Esholt, Yorks.
150. Ford Mill, Holmfirth, Yorks.
151. Royshaw Brickworks, Blackburn, Lancs.
152. Blaen Rhymney, Monmouth.
153. Holden Clough, Cowpe Mill, Waterfoot, Lancs.
154. Blue Scar Clough, U. Ponden, Stanbury Moor, Yorks.
155. Rlwy. cutting, S. of Bigrigg, Cumbria.
156. Redwater Clough, Portsmouth Stn., Yorks.
157. Rodmoor Borehole.
158. Wall Grange Brick Pit, Staffs.
159. Park House Mine, Bigrigg, Cumbria.
160. Scwrd-yr-Eina, Brecon, S. Wales.
161. Ynyscarbwll Farm, Nant Gwinev, Glamorgan.
162. Grain Brook/Cheesden Brook, Turf Moor, Lancs.
163. Howroyd Clough, Gorpley Res., Todmorden, Yorks.
164. Nab Scar, Shady Bank, Oxenhope, Yorks.
165. Scar Hill, Withins, Haworth, Yorks.
166. Knowsley Embankment, Charnock, Lancs.
167. Helmshore-Haslingden Road, Helmshore Stn., Lancs.
168. More Hall Res. B.H., Brighthomlee, Yorks.
169. Old Man's Hill, Bromiley, Belmont, Lancs.
170. Frog Hall, N. Staffs.
171. Halifax.
172. Ambergate Brickworks, Derbyshire.
173. High Murcroftfold, nr. Rochdale, Lancs.
174. Lower Lomax, Bury, Lancs.
175. Eaves Lane Colliery, Bucknall, Staffs.
176. Littleton Colliery, Staffs.
177. Himley Colliery, Dudley, Staffs.
178. Brick Pit, Ash Inn, Mow Cop, Staffs.
179. N. Staffs.
180. Alton Colliery, Alton, Derbs.
181. Elmton Green B.H., Elmton, Derbs.
182. Wanson Mouth, Widemouth, Cornwall.
183. Waterhead, Oldham, Lancs.
184. Syke Colliery, Rochdale, Lancs.
185. Bullion Mine, Blackburn, Lancs.
186. Horse & Jockey Inn, Huddersfield Rd., Elland, Yorks.

187. Boggart Brigg Colliery, Burnley, Lancs.
188. Shore Edge, Oldham, Lancs.
189. Waterhouse Pit, Tag Lock, Elland, Yorks.
190. Hapton Valley Colliery, Blackburn, Lancs.
191. Shore, Lancs.
192. Harrison Globe Works B.H.
193. Biddulph Grange, Staffs.
194. Ravenhead Quarry, Upholland, Lancs.
195. Mouth Mill, Clovelly, N. Devon.
196. Stepback, Darwen Hill, Lancs.
197. Thackley Tunnel, Bawdon Stn., Yorks.
198. Harrock Hill, Wrightington, Lancs.
199. Whitehaven Laundry B.H., Whitehaven, Cumbria.
200. Burnside Lane, Hepworth, Yorks.
201. Ashton Park Borehole, Bristol.
202. Hawksworth Quarry, Newby Stn., Yorks.
203. Tickhill B.H., Hindley Lane, Notts.
204. Bank Hall Colliery, Burnley, Lancs.
205. Doll Bridge, Leeming Res., Yorks.
206. Alston Works Borehole.
207. Abersychan B.H., Monmouthshire.
208. Storrs Mine, Barnsley, Yorks.
209. Windmill Inn, Wrightington, Lancs.
210. Greenside Mills Borehole.
211. Borehole, Kilkenny, Ireland.
212. Harbour Scars, Haworth Moor, Yorks.
213. Middle Moor Clough, Stanbury, Yorks.
214. Bently Hole Scar, Withins, Stanbury, Yorks.
215. Red Mines Clough, Withins, Stanbury, Yorks.
216. Esholt Tunnel, Esholt, Yorks.
217. Gill Beck, Ash House Farm, Hawksworth, Yorks.
218. Glovenshaw Pit, Baildon, Yorks.
219. Close Brow Quarry, Rishton, Lancs.
220. Chatham Hill, Green's House, Portsmouth, Lancs.
221. Red Brook, Lydgate Mill, Littleborough, Lancs.
222. The Precipice, South Ramsden, Walsden, Lancs.
223. Nuttall Mill, Brooksbottoms, Lancs.
224. Sunny Clough, Brooksbottoms, Lancs.
225. Shaly Dingle, Egg Hillock, nr. Belmont, Lancs.
226. N.W. of Cowan Res., Whitworth, Lancs.
227. Facit Stn., Lancs.
228. Neadon Middle Res., Rochdale, Lancs.
229. Ratten Clough, Portsmouth Stn., Lancs.
230. Deeply Vale, Bury, Lancs.
231. Greenthorne, Edgeworth, Lancs.

232. Bedlam Gill, Hensingham, Cumbria.
233. Huncoat Tunnel, nr. Accrington, Lancs.
234. Heaton House Drift Mine, Upholland, Lancs.
235. Hestcott Quarry, Hartland, N.Devon.
236. Lower Brownsham Farm, Hartland, N.Devon.
237. Norton Farm, Hartland, N.Devon.
238. Bouxharmont, Belgium.
239. Chokier, Belgium.
240. Alport Bridge, Ashop Valley, Derbs.

APPENDIX 2

Homoceratid specimens data file.

APPENDIX 2

Homoceratid specimens data file.

SPECIMEN CODE	ORIGINAL IDENTIFICATION (ABBREV.)	DIAMETER (mm)	S	C	T	N	R	P	D_u/D_s	W/H_w	R_i/H_w	P_i/H_w	D_o/H_w	P_o/H_w	D_h/H_w	L_t/H_w	H_t/H_w	CLUSTER CODE (OR NEAREST CLUSTER)	HORIZON + MORPHOSPECIES CODE	B.G.S. SPECIMEN NUMBER	LOCALITY CODE (SEE END OF APPENDIC
1.	1A SUB	13	.95	0	20.	0000	1.0	.1	.161	1.216	.838	.203	.047	.014	.203	0	0	Z1	H1AB	RS 1295	1
2.	1A SUB	4	1.	0	27.	0000	1.0	0	.444	2.067	00000	.1	.02	0	.033	0	0	(Y1)	H1AC	95366	2
3.	1A SUB	8	.9	.1	16.	9.	1.2	.2	.256	1.6	00000	.039	.011	0	.027	.067	.001	Y1	H1AC	95367	2
4.	1A SUB	9	1.	0	20.	0000	1.0	.1	.144	1.5	00000	.042	.017	0	.042	0	0	Y2	H1AB	95365	2
5.	1A SUB	19	1.	0	13.	0000	1.0	.1	.197	1.41	00000	.032	.016	.027	.043	0	0	(Z1)	H1AB	87319	3
6.	1A SUB	7	1.0	0	38.	0000	1.0	0	.208	1.389	00000	.014	0	0	.029	0	0	(Y2)	H1AB	Lz 1971	3
7.	1A SUB	9	.9	0	27.	8.0	1.8	.1	.156	1.269	00000	.019	.01	0	.038	.135	.006	Y2	H1AB	Lz 1973	3
8.	1A SUB	10	1.0	.1	21.	0000	1.0	0	.24	1.604	00000	.073	.013	0	.031	0	0	Y3	H1AA	51214	3
9.	1A SUB	11	.95	0	15.	15.	1.1	.5	.191	1.385	.808	0	.019	.001	.067	.029	.002	Z2	H1AA	PT 1293	4
10.	1A?SUB	18	1.0	.1	9.	0000	1.0	.8	.211	00000	.611	.099	.017	.011	.244	0	0	/	H1A	Da 1242	5
11.	1A?SUB	13	.95	0	13.	0000	1.0	.1	.208	00000	.746	.063	.016	0	.19	0	0	/	H1A	"	5
12.	1A?SUB	15	.95	0	16.	0000	1.0	.3	.161	00000	.733	.053	.02	.007	.173	0	0	/	H1A	Da 1245	5
13.	1A?SUB	9	1.0	.1	26.	0000	1.0	0	.1	00000	00000	.038	.005	0	.05	0	0	/	H1A	Da 1250	5
14.	1A SUB	16	.95	0	12.	0000	1.0	.3	.167	00000	00000	0	0	0	.05	0	0	/	H1A	82856	6
15.	1A SUB	11	1.0	0	11.	8.	1.0	.3	.164	1.255	00000	.018	0	.007	.127	.127	.004	Z2	H1AA	82855	6
16.	1A SUB	12	.95	0	18.	8.	1.6	.4	.154	1.262	00000	.066	.008	.01	.131	.123	.009	Z2	H1AA	82854	6
17.	1A SUB	21	1.0	0	10.	5.	1.6	.7	.129	1.221	.726	.032	.026	.026	.316	.137	.007	(Z2)	H1AA	82852	6
18.	1A SUB	12	1.0	0	12.	9.	1.7	.3	.16	1.452	.887	.032	.016	.024	.031	.194	.006	Z2	H1AA	"	6
19.	1A SUB	13	.95	.2	16.	8.	1.5	.5	.13	1.188	.688	.019	.019	.004	.263	.063	.004	Z2	H1AA	82853	6
20.	1A SUB	17	.95	0	11.	13.	2.0	.9	.239	1.474	.769	.103	.032	.026	.192	.256	.001	(Z3)	H1AC	Zi 4536	7
21.	1A SUB	13	1.0	0	16.	10.	1.4	.6	.269	1.82	.84	.1	.04	.036	.04	.16	.004	Z3	H1AC	"	7
22.	1A?SUB	14	1.0	0	16.	6.	1.2	0	.17	1.24	.747	.093	.04	.007	.173	.227	.007	(Z2)	H1AA	59993	8
23.	1A?SUB	7	1.0	.1	26.	15.	1.0	0	.24	1.3	00000	.038	.009	0	.03	.15	0	(Y2)	H1AB	59995	8
24.	1A?SUB	10	1.0	.1	20.	0000	1.0	0	.15	1.0	00000	.067	.025	0	.025	0	0	Y2	H1AB	59997	8
25.	1A?SUB	9	.85	.25	19.	0000	1.0	0	.143	1.192	.788	.144	.033	.006	.067	0	0	Y2	H1AB	59999	8
26.	1A?SUB	12	1.0	.05	16.	0000	1.0	0	.138	1.157	00000	.043	.003	0	.036	0	0	Z1	H1AB	59996	8
27.	1A?SUB	12	1.0	.1	24.	0000	1.0	0	.167	1.308	.754	.062	.038	0	.062	0	0	Z1	H1AB	59994	8
28.	1A?SUB	22	.95	.1	15.	0000	1.0	0	.207	1.136	.754	.095	.025	.017	.102	0	0	(Z1)	H1AB	JP 2481	9
29.	1A?SUB	12	.95	.1	19.	0000	1.0	0	.168	00000	00000	.048	.032	0	.111	0	0	/	H1A	Dw 4900	10
30.	1A?SUB	17	1.0	.1	16.	0000	1.0	0	.094	00000	.667	.046	.048	.029	.095	0	0	/	H1A	Dw 4897	10
31.	1A SUB	19	1.0	0	8.	0000	1.0	0	.12	1.1	.8	.06	.03	.025	.3	0	0	(Z2)	H1AA	59840	11
32.	1A SUB	10	.95	.1	15.	0000	1.0	0	.171	1.538	00000	.029	.002	0	.058	0	0	Y2	H1AB	"	11
33.	1A SUB	8	1.0	0	22.	0000	1.0	0	.171	1.325	00000	0	.05	0	.038	0	0	Y2	H1AB	59950	11
34.	1A SUB	9	1.0	0	27.	0000	1.0	0	.158	1.45	00000	.125	.036	0	.039	0	0	Y2	H1AB	59842	11
35.	1A SUB	10	.95	.05	38.	0000	1.0	0	.216	1.286	00000	.018	.027	0	.036	0	0	Y2	H1AB	59841	11
36.	1A SUB	9	.95	.05	23.	0000	1.0	0	.179	1.628	00000	0	0	0	.012	0	0	Y2	H1AB	59846	11
37.	2C EOS	6	1.0	0	25.	16.	1.0	0	.259	1.63	00000	.222	.011	0	.048	.111	.011	/	H2C	63075	12
38.	2C EOS	11	1.0	0	11.	6.	1.0	.7	.255	1.222	.759	.019	0	0	.13	.111	.004	Z1	H2CC	W420	13
39.	1A SUB	11	1.0	.1	14.	14.	1.0	.4	.304	1.729	00000	.104	.027	.004	0	.073	.004	Z3	H1AC	49917	3
40.	2A SMI	13	1.0	0	12.	0000	1.0	.8	.211	1.415	.805	.098	.027	.024	.171	0	0	(Z1)	H2AC/D	Zi 4592	14
41.	2A SMI	11	1.0	0	16.	0000	1.0	.6	.291	1.509	00000	.066	.028	0	.011	0	0	Y1	H2AC/D	" 4604	14
42.	2A SMI	13	1.0	0	13.	0000	1.0	.4	.294	1.55	.817	.042	.017	.003	.059	0	0	Z1	H2AC/D	" 4603	14
43.	2A SMI	14	1.0	0	12.	0000	1.0	.6	.257	1.554	.723	.1	.009	0	.154	0	0	Z1	H2AC/D	" 4602	14
44.	2A SMI	11	1.0	0	16.	22.	1.0	.5	.359	1.896	.833	.167	.052	0	.004	.146	.004	Y2	H2AA/B	" 4605	14
45.	2A SMI	13	1.0	0	18.	0000	1.0	.8	.237	1.484	.871	.226	.016	.003	.073	0	0	Z1	H2AC/D	" 4601	14
46.	2A SMI	11	1.0	0	20.	0000	1.0	.1	.182	1.273	.782	0	.018	0	.164	0	0	Y3	H2AE	" 4593	14
47.	2A SMI	9	.95	0	14.	23.	1.0	.5	.462	1.97	1.0	.273	.045	0	0	.121	.006	X1	H2AA	" 4606	14
48.	2A SMI	10	1.0	0	18.	0000	1.0	.4	.417	1.674	.93	.07	.033	.007	.04	0	0	Y1	H2AC/D	" 4599	14
49.	2A SMI	10	1.0	0	12.	0000	1.0	.4	.38	1.988	.979	.223	.045	0	.012	0	0	Y1	H2AC/D	" 4596	14
50.	2A SMI	8	1.0	0	14.	0000	1.0	0	.455	2.188	.953	.234	.047	0	.039	0	0	X3	H2AC	" 4598	14
51.	2A SMI	7	1.0	0	13.	0000	1.0	.3	.541	2.089	1.0	.156	.018	0	.004	0	0	(X4)	H2AD	" 4597	14
52.	2A SMI	6	1.0	0	29.	0000	1.0	.1	.441	1.654	.923	.077	.008	0	.009	0	0	(X5)	H2AE	" 4600	14

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 53.2A SMI  3 1.0   0 15.00001.0 .3 .4712.067 .933 .133 .043      0 .017    0    0   X4   H2AD     Z: 4595  14
 54.2A SMI 10 .95   0 11. 13.1.0 .3 .4752.083 .917 .083 .022      0 .042.063.006   Y2   H2AA/B   Z: 4594  14
 55.2A SMI 14 1.0   0  9. 21.1.0 .7 .2451.47100000 .221    0      0 .103.118    0   Z1   H2AC/D   Z: 4607A 14
 56.2A SMI 13 1.0   0 12.00001.0 .9 .2781.55200000 .138 .034      0 .007    0    0   Z1   H2AC/D         B 14
 57.2A SMI  9 1.0   0  8. 20.1.0 .5 .4351.921 .947 .158 .026      0 .003.075.003   X1   H2AA           C 14
 58.2A SMI 10 1.0   0 13.00001.0 .2 .4652.061 .909 .212  .03      0  .03    0    0   Y1   H2AC/D         D 14
 59.2A SMI 13 1.0   0  8. 50.1.0 .4 .2651.56900000 .103 .034      0 .026.121    0   Z2   H2AA/B         E 14
 60.2A SMI 12 1.0   0  9.00001.0 .5 .3171.52700000 .182 .027      0 .009    0    0   Z2   H2AA/B         F 14
 61.2A SMI  9 1.0   0 11. 22.1.0 .4 .4172.406 .969 .125 .047      0 .003.094.006   X1   H2AA           G 14
 62.2A SMI 10 1.0   0 15.00001.0 .3 .3521.894 .957 .277 .032      0 .032    0    0   Y1   H2AC/D         H 14
 63.2A SMI 11 1.0   0 10.00001.0 .3 .3451.40400000 .192  .01      0 .019    0    0   Y2   H2AA/B         I 14
 64.2A SMI 10 1.0   0 11. 20.1.0 .3  .37 1.48  .98  .14 .024      0 .006 .06.004   Y2   H2AA/B         J 14
 65.2A SMI  8 1.0   0 11. 12.1.0 .4 .4381.833 .933 .267 .033      0 .007.083.007   X1   H2AA           K 14
 66.2A SMI  9 1.0   0 19. 22.1.0 .2 .3981.811 .892 .162 .049      0 .054.066.003   X2   H2AB           L 14
 67.2A SMI 10 1.0   0 10. 16.1.0 .7 .3051.864 .977  .25 .023      0 .014.091.002   Y2   H2AA/B         M 14
 68.2A SMI  6  .8 .1 26. 30.1.0  0 .544 2.4500000  .15  .01      0 .015   .1    0   /    H2A            N 14
 69.2A SMI 10 1.0   0 14.00001.0 .2 .3692.08300000  .25 .056      0 .006    0    0   Y1   H2AC/D         O 14
 70.2A SMI  9 1.0   0 13. 23.1.0 .2 .4322.139 .972 .167 .044      0 .028.069.006   X2   H2AB           P 14
 71.2A SMI  8 .95   0 16. 22.1.0 .1 .476 2.25 .938 .219 .031      0 .013.078.006   X2   H2AB           Q 14
 72.2A SMI  8 1.0   0  9.00001.0 .2 .3762.067 .933 .233 .043      0 .033    0    0   X3   H2AC           R 14
 73.2A SMI 12 1.0   0  9. 21.1.0 .6 .339 1.7600000  .24    0      0    0   .1.002   Z2   H2AA/B         S 14
 74.2A SMI  9 1.0   0 17. 21.1.0 .3 .4212.438 .875 .344 .031      0 .016.094.006   X2   H2AB           T 14
 75.2A SMI  9 1.0   0  8.00001.0 .5   .42.33300000 .076 .045      0 .015    0    0   X3   H2AC           U 14
 76.2A SMI  8 1.0   0 10.00001.0 .3 .4352.182 .945 .145 .036      0 .073    0    0   X3   H2AC           V 14
 77.2A SMI  8 .95   0 18.00001.0  0   .5  2.000000 .113 .032      0  .01    0    0   X4   H2AD           W 14
 78.2A SMI  9 .95.05 15.00001.0 .2 .311 1.3500000   .1 .005      0 .038    0    0   X5   H2AE           X 14
 79.2A SMI  9 1.0   0 14.00001.0 .1  .492.056 .972 .194 .028      0 .003    0    0   X4   H2AD           Y 14
 80.2A SMI  8 1.0   0 12. 16.1.0 .1  .411.875 .938 .219 .031      0 .031.063.003   X2   H2AB           Z 14
 81.2A SMI 16 1.0   0 8.500001.0 .8 .16300000 .733 .067  .02 .011 .093    0    0   /    H2A      Rs 2599  15
 82.1B DIA 15 .95 .1 15. 19.1.0  0 .220000000000 .031 .018 .015 .038.062.002   (Z1) H1BA     Dw 4686  16
 83.1B DIA 28 1.0 .1 11.00001.0  0 .21400000 .643 .114 .025 .021 .229    0    0   (Z1) H1BA        "     16
 84.1B DIA 11 1.0.05 20. 30.1.0  0 .182000000000  .07 .004 .002 .006 .05.002   (Z1) H1BA        "     16
 85.1A?LEO  9  .9 .1 18.00001.0 .3 .4172.275 .975   .1 .038      0 .038    0    0   Y1   H1AC      95364   3
 86.3B SPI  9 .65 .6 22.  9.1.5 .2  .241.295  .75 .136 .034      0 .295.114.005   X1   HR1BA     71123  17
 87.3B SPI 12  .6 .7 20.00001.0  0 .2361.268 .768 .125 .021 .004 .116    0    0   Z1   HR1BA     63090  17
 88.3B SPI 26  .7 .7 28.00001.0  0 .178  1.0  .78 .333  .06 .027 .467    0    0   /    HR1B      63089  17
 89.1B DIA 18 1.0 .1 14. 18.1.0  0 .18300000 .653 .053 .032 .016 .084.053.005   (Z1) H1BA     Dw 4957  10
 90.1B DIA 14 1.0   0 13. 17.1.3 .8 .3011.58700000 .159 .002      0  .19.079.002   Z1   H1BA      50614   7
 91.1B DIA 18 1.0   0 13. 17.2.0 .5 .178 1.25 .739 .141 .043 .027  .25.272.011   Z2   H1BB      50613   7
 92.1B DIA 12 1.0   0 15. 20.1.0 .6 .224  1.4 .783 .067 .042 .013  .05 .05.005   Z1   H1BA        "      7
 93.1B DIA 22 1.0   0  9.00001.0  0 .205000000000 .027 .009      0 .136    0    0   (Z1) H1BA     Da 1053  18
 94.1B BEY 12 1.0   0 12.00001.0 .3  .3600000 .909 .291 .018      0 .036    0    0   Z1   H1BA     Dw 4675  16
 95.1B BEY 22 1.0   0 12. 24.1.0 .5 .17300000 .752 .221 .027 .004 .053.027.007   (Z3) H1BC     Dw 4960  10
 96.1B BEY  9 1.0   0 16. 12.1.2 .5 .189000000000 .136 .007 .005 .057.066.007   (Z1) H1BA      88677   6
 97.1B BEY 14 1.0   0 10. 50.1.0 .9  .321.754 .947 .158    0  .03      0.083.001   Z1   H1BA      50616   7
 98.1B BEY 19 1.0   0 18.00001.0 .1 .15800000 .678 .033 .033 .013 .122    0    0   (Z1) H1BA     Dw 4992  10
 99.1B BEY 14 1.0.05 10.00001.0 .7 .18600000 .756 .154 .032 .026 .038    0    0   Z1   H1BA     Lz 403   19
100.1B BEY  5 1.0   0 11.  8.1.21.0 .3961.667 .972 .778 .006      0      0.333.067   (Z2) H1BB     ED 1931  20
101.1B BEY  8 1.0   0  8. 11.1.0 .7   .51.813 .938 .438 .031      0      0.125.038   (Z3) H1BC      26295  20
102.1B BEY 15 1.0   0 10. 15.1.0 .7 .2871.833 .983 .717 .025      0      0.167.025   (Z3) H1BC      26297  20
103.1B BEY 12 1.0   0  9. 16.1.0 .9 .4411.957 .978 .696 .065 .004      0.065.011   Z3   H1BC      26296  20
104.1B?DIA 18 1.0   0 14.00001.0 .1 .20600000 .666    0 .006 .002 .133    0    0   (Z1) H1BA     Zh 218   20
105.1B BEY  8 1.0   0  6. 12.1.01.0 .4822.739 .913 .739  .03      0      0.065 .03   (Z3) H1BC      50617   7
106.1B BEY 13 1.0   0  6. 10.1.01.0 .4962.583 .972 .773 .028      0      0.069.011   Z3   H1BC      50615   7
107.1B BEY 11 1.0   0  6. 16.1.01.0 .3812.267 .844 .622 .044      0      0.067.018   (Z3) H1BC     Da 1051  18
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108.1B DIA 22 1.0  0  9.00001.0  0 .18200000 .636 .082 .014     0 .227   0   0   (Z1)  H1BA    Da 1052    18
109.1B DIA 16 1.0  0 17.00001.0  0 .21200000 .676 .068    0     0 .095   0   0   (Z1)  H1BA       "       18
110.1B BEY 22 1.0  0 10.00001.0 .8 .18200000   .8  .23  .03 .025  .25    0   0   (Z1)  H1BA    FOR 1782   239
111.1B BEY  6 1.0  0  8.  10.1.01.0 .4482.095 .905 .714 .029    0      0.095.048  (Z3)  H1BC      1/65     ?
112.1B BEY 13 1.0  0 11.  20.1.0 .5 .17700000 .597 .015 .022    0 .254.075.001    Z1   H1BA    Ze 1963    21
113.1B BEY 14 1.0  0 13.  10.1.8 .5 .25700000 .757 .014 .014 .003 .114.286.017    Z2   H1BB    Ze 1964    21
114.1B BEY 18   .9.15 12.  22.1.0  0 .16700000 .552 .198 .021    0 .229.063.003   (Z1)  H1BA    Dw 4683    16
115.1B BEY 11 1.0  0 50.  25.1.0  0 .1950000000000  .06  .01    0  .16 .06.002   (Z1)  H1BA -      "       16
116.1B ??? 12 1.0  0  5.00001.0 .7 .15800000 .717 .333  .05     0    0   0   0    Z1   H1BA      95348    22
117.1B ??? 17 1.0  0  3.00001.0 .9 .13500000 .706 .012 .018 .006 .212    0   0   (Z1)  H1BA     _95347    22
118.2B ???  8 .95  0 13.  14.1.0 .1 .3761.743 .857 .257 .029    0 .057.086.009   (Y1)  H2BA    Zi 4473    23
119.2B ???  7  .9  0 16.  18.1.0 .2 .3331.781 .906 .219 .038 .003 .003.094.003   (Y1)  H2BA    Zi 4471    23
120.2B ??? 29 1.0  0 5.500001.0 .8 .12100000 .556 .011 .002 .002 .306    0   0     /   H2B     Lz 328     24
121.1B ??? 14 1.0  0 3.5 7.01.0 .8  .1500000 .643 .029 .021 .004 .057.071.004    Z1   H1BA      95346    22
122.2B?UND 20 1.0  0 14.00001.0 .9 .14500000 .545 .073 .027 .009 .182    0   0     /   H2B     Da 2106    25
123.2B?UND 24 1.0  0 11.00001.0 .8 .10400000 .669 .231 .027 .012 .192    0   0     /   H2B     Da 2094    25
124.2B?UND 16 1.0  0  9.00001.0 .7 .19400000 .566 .026 .013     0 .132   0   0    Z1   H2BA/B  Da 2084    25
125.2B?UND 10 1.0  0 15.  25.1.0 .6  .251.825  .95  .15  .05     0 .003.088.003   (Y1)  H2BA     42/64     ?
126.2C?UND 27 1.0  0  8.  11.1.9 .9 .1111.104 .793 .345 .083 .014 .483.276.017   (Z3)  H2BD     T322B     26
127.2B?UND 14 1.0  0 15.00001.0 .4 .26400000 .561 .045 .005     0 .379   0   0     /   H2B      56434     27
128.2C?UND 26 1.0  0 14.00001.0 .4 .10800000 .767   .3  .06 .007   .3    0   0     /   H2B     Zi 7240    13
129.2C?UND 23 1.0  0 19.00001.0 .5 .12200000 .791 .364 .082 .023   .3    0   0     /   H2B     Zi 7239    13
130.2B UND 16 1.0  0 15.  7.01.0 .8 .2861.288 .838 .038 .003 .004 .225.125.005    Z2   H2BC    Zi 4535     7
131.2B UND 23 1.0  0 11.00001.0 .8 .1431.127 .691 .109 .032 .018 .409    0   0   (Z1)  H2BA/B   " 4537     7
132.2B UND 15 1.0  0 12.00001.0 .7 .2671.35700000 .043 .007      0   .2   0   0    Z1   H2BA/B   " 4538     7
133.2B UND 16 1.0  0 12.00001.0 .8  .28  1.4 .827 .173 .003      0   .2   0   0    Z1   H2BA/B   " 4539     7
134.2B UND 12 1.0  0 13.  20.1.0 .8 .3171.745 .872 .085 .006     0 .064.106.002    Y1   H2BA     " 4540     7
135.2B UND 10 1.0  0 12.  23.1.0 .7 .343 1.44  .92  .14  .03     0  .04 .06.004   (Y1)  H2BA     " 4541     7
136.2B UND  9 1.0  0 16.  24.1.0 .7 .2921.944 .833 .097 .008     0 .069.083.003   (Y1)  H2BA     " 4542     7
137.2B UND 10 1.0  0 14.  10.1.2 .5 .369 1.75 .917 .042 .021     0 .004.146.004   (Y4)  H2BB     " 4543     7
138.2B UND 10 1.0  0 15.  24.1.0 .7 .353 1.9500000  .1 .038      0 .038.063.003   (Y1)  H2BA     " 4544     7
139.2B UND 10 1.0  0 15.  11.1.5 .7 .2751.277 .894 .106 .021 .021 .011.106.006   (Y3)  H2BC/D   " 4545     7
140.2B UND  7 1.0  0 15.  26.1.0 .2  .41 2.32  .88  .12  .04     0 .008 .08.008   (Y1)  H2BA     " 4546     7
141.2B UND  6 1.0  0 16.  21.1.0  0 .3971.556 .963 .222 .011     0 .011.222.011   (Y3)  H2BC/D   " 4547     7
142.2B?UND 23 1.0  0  9.00001.0 .9 .16200000 .478  .13 .026     0 .304   0   0     /   H2B     JS 1250    28
143.2B?UND 16 1.0  0  8.00001.0 .9 .15600000 .563 .163    0     0 .163   0   0    Z1   H2BA/B  Da 208B    25
144.2B UND 25 1.0  0 10.00001.0 .9 .1681.225  .75  .05 .033 .033 .275    0   0   (Z1)  H2BA/B  Zi 4548 2042  7
145.2B UND 25 1.0  0 11.00001.0 .8 .2341.225 .792 .125 .033 .029  .25    0   0   (Z1)  H2BA/B   "  "  2198  7
146.2B UND 21 1.0  0 12.  14.1.0 .8 .173  1.2  .77  .08  .02  .02  .33  .06.003   (Z2)  H2BC     "  "  2059  7
147.2B UND 20 1.0  0 14.  12.1.0 .8  .281.341 .682  .04 .011     0 .341 .08.005   (Z2)  H2BC     "  "  2068  7
148.2B UND 19 1.0  0 12.00001.0 .9 .1911.222 .856 .111 .022 .011 .278    0   0   (Z1)  H2BA/B   "  "  2208  7
149.2B UND 13 1.0  0 16.  16.1.0 .8 .2311.698 .849 .038 .004 .006 .151.075.004    Y1   H2BA     "  "   "    7
150.2B UND 18 1.0 .1 17.  18.1.4 .8 .1961.205 .783  .06 .024 .024 .157.157.005   (Z3)  H2BD     "  "  2146  7
151.2B UND 16 1.0  0 13.  14.1.0 .9  .191.188  .75  .05 .025 .025  .15.075.003    Z3   H2BD     "  "  2058  7
152.2B UND 15 1.0  0 14.  16.2.0 .8 .227  1.1 .789 .038 .019 .006 .163.188.004    Z3   H2BD     "  "  2152  7
153.2B UND 16 1.0.05 13.  14.1.7 .7 .232 1.44   .8 .027     0    0 .227.133.003    Z2   H2BC     "  "  2148  7
154.2B UND 16 1.0  0 12.  13.1.5 .8 .2061.313 .688 .038     0    0 .339.075.003    Z2   H2BC     "  "  2154  7
155.2B UND 16 1.0  0 10.00001.0 .8 .216  1.4   .8 .053 .013     0 .187    0   0    Z1   H2BA/B   "  "  2190  7
156.2B UND 14 1.0  0 13.00001.0 .9 .1691.471 .735 .103 .015 .006 .147    0   0    Y2   H2BE     "  "  2215  7
157.2B UND 14 1.0  0 13.  20.1.0 .8 .255  1.6   .8 .054 .003 .009 .108.092.002    Y1   H2BA     "  "  2076  7
158.2B UND 15 1.0.05 18.  28.1.2 .8 .2531.581 .806 .145 .013 .005 .097.049.002    Z1   H2BA/B   "  "  2197  7
159.2B UND 15 1.0 .1 14.00001.1 .6 .2411.301 .712 .055     0    0 .123    0   0    Z1   H2BA/B   "  "  2214  7
160.2B UND 14 1.0  0 13.00001.0 .9  .251.314 .729 .014 .029 .007 .114    0   0    Y2   H2BE     "  "  2065  7
161.2B UND 17 1.0  0 12.  7.01.6 .9 .2771.571 .857 .129 .014  .01   .2  .1.004    Z3   H2BD     "  "  2217  7
162.2B UND 12 1.0  0 12.  15.1.1 .9 .2761.367 .933   .1 .005 .005 .067.117.005    Y1   H2BA     "  "   "    7
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 163.2B UND 14 1.0  0 14.  16.1.3 .8 .2521.492 .785 .046 .031 .015 .062.046.003    Y3    H2BC/D   "  "2066    7
 164.2B UND 13 1.0  0 12.  17.1.4 .8 .277  1.6 .855 .073 .019 .027 .055.145.005    Y3    H2BC/D   "  "2039    7
 165.2B UND 15 1.0  0 15.00001.0 .8 .248 1.38 .732 .029 .014 .001 .141    0   0    Z1    H2BA/B   "  "2209    7
 166.2B UND 13 1.0  0 15.00001.0 .8 .2911.53300000 .067    0    0  .05    0   0    Y1    H2BA     "  "2221    7
 167.2B UND 11 1.0  0 14.00001.0 .7  .251.702 .809 .064 .032    0 .017    0   0    (Y2)  H2BE     "  "2207    7
 168.2B UND 12 1.0 .1 16.00001.1 .8 .2641.54700000 .047 .028    0 .066    0   0    Y1    H2BA     "  "2157    7
 169.2B UND 12 1.0  0 15.  15.1.4 .9 .2641.46800000 .048 .009 .024 .145.306.005    Y3    H2BC/D   "  "2203    7
 170.2B UND 20 1.0  0 14.  10.1.4 .8 .1581.181 .648 .095 .019  .01 .229.257.004    (Z3)  H2BD     "  "K43/29  7
 171.2B UND 13 1.0.05 18.  18.1.0 .6 .2091.233 .808 .041 .025 .011 .137.065.004    Y4    H2BB     "  "K43/16  7
 172.2B UND 12 1.0.05 13.  23.1.3 .8 .2581.403 .871 .048 .032 .016 .056.048.003    Y3    H2BC     "  "K43/39  7
 173.2B UND 10 1.0.05 15.  28.1.0 .1 .2781.58300000 .063 .021    0 .004.063.004    (Y1)  H2BA     "  "K43/37  7
 174.2B UND 12 1.0.05 14.  30.1.1 .6 .2381.33900000 .065 .032 .003 .113.048.005    Y4    H2BB     "  "K43/30  7
 175.2B UND  8 1.0  0 15.  24.1.0 .9 .402  2.6 .813 .122  .02    0    0.081.004    (Y1)  H2BA     "  "K43/12  7
 176.2B UND 13 1.0  0 13.  27.1.0 .9 .2151.37300000    0 .001    0  .06.045.001    Y2    H2BE     "  "K43/A   7
 177.2B UND 10 1.0  0 18.  25.1.0 .8 .3241.596 .915 .106 .021    0 .021.064.004    (Y1)  H2BA     "  "K43/B   7
 178.2C PRE 23 1.0 .1 12.  10.1.6 .8 .15700000 .592  .24 .024 .016  .36 .16.002    ⁄     H2C      Ca 932     13
 179.2C PRE 14  .9 .1  9.   7.2.01.0 .34500000 .667 .283 .025    0   .2 .25.017    ⁄     H2C      Ca 930     13
 180.2C PRE 22 1.0 .1 10.  10.1.5 .8 .19500000 .571 .095 .057 .024 .266.238.002    ⁄     H2C        "        13
 181.3A MAG 13  .8.05 10.   5.1.2 .2 .3361.557 .803 .033 .016 .003 .115.131.049    Z1    HRIAF    71458      29
 182.3A MAG  8  .8 .1 28.   6.1.1 .2 .2771.475 .825 .013 .013 .013  .05.063.038    X1    HRIAC    71460      29
 183.3A MAG  7  .8 .1 31.   7.1.2 .2 .343 1.31 .897 .103 .017 .003 .086.138.052    X1    HRIAC    71461      29
 184.3A MAG 13  .9 .1 18.   6.1.3 .1 .218 1.25 .722 .042 .014 .028 .125.125.014    Z2    HRIAC    71454      29
 185.3A MAG  7  .8 .1 30.   9.1.2 .2 .3241.613 .903 .065 .016 .006 .065.097.006    X1    HRIAC    71456      29
 186.3A MAG  7  .9 .1 20.   8.1.1 .2  .261.515 .909 .212  .03 .015  .03.091.009    X2    HRIAA    71457      29
 187.3A MAG 10  .9 .1 19.   6.1.2 .2 .2041.125 .714 .054 .013 .021 .089.107.004    Y1    HRIAA    71455      29
 188.3A MAG 13 .95.05 24.   7.1.1 .1 .1561.054 .635 .149 .023 .009 .311.189.003    Z3    HRIAA    71453      29
 189.3A MAG 14  .9 .1 16.   7.1.2  0 .1461.064 .833 .064 .045 .026 .423.064.001    Z5    HRIAD    71452      29
 190.3A MAG 11 .95.05 16.   8.1.3 .1  .271.423 .846 .035 .019 .019 .096.135.029    Y4    HRIAC    Lz 341a    29
 191.3A MAG 10  .9 .2 24.  10.1.0 .1 .2131.214  .75 .071 .009 .009 .143.089.004    Y1    HRIAA    Lz 341b    29
 192.3A?MAG 15 1.0  0 17.  3.51.0  0 .1271.062 .778 .284 .037 .031 .358.111.002    Z5    HRIAD    Ze 1952    30
 193.3A MAG 19 1.0  0 16.00001.0  0 .146  1.0  .77  .15  .08  .03  .37    0   0    ⁄     HRIA     86911      31
 194.3A MAG 12 1.0.05 17.   6.1.0  0 .1521.302 .746    0 .016 .016 .111.079.003    Z2    HRIAC      "        31
 195.3A MAG 10  .9  0 20.   8.1.1  0 .252 1.34 .787 .149 .043 .032 .128.213.021    Y4    HRIAC    86909      31
 196.3A MAG 15  .9  0 18.  12.1.0  0 .1931.277 .783 .036 .024 .012 .217.036.002    Z3    HRIAA    86913      14
 197.3A MAG 17 .95 .1 20.   6.1.1 .1 .1471.012 .716 .037 .019 .012 .432.096.015    (Z3)  HRIAA    86910      31
 198.3A MAG 12 1.0 .1 19.   7.1.0 .1 .3091.517 .845 .026 .026 .021 .043.052.017    Z2    HRIAC    86912      14
 199.3A MAG  9 1.0.05 20.   6.1.2  0 .344  1.9   .9 .063  .05 .005  .07  .1.008    Y4    HRIAC      "        14
 200.3A MAG 23 1.0.05 13.00001.0  0 .1431.123 .719 .044 .031 .022 .492    0   0    ⁄     HRIA     86915      31
 201.3A MAG  9 1.0  0 17.   8.1.2  0 .3261.558  .93  .07 .016 .035 .023.174.042    Y4    HRIAC    86935      32
 202.3A MAG 11 1.0  0 16.  16.1.0 .1 .195  1.0 .683 .206 .048 .024 .317.042.002    Y3    HRIAD/E  83138      13
 203.3A MAG  5 1.0  0 28.   9.1.0 .1 .3931.944 .389 .167 .011    0 .011.167.006    (X1)  HRIAC    90011      29
 204.3A MAG  6 1.0  0 38.   6.1.0 .1 .3651.667 .833 .042 .008 .002 .104.167.021    (X1)  HRIAC      "        29
 205.3A MAG  9  .9  0 26.   6.1.0 .1 .2711.283 .783 .065 .022 .004 .054 .13.011    Y1    HRIAA      "        29
 206.3A MAG 12 1.0  0 35.   8.1.0 .1 .2111.143 .762 .222 .024 .005  .19.079.002    Z4    HRIAB    90012a     29
 207.3A MAG 12  .9.05 16.   6.1.0 .2 .22400000 .762 .095 .032 .003 .143.079.003    Z3    HRIAA         b     29
 208.3A MAG 10  .9.05 36.   8.1.0 .1 .2161.173 .731 .115 .029 .006 .154.135.004    Y1    HRIAA    90010      29
 209.3A MAG  6 1.0  0 30.   9.1.0 .1 .3551.545 .864 .273 .005    0 .005.136.005    (X1)  HRIAC    90014      29
 210.3A MAG 12 1.0.05 16.   5.1.0 .1 .1571.086 .729   .1 .043 .014 .314.071.003    Z5    HRIAD    90013      29
 211.3A MAG 13 1.0  0 18.   6.1.1 .1 .1371.139 .625 .056 .014 .008 .319.093.006    Z3    HRIAA    FOR 1833   33
 212.3A MAG 12 1.0  0 14.   6.1.0 .1 .1221.077 .877 .062 .015 .005 .323.046.003    Z3    HRIAA    FOR 1834   33
 213.3A MAG 19 1.0  0 10.00001.0 .2 .1371.055 .727   .2 .027 .003 .336    0   0    ⁄     HRIA     FOR 1835   33
 214.3A HEN 25 1.0 .1  8.00001.0  0 .11200000 .607 .074 .022 .004 .259    0   0    ⁄     HRIA     EWJ 3442   34
 215.3A HEN  7 1.0 .2 20.  30.1.0  0 .12200000 .838    0 .003 .003 .011.135   0    X3    HRIAG      "        34
 216.3A HEN 14 1.0  0 16.00001.0  0  .0900000  .55 .038 .013 .003  .15    0   0    Z3    HRIAA    "  3437    34
 217.3A HEN  7  .9 .3 25.  25.1.0  0 .18600000    0    0    0    0    0.156.031    X3    HRIAG    "  3460    34
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 218.3A HEN  8  .8  0  9. 11.1.0 .3 .2561.205     0 .051 .003 .005 .013.103.008    X2    HRIAA   90017    27
 219.3A HEN  8 1.0  0 12. 18.1.0  0 .2611.405  .73 .041 .008 .019 .027.108.008    X2    HRIAA   90018    27
 220.3A HEN 12 1.0  0 17. 15.1.0 .3 .1881.017 .898 .102 .051 .005 .441.136.003    Z6    HRIAE   Zi 4688  35
 221.3A HEN 12 1.0  0 12. 15.1.0 .1  .181.308 .769 .108 .046 .015 .246.077.002    Z6    HRIAE   Zi 4689  35
 222.3A HEN 11 1.0  0 16. 17.1.0 .1  .151.131 .689 .049 .025 .003 .213.082.003    Y1    HRIAA   Zi 4690  35
 223.3A HEN 28 1.0  0 12. 10.1.0 .1 .146 .897 .752 .255 .076 .028 .379.076.001    (Z5)  HRIAD   71448    29
 224.3A HEN  6  .8 .2 16. 20.1.0 .1 .2791.379 .897 .103 .052 .003 .024.103.003    (X2)  HRIAA   71451    29
 225.3A HEN 12  .9 .1 16. 16.1.0 .2 .1811.092 .769 .031 .023 .011 .277.077.003    Z3    HRIAA   41449    29
 226.3A?EOS  8  .9 .1 11. 15.1.0 .2 .207 1.25 .725 .125 .038 .005  .05.075.007    X2    HRIAA   63076    29
 227.3A ANG 30  .9 .1 16.00001.0  0 .183 .911 .762 .202 .095 .018 .405    0    0    /     HRIA    74163    6
 228.3A HEN  6  .9 .1 12. 17.1.0  0 .2271.318 .841 .045 .011 .027 .034.068.007    X2    HRIAA   FOR 1819 32
 229.3A HEN  8  .9  0 13.  9.1.0 .2 .3211.594 .813 .188 .003 .009 .078.125.009    X2    HRIAA   Da 2016  36
 230.3AEHEN  6 1.0  0 20. 13.1.0 .1 .2661.385 .885 .269 .012 .004 .009.115.004    /     HRIA    FOR 1822 33
 231.3AEHEN 16 .75 .2 17. 21.1.2 .1 .1681.108 .723  .06 .036  .03 .241.084.002    (X3)  HRIAG   FOR 1823 33
 232.3A?EOS 15 1.0  0 23.00001.0 .1 .2331.371 .714 .029 .029 .029 .429    0    0    Z5    HRIAD   Da 1228  29
 233.3A HEN  5 1.0  0 29. 10.1.0 .1 .3271.69600000 .087 .004    0 .087.174.039    (X2)  HRIAA   Da 2008  36
 234.3A HEN 18  .9 .1 22.00001.0 .2 .134  .98 .804 .245 .069  .02 .343    0    0    /     HRIA    Da 2008a 36
 235.3A HEN 14  .9 .1 24. 10.1.0 .2 .1551.063 .738 .063 .019 .006 .213.038.001    Z3    HRIAA      ..    36
 236.3A HEN  9 .75 .2 11. 17.1.0 .2 .266 1.3400000 .043 .004 .004 .032.085.006    X1    HRIAC   89946    27
 237.3A HEN 17 .85 .2 16. 15.1.0 .2  .141.078   .7 .156 .078 .022 .367.067.002    (Z6)  HRIAE   86934    31
 238.3A HEN 14  .9 .1 16. 18.1.0 .1  .161.254 .776 .075 .045 .015 .119.075.003    Z6    HRIAE      ..    31
 239.3A HEN 11 .95.05 12. 12.1.0 .2 .1951.333 .789 .053 .018 .004  .07.105.004    X1    HRIAC   86936    32
 240.3A HEN 28  .9 .1 10. 22.1.0 .1 .118 .816 .749 .048  .02 .017 .409.082.002    (Z3)  HRIAA   86931    14
 241.3A HEN 25 .95 .1 15. 26.1.0 .1 .12800000 .752 .301  .09 .023 .451.105.002    (Z5)  HRIAD   71501    37
 242.3B  SP 13  .9 .1 18.00001.0 .1 .2161.221 .735 .015 .029 .003 .176    0    0    Z1    HRIBA   Lz 1993  38
 243.3B  SP 20 1.0  0 24.00001.0  0 .1971.078 .578 .089 .033 .022 .522    0    0    (Z1)  HRIBA   Lz 1995  38
 244.3B  SP 19 1.0.05 27. 30.1.0 .1 .132 1.13  .75  .11  .03 .025  .41 .04.001    (Z1)  HRIBA   Lz 1994  38
 245.3B STR 16  .8 .8 29.00001.0  0 .13300000 .587 .033 .033 .016 .467    0    0    /     HRIB    87279    39
 246.3B SPB 10  .8 .3 22. 27.1.0 .3 .1851.625 .792 .063 .021 .004 .104.063    0    Y3    HRIBA   71462    29
 247.3B SPB  6  .8 .2 29. 20.1.0 .2  .35 1.68  .84  .12  .02 .004 .032 .08.004    (X1)  HRIBA   ZL 6051  6
 248.3B SPB 10 .85 .2 22.  7.1.0 .3  .21 1.4200000   .1 .006 .004  .18 .06.006    Y1    HRIBB   6050     6
 249.3B SPB  8 .85 .2 28.  7.1.0 .2 .2711.333 .806    0 .003    0 .083.083.006    X1    HRIBA   Da 2000  36
 250.3B SPB 10  .8 .2 20. 14.1.0 .3 .275 1.54  .76  .06  .03    0  .07 .06.004    Y1    HRIBB   Da 2018  36
 251.3B  SP 13  .8 .3 23.00001.0 .4 .1671.197 .732 .042 .042 .021 .141    0    0    Z1    HRIBA   ZL 6049  6
 252.3B   ?  8  .8 .1 18. 12.2.0 .8 .3541.656 .906 .078 .006 .003 .009.125.009    (X3)  HRIBB   We 2243  40
 253.3B  SP 20 1.0  0  8.  8.1.8 .5  .1300000 .655 .036 .036 .014 .427.055.003    (Z4)  HRIBD   95382    41
 254.3B  SP  7  .8 .1 30.  7.1.0 .1 .2141.438 .844 .063 .006    0 .094.125.003    X1    HRIBA   95373    41
 255.3B  SP  6 .65  0 30.00001.0 .1 .1211.33300000 .091    0    0 .024    0    0    /     HRIB    95371    41
 256.3B  SP  8  .9  0 35.00001.0 .1 .1671.47600000 .012 .002 .002 .036    0    0    X1    HRIBA   95372    41
 257.3B  SP 11  .8 .2 19.00001.0 .1 .1071.175 .825 .048 .002 .002  .04    0    0    Y3    HRIBA   95370    41
 258.3B  SP  8 1.0  0 30.00001.0  0 .0961.083 .729 .063 .027 .023  .25    0    0    X2    HRIBC   95380    41
 259.3B  SP 17 1.0  0  8. 10.2.0 .6 .14100000 .818 .205 .045 .023 .341 .08.003    (Z4)  HRIBD   95369    41
 260.3B STR 10 .95  0 16.  5.2.0 .5 .257 1.22  .82  .04  .03  .01  .06 .14.008    Y1    HRIBB   71459    29
 261.3B STR 18 .95 .1 12. 27.1.0 .3 .08900000  .75  .06  .04 .025  .22 .11.001    (Z3)  HRIBB   D88      42
 262.3B STR 19 .85 .2 22. 28.1.0 .2 .1391.136 .761 .182  .04 .028  .25.182.001    (Z1)  HRIBA   87278    39
 263.3B STR 17  .8 .2 24.  5.1.2 .2 .091  .92  .78  .05  .03 .025  .34 .12.002    (Z1)  HRIBA   T 287B   83
 264.3B STR 24  .8 .3 16. 25.1.0 .1 .109 .968  .72 .144 .064 .024 .456 .12.001    (Z1)  HRIBA   T 280B   83
 265.3B STR 15  .9 .2 19. 23.1.0 .1  .121.427  .84  .08 .017 .024  .24 .12.001    Z1    HRIBA      "     83
 266.3B STR 13 .95.05 21.00001.0 .1 .19200000 .631 .038 .038 .031   .2    0    0    Z1    HRIBA   SH 3258  43
 267.3B STR  9  .9 .1 33. 28.1.0  0   .200000 .857    0    0    0 .048.095.002    X1    HRIBA   BC 2451  48
 268.3B STR 30  .9 .2 19.00001.0 .1  .1500000 .745 .228  .09 .017 .324    0    0    (Z1)  HRIBA   BC 2450  48
 269.3B?STR 21  .9 .1 12.00001.0 .1 .1241.091 .782 .091 .027 .014 .345    0    0    (Z1)  HRIBA   Lz 1986  27
 270.3B  SP 14  .9 .1 25. 40.1.0 .1 .12300000  .75  .05 .038 .031 .125.125.001    Z1    HRIBA   ZL 6061  13
 271.3B  SP 13 .95.05 26.00001.0 .1 .1231.225 .817 .028 .028 .021 .099    0    0    Z1    HRIBA   ZL 6060  13
 272.3B  SP  7 .95.05 28.00001.0 .1 .184  1.500000 .008 .003    0 .038    0    0    X1    HRIBA   ZL 6062  13
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273.3B STR 19  .9 .1 21. 28.1.0 .1 .1161.267 .619 .114 .029 .024 .333.114.001   (Z1)  HRIBA . 63077    39
274.3B STR 12  .9 .1 24. 23.1.0  0 .1251.302 .698    0 .002 .016 .111.095.002    Z1   HRIBA     "     39
275.3B STR 10  .8 .3 25.  9.1.0 .2 .1711.286 .816 .006  .01 .002 .071.061.002    Y3   HRIBA   30816   43
276.3B STR  7  .8 .3 30. 30.1.0 .4  .2500000 .909 .045 .015    0 .021.061.003    X1   HRIBA   30815   43
277.3B STR 15  .9 .1 30.  7.1.0 .1 .1241.043 .576 .185 .033 .022 .413.065.003    Z2   HRIBC   30814   43
278.3B STR 22  .9 .3 20.  6.1.0 .1 .1361.205 .804 .134 .054 .027 .357.143.003   (Z1)  HRIBA   53478   39
279.3B STR 43 .85 .2 12.00001.0  0 .099 .832 .705  .25 .064 .036 .386    0    0   (Z1)  HRIBA   69924   39
280.3B?STR 10  .9 .2 30. 50.1.0  0 .219  1.4   .7  .02 .006 .008  .18   .1    0    Y3   HRIBA   73342   44
281.3B STR 16 1.0 .4 17.00001.0  0 .07900000 .765 .035 .071 .012 .235    0    0  -(Z2)  HRIBC   Dw 1254  45
282.3B STR 17  .9 .2 22. 30.1.0  0 .12900000 .725   .1  .05 .019  .19.163.001   (Z1)  HRIBA . Dw 1254a 45
283.2C PRE  8  .9 .2 21.  6.2.31.0 .31300000 .833 .333 .056 .028 .069.333.056    /    H2C     60114    ?
284.2C PRE 20  .9 .1 16.00001.0  0 .1351.086   .8 .219 .029 .014 .381    0    0    /    H2C   Zi 4669    7
285.2C PRE 13  .9 .1 16.00001.0 .4 .192 1.29 .758 .081 .024 .024 .226    0    0|   /    H2C       "      7
286.2C PRE 19 1.0 .1  9.  7.1.3 .6 .15800000 .591 .118 .014    0 .245.118.003    /    H2C     63071   43
287.3B SPC  8  .8 .3 19.  7.1.6 .7 .2771.394 .788 .091 .006    0 .076.273.018    X3   HRIBB   Da 2024  36
288.2C PRE  7 1.0 .2 25.  8.1.4 .2 .49400000 .818 .303 .091    0 .273.242.006    /    H2C     51226   21
289.3B  SP 11  .8 .1 12.  7.2.51.0 .21800000   .7  .05 .008 .025 .117 .25 .01-   Y2   HRIBD   BLB 976  46
290.3B VAR  8  .9 .2 25. 15.1.3 .4 .2751.324 .892 .108 .054 .005 .041.216.008    X3   HRIBB   Zi 4662   7
291.3B VAR  9  .9 .1 24. 10.1.6 .3 .2671.262 .714 .167 .062 .002  .06.429.012    X3   HRIBB   "  4661   7
292.3B VAR  8  .9 .1 27.  9.1.5 .2 .256 1.19 .857 .024 .005    0  .06 .31.007    X3   HRIBB   "  4663   7
293.3B VAR  8  .9 .1 24.  9.1.5 .2  .25  1.0 .826    0 .002    0  .13.283.007    X3   HRIBB   "  4664   7
294.3B VAR 12  .9 .1 20. 11.1.1 .1 .146 .882 .706 .103 .029 .003 .221.147.004    Z1   HRIBA   "  4665   7
295.3B VAR 11 1.0 .1 19.  9.1.2 .1 .1971.078 .766 .047    0    0 .188.281.003    Y1   HRIBB   "  4666   7
296.3B VAR 12  .8 .1 12. 10.1.6 .2 .2331.222 .794 .063 .016 .008  .19.238.005    Z3   HRIBB   "  4667   7
297.3B VAR 17  .9 .1  9. 11.1.0  0 .1571.043 .734|.085 .021 .013  .34.127.002   (Z3)  HRIBB   "  4668   7
298.3B VAR 12  .9 .1 20.  9.1.1 .2   .200000 .778    0 .006    0 .148.222.004    Z3   HRIBB   74167     6
299.3B VAR 10  .9 .1 12.  7.1.0 .3 .2241.111 .704 .046 .028    0 .148.093.006    Y1   HRIBB   74168     6
300.2C PRE 13  .9 .2 18. 11.1.8 .6 .1851.071 .743   .1 .029 .007 .186   .1.004   (Z3)  H2CB   Lz 3034 A  14
301.2C PRE 17  .8 .3 14. 11.1.9 .7 .197 .788 .788 .188 .012 .006 .447.235.004   (Z3)  H2CB      "    B  14
302.2C PRE 15  .9 .2  9. 10.2.0 .9 .31100000 .706 .191 .029 .015 .294.162.012    /    H2C       "    C  14
303.2C PRE 14  .9 .1 16.  9.3.0 .9  .251.238 .778 .206 .048 .008 .254.206.016   (Z3)  H2CB      "    D  14
304.2C PRE 15  .9 .2 10. 11.2.01.0 .1571.219 .828 .281 .047 .008  .25.406 .02   (Z3)  H2CB      "    E  14
305.2C PRE 13 1.0  0 14.  7.2.0 .8 .2541.092 .862   .2 .031    0 .185.308.008   (Z3)  H2CB      "    F  14
306.2C PRE  9 1.0 .1 10. 14.2.51.0 .389  1.5 .875   .5 .094    0 .125.375.063    Y1   H2CA      "    G  14
307.2C PRE 15  .9 .2 15.  8.3.0 .6 .3011.041  .74 .233 .027 .021  .37.411.018   (Z3)  H2CB      "    H  14
308.2C PRE 12 .95 .2 14.  7.2.2 .8 .3741.188 .813 .479 .042 .004 .271.229.052   (Z2)  H2CA      "    I  14
309.2C PRE  8  .9.25 17.  9.2.1 .7 .4531.467   .8 .433  .04 .007   .1  .3.043    Y1   H2CA      "    J  14
310.2C PRE 10  .9 .1 12.  9.2.0 .8  .381.538 .769 .308 .038 .005 .103.333.064    Z2   H2CA      "    K  14
311.2C PRE 10 1.0  0 16. 11.1.6 .6 .3171.208 .771 .292 .052    0 .188 .25.021    Z3   H2CB      "    L  14
312.2C PRE  8 .95 .1 12.  9.2.0 .8 .3531.286 .857 .457 .057 .003   .2.229.014    Y2   H2CB      "    M  14
313.2C PRE  9 .95 .3 21. 10.2.5 .5 .4071.343   .8 .371 .014 .006 .143.229 .04    Y2   H2CB      "    N  14
314.2C PRE  9  .9 .2 12.  6.2.0 .7 .4231.324 .892 .351 .014 .003 .081.324.054    Y1   H2CA      "    O  14
315.2C PRE  8 .95 .1 22.  8.2.0 .5 .3371.429   .8 .371 .043    0 .171.229.034    Y2   H2CB      "    P  14
316.2C PRE  8 .95 .2 22.  6.2.2 .6 .3431.382 .882 .324  .05 .029 .176.382.044    Y2   H2CB      "    Q  14
317.2C PRE 10 .95 .1 11.  7.2.5 .8 .3431.182 .841 .341 .045    0 .136 .25.027    Z3   H2CB      "    R  14
318.2C PRE  8 .95 .1 14.  8.2.4 .8 .3861.469 .875 .375 .031    0 .109.406.038    Y1   H2CA      "    S  14
319.2C PRE  8  1.  0 11.  6.2.2 .8 .3491.455 .879 .212 .015 .006 .091.364.045    Y1   H2CA      "    T  14
320.2C PRE  8  .9 .3 13.  6. 2. .8 .3761.429 .857 .486 .043 .009 .114.371.037    Y1   H2CA      "    U  14
321.2C PRE  8 .95 .1 12.  8. 2. .7 .4251.375 .813   .5 .031 .006 .056 .25.063    Y1   H2CA      "    V  14
322.2C PRE  9  .9 .2 24. 10. 3. .4 .2981.128 .766 .362 .064 .004 .149.191.006    Y2   H2CB      "    W  14
323.2C PRE  8 .95 .1 20.  8.2.6 .7 .4351.667   .9 .333  .05 .007 .117.333 .05    Y1   H2CA      "    X  14
324.2C PRE  7  .9 .2 14.  7. 2. .7 .4181.452 .903 .419 .097  .01  .09.387.042   (Y1)  H2CA      "    Y  14
325.2C PRE  8  .9 .2 30.  8.1.7 .5  .351.294 .765 .382 .044 .003 .118.235.026    Y2   H2CB      "    Z  14
326.2C PRE 16 .95 .1 11.  5.1.5 .8  .171.025 .738 .313 .075 .003 .288 .25.006   (Z3)  H2CB Lz 3035 A  14
327.2C PRE 11  1.  0 11.  7. 2. .7 .314 1.24  .82  .32  .07  .02  .26 .24.026    Z3   H2CB      "    B  14
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328.2C PRE 11  .9 .1 25.  7. 2. .6 .3331.118 .804 .255 .029    0 .196.176.029   Z3   H2CB     "      C 14
329.2C PRE 10  1.  0 11. 10.1.8 .9 .3791.325  .8  .325 .038    0 .225 .45.033   Z3   H2CB     "      D 14
330.2C PRE  9 .95 .1 16. 10.1.5 .7 .4581.424 .848 .394 .039    0 .091.424 .03   Y1   H2CA     "      E 14
331.2C PRE 10  .9 .1 11.  8. 2. .9 .4391.474 .763 .263 .026 .003 .132.342.039   Z2   H2CA     "      F 14
332.2C PRE 10 .95 .1 12.  7. 2. 1. .3661.368 .842 .421 .092 .005 .184.368.034   Z3   H2CB     "      G 14
333.2C PRE  8  1.  0 10.  6.2.2 .9 .4141.419 .742 .337 .032 .003 .113.355.058   Y1   H2CA     "      H 14
334.2C PRE  7  1.  0 15.  7. 2. .6 .3591.438 .875 .219 .056    0 .188.281.016  (Y2)  H2CB     "      I 14
335.2C PRE  6 .95 .1 30.  8. 2. .6 .3381.615 .885 .346 .058    0 .108.269.031  (Y1)  H2CA     "      J 14
336.2C?PRE  5  1.  0 18. 14. 1.  0 .268  1.5 .893 .071 .007    0 .004.125.004  (Y3)  H2CC   Zl 6044    6
337.2C?PRE 10  1.  0 11.  8.1.4 .3  .33 1.38  .8  .04     0    0  .05 .18.002   Z1   H2CC   Zl 604-    6
338.2C?PRE  8  1.  0 16. 16. 1. .3 .239 1.37 .848    0     0    0 .065.054.004   Y3   H2CC   ZL 604-    6
339.3A VAR  6 .95 .2 26. 13.1.8 .2 .3451.806 .839 .194 .048    0 .081.419.026   X4   HRIAB  83140     13
340.3A VAR  7  1. .1 28.  7. 2. .3 .371 1.72  .88    .1 .004    0 .016 .44.024   X4   HRIAB  83139     13
341.3A VAR  4  1. .1 32.  7.2.3 .2 .4581.389 .889 .333 .006    0 .011.278.056  (X4)  HRIAB  FOR 1818  32
342.3A VAR  9  .9  0 24. 11. 2. .2 .3051.774 .806 .161 .016 .006 .042.452.023 - X4   HRIAB  83142     13
343.3A VAR  9 .95  0 25. 10.1.2 .1 .2421.283 .848 .043 .033 .022 .065.261.011   Y4   HRIAC  86930     32
344.3A MUT 18  1.  0 16. 12.1.7 .7 .19400000 .611 .133 .033 .017 .367.256.004   /    HRIA   83922      6
345.3A MUT  9  .9 .3 22. 18. 1. .2 .26600000 .683 .073 .024 .024 .171.171   0   Y1   HRIAA  SH 3256a  43
346.3A MUT  7  .9 .1 27. 10. 2. 1. .34300000 .963 .148 .037 .011 .093.444.007   X4   HRIAB     "  b   43
347.3A MUT  7  1. .2 40.  8.1.8 .2 .31400000 .667 .067 .033 .003 .083.333 .01   X4   HRIAB     "  c   43
348.3A VAR  9  1.  0 35. 16.1.2 .2 .256  1.5  .8   .15 .003  .02  .07.325.008   Y2   HRIAB  Zi 4682    35
349.3A VAR  9  1.  0 32. 11.1.3  0 .2231.104 .646 .104 .021 .002 .063 .25.004   Y1   HRIAA   " 4685    35
350.3A VAR 12  1.  0 20.  9.1.6 .2 .1811.014  .71  .13 .016 .002 .087.333.012   Z4   HRIAB   " 4683    35
351.3A VAR 10  1.  0 25.  8.1.1 .1 .1761.135 .769 .135 .019 .019 .192.404.006   Y2   HRIAB   " 4684    35
352.2C PRE 21  .9 .3 15. 16.1.7 .6 .16700000  .64  .14  .04 .025  .44 .22.002   /    H2C     51223    21
353.3B?DIV 13 .95  0  7. 10.1.9 .9 .13300000 .934 .056 .003    0 .098    0   0   Z4   HRIBD   59849     8
354.3A MUT 15  1.  0 19. 19. 1. .2 .18700000 .746 .299 .037 .004 .134.134.003   Z6   HRIAE   71111     6
355.3A MUT 11  1. .1 15. 16. 1. .7 .19600000 .792 .226 .047 .002 .208.113.004   Y3   HRIAD/E 83921     6
356.5B?DIV 23  1.  0  8. 14.1.5 .8 .10900000 .624  .44 .064    0   .4    0   0  (Z1)  HRICGA  SH 3007   47
357.3C DIV 26  1.  0  8.  8. 2. .9 .121 .887 .687 .293 .033 .027 .367    0   0  (Z1)  HRICGA  62334      6
358.3C DIV 13  1.  0 13. 10. 2. .9 .1311.086 .686 .186 .004 .003 .114    0   0   Z1   HRICGA  FOR 2171  49
359.4C?DIV 19  1.  0 13. 11. 1. .9 .09500000 .712 .058 .029 .029 .115    0   0  (Z1)  HRICGA  RS 1563   50
360.4C FOR 12  1.  0  9.  8.1.3 1. .27200000 .645 .161 .008 .008 .097    0   0   Z1   HRICGA  IPS 739   51
361.4C FOR 15 .95 .2 10. 11. 2. .9 .30700000 .714 .079 .038    0 .095.143.005  (Z1)  HRICGA  IPS 740   51
362.4C FOR 17  1.  0 11. 12.1.2 .9 .14300000 .659 .098 .024 .024 .146    0   0  (Z1)  HRICGA  IPS 737   51
363.4C FOR 10  1.  0 16.  7. 2. .9 .29100000 .717 .065 .043 .007 .152.217.011  (Z1)  HRICGA  Zh 558    52
364.4C FOR 12  .7 .8 13.  8. 1. .4 .4421.575 .875   .3 .063    0 .063.275.008   Z2   HRICGB  ZL 5121   51
365.4C FOR 10  1.  0 10.  6. 2. 1. .25500000 .659 .098 .024 .024 .146 .22 .01  (Z1)  HRICGA  IPS 733   51
366.4C FOR 18  1.  0  8.  8.1.6 1. .29400000 .689 .027 .027 .014 .243.311.014  (Z1)  HRICGA  Lz 3603   52
367.4C FOR 11  1. .1 10.  8. 2. 1. .24100000 .625 .104 .031 .004  .25.146.013   Z1   HRICGA  Lz 3602a  52
368.4C FOR 15  1. .1 15. 14.1.8 .9 .23300000 .635 .024 .024 .008 .175    0   0  (Z1)  HRICGA   "    " b 52
369.4C FOR 12 .95 .1  9.  8.1.8 .9 .2400000  .679 .069 .036    0 .125.304.005   Z1   HRICGA  Lz 3601   52
370.4C FOR 16  1.  0 10.  8.1.7 .9 .25800000 .667    0  .04 .003 .173 .16.007  (Z1)  HRICGA  Zh 563    52
371.4C FOR 21  1. .1  8. 11.1.6 1. .11400000 .619 .076 .048 .019  .19    0   0  (Z1)  HRICGA  Zl 5124   51
372.4C FOR  6  .9 .5 14.  8.1.3 .3 .55400000 .765 .176 .088    0 .118.176.018   /    HRICG   Zl 5126   51
373.4C FOR 12  1.  0 10. 10.1.3 .9 .31700000 .727 .068 .045    0 .159    0   0   Z1   HRICGA  IPS 734   51
374.4C FOR 13 .95  0  9.  9.1.3 .8 .21500000   .7    0 .003 .003 .233  .2.005   Z1   HRICGA  Zh 5661    ?
375.4C FOR 18 .95 .4 10. 12.1.8 .4 .34200000 .723 .096  .03    0  .12.181.004   /    HRICG   Zl 5173   52
376.5A DIV 24  1.  0  6.  9.1.2 1. .08100000  .64  .12 .032    0  .56    0   0  (Z1)  HRICGA  SH 204    53
377.5B DIV 39  1.  0  5.  8.1.1 .7 .10200000 .705 .182 .091 .059 .364    0   0  (Z3)  HRICGC  WE 869    54
378.6  DIV 22  1.  0  8.00001.2 .7 .103 .933 .767 .125 .067 .025  .45    0   0  (Z3)  HRICGC  86684     55
379.6B SP  26  1.  0  8.  9. 2. 1. .12500000 .699  .07 .084 .042  .35    0   0  (Z1)  HRICGA  Zb 4768   56
380.6  JAC 19  1.  0  8.0000 1. .3    000000 .625    0 .058   .1 .375    0   0  (Z3)  HRICGC  Hs 4998   57
381.6  KIT 33  1.  0  4.0000 1. .5  .0600000 .648 .192 .155 .052  .57    0   0  (Z3)  HRICGC  Bb 3097    ?
382.6  JAC 13  1.  0 15.0000 1. .2 .19300000 .645 .113 .091 .032 .402    0   0   Z3   HRICGC  WD 335    58
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 383.6  KIT  6  1.   0 30.   8.1.7 .1 .18500000  .71 .065 .046 .006 .097.323 .01   (Z1) HRICGA  Ba 1572  59
 384.7  KIT 13  1.   0  9. 15. 1. .2 .11900000 .736 .236 .056 .021 .399.111.001    Z3  HRICGC  Ba 1967  59
 385.7  KIT 11  1.   0 15. 12.1.1 .1 .15800000 .772 .175 .053 .018 .316    0    0   Z3  HRICGC  Ba 1966  59
 386.7  KIT 12  .9   0 10.00001.1 .2  .1500000 .719 .281 .094 .039 .281    0    0   Z3  HRICGC WBE 2938 60
 387.7  KIT 14  1.   0 10.00001.1 .2 .13600000  .82 .213 .049 .016 .197    0    0  (Z3) HRICGC  Ba 1968  59
 388.7  KIT 16 .95   0 11. 12.1.1 .4   .100000 .714 .274 .093 .024 .369.107    0  (Z3) HRICGC   49256  59
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Appendix 2b : Holotypes

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                                                                                      Vg    Lg
ALVEAT 18   .9   0 18.0 13.0  1.3   .3  .43  2.0  1.0  .35  .14 .066  .02  .42  .03   1.    1.
ARAVAN 20   .9  .2  8.0 10.0  1.0   .6  .28  1.6   .9    0  .01  .02  .08  .02 .002   1.    1.
 ARTUM 48 00000000000000000000  1.0    0 .156 .717  .76  .25 .071 .014 .333    0    0 1.5   1.
 ASPER 18  1.0   0 16.0  8.0  1.2   .2  .36  2.2  .83  .08  .05 .027  .08  .15 .015   1.    1.
 ASSEL 26  1.0   0 12.000000  1.0   .5  .24  1.1  .85   .4  .04 .016  .14    0    0   1.    1.
BIFURC 23  1.0   0  4.0  9.0  2.0  1.0  .34  1.2  .67  .25    0    0  .21  .09 .005   1.    1.
FERGAN 35  1.0   0 16.000000  1.0    0  .09   1.  .73    0  .01 .019  .34    0    0   1.    1.
 HAUGI 20  1.0   0  8.0  9.0  1.0   .7  .38  1.3  .92   .1  .02 .002  .05  .11  .01   1.    1.
ASTRIC 20  1.0   0  6.0  9.0  1.7   .7  .36  1.4   .8  .22  .01 .002   .1  .19  .01   1.    1.
 INOST 30  1.0 .03  6.000000  1.1   .8  .15  1.1  .72  .12 .025 .017  .23    0    0   1.    1.
 KALMI 11  .87  .1 34.0  8.0  1.1  .05  .32  1.4  .85  .07  .02 .002  .09  .08  .01   1.    1.
KARSAK 14  1.0   0 10.0  7.0  1.0    0  .27  1.5  .89  .28  .08 .015  .13  .07 .007    0    1.
 KUGAR 14  1.0   0  6.000000  1.0    0  .25  1.7  .92   .2  .03 .003  .21    0    0 1.4  . .5
KURUIL 23  1.0   0  4.0 11.0  1.2   .6  .39  1.9  .88  .08  .05 .004  .11  .13  .01   .5    1.
LIBROV 24  1.0 .03 22.0 10.0  1.0    0  .12  1.0  .77   .3 .043 .019  .29    0    0   1.    1.
MODEST 18  1.0  .1 12.0 12.0  1.6   .7  .13  1.2  .76  .25  .04 .022  .17  .01 .002   1.    1.
 PAMIR 32  1.0   0  4.0 18.0  1.2   .8  .26  1.3  .87  .01 .015 .013   .1    0    0   1.    1.
PORTEN 30  1.0   0  9.0 10.0  2.0   .3  .12   .9  .74  .13  .03 .006  .19    0    0   1.    1.
PRAEMA 15  1.0   0  8.000000  1.0   .4 .142 1.29  .75   .2 .062 .005   .2  .15    0   1.    1.
 SALAV 20  1.0   0  7.000000   1.   .1  .32  1.6  .93  .17  .05    0   .1    0    0   1.    1.
SCHART 32  1.0 .04   7.000000 1.5    0   .3  .26  1.3  .75  .13  .02 .022  .14    0   1.    1.
SCHMID 17   .9 .16 16.0 12.0  1.0   .2  .14  1.2  .82  .12 .065 .017  .17  .15 .002   1.    1.
SUBALV 22  1.0   0 17.0 24.0  1.1   .6  .31  1.7  1.0  .32  .11 .014  .02    0    0   .9    1.
 USKAL 16  1.0   0  6.0  6.0  1.2   1.  .45  2.7  .88  .07  .05    0  .04  .19  .05    0    1.
BEYRIC 14  1.0   0  5.0 15.0  1.0  1.0  .51 3.66  1.0  .77  .05    0    0 .167 .011   1.    1.
SMITHI 17  1.0   0 12.000000  1.0   .3 .15400000 .882 .029 .01200000 .11700000000000   1.    1.
 UNDUL 18  .95   0 15.000000  1.2   .3 .195  1.1   .7    0 .025 .037 .137    0    0   1.    1.
PRERET 11   .9  .1 13.0  7.0  2.2   .4 .29500000 .833 .277 .033 .011 .166 .22200000   1.    1.
  EOST 11  1.0   0 12.000000   1.   .2 .22700000   .7  .03 .015 .005 .175    0    0   1.    1.
HENKEI  5  1.0   0 30.0 11.0  1.2   .3  .300000 .937    0 .025 .025    0    0    0   1.    1.
 VARIC 27  1.0   000000000000000000000 .15500000 .715 .154 .015 .376 .192    0    0   1.    1.
STRIOL 26   .9  .2 10.0 10.0  1.0   .1 .135000000000000000000000000000          .1    0   1.    1.
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APPENDIX 3

Reticuloceratid (s.l.) specimens data file.

SPECIMEN CODE · ORIGINAL IDENTIFICATION (ABBREV.) · DIAMETER (mm) · S · C · T · L · R · V_g · L_g · D_u/D_s · W/H_w · R_t/H_w · P_i/H_w · D_o/H_w · P_o/H_w · D_h/H_w · L_t/H_w · H_t/H_w	CLUSTER CODE (OR NEAREST CLUSTER)	HORIZON + MORPHOSPECIES CODE	B.G.S. SPECIMEN NUMBER	LOCALITY CODE (SEE END OF APPENDICES)
1.R ADPR 21 1.0 .3 30.0000000000 0 .1900000 .7 .255 .055 .001 .391 0 0	(Z1)	RIA2G	Da 1096	61
2.R ADPR 10 1.0 .3 35.0000000000 0 .26700000 .875 .479 .125 .0100000 0 0	W1	RIA2G	"	61
3.R ADPR 20 1.0 .3 28.0000000 0 10000000000 .632 .316 .137 .004 .432 0 0	/	RIA2	Da 1097	61
4.R ADPR 14 1.0 .3 38.0000000000 00000000000 .833 .4 .15 .005 .667 0 0	/	RIA2	"	61
5.R ADPR 12 .9 .2 18. 40.000000 00000000000 .746 .328 .104 .022 .448 0 0	/	RIA2	71129	43
6.R ADPR 19 1.0 .2 35.0000000000 00000000000 .686 .305 .105 .005 .352 0 0	/	RIA2	71130	43
7.R ADPR 7 .8 .6 20. 32.1.2000 00000000000 .618 .171 .079 0 .211.316.026	/	RIA2	71128	43
8.R ADPR 22 1.0 .2 34.0000000000 0 .15500000 .713 .389 .148 .007 .389 0 0	(Z1)	RIA2G	71126	43
9.R ADPR 11 1.0 .2 37.0000000000 0 .18200000 .717 .226 .066 .004 .358 0 0	(W1)	RIA2G	71127	43
10.R ADPR 23 .9 .7 19. 25.000 0-1. .19600000 .619 .495 .133 0 .448 0 0	(Z2)	RIA2D	71131	43
11.R ADPR 8 .9 .2 22.00001.3000 0 .32900000 .867 .367 .1 .0030000.333 .05	V1	RIA2C	"	43
12.R ADPR 18 .95 .5 17. 15.000000 0 .27800000 .627 .4930000000000 .76 0 0	/	RIA2	71132	43
13.R ADPR 20 .75 .7 19. 20. 1.000 1.0000000000 .725 .373 .108 .01 .441.098.008	/	RIA2	"	43
14.R?CIRC 14 .8000 12.0000 2. .5 0 .407 1.8 .82 .3 .05 0 .24 .5 .06	/	RIA1	Zi 4695	35
15.R CIRC 15 .9 .3 22.00001.5 0 0 .395 1.56 .82 .32 .06 0 .32 .46 .04	Z1	RIA1C	86939	12
16.R CIRC 13 .7 .8 18. 35.1.3 .8 0 .4462.195 .805 .537 .049 0 .293.512.061	Z2	RIA1B	85388	14
17.R CIRC 14 .9 .2 13.00001.3 .2 0 .405 1.47 .8 .56 .02 0 .56 .26 .05	Z1	RIA1C	86917	32
18.R?CIRC 15 .75 .6 22. 30.1.2000000 .38700000 .877 .281 .114 0 .296.281.035	/	RIA1	63072	43
19.R ???? 8 .9 0 50.00001.3000000 .32500000 .844 .219 .094 0 .094.156.019	X1	RIA1D	"	43
20.R?CIRC 18 .85 .5 20. 20.1.1000000 .36800000 .817 .3 .1 0 .117 .2.017	/	RIA1	"	43
21.R ???? 15 .85.85 38.000000000000 .26700000 .804 .321 .107 .009 .357.179.004	/	RIA1	"	43
22.R?COMP 11 .85000 22.0000 1. .5 0 .4211.872 .872 .487 .103 0 .333.385.008	Y1	RIA1B	Lz 3240	35
23.R COMP 23 .8 .9 17.0000 1.0000000000000000 .722 .3 .056 0 .222.222.017	/	RIA1	R_s 1879	62
24.R?CIRC 14 .9000 15.00001.1-.5 0 .464 2.1 .8 .8 .063 0 .75 .55.063	Z1	RIA1C	Zi 4702a	35
25.R?CIRC 15 .75 .8 22. 35.1.3-.5-1. .381.429 .794 .365 .035 0 .19 .27 .04	Z3	RIA1A	" b	35
26.R?CIRC 14 .8 .5 25.00001.4 0 0 .3421.379 .724 .448 .052 0 .362.276.026	Z3	RIA1A	" c	35
27.R?CIRC 12 .75 .8 28.00001.5 0 1. .407 2.5 .816 .789 0 0 .132.289.053	Y1	RIA1B	" d	35
28.R?CIRC 11 .8000 17.00001.3 0 .5 .4442.079 .763 .553 .066 0 .342.526.066	Y2	RIA1C	" e	35
29.R?CIRC 10 .9000 26.00001.2 0 0 .4441.763 .763 .395 .013 0 .197.316.039	Y3	RIA1A	" f	35
30.R?CIRC 10 .9000 35.0000 1. 0 0 .4021.609 .804 .174 .033 0 .174.239.033	Y3	RIA1A	" g	35
31.R?CIRC 11 .7000 20. 35.1.11.2 .3 .4872.839 .871 .839 .081 0 .387.645.048	Y1	RIA1B	" h	35
32.R?CIRC 8 .8 .5 30. 30.1.0 0 .3 .4612.148 .889 .741 .074 0 .222.519.037	Y1	RIA1B	" i	35
33.R?CIRC 9 .9000 32.00001.3 0 2. .4381.688 .875 .644 .031 0 .344.344.025	Y1	RIA1B	" j	35
34.R?CIRC 17 .9 .2 24.00001.7 .9 0000001.275 .75 .375 .023 0 .375.275.013	/	RIA1	Zi 4694	35
35.R?CIRC 7 .9000 23.00002.52.0 0 .5292.278 .889 .778 .017 0 .222.333.083	Y1	RIA1B	" 4692	35
36.R?CIRC 13 .8 .5 20. 35.1.3 .8 0 .3621.296 .833 .333 .028 0 .241.296.028	Z3	RIA1A	" 4691	35
37.R?CIRC 11 .8000 22.00001.8 .9 .9 .461 1.7 .825 .7 .05 0 .45 .4.038	Y2	RIA1C	" 4693	35
38.R?CIRC 10 .8 .8 20.00001.5 .8 0 .409 1.65 .725 .25 .008 0 .25 .4 .02	Y2	RIA1C	" 4701	35
39.R?CIRC 9 .8 .2 27.00001.2 1. .4 .4521.475 .65 .425 .02 0 .2.375.033	X3	RIA1B	" 4697	35
40.R?CIRC 5 1.0 0 28.00001.3 1. 0 .5171.882 .924 .529 .006 0 .059.353.018	(X3)	RIA1A/B	" 4696	35
41.R?CIRC 11 .8 .8 28. 30.1.1 .5 0 .3961.895 .816 .526 .053 0 .184.289.034	Y3	RIA1A	" 4700	35
42.R?CIRC 16 .75 .7 27. 30.1.2-.2 0 .3251.538 .692 .2 .038 0 .262.308.015	Z3	RIA1A	" 4698	35
43.R CIRC 15 .85 .5 18.00001.1 .7 0 .3471.525 .78 .356 .047 0 .288 .39.025	Z3	RIA1A	95231	7
44.R CIRC 17 .8 .5 28.00001.3 .3 .2 .3181.328 .791 .449 .06 0 .299.239.012	(Z3)	RIA1A	95235	7
45.R CIRC 13 .8 .4 25.00001.3 0 .2 .2831.164 .701 .419 .045 0 .358.239.031	Z3	RIA1A	95231	7
46.R CIRC 11 .75 .4 29. 30.1.1 1. 0 .3141.264 .943 .377 .015 0 .415.283.113	Y4	RIA1E	95234	7
47.R CIRC 11 .9000 26.00001.2 0 .5 .4531.738 .738 .476 .06 0 .238.357.019	Y3	RIA1A	95233	7
48.R CIRC 16 .7 .9 24. 32.1.3 0 0 .3441.453 .813 .375 .047 0 .328.391.016	Z2	RIA1B	95236	7
49.R CIRC 11 .9 .4 22.00001.2 .9 0 .3931.914 .857 .543 .029 0 .2.486.063	Y1	RIA1B	86938	12
50.R COMP 11 .85 .4 30.00001.1 0 0 .336 1.26 .8 .5 .006 0 .26 .3 .03	Y3	RIA1A	63091	6
51.R COMP 6 1.0 0 33.00001.5 0 0 .3281.444 .852 .259 .03 0 .093.259.011	/	RIA1	63092	6

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 52.R COMP 16 1.0 .5 30.0000 1.  0  0 .3071.493 .776 .449  .03    0 .179.224.009   Z3    RIAIA    63093      6
 53.R COMP 21  .9 .6 30.0000 1.  01.2 .2861.269 .744 .321 .038    0 .321.219.013   (Z1)  RIAIC    86929      14
 54.R CORO 14 .85 .6 30.00001.2  0 .3 .4391.712 .786 .653 .087    0 .385.346.038   (Z2)  RIAIB    Da 2041    36
 55.R?CORO 12  .9 .7 28.00001.21.2 .2   .52.297 .865 .649 .027    0 .486.405.068   YI    RIAIB    74171      6
 56.R CORO 11 1.0 .3 30.0000 1.1.8  0  .472.786 .857 .714 .054    0 .179.179.107   YI    RIAIB    Da 2031    36
 57.R CORO 13 1.0 .8 30.0000 1.  0 1. .4152.065 .848   .5 .065    0 .543.435.033   Z2    RIAIB      "        36
 58.R CORO  7 1.0 .2 35.0000 1.  0 .3 .4591.846 .923 .385 .012    0 .115.308.038   X3    RIAIB      "        36
 59.R CORO  8 .85 .3 30.00001.1  0  000000  2.2  .88   .4  .04    0  .24 .48 .08   /     RIAI     Da 2032    36
 60.R CORO 11  .8 .8 25. 32. 1. 1. .2 .4361.833 .933  1.1 .017    0  .08  .5 .04   YI    RIAIB    Da 2033    36
 61.R CORE 26 1.0 .6 14.0000000000  0 .21200000  .65  .75 .083    0 .375   0   0   (Z1)  RICA     Lz 135     63
 62.R CORE  7 1.0 .2 15.00001.2 .4  0 .4441.615 .885 .346 .077    0 .108 269.015   (Z1)  RICA     FOR 1820   64
 63.R CORE  6  .9 .3 12.00001.2  0  0 .4691.833 .833 .292 .125    0 .167.167.083   (Z2)  RICB       "        64
 64.R CORE  7 1.0 .2 15.00001.0  0 .2 .4792.333 .917 .625 .104    0 .125.167.063   (Z2)  RICB       "        64
 65.R CORE 26  .8 .8 17. 20.000000  00000000000 .769 .369 .115    0 .308   0   0   /     RIC        "        64
 66.R?CORO     .85 .4 16.00002.0000-.200000  2.0 .844 .444 .056 .022   .4  .4.056  /     RIAI     WE 485     65
 67.R?CORE 17 1.0 .8 14.00001.1  0  0 .2861.051 .744 .295 .109 .003 .397.154 .01   (Z1)  RICA     FOR 1864   64
 68.R INCO 22 1.0 .4 18.00001.1000-.20000000000 .579 .284 .074    0 .484.158.005   /     RIAI     WE 497     65
 69.R INCO 25 1.0 .3 20.0000000000 .10000000000 .682 .136 .091 .009 .273   0   0   /     RIAI     WE 496     65
 70.R?CORO  9  .90000 36.00001.3  0  0 .44200000 .833 .467  .01    0   .2.467.083  X3    RIAIB    Da 2008    36
 71.R?CORO     .85 .2 20.0000000  0  000000 2.28  .84  .48 .004    0  .12 .32 .08   /     RIAI     WE 492     65
 72.R?CORE  6 1.0 .1 12.00001.8  0  0 .5331.667 .833  .25 .017    0 .146 .25.063   (Z2)  RICB     JE 332a    66
 73.R?CORO  6 1.0000 28.00001.1  0 1. .515  2.0 .895 .388 .042    0 .184.316.079   (X3)  RIAIB    Da 2006    36
 74.R CORE 10 .75 .8 20. 40.000000  0 .31400000 .711 .311 .067    0 .15600000000   Z1    RICA     Lz 340     67
 75.R CORE 12  .7 .7 19. 35.000000  0 .22400000  .67 .224 .133 .043 .293   0   0   Z1    RICA       "        67
 76.R CORE 11  .8 .8 20. 35. 1.000  0 .23600000 .674 .261 .065    0 .293.109.022   (Z1)  RICA       "        67
 77.R CORE 17 .85 .8 17.0000000000  0 .16500000 .721 .407 .116    0 .209   0   0   (Z1)  RICA       "        67
 78.R CORE 14  .7 .7 23. 35.000000  0   .200000 .575 .315 .055    0 .178   0   0   Z1    RICA       "        67
 79.R CORE 45  .8 .6 15.0000000000 .50000000000 .545 .214 .118    0 .614   0   0   /     RIC        "        67
 80.R INCO 11  .9000 22.00001.1 .5 .3  .472.054 .919 .811 .041    0 .297.514.054   YI    RIAIB    Da 2005 a  36
 81.R INCO 27 1.0000 16.0000 1.  01.3 .3331.683 .817 .433 .077    0 .288.106.014   (Z3)  RIAIA    Da 2005    36
 82.R?DUBI  7 1.0 .2 36.0000000000  0 .25300000 .571 .429 .107 .007 .393   0   0   V4    RIA2G    Da 1121    61
 83.R DUBI    .85 .2 25.0000000000-1.0000000000 .688 .275 .094 .006 .375   0   0   /     RIA2     WE 1103    68
 84.R DUBI     .9 .1 60.0000000000  00000000000 .698 .395  .07 .012 .163   0   0   /     RIA2     WE 1113    68
 85.R DUBI 10 1.0 .1 60.0000000000  0   .300000 .792 .104 .104 .021 .229   0   0   W1    RIA2G    "  1110    68
 86.R DUBI    1.0 .3 40.0000000000  00000000000 .657 .314 .043 .007 .429   0   0   /     RIA2     "  1105    68
 87.R DUBI 19  .9 .2 65.0000000000-.30000000000 .768 .421 .126 .016 .316   0   0   /     RIA2     "  1105    68
 88.R DUBI    .85 .5 40. 30. 1.000  00000000000   .6 .143 .036 .003 .286.214.029   /     RIA2     "  1114    68
 89.R DUBI     .9 .2 45.0000000000-.20000000000 .676 .362 .124 .029 .448   0   0   /     RIA2     "  1115    68
 90.R DUBI 16 1.0 .1 38.0000000000-.2 .12500000 .659 .412 .059 .018 .294   0   0   Z1    RIA2G    "  1108    68
 91.R DAVI 32 00000000000000000-.1-.1 .266  1.5 .833 .375 .167 .058 .458   0   0   /     RIC      82287      39
 92.R DAVI 24  .7 .7 25. 20.000  0-.2 .234 1.67 .935    0 .078 .024  .34   0   0   /     RIC      71122      39
 93.R DAVI    1.0 .2 13.0000000000  00000000000 .571 .267 .067  .01 .248   0   0   /     RIC      WE 482     65
 94.R EORE 18  .9 .9 19.0000000000  0 .22200000 .625  .25 .138 .009 .463   0   0   Z1    RIBD     88688      13
 95.R EORE 13 .95 .6 38.0000 1.000  0 .26900000 .709 .418 .073 .004 .273.145.009   /     RIB      95368      12
 96.R EORE    .65.95 13. 18.000000  00000000000 .763 .163  .15 .001 .188   0   0   Z2    RIBA     88686      13
 97.R EORE  7  .8 .4 16.00001.1000  0 .46700000   .8  .16  .12    0  .12 .28 .06   (X2)  RIBB     88689      13
 98.R EORE     .7 .9 20. 30.000000  00000000000  .85 .213 .125    0 .275   0   0   Z2    RIBA     88687      13
 99.R EORE 14  .8000000000000000-.2  0 .2261.294 .853 .324 .088 .015 .294   0   0   /     RIB      88680      13
100.R EORE 24 1.0 .9 25.00000000000000 .17300000 .591 .364 .109 .018 .273   0   0   /     RIB      Zl 5045A   13
101.R EORE 14 .85 .9 25.0000000000  0 .17900000 .685 .507 .137 .027 .342   0   0   /     RIB      71069      12
102.R EORE 21 .85 .6 23.0000000000  0 .18100000 .755  .49 .147  .02  .47   0   0   (Z1)  RIBD     71073      12
103.R EORE 10 .65 .7 22. 35.1.2000  0  .2500000 .762 .214 .119 .002  .19.238.007   X1    RIBA/E   71072      12
104.R EORE  8  .7 .8 16. 32.1.2000  0   .300000 .844 .313 .078    0 .109.189.019   X1    RIBA/E   71072      12
105.R EORE  7  .8 .3 14. 40.1.1000  0  .3200000 .765 .206 .074    0 .132.176.015   (X1)  RIBA/E   71070      12
106.R EORE     .8 .5 20. 18.000000  00000000000 .733 .422 .133 .006 .422   0   0   Z1    RIBD     71071      12
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107.R EORT      .8 .3 13.0000000000  00000000000   .7 .367 .047  .02 .267   0   0     /     RIB       Ze 1958   21
108.R INCO  4 000000 60.00001.1  0  0 .5332.077 .923 .231 .015    0 .231.385.023     Y1    RIAIB     Ht 2955   ?
109.R INCO  5 1.0000 30.00001.4  0  0 .448  1.6   .9  .25 .025    0  .15  .5.075     (X3)  RIAIB     Ht 2952   ?
110.R INCO 21 00000000000000 1.  0-.3 .3811.264 .805 .667  .23 .006 .379.227.002     /     RIAI      T419B     69
111.R INCO 18 000 .3 22.0000 1.  0  0 .3531.621 .776 .603 .136   000000.379.012     /     RIAI      T411B     69
112.R?INCO 17  .8000 17.0000 1.  0  0 .29400000 .853  .28 .093 .009 .333  .2.005     /     RIAI      59984     70
113.R?INCO  7  .8 .4 19. 50. 2.  0  0    .41.929 .893 .393 .143    0 .232.214.036     X2    RIAIC     59987     70
114.R?INCO 16 .75 .8 12. 28.1.8  0  0  .351.614 .789 .649 .105    0 .246.386.035     Z1    RIAIC     59986     70
115.R?INCO  9  .8 .5 11. 40. 2.  0  0 .4441.893 .786 .286 .125    0  .25.429.054     X2    RIAIC     59985     70
116.R INCO 14 00000000000001.1  0  0 .3791.933 .844 .33300000    0 .178.467.067     /     RIAI      SH 3269   43
117.R?INCO 12  .8000 10.00001.6 .2  0000001.831 .881  .31 .036    0 .119.357.036     /     RIAI      WE 2239   40
118.R INCO     .85 .6 17.0000 1.000  00000000000 .688   .5 .025  . 0 .375.188   0     /     RIAI      D 152     42
119.R INCO 17 .95 .6 10.00001.2000  0 .41200000 .759 .603 .034    0 .379.103.019     /     RIAI      ED 803    71
120.R INCO 11 .85 .4 28.0000000000  0 .22600000 .808 .423 .115    0 .538   0   0     /     RIAI      T 258 B   72
121.R INCO     1.0 .4 22.0000000000-2.0000000000 .668 .281 .219 .013 .438   0   0     /     RIAI      ..        72
122.R INCO     1.0 .6 20.0000000000  00000000000 .697 .352 .121 .002 .333   0   0     /     RIAI      T 262     72
123.R?INCO     1.0 .8 15.0000000000  00000000000 .733   .2 .133 .017 .467   0   0     /     RIAI      54524     73
124.R MOOR 22  .9 .6 20.0000000  0  0 .149 1.08 .796 .336 .133 .009 .531   0   0     (Z1)  RIBD      71056     6
125.R MOOR  8  .7 .6 16. 35.1.6  0  0 .3381.419 .903 .258 .113 .006 .194.387.032     X2    RIBB      71058     6
126.R MOOR 11  .7 .9 16. 35.1.2  0  0 .3111.157 .804 .176 .059 .029 .235.176.036     Y1    RIBA/E    71057     6
127.R MOOR  3 1.0 .2 22.0000 1.  0  0 .5131.918 .909 .273 .091    0 .136.455.018     (X3)  RIBC      71060     6
128.R MOOR  6  .8 .5 16. 38. 2.  0  0 .4551.522 .913 .565 .109    0 .261.348.065     (X3)  RIBC      71059     6
129.R MOOR 16  .7 .8 23. 30.000  0-.2 .2341.107  .76 .333 .093 .013 .493   0   0     (Z2)  RIBB      71055     6
130.R PAUC 11  .8000 12.00001.5  0  0 .4241.905 .833 .619 .095    0 .524.524 .06     X1    RIA2A/B   Lz 1892   13
131.R PAUC 13 .75 .6 10. 24.2.3-1. 1. .4922.122 .929 .732 .073    0 .415.415.073     Y1    RIA2A/B   .. 1893   13
132.R PAUC  8  .9000 15.0000 2. .3  0    .52.077 .769 .577 .096    0 .231.462.058     V5    RIA2A     .. 1894   13
133.R PAUC 12 .75000 15.00001.3-.2 .2 .4751.951 .929 .929 .073    0 .366 .39.037     X1    RIA2A/B   .. 1895   13
134.R PAUC  7  .9 .5 18.00001.3  0  0 .4582.136 .818 .591 .114    0 .227  .5.045     V5    RIA2A     . 1896    13
135.R PAUC 10  .9 .4 20.00001.2  01.2 .3671.512 .829 .683 .098    0 .488.512.049     W3    RIA2A/B   . 1897    13
136.R PAUC  8 .75 .4 11. 40.1.6 .7 .7 .391 .972 .806 .583 .069    0 .361.361.056     V5    RIA2A     . 1901    13
137.R PAUC 16  .9 .3 20.00001.5-1.1.3 .3751.273 .732 .582 .154    0 .436.029.045     Z4    RIA2A/B   .. 1904   13
138.R PAUC 10  .8000 11.0000 2.-.3 1. .4421.906 .813 .813 .063    0 .375.375.072     W3    RIA2A/B   ..        13
139.R PAUC  7  .8000 10.00001.5  0  0 .5322.682 .818 .591 .063    0 .364.364.068     V5    RIA2A     .. .      13
140.R PAUC 12 .65 .8  8. 28.1.6  0  0 .5252.158 .816 .711 .026    0 .316.447.066     X1    RIA2A/B   ..        13
141.R PAUC  6 .85 .1 24.00001.5  0  0 .3641.962 .846 .346 .077    0 .192.346.039     U1    RIA2D     .. 1980   13
142.R PAUC 14  .8 .7 25.0000000  0  0 .2381.633   .9    0 .058 .017 .233   0   0     Y2    RIA2C/D   .. 1983 a 13
143.R PAUC     .8 .5 20.0000000  0  000000 1.44  .82  .24  .08  .01  .26  .3 .01     /     RIA2      ..   b    13
144.R PAUC 12 .75 .5 20. 40.1.2  0 .1  .25 1.54   .8  .32  .06    0  .26 .28.006     X2    RIA2E     ..   c    13
145.R PAUC     .85 .9 31.0000000  0  0000001.659 .773 .068 .023 .011 .364   0   0     /     RIA2      .    d    13
146.R PAUC  7 1.  .5 30.00001.1  0  0 .1941.424 .848 .182 .061 .003 .091.242.015     V1    RIA2C     ..   e    13
147.R PAUC  7  .8 .4 20. 35.1.9  0  0 .3251.828 .862 .241 .086    0 .172 .31.034     V1    RIA2C     ..   f    13
148.R NODO  8 .75 .7 16. 32. 2.  0 .2 .4091.586 .897 .586 .121    0 .276.379.069     X3    RIBC      63088     17
149.R NODO 11  .7000 13. 28.1.5  0  0 .3031.333 .889   .4 .076    0 .222.244.033     Y2    RIBB      71117     17
150.R NODO 11  .8000 15.00001.8  0 .4 .4092.081 .892 .703 .054    0  .27.351.041     Y3    RIBC      71120     17
151.R NODO  5 1.0  0 17.00001.82.5  0 .589  2.0 .857 .536 .071    0 .214  .5.143     (X3)  RIBC      71114     17
152.R NODO 11  .8000 15.00001.6  0 .7 .4411.778 .861 .222 .069    0 .222.417.056     Y3    RIBC      71116     17
153.R NODO 11 .65 .6 26. 40.1.2  0  0 .2451.364 .773 .341 .057    0 .182.182.011     Y1    RIBE/A    71118     17
154.R NODO  6 1.0000 15.00001.8 .7  0 .5541.944 .833 .556 .083    0 .167.444.067     (X3)  RIBC      71117     17
155.R NODO  8  .8000 15.00001.4 .4 .4 .4121.485 .818 .424 .106    0 .242.333 .03     X3    RIBC      71113     17
156.R NODO  9  .8000 28.00001.2  0  0 .4091.618 .824 .529 .074    0 .103.324.029     X3    RIBC      71119     17
157.R?NODO  6  .7 .5 17. 52.1.2  0  0 .417  2.0 .842 .421 .079    0 .211.316.053     (X2)  RIBB      Wv 344    74
158.R?NODO  6 .75 .5 13. 55.1.9  0  0 .4181.739 .783 .391 .087    0 .217.391.087     (X3)  RIBC      ..        74
159.R PAUC 16  .7000 11.00001.3  0 .2 .3441.661 .887 .403 .056    0 .226.371.032     Z4    RIA2A/B   Zi 7103   75
160.R PAUC 10 .75000 8.000001.9-1.1.6 .423 2.03 .758 .738 .076    0 .273.394.076     W3    RIA2A/B   Lz 1884   13
161.R PAUC  8  .8000 20.00001.2  0  0 .5412.136 .864 .636    0    0 .162.409.045     V6    RIA2B     Lz 1889   13
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 162.R PAUC 10   .7000 13.00001.8 .4-.4 .4021.711 .789 .421 .211     0 .421.447.066    W3   R1A2A/B   Lz 1883    13
 163.R PAUC  8 .65000 15.  45.1.8-.4-.4 .3611.581 .774 .548 .081     0 .387.387.065    V5   R1A2A     ..  1888   13
 164.R PAUC  7  .7000 15.  32.1.82.5  0 .4032.067  .87 .696 .065     0 .348.565.109    V5   R1A2A     ..  1871   13
 165.R PAUC  7  .8000 13.00001.4 3.   0 .3971.769 .808 .654 .096     0 .231.462.077    V5   R1A2A     ..  1882   13
 166.R PAUC  8  .8000 10.00001.8 1.   0 .5132.091 .864 .682 .068     0 .318.364.068    V5   R1A2A     ..  1878   13
 167.R PAUC  6  .8000 15.00001.5 1. .5 .419  2.0  .85   .6  .125     0  .35 .45.075    U4   R1A2A     ..  1872   13
 168.R PAUC  5  .8000 20.00001.4 .3   0  .421.706 .882 .441 .029     0 .206.412.029    U4   R1A2A     ..  1881   13
 169.R PAUC  7 .75 .5 15.00001.7  0 .7 .4731.917 .875 .708 .063     0 .313.292.083    V5   R1A2A     ..  1951   13
 170.R PAUC 11 .65 .6 9.0  30.1.1-.3-.2 .3811.634 .805 .659 .037     0 .244.341.049    X1   R1A2A/B   ..  1950   13
 171.R PAUC  8 .75000 10.  30.1.4 .1  0 .4941.964 .893 .464 .018     0 .286.393.089    V6   R1A2B     ..  1952   13
 172.R PAUC  8  .7000 10.00001.2  0   0 .398  1.6 .867 .367 .033     0 .433.333.067    V6   R1A2B     ..  1948   13
 173.R PAUC 13  .7 .8 15.  37.1.4 .8-.8 .383  1.7  .84   .6  .15     0  .54  .4 .03    Y1   R1A2A/B   ..  1954   13
 174.R PAUC  7  .7000 20.  30.1.3  0  0 .3941.885 .808 .538 .019     0 .346.269.158    V6   R1A2B     ..  1947   13
 175.R PAUC  7  .7 .6 10.  40.1.8 .6 .6 .4431.917 .875 .708 .021     0 .313.417.042    V6   R1A2B     ..  1959   13
 176.R PAUC 18 .75 .7 13.  24.1.5  0-1. .4371.897  .81 .759 .069     0 .503.379.043    Z4   R1A2A/B   ..  1866   13
 177.R?PAUC     .8 .7 14.  20.1.7000  00000000000  .75 .458 .108     0   .5.167.008    /    R1A2      71134      43
 178.R PAUC  9 .65 .6 22.  35.1.4-.4 .3 .2871.603 .789 .289 .079     0 .316.158.039    W2   R1A2C/D   Zi 7097    75
 179.R PAUC  8  .7 .5 24.  32.1.6  0  0 .2641.421 .789 .342 .092     0 .316.263.013    V2   R1A2D     ..  7098   75
 180.R PAUC 12 .65000 13.  30.1.4 .7  0 .4181.953 .884 .326 .081     0 .256.256.023    X3   R1A2D     ..  7096   75
 181.R PAUC     .8.75 13.  30.1.7000-.70000000000 .689 .667 .144 .011 .644.222.017    /    R1A2      71074      43
 182.R?PAUC     .8 .6 24.0000000  0-.30000000000 .636 .482 .164     0 .682   0   0    /    R1A2       ..        43
 183.R PAUC     .7 .8 20.  28.  2.000 .90000000000 .846 .554 .108     0 .415.308.015    /    R1A2      Lz 1935    13
 184.R PAUC  9  .8000 10.0000 2.   0  0 .3811.939 .818 .606 .061     0 .364.303.061    W3   R1A2A/B   ..  1942   13
 185.R PAUC  6  .8000 11.00001.5  01.3  .451.947 .842 .579 .026     0 .263.368.053    U4   R1A2A     ..  1939   13
 186.R PAUC 10  .7 .7 10.  28.  2.  01.2 .4911.558 .814 .674 .035     0 .372.302.058    W3   R1A2A/B   ..  1936   13
 187.R PAUC 11  .7000 10.0000 2.-1.-.5 .4862.176 .853 .706 .015     0 .324.324.059    X1   R1A2A/B   ..  1934   13
 188.R PAUC  9 .75000 10.0000 2.-.51.2 .536 2.37 .815 .667 .019     0  .37.556.074    W3   R1A2A/B   ..  1932   13
 189.R PAUC  9  .8000 16.00001.8 2.-.7 .3221.818 .879 .545 .121     0 .242.364.076    W3   R1A2A/B   ..  1908   13
 190.R PAUC  9 .75000  7.00001.9 .2   0 .5432.269 .846 .769 .019     0 .346.577.096    W3   R1A2A/B   ..  1933   13
 191.R PAUC 13  .8000 14.00001.2 1. 1. .2951.296 .833 .741 .185     0 .481.222.018    Y1   R1A2A/B   ..  1931   13
 192.R PAUC  6 .75000 10.  40.  2.  0 .8 .435 1.85  .85  .55 .025     0   .5  .3  .1    U5   R1A2B     ..  1930   13
 193.R PAUC  5  .8000 25.00001.6 2.   0 .3451.478 .826 .391 .043     0 .174.261.009    U1   R1A2D     ..  1925   13
 194.R PAUC  5  .7000 19.00001.8  0   0 .4441.842 .895 .684 .053     0 .263.158.079    U5   R1A2B     ..  1927   13
 195.R PAUC  5  .7000 8.000001.7  0   0 .4741.882 .824 .824 .029     0 .206.412.088    U5   R1A2B     ..  1929   13
 196.R PAUC  8  .8000 15.00001.1  0 .3 .3751.821 .893 .643 .107     0 .393.393.054    V5   R1A2A     ..  1911   13
 197.R PAUC  6  .8000 11.00001.8  0   0  .461.857 .762 .762 .024     0 .238.333.095    U5   R1A2B     ..  1915   13
 198.R PAUC  6 .75000 22.00001.6 2.   0 .441 1.87 .826 .609 .065     0 .304.435.043    U4   R1A2A     ..  1914   13
 199.R PAUC  9 .85 .3 20.  43.1.2 1.  0  .411.778 .778 .704 .056     0  .37.333.037    W3   R1A2A/B   ..  1906   13
 200.R PAUC  7  .7 .5  9.  38.  2. 1.  0 .4181.704 .778 .741 .056     0 .185 .37.074    V5   R1A2A     ..  1905   13
 201.R PAUC  7  .7000 20.00001.4  0 .5 .4931.792  .75 .667 .063     0  .25.333.042    V2   R1A2D     ..  1909   13
 202.R PAUC  8 .65 .7 11.  28.1.6  0  0 .425 1.75 .821 .714 .054     0 .286.429.071    V5   R1A2A     ..  1912   13
 203.R PAUC  6 .65000 15.  35.1.8  0  0 .4031.636 .773 .545 .023     0 .227.318.068    U5   R1A2B     ..  1910   13
 204.R PAUC 18  .8000 15.00001.4  0   0  .351.543 .743 .714 .121     0 .557.386.007    Z4   R1A2A/B   82814      13
 205.R PAUC 18  .8000 17.00001.3 .6   0 .421 1.75  .85 .667 .133 .008 .467.383.005    Z4   R1A2A/B   95250      13
 206.R PAUC 15  .7 .5 12.00001.9  0 1. .4461.936 .851 .979 .128     0 .638.319.064    Y1   R1A2A/B   95251      13
 207.R PAUC 14  .8000  8.00001.8  0   0 .4832.289 .933 .844 .067     0   .4.511.067    Y1   R1A2A/B   95249      13
 208.R PAUC 13  .8000 10.00001.8  0   0 .4591.814  .86 .791 .081     0 .419.442.058    Y1   R1A2A/B   95252      13
 209.R PAUC     .9 .7 10.00001.1  0    00000000000 .733 .514 .124 .002  .41.305 .01    /    R1A2      71076      43
 210.R PAUC  6  1. .3 37.0000 1.  0   0 .3541.462 .846 .154 .115     0 .269.308.006    U2   R1A2C     Zi 7344    76
 211.R PAUC  6  .9 .3 28.00001.2  0   0 .3751.792 .833 .458 .083     0  .25.313.042    U1   R1A2D     ..  7345   76
 212.R PAUC  7  .9 .5 27.00001.2 .9   0 .4371.792 .833 .667 .042     0 .333.417.042    V6   R1A2B     ..  7341   76
 213.R PAUC  6  .9 .4 26.00001.4  0   0 .4381.739 .739 .261  .03     0 .217.348.043    U1   R1A2D     ..  7342   76
 214.R PAUC  8  .7000 20.00001.3-.21.4 .4021.667 .833 .467 .083     0 .267.267 .05    V2   R1A2D     ..  7340   76
 215.R?PAUC 21  .7000 17.0000000  0   0 .2681.389 .867   .5 .076     0 .256   0   0    (Z2) R1A2D     ..  7111   77
 216.R ???? 22  .9 .4 32.00000000000-.5 .20500000 .679 .453 .085     0 .406   0   0    (Z2) R1A2D     T 2578     72
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217.R?PULC     .7 .7 39. 22.000000   00000000000 .726 .214 .068 .019 .136   0   0     /    RIA2      63074    43
218.R?PULC    .95  0 38.00001.5  0   0000001.885 .808 .154 .077    0 .115.115.012     /    RIA2      JS 639   240
219.R?PULC    .85.75 16.00001.7  0   00000000000 .667 .093  .04  .02   .1.173.007     /    RIA2      RE 4804  39
220.R?PULC  7 .85 .2 22.00002.2  0   0 .2761.529 .824 .265 .074 .003 .147.176.015     V1   RIA2C     63083    240
221.R?PULC  6 .95  0 31.00002.2  0   0 .3281.808 .846 .269 .053 .004 .115.308.038     U3   RIA2E     63082    240
222.R?PULC  6 .95 .1 30.0000 2.  0   0 .361 1.72  .88  .24   .1    0 .112  .2 .04     U3   RIA2E     63079    240
223.R?PULC  9  .9 .3 19.0000000  0   0000001.889 .861 .222 .097    0 .19400000000     /    RIA2      89623    6
224.R?PULC  8  .9 .1 18.00002.2  0   0 .3861.697 .909 .152 .061    0 .121.273 .03     V1   RIA2C     89624    6
225.R REGU     .7000 16.00001.2 .4   0000001.474 .868 .289 .066    0 .184.342.005     Y1   RIBA/E    82930    78
226.R REGU  6 .75 .4 14. 37.1.7  0   0 .3731.889 .889 .417 .139    0 .194.194.083     (X3) RIBC      82929    78
227.R REGU 17 .65 .6 18. 20.000-.2-.2 .2021.397 .838 .235 .088 .029 .338   0   0     Z2   RIBA      82927    78
228.R?PULC    .75 .7 28. 35.1.2  0-.1000001.414 .828 .172 .043 .005 .293.172.014     /    RIA2      63078    240
229.R?REGU 17  .9 .2 13.00001.3  0   0 .1611.235 .765 .235 .076 .005 .271.118.012     Z4   RIBE      89947    79
230.R?PULC 23  .8 .8 26. 20.000  0-.3 .2061.305 .838 .333 .038  .01 .524   0   0     (Z3) RIA2C     63087    240
231.R?PULC 12 .75 .7 17. 29.1.2  0-.2 .234  1.5   .81 .172 .052 .006 .276.172.007     X2   RIA2C/E   63086    240
232.R?PULC    .75.75 40. 14.000-.3-.200000  1.2 .739 .478 .087 .002 .409   0   0     /    RIA2      89620    6
233.R?PULC 26  .8 .8 25. 32.000-.2  0 .1621.174 .722 .235 .052 .013 .322   0   0     Z3   RIA2C     89621    6
234.R PULC  5 .85 .2 20.0000 2.  0   0 .4261.892 .919 .216 .054    0 .135.216.081     U3   RIA2E     71083    240
235.R PULC    .85 .3 24.00001.8  0   000000  2.0 .882 .235 .059    0   .1.294.047     /    RIA2      71084    240
236.R PULC  6  1. .3 29.00001.4  0   0 .343 1.63 .833 .204   .1    0 .111.296.037     U2   RIA2C     71085    240
237.R PULC  6 .95.25 27.00001.9  0   0 .3431.423 .885 .231 .096    0 .096.365.045     U2   RIA2C     71086    240
238.R PULC  6  .9 .2 28.0000 2.  0   0 .3361.429 .857  .25 .107    0 .107.268.043     U2   RIA2C     71087    240
239.R PULC  7 .85000 20.00001.8  0   0 .3291.235 .853 .176 .044    0 .074.324.035     V1   RIA2C     71088    240
240.R PULC  7  .9 .3 30.00001.9  0   0 .2861.821 .893  .25 .054    0 .114.179.007     V1   RIA2C     71089    240
241.R PULC 11  .8 .5 14. 48. 2.  0   0 .1881.457 .848 .174 .065    0 .163.196.011     (X2) RIA2C/E   71090    240
242.R PULC 11 .75 .5 19.00001.5  0   000000 1.46   .9  .14  .05 .014  .15 .36.014     /    RIA2      71091    240
243.R PULC 12 .75 .7 24. 40.1.8  0   0000001.517 .862 .155  .06 .007 .276.138.005     /    RIA2      71093    240
244.R PULC 23  .7 .7 40. 30.000000   0 .17400000 .842 .316 .034 .016 .316   0   0     /    RIA2      71094    240
245.R PULC 15  .9 .5 28.0000000  0   0 .18300000 .932 .192 .048 .021 .247   0   0     (Y2) RIA2C/D   71095    240
246.R PULC 11  .8000 16.00002.3  0   0 .293 1.25 .768 .152 .045    0 .214 .25.027     X3   RIA2C/E   71096    240
247.R PULC  9  .9 .4 32. 50.000  0   0 .191 1.25 .813 .333 .052 .001 .146   0   0     W2   RIA2C/D   71097    240
248.R RETI 16 .65 .8 30. 27. 1.  0-.2 .2531.093 .779 .291 .093 .006 .372.093.008     (Z1) RICA      30803    39
249.R RETI     .8 .1 22.0000000000   00000000000 .737 .289 .116 .021 .421   0   0     /    RIC       RE 4715  80
250.R?REGU     .7 .9 13. 14.000  0   00000000000 .607 .271 .086 .021  .25   0   0     /    RIB       RE 4692  80
251.R?REGU    .75 .5 14. 35.000  0   00000000000 .713 .175 .075 .013 .17500000000     Z4   RIBE      RE 4306  80
252.R REGU     .7 .3 20. 28.1.4  0   00000000000 .723 .234 .053 .004 .128.234.015     Y1   RIBA/E    71068    81
253.R REGU     .8 .6 20.0000000000-.40000000000 .656 .375 .094 .004 .375   0   0     /    RIB       71067    81
254.R REGU     .7 .8 16. 22.000000-.20000000000 .667 .187 .067  .02 .333   0   0     /    RIB         ..     81
255.R REGU    .75 .8 15. 28.1.2000   00000000000 .624 .212 .059 .004 .118.153.006     Z4   RIBE      71062    81
256.R REGU    .75 .7 15. 35.1.3000   00000000000 .796 .204 .061  .02 .204.224 .02     Y1   RIBA/E    71066    81
257.R REGU     .8 .5 35.0000000000   00000000000 .717 .326 .109 .001 .467   0   0     Z1   RIBD      71064    81
258.R REGU    .85 .6 14. 37.000000   00000000000 .664 .164 .082 .014 .294   0   0     /    RIB       71061    81
259.R?SUBR     .9.75 18. 26.000000   00000000000  .65   .3 ~.05    0  .42   0   0     /    RIB       JS 508a  67
260.R?SUBR 18 .85.75 16. 40.000000   0 .22700000 .739 .326 .109 .001  .25 ~ 0   0     Z2   RIB         ..  b  67
261.R?RETI     .6 .7 16. 18.000  0-1.0000000000 .735 .353 .294 .003 .341   0   0     /    RIC       HR 1080  82
262.R RETI 22 .85 .6 20.0000000  0   0 .27300000 .842 .368 .13700000 .31600000000     /    RIC       Da 728   67
263.R RETI 26 .75000 20. 32.000-.8-2. .1671.127  .81 .587 .119 .012 .349   0   0     (Z1) RICA      52145    39
264.R RETI 19 .85 .6 17.0000 1.  0-1. .1721.063 .781 .552 .115 .002 .375.156.009     (Z1) RICA      52153    39
265.R RETI 16  .8000 13.0000000  0   0 .204 1.16 .802 .198 .049 .012 .358   0   0     (Z1) RICA      52150    39
266.R RETI 10-.75 .7 30. 45. 1.  0   0 .2551.255 .804 .255 .069 .004 .216.196 .01     (Z1) RICA      52160    39
267.R RETI 12  .7000 19. 24.000  0   0 .2581.264 .774 .321 .094 .006  .34   0   0     Z1   RICA      52158    39
268.R RETI 11  .4.75 20. 45. 1.  0   0 .2341.413 .848 .261 .076 .007 .217.087.009     (Z1) RICA      52161    39
269.R RETI 12 .65 .9 20. 40.1.2  0   0 .2721.072 .736 .272  .08 .016 .288.208.016     Z1   RICA      52156    39
270.R.RETI 12 .75000 20.00001.1  0   0 .2851.298 .789 .263  .07 .014 .123 .14.011     Z1   RICA      52157    39
271.R RETI 13  .7 .7 15. 50.2.0  0   0 .3161.279  .77 .246 .107 .007 .246.246.025     Z2   RICB      52159    39
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272.R RETI       .7000 19. 22. 1.  0-1.000001.338 .831 .569 .154 .015 .462.123.003    /    RIC       52151      39
273.R.RETI 17 .65000 20. 34. 1.  0  0 .203 1.15 .788 .475 .094 .003 .338 .15.004   (Z1)  RICA      52149      39
274.R RETI 14  .7 .7 22. 40. 1.  0  0 .2041.164 .761 .323 .052 .004 .313.075.006    Z1   RICA      52155      39
275.R RETI 14 .65 .8 20. 35.000  0  0 .2411.224 .716 .224  .06 .015 .343   0   0    Z1   RICA      52154      39
276.R RETI 24 .75 .8 11. 20.000  0  0 .31300000 .686 .667 .17100000 .505   0   0    /    RIC       JS 505     67
277.R RETI 11 .55 .6 30. 30.000  0  0 .2261.224 .793 .397 .086    0 .2240000000    /    RIC       30811      81
278.R RETI 13  .7 .6 24. 19.000  0  0 .2131.159 .812 .232 .087 .017 .261   0   0    Z1   RICA      62446      39
279.R RETI 14  .7 .6 23. 24.000  0  0  .191.214 .757 .386 .057 .014 .543   0   0    Z1   RICA      71105      39
280.R RETI 23  .7000 25. 20.000  0-2. .179 .939 .748 .374  .13    0 .361   0   0   (Z1)  RICA      71104      39
281.R RETI 14 .65 .7 16. 30.1.8  0  0 .2381.343 .761 .194 .052 .003 .149.269.022    Z2   RICB      T 281 B    83
282.R RETI 23  .7 .6 18. 28.000  0  0 .137 1.13 .741  .37 .185 .014 .481   0   0   (Z1)  RICA      71106      39
283.R RETI  7  .8 .5 12. 50.1.8  0  0 .395  1.8  .84   .4 .048    0  .14 .48.048   (Z2)  RICB      71100      39
284.R RETI 16 .65 .7 12. 42.2.0-.8-.8 .3051.515 .838 .353 .118 .007  .25.176.022   (Z2)  RICB      71099      39
285.R RETI 28  .8 .6 25.0000000  0 .5 .213  1.1 .823 .438 .154 .004 .408   0   0   (Z1)  RICA      71101      39
286.R RETI 26  .8000 17.0000000-.8  0 .2691.136 .822 .356  .11 .002 .407   0   0   (Z1)  RICA      71102      39
287.R RETI 15  .7000 16. 26.1.6  0 .5 .3591.533 .833 .467 .075 .005 .263.233.017   (Z2)  RICB      71103      39
288.R TODM  6  .8 .2 18.00002.2  0  0 .3771.864 .955 .227 .045    0 .127.273.068    U3   RIA2E     95244      13
289.R TODM  7  .9000 14.00002.0  0  0 .3611.656 .906 .203 .078 .009 .125.281.047    V3   RIA2E     95247      13
290.R TODM  5 .85 .1 24.00002.6  0  0 .3561.818 .864 .182 .055    0 .114.227.055    U3   RIA2E     95245      13
291.R TODM  4  .9000 22.0000 2. 2.  0 .4551.733 .933 .233 .033    0  .12.267.073   (U3)  RIA2E     95246      13
292.R TODM  7  .9000 37.00001.4 .8  0 .288  1.4 .833   .3  .05 .003 .167.233 .02    V1   RIA2C     95239      13
293.R TODM  8 .75000 18.00001.9  0 .2 .3291.556 .778 .306  .05    0 .167 .25.042    V1   RIA2C     95242      13
294.R TODM  9 .75000 28.0000000  0  0 .1811.176 .804 .196  .02 .002 .255.059.002    W2   RIA2C/D   95238      13
295.R TODM 10 .75 .7 40. 32.000  0  0  .251.313 .875  .25 .058 .017 .333   0   0    W2   RIA2C/D   95240      13
296.R TODM 10  .8000 20.0000 1.  0  0 .2841.338 .616 .224 .051 .004 .143.265.016    W2   RIA2C/D   95241      13
297.R TODM  9  .8000 19.00001.8  0  0 .3011.239 .717 .152 .054 .002 .217.217.022    W2   RIA2C/D   95243      13
298.R?STUB 19 .75 .8 11. 33.1.3 .5  0 .2471.262 .833 .393 .143 .024 .321.202.012    Z3   RIBB      89948      79
299.R?STUB 16 .75000 14. 25.000  0  0  .23  1.2 .775 .338 .063  .01 .2630000000    /    RIB       82857       6
300.R?STUB  9  .7 .7 19. 32.1.2 .2  0 .4441.833   .9 .433 .073    0 .133.367.083    X3   RIBB      82858       6
301.R STUB     .8 .6 11.00003.1000000000000000  .74  .32   .1    0  .32 .36 .04    /    RIB       HR 2023    84
302.R?STUB  8  .6 .7 16. 37.1.9  0  0 .3492.114 .829 .214 .086 .017 .171.343.034    X2   RIBB      89039      78
303.R?STUB  6  .8 .2 17. 43. 2.  0  0 .444 1.81 .857 .571 .071    0 .157.381.048   (X3)  RIBC      89040      78
304.R?STUB  8 .65 .4 16. 38.2.2 .3  0 .3251.781 .875 .313 .094 .006 .156.344.035    X2   RIBB      89038      78
305.R?STUB 11  .8000 15. 47.1.5  0-.3 .3931.723 .851 .298 .106 .002 .266.255.021    T2   RIBB      FOR 1865   49
306.R?STUB 10  .8000 20.00001.3  0  0 .3791.921 .866 .184 .158 .011 .289.316.021    X2   RIBB      FOR 1866   49
307.R STUB 16  .7 .7 13. 25.1.5  0  0 .3941.692 .846 .385 .185    0 .215.169.009   (X2)  RIBB      63084      30
308.R?STUB 31 .85 .6 22.0000000  0  0 .2221.111 .902 .392 .105  .01 .405   0   0   (Z3)  RIBC      73338      44
309.R?STUB 17 .75 .5 16. 30.000  0  0 .306  .14 .733 .293 .093 .007 .107   0   0    Z4   RIBE        "        44
310.R?STUB 17  .7 .5 12. 30.   0  0  0 .174 1.31 .724 .241 .069 .009 .195   0   0    Z4   RIBE      73340      44
311.R?STUB 13 .65 .9 16. 27. 1.  0  0 .3641.917 .813 .313 .052    0 .146.229.021   (X1)  RIBA/E    73339      44
312.R?STUB  9  .8 .3 10.00001.4  0  0 .402 1.69 .905 .381 .048    0 .083.381 .06    X3   RIBC      73341      44
313.R?STUB  8  .8 .3 16.0000 1.  0  0 .289 1.39 .854 .171 .085    0 .122.195.024    X1   RIBA/E    JS 638     17
314.R?STUB 20  .8 .6 16.0000000 .5  0 .184 1.16  .78  .38  .06 .015  .33   0   0    Z1   RIBD      71824      30
315.R TODM 25  .9 .5 28.0000000000-.3 .12800000 .818 .336 .136 .014 .418   0   0   (Z2)  RIA2D     63066      43
316.R?TODM 13 .75 .5 18. 28.000 .1  0 .2991.368 .735 .294 .066 .012  .25   0   0    Y2   RIA2C/D   Z1 6017    13
317.R?TODM 10  .7000 24. 29. 1.  0  0 .2721.333 .843 .235 .029 .004 .196.275 .01    W2   RIA2C/D    " 6021    13
318.R?TODM  8 .75 .3 24. 63. 1.  0  0 .2141.439 .829  .22 .049    0  .22.122 .02    V2   RIA2D      " 6019    13
319.R?TODM  8  .8 .4 20. 46.1.9  0 .2  .281.738 .758 .212 .076 .006 .152.303.036    V1   RIA2C      " 6020    13
320.R?TODM 16 .85 .5 15.0000000  0  0 .2141.309 .815 .383 .037    0 .457   0   0    Z2   RIA2D      " 6058    13
321.R?TODM 10  .8 .5 19. 42.1.2  0  0 .3271.773 .886 .136 .045    0 .159.364.034    W2   RIA2C/D    " 6063    13
322.R TODM 11  .8 .4 20. 32.1.1  0  0 .243  1.4  .82   .3  .06 .006  .18 .26.004    X2   RIA2E     83927      13
323.R TODM 17  .8 .8 48. 27.000  0  0 .1261.068 .761 .443 .085 .001 .398   0   0    Z1   RIA2G     ZL 6010    13
324.R TODM 14  .8 .7 14. 23.1.2  0  0 .1791.368  .75 .353 .044 .022  .25.103.009    Y2   RIA2C/D   83928      13
325.R?TODM 12 .75000 18. 30.1.7  0  0 .3081.653 .837 .306 .071  .01 .224.265.024    X3   RIA2D   - Z1 6011    13
326.R?TODM 20  .8 .8 35.0000000 .2  0 .2521.222 .744 .179 .067 .002 .399   0   0   (Z2)  RIA2D     Z1 6013    13
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FILE: NAHRETIC DATA      A   LEEDS UNIVERSITY VM/SP 1.12                                   PAGE 007

 327.R?TODM  8 .85 .4 23. 40.1.5  0  0 .3181.359 .821 .205 .026     0 .154.231.026   V1   R/A2C     Z1 6015   13
 328.R SAML 12 .65 .5 24. 28.   0  0-.2 .3231.259  .81 .293 .121 .003 .345    0    0   /    R1A2      63085     6
 329.R SAML 10 .75 .7 14. 24.1.8  0 .3000002 258 .871 .452 .113     0 .242.355.055   /    R1A2      71082     6
 330.R SAML  9 .75 .6 16. 40.1.2  0  0 .3781.581 .884 .302 .116     0 .233.302.023   /    R1A2      71079     6
 331.R SAML  8 .65 .7 36. 40.1.2  0  0 .3541.636 .727 .227 .091 .003 .212.364 .03    /    R1A2      71080     6
 332.R SUBR  9  .8 .5 16. 45.1.1  0  0 .3021.512 .829 .293 .073     0 .171.317.049   W2   R1A2C/D   Lz 1999   38
 333.R SUBR  7 .75 .5 19. 50.1.2  0  0 .3381.655 .759 .414 .086     0 .207 .31.034   V2   R1A2D     Lz 1997   38
 334.R SUBR 18  .8 .7 22.0000000  0  0 .1351.449 .808 .321 .051 .019 .462    0    0   Z2   R1A2D     83930     13
 335.R SUBR 18  .4 .8 35. 17.000  0-.1 .1581.124 .798 .258  .09 .039  .27    0    0   Z3   R1A2C     85386     77
 336.R SUBR 13  .5 .8 30. 20.000  0 1. .1651.122 .797 .595 .135 .027 .378    0    0   Y2   R1A2D     Lz 1988   77
 337.R SUBR  8  .7000 19. 35.2.5  0  0 .335  1.4 .914 .429 .077     0 .129.343.029   V1   R1A2C     Zi 7115   77
 338.R SUBR  7  .8 .4 20. 40.1.7  0 .7 .3291.419 .919 .355 .087 .016 .226.258.032   V3   R1A2E     " 7112    77
 339.R SUBR  6  .8 .3 16. 45.1.8 .2  0 .3481.564   .8 .364 .073     0 .127.364.044   U1   R1A2D     " 7113    77
 340.R SUBR  7 .75 .2 16. 50. 2.  0  0 .3161.656 .875 .375 .069     0 .156.281.031   V1   R1A2C     " 7118    77
 341.R SUBR 11  .8 .3 19. 28.000  0  0 .1781.069  .81 .328 .155 .005 .397    0    0   X2   R1A2C/E   " 7116    77
 342.R SUBR 15 .75 .5 19. 31.000  0  0 .2521.203 .768 .319 .116 .001 .435    0    0   Y2   R1A2C/D   " 7117    77
 343.R SUBR 17  .7 .4 20. 43.000  0  0 .1851.087 .761 .489 .087 .005 .511    0    0   Z2   R1A2D     " 7123    77
 344.R SUBR 19  .9 .1 25.0000000  0 .8 .208 .959 .784 .485 .227 .026  .33    0    0   Z1   R1A2G     " 7119    77
 345.R SUBR 37  1.  0 15.0000000 .3  0 .203 .823 .674 .371 .371 .043 .371    0    0   (Z1) R1A2G     " 7120    77
 346.R TODM 12 .85 .5 20.00001.2000  0 .16400000 .754 .148 .033     0 .197.148.013   X2   R1A2C/E   63070     43
 347.R TODM 13 .85 .4 30.0000000000  0 .15800000 .836 .623 .082 .025 .311    0    0   (Y2) R1A2C     63069     43
 348.R TODM 12  .8 .3 23.0000000000  0 .14800000 .742 .226 .048 .008 .339    0    0   X2   R1A2C/E   63067     43
 349.R TODM 11  .9 .5 30.00001.3000  0 .17100000 .693 .365 .079 .032 .397.143.013   X4   R1A2F     63068     43
 350.R TODM 10  .9 .4 20.00001.1000  0  .1500000 .776 .345  .06 .031 .293.103.009   W1   R1A2G     "         43
 351.R UMBI 20  .9 .6 18.0000000000 .1   .300000 .687 .337 .078 .004 .458    0    0   /    R1A1      WE 1102   68
 352.R SUBR 14  .8 .7 17.0000000  0  0 .2031.214 .814 .186 .086 .021 .329    0    0   Y2   R1A2C/D   Zi 7121   77
 353.R UMBI 28  .9 .4 28.0000000000  0  .2500000 .767  .35 .108     0 .333    0    0   /    R1A1      Da 2051   36
 354.R ???? 35 .85 .5 32.0000000 .5 .6  .161.429 .767 .451 .195 .011 .451    0    0   /    R1        52144     39
 355.R ???? 30 .85 .5 31.0000000  0  0 .1771.114  .78 .348 .09800000 .492    0    0   /    R1        89622     6
 356.R ???? 10  .9 .4 15.00001.8-1.  0  .321.171 .805 .439 .134     0 .244.317.012   /    R1        73345     44
 357.R SPNO 14  .9.65 28.0000 1.  0 .2 .2641.217 .717   .4 .117     0 .417.267.017   /    R1        95248     13
 358.R ????  6  1. .1 24.0000 1. .3  0 .3081.633  .75 .167 .013     0   .2   .4 .02   /    R1        95237     13
 359.R ???? 28  .8 .4 16.0000000  0  0  .2500000 .701 .667 .162     0 .479.034.001   /    R1        Zi 8142   85
 360.R?COMP      1. .5 22.00001.5  0 .2000000000 .682 .336 .064     0 .436  .2.009   /    R1A1      " 7125    35
 361.R ???? 20  .7 .7 20. 18.000  0  0  .271.206 .825 .474 .093  .01 .361    0    0   /    R1        87276     86
 362.R ???? 15 .65 .8 30. 22.000  0  0  .26 1.61  .74 .234 .169 .004 .532    0    0   /    R1        87277     86
 363.R ???? 11  .7 .8 15. 27.000  0  0 .2171.216 .765 .314 .078 .029 .333    0    0   /    R1        87274     86
 364.R ???? 13 .85 .6 27.00001.2  0  0 .3621.923 .827 .288 .096     0 .231 .25.019   /    R1        "         86
 365.R ????  6 .95 .1 20.0000000  0  0 .3541.731 .731 .115 .012     0 .058    0    0   /    R1        87275     86
 366.R ???? 15 .75 .9 20. 18.000  0 .1 .2851.615 .877 .169 .123 .011 .477    0    0   /    R1        87274     86
 367.R ????  8 .75 .6 10. 22.1.6  0  0 .4941.848 .909 .515 .061     0 .152.333.061   /    R1        87255     86
 368.R ???? 23 .95.05 28.0000000  0  0 .21700000 .619 .319 .062 .022  .31    0    0   /    R1        63073     43
 369.R ???? 17 .75 .6 16. 28.000  0  0 .1831.048 .771 .301 .157     0 .434    0    0   /    R1        87271     86
 370.R ???? 19  .8 .2 20.00001.2  0  0 .2561.148  .57 .341 .034     0 .307.227.017   /    R1        Lz 3250   7
 371.R ???? 50  .9 .3 40.0000000  0-.8  .1600000  .68  .32  .14 .004   .3    0    0   /    R1        Lz 3587   87
 372.R ???? 14  .9 .3 24.0000 1.  0 2. .3641.429 .839 .804  .08     0 .464.321.036   /    R1        Z1 6052   6
 373.R GRAC 19 .55 .5 37. 27.1.1  0-.1 .247          .603 .423 .167     0 .474.179 .01   (Z1) R2AA      AT 2650   88
 374.R GRAC 43 .75 .3 38. 26.000000  0 .17200030 .838 .248 .224 .062 .381    0    0   (Z2) R2AB      " 2630    88
 375.R GRAC 39  .3 .7 48. 25.000000  0 .13600000 .793 .328 .136  .01 .455    0    0   (Z1) R2AA      " 2910    89
 376.R GRAC 13 .55 .5 50. 45.1.3000-.5000000000   .65 .383 .167 .005 .417.133.013   /    R2A       D 1569    90
 377.R GRAC 15 .55 .9 32. 30.1.1000-2.0000000000 .643 .643 .129     0 .414.143.017   /    R2A       38429     88
 378.R GRAC 10 .65 .4 35. 40.1.2000  00000000000 .778   .6 .178     0 .533.289.044   /    R2A       "         88
 379.R GRAC 29  .4 1. 50. 38.000000-.5000000000 .692 .254 .092 .008 .346    0    0   /    R2A       87004     91
 380.R EMUA  6 .65 .5 40. 33.1.5000  00000000000 .714 .357 .179     0 .286.464.071   /    R2A       Lz-3314   92
 381.R GRAC 28  .5 .7 52. 42.000000 .5 .18200000  .84  .68 .208 .002  .36    0    0   (Z1) R2AA      87006     91
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382.R GRAC 18  .6 .7 40. 27. 1.000  0 .27600000 .744 .359 .19200000  .359.103.013    /    R2A    38429     88
383.R GRAC 43  .7 .7 35. 27. 1.000-3.0000000000 .629 .548 .143 .001 .619.029.002    /    R2A     ..       88
384.R GRAC 35  .4 .9 35. 28.000000-3.0000000000 .624 .497  .17    0 .321   0   0    /    R2A     ..       88
385.R GRAC  5  .8 .7 25. 50.1.1000  00000000000  .75  .45 .175    0  .2.375 .05    /    R2A     "        88
386.R GRAC 32  .4 .9 48. 42.000000-2.0000000000 .567 .447 .147 .001   .5   0   0    /    R2A     ..       88
387.R RETI 19  .7 .5 16. 19.000  0  0 .2721.472 .921 .213 .112    0 .258   0   0  (Z2) R2AB   30807     93
388.R MU A 14 .45 .7 44. 43 1.3  0 .5 .3111.369 .785 .308 .169    0 .538.277.038   Z1  R2AA   30808     93
389.R MU A 16  .6 .8 45. 45.1.1  0  0 .2561.192 .781 .616 .233    0 .521.095 .01   Z1  R2AA   30806     93
390.R MU A 26  .7 .6 38. 35.000000 .5 .258 .933  .75 .667 .267    000000   0   0    /    R2A    30804 a   93
391.R MU A 14  .6 .7 55. 43. 1. 1.  0 .457 1.75 .731 .731 .096    0 .481.442.038   Z3  R2AC     ..   b   93
392.R MU A 12  .7 .3 12. 30.1.8  0  0000001.568 .919 .676 .135    000000.514.081    /    R2A     ..   c   93
393.R MU A 11 .75 .3 11. 32.1.7  0 .7000001.938 .719 .656 .094    0 .469.531.125    /    R2A     "    d   93
394.R MU A 20  .8 .5 35. 42.1.2  0  0000001.044 .778 .756 .167 .001 .578.278.011    /    R2A     ..   e   93
395.R MU A 15  .8 .6 40. 52.1.6  0 .4 .35300000  .78 .559 .203    0 .305.339.025   Z3  R2AC     ..   f   93
396.R MU A 11  .7 .5 42. 45.1.1000-.2 .22600000  .84  .44  .15    0  .42 .18.004  (Z1) R2AA   WY139      94
397.R MU A  8  .7 .4 42. 32.1.7  0  00000000000 .692 .282 .179    0 .231.256.031    /    R2A  AT 2848    95
398.R MU A 18  .6 .4 38. 50.000000-.2 .11700000 .716 .316 .095    0 .495   0   0  (Z1) R2AA     "        95
399.R MU A 26  .4 .6 50. 33.000000  0 .15400000 .769 .385 .146 .015 .462   0   0  (Z1) R2AA   AT 2844    95
400.R GRAC 13  .8 .4 36. 35.000000  0 .20700000 .836 .672 .269    0 .493   0   0   Z2  R2AB   Da 855     96
401.R GRAC 14 .85 .2 35.0000000000-.3 .18600000  .77 .623 .279    0 .574   0   0   Z2  R2AB   .. 862     96
402.R GRAC  7  .8 .2 40. 46.1.3000  0 .29600000 .862 .448 .172    0 .207.207.028    /    R2A    .. 866     96
403.R GRAC 26  .9 .2 55.0000000000  0 .14600000 .717 .417 .225    0 .583   0   0  (Z2) R2AB   .. 863     96
404.R EMUA 14 .65 .8 30. 32.1.5000  00000000000 .692 .431 .277    0 .369.169.028    /    R2A    .. 860     96
405.R EGRA 16 .55 .7 90. 35.1.5000-.10000000000  .75 .625 .175 .001 .525   0   0    /    R2A    JS 70      96
406.R EGRA 33 .85 .3 38.0000000  0  0 .145   1. .871 .591 .226    0 .484   0   0  (Z2) R2AB   ZL 5252    97
407.R EGRA 20  .8 .4 42. 35.000  0-1. .215 1.01 .733 .333   .2    0 .429   0   0  (Z2) R2AB   .. 5254    97
408.R EGRA 15  .7 .7 43. 34.1.1  0  0 .242  1.2 .813  .44 .167    0  .36  .2.009   Z2  R2AB   " 5256     97
409.R EGRA 11  .9 .3 45.00001.5  0  0 .2931.226 .792  .34 .123 .006 .434.113.011  (Z2) R2AB   .. 5255    97
410.R EGRA 11 .75 .5 15. 30. 2.  0 .3   .51.657 .829 .571 .171    0 .343.457 .08  (Z3) R2AC   .. 5260    97
411.R EGRA  8 .75 .4 31. 34.1.1  0  0 .4191.433 .867 .533 .133    0 .267.467.083  (Z3) R2AC   .. 5261    97
412.R EGRA  9  .8 .3 40.00001.2  0  0 .2681.304 .804 .543 .196    0 .435.152.015  (Z2) R2AB   " 5258     97
413.R EGRA 11  .9 .2 46.00001.2  0  0 .2251.308 .788 .442 .135    0 .404.096.008  (Z2) R2AB   " 5257     97
414.R EGRA  7 .85 .3 42.00001.2  0  0 .3141.433 .833   .7 .117 .003   .4.367 .01    /    R2A    .. 5259    97
415.R EGRA 28 .85 .7 36.0000000  0 2.000001.225 .833 .583 .292    0 .625   0   0    /    R2A    " 5266     66
416.R EGRA 20  .8 .3 28.00001.3 .2  0 .2751.163 .775   .6 .225    0   .5.183 .01  (Z2) R2AB   " 5265     66
417.R EGRA 15  .9 .5 35.00001.2  0 .2 .4251.814 .791 .884 .093    0 .465.465.058   Z3  R2AC   . 5268     66
418.R LGRA 16  .7 .7 70. 33.1.1000  0 .19800000 .723 .361 .157 .004 .506 .12.002   Z1  R2AA   Dw 1226    98
419.R LGRA 12  .8 .8 45.00001.8000  0 .24200000 .863 .294 .196 .004 .471.235.012  (Z1) R2AA   .. 1231    98
420.R LGRA 30 .85 .2 42.0000000000  0  .1800000  .71 .586 .228 .012 .586   0   0  (Z2) R2AB   AT 3608    99
421.R LGRA 16  .5 .8 32. 42.1.3000-.2 .30600000   .6   .5   .2    0 .614.143.009   Z1  R2AA   .. "   B   99
422.R LGRA 19  .8 .4 45.0000000000  0 .26200000 .763 .438 .213 .003  .75   0   0  (Z2) R2AB   AT 3602    99
423.R LGRA 18  .9 .3 25.00001.4000  0 .22200000 .765 .647 .188 .002 .553.071.004  (Z2) R2AB   " "        99
424.R LGRA 11  .7 .5 20. 45.1.6000  0 .38100000 .744 .581  .14    0 .419.256.028  (Z3) R2AC   .. 3605    99
425.R LGRA 11  .8 .4 18. 33.1.2000  0 .34800000 .717 .652  .13 .002 .587.109.011  (Z2) R2AB   .. "       99
426.R LGRA 18  .9 .3 30.00001.1000  0 .24900000 .903 .452 .113    0 .726   0   0  (Z2) R2AB   .. ..      99.
427.R LGRA 13  .7 .3 55. 30. 1.000  0 .25900000 .741 .485 .121    0 .552.052.001   Z1  R2AA   .. 3603    99
428.R LGRA 25 .55 .5 38. 25.000000  0 .26800000 .652 .652 .174    0 .696   0   0  (Z1) R2AA   .. 3600    99
429.R LGRA 15  .8 .4 36.00001.1000  0   .300000 .662 .354 .185    0   .6.123.011   Z1  R2AA   .. ..      99
430.R EBIL 22 .95 .6 36.0000000000-.5 .12700000 .642 .583 .183 .003 .642   0   0  (Z2) R2BF   " 3622 a   99
431.R EBIL 19 .95 .3 28.0000000000-.4 .14900000 .793 .483 .174    0 .565   0 - 0   Z1  R2BA   .. ..  b   99
432.R EBIL 17  .9 .4 27.0000000000-.6  .1600000 .738   .5 .238    0 .512   0   0   Y1  R2BA   .. ..  c   99
433.R EBIL 11  .9 .3 26.00001.4000-.2 .23700000 .804 .536 .214 .009 .482.071.001   W1- R2BD/G .. ..  d   99
434.R EBIL 10 .95 .3 25.00001.3000000  .2800000 .636 .909 .295    0 .909.114.011   W3  R2BA/F .. ..  e   99
435.R EBIL  8 .95 .2 27.0000000000  0 .27700000 .816 .526 .184    0 .474   0   0  (W1) R2BD/G .. ..  f   99
436.R EBIL  7  .9 .2 20.00001.4000  0 .34700000   .8 .433 .233    0 .533.233.013  (W2) R2BC   .. ..  g   99
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437.R EBIL 26  .9 .7 37.0000000000  0    .100000  .58 .247 .113 .001 .513    0   0    (Z1)  R2BA     " 3625     99
438.R EBIL 23  .9 .4 25.0000000000-1.  .10400000 .757 .417 .217 .011 .574    0   0    (Z1)  R2BA     "   "   A  99
439.R EMUB 22 .95 .2 32.0000000000-.8  .18200000 .745   .5 .182 .002 .545    0   0    (Z1)  R2BA     " 3106     100
440.R EMUB 24  .9 .3 19.0000000000-.2    .200000 .743 .461   .2 .002 .574    0   0    (Z1)  R2BA     " 3103 a   100
441.R EMUB 25  1. .6 26.0000000000-1.   .1600000 .733 .483   .2 .008  .75    0   0    (Z2)  R2BF     -   "  b   100
442.R EMUB 21  1. .1 25.0000000000   0 .14900000 .745 .409 .209 .014 .545    0   0    Z3    R2BB     "   "  c   100
443.R EMUB 16 .85 .5 40.00001.2000   0 .31900000 .773 .632 .242    0   .5.091.005    Y4    R2BD     "   "  d   100
444.R EMUB 19 .95 .3 19.0000000000-.5    .200000 .705 .568 .227    0 .625    0   0    Z4    R2BC     "   "  e   100
445.R EMUB 13  .9 .3 23.0000 1.000   0 .23800000 .742 .548 .242 .002    .5.057.003    X1    R2BC     "   "  f   100
446.R LMUB 12  1. .3 21.0000000  0   0 .26700000  .83  .54   .3  .02  .54    0   0    X5    R2BB     " 3108 a   101
447.R LMUB  9  1. .1 19.0000000  0   0 .35900000 .845 .462 .282 .003 .513    0   0    W5    R2BB     "   "  b   101
448.R LMUB  8 .95 .2 25.00001.3  0   0 .37800000 .811 .405  .27 .014 .378.135.008    (W5)  R2BB     "   "  c   101
449.R ???? 14  .9 .4 18.00001.2000   0 .16900000 .757   .5 .171 .003 .429   .1.001    X1    R2BC     HR 1822    99
450.R EMUB 22  .9 .5 17.0000000000   0 .20900000 .651 .443  .17    0 .585    0   0    (Z4)  R2BC     AT 2593    102
451.R EMUB 21  .9 .5 23.0000000000   0 .22400000 .656 .469  .25 .002 .583    0   0    Z4    R2BC        "       102
452.R EMUB 15 .95 .3 28.0000000000-.8   .1900000 .658 .438 .178 .001 .534    0   0    Y1    R2BA     31862      99
453.R EMUB 21 .95 .4 34.0000000000-.6 .17400000  .67 .409   .2 .001 .609    0   0    Z1    R2BA     31861      99
454.R EMUB 31  1. .2 24.0000000000-.8 .16500000 .648 .483 .124    0  .69    0   0    (Z1)  R2BA     AT 3621 a  99
455.R EMUB 14  .9 .4 20.00001.4000-.2 .20600000 .653  .76 .173 .001  .64.093.001    X1    R2BC        "    b  99
456.R EMUB 12  .9 .3 25.00001.2000-.6 .24200000 .672 .345 .207    0 .552.103.003    X1    R2BC        "    c  99
457.R EMUB 10  1. .2 22.0000000000   0 .29200000 .689 .667 .156    0 .667.133.013    W3    R2BA/F      "    d  99
458.R ???? 20 .95 .2 26.0000000000-.9   .1800000 .761 .543 .263    0 .598    0   0    Z2    R2BF     HR 1811    99
459.R EMUB 23  .9 .5 16.00001.2000-.3 .22200000 .739 .609 .243    0 .522.061.002    (Z6)  R2BD     RE 4579    103
460.R EMUB 19  .9 .3 13.00001.7000-.7 .21500000 .612 .534 .155    0 .534.049.005    Z4    R2BC     " 4577     103
461.R EMUB 15  .9 .5 18.0000000000   0 .25800000 .829 .571 .214 .014 .571    0   0    Y2    R2BB     " 4575     103
462.R EMUB 17 .95 .3 17.00001.2000-.1 .23600000 .647 .424 .188    0 .706.052.002    Y5    R2BC     " 4574     103
463.R EMUB  7  .9 .2 30.00001.1000   0  .311.291 .875   .5 .188    0 .375.344.009    (W2)  R2BC     30801      104
464.R EMUB 14  .9 .4 35. 40.1.2000   0 .24300000 .708 .446 .154 .002 .815.092.002    X1    R2BC     87003      99
465.R EMUB  7  .9 .3 24.00001.2000   0 .32400000 .806 .355 .194    0 .419.161.006    (W2)  R2BC        "       99
466.R ???? 15  .9 .3 25.0000000000   0   .200000 .789 .817 .296    0 .789    0   0    Y1    R2BA     HR 1820    99
467.R EMUB 22 .85 .6 17.00001.2000   0 .21800000  .72  .63  .18    0   .5 .12.003    (Z4)  R2BC     AT 3618    99
468.R EBIL  8  .9 .4 19.00001.1000   0 .30100000 .688 .344 .219    0 .719.188.009    (W2)  R2BC     30834      99
469.R EBIL 13 .85 .5 20.00001.5000   0 .32800000 .736 .528 .264    0 .698.151.008    X7    R2BE     30840      99
470.R EBIL 10  .9 .4 23.0000000000   0  .2500000  .75 .458 .208    0 .458    0   0    W1    R2BD/G   30837      99
471.R MU B 11  .9 .3 17.00001.8000   0 .25500000 .681 .553 .128    0 .574.191.011    W2    R2BC     AT 30806 a 105
472.R MU B 15  .9 .3 25.0000000000   0 .23900000 .667 .633  .35    0 .533    0   0    Y1    R2BA     "   "    b 105
473.R MU B  8 .95 .2 18.00001.3000   0 .32900000 .658 .605 .237    0 .658.132.003    (W3)  R2BA/F   "   "    c 105
474.R BILI 24  .9 .3 24.0000000000-1.  .19600000   .7   .5 .167    0 .625    0   0    (Z1)  R2BA     87001      104
475.R BILI 21 .95 .6 13.00001.6000-.4 .20900000 .733 .524   .2 .001 .552.037.002    Z4    R2BC        "       104
476.R BILI 24 .95 .4 25.0000000000   0  .1800000 .722 .652 .278    0 .635    0   0    (Z2)  R2BF     86999      104
477.R BILI  7  1. .1 22.00001.6000   0 .31400000 .821 .429 .179    0 .143.286.011    (W2)  R2BC        "       104
478.R BILI  5 .95 .1 29.00001.1000   0 .36200000 .833 .417 .292 .004 .167.208.008    (W5)  R2BB        "       104
479.R BILI 16  .9 .5 14.0000000000-1.0000000000 .573 .867   .4 .007 .8270000000    /     R2B      Zi 7847    106
480.R BILI 26  .9 .3 14.00001.1000-2.0000000000  .68  .68  .32 .006 .616.128.008    /     R2B      - 7845     106
481.R BILI 26  .9 .3 18.0000 1.000-2.0000000000 .752   .8  .32    0  .72.048.005    /     R2B      - 7843     106
482.R BILI 14  .9 .3 16.0000000000   0  .2300000 .712 .803 .197    0 .606    0   0    X4    R2BF     Wy 107     88
483.R BILI 13 .95 .3 28.00001.2000-1.  .28500000 .702 .474 .228 .004 .667.068.004    X1    R2BC     Lz 3574    107
484.R BILI 21 .95 .4 32.0000000000-.4 .16200000 .755   .5 .191 .005 .518    0   0    Z1    R2BA     Lz 3578    107
485.R ?MUB 25  .9 .3 18.0000000000-.8   .2200000 .692  .75 .225 .001  .75    0   0    (Z2)  R2BF     Da 2263    108
486.R BILI 19  1. .4 29.0000000000-2.  .16400000 .819 .798 .245    0 .745    0   0    Z2    R2BF     Ba 998     111
487.R BILI 11 .95 .2 23.00001.1000   0 .20900000 .818 .727 .273    0 .727.114.005    W3    R2BA/F   "   "      111
488.R BILI 19  .9 .5 25.0000000000  .5 .18800000  .76 .885 .219 .002 .677    0  -0    Z2    R2BF     Ba 1000    111
489.R BILI 23 .95 .4 24.0000000000   0 .14500000 .773 .545 .209 .002   .8    0   0    (Z2)  R2BF     30831      109
490.R BILI 16  .9 .3 25.0000000000   0 .18800000  .75 .563 .188    0 .525    0   0    Y1    R2BA     -Ba 1007   111
491.R BILI 15 .95 .4 19.0000000000-1.  .15500000 .733 .773  .16 .003   .8    0   0    Y1    R2BA     " 1010     111
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492.R BILI 26  1. .3 30.0000000000  0 .14600000 .638 .462 .169    0 .615  0  0    (Z1)  R2BA     30835       109
493.R MU B 20  .9 .3 15.00001.8000-.1 .22500000 .613 .625 .263    0  .95.125 .01   Z5   R2BG     Ba 277      112
494.R MU B 14  .9 .3 16.00001.2000  0 .25300000 .724 .828 .293    0 .862.172.014   X7   R2BE       "         112
495.R MUBI  6  .9 .3 20.00001.5  0  0 .40400000 .636 .691 .182 .004 .291.255.018  (W2)  R2BC     Da 2286 ·   108
496.R MUBI 16 .85 .7 16.00001.4  0-.7 .36300000 .851 .821 .403 .022  .97.179.012   Y7   R2BI       "         108
497.R MU B 42  .9 .5 37.0000000000 .2 .26200000 .757 .486 .189 .003 .432  0  0    (Z3)  R2BB     AT 3089     105
498.R MU B  7 .75 .2 30.  30.1.7  0  0 .31100000 .667 .667   .2    0 .533.267 .01  (W2)  R2BC     WY 110      88
499.R MU B 15  .8 .3 22.  30.000000-.3 .24500000 .729 .789 .229    0 .857  0  0     Y1   R2BA       "         88
500.R MU B 21  .9 .3 18.0000000000-.2 .23800000   .6 .552  .19    0 .762  0  0     Z4   R2BC       "         88
501.R MU B 21 .95 .2 42.0000000000-.4 .22300000 .745 .455 .164    0 .455  0  0     Z1   R2BA     D 1602      110
502.R MUBI 13  .7 .7 13.  32.1.6  0-.2 .34100000   .8 .633  .25    0  .75.067.013   X7   R2BE     Da 2280     108
503.R MUBI 11  .8 .4 16.00001.7  0  0 .35700000 .882 .882 .255    0  .98.216.006   W4   R2BE     " 2281      108
504.R BILI 19  .8 .5 21.0000000000-.1 .23700000 .6821.059 .353    0 .882  0  0     Z7   R2BE     Zi 7841     106
505.R MU B 25 .85 .5 32.0000000000-.8 .16800000 .621 .414  .09    0 .483  0  0    (Z1)  R2BA     SH 2077     113
506.R MU B 18  .8 .5 19.00001.1000-.2  .2500000 .683 .512 .268    0 .671.159.004   Z6   R2BD     RE 4581     103
507.R MU B 18  .8 .4 20.0000000000-.3 .30300000 .707 .733  .28    0 .667  0  0     Z4   R2BC     " 4588      103
508.R MU B 14  .9 .3 30.00001.3000  0 .29300000 .806 .694  .29    0 .565.065.006   X2   R2BD     " 4585      103
509.R MU B 16  .8 .5 15.00001.1000  0 .25500000 .684 .526 .197    0 .789.145.004   Y5   R2BC     ·   "       103
510.R MU B 32  .8 .4 32.0000000000-2. .19700000 .733 .897 .152 .017  .69  0  0    (Z2)  R2BF     "   "       103
511.R MU B 18 .75 .6 18.  22.1.2000  0  .300000 .648 .662 .183    0 .915.056.003   Z6   R2BD     " 4592      103
512.R MU B 15  .8 .5 28.  27.1.5000  0 .28700000 .806 .417  .09    0 .444.097.004   Y4   R2BD     " 4593      103
513.R MU B 13  .8 .5 42.  35.1.3000-.2 .22400000 .688 .516 .156    0   .5.094.005   X1   R2BC     SH 829      103
514.R MU B 19  .9 .4 18.0000000000-.2 .26300000 .723 .651 .253    0 .602  0  0     Z4   R2BC     " 852       103
515.R BILI 47 .95 .3 33.0000000000-1.  .1700000 .717  .37 .165 .003 .565  0  0    (Z3)  R2BB     WY 112      88
516.R BILI 14 .85 .2 19.00001.1000-.1 .19300000 .794 .735 .191    0 .853.103.004   X3   R2BG       "         88
517.R BILI 27  .9 .2 31.0000000000-1.0000000000 .677 .355 .206    0 .577  0  0     /    R2B        "         88
518.R MU B 13 .85 .2 16.00001.2000-.20000000000 .661 .532 .161    0 .613.081.003   /    R2B      D 1719      114
519.R BILI 14 .75 .5 15.  28.1.8000  0 .25900000  .75 .735 .191    0 .515.118.003   X7   R2BE     ZL 3322     115
520.R BILI  5  1.  0 24.0000-2.000  0 .32800000 .692   .5 .154    0 .462.192.019   W1   R2BD/G   WY 108      88
521.R BILI 13  .9 .1 14.00001.2000-.1  .200000 .721  .77 .197    0  .77.082.005   X3   R2BG       "         88
522.R BILI 19 .85 .5 20.00001.1000-.4 .18400000 .691 .691 .234    0 .745.064.002   Z4   R2BC     AT 3163     116
523.R BILI  9 .85 .5 23.00001.3000-.2 .28400000 .773 .523 .205    0 .477.182.014   W2   R2BC       "         116
524.R BILI 10  .8 .3 30.00001.5000-.2  .2900000 .711 .533 .167    0 .711.111.007   W2   R2BC       "         116
525.R BILI 12  .9 .2 17.0000000000  0 .24400000 .746 .644 .254    0 .678  0  0     X4   R2BA/F   Lz 3374     117
526.R BILI 14  .9 .5 28.0000000000  0 .24800000 .769 .692 .154    0 .769  0  0     X4   R2BA/F   " 3373      117
527.R BILI 13 .85 .4 22.00001.5000-.50000000000 .645 .694 .194    0  .71.065.005   /    R2B      57775       111
528.R BILI 55  .8 .7 30.  30.000000-2.0000000000  .66   .3 .172    0  .52  0  0     /    R2B      57774       111
529.R BILI 21 .85 .8 15.00001.7000-2.  .1900000 .676   .5 .244    0 .633.122.004   Z6   R2BD     BT 919 a    118
530.R BILI 33 .95 .2 40.0000000000-1. .125 .935 .776 .471 .206 .009 .794  0  0    (Z1)  R2BA     6828        99
531.R BILI 12  .8 .4 14.00001.4000-.5 .22200000 .817 .667 .283    0 .533.083.003   X7   R2BE     Ze 1906     119
532.R BILI  8  .8 .6 15.00001.6000-.4 .31700000 .697 .759 .212    0  .97.152.018  (W4)  R2BE     "  "        119
533.R BILI  9  .9 .3 18.00001.6000  0 .26700000 .717 .696 .261    0 .717.109.004   W3   R2BA/F   " 1905      119
534.R BILI 13  .9 .4 16.0000000000-.7 .24600000 .714 .841  .27    0 .603  0  0     X4   R2BA/F   "  "        119
535.R MUTB 19 .95 .7 29.0000 1.000  0  .200000 .686   .5 .174    0 .558.058.002   Z4   R2BC     AT 3048     120
536.R MUTB 24 .95 .8 25.0000000000-.20000000000 .667 .429 .161 .002 .438  0  0     /    R2B      "  "        120
537.R MUTB 16 .95 .3 28.00001.8000-.1  .200000 .714 .643 .214 .003 .714.057.003   Y5   R2BC     "  "        120
538.R MUTB 13 .95 .3 35.00001.1000  0 .29200000 .768 .804 .179    0 .536.143.005   X2   R2BD     " 2826      121
539.R MUTB 18  .9 .6 28.0000000  0-1. .151 .952 .838 .571 .181    0 .667  0  0     Z1   R2BA     " 3075      120
540.R MUTB 11  1. .4 18.00001.2  0  0 .26400000  .32   .6   .3 .006  .56 .16.004   W1   R2BD/G   " 3074      120
541.R BILI 20  .9 .3 16.00001.4  0  0 .23500000 .833 .679  .31    0 .655.107.002  (Z5)  R2BG     " 3113A     101
542.R BILI  7  1. .1 16.00001.5  0  0 .371  2.0 .792 .625 .104    0 .458.542.063  (W2)  R2BC     " 3113      101
543.R BILI 11 .85 .4 20.00001.5-.7-.5 .3361.154 .827 .865 .308    0 .827.231.029   W4   R2BE     " 3113 B    101
544.R BILI 10  .9 .3 22.00001.7  0  0 .30400000  .83 .532 .277 .006 .511.191.004   W1   R2BD/G – " 3107      .101
545.R MUTB  9  1. .1 21.0000000  0  0  .300000   .8 .575   .4 .013  .55  0  0     W5   R2BB     " 3110      101
546.R MUTB 16 .95 .6 27.0000000  0  0 .21800000 .772 .633 .291 .004 .633  0  0     Y2   R2BB     " 3110      101
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547.R MUTB 13  .9 .5 25.0000000  0-.7  .2300000 .841 .524 .238 .024 .509    0    0    X5   R2BB    AT 3198    107
548.R MUTB 17  .9 .5 32.0000000  0-.5 .22400000 .883 .519 .182 .001 .545    0    0    Y2   R2BB    "   "      107
549.R MUTB 14 .95 .3 28.00001.4  0-.8 .25500000 .821 .493 .269 .003 .612.134.003    X2   R2BD    "  3197    107
550.R MUTB 14  .9 .4 31.0000000  0-.5 .21400000 .843   .6 .186 .001 .071    0    0    X6   R2BK    "   "      107
551.R MUTB 20  .9 .4 20.0000000000-.2  .1500000 .766 .447 .191 .003 .553    0    0    Z1   R2BA    "  3076    120
552.R MUTB 21  .9 .4 22.0000000000-.4 .16700000 .727 .591 .182 .002 .682    0    0    Z1   R2BA    "   "      120
553.R LMUB 18  .9 .3 20.00001.4000-1. .25600000 .7471.084 .386    0 .843 .06.001    Z7   R2BE    Ze 1908    119
554.R LMUB 20 .95 .3 28.0000000000-1. .19500000 .626 .549 .132    0 .714    0    0    Z1   R2BA    D 1799     122
555.R LMUB 13  .9 .2 20.00001.8000-.8 .25200000   .7 .717 .183    0  .75.183.005    X3   R2BG      "        122
556.R LMUB 12  .9 .3 25.00001.4000-.4 .29400000 .791 .859 .219 .003 .703.078.002    X2   R2BD      "        122
557.R LMUB  8  .8 .4 18.00001.5000-.3 .29900000   .8   .6 .257    0 .857.223.009    (W4) R2BE      "        122
558.R LMUB 20  .8 .5 18.0000000000-.4 .17500000 .758   .6 .168    0 .579    0    0    Z4   R2BC    48544      123
559.R LMUB 65  .9 .3 40.0000000000-.50000000000   .7   .3 .117 .027 .433    0    0    /    R2B     DT 331      ?
560.R LMUB 16  .9 .2 25.0000000000-2.  .181.012 .837 .756 .221    0 .674    0    0    Y1   R2BA    50265 A    124
561.R LMUB 11  .8 .2 22.00001.7000-.5 .1881.094 .641   .5 .156    0 .656.156.008    W2   R2BC    50268      124
562.R LMUB 22  .8 .5 19.0000000000-.8 .18900000  .85   .7  .22    0   .4    0    0    (Z4) R2BC    Lz 3369    119
563.R LMUB 16  .9 .5 20.0000000000-.1 .20600000 .846 .723 .308    0 .769    0    0    Y2   R2BB    "   "      119
564.R LMUB 13 .85 .4 20.000000000000 .26700000 .759 .837 .226    0 .726    0    0    X4   R2BA/F  "   "      119
565.R LMUB  9  .9 .2 26.00001.4000-.1 .31100000 .805 .659 .244    0 .854.244.017    W3   R2BA/F  " 3573     125
566.R LMUB 17  .8 .6 24.0000000000-.6 .19400000 .663 .688 .125    0 .725    0    0    Y1   R2BA    50265      124
567.R EOME 19  .8 .2 35.0000000000-.5 .16800000 .816 .506 .207    0 .517    0    0    Z1   R2BA    DT 343     126
568.R EOME 16  .7 .8 20. 40.1.8000-.3 .18800000 .768 .829 .256    0  .61.085.002    Y6   R2BH    " 344      126
569.R EOME 15  .8 .4 30.00001.3000-1.0000000000  .73 .743 .243    0 .743.108.003    /    R2B     "   "      126
570.R LMUB 22  .9 .3 28.0000000000-.1 .16900000 .753 .706 .259    0 .588    0    0    (Z2) R2BF    JS 97      127
571.R LMUB 21 .95 .4 37.0000000  0-.8   .200000 .789 .737 .263    0 .737    0    0    Z2   R2BF    AT 3195    107
572.R LMUB 15 .95 .5 25.0000000  0-.6   .200000 .849 .548 .247 .004 .712    0    0    Y2   R2BB    "   "      107
573.R LMUB 26  .8 .4 24.0000000  0-2. .18800000 .755 .545 .227 .003 .545    0    0    (Z4) R2BC    JS 543     128
574.R LMUB 13 .95 .3 19.0000000  0-.3 .23800000 .754 .525 .277 .003   .5    0    0    X4   R2BA/F  AT 3109    101
575.R LMUB  8 .95 .2 17.00001.3  0  0 .28700000 .838 .649 .324 .008 .811.243.005    (W3) R2BA/F  "   "      101
576.R?LMUB 20 .95 .1 23.0000000000-.6  .1200000 .704 .439 .163    0 .663    0    0    Z1   R2BA    JS 555     129
577.R LMUB  9 .85 .2 17.00001.22.0-.3 .2631.341 .902 .561  .22    0 .732.244.002    W1   R2BD/G  50272      124
578.R LMUB 16 .95 .2 22.0000000000-.10000000000  .75 .663 .275 .001 .663    0    0    /    R2B     D 1334     130
579.R?WRIG  9  .8 .3 21. 37.1.2  0-.3 .2261.152 .696   .5 .196 .002 .522.217.011    W2   R2BC    D 1333     130
580.R WRIG 24  .7 .6 26. 28.000000-1. .19800000  .73 .478 .226 .002 .522    0    0    (Z4) R2BC    Lz 300     128
581.R LMUB 18 .95 .2 25.0000000000-.2  .1500000 .738 .688 .313    0 .688    0    0    Z2   R2BF    Js 556     129
582.R LMUB 19 .75 .6 25. 38.000000-.2 .22100000 .795 .554 .253    0 .651    0    0    Z4   R2BC    - 540      129
583.R?META 26  .9 .4 22.0000000000-.1  .2500000 .708 .583 .292 .001 .708    0    0    (Z2) R2BF    Ba 995     111
584.R META 26  .9 .2 45.0000000000-2. .10900000 .766 .407 .336 .009 .714    0    0    (Z2) R2BF    He 2967    131
585.R META 19  .9 .3 16.0000000000-2. .17400000 .674 .815 .359    0  .87    0    0    Z7   R2BE    37921      132
586.R META 17  .9 .3 27.0000000000-.1 .19400000 .688 .788 .338 .003  .75    0    0    Y1   R2BA    37928      132
587.R META 23  .9 .2 15.0000000000-2. .17900000 .777 .732 .286    0 .777    0    0    (Z2) R2BF    37931      132
588.R META 25 .95 .1 24.0000000000-2. .19100000 .792 .833 .358    0 .958    0    0    (Z7) R2BE      "        132
589.R META 15  .9 .3 14.0000000000-1. .26700000 .767  .89 .315    0   .7    0    0    Y3   R2BE      "        132
590.R META 15  .9 .4 18.0000 1.000-.3 .27500000 .792  .75 .458    0 .875.042.001    Y3   R2BE    37930      132
591.R EOME 15  .9 .2 14.0000000000-1. .26600000 .708 .954 .462    01.077    0    0    Y3   R2BE    37922      132
592.R META 32 .95 .4 22.0000000000-2. .15600000 .794   .5 .313 .001 .719    0    0    Z2   R2BF    37920      132
593.R MUTC 13 .95 .2 20.0000000000-.5 .23800000 .712 .423 .327    0 .827    0    0    Z1   R2CA    AT 3136    133
594.R MUTC 13 .95 .1 28.0000000000-.3 .16900000 .779 .618 .324    0 .779    0    0    Z1   R2CA      "        133
595.R MUTC 14 1.0  0 24.0000000000-2. .17100000 .743 .429 .243    0 .714    0    0    Z2   R2CB      "        133
596.R SUPE 12  .9 .3 13.00001.9000-.5 .22500000 .808 .865 .346    0 .962.173 .01    Z4   R2CD    Ze 2023    134
597.R RELF 42  .8 1. 14.0000000000-.5  .1600000 .778 .556 .167 .039 .444    0    0    /    R2C     Ba 107     135
598.R META 34 .95 .1 17.0000000000-2. .18200000 .779 .517 .248    0 .759    0    0    (Z1) R2CA    SH 319     132
599.R SUPE  9 .95 .1 25.00001.2  0-.7 .211 1.02 .796 .694 .204 .002 .653.082.006    (Z1) R2CA    Zl 194     136
600.R SUPE 19  .9 .4 35.0000000000-2. .12300000 .713 .478 .165 .001 .565    0    0    (Z2) R2CB    Zi 4811    137
601.R SUPE 19 .95 .3 42.0000 1.000-2. .14200000 .648 .571 .286 .003 .762.039.001    (Z1) R2CA    "   "      137
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602.R SUPE 15  .9 .3 40.0000000000-2. .17300000 .757 .568 .216    0 .473   0   0   (Z2)  R2CB  Zi 4811   137
603.R SUPE 10 .95 .2 28.0000 1.000-1.  .2100000 .711 .578 .267    0   .6.078.002   (Z2)  R2CB  "    "    137
604.R SUPE 11 .95 .2 32.0000 1.000-1. .20500000 .755 .679 .283    0 .717.066.004    Z1   R2CA  "    "    137
605.R SUPE 28 1.0 .1 50.0000000000-1. .20400000 .708 .423 .215    0 .485   0   0   (Z2)  R2CB  FWC 98    138
606.R SUPE 17 1.0 .1 19.0000000000-1. .14500000 .591 .462 .172    0 .677   0   0   (Z2)  R2CB  Lz  3611  52
607.R SUPE 13 .95 .2 23.00000000000000 .14800000 .613   .6  .16   0  .52   0   0    Z2   R2CB  "    "    52
608.R SUPE 12  .9 .3 16.00001.2000-1. .14200000 .842 .596 .246    0 .702.105.002    Z3   R2CC  "    "    52
609.R SUPE  8 .95 .1 12.00001.8000-.2 .28200000 .794 .647 .353    0 .676.118.006   (Z3)  R2CC  "    "    52
610.R SUPE 20 .95 .2 20.0000000000-.5 .18700000 .677 .625 .271    0 .833   0   0   (Z1)  R2CA  RAE.1780  139
611.R SUPE 18  .9 .2 24.0000000000-.8 .15900000 .729 .647 .271    0 .882   0   0   (Z1)  R2CA  "    "    139
612.R SUPE 16  .9 .2 26.0000000000-1. .14400000 .741 .624 .271 .004 .647   0   0   (Z3)  R2CC  SH 3103   140
613.R SUPE 12 .95 .1 27.0000000000-.9 .15800000 .787 .525 .361 .0021.016   0   0    Z1   R2CA  "    "    140
614.R SUPE 10 .95 .1 22.00001.3000-.5  .1600000 .596   .5 .231    0 .558.096.004   (Z2)  R2CB  "    "    140
615.R SUPE  8 .95.15 24.0000000000-.2 .21700000  .78 .634 .268    0 .634   0   0   (Z2)  R2CB  "    "    140
616.R SUPE 13  .9 .1 23.0000000000-.4 .16800000 .758 .682 .212    0 .712   0   0    Z2   R2CB  "    "    140
617.R SUPE  8 1.0 .1 36.0000000000-.1 .21900000 .757 .351 .216    0 .595   0   0   (Z2)  R2CB  "    "    140
618.R SUPE 13 .95 .1 16.00001.5000-.8   .200000 .582 .672 .194    0 .746.045.001    Z3   R2CC  AT 3518   141
619.R EMUC 15 .95 .3 22.00001.2000-.50000000000 .689 .689 .257    0 .622.054.001    /    R2C   SH 2132   113
620.R?EMUC 26  .9 .3 20.0000000000-2. .22400000 .695  .89 .203    0 .593   0   0   (Z3)  R2CC  SH 2128   113
621.R MUTC 13 .95 .2 26.0000000000-.3 .14300000 .785 .769 .338    0 .769   0   0    Z1   R2CA  IPS 734   51
622.R MUTC 12 .95 .1 20.00001.5000-.7 .18300000 .764 .909 .345    0 .691.091.004    Z3   R2CC  "    "    51
623.G MUTC  9  .9 .3 20.0000 2.  0-.1 .2341.067 .844 .444 .267 .002 .511.244.009   (Z3)  R2CC  89037     42
624.G MUTC 20 .95 .1 20.0000000000-1. .11500000 .676 .667 .229    0  .81   0   0   (Z1)  R2CA  30843     53
625.G MUTC 18 .95 .1 40.0000000000-.3 .08900000 .782 .632 .184    0  .69   0   0   (Z2)  R2CB  87002     53
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Appendix 3b : Holotypes

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                  S     C    T     R   Du/Ds  W/Hw  Rl/Hw Pl/Hw Do/Hw Po/Hw  Dh/Hw  Lt/Hw  Ht/Hw
     ALPHA 23    .9    .2 18.0   1.1   .32   1.2   .82   .46   .11  .007    .4      0      0
     ASIAS 24    .7    39  8.0   1.5   .57   1.3    .9   .69   .14     0   .41    .42    .02
    BEREST  6   .82   .53 39.0   1.0   .29   1.7   .93   .42   .15     0    .1      0      0
      BETA 32   .74    .6 19.0   1.0   .26    .9   .76   .48   .11  .009   .36      0      0
     CANAD 30   .98    .2  8.0   1.1   .31   1.2   .75    .7    .3  .005    .6     .1   .002
    CONFIN 51 0000000000000000   1.0  .313000000000000000000000000000000      0      0
    COSTAT 14   .82   .33 13.0   1.9   .52   1.5   .94   .69   .22     0   .25    .44   .035
     DEGEN 12   .82   .45 24.0   1.1   .42   1.5   .84    .9   .28     0   .57     .1    .01
    DEVIUM 18   .87   .52 12.0   1.8   .24   1.2   .83   .35   .12     0   .28    .01      0
    ELIASI 34    .9    .5  7.0   1.2   .27   1.6   .83   .34   .33   .02   .74    .05    .01
    EXCULT 15   .82   .31 33.0   1.0   .18   1.1   .81   .33   .15  .015   .26      0      0
     EXIMI 16   .82   .45 19.0   1.0   .32   1.5   .93   .53   .37  .009   .64    .02      0
    EXTREM 36   .86    47  8.0   1.1   .45   2.0    .8   .33    .2  .019    .3    .09    .01
     FENIN  8   .79   .36 31.0   1.6    .3   1.4   .82    .3   .04  .013   .11    .27    .02
     GAMMA 40   .95   .05   9.   1.2   .24   1.1   .77   .27   .15  .032   .31      0      0
    GRADIL 32   .92    .2 16.0   1.3   .27   1.1   .76   .22   .08   .02    .3      0      0
    HEIBER 25   .94    .2 21.0   1.0   .26   1.2   .82   .35   .16  .014   .43      0      0
    HENBES 32   .74   .28  8.0   1.3   .42   2.0    .9   .62   .22  .011   .38     .2    .01
    HODSON 57 0000000000000000   1.0  .272 1.24000000000000000000000000000      0      0
    INSTAT 30   .94   .08   7.   1.0   .11    .7   .81   .54   .13  .011    .4      0      0
     JUVEN 16   .81    .5 12.5   1.1   .53   2.9   .94    .7   .27     0   .19    .68    .04
     LAXUS 30   .74   .77 11.0   1.9   .44   1.4   .71   .28   .14  .002    .3    .21    .01
    LINGUA 24   .74   .28 14.5   1.0   .26    .9   .78   .34   .14  .006   .38      0      0
     MALUS 50 0000000000000000   1.0   .26 1.000000000000000000000000000      0      0
     MICRO 25   .92   .12 10.0   1.2   .21   1.1    .9   .43   .18  .014   .28    .22   .005
    OBSCUR 30    .8    .6  23.   1.0   .28   1.3   .78    .3   .14     0    .4    .02      0
    ORIENT 21   .91   .41  11.   1.0    .2   1.1    .8   .34    .1  .012   .28      0      0
     ORTIV 26    .8   .65 14.0   1.2   .35   1.4   .79   .36   .16     0   .33     .2   .005
    PAVLOV  8   .85    .3 16.0    1.   .16   1.0   .82   .48   .26  .027    .5      0      0
     POLIT 19   .95    .1 31.0   1.0   .18   1.1   .82   .59   .27  .004   .69      0      0
    POSTER 53    .9    .1  5.0   1.0  .351  1.04  .6900000000000 .065    .5      0      0
    RELICT 23    .9    .4  6.0   1.4   .52   2.8   .96   .59   .56     0   .72     .5    .05
     REDIV 23   .65    .5  6.0   1.6   .35   1.6   .88   .54   .33  .019   .68    .16   .015
    REMISS 18   1.0    .3 23.0   1.6   .36   1.3   .71   .26   .07     0   .26    .06   .005
     SEMIR 25   .75    .5  8.0    2.   .46   2.1   .93   .62   .17  .008   .37    .33    .01
     SEPAR 15   .79   .39 13.0   1.5   .31  1.35   .81   .22   .17     0   .26    .23    .01
    SUBCAR 14    .9    .3  9.0   1.8  .465  1.15   .84   .68   .18     0   .35    .26   .005
     SUREN 32   .95   .25 24.0   1.0   .18   1.0   .74   .36   .09  .014   .29      0      0
    TERSUM 16   .85   .15 23.0   1.0   .18   1.3   .72   .62   .09  .029    .5      0      0
    TEXTUM 25    .7   .65  7.0   1.8   .47   2.6   .88   .65    .2  .022    .6     .3    .05
      TIRO 11   .95    .4 20.0   1.7   .31   2.0   .95   .26   .07  .008   .16    .17    .02
      WAIN 37    .9    .3  10.   1.0   .14  1.15   .76   .33   .06  .042   .32      0      0
R1A1C CIRC 17    .7    .3 20.0   2.5 .41400000     .84   .44   .08     0   .36     .4      0
R1A2C SUBR 22   .85    .8 22.0   1.8 .20500000    .823  .206    .1  .044  .382      0      0
R1A2D PULC 30    .8    .7 28.0   1.3   .200000      .8  .156  .067  .007  .267      0      0
R1CA  RETI 27    .7    .7 15.0   1.3 .16500000    .846  .461  .115     0  .307  .07700000
R2AA  GRAC 14    .5    .3 55.0   1.0  .2500000    .727  .182  .068     0  .409  .13000000
R2BC  BETA 15    .9    .3 20.0   1.5 .24500000     .72   .43    .2     0   .48    .800000
R2CA SUPER  8   .95    .1 25.0   1.0 .13300000    .821  .642    .5 .00700000         0      0
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APPENDIX 4

Gastrioceratid (s.l.) specimens data file.

~~SPECIMEN CODE~~	ORIGINAL IDENTIFICATION (ABBREV.)	DIAM. (mm)	R	N	S	C	T	D_w/D_s	W/H_w	L_t/H_w	D_h/H_w	D_o/H_w	H_t/H_w	L	CLUSTER CODE (OR NEAREST CLUSTER)	HORIZON + MORPHOSPECIES CODE	B.G.S. SPECIMEN NUMBER	LOCALITY CODE (SEE END OF APPENDICES)
1	? ?	16	1.0	00000	.75	00000	00000	.245	1.264	.417	.097	.111	.014	00000	/	GI	BLH 4875	142
2	? ?	23	00000	00000	0.9	0.5	25.0	.319	1.305	00000	.105	.074	0	00000	/	GI	BLH 4876	142
3	? ?	15	1.0	8.0	0.9	0	12.0	.43	1.75	0.5	.167	.1	.117	00000	/	GI	AL 1825	143
4	C CANC	34	1.0	8.0	0.4	.75	30.0	.235	00000	.269	.154	.077	.115	13.0	(Z4)	GIAA	SH 212	53
5	C ?	24	1.0	7.0	0.6	0	20.0	.407	2.143	.429	.286	.071	.143	00000	/	GIA	T 88 B	144
6	C CANC	18	1.0	8.0	.75	00000	00000	.43	1.9	.5	.3	.05	.1	00000	/	GIA	T 86 B	144
7	C CANC	13	1.0	9.0	.75	00000	20.0	.394	1.889	.556	.167	.111	.067	00000	/	GIA	T 83 B	144
8	C CREC	14	1.0	12.0	0.6	1.0	30.0	00000	.696	00000	.052	.087	.017	25.0	/	GIA	T 80 B	144
9	? ?	31	1.0	18.0	0.8	1.0	50.0	.288	1.741	.357	.179	.112	.004	00000	/	GI	Zf 865	?
10	C BRAN		1.0	10.0	0.9	0.8	25.0	0000	00000	00000	00000	00000	00000	12.0	/	GIA	Bj 8380	147
11	C?CREC	17	1.0	9.0	.75	00000	20.0	.324	1.286	.214	.1	.071	.014	00000	/	GIA	54231	145
12	C?CREC	10	2.0	9.0	0.7	0.4	30.0	.302	1.277	.319	.149	.106	.021	50.0	W1	GIAB/G	54229	145
13	C BRAN		00000	00000	0.7	0	11.0	0000	00000	00000	00000	00000	00000	28.0	/	GIA	62442	146
14	C BRAN	20	3.0	13.0	0.7	0.1	15.0	.225	00000	.429	00000	.127	.014	00000	Z1	GIAB	62443	146
15	C BRAN		3.0	8.0	0.7	0.1	10.0	0000	1.071	1.0	.048	.119	.095	40.0	/	GIA	62441	146
16	C?CREC	28	00000	00000	.55	0.7	20.0	.321	1.336	00000	.045	.091	00000	33.0	/	GIA	54226	145
17	C?CREC	8	1.5	11.0	0.7	0.4	30.0	.379	00000	.5	.133	.067	.067	46.0	/	GIA	54227	145
18	C?CREC	17	1.0	9.0	0.4	0.9	40.0	.412	1.385	.462	.308	.108	.046	00000	Y1	GIAB	89035	42
19	C?CREC	19	1.0	9.0	0.5	0.9	30.0	.354	1.371	.357	.143	.1	.043	00000	Z4	GIAA	89034	42
20	C?CREC	13	1.0	9.0	0.5	0.9	27.0	.353	1.345	.509	.091	.127	.055	00000	X1	GIAA/B/G	89036	42
21	C?CREC		1.0	12.0	0.6	0.7	20.0	0000	00000	.5	.083	.083	.1	32.0	/	GIA	50612	146
22	C?CREC	18	1.0	10.0	00000	00000	00000	.35	00000	.786	00000	00000	.086	00000	/	GIA	XV 6/39	?
23	C?CREC		1.0	10.0	0.6	1.0	15.0	0000	00000	.278	00000	.083	.056	18.0	/	GIA	WE 1369	148
24	C CREC		1.0	9.0	0.6	0.9	8.0	0000	00000	00000	00000	00000	00000	10.0	/	GIA	DA 2978A	149
25	C CREC	20	1.0	10.0	0.7	0.9	18.0	.325	00000	.35	.05	.05	.04	40.0	Z7	GIAC	Zi 7473	150
26	C CREC	21	1.0	9.0	0.7	0.9	25.0	.372	00000	.312	.062	.037	.062	30.0	Z7	GIAC	RE 4340	151
27	C CREC	23	1.0	10.0	0.5	1.0	20.0	.47	00000	.42	00000	.1	.02	26.0	Z4	GIAA	" 4330	151
28	C CREC		1.0	10.0	0.6	1.0	6.5	0000	00000	00000	00000	00000	00000	13.0	/	GIA	JP 435	152
29	C CREC	19	1.0	10.0	0.6	0.8	35.0	.359	00000	.405	00000	.027	.101	24.0	Z5	GIAE	SH 186	153
30	C CREC		1.0	00000	0.5	0.8	25.0	0000	00000	00000	00000	00000	00000	18.0	/	GIA	" "	153
31	C CARI	50	00000	00000	0.6	0.3	20.0	.256	00000	0	.292	.104	0	9.0	(Z2)	GIAF	" 181	153
32	C RURA	40	1.0	9.0	0.8	0.8	7.0	.455	2.35	.3	.3	.05	.05	15.0	(Y1)	GIAB	FOR 2070	32
33	C RURA	33	1.0	9.0	0.6	1.0	17.0	.388	1.777	.388	.194	.097	.073	15.0	(Y1)	GIAB	" 2071	32
34	C RURA		1.0	13.0	0.6	1.0	30.0	0000	1.725	.441	.196	.098	.02	13.0	/	GIA	" 2072	32
35	C RURA	16	1.0	8.0	0.5	0.8	38.0	.344	1.572	.357	.314	.071	.014	22.0	Y2	GIAA	" 2073	32
36	C RURA	22	1.0	13.0	0.4	0.5	40.0	.295	00000	.25	.2	.12	.01	25.0	Z1	GIAB	" 2099	32
37	C RURA		1.0	00000	0.5	0.6	18.0	0000	00000	00000	00000	00000	00000	14.0	/	GIA	WE 900	54
38	C CARI	20	00000	00000	0.5	0.8	33.0	.2	00000	00000	.125	.083	00000	00000	Z3	GIAG	WE 890	54
39	C CARI	11	00000	00000	0.1	0	35.0	.318	00000	0	.423	.096		00000	W3/X2	GIAH	" 899 B	54
40	C RURA	23	1.0	10.0	0.5	1.0	27.0	.261	00000	.275	.132	.033	.011	20.0	Z3	GIAG	BG 1115	?
41	K CREN	23	1.0	8.0	0.6	1.0	15.0	.304	00000	.3	.1	.03	.05	24.0	Z1	GIBB	JS 468	154
42	K CREN	16	1.0	8.0	0.7	0.8	15.0	.313	00000	.373	.045	.045	.075	30.0	Y1	GIBB	" "	154
43	K CREN	26	1.0	9.0	0.6	0.9	12.0	.315	00000	.365	.104	.052	.031	20.0	(Z1)	GIBB	" "	154
44	K CUMB	17	2.0	7.0	0.7	0.2	10.0	.324	00000	.583	.083	.125	.05	30.0	Y3	GIBD/E	Re 3156	155
45	K CUMB		2.0	00000	0.8	0.2	7.0	0000	00000	00000	00000	00000	00000	20.0	/	GIB	" 3164	155
46	K CUMB	18	2.0	6.0	0.8	0.5	11.0	.255	00000	.421	.105	.053	.021	32.0	Z5	GIBD/E	" 3169	155
47	K CUMB	12	2.5	8.0	0.7	0.4	10.0	.375	00000	.773	00000	.017	.067	40.0	X1	GIBG	" 4533	156
48	K CUMB	12	2.0	7.0	0.9	0	13.0	.323	00000	.667	.067	.111	.022	00000	X3	GIBD/E	LZA 553	155
49	K CUMB		1.0	8.0	0.7	0.4	11.0	0000	00000	00000	00000	00000	00000	20.0	/	GIB	PT 6770	158
50	K CUMB	17	1.0	7.0	0.8	0.1	8.0	.335	00000	.294	.082	.024	.071	25.0	Y2	GIBF	" "	158
51	K CUMB	18	2.0	8.0	0.8	0.4	8.0	.286	00000	.25	.075	.125	.025	28.0	Z5	GIBD/E	LZA 555	155
52	K CREN	60	1.0	7.0	0.7	1.0	20.0	.322	.721	.045	.27	.045	.005	15.0	(Z1)	GIBB	RE 3132	155
53	K CREN	35	1.0	9.0	0.7	0.9	17.0	.338	00000	.321	.286	.036	.014	18.0	(Z1)	GIBB	87228	159
54	K?CREN	24	1.0	8.0	00000	00000	00000	.417	1.184	.592	00000	00000	.132	00000	/	GIB	WO 65	160
55	K CUMB	12	1.5	8.0	1.0	0	5.0	.352	1.86	1.0	.047	.023	.116	00000	X1	GIBG	Zi 7443	161

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FILE: ALLGAST  DATA      A   LEEDS UNIVERSITY VM/SP 1.12                                                   PAGE 002

   56 K CUMB 11     1.0 10.0   0.8   0.2 15.0 .254   1.0    .4   .06   .14   .02 43.0     W1/X3  G1BD      RE 3170      155
   57?K    ? 34     1.0  9.0   0.7   0.6 15.0 .43500000 .364000000000 .13600000          /     G1B       SH 1421      162
   58 C?CANC 17     1.0  8.0   0.4   0.7 23.0 .52300000 .389 .111 .067 .022 29.0         Y2     G1AA      " 215         53
   59 C CANC 35     1.0  7.0   0.4   0.5 20.0    .300000 .238 .102 .102 .051 14.0       (Z1)    G1AB      " 2016        47
   60 C CANC 25     1.000000   0.4   0.8 15.0 .2531.221 .192 .337 .115   .01 17.0       (Z1)    G1AB      54234        153
   61 C CANC 23     1.0  8.0   0.4   0.5 30.0 .21700000   .25 .188 .042 .017 22.0        Z3     G1AG      SH 45        163
   62 C CANC 33     1.0  8.0   0.4   0.6 30.0  .2700000 .207   .31 .069 .00700000       (Z1)    G1AB      54730         53
   63 K CREN 14     1.0  9.0   0.8   0.6 15.0 .32900000 .351 .088 .052 .018 20.0         Y4     G1BA      Lz 308       164
   64 K CREN 24     1.0  7.0   0.6   0.5 22.0 .34600000 .343 .147 .049 .069 25.0       (Z1)    G1BB      " 302        165
   65 K CREN 22     1.0  8.0   0.9   0.6 22.0 .37300000   .38 .109 .054 .05400000        Z5     G1BD/E/F  " 314        165
   66 R  SIG     0000000000    0.8   0.1000000000000000000000 .304 .095       000000      /     R2C       SH 3408      166.
   67 R  LIN        1.000000   0.9     0 35.000000000000000000000000000000000000000      /     R2C       " 3115       167
   68 R  LIN        1.0 10.0   0.9     0 35.000000000000000000000000000000000000000      /     R2C       " 3114       167
   69 R  LIN        1.0 10.0   0.9     0 40.00000000000   .25 .125 .025 .06700000       /     R2C       RE 4413      151
   70 R  SIG     0000000000    0.8     0 70.00000000000      0 .227 .055       000000      /     R2C       SH 3085       47
   71 R ?LIN 21     1.0  9.0   .75000000000   .33  1.0 .3250000000000 .02600000        /     R2C       Ze 2012      134
   72 R    ?        2.500000   0.7     0 17.000000000000000000000000000000000000000      /     R2C       JS 284       168
   73 R  SIG 13 0000000000    0.9   0.1 70.0 .23400000      0 .363 .081       000000      /     R2C       SH 3086       47
   74 R  LIN        1.000000   0.9   0.1 35.00000000000 .259 .074 .074  .0300000        /     R2C       " 3115 A     167
   75 R  LIN 29     1.0  7.0   0.9   0.1 32.0 .33900000    .2 .067 .033  .0200000        /     R2C       " " B         167
   76 R  LIN 25     1.0  7.0   0.9     0 30.0 .35700000 .556 .093 .019 .0930000        /     R2C       RE 4399      151
   77 R ?SIG 33 0000000000    .75000000000 .3881.625    00000000000        000000      /     R2C       ZE 2011      134
   78 R  SIG 15 0000000000    0.7      000000  .1900000      0   .2 .067       000000      /     R2C       Da 211       169
   79 R  SIG 14 0000000000    .7500000 70.0 .16600000      0 .069 .103       000000      /     R2C       SH 3089       47
   80 R  SIG 18 0000000000    .75000000000 .18100000      0 .095 .048       000000      /     R2C       Da 209       169
   81 R  SIG 20 0000000000    0.9      000000  .14600000      0 .288  .01       000000      /     R2C       " 196        169
   82 ? CARB 71     1.0  6.5   .7500000 15.0 .3321.067 .337   .15     0 .03700000 ALL00  /     G2B       5205          ?
   83 ? CARB 20     1.0 10.0   0.8   0.2 40.0 .4352.262 .538 .077 .031 .031     ALL00020  /     G2B       86692        170
   84 ? CARB 57     1.0  3.0   0.7   0.1 20.0  .341.265 .163 .279 .047 .014     ALL00030  /     G2B       7387         171
   85 L CARB 24     1.0 12.0   .75000000000 .344   1.7    .3    .3   .01   .01     ALL00040  /     G2B       JP 2201      172
   86 L?CARB 42     1.0  8.0   0.8   0.5 20.0 .3101.393 .137 .219 .011 .011     ALL00050 (Z1)  G2BD-G    30789        173
   87 L?CARB 30     1.0  9.0   0.9   0.3 23.0 .327   1.7 .227 .318 .045 .036     ALL00060  Z1   G2BD-G    30788        173
   88 L?CARB 28     1.0 10.0   0.8   0.100000 .368 1.79   .45 .225   .05   .04     ALL00070  /     G2B       30790        173
   89 L?CARB 25     1.0  8.0   0.9   0.1 40.0 .3521.629 .337 .225 .034 .045     ALL00080  Y1   G2BD-G    30791        173
   90 L?CARB 24     1.0  8.0   0.9     0 00000 .2791.432 .474 .263 .021 .021     ALL00090  /     G2B       30792        173
   91 L?CARB 19     1.0  9.0   0.90000000000 .4632.167   0.5 .167 .083 .033     ALL00100  /     G2B       30796        173
   92 L?CARB 22     1.0  9.0   0.9     0 30.0 .3561.654   .37 .309 .025 .012     ALL00110  X1   G2BE      30826        174
   93 L?CARB 27     1.0 10.0   0.9      000000 .3491.505 .215 .215 .086 .005     ALL00120  /     G2B       30822        174
   94 L?CARB 26     1.0  9.0   0.8   0.4 50.0 .293 1.25   .15   .25   .01 .005     ALL00130  Y1   G2BD-G    30823        174
   95 L?CARB 12     1.0 11.0   0.800000 35.0 .4181.857 .357 .143 .024 .036     ALL00140  /     G2B       30829        174
   96 L CIRC 14     1.0  8.0   0.8   0.3 35.0 .4192.826 .435 .043 .065 .065     ALL00150  W1   G2BA      Zh 3583 b    175
   97 L?CIRC 21     1.0  8.0   0.7   0.4 35.0 .3331.725 .313 .088 .038 .038     ALL00160  X2   G2BD/G    Lz 338       171
   98 L CIRC 30     1.0  9.0   0.9   0.200000 .337 1.82   .25    .2   .07   .02     ALL00170  /     G2B       ZL 3579      176
   99 L?CIRC-19     1.0  9.0   0.8   0.4 10.0 .4592.976 .595 .233 .167   .19     ALL00180  X5   G2BC      ZL 4123      177
  100 L CIRC        1.000000   0.8   0.6 22.500000000000000000000000000000000     ALL00190  /     G2B       FWC 373      178
  101 A DEP  20     1.0  8.0   .7500000 10.0 .2931.706 .353 .353 .059 .035                /     WC        71011        179
  102 L CIRC 23     1.000000   0.9   0.2 30.0 .2172.21400000 .286 .057 .029     ALL00210  /     G2B       WG 408       180
  103 L CIRC 29     1.0  9.0   0.900000 25.0 .3121.319 .127 .127 .025 .019     ALL00220  /     G2B       " 419        180
  104 A?DEP         1.0  7.0   0.800000000000000000000 .22100000 .015 .074                /     WC        Bu 1240      181
  105 L?CORO 21     4.0 10.0   1.0     0 10.0 .5252.349 .238 .016 .016 .111     ALL00240  X6   G2BB      102579       182
  106 L CORO  5     2.0  6.0   1.0     0 15.0 .4552.813 .625 .031     0 .125     ALL00250 (U1)  G2BB      WG 415       180
  107 L CORO-10     2.5 10.0   1.0     0 13.0  .53  2.0 .429     0 .029 .086     ALL00260  U1   G2BB      " "          180
  108 LBLIST 44     1.0  7.0   0.9     0  5.0 .4762.352 .246 .205 .008 .123     ALL00270 (Z3)  G2BB      50507        183
  109 L    ? 66     1.0  6.0   1.0     0 60.0 .4322.105 .316 .368     0 .105     ALL00280  /     G2B       86697        184
  110 L    ? 24     1.0  7.0   1.00000000000 .3511.963 .313 .188     0   .05     ALL00290  /     G2B       86699        184
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111 LALIST       2.0  6.0  1.0    0  8.000000 2.56   .4  .02  .02  .24   ALL00300 /   G2B     86704      183
112 LALIST 21    1.0  8.5  0.8  0.4 30.0 .4382.651 .476 .048    0 .063   ALL00310 X7  G2BA    86703      183
113 LBLIST 80    1.0  7.0  1.0  0.5 20.0 .3741.951 .141  .37    0 .042   ALL00320 /   G2B     Lz 238     185
114 L CORO 16    3.5  7.0  1.0    0 10.0 .457  2.5   .4  .06  .02  .16   ALL00330 W3  G2BB    AT 3551    186
115 L CORO 12    3.0  4.0  1.0    0  7.0 .451  3.8 .583   .1    0 .267   ALL00340 (V1) G2BK   "  "       186
116 L CORO 31    3.0  7.0  1.0  0.3  7.0 .5483.038  .25 .038    0 .125   ALL00350 Z3  G2BB    Zl 821     187
117 LBLIST 29    1.0  8.0  0.8  0.1 15.0 .4011.989 .284 .375 .011 .023   ALL00360 Z1  G2BD-G  86689      152
118 LALIST 18    1.0  8.0  1.0    0 20.0 .372 1.81 .239 .016 .008 .016   ALL00370 X2  G2BD    86685      152
119 LALIST 15    1.5  8.0  1.0     000000   .5 3.05 .375  .05    0   .1   ALL00380 /   G2B     86690      152
120 LALIST 12    1.0  8.0  1.00000000000 .342 2.25 .375  .05    0  .05   ALL00390 /   G2B     86686      152
121 LALIST       2.0  5.0  1.0    0 10.0000002.365 .261 .017 .009  .13   ALL00400 /   G2B     50509      55
122 LBLIST 42    2.0  8.0  0.9  0.3 60.0 .4121.936  .24 .312 .024  .08   ALL00410 /   G2B     50508      55
123 LBLIST 27    1.0  8.0  0.8  0.4 20.0 .3411.561 .219 .263 .009 .026   ALL00420 Y1  G2BD-G  53782      191
124 LBLIST 33    1.0  8.000000000000000 .3991.593 .265 .177    0 .018   ALL00430 /   G2B     53781      191
125 LBLIST 20    2.0  9.0  1.0    0 22.0 .3752.194 .494 .161 .032 .016   ALL00440 X3  G2BF    53786      191
126 LBLIST 17    1.0  9.000000000000000 .4261.806 .403 .161 .016 .032   ALL00450 /   G2B     53785      191
127 LBLIST 29    2.0  9.0  1.0  0.1 10.0 .24300000 .246 .164 .008 .016   ALL00460 /   G2B     AT 3534    186
128 L LIST       1.0  9.0  0.9  0.5 15.00000000000000000000000000000000   ALL00470 /   G2B     "  "       186
129 LALIST 21    2.5  6.5  0.8  0.2 14.0 .4432.323 .462 .031 .015 .123   ALL00480 X6  G2BB    56454      191
130 LBLIST 38 00000 10.0   1.000000  7.0 .4382.037 .324 .111 .028 .046   ALL00490 /   G2B     J 557      191
131 LALIST  9    1.0 11.1  1.00000000000 .4221.857 .429    0    0 .029   ALL00500 /   G2B     87229      189
132 LBLIST 81    1.0  5.5  0.9  0.4 27.0 .3672.126  .37 .296 .004 .056   ALL00510 /   G2B     RLS 629    189
133 L<LIST 27    1.0  6.0  0.8  0.2  6.0 .5191.411 .205 .068 .027 .164   ALL00520 Y3  G2BC    Zh 3578    175
134 L LIST       1.0  7.0  0.6  0.4 20.00000000000000000000000000000000   ALL00530 /   G2B     AT 3537 a  186
135 L LIST       1.0  8.0  0.9  0.5  8.00000000000000000000000000000000   ALL00540 /   G2B     "  " c     186
136 LBLIST 98    1.0  7.0  0.9  0.5 25.0 .4061.822 .083 .27800000 .042   ALL00550 /   G2B     SH 2849    190
137 L?RETR 25    00000000  0.7  0.3 25.0 .22300000000 .196  .02  .01   ALL00560 /   G2B     Ba 3344a   192
138 L?RETR 35    1.0  6.0  1.0    0 50.0 .25900000 .184 .245 .049 .012   ALL00570 /   G2B     T 58 B     193
139 L CIRC 21    1.000000  1.0     000000 .3521.831  .39  .26 .013 .013   ALL00580 /   G2B     Zl 651     187
140 L RETR 17    1.0  9.0  1.0  0.3 50.0 .269 1.79 .484 .323 .032 .016   ALL00590 W5  G2BD    56456      191
141 L NORM 11    1.0  7.0  0.7  0.4 50.0  .43  2.6 .429 .036 .029 .036   ALL00600 U3/V2 G2BF  56487      194
142 L RETR 19    2.0  8.0  1.0  0.100000 .3521.633  .19  .19 .013 .025   ALL00610 /   G2B     56459      191
143 L NORM 18 00000  9.0  0.9  0.3 35.0 .3851.879 .227 .182 .015  .03   ALL00620 /   G2B     56486      194
144 L RETR 18    1.0 10.0  1.0  0.2 38.0 .3241.618 .368 .324 .015 .015   ALL00630 X1  G2BE    56460      191
145 L RETR 19    1.0 13.0  1.0  0.2 50.0 .2861.624 .412 .176 .035 .006   ALL00640 X1  G2BE    56458      191
146 L RETR 20    1.0  9.0  1.0  0.3 55.0 .3231.603 .321 .167 .038 .013   ALL00650 X1  G2BE    56455      191
147 L NORM 24    1.0  8.5  1.0  0.3 50.0 .3731.928 .301 .241 .012 .036   ALL00660 Y1  G2BD-G  56485      194
148 L CIRC 22    1.0 12.0  1.0  0.3 50.0  .321.807 .301 .241 .048 .012   ALL00670 X1  G2BE    56475      191
149 L CIRC 22    1.0 11.0  1.0  0.4 50.0 .2851.788 .375  .25 .025 .019   ALL00680 X1  G2BE    56473      191
150 L NORM 24    1.0 10.0  0.9  0.4 50.0 .3562.039 .461 .224 .013 .026   ALL00690 Y1  G2BD-G  56488      194
151 L RETR 18    2.0 10.0  0.8  0.4 50.0  .331.729 .143 .243 .029 .014   ALL00700 X1  G2BE    86705      195
152 L?RETR 25    1.0 10.0  0.9  0.6 40.0 .3161.965 .294 .294 .024 .024   ALL00710 Y1  G2BD-G  56483      191
153 L?RETR 16    1.0 11.0  0.90000000000 .319  2.5 .481 .038 .019 .038   ALL00720 /   G2B     56482      191
154 L?RETR 23    1.0  8.0  0.90000000000 .27800000 .42600000 .021 .021   ALL00730 /   G2B     Da 242     196
155 L?RETR 21    1.0  8.5  0.90000000000 .35700000 .278 .167 .011 .022   ALL00740 V1  G2BK    " 252      196
156 L?RETR       1.0  8.0  1.0  0.1 30.00000000000000000000000000000000   ALL00750 /   G2B     "  "       196
157 S SUBC 17    1.0  8.0  1.000000 35.0 .29500000 .203 .203 .014 .014   ALL00760 /   G2A     " 3009     197
158 S?SUBC       00000000 0.55  1.0 50.00000000000000000000000000000000   ALL00770 /   G2A     Hs 1488    198
159 S SUBC       1.0  7.0  0.9  0.1 16.00000000000 .236 .075 .019 .028   ALL00780 /   G2A     Bb 1523    199
160 S SUBC 22 0000000000  0.9    0 50.0 .396 2.0400000 .333  .04    0   ALL00790 /   G2A     ZL 5839    198
161 S SUBC  9    1.0  9.0  1.0    0 20.0 .413  1.0 .286 .143 .029 .029   ALL00800 U1  G2AA    " 5836     198
162 S SUBC 13 0000000000  0.80000000000 .3261.70800000 .125 .042   .0   ALL00810 /   G2A     "  "       198
163 S SUBC    0000000000  1.0  0.3 50.000000001.000000 .182 .036    0   ALL00820 /   G2A     " 5834     198
164 S SUBC 14    1.0 10.0  0.90000000000 .268 .521 .141 .085 .028 .007   ALL00830 /   G2A     " 5833     198
165 S     ? 12   1.0  9.0  1.0    0 15.0  .351.524 .238  .19 .048 .024   ALL00840 V1  G2AA    " 5835     198
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 166 S SUBC       1.0  9.0  1.0  0.5 70.00000000000 .169 .127 .017 .008     ALL00850 /   G2A   D1722      200
 167 S SUBC 23 0000000000  0.7  1.0 40.0 .2721.82900000 .305 .037    0     ALL00860 /   G2A   Bk 1172    201
 168 S SUBC 16   1.0  6.0  0.9  0.2 30 0 .13700000 .195 .195 .026 .013     ALL00870 /   G2A   Da 3240    202
 169 S SUBC 29 0000000000  1.0  0.2 40.0 .242000000000   .08 .024    0     ALL00880 /   G2A   Bk 1260    201
 170 S SUBC       1.0 11.0  1.0  0.1 60.0000000000000000000000000000000     ALL00890 /   G2A   Bu 242a    203
 171 L CIRC 89   1.0  6.0  0.9  0.3 70.0 .3791.859 .197 .329 .016 .059     ALL00900 /   G2B   75164      204
 172 L CIRC 66   1.0  7.0  0.9  0.2 50.0 .3331.556 .079 .278    0 .056     ALL00910 /   G2B   75149      204
 173 L CIRC 70   1.0  6.0  0.9  0.4 70.0 .3531.328 .094 .377 .026  .03     ALL00920 /   G2B   54731      204
 174 L CIRC 86   1.0  6.0  0.9  0.3 35.0 .3881.814 .172 .378 .007 .076     ALL00930 /   G2B   75166      204
 175 L CIRC 103  1.0  6.0  0.9  0.3 60.0 .4331.754 .084 .155 .003 .056     ALL00940 /   G2B   75181      204
 176 L CIRC 113  1.0  6.0  0.9  0.2 60.0 .3981.909 .121  .43    0 .062     ALL00950 /   G2B   75172      204
 177 L CIRC 72   1.0  8.0  0.9  0.1 60.0 .3472.012 .234 .352 .004 .047     ALL00960 /   G2B   75169      204
 178 L CIRC 89   1.0  6.0  0.9  0.2 50.0 .4021.845 .129 .494 .006 .055     ALL00970 /   G2B   75167      204
 179 L CIRC 85   1.0  6.0  0.8  0.3 45.0 .4051.959 .133 .414 .003 .041     ALL00980 /   G2B   75146      204
 180 L CIRC 112  1.0  5.0  0.9  0.2 40.0 .379  1.4 .035 .375  .01  .05     ALL00990 /   G2B   75148      204
 181 L CIRC 75   1.0  5.0  0.9  0.2 40.0 .3721.447 .165 .476 .004 .055     ALL01000 /   G2B   75177      204
 182 L CIRC 66   1.0  6.0  0.9  0.2 40.0 .3821.349 .172 .388 .034 .043     ALL01010 /   G2B   75139      204
 183 L CIRC 92   1.0  5.5  1.0  0.2 40.0  0.41.901 .309 .355    0 .058     ALL01020 /   G2B   75160      204
 184 S?SUBC 14   3.0  8.0  1.0    0 25.0 .21500000 .28600000 .043 .029     ALL01030 /   G2A   Da 824     205
 185 S SUBC 17 0000000000  1.0  0.1 75.0  .33 1.5300000 .103 .04400000     ALL01040 /   G2A   Ba 4674    206
 186 S    ? 10   3.0 10.0  1.0  0.1 17.0 .39600000  .25 .125 .075 .025     ALL01050 /   G2A   Hc 1585    207
 187 S SUBC       1.0 10.0  1.0    0 40.0000000000  .05 .069  .02  .01     ALL01060 /   G2A   IPS 611    208
 188 S?SUBC 17   1.0 10.0  1.0    0 25.0 .2821.593 .169 .085 .034 .017     ALL01070 WI  G2AG  De 4588    209
 189 S SUBC 26 0000000000  0.9  0.1 40.0 .3521.51400000 .381 .019    0     ALL01080 /   G2A   Hs 1521    198
 190 S SUBC       1.0  8.0  0.9  0.1 25.0      1.694 .184 .082 .041  .02     ALL01090 /   G2A   BL 1992    ?
 191 S SUBC 18   1.0  9.0  0.9    0 40.0 .27600000  .19 .152 .025 .013     ALL01100 /   G2A   Hs 1519    198
 192 S SUBC 26   1.0  9.0  1.0  0.1 55.0 .36500000 .208 .183 .008 .017     ALL01110 /   G2A   Ba 4607    210
 193 S?SUBC 12   1.0  9.0  1.0    0 40.0000001.921 .395 .079 .026 .026     ALL01120 /   G2A   Zf 4664    106
 194 S?SUBC 21   1.0  9.0  0.8  0.5 50.0 .3711.727 .325  .13 .052 .013     ALL01130 XI  G2AI  " 4658     106
 195 L WERI       1.0  7.5  0.7  1.0 25.00000000000 .258 .124 .031 .052     ALL01140 /   G2B   Lz 1857    211
 196 L SUBC 25 0000000000  1.0  0.2 60.0 .3471.68400000 .316 .011    0     ALL01150 /   G2B   Zf 4657    106
 197 L SUBC 20 0000000000  0.9  0.6 45.0000001.56900000 .139 .05600000     ALL01160 /   G2B   " 5837     ?
 198 L    ? 121  1.0  6.0  0.9  0.300000 .4312.002   .2 .274    0 .065     ALL01170 /   G2B   87347      190
 199 L    ? 10   1.0  7.500000000000000  .342.297 .216 .135 .027 .054     ALL01180 /   G2B   Zl 731     187
 200 L    ? 11   1.0  7.0  0.9  0.2 27.000000 2.39 .244 .049 .024 .049     ALL01190 /   G2B   "   "      187
 201 L    ? 102  1.0  6.5  0.6  0.6 35.0 .4061.742 .179 .332    0 .036     ALL01200 /   G2B   87353      190
 202 L    ? 93   1.0  6.0  0.9  0.300000 .3961.691 .143 .286 .006 .051     ALL01210 /   G2B   87350      190
 203 L    ? 62   1.0  7.0  0.7  0.4 35.0 .4172.086 .287 .431    0 .043     ALL01220 /   G2B   87349      190
 204 L    ? 105  1.0  6.0  0.9  0.1 40.0 .3871.721 .141 .479 .028 .042     ALL01230 /   G2B   87345      190
 205 L    ? 81   1.0  6.0  0.9  0.1 50.0 .4212.244 .218 .291    0 .065     ALL01240 /   G2B   87348      190
 206 L    ? 63   1.0  5.5  0.9  0.2 80.0 .3231.252 .122 .407 .049 .041     ALL01250 /   G2B   75141      204
 207 L    ? 73   1.0  6.5  0.8  0.3 60.0 .3841.443 .221 .369 .018 .048     ALL01260 /   G2B   75169      "
 208 L    ? 76   1.0  5.5  0.9  0.2 60.0 .4021.419 .127 .413 .006 .038     ALL01270 /   G2B   75176      "
 209 L    ? 78   1.0  6.0  0.9  0.2 50.0 .4032.373 .278 .298    0 .079     ALL01280 /   G2B   75163      "
 210 L    ? 93   1.0  5.5  0.9  0.2 70.0 .3881.463 .152 .518 .009 .058     ALL01290 /   G2B   75168      "
 211 L    ? 79   1.0  5.5  0.9  0.2 60.0 .3741.772 .232 .497 .003 .066     ALL01300 /   G2B   75142      "
 212 L    ? 80   1.0  6.0  0.9  0.2 50.0 .4042.037 .259 .556    0 .081     ALL01310 /   G2B   75183      "
 213 L    ? 74   1.0  6.0  0.9  0.1 50.0 .3912.084 .153 .287    0 .031     ALL01320 /   G2B   75162      "
 214 L    ? 71   1.0  6.0  0.9  0.1 40.0 .3671.296 .098 .456 .016 .036     ALL01330 /   G2B   75145      "
 215 L    ? 54   1.0  7.0  0.9  0.1 40.0 .3531.448 .199 .398  .01  .03     ALL01340 /   G2B   75152      "
 216 L    ? 56   1.0  7.0  0.9  0.3 30.0  .341.324 .238 .429  .01 .049     ALL01350 /   G2B   75144      "
 217 L    ? 87   1.0  7.0  0.9  0.3 60.0 .4131.843 .192 .491    0 .042     ALL01360 /   G2B   75165      "
 218 L    ? 97   1.0  6.0  0.9  0.1 40.0  .371.624 .133  .48    0 .051     ALL01370 /   G2B   75173      "
 219 L    ? 69   1.0  7.5  0.9  0.2 50.0 .3972.294 .298 .226    0 .068     ALL01380 /   G2B   75154      "
 220 L    ? 77   1.0  7.5  0.9  0.2 40.0  .35 1.22 .124 .341 .009 .019     ALL01390 /   G2B   75179      "
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221 L     ? 99   1.0  5.0  0.9  0.1 50.0 .3781.594 .109 .504 .025 .054   ALL01400 /    G2B     75147    204
222 L     ? 77   1.0  5.5  0.9  0.2 50.0 .3591.344 .111 .643 .019 .044   ALL01410 /    G2B     75178    "
223 L     ? 63   1.0  7.5  0.9  0.2 50.0 .333  1.5 .174 .652 .004 .013   ALL01420 /    G2B     75182    "
224 L     ? 58   1.0  5.5  0.9  0.2 50.0 .336  1.5 .227 .409 .032 .059   ALL01430 /    G2B     75155    "
225 L     ? 72   1.0  5.5  0.9  0.2 60.0 .3791.358 .169 .574 .003 .051   ALL01440 /    G2B     75143    "
226 L     ? 70   1.0  6.0  0.9  0.2 40.0 .3661.381 .156 .623 .023 .051   ALL01450 /    G2B     75158    "
227 L     ? 76   1.0  5.5  0.9  0.100000 .42600000  .2200000    0  .04   ALL01460 /    G2B     75184    "
228 L     ? 75   1.0  5.0  0.9  0.2 40.0 .4091.422 .174 .453 .024 .045   ALL01470 /    G2B     75175    "
229 L     ? 71   1.0  6.0  1.0  0.1 45.0  .371.472 .121 .444 .004  .04   ALL01480 /    G2B     75153    "
230 L     ? 49   1.0  6.5  0.8  0.3 50.0 .3361.408 .217 .333 .016 .054   ALL01490 /    G2B     75156    "
231 L     ? 73   1.0  7.0  1.0  0.2 40.0 .3581.346 .114  .38 .027 .027   ALL01500 /    G2B     75140    "
232 L     ? 74   1.0  7.0  1.0  0.1 50.0 .3651.732 .117 .467    0 .047   ALL01510 /    G2B     75180    "
233 S     ? 9    1.0  6.5  1.0    0 25.0 .3131.605 .263 .132 .053 .026   ALL01520 U1   G2AA    De 4611  209
234 S     ? 6    1.000000  1.0    0 30.0 .3831.609 .304  .13 .087 .022   ALL01530 /    G2A     "  "     209
235 S     ? 15 0000000000  1.0    0 25.0 .3631.6180000 .127 .036    0   ALL01540 /    G2A     " 4589   209
236 S     ?    0000000000  1.0    0 20.0000000000000000000000000000000   ALL01550 /    G2A     " 4602   209
237?S     ? 21   1.0  8.0  0.9  0.2 40.0 .28600000  .25   .1 .038 .025   ALL01560 /    G2A     Bk 1063  201
238 L     ? 44   1.0  6.0  0.8  0.3 50.0 .3641.957 .247 .319    0 .049   ALL01570 (Z1) G2BD-G  87351    190
239?S     ? 3    2.0  8.0  1.0    0 30.0000000000000000000000000000000   ALL01580 /    G2A     Bk 1303  201
240 S?SUBC     0000000000  0.9  0.1 35.000000 1.2500000   .1  .05    0   ALL01590 /    G2A     De 4619  209
241 S     ?    0000000000  1.0  0.1 40.0000001.12500000  .15    0    0   ALL01600 /    G2A     " 4618   209
242?L     ? 29 0000000000  1.0    0 50.0 .3061.70300000 .198  .01    0   ALL01610 /    G2B     Ze 3836  180
243?L     ? 18   1.0 12.000000000000000000 .3631.667 .513 .038 .013 .026   ALL01620 /    G2B     " 3838   180
244?L     ? 12   1.000000  1.0    0 40.0 .4330000000000000000000000000   ALL01630 /    G2B     " 3840   180
245?L     ? 19   1.000000  0.9    0 60.0 .356  2.1 .357   .1 .014 .029   ALL01640 X3   G2BF    " 3839   180
246?L     ? 34   1.0  8.0  1.0  0.1 50.0 .3681.731 .192 .231 .046 .015   ALL01650 (Z1) G2BD-G  " 3837   180
247 L     ? 35   1.0  8.0  1.0    0 50.0 .441 2.23  .35   .1  .07  .02   ALL01660 (Z1) G2BD-G  86694    55
248 L     ? 41   1.0  7.0  1.0  0.1 25.0  .471.852 .259 .431 .007  .03   ALL01670 (Z1) G2BD-G  86695    55
249?S     ? 16   1.0  8.0  0.9  0.2 20.0 .26300000 .221 .044 .015 .015   ALL01680 /    G2A     Bk 1142  201
250 L     ? 13   1.0  7.0  1.0    0 15.0 .3851.727 .364 .109 .036 .036   ALL01690 V2   G2BF    56489    191
251 L     ? 57   1.0  8.000000000000000000 .3811.503 .103 .564 .005 .015   ALL01700 /    G2B     87352    190
252 S     ?      1.000000  1.0    0 25.0000000000000000000000000000000   ALL01710 /    G2A     Bk 1394  201
253 L?CIRC 26    1.0  7.0  0.9  0.2 40.0 .36900000 .288 .049  .01 .019   ALL01720 /    G2B     T61 B    193
254 S     ? 9  0000000000  0.9    0 17.0000000000000000000000000000000   ALL01730 /    G2A     Hs 1523  198
255 S     ?      1.0  8.0  0.8    0 18.0000000000000000000000000000000   ALL01740 /    G2A     "        198
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260 K CREN 14    1.0  8.0  0.8  0.6 25.0 .30200000 .214 .071 .029 .029 20.0   Y4   G1BA    JS 495   212
261 K CUMB 13 000000000000000000000 15.0  .261.70800000 .06300000000000000   /    G1B     "  "     "
262 K CREN 14    1.0  7.0  0.9  0.5 22.0 .32400000  .25 .033 .067 .03300000   Y4   G1BA    "  "     "
263 K?CREN 14    1.0  9.0  0.7  0.8 20.0 .37200000   .3  .02  .04  .04 30.0   Y1   G1BB    "  "     "
264 K?CUMB 12    1.5  8.0  0.8  0.7 16.0 .41600000 .469 .094 .125 .12500000   X2   G1BB    "  "     "
265 K?CUMB 13    1.0  7.0  0.9  0.2 13.0 .30800000 .222 .067 .044 .04400000   X4   G1BF    " 494    "
266 K?CREN 10    1.000000  1.0  0.2 16.0 .29400000 .222 .089 .067 .04400000   W2   G1BE    "  "     "
267 K CREN 19    1.0  8.0  0.8  1.0 22.0 .35100000 .267  .04  .04  .04 30.0   Z2   G1BA    "  "     "
268 K?CREN 19    1.0  7.0  0.7  1.0 11.0 .26300000 .288 .075 .038  .05 30.0   Z1   G1BB    "  "     "
269 K?CREN 14    1.0  8.0  0.7  0.9 18.0 .35700000   .3 .067 .033 .042 30.0   Y1   G1BB    "  "     "
270 K?CAPI 20    1.000000  0.8  0.8 50.0 .27100000    0 .042 .016    000000   Z3   G1BI    " 498    "
271 K CREN 16    1.0  8.0  0.9  1.0 24.0 .27900000 .273 .052 .039 .039 32.0   Y4   G1BA    " 497    "
272 K?CUMB 9     1.0  7.0  1.0  .45 15.0 .30100000 .514 .043 .086 .05700000   W2   G1BE    " 513    "
273 K CREN 16    1.0  7.0  0.8  .65 22.0 .23800000 .217 .067  .05 .03300000   Y4   G1BA    " 512    "
274 K CUMB 6     1.000000  0.9    0 20.0 .33300000 .364 .045 .091 .06800000   (W2) G1BE    " 514    "
275 K CREN 13    1.000000  0.9  0.5 17.0 .23200000 .211 .053 .053 .02600000   X5   G1BA/C  "  "     "
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276 K CUMB 8      1.000000   1.0  0.2 14.0 .30500000 .135 .054 .041 .02700000     (W3)   GIBA/C  JS 514 212
277 K CUMB 8      1.0   7.0  1.0  0.1 14.0 .26800000 .435 .174  .13 .08700000     (W1)   GIBD    "  "   "
278 K CREN 16     1.0   8.0  0.8  0.9 28.0 .14900000 .167 .022 .022 .011 22.0     Y6     GIBC    "  492 "
279 K?CREN 10     1.000000   0.9 0.55 17.0 .27800000 .145 .055 .036 .01900000     W3     GIBA/C  "  "   "
280 K CREN 17     1.0   7.0  0.9  0.7 16.0 .25800000 .171 .043 .043 .02900000     Y4     GIBA    "  496 "
281 K CREN 18     1.0   7.0  0.7  0.9 28.0 .22200000  .25 .038 .013 .025 18.0     Z4     GIBC    "  "   "
282 C S.N. 17     1.0   7.0  0.5  0.9 55.0 .28200000 .183 .061 .037 .024 20.0     Y3     GIBD/E  Da 598 213
283 K CREN 15     1.0   7.0  0.8  0.8 30.0 .16700000 .214 .057 .029 .029 26.0     Y6     GIBC    "  622 213
284 K CREN 22 0000000000     0.9  0.8 18.0 .1750000000000 .033 .01100000 25.0     /      GIB     "  621 213
285 K CREN 14     1.0   7.0  0.9  0.6 22.0 .24100000   .3 .033 .033 .03300000     Y4     GIBA    "  620 213
286 K?CREN 14 00000000000000      0.8 24.0 .3661.8090000000000000000000000000     /      GIB     "  616 213
287 K CREN 11     1.0   8.0  0.9  0.5 25.0 .27300000  .25 .033  .05 .01700000     W3/x5  GIBA/C  "  "   213
288 K?CREN 21     1.0   7.0  0.8  0.9 15.0 .20600000 .217 .043 .011 .022 24.0     Z4     GIBC    "  631 214
289 K?CREN 18     1.0   8.0  0.7  0.9 20.0 .36600000  .15 .038 .038 .025 27.0     Z2     GIBA    "  630 214
290 K CREN 39     1.0   7.0  0.7  0.9 20.0 .303000000000000 .088 .029 .018 28.0   /      GIB     "  629 214
291 K CUMB 11     1.000000   0.9  0.3 12.0 .34800000 .167 .071 .143 .04800000     W1/x3  GIBD    "  628 214
292 K?CREN 17     1.0   8.0  0.9  0.5 18.0 .25600000 .159 .048 .032 .03200000     Y4     GIBA    "  627 214
293 K?CREN 12     1.000000   0.7  0.8 18.0  .2400000 .154 .108 .046 .031 33.0     x5     GIBA/C  "  626 214
294 K CREN 17     1.0   8.0  0.8  0.8 18.0 .27600000 .159 .049 .012 .02400000     Y4     GIBA    "  641 215
295 K CREN 18     1.000000   0.9  0.9 27.0 .24100000 .137 .055 .041 .027 24.0     Z4     GIBC    "  640 215
296 K CUMB 11     1.000000   0.8  0.1  9.00000000000 .205 .063 .063 .02100000     /      GIB     "  "   215
297 K CREN 11     1.0   8.0  0.9  0.8 22.0 .35900000  .28 .038 .038 .038 30.0     W3/x4  GIBF    "  "   215
298 K CREN 26     1.0   9.0  0.9  1.0 35.0  .3900000 .289 .029 .029 .029 23.0     (Z2)   GIBA    "  639 215
299 K?CUMB 11     1.000000   0.9  0.4 22.0  .2800000 .244 .049 .073 .03700000     W3/x5  GIBA/C  "  638 214
300 K CREN 21     1.0   7.0  0.8  0.8 22.0 .38100000 .294 .035 .024 .047 20.0     Z2     GIBA    "  632 214
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356 K CREN 64 0000000000  1.0   0.9 25.000000000000000000000000000000000000    /      GIB      Da 642    215
357 K CUMB 12    1.0  8.0  0.7   0.5 17.0    .400000 .23400000  .064 .06400000    X4     GIBF     "   "     "
358 K?CUMB 11    1.000000  1.0   0.1 35.00000000000 .091    .1  .05 .02500000     /      GIB      "  645    "
359 K?CREN 17    1.000000  1.0   0.1 25.0 .34100000 .068 .137 .068 .00700000     Y5     GIBH     "  644    "
360 K CUMB 11    1.0  9.0  1.0     0 13.0 .34800000   .3  .14   .1 .04000000     W2/X3  GIBE     "   "     "
361 K?CREN 12    1.0  7.0  0.9     0 22.0 .33300000  .25 .058 .019 .04900000     X4     GIBF     "  646    "
362 K CUMB 16    1.0  8.0  0.8   0.5 15.0 .29100000  .25  .05 .033  .05 34.0     Y2     GIBF     "   "     "
363 K?CREN 32    1.0  6.0  0.6   0.9 15.0 .39100000 .202 .088 .018 .044 20.0     (Z1)   GIBB     "  648    "
364 K?CREN 15    1.000000  0.7   0.6 13.0 .46700000   .6  .05  .04  .06 30.0     Y1     GIBB     "  649    "
365 K CUMR 13    1.000000  0.9   0.3 12.0 .34800000  .26  .04  .04  .0500000     X4     GIBF     "  650    "
366 K CUMB 12    1.0  8.0  0.9   0.1  9.0 .35400000 .273 .036 .055 .05500000     X4     GIBF     "  653    "
367 K CUMB 18    1.0  7.0  0.8   .25  7.0 .4860000000000000000000000000 30.0     /      GIB      "  654    "
368 K CREN 17    1.000000  0.9   0.5 19.0 .31800000 .323  .04 .016 .01600000     Y4     GIBA     "  656    "
369 K CREN 15    1.000000  0.9   0.6 16.0 .25500000 .167  .05   .1 .017 30.0     Y4     GIBA     "   "     "
370 K CREN 10    1.000000  0.9   0.3 18.0  .3200000 .122 .073 .122 .02400000     W1     GIBD     "   "     "
371 K CREN 10    1.000000  0.9   0.2 15.0  .3200000  .25   .1  .05 .02500000     W3     GIBA/C   "  655    "
372 K CREN 21    1.0  9.0  0.8   0.9 27.0 .38100000 .277 .024 .024 .012 27.0     Z2     GIBA     "  658    "
373 K CREN 33    1.0  9.0  0.8   0.7 20.0 .25800000 .148 .074 .022 .015 20.0     (Z4)   GIBC     "  657    "
374 K?CREN 20    1.0  7.0  0.8   0.9 15.0  .3300000 .192 .064 .103 .051 23.0     Z1     GIBB     "  693    165
375 K CREN 21    1.0  6.0  0.9   0.9 20.0 .41900000 .313 .063 .013 .031 18.0     Z2     GIBA     "  694    "
376 K CREN 17    1.000000  0.9   1.0 33.0 .36600000 .161 .065 .032 .016 24.0     Y6     GIBC     "  695    "
377 K CUMB  7 0000000000  1.0     0 12.0 .32100000 .156 .063 .094 .03100000     /      GIB      "  697    "
378 K CREN 19    1.0  8.0  0.9   0.5 20.0 .36700000 .299 .075  .03 .022 25.0     Z5     GIBD/E/F "  698    "
379 K?CUMB 17    1.000000  0.9  0.25 16.0 .31200000  - .3  .04  .04  .0400000     Y4     GIBA     "  700    "
380 K?CUMB  9    1.0  7.0  0.8   0.6 18.0 .44200000 .286   .1 .057 .05700000     W4     GIBB     "  699    "
381 K?CREN 24    1.0  8.0  0.7   1.0 12.0 .29100000 .278 .044 .011 .011 22.0     (Z1)   GIBB     "  705    "
382 K CREN 15    1.0  8.0  0.9   0.6 20.0 .26800000 .167 .042 .069 .014 20.0     Y4     GIBA     "  707    "
383 C S.N. 18    1.000000  0.4   1.0 70.0 .29900000 .241 .094 .036 .024 18.0     Z6     GIAD     WE 850    216
384 K CUMB 10 0000000000  0.9   0.1 15.0  .382.1110000000000000000000000000     /      GIB      Da 2370   217
385 K?CREN 13    1.0  7.0  0.9   .55 18.0 .36200000 .192 .058 .058 .03800000     X4     GIBF     "  2361   217
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386 K CREN 14    1.0   8.5   0.8   0.7 20.0 .30800000 .196 .059 .059 .039 22.0        Y4    GIBA    Da 2362  217
387 K?CREN 17    1.0   8.0   0.8 0.65 14.0  .3200000 .167 .056 .028 .02100000        Y4    GIBA    "  2366  217
388 K CUMB 10 00000000000000000000 15.0  .372.1670000000000000000000000000          /     GIB     "  2370  217
389 K CREN 26    1.000000    0.9 0.55 18.0 .25200000 .07500000 .038 .014 18.0        /     GIB     "  2371  217
390 K CUMB  8    1.000000    1.0  0.3 15.0 .25900000 .105 .053 .079 .02600000       (W3)   GIBA/C  "  2376  217
391 L LIST       1.000000    1.0  0.2  6.00000000000 .171 .029 .014 .086   ALL01750 /     G2B     "  2381  218
392?K?CREN 14 0000000000     0.9  0.6 18.0 .3780000000000 .019 .019 .00900000       /     GIB     "  2382  218
393 L?LIST 16 0000000000     1.0  0.2  6.0  0.500000  .15 .013 .025 .075   ALL01760 /     G2B     "  2386  218
394?K?CREN 15    1.5   7.5   0.9 0.55 12.0 .35300000 .361 .042 .028 .05600000        /  .  GIB     "  2380  218
395?K?CREN 21    1.000000    0.7  0.8 25.0 .21400000  .16 .032 .027 .011 25.0        /     GIB     RE 4202  219
396 C?CREC 10    1.000000    0.8  1.0 30.0 .29100000 .222 .111 .044 .13300000        W5    GIAE/D  "  "     "
397 C?CREC 11    1.0   8.0   0.9  0.1 15.0 .33600000 .26700000 .067 .04400000        W1/X1 GIAB/G  "  4205  "
398 C?CREC 27    1.0   8.0   0.7  1.0 15.0 .25900000 .125  .05 .017 .017 15.0       (Z7)   GIAC    "  4210  "
399 C?CREC  9    1.000000    1.0    0 15.0 .38900000   .4  .12  .16  .0600000        W1    GIAB/G  "  "     "
400 C?CREC 18    1.000000    0.7  0.9 30.0 .28600000 .2420000000000 .032 30.0        /     GIA     "  4211  "
401 C?CREC 20    1.000000    0.9  0.8 30.0 .27500000 .188 .025 .019 .01300000        Z7    GIAC    "  4213  "
402?K?CREN  8    1.000000    1.0  0.4 30.0 .34100000 .184 .053 .053 .01300000        /     GIB     "  4216  "
403 C?CANC 48    1.000000    0.8  1.0 25.0 .32300000 .303  .03 .006 .018 13.0       (Z7)   GIAC    "  4316  151
404 C?CREC 16    1.000000    0.9  0.3 20.0 .28800000 .079 .048 .016 .00800000        Y5    GIAC/F  "  4324  "
405 C CREC 22    1.0   8.0   0.7  1.0 18.0  .3100000 .5560000000000 .033 17.0        /     GIA     "  4331  "
406 C S.N. 36    1.0   8.0   0.6  0.7 55.0 .2921.384  .24  .28 .024 .032 12.0       (Z3)   GIAG    "  4363  "
407 C CANC 15    1.000000    0.6  0.5 25.0 .2791.063 .188  .25 .075 .019 25.0        Y4    GIAD/G  "  4369  "
408 C CANC 15    1.000000    0.4  0.7 20.0 .2911.286 .286 .229 .043 .021 30.0        Y4    GIAD/G  "  4374  "
409 C?CANC  7    1.000000    0.9    0 18.0 .427  .96  .52  .08   .1  .0400000       (W1)   GIAB/G  "  4362  "
410 C?S.N. 39 0000000000     .55   .8 37.0 .2561.1330000  .22  .0800000 16.0         /     GIA     "  4371  "
411 C?CANC 13    1.000000    0.5  0.6 18.0 .294  1.2  .32  .08  .03  .03 30.0        X3    GIAC/F  "  4376  "
412 C CREC 15    1.0   8.0   0.7  1.0 30.0 .41300000 .316 .105  .07 .044 27.0        Y2    GIAA    "  4390  "
413 C CREC 16    1.0   7.0   0.6  1.0 17.0 .3441.349 .254 .048 .032  .04 30.0        Y4    GIAD/G  "  4392  "
414 C CREC 10    1.000000    0.7  0.1 17.0  .331.714 .643 .214 .143 .054 30.0        W1    GIAB/G  "  4397  "
415 C S.N. 31    1.000000    1.000000 18.0 .31300000 .032 .017 .008 .01700000        /     GIA     "  4406  "
416 C S.N. 32    1.000000    1.0  0.5 18.0 .30800000 .141 .014 .007 .01400000       (Z7)   GIAC    "  4407  "
417 C?S.N. 36    1.000000    0.8  0.8 60.0 .18600000  .25 .208 .042 .017 17.0       (Z3)   GIAG    "  4771  220
418 C CANC 19    1.000000    0.4  0.9 25.0 .21100000 .147 .059 .029 .015 18.0        Z3    GIAG    "  4773  "
419 C CANC 22    1.000000    0.4  0.8 35.0 .25500000 .164 .182 .045 .014 18.0        Z3    GIAG    "  4774  "
420 C?S.N. 22    1.000000    0.5  0.8 45.0 .30200000  .15   .2  .04  .02 20.0        Z3    GIAG    "  4777  "
421 C?CANC 12    1.000000    0.6  0.8 27.0 .23300000 .259 .069 .017 .017 20.0        X3    GIAC/F  "  4776  "
422 C CANC 16    1.0   8.0   0.6  0.7 25.0 .24200000  .25 .075 .038 .025 19.0        Y4    GIAD/G  "  4784  "
423 C CREC 10    1.5   8.0   0.8 0.35 24.0 .45600000 .606 .065 .129 .097 35.0        W2    GIAA    "  4785  "
424 C CANC 15    1.0   8.0   0.6  0.7 28.0 .35700000 .244 .078 .022 .022 20.0        Y4    GIAD/G  "  "     "
425?K CREN 22    1.000000    0.8  0.7 18.0 .19500000  .12 .241 .024 .006 25.0        /     GIB     "  4795  "
426?C CANC 35 0000000000     0.7  0.9 22.0 .1630000000000 .127 .013    0 20.0        /     GIA     "  4798  "
427 L LIST 11 0000000000     1.0    0 10.0 .43500000 .3750000000000 .075   ALL01770 /     G2B     "  4846  221
428 C CANC 21 0000000000     0.7  0.9 30.0 .34300000 .167   .2 .033 .011 16.0        Z7    GIAC    SH 136   222
429 C?CARI 11 0000000000     0.9  0.7 50.0   .300000    0  .07 .023    000000        W4/X3 GIAC/F  "  "     "
430 C CREC    0000000000     0.6  1.0 17.0000000000000000000000000000000 18.0        /     GIA     "  137   "
431 C?BRAN 11    1.5   7.0   0.8  0.5 10.0 .38400000 .489 .156 .156 .089 30.0        W1/X1 GIAB/G  "  140   "
432 C?BRAN 10    1.5   8.0   0.8  0.6 20.0  .3400000 .37500000  .15 .06300000        W1    GIAB/G  "  "     "
433 C?CARI 10    1.000000    0.8  0.5 65.0 .32700000 .189 .075 .038 .01900000        W4    GIAC/F  "  144   "
434 C S.N. 23    1.0   8.0   0.7  0.9 40.0  .3700000 .227 .045 .045 .034 15.0        Z7    GIAC    "  "     "
435 C?CREC       1.000000    0.7  1.0 25.00000000000000000000000000000000 15.0       /     GIA     "  146   "
436 C?CANC 11    1.000000    0.8  0.6 40.0 .28800000 .233 .116  .14 .035 45.0        W1/X1 GIAB/G  "  148   "
437 C?CREC 15    1.000000    0.7  0.8 30.0 .33300000 .577 .154 .077 .048 30.0        Y2    GIAA    "  "     "
438 C?CARI 25    1.000000    0.6  0.6 30.0 .2920000000000 .208 .067 .008 16.0        /     GIA     "  149   "
439 C?CARI       1.000000    0.5  0.8 40.00000000000 .133 .173 .027 .003 14.0        /     GIA     "  175   153
440 C S.N. 38    1.0   7.0   0.5  0.9 45.0 .28900000   .2   .1 .013 .013 14.0       (Z6)   GIAD    "  178   "
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441 C?CREC 19    1.0 10.0   0.7   0.8 45.0 .42100000 .627 .067  .04 .033 30.0          Z5   GIAE     SH 185    153
442 C CREC 22    1.0  8.0   .65   1.0 35.0 .30500000   .6 .143 .043 .043 20.0          Z5   GIAE     "  188    153
443 C CANC 35    1.0  7.0   0.5   1.0 22.0 .28600000 .188 .106 .019 .025 14.0          (Z6) GIAD     "  211    53
444 C?CARI  5    1.0 10.0   1.0     0 50.0  .3200000 .333 .104 .042 .04200000          (W1) GIAB/G   "  221    53
445 C?CANC 10    1.0  6.0   0.8   0.9 40.0 .31100000 .515 .121 .061 .061 30.0          W5   GIAB/G   "  "      53
446 C S.N. 19    1.000000   0.6   0.9 50.0 .26300000 .153 .255 .031 .026 14.0          Z3   GIAG     "  226    53
447 C?CREC 21    1.0  7.0   0.4   1.0 30.0 .42900000 .353 .118 .047 .047 27.0          Z4   GIAA     "  234    223
448 C CREC 10    1.0  9.0   0.9   0.5 30.0 .42900000 .57100000 .086 .04300000          W2   GIAA     "  249    223
449 C?CANC 18    1.0  8.0   0.4   1.0 25.0 .33300000 .333 .144 .033 .033 24.0          Z4   GIAA     "  260    223
450 C CANC 16    1.000000   0.6   1.0 25.0 .32500000 .227 .076 .015  .03 23.0          Y4   GIAD/G   "  264    224
451 C?CREC  8    1.000000   0.9   0.2 30. 0 .37600000 .31300000 .125 .04700000        /    GIA      "  264    "
452 C CANC 18    1.000000   0.7   0.8 30.0 .27800000 .222 .167 .033 .022 18.0          Z7   GIAC     "  "      "
453 C CARI 22 0000000000   0.8   0.2 40.0 .29800000    0   .1 .075    0 24.0          Z2   GIAF     "  268    "
454 C CARI 21 0000000000   0.7   0.5 40.0 .31900000    0 .108 .032    0 29.0          Z2   GIAF     "  "      "
     455 C CANC 29    1.000000   0.6   0.7 20.0 .30500000 .167  .25 .042 .025          (Z2) GIAF     "  270    "
456 C CREC 20    1.000000   0.7   0.7 27.0 .42500000 .235 .176 .035 .024 27.0          Z7   GIAC     "  271    "
457 C?CARI 13    1.0  8.0   0.8   0.6 30.0 .36900000 .33300000 .067 .033 32.0          X1   GIAA/B/G "  273    "
458 C?RURA 19    1.0  7.0   0.7   0.7 15.0 .31300000  .25 .188 .038 .039 26.0          Z7   GIAC     "  277    "
459 C?RURA       1.000000   0.7   0.9 15.0000000000 .214 .129 .071 .029 30.0          /    GIA      "  278    "
460 C?CARI 17 0000000000   0.7   0.7 30.0  .2400000000 .176 .068    0 35.0          /    GIA      "  275    "
461 C?RURA       1.000000   0.6   0.8  8.00000000000000000000000000000 14.0          /    GIA      "  279    "
462 L LIST 21    1.0  7.0   1.0   0.2 22.0 .35700000 .389 .033 .022 .133    ALL01780 /  G2B      "  297    225
463 L LIST 28    1.0  9.0   1.0   0.1 15.0 .43900000 .467 .022 .011 .178    ALL01790 /  G2B      "  296    "
464 K CUMB       1.500000   0.7   0.4  6.00000000000000000000000000000 40.0          /    G1B      "  566    226
465 K?CUMB       0000000000   0.7   0.8 15.00000000000000000000000000000 23.0          /    G1B      "  620    227
466 L LIST 27    1.0  9.0   1.0   0.2 17.0 .41900000   .4   .1  .02  .08    ALL01800 // G2B      "  678    228
467 L?LIST 37    1.0  8.0   0.9   0.2  5.0 .45900000  .4500000000000   .2    ALL01810 /  G2B      "  678    "
468 L?LIST 10    1.0  8.0   1.0     0 12.0  .3700000  .300000  .08  .05    ALL01820 /  G2B      "  "      "
469 L LIST 21    1.000000   1.0   0.3 15.0  .4100000 .6250000000000 .125    ALL01830 /  G2B      "  676    "
470 L?LIST 6     1.5  7.0   1.0     0 15.0 .54700000 .435 .087 .087 .065    ALL01840 /  G2B      "  "      "
471 C?S.N. 24 0000000000   0.8   0.5 50.0 .2860000000000 .167 .042    0 17.0          /    GIA      "  747B   229
472 C CANC 19 0000000000   0.5   0.8 30.0 .1840000000000 .1050000000000 18.0          /    GIA      "  767    "
473 C?CANC       1.0 11.0   0.5   0.8 30.00000000000 .353 .118 .035 .029 33.0          /    GIA      "  772    "
474 C?S.N. 16    1.0  8.0   0.4   0.9 50.0 .32500000 .435 .141 .047 .035 16.0          Y2   GIAA     "  780    156
475 K?CREN 12    1.000000   0.6   0.8 17.0 .28800000  .25 .133  .05 .033 30.0          X5   GIBC     "  782    "
476 K CUMB 11    1.000000   0.7   0.3 12.0 .39100000 .5510000000000  .0700000          /    GIB      "  "      "
477 K?CUMB 14    1.000000   0.8   0.8 15.0 .21400000 .32800000 .098 .033 35.0          Y4   GIBA     "  "      "
478 K?CUMB       1.000000   0.6   0.9 12.00000000000000000000000000000 25.0          /    GIB      "  "      "
479 C CANC 24    1.000000   0.4   1.0 35.0 .36700000  .35  .08  .08  .03 14.0          Z4   GIAA     "  784    "
480 K CUMB 14    1.500000   0.8   0.3 17.0 .37300000  .25 .133 .133 .033 25.0          Y3   GIBD/E   "  792    "
481 L LIST 13    1.0  6.5   1.0   0.1 13.0  .4700000 .66700000 .067 .089    ALL01850 // G2B      "  1405   162
482 L LIST 7     1.000000   1.0     0 15.0 .45100000   .5 .067 .067 .033    ALL01860 /  G2B      "  1413   162
483 L LIST 13    1.000000   1.0   0.1 15.0 .40700000 .43900000 .035 .053    ALL01870 // G2B      "  1416   162
484?K?CUMB       1.000000   0.8   0.3  8.000000000000000000000000000000000          /    G1B      "  1439   230
485 L LIST 17    1.000000   0.9   0.3 20.0 .37600000 .35600000 .033 .111    ALL01880 // G2B      "  1427   162
486 K?CUMB 16    2.0  7.0   0.70000000000 .52100000 .536 .071 .054 .10700000          /    G1B      "  1455   230
487 K?CUMB  5 0000000000   0.9   0.1 15.0  .4600000  .25  0.2   .1 .02500000          /    G1B      "  1467   230
488                                                                                    /    /        "  "      230
489 K?CUMB  9    1.5  8.0   1.0   0.1 18.0 .35600000 .42900000 .086 .05700000          W2   GIBE     "  1463   230
490 C CREC 21    1.000000   0.6   0.7 25.0 .41400000 .256 .064 .038 .051 18.0          Z7   GIAC     "  1564   230
491 C S.N. 21    1.0  8.0   0.4   0.9 50.0 .37200000 .357 .214 .057 .071 18.0          Z6   GIAD     "  1567   230
492 C S.N. 20    1.000000   0.4   0.9 50.0  .3600000  .25 .075 .025  .05 20.0          Z6   GIAD     "  "      230
493 C S.N. 19    1.0  8.0   0.4   0.8 50.0 .34700000 .286   .1 .043 .043 22.0          Z6   GIAD     "  "      230
494 L LIST 19    1.000000   0.9   0.2 20.0 .4870000000000 .045  .03 .076    ALL01890 // G2B      "  1578   230
495 L LIST       1.500000   0.9   0.1 12.00000000000000000000000000000    ALL01900 // G2B      "  1582   230.
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496 L?CORO 15   1.000000  0.9  0.1 15.0 .43300000 .597 .087 .043 .109      ALL01910 /  G2B       SH 1582   230
497 L LIST 16   1.0  7.0  0.9  0.2 20.0 .38800000 .3470000000000 .069      ALL01920 /  G2B        " 1611   230
498 C CANC 28   1.0  7.5  0.4  1.0 25.0 .37100000 .46500000 .058  .07 17.0          /  G1A        " 1617   223
499 C?S.N. 13   1.000000 0.45  1.0 50.0 .24600000 .308 .077 .046 .092 26.0         X4  G1AE/D     " 1619    "
500 C?S.N. 11   1.0  7.0  0.7  0.9 50.0 .35400000 .444 .111 .067 .089 32.0      W5/X4  G1AE/D     "  "      "
501 C?CREC 10   1.0  6.5  0.9  0.4 28.0 .32400000 .447 .079 .053 .07900000         W1  G1AB/G     "  "      "
502 C?CREC  9   1.000000  0.9  0.4 30.0 .42100000 .433   .1 .067 .067 45.0         W2  G1AA       "  "      "
503 C?CANC 24   1.000000  0.4  0.9 40.0 .38800000 .182 .15500000 .027 15.0          /  G1A        " 1622    "
504 C?S.N. 15   1.000000  0.5  0.9 60.0 0.400000 .442 .231 .096 .077 25.0          Y1  G1AB       "  "      "
505 C?CANC 13   1.000000  0.6  0.8 40.0 .33600000   .4  .08  .04  .08 33.0         X4  G1AD/E     "  "      "
506 C CREC 20   1.0  8.0  0.6  0.8 25.0 .36600000 .412 .035 .012 .071 30.0         Z5  G1AE       " 2287    53
507 C CREC 24   1.0  8.0  0.7  0.8 25.0 .49400000 .458 .067 .017 .067 18.0       (Z5)  G1AE       " 2291    "
508 C?CANC 26   1.0  8.0  0.5  1.0 25.0 .19600000 .417   .1 .025 .033 32.0         Z6  G1AD       " 2311    "
509 C?CANC 18   1.000000  0.8  0.8 25.0 .24100000 .267 .053 .013  .02 18.0         Z7  G1AC       " 2345    "
510 C?CANC 33 0000000000  0.3  1.0 22.0 .18200000000000 .07500000    0 16.0          /  G1A        " 2351   231
511 C CREC 12   1.000000  0.7  0.7 25.0 .44400000 .426 .085 .085 .043 40.0         X1. G1AA/G     "  "      "
512 C CARI 38 0000000000  0.9  0.7 35.0 .21100000000000 .598 .01200000000000          /  G1A        " 2378    "
513 C?CARI 18   1.000000  0.5  0.8 60.0 .21900000  .36  .12 .036 .006 15.0         Z3  G1AG       " 2392    "
514 L LIST 25   1.0  9.0  0.8  0.4 20.0   .400000 .318 .027 .027 .055      ALL01930 /  G2B        " 2476   225
515 L LIST 11   1.000000  0.9  0.3 13.0 .49100000 .472 .038 .038 .057      ALL01940 /  G2B        "  "      "
516 S?SUBC 19   1.000000  0.9  0.1 15.0 .37500000 .466 .086 .086 .052      ALL01950 /  G2A        " 2482    "
517 L LIST 32   1.000000  1.0  0.1 16.0 .35900000  .28 .048 .032 .048      ALL01960 /  G2B        " 2485    "
518 L LIST 25   1.000000  1.0  0.2  8.0   .400000  .27  .02  .04  .03      ALL01970 /  G2B       RE 4192   163
519 ? ????    0000000000  1.0  0.1 20.0000000000000000 .167 .03300000000000          /  G2         " 4997    "
520 ? ???? 10   1.000000  0.8  0.4 40.0 .35500000 .227 .136 .068 .04500000          /  G2         " 4999    "
521 ? ???? 17   1.0 14.0  0.7  0.9 25.0 .52900000   .6  .14  .04 .04000000          /  G2         " 5000    "
522 S SUBC 25   1.000000  1.0  0.2 40.00000000000 .375 .313 .031 .013      ALL01980 /  G2A       SH 8       "
523 K?CUMB      1.000000  1.0  0.1 13.0000000000000000000000000000000               /  G1B       RE 2767   232
524 ? ???? 32   1.0  7.0  0.8  0.5 15.0 .4220000000000000000000000000               /  G1         " 2772   232
525 K CREN 35   1.000000  0.8  0.8 25.0   .300000 .162 .143  .01 .01900000       (Z4)  G1BC       " 3061   155
526 K CUMB      2.000000  0.7  0.1  6.00000000000 .364 .055 .055 .055 20.0          /  G1B        " 3062    "
527 K CUMB    0000000000  0.9  0.1 17.0000000000000000000000000000000 20.0          /  G1B        " 3073    "
528 S?SUBC      1.000000  1.0    0 28.00000000000 .375 .125 .025 .025      ALL01990 /  G2A        " 3105    "
529 L?LIST      1.000000  1.0  0.1 20.0000000000000000000000000000000      ALL02000 /  G2B        " 3125    "
530 L?CORO      1.500000  1.0    0 17.0000000000000000000000000000000      ALL02010 /  G2B        " 3128    "
531 K CREN    0000000000  1.0  1.0 20.0000000000000000 .174 .00900000 14.0          /  G1B        " 3155    "
532 K CREN    0000000000  0.7  0.8 35.0000000000000000000000000000000 20.0          /  G1B        " 3157    "
533 K CREN 26   1.000000  0.9  0.5 24.0 .32700000 .192 .082 .009 .02300000       (Z4)  G1BC       " 3165    "
534 K CREN      1.0  8.0  1.0  0.1 20.00000000000 .174 .104 .009 .01700000          /  G1B        " 3166    "
535 K?CUMB  7   2.0  6.0  1.0    0 10.0 .57100000 .9090000000000 .13600000          /  G1B        " 3167    "
536 K?CUMB 17   1.5  7.0  0.8  0.3 12.0 .33500000 .403 .104 .015 .037 35.0         Y2  G1BF       " 3171    "
537 S?SUBC  7   1.0 12.0  1.0    0 15.0 .45800000 .417 .083 .021 .042      ALL02020 /  G2A        " 3186    "
538 S?SUBC      1.0  9.0  1.0    0 20.00000000000 .253 .186 .021 .021      ALL02030 /  G2A        " 3204   159
539 K?CREN    0000000000  0.8  0.9 20.0000000000000000000000000000000 18.0          /  G1B        " 3211    "
540 K?CUMB    0000000000  0.6  1.0 15.000000000000000000000000000000000000          /  G1B        "  "      "
541 K?CUMB      2.0  6.0  1.0    0  8.00000000000 .61500000 .096 .05800000          /  G1B        " 3212    "
542 K?CREN      1.000000  1.0  .55 22.00000000000 .318 .092    0 .02300000          /  G1B        " 3214    "
543 K CUMB    0000000000  0.8  0.1 11.0000000000000000000000000000000 26.0          /  G1B        " 3216    "
544 K?CUMB      1.000000  0.7  0.7 12.0000000000000000000000000000000 19.0          /  G1B        " 3217    "
545 K CREN    0000000000  0.8  0.8 17.0000000000000000  .12 .02400000000000          /  G1B        " 3219    "
546 K CREN      1.5  6.0  0.9    0 12.00000000000 .523 .114 .081 .06800000          /  G1B        " 3220    "
547 K?CREN      1.000000  0.8  0.4 15.00000000000 .235 .094 .024 .018 38.0          /  G1B        " 3223    "
548 K CREN 22   1.000000  0.9  0.6 20.0 .30500000   .2 .133 .039 .02200000         Z5  G1BD/E/F   " 3222    "
549 K?CUMB      1.2  8.0 0.75  0.5 18.00000000000 .314 .186 .036 .036 40.0          /  G1B        " 3221    "
550 K?CUMB    0000000000  0.7  0.2  7.0000000000000000000000000000000 25.0          /  G1B        " 3228    "
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551 L CIRC 25    1.5 12.0  0.9  0.3 22.0 .3231.476  .34 .223  .01 .029   ALL02040 Y2     G2BH    LZB 413   233
552 L LIST 9     1.0  7.0  1.0  0.1 18.0 .3682.118 .234 .074 .044 .074   ALL02050 U5     G2BD     "  415   191
553 L LIST 12    1.5 11.0  0.9  0.2 10.0 .367  2.0 .326 .022 .033 .065   ALL02060 V4     G2BA     "  416    "
554 L LIST 7     2.5  7.5  1.0    0 20.0 .464 2.28  .32  .04  .02  .06   ALL02070 (U3)   G2BF     "  417    "
555 L CORO 10    2.0  5.0  0.9    0  7.0 .4572.656 .469 .016    0 .156   ALL02080 U1     G2BB     "  418    "
556 L CIRC 12    1.5  8.0  0.9  0.2 14.0 .3361.875 .313 .104 .104 .021   ALL02090 V6     G2BH     "  419    "
557 L LIST 13    2.0  7.0  1.0    0  8.0 .3842.488 .415 .049 .024 .098   ALL02100 V4     G2BA     "  420    "
558 L CIRC 13 00000  9.0  1.0    0 15.0 .3041.724 .345 .052 .052 .017   ALL02110 V5     G2BD/G   "  421    "
559 L LIST 15    2.0  9.0  0.7  0.4 11.0  .341.697 .212 .061  .03 .038   ALL02120 W4     G2BH     "  422    "
560 L LIST 15    2.0  7.5  0.9  0.4  9.0 .421 1.95 .333 .067 .017  .05   ALL02130 W4     G2BH     "  423    "
561 L?CIRC 15    1.0  7.0  0.8  0.5 23.0 .3791.917 .367 .042 .008 .042   ALL02140 W4     G2BH     "  424    "
562 L?LIST 15    1.0  7.5  0.9  0.4 15.0 .386 1.78 .339 .068 .034 .051   ALL02150 W4     G2BH     "  425    "
563 L LIST 15    2.0  6.0  1.0  0.3  8.0 .4422.309 .455 .036 .018 .145   ALL02160 W3     G2BB     "  426    "
564 L LIST 17    3.0  5.0  0.8  0.4 10.0 .3491.935 .455  .03    0 .076   ALL02170 W3     G2BB     "  427    "
565 L CIRC 15    1.0  7.5  1.0  0.6 18.0 .3591.667 .397 .095  .04 .024   ALL02180 W4     G2BH     "  428    "
566 L LIST 16    2.0 11.0  0.9  0.4 11.0 .4042.069 .172 .043 .069 .034   ALL02190 W4     G2BH     "  429    "
567 L LIST 17    2.0  6.5  1.0  0.1  8.0 .4662.464 .179 .071 .071 .099   ALL02200 W1     G2BA     "  430    "
568 L?LIST 33    1.0  8.0  1.0  0.6 12.0 .3651.847 .254 .297 .042 .034   ALL02210 (Z1)   G2BD-G   "  431    "
569 L?LIST 17    1.0  6.0  1.0  0.2 25.0 .4711.711 .329 .039 .013  .02   ALL02220 W2     G2BF     "  432   190
570 L      ? 40 0000000000  0.8  0.2 50.0  .351.84600000 .192 .02300000   ALL02230 /      G2B      "  433    "
571 L LIST 30    1.000000  1.0  0.1 10.0   .62.917 .583   .1    0   .1   ALL02240 Z3     G2BB     "  434   195
572 L?LIST 19    1.0  9.0  1.0  0.2 45.0 .3081.857 .214 .129 .014 .021   ALL02250 X1     G2BE     "  436    "
573 L LIST 16    1.0  9.0  1.0  0.1 15.0 .432  2.6   .4  .06  .04  .04   ALL02260 W1     G2BA     "  437    "
574 L CIRC 18    1.000000  1.0  0.1 60.0 .3391.644 .342 .062 .027 .027   ALL02270 X1     G2BE     "  438    "
575 L?CIRC 19    1.000000  1.0  0.2 40.0 .3581.603 .321 .103 .051 .026   ALL02280 X2     G2BD     "  439    "
576 L LIST 17    1.0  8.0  0.9  0.2 30.0 .4121.846 .38500000000000 .054   ALL02290 /      G2B      "  441    "
577 L?LIST 17    1.0 10.0  1.0  0.1 50.0 .3532.183 .333 .133 .017 .025   ALL02300 W5     G2BD     "  443    "
578 L?LIST 17    1.000000  1.0  0.1 40.0000000000000000000000000000000   ALL02310 /      G2B      "  446    "
579 L CIRC 16    1.000000  1.0  0.1 50.0 .3031.671 .143 .143 .029 .014   ALL02320 W6     G2BG     "  449    "
580 L CIRC 18    1.0  8.0  1.0  0.1 50.0 .2781.538 .192 .154 .038 .013   ALL02330 W6/X1  G2BG     "  450    "
581 L CIRC 15    1.000000  1.0  0.1 60.0  .311.558  .13  .13 .039 .019   ALL02340 /      G2B      "  451    "
582 L?CIRC 15    1.000000  1.0  0.1 40.0 .323 1.9500000 .117  .0500000   ALL02350 /      G2B      "  452    "
583 L LIST 15    1.0000000000000000000000 .452 3.25  .5000000000000   .1   ALL02360 /      G2B      "  453    "
584 L CIRC 15    1.000000  1.0  0.1 40.0 .288  1.7  .25 .083 .025 .033   ALL02370 W6     G2BG     "  454    "
585 L LIST 19    1.000000  1.0  0.2 60.0 .4212.167  .25 .083 .025 .042   ALL02380 X3     G2BF     "  455    "
586 L CIRC 17    1.000000  1.0  0.1 50.0 .3652.033 .333 .183 .033 .017   ALL02390 W5     G2BD     "  457    "
587 L CIRC 15    1.000000  1.0  0.1 15.0 .3041.479 .205 .096 .014 .014   ALL02400 W6     G2BG     "  458    "
588 L?CIRC 16    1.000000  1.0  0.1 60.0 .3711.767 .333   .1 .033 .067   ALL02410 W2     G2BF     "  459    "
589 L CIRC 14    1.000000  0.8  0.1 50.0 .379  2.2   .5  .22  .02  .03   ALL02420 W5     G2BD     "  460    "
590 L CIRC 15    1.000000  1.0  0.1 50.0 .3271.833 .333 .083 .025 .025   ALL02430 W6     G2BG     "  463    "
591 L CORO 9     1.000000  1.0    0 60.0 .4442.633   .5 .033    0 .133   ALL02440 U3     G2BF     "  464    "
592 L?CIRC 14    1.0  7.0  1.0  0.1 55.0 .3382.375 .375 .083 .021 .052   ALL02450 W2     G2BE     "  465    "
593 L CIRC 18    1.000000  1.0  0.1 45.0 .3061.765 .294 .118 .015 .022   ALL02460 X1     G2BE     "  468    "
594 L CIRC 13    1.0  8.0  1.0  0.1 50.0 .356 2.36   .4  .07  .04  .03   ALL02470 V2     G2BF     "  469    "
595 L?LIST 14    1.0  9.0  0.9  0.1 45.0 .439  2.6 .444 .089 .022 .056   ALL02480 W2     G2BE     "  471    "
596 L LIST 14    1.000000  1.0  0.1 30.0 .338 2.34   .4  .08  .03  .05   ALL02490 W2     G2BF     "  472    "
597 L?LIST 15    1.0 10.0  1.0  0.1 30.0 .419 2.24   .5  .04  .04  .04   ALL02500 W2     G2BF     "  473    "
598 L?LIST 13    1.0  9.0  0.7  0.1 35.0 .345  2.0  .24  .06  .03  .04   ALL02510 V5     G2BD/G   "  476    "
599 L?CIRC 11    1.000000  1.0  0.1 35.0 .336 2.25 .375   .1  .05 .038   ALL02520 U5/V2  G2BD/F   "  477    "
600 L?CIRC 13    1.000000  1.0 0.05 50.0 .2882.132 .226 .075 .047 .028   ALL02530 V5     G2BD/G   "  480    "
601 L?CIRC 9     1.000000  1.0 0.05 50.0 .4622.724 .345 .069 .034 .052   ALL02540 U3     G2BF     "  481    "
602 L?CIRC 10    1.000000  1.0    0 40.0   .42.103 .256 .038 .064 .026   ALL02550 U4     G2BG     "  482    "
603 L?LIST 11    1.000000  1.0  0.1 60.0  .422.432 .405 .095 .041 .027   ALL02560 U3/V2  G2BF     "  486    "
604 L CIRC 15    1.000000  1.0 0.05 40.0 .373 2.24   .4  .18  .03  .04   ALL02570 W5     G2BD     "  487    "
605 L?LIST 10    1.0  6.5  0.7    0 20.0 .4042.563 .375 .094 .063 .063   ALL02580 U5     G2BD     "  490    "
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606 L CIRC 12    1.0 11.0   1.0  0.1 50.0 .3672.065 .326 .087 .043 .022   ALL02590 V2     G2BF     LZB 491  195
607 L LIST 14    1.0  8.5   1.0  0.1 35.0 .448  3.0   .5   .1 .038 .063   ALL02600 W1     G2BA      "  493   "
608 L?CIRC 11    1.000000   1.0  0.1 55.0 .372 2.25   .3  .15 .075 .025   ALL02610 U5/V2  G2BD/F    "  494   "
609 L     ? 8    1.000000   1.0    0 50.0 .4272.586 .241 .069 .034 .017   ALL02620 (U4)   G2BG      "  495   "
610 L LIST 8     1.000000   1.0    0 27.0 .3652.759 .276 .002 .002 .034   ALL02630 (U3)   G2BF      "  505   "
611 S SUBC 12    1.000000   1.0 0.05 17.0  .281.393 .082 .197 .041 .008   ALL02640 V2     G2AB      "  516  209
612 S SUBC 15    1.0  6.0   0.9  0.1 50.0 .2521.354 .231 .169 .092 .008   ALL02650 W4     G2AB      "  517   "
613 S SUBC 9     1.000000   0.9    0 16.0 .367  1.5   .2 .075   .1 .013   ALL02660 U3     G2AE/G    "  522   "
614 S SUBC 16    1.000000   0.9    0 30.0 .3131.694 .081 .194 .097 .008   ALL02670 W4     G2AB      "  523   "
615 S SUBC     0000000000   0.9  0.2 25.0000000000000000000000000000000   ALL02680 /      G2A       "  524   "
616 S SUBC 15    1.000000   1.0  0.1 50.0000000000000000000000000000000   ALL02690 /      G2A       "  530   "
617 S SUBC 17    1.000000   0.8    0 30.0 .3671.694 .161 .194  .04 .008   ALL02700 W1     G2AG      "  531   "
618 S SUBC 12 0000000000   0.9  0.1 18.0000001.676    0 .109 .041    0   ALL02710 /      G2A       "  532   "
619 S SUBC 7  0000000000   1.0    0 24.0 .3572.091    0 .091 .023    0   ALL02720 /      G2A       "  534   "
620 S SUBC 13 0000000000   1.0  0.1 28.0 .3621.635 .192 .115 .058  .01   ALL02730 V3     G2AE/G    "  536   "
621 S SUBC 16    1.000000   0.9  0.2 28.0 .3151.538 .154 .103 .038 .008   ALL02740 W2     G2AD      "  537   "
622 S SUBC 13    1.000000   1.0    0 17.0 .3151.778 .178 .089 .089 .011   ALL02750 V3     G2AE/G    "  542   "
623 S SUBC 20 0000000000   0.9  0.1 40.000000 .91200000 .147 .05900000   ALL02760 /      G2A       "  541   "
624 S SUBC 14    1.000000   0.8  0.2 30.0 .3211.604 .094 .113 .057 .009   ALL02770 W2     G2AD      "  543   "
625 S SUBC 11    1.000000   0.8    0 20.0 .318  1.6 .125 .063 .063 .013   ALL02780 V3/U4  G2AB/E/G  "  544   "
626 S SUBC 10 0000000000   1.0    0 20.0 .3671.57900000 .092 .07900000   ALL02790 /      G2A       "  545   "
627 S SUBC 7     1.000000   1.0    0 20.0 .3612.038 .385 .096 .115 .038   ALL02800 (U3)   G2AE/G    "  547   "
628 S SUBC 7     1.000000   1.0    0 17.0 .301 1.64   .4   .1  .06  .02   ALL02810 (U4)   G2AB      "  549   "
629 S SUBC 19 0000000000   1.0    0 30.0 .352  1.5    0 .186 .029    0   ALL02820 X3     G2AC      "  551   "
630 S SUBC 14 0000000000   0.9  0.1 27.0 .3361.698    0 .113 .057    0   ALL02830 W5     G2AE      "  552   "
631 S SUBC 20    1.000000   0.9  0.1 25.0 .2981.463 .122  .22 .024 .006   ALL02840 X4     G2AE/G    "  553   "
632 S SUBC 15 0000000000   1.0    0 22.0  .261.431    0 .169 .031    0   ALL02850 W1     G2AG      "  560   "
633 S SUBC 14    1.000000   1.0    0 29.0 .3081.818 .182 .145 .055 .009   ALL02860 W1     G2AG      "  561   "
634 S SUBC 19 0000000000   1.0  0.1 20.0 .2791.467    0  .08 .033    0   ALL02870 X4     G2AE/G    "  565   "
635 S SUBC 16 0000000000   1.0    0 20.0 .2691.493    0 .149  .03    0   ALL02880 W1     G2AG      "  568   "
636 S SUBC 9     1.500000   1.0    0 25.0 .3961.818 .303 .076 .106  .03   ALL02890 U3     G2AE/G    "  569   "
637 S SUBC 11    1.000000   1.0    0 20.0 .3911.905 .357 .119 .024 .012   ALL02900 V5/U1  G2AH      "  571   "
638 S SUBC 17    1.000000   0.9  0.1 22.0 .2811.467   .2 .173 .033 .007   ALL02910 W1     G2AG      "  576   "
639 S SUBC 8     1.500000   1.0    0 28.0 .4472.286 .357 .125 .089 .036   ALL02920 (U5)   G2AI      "  578   "
640 S SUBC 20 0000000000   1.0  0.1 20.0 .2761.529    0 .118 .035    0   ALL02930 X4     G2AE/G    "  584   "
641 S SUBC 19 0000000000   0.8    0 24.0 .2971.778     00000000000    0   ALL02940 /      G2A       "  587   "
642 S SUBC 12    1.000000   1.0    0 22.0 .3331.739 .109 .152 .065 .011   ALL02950 V3     G2AE/G    "   "    "
643 S SUBC 11    1.000000   1.0  0.1 20.0 .3932.211 .263 .132 .079 .013   ALL02960 V5/U1  G2AH      "  606   "
644 S SUBC       1.000000   0.9  0.1 12.0000001.269    0 .144 .029    0   ALL02970 /      G2A       "  608   "
645 S SUBC 10 0000000000   0.8    0 20.0 .3141.667    0 .077 .051    0   ALL02980 /      G2A       "  613   "
646 S SUBC 20 0000000000   0.9  0.1 22.0000001.295    0 .126 .026    0   ALL02990 /      G2A       "  622   "
647 S SUBC 22 0000000000   0.7  0.5 17.0 .3411.196    0 .141 .054    0   ALL03000 X5     G2AD      "  629   "
648 S SUBC 23 0000000000   1.0  0.1 25.000000  1.4    0  .25 .063    0   ALL03010 U4     G2AB      "  630   "
649 S SUBC 9     1.000000   1.0    0 25.0 .3612.914 .286 .086 .057 .014   ALL03020 U5     G2AI      "  631   "
650 S SUBC 13 0000000000   1.0    0 27.0 .2991.379    0 .207 .052    0   ALL03030 V2     G2AB      "  632   "
651 S SUBC 13 0000000000   1.0    0 25.0 .285  1.6    0 .182 .055    0   ALL03040 V2     G2AB      "  637   "
652 S SUBC 12    1.000000   0.9  0.1 20.0 .3331.491 .182 .091 .045 .009   ALL03050 V3     G2AE/G    "  639   "
653 S SUBC 11 0000000000   0.9  0.1 20.0 .3391.404    0 .096 .058    0   ALL03060 V3/U4  G2AB/E/G  "  640   "
654 S SUBC 12    1.000000   1.0    0 20.0 .341 1.76   .3  .16  .06  .01   ALL03070 V1     G2AA      "  652   "
655 S SUBC 10    1.000000   1.0    0 18.0  .371.974 .194 .079 .053 .013   ALL03080 U4     G2AB      "  653   "
656 S SUBC 12    1.000000   1.0    0 27.0 .3441.458 .313 .146 .083  .01   ALL03090 V3     G2AE/G    "  654   "
657 S SUBC 10    1.000000   1.0    0 18.0 .333 1.85  .25   .1  .05 .025   ALL03100 U1     G2AA      "  655   "
658 S SUBC 13    1.000000   0.8  0.3 17.000000  2.0 .263 .079 .105 .013   ALL03110 /      G2A       "  658   "
659 S SUBC 35    1.000000   1.0  0.1 15.0 .2861.336 .143   .2 .021 .004   ALL03120 (Y1)   G2AH      "  663   "
660 S SUBC 23 0000000000   0.7  0.6 30.0000001.388    0 .259 .082    0   ALL03130 /      G2A       "  668   "
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661 S SUBC 20 0000000000  0.8- 0.3 30.0000001.667    0 .319 .035    0   ALL03140  /     G2A    LZB 670  209
662 S SUBC 15 0000000000  0.7  0.4 20.0000001.621    0 .207 .078    0   ALL03150  /     G2A     "  674   "
663 S SUBC 8  0000000000  1.0    0 22.0 .3571.658    0 .105 .066    0   ALL03160 (U4)   G2AB    "  675   "
664 S SUBC 16   1.000000  0.9  0.3 25.0 .383 .862 .172 .172 .034 .009  ALL03170 W2     G2AD    "  682   "
665 S SUBC 13   1.000000  0.9  0.2 20.0 .361  1.7   .2  .16  .05  .01  ALL03180 V4     G2AC/D  "  687   "
666 S SUBC 23   1.000000  0.9  0.3 20.0   .31.422 .222 .222 .056 .006  ALL03190 X4/Y1  G2AH    "  691   "
667 S SUBC 21 0000000000  0.9  0.4 30.0000001.375    0 .188 .025    0   ALL03200  /     G2A     "  708   "
668 S SUBC 19 0000000000  0.8  0.3 27.000000  1.4    0  .28  .04    0   ALL03210  /     G2A     "  717   "
669 S SUBC 14 0000000000  1.0  0.2 23.0 .3571.545    0 .164 .073    0   ALL03220 W5     G2AE    "  718   "
670 S SUBC 15 0000000000  0.9  0.2 18.0 .3331.564    0 .109 .073    0   ALL03230 W5     G2AE    "  720   "
671 S SUBC 13   1.000000  1.0  0.1 40.0 .3131.813 .313 .208 .063 .021  ALL03240 V1     G2AA    "  727  234
672 S SUBC 29 0000000000  0.9  0.3 35.0 .2931.415    0 .217 .057    0   ALL03250 (Y2)   G2AI    "  728   "
673 S SUBC 32 0000000000  1.0  0.1 40.0 .3221.393    0 .385 .043    0   ALL03260  /     G2A     "  729   "
674 S SUBC 30   1.000000  0.9  0.2 50.0 .3231.304 .174 .348 .052 .004  ALL03270 (Y2)   G2AI    "  730   "
675 S SUBC 31 0000000000  0.9  0.2 45.0 .349 1.59    0 .381 .029    0   ALL03280 (Y3)   G2AC    "  731   "
676 S SUBC 20   1.000000  0.8  0.3 50.0 .3331.722 .347 .278 .069 .021  ALL03290 X1     G2AI    "  732   "
677 S SUBC 9    1.000000  0.9    0 21.0 .3671.758 .303 .121 .061 .015  ALL03300 U1     G2AA    "  791   "
678 S SUBC 17   1.000000 0.75  0.3 16.0 .3181.618 .365 .191 .044 .007  ALL03310 W1     G2AG    "  794   "
679 S SUBC 24   1.000000  0.9  0.4 35.0 .3331.647 .113 .376 .024 .006  ALL03320 Y3     G2AC    "  816   "
680 S SUBC 18 0000000000  0.9  0.1 30.0 .301 1.22    0 .183 .037    0   ALL03330 X4     G2AA/E/G "  821  "
681 S SUBC 16 0000000000  1.0  0.1 45.0 .3831.897    0 .103 .026    0   ALL03340 W6     G2AC    "  824 \  "
682 S SUBC 20   1.000000  0.9  0.1 50.0 .3321.528 .209 .181 .023 .014  ALL03350 X1     G2AI    "  837   "
683 S SUBC 17   1.000000  0.9  0.1 16.0 .3241.538 .154 .231 .046 .008  ALL03360 W1     G2AG    "  844   "
684 S SUBC 9    1.000000  1.0    0 20.0 .3551.765 .147 .103 .059 .015  ALL03370 U4     G2AB    "  846   "
685 S SUBC 9    1.000000  0.8    0 30.0 .4952.867 .333 .067    0 .067  ALL03380 U6     G2AF    "  847   "
686 S SUBC 4    1.500000  1.0    0 30.0 .5813.167 .333 .125    0 .083  ALL03390 (U6)   G2AF    "  850   "
687 S SUBC 20 0000000000  0.9  0.2 25.0000001.403    0 .234 .032    0   ALL03400  /     G2A     "  854   "
688 S SUBC 9  0000000000  0.9    0 19.0 .3671.486    0   .1 .057    0   ALL03410 U4     G2AB    "  857   "
689 S SUBC 22 0000000000  0.9  0.8 25.0 .3141.222    0   .3 .033    0   ALL03420 X5     G2AD    "  865   "
690 S SUBC 20 0000000000  1.0    0 37.0   .31.5630000000000000000000   ALL03430  /     G2A     "  871   "
691 S SUBC 13 0000000000  1.0    0 15.0 .296  1.5    0  .12  .03    0   ALL03440 V2     G2AB    "  885   "
692 S SUBC 10 0000000000  0.8  0.2 17.0 .2862.22900000 .114 .04300000   ALL03450  /     G2A     "  887   "
693 S SUBC 41 000000000000000000000000 .3051.344    0  .25 .063    0   ALL03460  /     G2A     "  891   "
694 S SUBC 22 0000000000  0.8  0.3 28.0000000000000000000000000000000   ALL03470  /     G2A     "  896   "
695 S SUBC 24 0000000000  0.8  0.6 27.0 .333  1.2    0  .22  .03    0   ALL03480 Y4     G2AD    "  897   "
696 S SUBC 14 0000000000  0.9  0.2 28.0000001.455    0 .073 .036    0   ALL03490  /     G2A     "  914   "
697 S SUBC 10 0000000000  0.9    0 20.0  .341.622    0 .081 .068    0   ALL03500 U4     G2AB    "  911   "
698 S SUBC 19 0000000000  0.9  0.5 45.0000001.786    0 .186 .057    0   ALL03510  /     G2A     "  921   "
699 S SUBC 9  0000000000  0.9  0.1 20.0000000000000000000000000000000   ALL03520  /     G2A     "  934   "
700 S SUBC 7      2.0  7.0  0.9    0 25.0 .474 2.72  0.4  .06  .02   .1  ALL03530 (U6)   G2AF    "  935   "
701 S SUBC 21 0000000000  0.9  0.1 45.0 .329  1.4    0 .275 .038    0   ALL03540 X3     G2AC    "  937   "
702 S SUBC 26     1.0  7.5  0.9  0.2 60.0 .2961.262 .164 .107 .025 .028  ALL03550 Y2     G2AI    "  938   "
703 S SUBC 7      2.0  7.5  1.0    0 18.0 .3782.696 .435 .087 .022 .109  ALL03560 (U6)   G2AF    "  940   "
704 S SUBC 21   1.000000  0.9  0.1 40.0 .39200000  .25 .213 .025 .006  ALL03570  /     G2A     "  944   "
705 S SUBC 23 0000000000  0.9  0.1 40.0 .232  1.500000 .311 .04400000   ALL03580  /     G2A     "  945   "
706 S SUBC 19     1.0  7.5  0.9  0.2 35.0 .3051.438 .188 .188    0 .013  ALL03590 X4     G2AA/E/G "  946  "
707 S SUBC 28 0000000000  1.0  0.1 47.0 .286 1.72    0 .301 .022    0   ALL03600 (Y2)   G2AI    "  947   "
708 S SUBC 18 0000000000  1.0  0.3 48.0 .3511.547    0 .267 .013    0   ALL03610 X3     G2AC    "  948   "
709 S SUBC 12 0000000000  1.0  0.2 20.0 .375  1.6    0  .14  .06    0   ALL03620 V3     G2AE/G  "  949   "
710 S SUBC 26 0000000000  1.0  0.1 38.0 .2871.524 .286  .21 .029 .005  ALL03630 Y1     G2AH    "   "    "
711 S SUBC 22 0000000000  1.0    0 39.0 .311  1.8    0 .375 .025    0   ALL03640 X3     G2AC    "  950   "
712 S SUBC 14   1.000000  0.9  0.2 30.0 .379  2.1   .3  .06  .02  .02  ALL03650 W7     G2AH/I  "  951   "
713 S SUBC 29 0000000000  0.9  0.1 45.0 .305 1.25    0  .25 .033    0   ALL03660 (Y1)   G2AH    "  952   "
714 S SUBC 24 0000000000  1.0  0.1 55.0 .286 1.48    0  .23  .03    0   ALL03670 Y2     G2AI    "  955   "
715 S SUBC 25 0000000000  0.9  0.3 50.0   .31.364    0 .182 .027    0   ALL03680 Y2     G2AI    "  956   "
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716 S SUBC 37 0000000000  0.9  0.3 24.00000000000000000000000000000000  ALL03690  /    G2A      LZB  958   234
717 S SUBC 35 0000000000  0.9  0.5 30.0 .3141.286    0 .214 .014    0  ALL03700 (Y3) G2AC      "   961    "
718 S SUBC 16 0000000000  1.0  0.1 40.0 .3541.724    0 .121 .034    0  ALL03710  W6  G2AC      "   964    "
719 S SUBC 37 0000000000  0.9  0.3 45.0 .3071.286    0 .214 .029    0  ALL03720 (Y2) G2AI      "   968    "
720 S SUBC 8  0000000000  0.9  0.2 40.0 .3762.267 .233  .05 .017 .033  ALL03730 (U7) G2AL      "   972    "
721 S SUBC 14 0000000000  0.9  0.1 33.0 .3431.722    0 .093 .037    0  ALL03740  W6  G2AC      "   974    "
722 S SUBC 21 0000000000  0.9  0.3 18.0 .2811.375    0 .238 .013    0  ALL03750  X4  G2AA/E/G  "   979    "
723 S SUBC 21 0000000000  0.8  0.2 30.0  .361.625    0 .278 .042    0  ALL03760  X3  G2AC      "   980    "
724 S SUBC 24 0000000000  0.8  0.5 32.0 .2891.344    0 .222 .056    0  ALL03770  Y4  G2AD      "   981    "
725 S SUBC 22 0000000000  1.0  0.2 28.0 .3291.232    0 .211 .021    0  ALL03780  X4  G2AA/E/G  "   988    "
726 S SUBC 16    1.000000  0.9  0.2 55.0 .3591.833  .25 .117 .025 .017  ALL03790  W7  G2AH/I    "   992    "
727 S SUBC 10    1.000000  1.0  0.1 30.0 .3622.314 .429 .114 .043 .043  ALL03800  U5  G2AI      "   992    "
728 S SUBC 19    1.000000  1.0    0 32.0 .316 1.62 .141 .183 .056 .007  ALL03810  X4  G2AA/E/G  "  1007    "
729 S SUBC 15    1.000000  1.0    0 20.0   .31.583 .333 .167  .05 .008  ALL03820  W1  G2AG      "  1017    "
730 S SUBC 17 0000000000  0.8  0.4 25.0 .2591.429    0 .086 .029    0  ALL03830  W2  G2AD      "  1027    "
731 S SUBC 23 0000000000  1.0  0.1 37.0000000000     00000000000    0  ALL03840  /    G2A      "  1033    "
732 S SUBC 12 0000000000  0.9  0.3 18.0 .328 1.1200000   .1  .0500000  ALL03850  /    G2A      "  1043    "
733 S SUBC 28    1.000000  0.9  0.6 25.00000000000000000000000000000000  ALL03860  /    G2A      "  1044    "
734 S SUBC 20 0000000000  0.8  0.4 20.0000001.389    0 .167 .067    0  ALL03870  /    G2A      "  1048    "
735 S SUBC 18 0000000000  0.9  0.3 18.0 .32400000    0 .186 .057    0  ALL03880  /    G2A      "  1057    "
736 S SUBC 9     1.000000  1.0    0 40.0000002.167   .5   .1 .017 .033  ALL03890  /    G2A      "  1063    "
737 L CIRC 22    1.000000  1.0  0.2 50.0 .2951.625   .5  .15 .025 .038  ALL03900  X1  G2BE      "  1075   194
738 L CIRC 19    1.000000  0.8  0.2 40.0 .449 2.25 .417  .25 .017 .042  ALL03910  X3  G2BF      "  1076    "
739 L CIRC 21    1.0000000000000000000000 .327  1.9 .375 .163   .1 .019  ALL03920  /    G2B      "  1078    "
740 L CIRC 29    1.000000  1.0  0.3 25.0 .3451.636 .182 .255 .027 .027  ALL03930  Z1  G2BD-G    "  1080    "
741 L CIRC 14    1.000000  0.9  0.1 60.0 .3431.818 .273 .073 .027 .009  ALL03940  W6  G2BG      "  1081    "
742 L CIRC 21    1.000000  1.0    0 40.0 .369  2.0   .4  .08 .013 .027  ALL03950  X3  G2BF      "  1082    "
743 L CIRC 16    1.000000  1.0  0.2 40.0 .3371.786 .214 .129 .043 .029  ALL03960  W6  G2BG      "  1084    "
744 L CIRC 20    1.000000  1.0  0.1 50.0  .351.775 .313   .2 .038 .025  ALL03970  X1  G2BE      "  1093    "
745 L?LIST 13    1.000000  1.0    0 25.0 .4232.556 .333 .044 .011 .044  ALL03980  V2  G2BF      "  1094    "
746 L CIRC 19    1.0000000000000000000000 .3711.778 .417 .069 .028 .035  ALL03990  /    G2B      "  1095    "
747 L CIRC 20    1.0  9.0  0.9  0.2 45.0 .3241.609  .23 .207 .023 .023  ALL04000  X1  G2BE      "  1097    "
748 L CIRC 23    1.0  8.5  1.0  0.1 70.0 .3811.854 .366 .305    0  .03  ALL04010 X1/Y1 G2BE     "  1098    "
749 L CIRC 22    1.000000  1.0  0.1 45.0 .3351.829 .183  .22 .037 .018  ALL04020  X1  G2BE      "  1100    "
750 L CIRC 30    1.000000  1.0  0.1 50.0 .317 1.49  .08   .2    0 .004  ALL04030  Z1  G2BD-G    "  1104    "
751 L CIRC 17    1.000000  1.0  0.2 45.0 .2891.743 .214 .171 .043 .014  ALL04040  W6  G2BG      "  1105    "
752 L CIRC 30 0000000000  1.0  0.1 40.0   .31.58300000 .183 .03300000  ALL04050  /    G2B      "  1106    "
753 L CIRC 15    1.000000  1.0  0.1 65.0 .331  1.8  .25 .117 .083  .02  ALL04060  W7  G2BE      "  1107    "
754 L CIRC 20    1.0 10.0  0.9  0.3 55.0 .3351.893 .373 .267 .013  .04  ALL04070  X1  G2BE      "  1109    "
755 L NORM 13    1.0 11.0  1.0  0.1 50.0 .3642.111 .333 .067    0 .044  ALL04080  V2  G2BF      "  1110    "
756 L CIRC 24    1.0  8.0  1.0  0.2 20.0  .361.653 .204 .143    0 .041  ALL04090  Y1  G2BD-G    "  1111    "
757 L CIRC 16    1.0 10.0  1.0  0.1 45.0 .4352.269   .5 .115    0 .058  ALL04100  W2  G2BF      "  1112    "
758 L CIRC 22    1.000000  1.0  0.1 50.0 .3471.671 .118 .176    0 .012  ALL04110  X1  G2BE      "  1113    "
759 L CIRC 21    1.000000 -1.0  0.1 50.0  .311.534 .114 .227 .023 .011  ALL04120  X1  G2BE      "  1114    "
760 L CIRC 16    1.000000  1.0  0.1 55.0 .3851.627   .2  .16 .027  .02  ALL04130  W6  G2BG      "  1115    "
761 L CIRC 9     1.000000  0.8  0.1 48.00000000000000000000000000000000  ALL04140  /    G2B      "  1117    "
762 L CIRC 20    1.000000  1.0  0.1 50.0 .325 1.76 .333 .333 .013 .027  ALL04150  X1  G2BE      "  1124    "
763 L?LIST 13    1.0  9.0  0.9  0.1 45.0 .4772.381 .357 .036 .024 .071  ALL04160  V2  G2BF      "  1126    "
764 L CIRC 21    1.000000  1.0  0.2 60.0 .3331.563  .25 .175 .013 .025  ALL04170  X1  G2BE      "  1127    "
765 L CIRC 26    1.000000  0.9  0.1 70.0 .3271.632 .211 .232 .011 .016  ALL04180  Y1  G2BD-G    "  1128    "
766 L CIRC 11    1.000000  1.0  0.1 55.0 .4092.286 .429 .057 .029 .029  ALL04190 U3/V2 G2BF     "  1132    "
767 L CIRC 20    1.0 10.0 -0.8  0.3 25.0  .351.875 .313 .038 .013  .05  ALL04200  X2  G2BD      "  1133    "
768 L CIRC 12    1.000000  1.0  0.1 30.0 .3682.174 .435 .065 .043 .054  ALL04210  V2  G2BF      "  1135    "
769 L CIRC 12    1.000000  0.8  0.1 50.0 .3872.111 .333 .056 .022 .022  ALL04220  V2  G2BF      "  1135    "
770 L?LIST 15    1.000000  1.0  0.2 35.0 .4251.867 .417   .2 .042  .05  ALL04230  W2  G2BF      "  1140    "
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771 L?CIRC 19   1.000000  1.0  0.1 30.0 .3541.775 .375  .15 .025 .025  ALL04240 X2     G2BD    LZB 1141   194
772 L?CIRC 14   1.000000  0.8  0.2 42.0 .377  2.0   .4  .06  .06  .05  ALL04250 W2     G2BF    "   1146   "
773 L?LIST 13   1.000000  1.0  0.1 47.0 .3792.188 .417 .292 .063 .052  ALL04260 V3     G2BF    "   1147   "
774 L?CIRC 15   1.0 11.0  1.0    0 40.0  .342.109 .364 .127 .073 .027  ALL04270 W7     G2BE    "   1150   "
775 L CIRC 26   1.000000  1.0  0.3 40.0 .385  1.7   .3   .3  .02  .01  ALL04280 Y1     G2BD-G  "   1153   "
776 L CIRC 18   1.000000  1.0  0.1 40.0 .3611.729 .214 .143 .057 .029  ALL04290 X2     G2BD    "   1155   "
777 L?CIRC 7    1.000000  1.0  0.1 50.0 .4572.864 .316 .023 .023 .068  ALL04300 (U3)   G2BF    "   1158   "
778 L?CIRC 5    1.000000  1.0    0 45.0 .4042.611 .278 .028 .028 .056  ALL04310 (U4)   G2BG    "   1161   "
779 L?CIRC 5    1.000000  1.0    0 50.0 .491  2.5 .188 .031    0 .125  ALL04320 (U3)   G2BF    "   1162   "
780 L?CIRC 5    1.000000  1.0    0 42.0 .4112.389 .389 .028    0 .039  ALL04330 U4     G2BG    "   1163   "
781 L?CORO 9    1.0  6.0  0.8  0.2 20.0  .482.438 .469 .063    0 .094  ALL04340 U3     G2BF    "   1165   "
782 L CIRC 13   1.000000  1.0  0.1 30.0 .326 1.83 .283 .075 .038 .028  ALL04350 V5     G2BD/G  "   1166   "
783 L CIRC 11   1.0  8.0  1.0  0.1 35.0 .362 2.05 .375 .075  .05  .05  ALL04360 U5/V2  G2BD/F  "   1168   "
784 L CIRC 11   1.000000  1.0    0 35.0 .3781.905 .357 .024    0 .048  ALL04370 U4/V2  G2BF/G  "   1169   "
785 L CIRC 8    1.0  6.0  1.0    0 38.0 .4592.313 .313 .009 .031 .078  ALL04380 (U3)   G2BF    "   1171   "
786 L CIRC 17   1.000000  1.0  0.2 50.0 .353 2.15  .25 .333 .033 .017  ALL04390 W5     G2BD    "   1194   "
787 L CIRC 14   1.000000  1.0  0.1 35.0 .3361.735 .368 .294 .044 .015  ALL04400 W5     G2BD    "   1198   "
788 L CIRC 14   1.000000  1.0    0 70.0 .338  2.0 .455 .273 .018 .027  ALL04410 W5     G2BD    "   1202   "
789 L CIRC 18   1.000000  0.9  0.2 50.0 .361  1.6 .267 .133 .013 .027  ALL04420 X1     G2BE    "   1203   "
790 L CIRC 12   1.000000  0.8  0.2 80.0 .3812.167 .313 .052 .073 .042  ALL04430 V2     G2BF    "   1204   "
791 L CIRC 10   1.000000  1.0  0.1 45.0 .392 1.25 .417 .139 .056 .028  ALL04440 U5     G2BD    "   1208   "
792 L CIRC 21   1.0  9.0  0.9  0.2 28.0 .322 1.62 .217 .043 .022 .033  ALL04450 X2     G2BD    "   1215   "
793 L CIRC 23   1.000000  1.0  0.1 30.0 .3381.889 .333 .244 .044 .033  ALL04460 X2/Y1  G2BD    "   1221   "
794 L CIRC 11   1.0  7.0  1.0  0.1 60.0 .3722.195 .366 .049 .024 .073  ALL04470 U4/V2  G2BG/F  "   1222   "
795 L CIRC 25   1.000000  1.0  0.2 38.0 .317 1.57  .15  .24  .04  .02  ALL04480 Y1     G2BD-G  "   1223   "
796 L CIRC 14   1.000000  1.0  0.1 50.0 .379  2.0   .4  .04  .04  .04  ALL04490 W2     G2BF    "   1226   "
797 L CIRC 24   1.000000  1.0  0.1 35.0 .3331.667 .333 .156 .025 .022  ALL04500 Y1     G2BD-G  "   1229   "
798 L CIRC 19   1.000000  1.0  0.2 25.0 .3371.714 .357 .171 .071 .043  ALL04510 X2     G2BD    "   1230   "
799 L CIRC 14   1.000000  0.9  0.1 30.0 .386 2.14   .4  .06  .02  .07  ALL04520 W2     G2BF    "   1231   "
800 L CIRC 10   1.000000  1.0  0.1 60.0 .315 1.95 .375 .013 .025 .038  ALL04530 (U4)   G2BG    "   1233   "
801 L CIRC 13   1.000000  0.9  0.1 30.0 .3852.222 .333 .033 .044 .067  ALL04540 V4     G2BA    "   1235   "
802 L?CIRC 15   1.0  6.0  0.9  0.2 34.0 .4131.877 .263 .175 .009 .061  ALL04550 W2     G2BF    "   1251   "
803 L CIRC 8    1.000000  1.0    0 30.0 .4122.233 .167 .017 .017 .033  ALL04560 (U4)   G2BG    "   1252   "
804 L CIRC 11   1.0  7.0  1.0    0 55.0 .3642.263 .316 .039 .026 .039  ALL04570 U4/V2  G2BG/F  "   1255   "
805 L CIRC 19   1.000000  1.0  0.1 60.0 .3181.875 .225  .15  .05 .019  ALL04580 X1     G2BE    "   1257   "
806 L CIRC 24   1.000000  1.0  0.2 60.0 .3891.821 .263 .316 .053 .021  ALL04590 Y1     G2BD-G  "   1258   "
807 L CIRC 13   1.000000  1.0    0 50.0 .385  2.0   .3  .03  .04  .04  ALL04600 V2     G2BF    "   1259   "
808 L CIRC 10   1.0  7.000000000000000000 .374 1.75  .25  .05 .025  .05  ALL04610 /      G2B     "   1271   "
809 L CIRC 21   1.000000000000000000000000 .3521.625 .188 .275 .038 .038  ALL04620 /      G2B     "   1275   "
810 L CIRC 16   1.000000  1.0  0.1 25.0 .3662.273 .364 .145 .055 .018  ALL04630 W7     G2BE    "   1277   "
811 L CIRC 18   1,..00000C  1.0  0.1 40.0  .331.765 .294 .118 .044 .022  ALL04640 /      G2B     "   1281   "
812 L CIRC 14   1.000000  1.0    0 35.0 .3422.091 .273 .091 .036 .018  ALL04650 W6     G2BG    "   1282   "
813 L CIRC 8    1.0  8.0  1.0  0.1 40.0 .438  2.2  .12  .02  .04  .06  ALL04660 (U4)   G2BG    "   1291   "
814 L CIRC 9    1.000000  1.0  0.1 30.0 .4522.933 .267 .033 .017 .083  ALL04670 U3     G2BF    "   1295   "
815 L CIRC 11   1.000000  1.0 0.05 35.0 .3561.911 .222 .022 .033 .044  ALL04680 U4/V5  G2BG    "   1296   "
816 L CIRC 10   1.000000  1.0    0 50.0 .3621.778 .333 .044 .044 .033  ALL04690 U4     G2BG    "   1299   "
817 L CIRC 5    1.000000  1.0    0 30.0000000000000000000000      000000  ALL04700 /      G2B     "   1300   "
818 L CIRC 20   1.000000  1.0  0.1 50.0 .415 2.09 .321 .256 .038 .019  ALL04710 X3     G2BF    "   1325   "
819 L CIRC 16   1.0  8.5  0.9  0.3 35.0 .4192.105 .526 .088 .035 .061  ALL04720 W2     G2BF    "   1327   "
820 L NORM 14   1.000000  1.0    0 60.0 .3712.333 .333 .044 .067 .033  ALL04730 W7     G2BE    "   1330   "
821 L?LIST 5    1.000000  1.0      000000 .5592.632 .421 .053    0 .132  ALL04740 /      G2B     "   1333   "
822 L?CIRC 6    1.000000  1.0    0 55.0 .3811.786 .179 .036 .036 .036  ALL04750 (U4)   G2BG    "   1338   "
823 L CIRC 11   1.000000  1.0  0.1 50.0 .3021.889 .333 .011 .022 .056  ALL04760 U4/V5  G2BG    "   1342   "
824 L CIRC 10   1.000000  1.0  0.1 45.0 .4712.158 .263 .053 .026 .079  ALL04770 U3     G2BF    "   1347   "
825 L CIRC 16   1.000000  1.0  0.1 45.0 .3931.692 .231 .046 .039 .023  ALL04780 W6     G2BG    "   1349   "
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826 L CIRC 15    1.000000   1.0  0.1 30.0 .3531.774 .242 .049 .016  .04    ALL04790  W6      G2BG       LZB 1350   194
827 L CIRC 12    1.000000   1.0  0.1 22.0 .3912.021 .417 .146 .021 .052    ALL04800  V2      G2BF        "  1352   194
828 S?SUBC 12    1.00000000000000000 40.0 .4711.977 .279  .07 .047 .058    ALL04810  /       G2A         "  1356   209
829 S?SUBC 15    1.000000   1.0  0.1 42.0   .4  2.1   .3  .04  .03  .04    ALL04820  W7      G2AH/I      "  1357    "
830 S?SUBC 14    1.000000   1.0  0.1 38.0 .3861.945 .273 .091 .036 .055    ALL04830  W7      G2AH/I      "  1359    "
831 S?SUBC 11    1.000000   1.0  0.1 75.0 .364 2.25 .375 .063 .038  .05    ALL04840  U7/V7   G2AL        "  1361    "
832 S SUBC 11    1.000000   1.0  0.1 40.0 .3952.158 .395 .079 .079 .066    ALL04850  V6/U5   G2AI        "  1362    "
833 S SUBC 11    1.000000   0.9    0 20.0 .3421.604 .208 .146 .042  .01    ALL04860  V1/U1   G2AA        "  1363    "
834 S SUBC 5     1.0   9.0  1.0    0 31.0 .436 1.75  .35 .075 .025  .05    ALL04870  (U5)    G2AI        "  1364    "
835 S SUBC 4     1.000000   1.0    0 35.0 .4221.647 .294 .059 .029 .029    ALL04880  (U5)    G2AI        "  1365    "
836 S SUBC 4     1.0   9.0  1.0    0 35.0 .5111.867 .033 .333   .1 .033    ALL04890  (U1)    G2AA        "  1366    "
837 S SUBC 6     1.000000   1.0    0 25.0 .4221.783 .522 .065 .043 .013    ALL04900  (U5)    G2AI        "  1367    "
838 S SUBC 11    1.000000   1.0    0 27.0 .3361.646 .313 .167 .052 .006    ALL04910  V1/U1   G2AA        "  1368    "
839 S SUBC 13    1.000000   1.0    0 27.0 .3852.093 .233  .07 .047 .012    ALL04920  V5      G2AI        "  1369    "
840 S SUBC 10    1.000000   0.9    0 20.0 .3581.838  .27 .108 .068 .014    ALL04930  U1      G2AA        "  1371    "
841 S SUBC 10    1.000000   1.0    0 22.0 .3691.846 .256 .179 .064 .013    ALL04940  U1      G2AA        "  1372    "
842 S SUBC 10    1.000000   1.0    0 17.0 .3641.875  .25 .125 .038 .013    ALL04950  U1      G2AA        "  1373    "
843 S SUBC 10    1.000000   1.0    0 18.0 .3821.575 .125   .1  .05 .008    ALL04960  U4      G2AB        "  1374    "
844 S SUBC 11    2.000000   0.8  0.3 18.0 .4212.105 .395 .066 .053 .026    ALL04970  U8/V6   G2AI/J      "  1375    "
845 S SUBC 10    1.000000   0.8  0.3 17.0 .308  1.7  .25  .15 .063 .013    ALL04980  U2      G2AC/D      "  1376    "
846 S SUBC 10    1.000000   1.0    0 15.0 .3981.794 .294 .059 .059 .009    ALL04990  U4      G2AB        "  1377    "
847 S SUBC 11    1.000000   0.8  0.3 18.0 .373  1.8  .25 .125  .05 .013    ALL05000  V4/U2   G2AC/D      "  1378    "
848 S SUBC 8     1.000000   1.0  0.1 22.0 .3861.781 .313 .094 .063 .016    ALL05010  (U1)    G2AA        "  1379    "
849 S SUBC 8     1.000000   0.9    0 22.0 .398 1.75  .25 .047 .078 .016    ALL05020  (U1)    G2AA        "  1381    "
850 S SUBC 10    1.000000   1.0  0.1 23.0 .3881.333 .178 .133 .044 .004    ALL05030  U1      G2AA       /"  1382    "
851 S SUBC 9     1.000000   1.0    0 25.0 .398  1.5  .15 .125 .063 .008    ALL05040  U1      G2AA        "  1383    "
852 S SUBC 8     1.000000   0.9  0.1 22.0 .3812.067 .333   .1 .083 .017    ALL05050  (U8)    G2AJ        "  1384    "
853 S SUBC 13 0000000000    1.0  0.2 22.0 .3581.571    0 .089 .045    0    ALL05060  V3      G2AE/G      "  1385    "
854 S SUBC 8     1.000000   1.0  0.1 18.0 .3761.875 .313 .094 .078 .025    ALL05070  (U1)    G2AA        "  1386    "
855 S SUBC 7     1.000000   1.0  0.1 21.0 .4321.821 .286 .089 .107 .054    ALL05080  (U1)    G2AA        "  1389    "
856 S SUBC 7     1.000000   1.0  0.1 20.0   .41.857 .357 .143 .071 .018    ALL05090  (U1)    G2AA        "  1393    "
857 S SUBC 7     1.000000   1.0    0 28.0  .381.433 .333 .067 .033 .007    ALL05100  (U1)    G2AA        "  1396  , "
858 S SUBC 7     1.000000   1.0    0 28.0 .4291.571 .179 .089 .036 .011    ALL05110  (U8)    G2AJ        "  1397    "
859 S SUBC 8     1.000000   0.9  0.1 22.0 .3861.545 .121 .106  .03 .003    ALL05120  (U2)    G2AC/D      "  1402    "
860 S SUBC 8     1.000000   0.9    0 20.0 .3411.618 .206 .088 .059 .029    ALL05130  (U1)    G2AA        "  1404    "
861 S SUBC 3     1.000000   1.0    0 40.0   .51.833 .333 .125 .042 .042    ALL05140  (U5)    G2AI        "  1405    "
862 S SUBC 14    1.000000   0.9  0.2 18.0 .306  1.5 .086 .172 .034 .009    ALL05150  W1      G2AG        "  1406    "
863 S SUBC 14    1.000000   0.9  0.2 20.0 .333  1.4  .25 .167  .05 .008    ALL05160  W1      G2AG        "  1407    "
864 S SUBC 6     1.000000   1.0    0 35.0 .383  1.6   .2   .1  .02 .008    ALL05170  (U8)    G2AJ        "  1410    "
865 S SUBC 10    1.000000   1.0  0.2 18.0 .3241.511 .222 .111 .056 .011    ALL05180  U2      G2AC/D      "  1412    "
866 S SUBC 8     1.000000   1.0  0.1 20.0 .3131.613 .226 .113 .065 .016    ALL05190  (U4)    G2AB        "  1416    "
867 S SUBC 27 0000000000    0.9  0.4 24.0 .2981.318    0 .245 .073    0    ALL05200  Y4      G2AD        "  1417    "
868 S SUBC 12    1.000000   0.8  0.1 30.0 .3491.667 .111 .156 .067 .004    ALL05210  V3      G2AE/G      "  1418    "
869 S SUBC 17    1.000000   0.7  0.8 18.0 .3461.647 .221 .294 .029 .015    ALL05220  W3      G2AK        "  1420    "
870 S SUBC 12    1.000000   0.8  0.3 23.0  .32 1.66   .2   .2  .04 .006    ALL05230  V4      G2AC/D      "  1422    "
871 S SUBC 16    1.000000   0.8  0.5 18.0 .3311.309 .147 .103 .044 .003    ALL05240  W2      G2AD        "  1423    "
872 S SUBC 23 0000000000    0.9  0.4 25.0 .321 1.31    0   .2  .03    0    ALL05250  X4/Y4   G2A/D/E/G   "  1427    "
873 S SUBC 14    1.000000   1.0  0.1 18.0 .3641.618 .273 .182 .018 .018   -ALL05260  W1      G2AG        "  1428    "
874 S SUBC 18    1.000000   0.8  0.5 17.0 .2871.315 .137 .274 .027 .005    ALL05270  X4      G2AA/E/G    "  1429    "
875 S SUBC 13    1.000000   0.9  0.1 20.0 .3461.538 .096 .154 .058 .004    ALL05280  V3      G2AE/G      "  1432    "
876 S SUBC 17 0000000000    0.8  0.2 37.0 .3081.476    0 .317 .079    0    ALL05290  W4      G2AB        "  1434    "
877 S SUBC 14    1.000000   0.8  0.3 14.0 .3381.618 .182 .182 .091 .009    ALL05300  W5      G2AE        "  1435    "
878 S SUBC 14    1.000000   0.8  0.3 18.0 .3361.559 .085 .169 .068 .003    ALL05310  W5      G2AE        "  1436    "
879 S SUBC 19    1.000000   0.8  0.3 16.0 .316  1.5 .143 .186 .043 .003    ALL05320  X4      G2AA/E/G    "  1437    "
880 S SUBC 12 0000000000    1.0  0.2 18.0 .3521.50900000 .113 .03800000   ALL05330  /       G2A         "  1438    "
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881 S SUBC 9     1.000000  1.0  0.1 35.0 .341.526 .263 .053 .039 .008   ALL05340 U4    G2AB     LZB 1439    209
882 S SUBC 7     1.000000  1.0  0.1 24.0 .391.929 .357 .107 .071 .025   ALL05350 (U8)  G2AJ      "  1440     "
883 S SUBC 18    1.000000  0.7  0.7 15.0 .2851.329 .061 .171 .049 .006  ALL05360 X5    G2AD      "  1443     "
884 S SUBC 20    1.000000  0.8  0.4 32.0 .3041.518 .181 .317 .042 .01   ALL05370 X4    G2AA/E/G  "  1444     "
885 S SUBC 24 0000000000  0.8  0.3 22.0 .3061.196    0 .294 .029    0  ALL05380 Y4    G2AD      "  1446     "
886 S SUBC 10 0000000000  1.0  0.1 22.0 .341.632     0 .105 .053    0  ALL05390 U4    G2AB      "  1447     "
887 S SUBC 15    1.000000  0.8  0.3 35.0 .3141.452 .161 .145 .048 .003  ALL05400 W2    G2AD      "  1450     "
888 S SUBC 17 0000000000  0.9  0.2 20.0 .282 1.37     0 .205 .082    0  ALL05410 W4    G2AB      "  1451     "
889 S SUBC 4     1.000000  1.0    0 45.0 .444 1.75 .313  .05 .013 .019  ALL05420 (U5)  G2AI      "  1452     "
890 S SUBC 23    1.000000  0.9  0.5 40.0 .3261.349  .12 .398 .036 .004  ALL05430 Y3/X3 G2AC      "  1453     "
891 S SUBC 16    1.000000  1.0  0.2 20.0 .3171.618 .147  .25 .044 .006  ALL05440 W1    G2AG      "  1454     "
892 S SUBC 24 00000000000000000000000000 .263 1.13    0 .248 .019    0  ALL05450 /     G2A       "  1455     "
893 S SUBC 27    1.000000  0.8  0.6 32.0 .3091.296 .093 .259 .046 .005  ALL05460 Y4    G2AD      "  1456     "
894 S SUBC 18    1.0000000000000000000000 .2931.387 .067  .24  .04 .004  ALL05470 /     G2A       "  1457     "
895 S SUBC 14 0000000000  1.0  0.1 25.0 .3221.567    0   .2 .058    0  ALL05480 W5    G2AE      "  1458     "
896 S SUBC 25    1.000000  0.8  0.4 32.0 .2531.371 .048 .267 .095 .003  ALL05490 Y4    G2AD      "  1459     "
897 S SUBC 22 0000000000  0.9  0.6 28.0 .2941.348    0 .217 .054    0  ALL05500 X5    G2AD      "  1461     "
898 S SUBC 17    1.000000  0.9  0.2 18.0 .3111.571 .143 .186 .057 .004  ALL05510 W5    G2AE      "  1464     "
899 S SUBC 28 0000000000  0.9  0.7 30.0 .3211.391    0 .243 .026    0  ALL05520 Y3    G2AC      "  1465     "
900 S SUBC 25 00000000000000000000000000 .276 1.43    0   .2  .03    0  ALL05530 /     G2A       "  1467     "
901 S SUBC 21    1.000000  1.0  0.2 20.0 .3131.196 .147 .225 .078 .002  ALL05540 X5    G2AD      "  1468     "
902 S SUBC 14 0000000000  1.0  0.1 22.0 .3311.517    0 .172 .086    0  ALL05550 W5    G2AE      "  1470     "
903 S SUBC 15    1.000000000000000000 15.0 .3651.717  .25 .133 .042 .003  ALL05560 /     G2A       "  1471     "
904 S SUBC 7     1.000000  1.0    0 20.0 .3431.769 .385 .096 .038 .015  ALL05570 (U8)  G2AJ      "  1472     "
905 S SUBC 17 000000000000000000000 15.0 .321.587     0  .19 .048    0  ALL05580 /     G2A       "  1473     "
906 S SUBC 16 0000000000  0.9  0.2 15.0 .3351.767    0 .167  .05    0  ALL05590 W5    G2AE      "  1474     "
907 S SUBC 11    1.000000  1.0  0.1 25.0 .3571.542 .313 .146 .073 .004  ALL05600 U1    G2AA      "  1475     "
908 S SUBC 13    1.000000  1.0  0.2 34.0 .3411.517 .259 .121 .052 .014  ALL05610 V4    G2AC/D    "  1476     "
909 S SUBC 33 0000000000  0.9  0.3 27.0 .3031.446    0 .231 .062    0  ALL05620 (Y4)  G2AD      "  1477     "
910 S SUBC 8     1.500000  1.0    0 18.0 .3661.765 .294 .118 .074 .009  ALL05630 (U4)  G2AB      "  1481     "
911 S SUBC 12    1.000000  0.8  0.3 18.0 .306  1.8 .299 .167 .067 .022  ALL05640 V4    G2AC/D    "  1482     "
912 S SUBC 10 0000000000  1.0    0 30.0 .3551.725    0 .088 .063    0  ALL05650 U4    G2AB      "  1484     "
913 S SUBC 10    1.000000  1.0    0 20.0 .3461.683 .244 .122 .061 .005  ALL05660 U1    G2AA      "  1485     "
914 S SUBC 11    1.000000  1.0  0.1 17.0 .3731.814 .233  .07 .058 .019  ALL05670 V5/U4 G2AB/H    "  1486     "
915 S SUBC 10    1.000000  0.9  0.1 20.0 .3661.825   .2 .125 .125  .01  ALL05680 U3    G2AE/G    "  1487     "
916 S       ? 30 1.500000  1.0  0.2 22.0 .2631.389 .079 .357  .04 .012  ALL05690 (Y2)  G2AI     CL 199      235
917 S       ? 12 2.500000  1.0    0 17.0 .308  2.0 .233 .059 .058 .035  ALL05700 V8    G2AJ      "   " 62    "
918 S       ? 11 2.000000  1.0  0.1 14.0 .2971.585  .25 .117  .05 .025  ALL05710 V8/U8 G2AJ      "   " 12    "
919 S       ? 31 1.500000  1.0  0.1 18.0 .286  1.5 .167 .333  .05 .013  ALL05720 (Y1)  G2AH      "  192      "
920 S       ? 15 2.000000  1.0  0.1 18.0  .27  1.6 .167   .2  .05 .025  ALL05730 W8    G2AJ      "   " 12    "
921 S       ? 16 1.500000  1.0  0.1 19.0 .311.701 .269 .269  .06  .03  ALL05740 W8    G2AJ      "  194      "
922 S       ? 17 1.500000  1.0  0.1 16.0 .2941.375 .125 .275 .031  .12  ALL05750 W8    G2AJ      "  52/3     "
923 S       ? 14 1.500000  1.0  0.1 10.0 .4432.388 .347 .102  .01 .143  ALL05760 W9    G2AF      "  42       236
924 S SUBC 23    1.000000  1.0  0.1 40.0 .348 1.63  .25   .1  .01 .015  ALL05770 X1/Y1 G2AH/I    "  37        "
925 S SUBC 10    1.0000000000000000000000 .3641.705 .3410000000000 .034  ALL05780 /     G2A       "  "         "
926 S SUBC 30    1.200000  1.0  0.2 50.0 .281.539 .154 .335 .031 .015   ALL05790 (Y3)  G2AC      "   " 148   "
927 S SUBC 20    1.000000  0.9  0.4 40.0 .2921.667 .333   .2 .056 .033  ALL05800 X1    G2AI      "  38        "
928 S SUBC 25    1.000000  0.9  0.2 50.0 .321.524 .143 .238 .029 .033   ALL05810 Y1    G2AH      "  41        "
929 S SUBC 32    1.000000  1.0    0 50.0 .2500000   .2  .24 .028 .016   ALL05820 /     G2A       "  "         "
930 S SUBC 16    1.000000  1.0    0 16.0 .3411.825 .238  .19 .048 .008  ALL05830 W1    G2AG     HS 1471      209
931 S SUBC 9     1.500000  1.0    0 18.0 .4391.706 .294 .118 .088 .009  ALL05840 U3    G2AE/G    "  1472      "
932 S       ? 10 1.200000  1.0    0  9.0 .3331.733 .444 .089 .044 .044  ALL05850 U5    G2AI     CL 196       235
933 S       ? 11 1.500000  1.0    0  9.0 .3832.158 .316 .079 .053 .066  ALL05860 V6/U5 G2AI         " 12      "
934 S       ? 18 1.200000  1.0  0.1 25.0 .3851.806 .242 .161 .032  .04  ALL05870 X2    G2AH -       " A       "
935 S       ? 12 1.500000  1.0    0 13.0 .3251.552 .158 .207 .034 .017  ALL05880 V1    G2AA         " 12      "
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 936 S     ? 8    1.200000  1.0      0 16.0 .341  2.0 .333 .067 .017  .05   ALL05890  /     G2A    CL  197     235
 943 L CORO 9     1.200000  1.0      0  8.0 .4382.444 .389    0 .028 .069   ALL05900  U3    G2BF   CL  26      237
 944 L CORO 13    2.500000  1.0      0  6.0   .5  3.0 .514    0 .014   .2   ALL05910  V1    G2BK   103127      182
 945 L?CIRC 21    1.000000  0.9    0.2 26.0 .4792.794 .476 .111 .008 .079   ALL05920  X8    G2BI   ZI  693     ?
 946 L WERI 13    1.500000  0.800000 17.0 .3091.673 .364 .091 .036 .027   ALL05930  /     G2B    FOR 2190    238
 947 L WERI 26    1.200000  0.7    1.0 14.0 .3461.722 .309 .227 .021 .041   ALL05940  Y2    G2BH   "   2185    "
 948 L WERI 35    1.000000  0.9    0.7 25.0 .3712.591 .455 .273    0 .055   ALL05950  (Z2)  G2BH   "   2187    "
 949 L WERI 22    1.000000  0.7    0.9 20.0 .5452.357 .714 .143    0 .143   ALL05960  X8    G2BI   "   "       "
 950 L WERI 10    1.000000  0.9    0.9 34.0  .552.733   .5 .167 .017 .257   ALL05970  U2    G2BI   "   "       "
 951 L WERI 25    1.5   7.0 0.8    0.5 16.0 .4021.905 .417 .214    0 .071   ALL05980  Y4    G2BI   "   2081    "
 952 L WERI 28    1.2   7.0 0.7    0.9 17.0 .4572.044 .444 .133 .006 .067   ALL05990  Z2    G2BH   "   2080    "
 953 L WERI 41    1.0   6.0 0.6    0.3 45.0 .4272.127 .423 .246    0  .07   ALL06000  (Z2)  G2BH   "   2079    "
 954 L WERI 11    1.200000  0.8    0.5 15.0 .351  2.0 .375 .038 .063 .025   ALL06010  U6/V6 G2BH   "   2189    "
 955 L WERI 29    1.200000  0.7    0.7 18.0 .3391.638 .381   .4 .024 .038   ALL06020  Z2    G2BH   "   2184    "
 956 L WERI 26    1.0   7.0 0.7    0.9 17.0 .387  1.3  .55   .1  .01  .07   ALL06030  Y2    G2BH   "   2188    "
 957 L CIRC 20 0000000000 0.9    0.1 50.0 .3621.561    0 .183  .03    0   ALL06040  X1    G2BE       56468   191
 958 L CIRC 16    1.0   8.0 0.9    0.1 70.0 .3191.713  .25  .25 .006 .019   ALL06050  X1    G2BE       56466   "
 959 L CIRC 19    1.000000  1.0    0.1 80.0 .2941.627   .2   .2  .02 .007   ALL06060  X1    G2BE       56480   "
 960 L CIRC 15    1.000000  0.9    0.2 50.0 .2942.065 .242 .242 .016 .024   ALL06070  W5    G2BD       56471   "
 961 L CIRC 13    1.0   7.0 1.0    0.1 50.0 .403  2.2 .333 .078 .044 .056   ALL06080  V2    G2BF       56472   "
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SPECIMENS CITED FROM COLLECTIONS ABROAD (all G_{2b} zone)

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 X26 L WERI 35   1.000000  .65   .5 30.0 .3991.967 .533 .303    0 .076   Ref. Demanet 1943 Pl.7, 18
 X27 L WERI 31   1.000000  .75   .5 12.0 .394 1.93 .252 .241 .001 .043        "      "     "   6
 X28 L WERI 33   1.100000   .8  .65 22.0 .4311.734 .424 .237 .002 .051        "      "     "   2
 X30 L WERI 12   1.200000   .9   .3 12.0 .4021.896 .292 .042    0 .104        "      "     "   15
 X31 L WERI 34   1.300000   .7   .7 13.0 .4462.102 .381 .229    0 .093        "      "     "   1
 X33 L WERI 35   1.400000  .75   .6 36.0 .4231.779 .369 .311    0 .065        "      "     "   13
 X37 L WERI 43   1.000000  .85   .6 15.0 .3921.595 .281 .353    0 .033        "      "     "   3
 X38 L WERI 31   1.100000   .8  .75 11.0 .3471.759  .33 .277    0 .067        "      "     "   3
 X39 L WERI  9   1.200000   .9   .5 22.0 .3131.689 .133 .071 .056 .044        "      "     "   12
 X40 L WERI 11   1.500000   .8   .8 29.0 .398  2.0 .341 .122 .037 .049        "      "     "   11
 X42 L WERI 10   1.600000   .8   .7 15.0 .4171.951 .561 .049 .049 .073        "      "     "   14
 X43 L WERI 44   1.100000  .75   .3 27.0 .3931.771 .478 .446 .001 .076        "      "     "   7
 X44 L WERI 29   1.200000   .7  .75 14.0  .351.778 .398 .306    0 .046        "      "     "   7
 X46 L WERI 33   1.000000  .75   .5 26.0 .3481.632 .338 .278    0 .053        "      "     "   5
 X47 L WERI 22   1.000000   .7  .75 17.0 .3511.841 .455  .33 .001  .04        "      "     "   5
 X54 L CREN 59   1.200000   .8   .5 12.0 .463  2.1  .25  .21    0 .035        "      "   Pl. 6, 3a    Musée Roy. Histoire
 X55 L CREN 41   1.100000   .8   .5  9.0 .4562.448  .36 .104    0 .064        "      "     "   3a     Natur. Belgique,
 X56 L CREN  7   1.400000   .9   .2 19.0 .403 1.92   .2   .1 .024 .032        "      "     "   6        Brussels.
 X58 L CREN  5   1.100000   .9   .1 23.0 .446 2.19 .262 .081 .043 .014        "      "     "   7
 X60 L CREN 45   1.100000   .8   .5 38.0 .3681.769 .313 .469    0 .038        "      "     "   2
 X61 L CREN 26   1.000000  .85   .8 18.0 .313 1.56   .4  .18 .013 .035        "      "     "   5
 X62 L CREN 12   1.300000  .85   .5 16.0 .3771.977 .279  .07 .081  .07        "      "     "   15
 X64 L CREN 16   1.400000  .85   .3  8.0 .3991.762 .381 .063 .048 .056        "      "     "   9
 X65 L CREN 12   1.800000   .8   .1  6.0  .361.935 .522 .022 .011 .087        "      "     "   9
 X66 L CREN 17   1.600000  .75   .5  9.0 .3551.845 .397 .052 .034 .052        "      "     "   16
 X67 L CREN 37   1.200000  .85  .75 35.0 .4052.198 .331 .062    0 .091        "      "     "   17
 X68 L CREN 45   1.200000   .9   .4 40.0 .4331.908 .342 .329    0 .023        "      "     "   10
 X69 L CREN 17   1.700000   .8   .3 11.0 .3331.492 .206 .103 .035  .04        "      "     "   11
 X70 L CREN 25   1.600000   .8   .8 17.0 .3291.538 .385 .238 .001 .053        "      "     "   22
 X71 L CREN 17   1.500000  .75   .8 12.0 .3311.437 .465 .183 .047 .056        "      "     "   22
 X72 L CREN 12   1.300000   .7   .3  7.5 .3972.222 .089 .056 .067 .056        "      "     "   20
 X73 L CREN 35   1.800000   .8   .5 42.0 .3481.948 .407 .407    0 .061        "      "     "   18
 X74 L CREN 11   1.700000   .8   .6 16.0 .4442.231 .333 .031 .041 .077        "      "     "   14
 X76 L WERI 30   1.200000   .9   .2  7.0 .4131.806 .463 .065    0 .065   Ref. Patteisky 1965 no. 1888
 X83 L WERI 23   1.000000  .75   .5 24.0 .3841.676   .5 .111    0 .056        "        "      26716
 X96 L LIST  9   1.700000   .9   .1 12.0 .4743.222 .648 .004 .037 .204        "        "      1693
X102 L CIRC 18   1.200000   .8   .7 11.0 .3331.625 .153 .194 .035 .014        "        "      1549    Böchum
X106 L LIST 25   1.700000   .8   .6  5.5 .4772.337 .361 .048 .001 .145        "        "      2706
X107 L LIST 26   1.500000   .9   .5  5.0 .4872.216 .318 .034 .034  .08        "        "      1173
X138 L WERI 35   1.200000   .8   .8 16.0 .4331.855 .419 .194    0 .056        "        "      9916
X150 L CIRC 10   1.100000   .8   .6 16.0 .2591.612 .224 .102 .047 .016     Cat. no.  480 119 - Göttingen
X160 L CIRC 24   1.100000  1.0   .2  7.0 .3631.677 .323 .129 .032 .054     Cat. no.     1060 - Essen

END OF LISTING OF FILE :GLSWAN.SOURCELIBRARY(1,*,1).WERIDATA(1) FOR USER :GLSWAN AT 1984/07/09__14:59:22

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Appendix 4b : Holotypes

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        AMAL 45    1.000000    .9   .56 38.0 .175    .9  .02  .48  .05    0
        ARAI 25    1.0   5.0  1.0     0 29.0  .26 1.35   .1  .28 .004 .015
      ASIAM 36  1.15   7.3   .82    .7 14.5 .305 1.45    0  .22 .035    0
      ATTEN 77    1.0   7.0  1.0     0 60.0  .42  1.4  .13  .36    0  .05
       BISA 26    1.6   8.0   .56   .84 47.0   .5 1.78  .47  .14  .75  .04
       CONT 51    1.0  13.7   .98     0 41.0  .39 1.35  .02  .36    0    0
       DELI 11    2.2   9.2   .72   .65 15.0  .52  1.8  .37   .1  .14  .08
       DEPR 40    1.0   4.7    .9   .16 60.0 .285 1.75 .2300000 .012 .022
      DILAT 25    1.1   6.3   .85   .28 23.0 .505 1.95  .57  .08 .075 .084
       ELEG 13    2.0   9.0   .79   .56 11.0   .5  2.1  .48  .08  .16 .045
      EXTEN 15    2.0  12.5   .78    .9 22.0   .5  1.7  .64 .085  .17  .02
     FITTSI 50    1.0   6.7  1.0     0 80.0  .41 2.25  .27   .1  .13 .045
       GLEN 25    1.0   5.0   .93   .43 50.0  .36  2.7  .27  .06  .15  .06
      HUNTS 28    1.0   6.5   .68   .75 30.0  .53  2.4  .45  .08 .045  .07
     INFANS  9    1.5   9.2   .75   .61 17.0  .54  1.8   .5  .14  .09 .075
      KUTEJ  9    1.0   6.5   .94   .24 36.0  .27  1.6   .4  .06  .01  .02
      LUPIN 26    1.0   4.8   .95    .3 40.0  .28 1.55  .17  .28  .17  .04
       MART 35    1.300000    .7   1.0   8.0 .3832.083 .409 .191 .017 .096
       MELV 20    1.3   6.0   .71    .8 17.0  .48  2.5  .65   .1  .09 .185
      PARAS 32    1.000000   .8900000 14.0 .415  1.7    0  .17 .045    0
       RURA 30    1.5  10.0   .79   .84 14.0  .32  1.6  .23  .21  .07  .03
      SOLID 14    1.2   5.8   .51   .76 18.0  .32 1.95  .32  .22 .055  .08
      TENER 14    1.3  12.2   .62   .83 20.0 .315  1.5   .2  .15  .14  .01
G1AD   CANC 25    1.0   7.0    .4    .8 32.0 .3590000 .138 .214 .054 .018
G1AB  EVANS 23    1.1   8.0    .3    .7 55.0 .314 1.37 .185 .185 .085 .011
G1AF  CARIN 46000000000000000000000000000 .2251.1390000000000000000000000
G1BC  CRENU 35    1.0   7.0    .5    .9 18.0 .2500000 .125 .156 .018 .015
GIBD   CUMB 15    2.0   8.0   .85    .2  7.0 .3680000 .229 .086 .0430000
G2AD   SUBC     (NOT AVAILABLE
G2BA  BELGI 44    1.100000   .75    .3 27.0 .3931.771 .478 .446 .001 .075
G2BB   LIST 22    2.0  10.0000000000   9.0 .4592.194 .389 .083 .056 .085
G2BD   CIRC 25    1.1   8.0    .9   .100000 .3480000 .217 .1960000000000
G2BH  ADLER 24    1.000000  1.0    .1 16.0 .2820000  .13  .06  .01  .02
G2BI   WERI 34    1.3  11.0    .7    .7 13.0 .4462.102 .381 .229    0 .093
CANCELLATUM 19    1.0   6.0    .4    .9 50.0 .4210000 .4910000000000 .055
  CORONATUM 17    1.0  10.0    .9    .2 28.0 .4832.407 .373 .085    0 .102
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