Time, Trade, and Identity: Bone and Antler Combs in Northern Britain c. AD 700-1400

Volume 2 of 2: Data, Images, and Appendices

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THESIS CONTAINS

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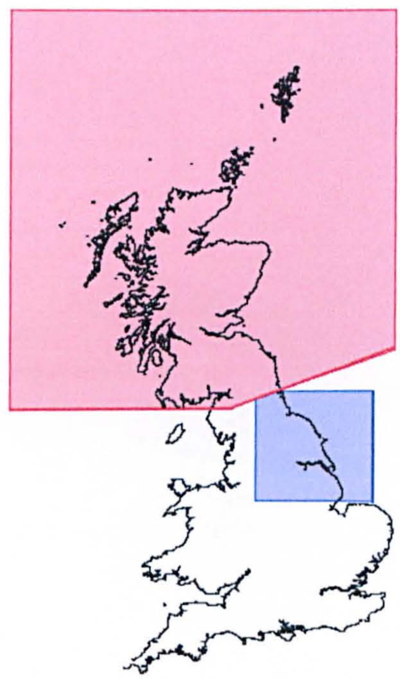


Figure 1. 1 Outline of the study areas

Figures for Chapter 2

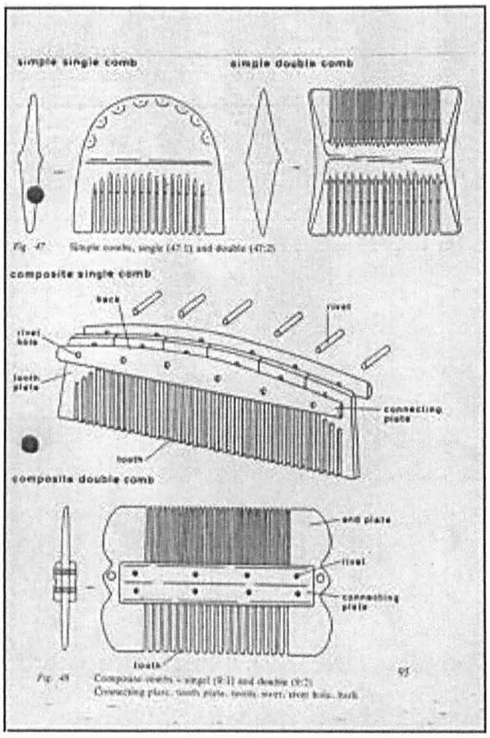


Figure 2. 1 The four basic forms of comb (Ambrosiani 1981: 95). All typologies work within this basic template.

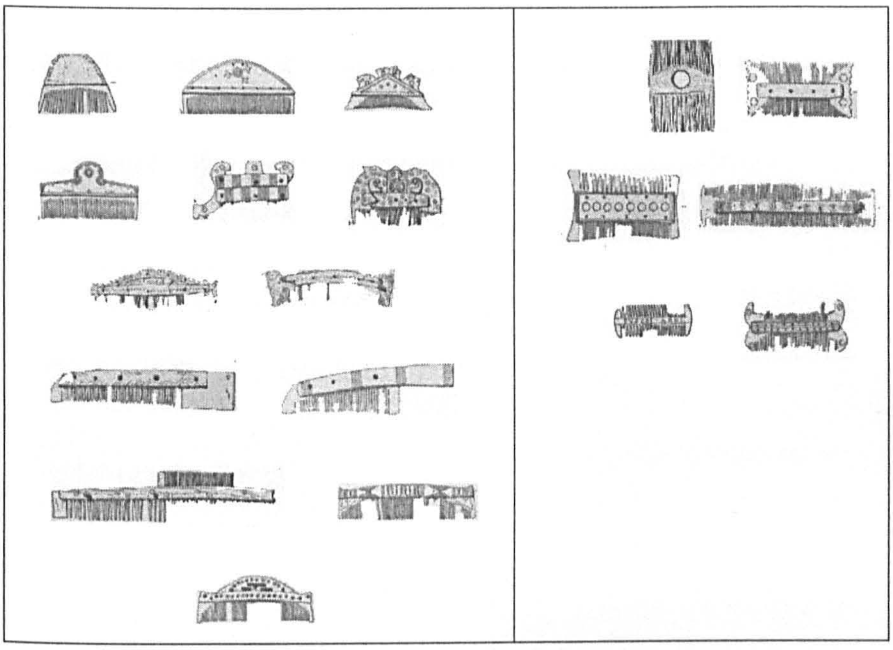


Figure 2.2 A selection of the comb types discussed by MacGregor (1985: 77-93).
See also Table 2.1

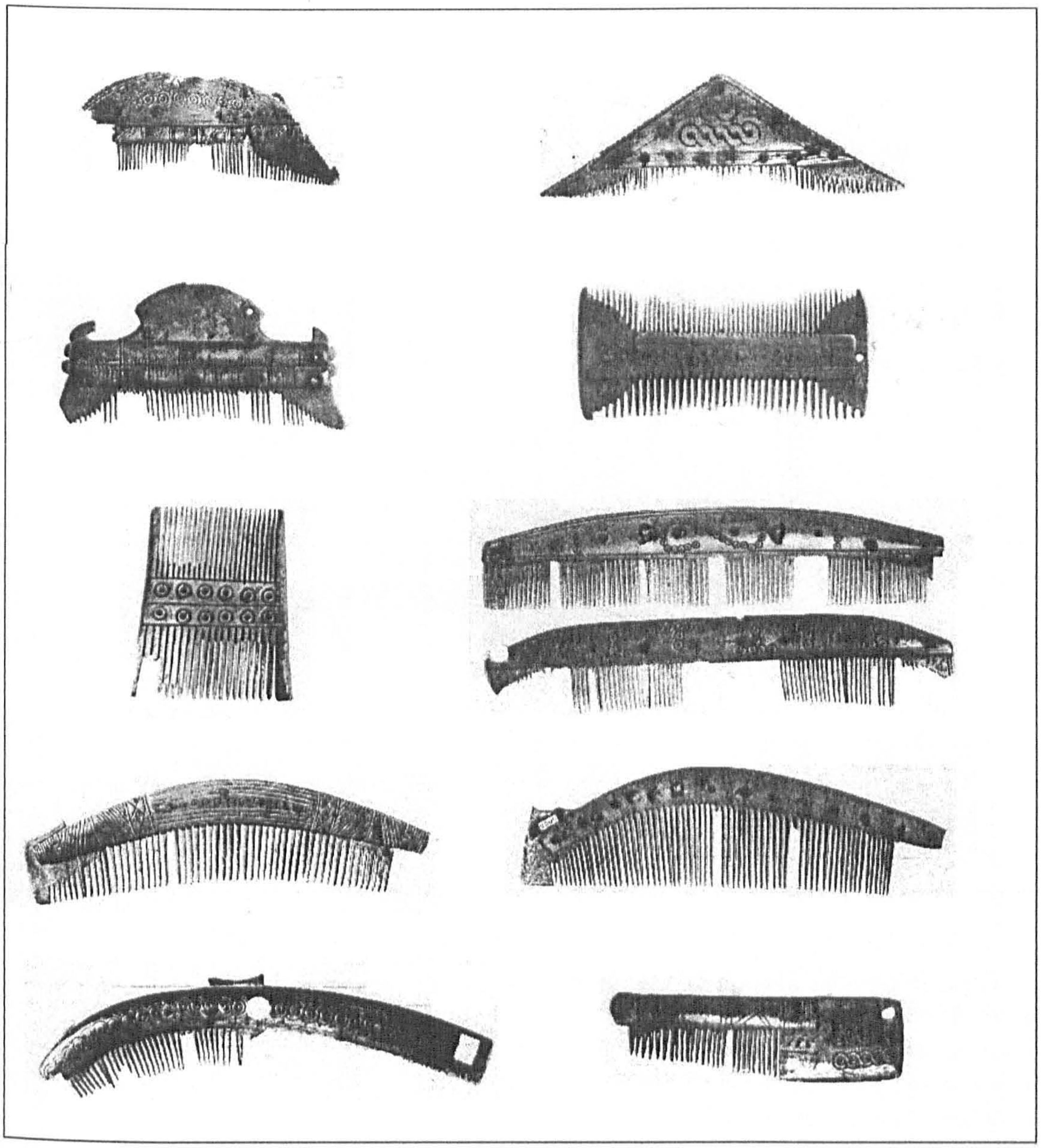


Figure 2. 3 A selection of combs from the Frisian Terpen (after Roes 1963)

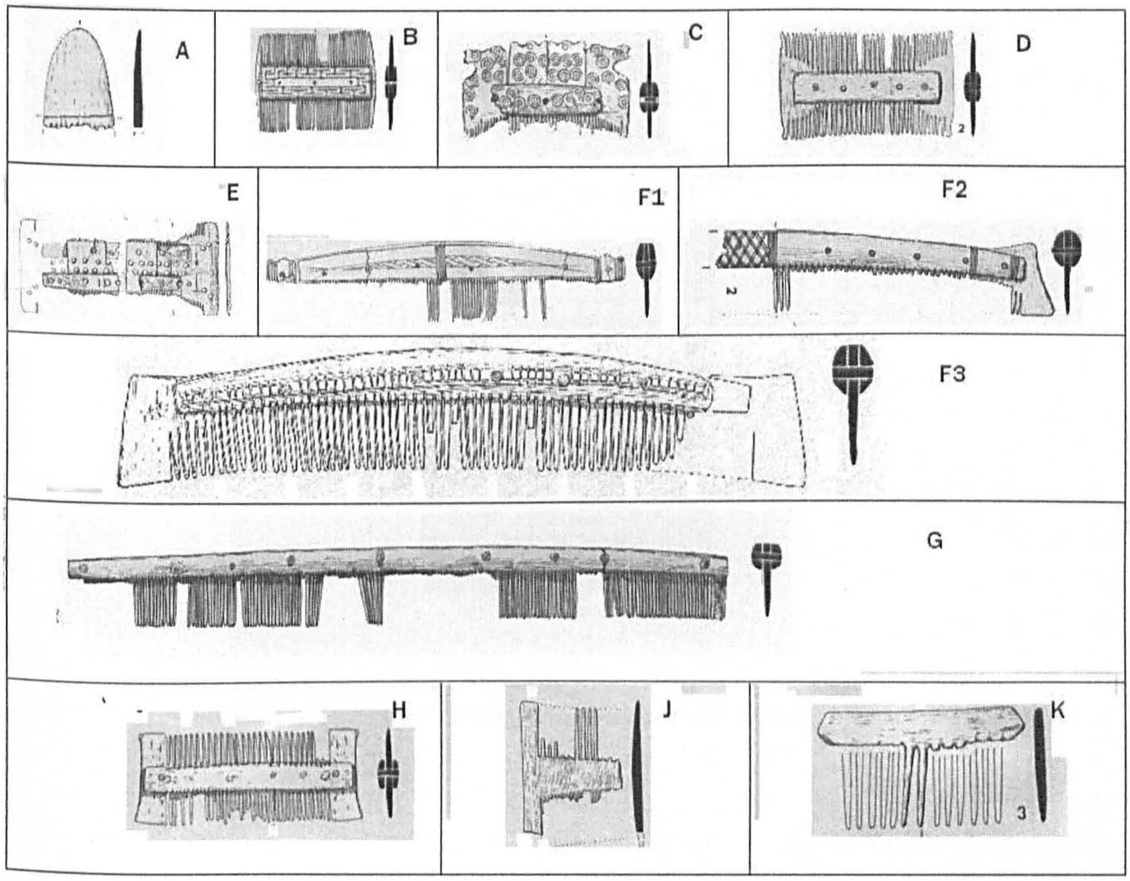


Figure 2.4 Some types from Dunlevy's (1988) classification of Irish Combs

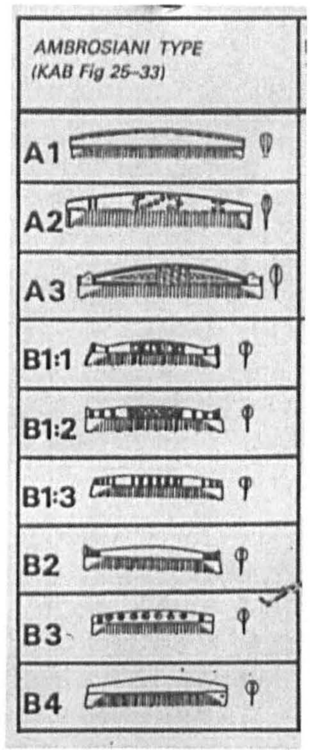


Figure 2. 5 Ambrosiani's typology for combs from Birka and Ribe
(adapted from Ambrosiani 1981: 19)

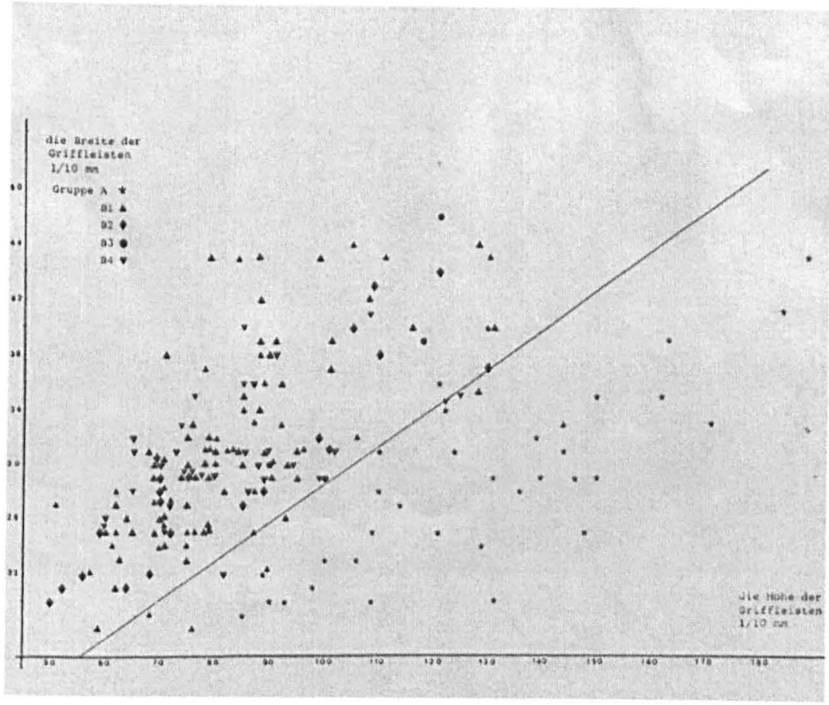


Figure 2. 6 Size distribution of A and B combs (Ambrosiani 1981)

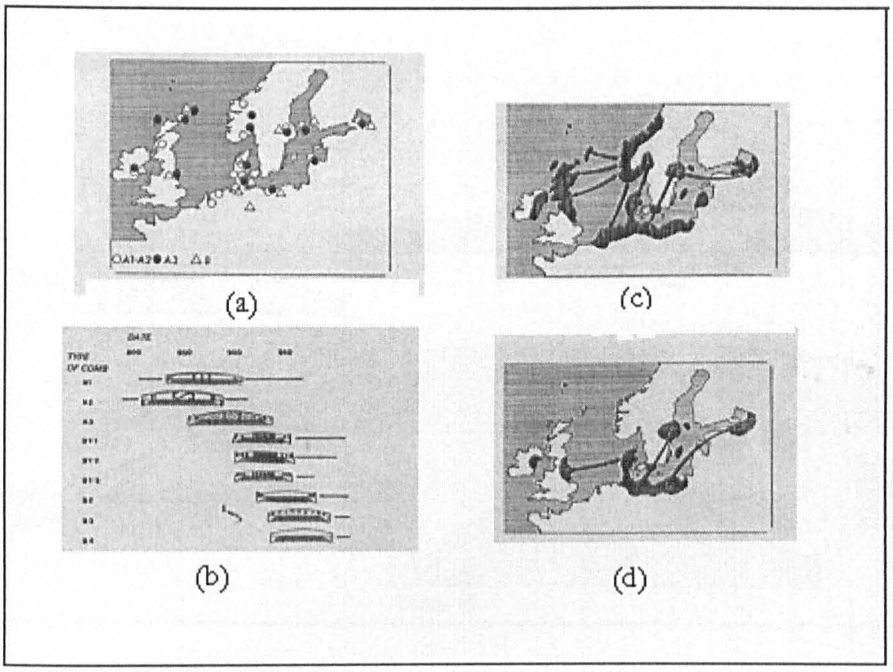


Figure 2. 7 Ambrosiani's (1981) proposed distributions, origins, and time ranges for A and B Combs: (a) Findspots; (b) Birka chronology; (c) proposed means of distribution of A Combs; (d) proposed means of distribution of B Combs.

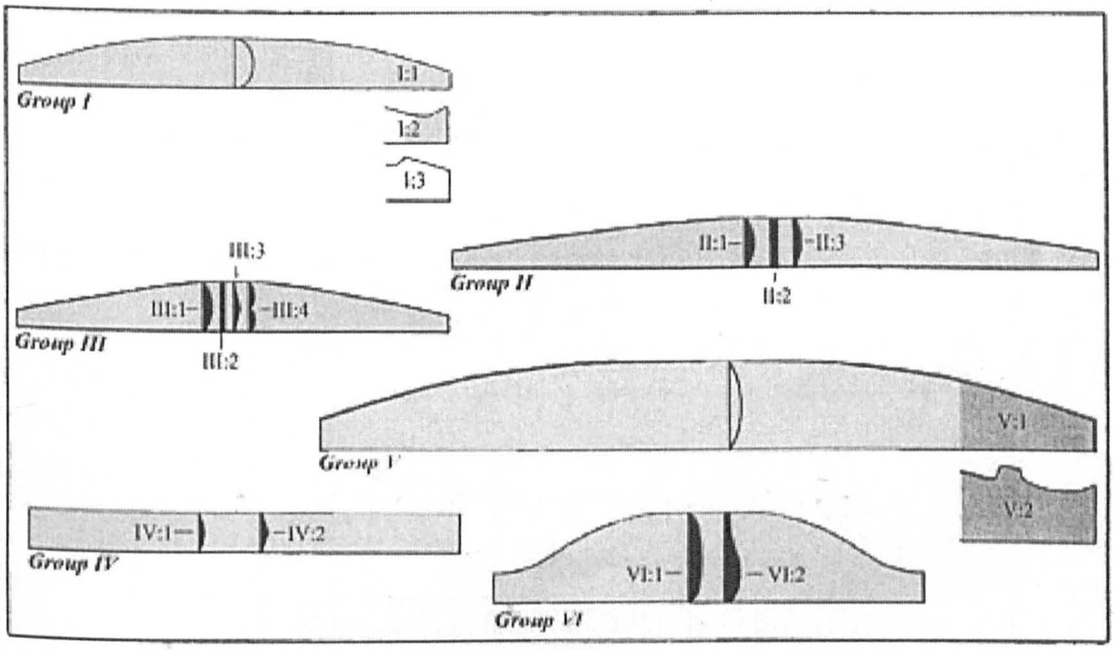


Figure 2. 8 Smirnova's Novgorod classification (Smirnova 2005: fig 3.67)

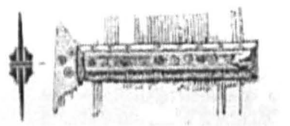
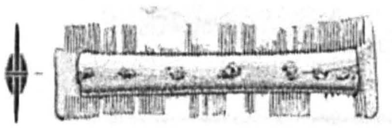
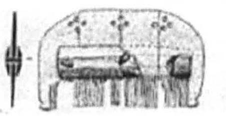
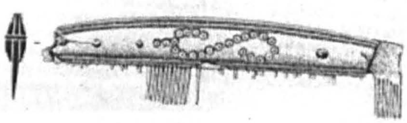
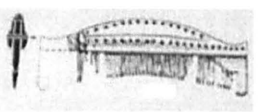
Double-sided Type A	
Double-sided Type B	
High-Backed	
'Norse'	 

Figure 2. 9 Curle's (1982) Brough of Birsay classification

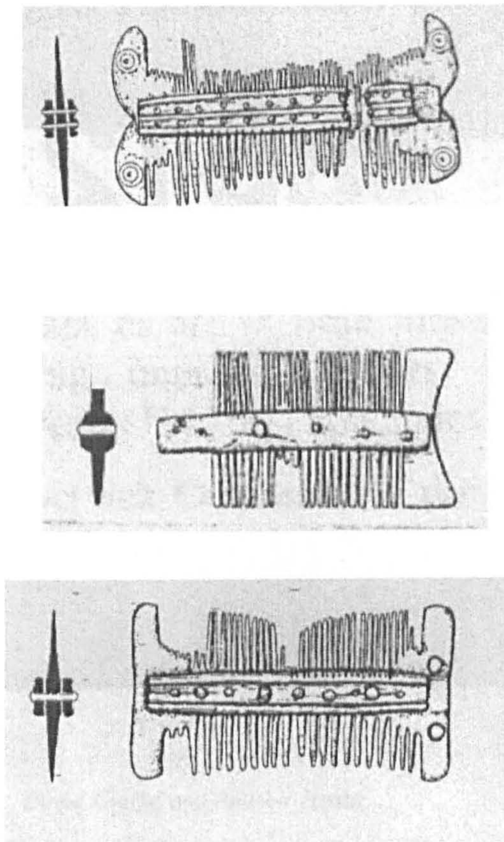


Figure 2. 10 Clarke and Heald's (2002) Classification of Scottish medieval ombs: 'fishtail', concave-ended , and straight-ended double-sided combs

COLOUR IN ORIGINAL

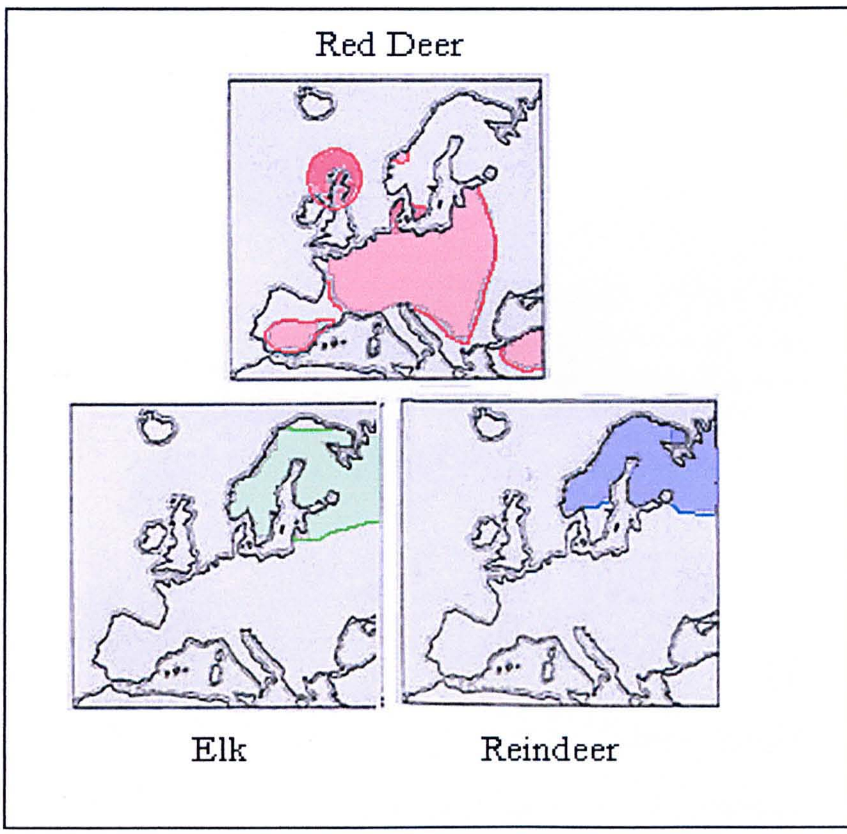


Figure 2. 11 Biogeographic zones of various cervids (adapted from MacGregor 1985: 33)

COLOUR IN ORIGINAL

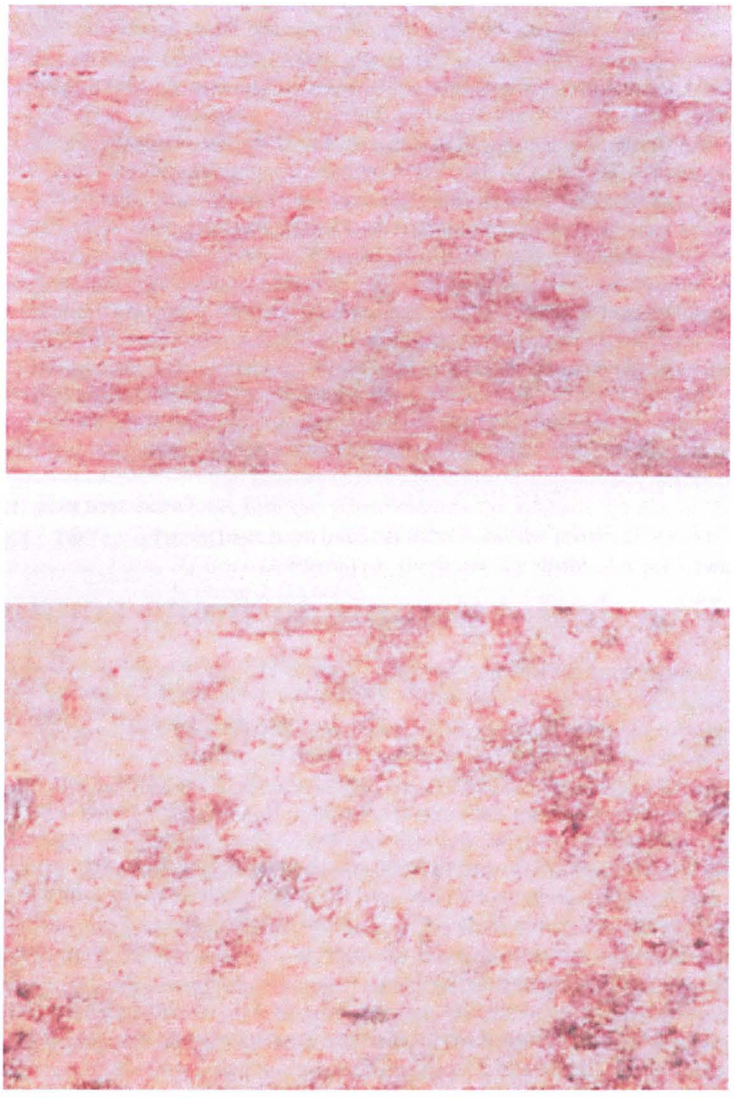


Figure 2. 12 Differentiation of (a) antler and (b) bone (Ambrosiani 1981: 104-105). Ambrosiani claims that antler is more lenticular than bone, but the published images are ambiguous.

COLOUR IN ORIGINAL

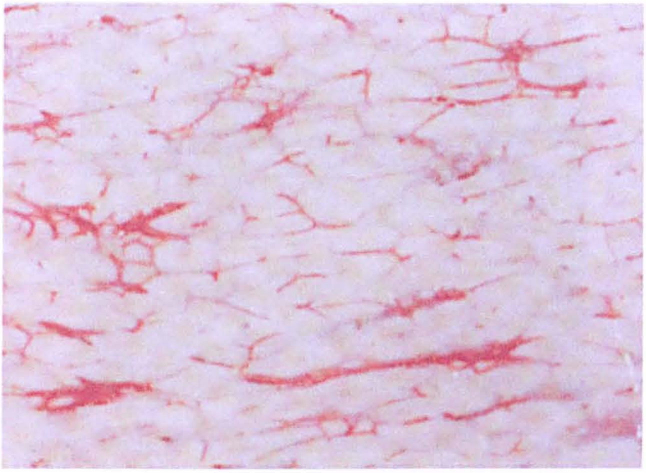
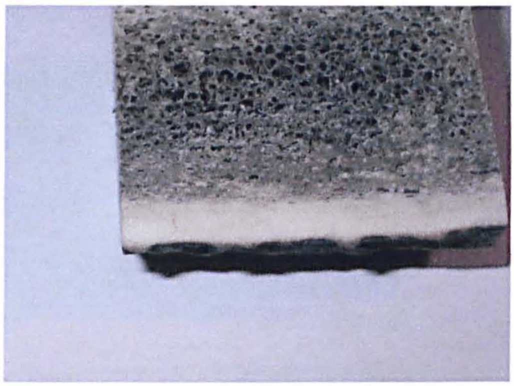


Figure 2. 13 Recognition of recent elk antler by presence of blood vessels (Ambrosiani 1981: 107). The images shows modern antler, but Ambrosiani argues that the features of interest are preserved in archaeological material as 'black threads'.

COLOUR IN ORIGINAL



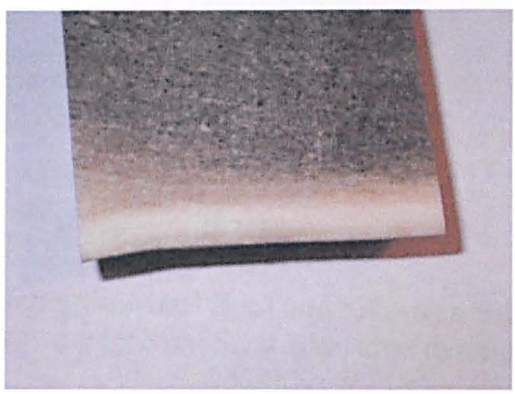


Figure 2. 14 Distinctive macrostructure in red deer (top) and reindeer (bottom) antler. Note gradational compacta/core boundary in the latter. The distinction is clear under low-power microscopy (see Chapter 5 for micrographs), but in many large, part-worked fragments is also evident with the naked eye

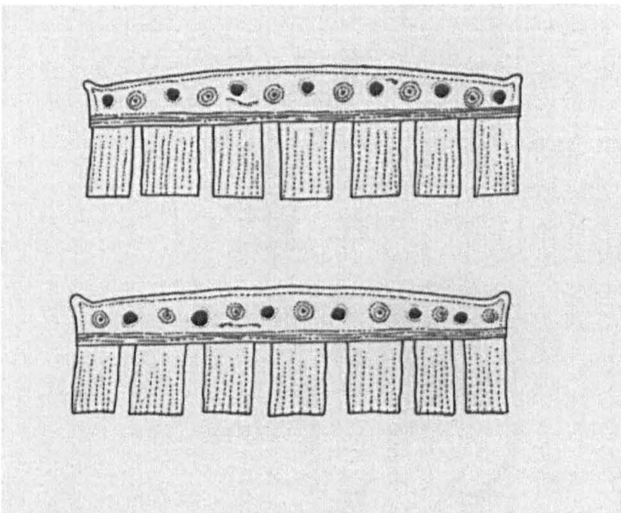


Figure 2. 15 'Eastern Scandinavian' (top) and 'Western Scandinavian' (bottom) riveting techniques (drawing by Sven Schroeder, after descriptions from Smirnova 2002)

Figures for Chapter 4

COLOUR IN ORIGINAL

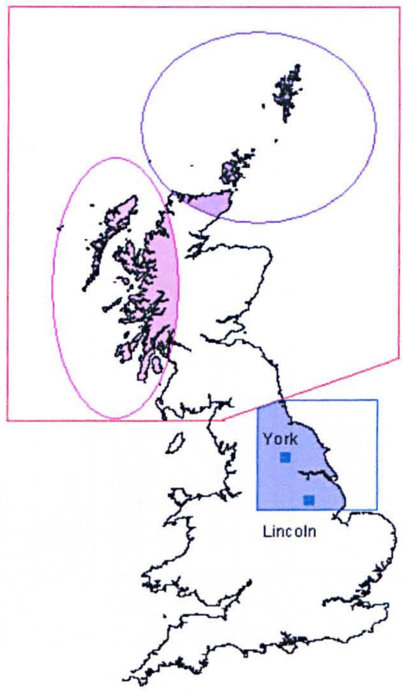


Figure 4. 1 Regions of interest (northern England and Scotland), and more focused case studies (York, Lincoln, northern Scotland and western Scotland).

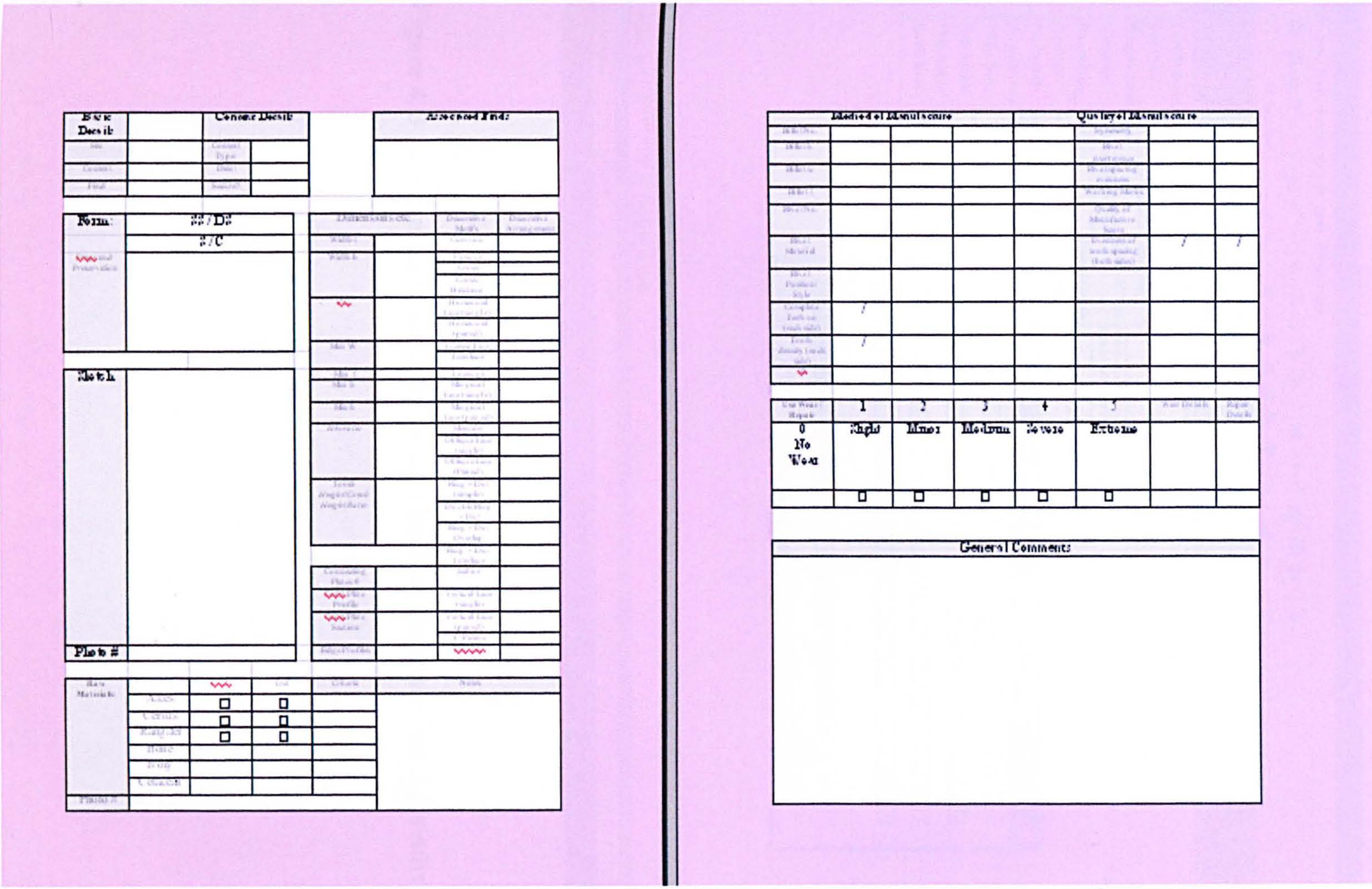


Figure 4. 2 Example of a recording sheet

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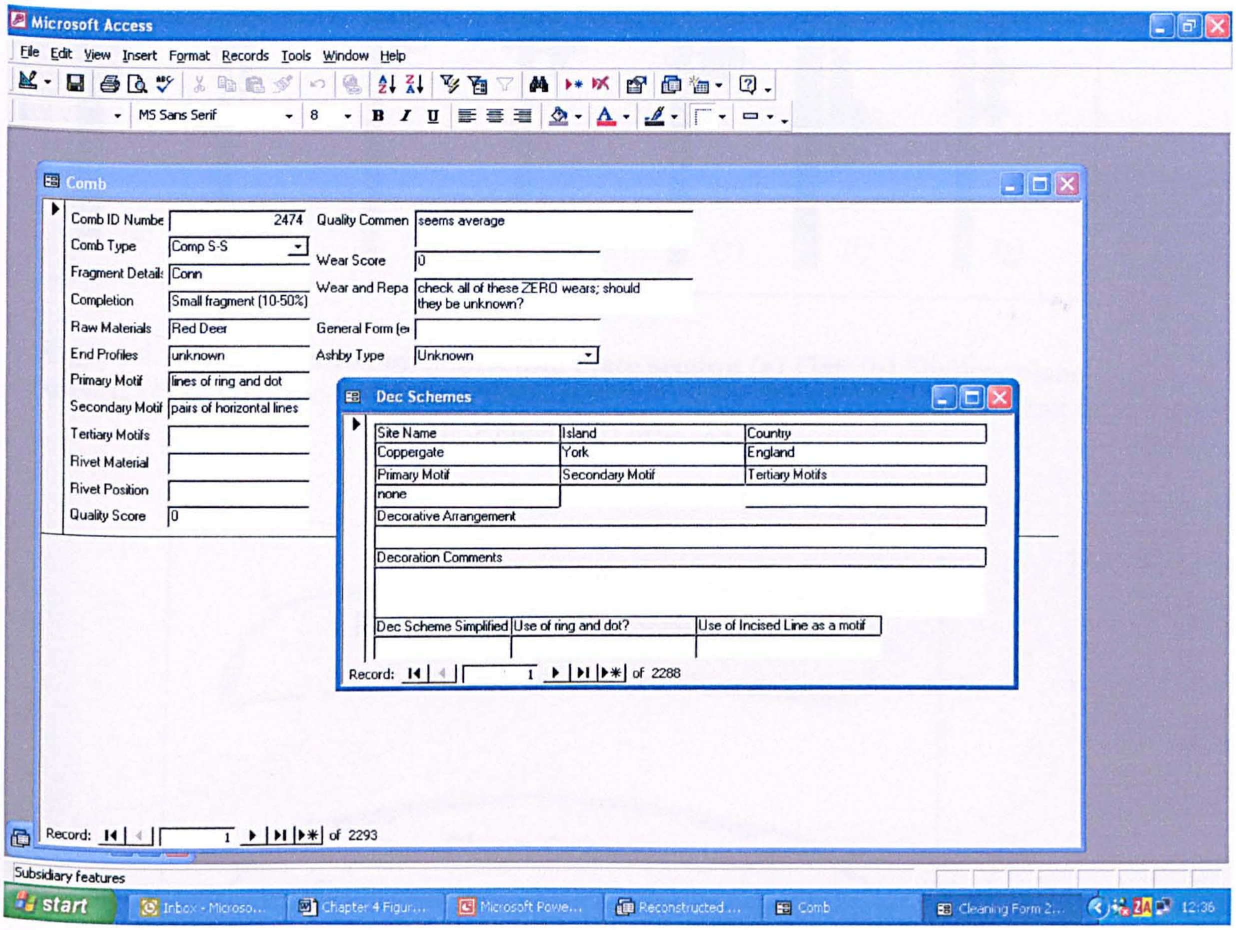


Figure 4. 3 An example of an entry in the *Combase* database (see Appendix IV)

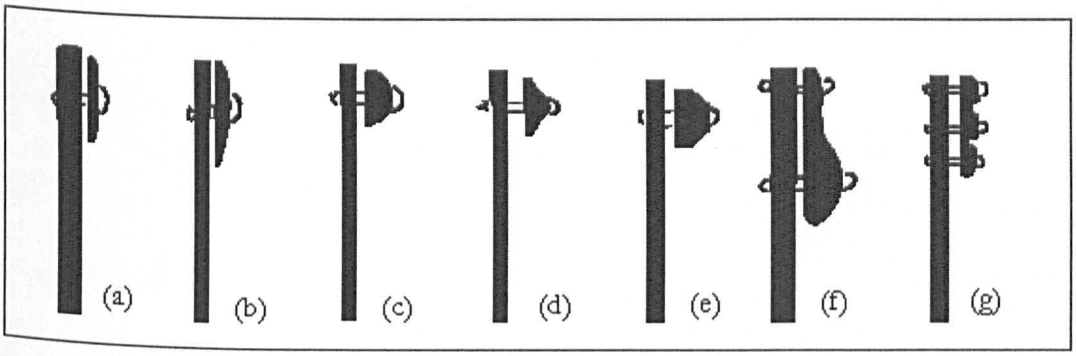


Figure 4. 4 Classification of connecting plate section (a) Flat; (b) Shallow plano-convex; (c) Deep plano-convex; (d) triangular; (e) trapezoidal; (f) plano-piriform; or 'false-ribbed'; (g) grooved.

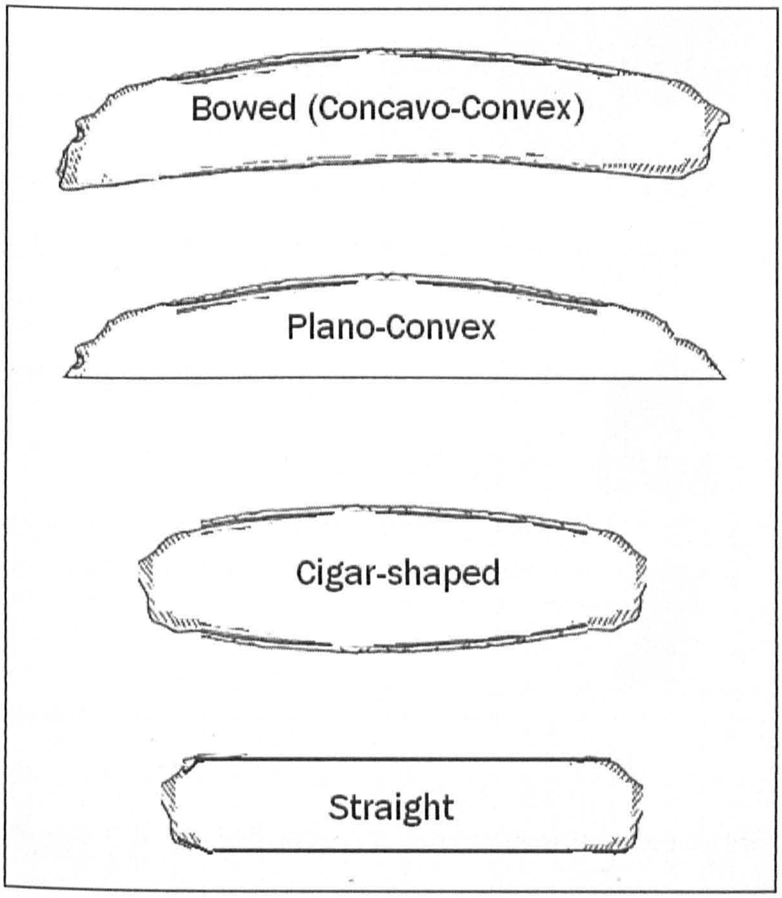


Figure 4. 5 Classification of connecting plate profile

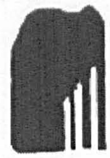
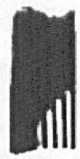
1A	Straight, unhorned	
1B	Straight, horned	
1C	Sloping, unhorned	
1D	Sloping, horned	
1E	Zoomorphic Upper Edge	
1F	Complex End Profile	

Figure 4. 6 Classification of endplate profile (single-sided)

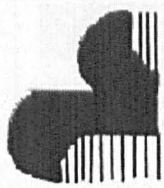
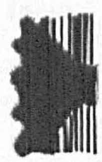
2A	Straight End Profile	
2B	Concave End Profile	
2C	Convex End Profile	
2D	Biconvex ('Butterfly' or 'Fishtail') End Profile	
2E	Offset Ends	
2F	Complex End Profile	

Figure 4. 7 Classification of endplate profile (double-sided)

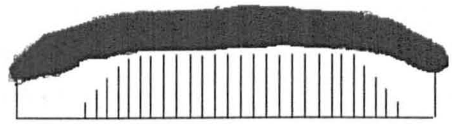
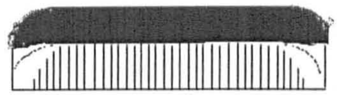
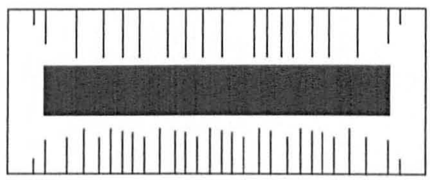
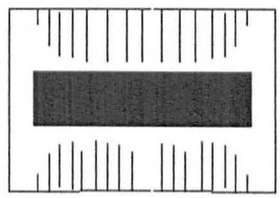
Short Bowed	
Short Straight	
Long Bowed	
Long Straight	
Long Double-Sided	
Short Double-Sided	

Figure 4. 8 Classification of overall form

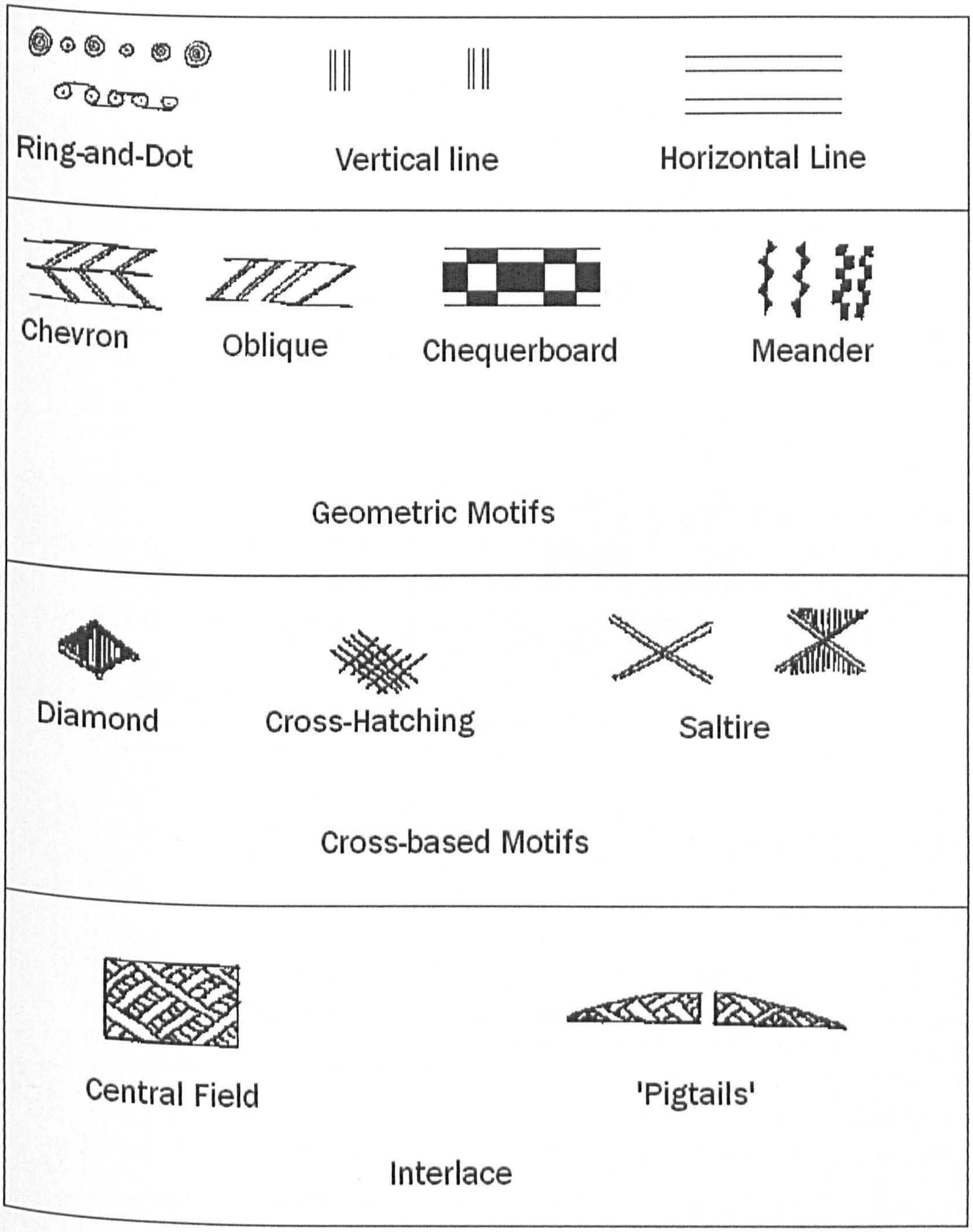


Figure 4. 9 Classification of decorative motifs

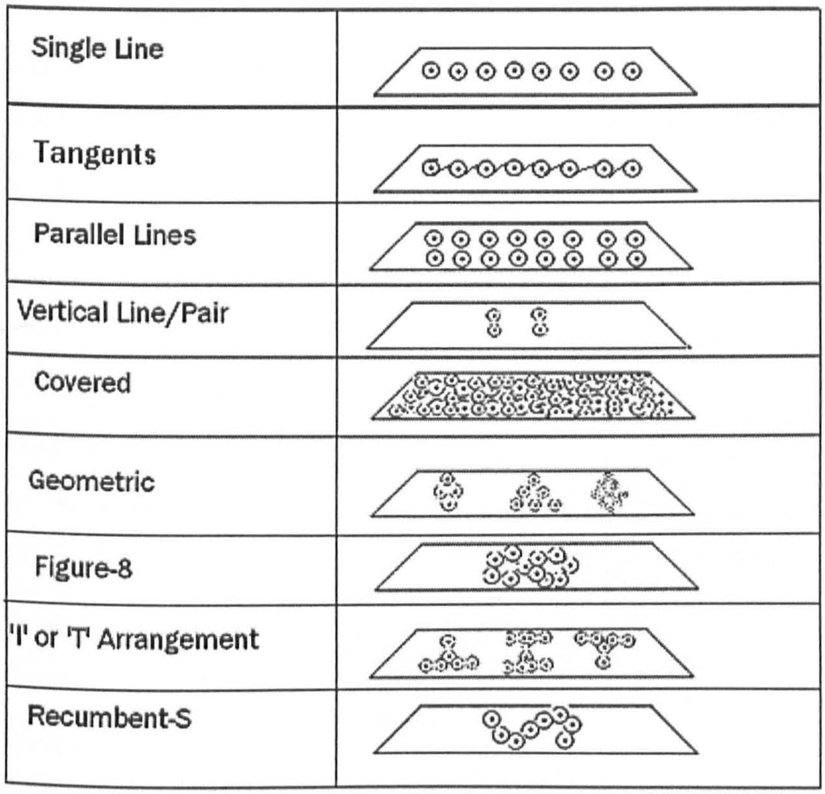


Figure 4. 10 Classification of decorative arrangements

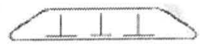
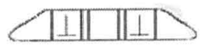
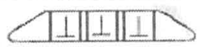
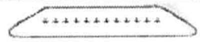
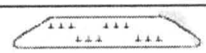
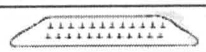
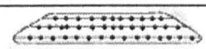
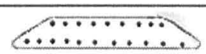
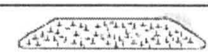
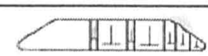
1A	Central Field	
1B	Horizontal Panels	
1C	Terminal Ornament Only	
1D	Single Large Motif	
1E	Multiple Large Motifs	
1F	Alternate Fields	
1G	Every Field	
1H	Central Line of Motifs	
1J	Alternating/Offset Lines of Motifs	
1K	Parallel Lines of Motifs	
1L	Marginal Line Only	
1M	Rivet-and-Groove	
1N	Rivets Only	
1Q	Covered	
1P	Asymmetrical	
1R	Unornamented	

Figure 4. 11 Decorative schemes (single-sided)

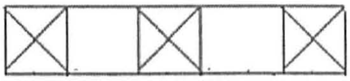
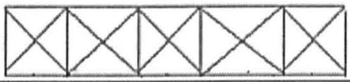
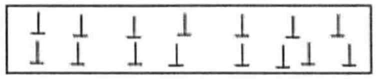
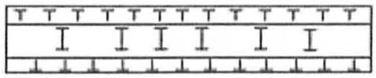
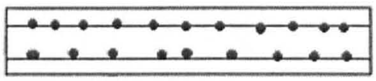
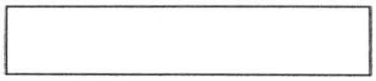
2A	Alternating Fields	
2B	Every Field	
2C	Covered	
2D	Parallel Lines	
2E	Central Line	
2F	Horizontal Panels	
2G	Rivet-and-Groove	
2H	Unornamented	

Figure 4. 12 Decorative schemes (double-sided)

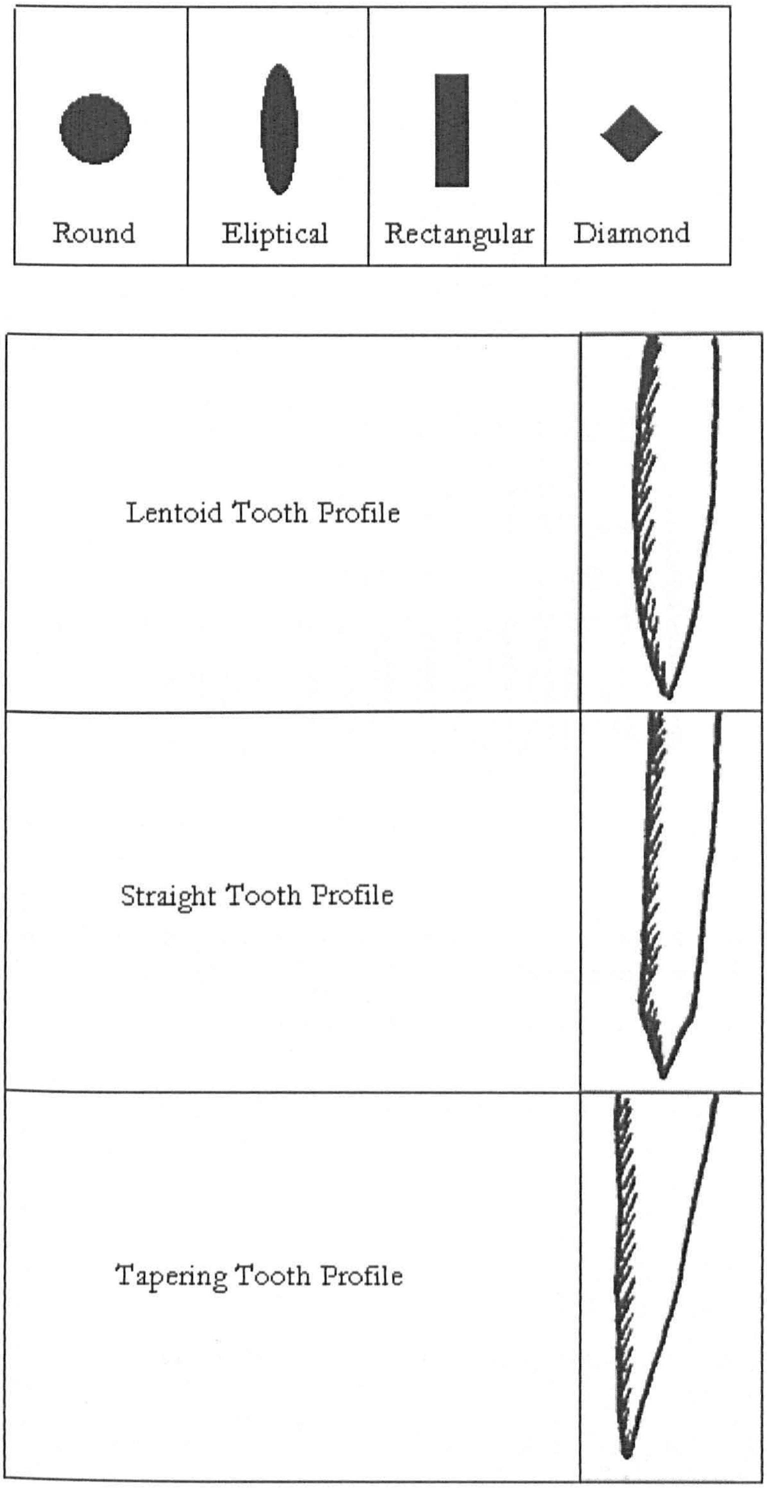


Figure 4. 13 Classification of tooth section and profile

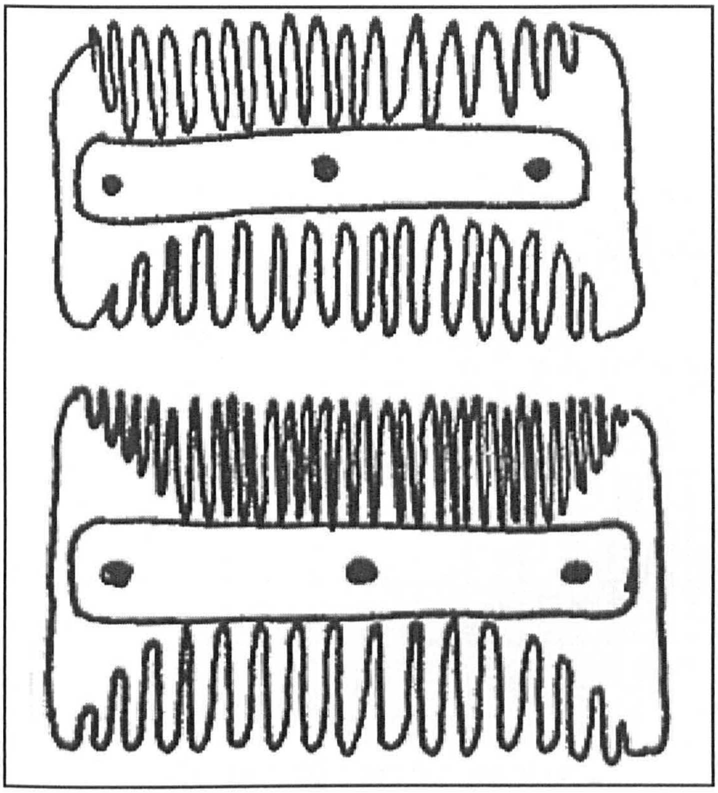


Figure 4. 14 Tooth Differentiation.

Note difference in gauge between two sided of each comb. Upper comb is said to have *undifferentiated* teeth, lower has *differentiated teeth.*

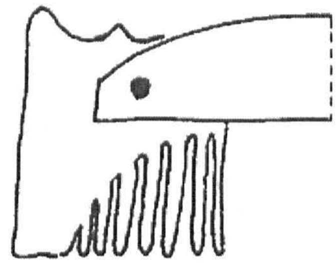
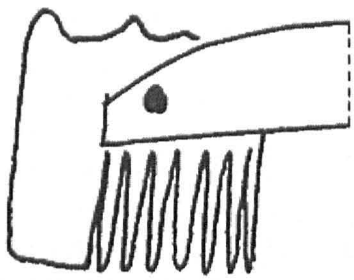
Graduated Teeth	
Ungraduated Teeth	

Figure 4. 15 Tooth graduation

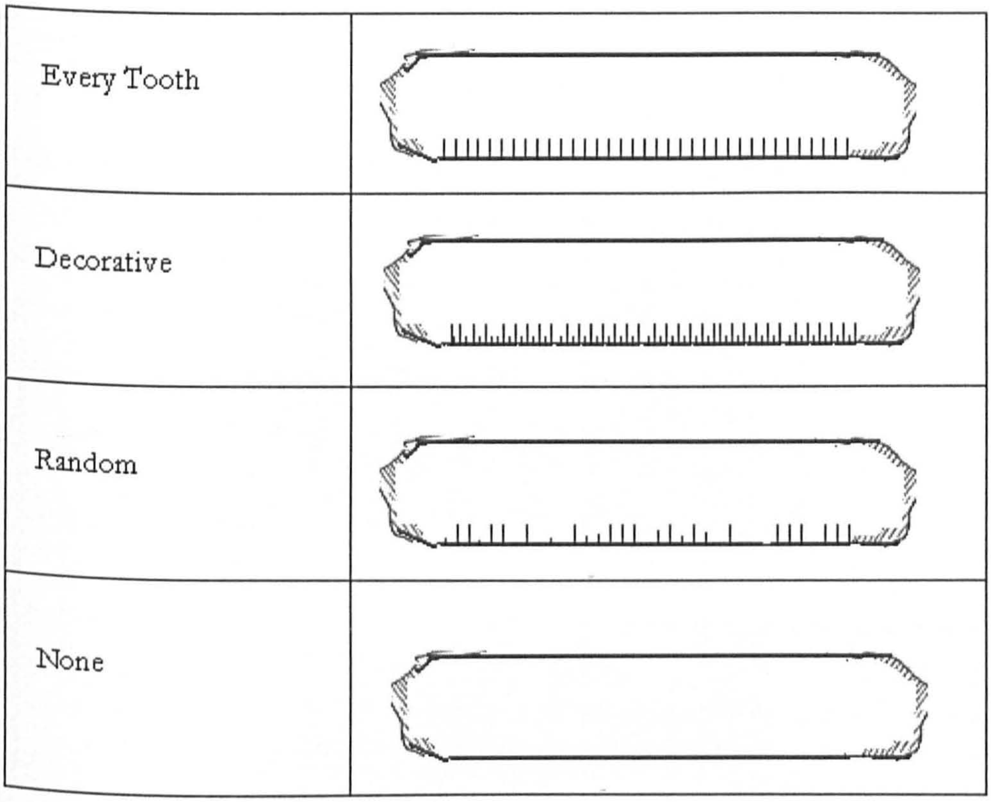


Figure 4. 16 Classification of marks from tooth-cutting

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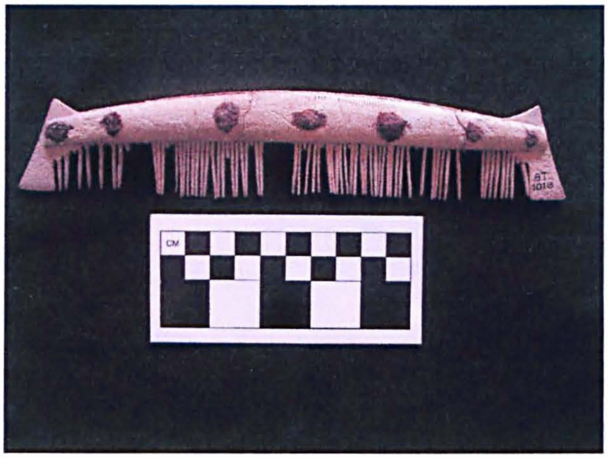


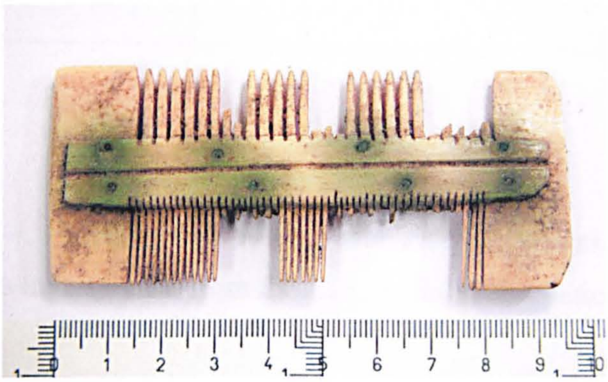


Figure 4. 17 Various rivet materials (top: iron; centre: copper alloy; bottom: bone)
Note comb in lower image also has a single iron rivet. Centre image from Carlsson 2002.

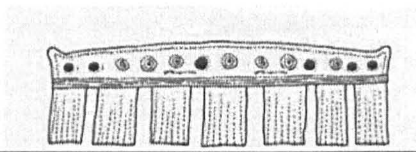
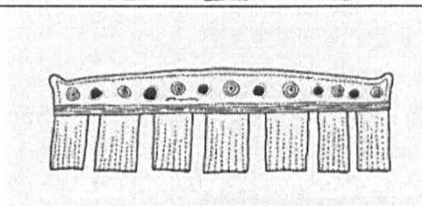
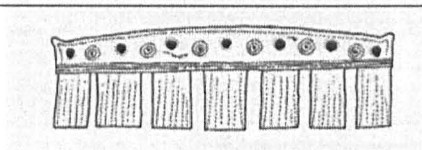
'Alternating Edge'	
'Every Edge'	
'Central'	

Figure 4. 18 Classification of 'basic' riveting techniques

(drawings adapted from fig 2.15, by Sven Schroeder)

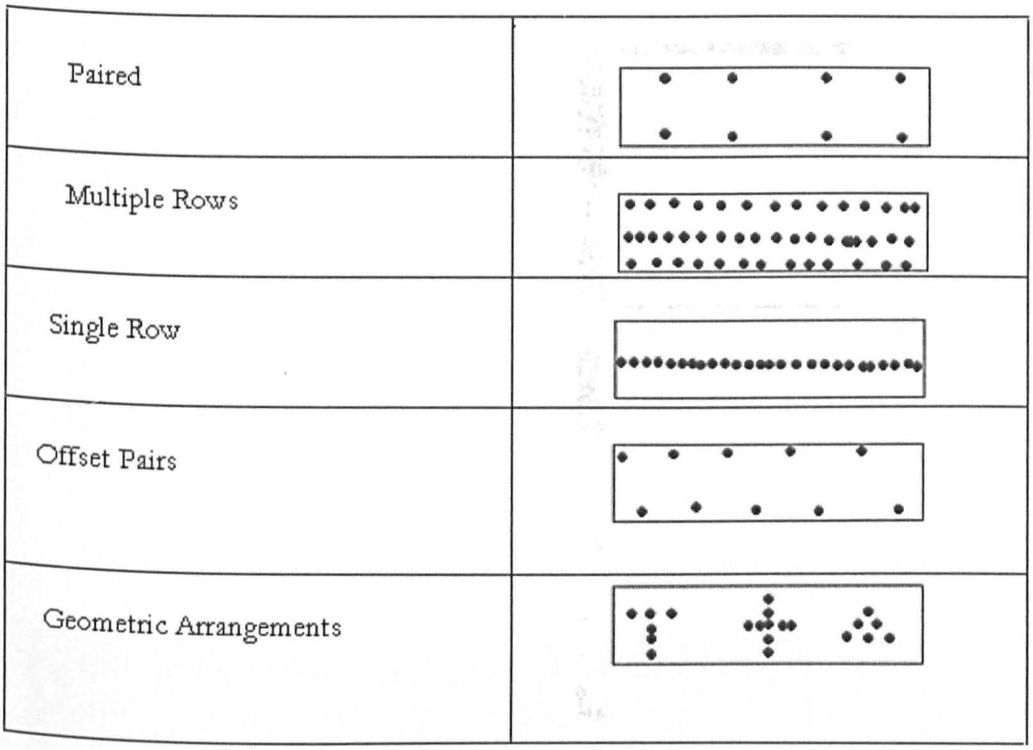


Figure 4. 19 Classification of 'decorative' riveting techniques

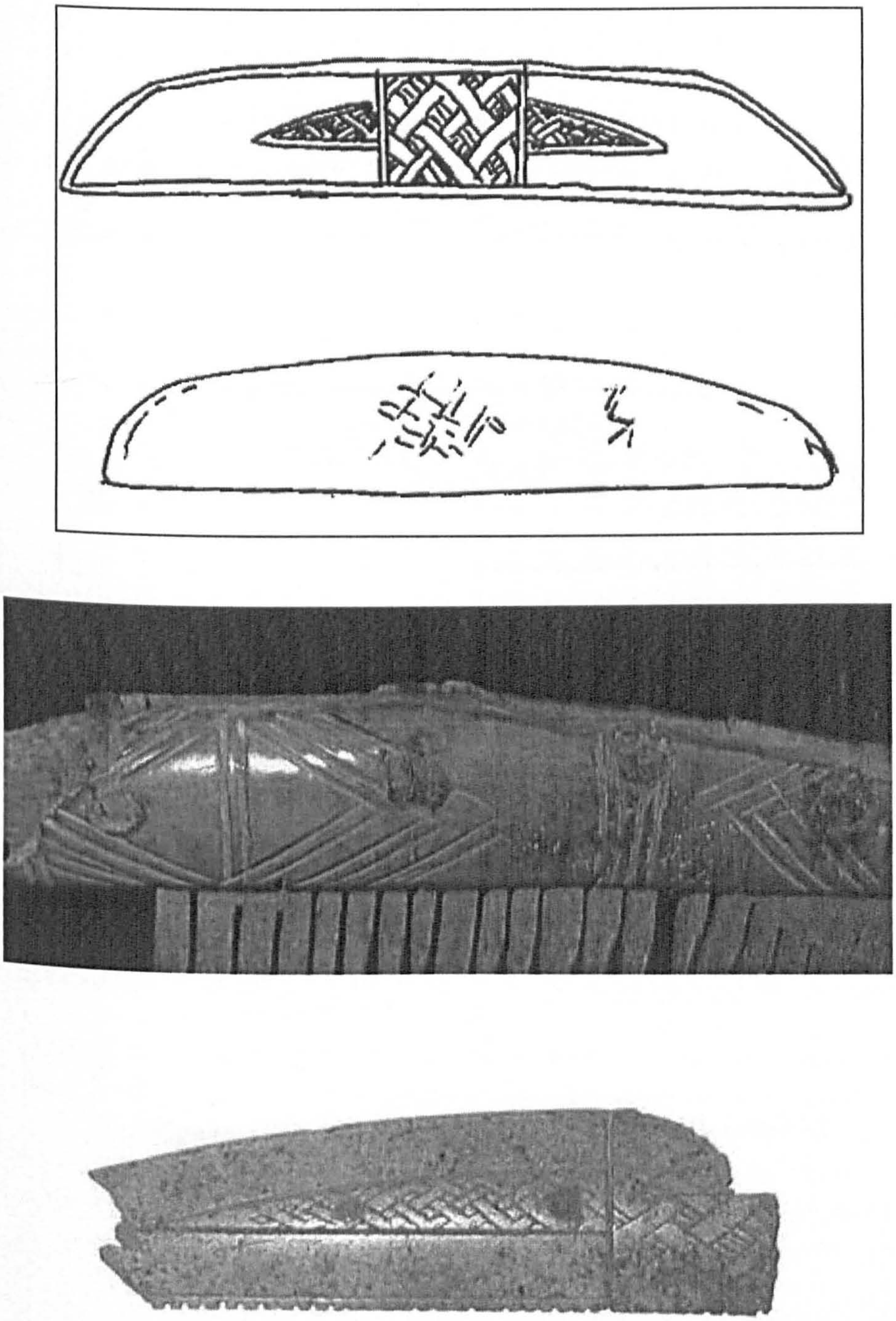


Figure 4. 20 Assessment of quality: quality of decoration
(Top: Schematics of 'High' and 'Poor' Quality. Bottom: Examples of 'Medium' (York) and High (Birka) Quality Ornament)

COLOUR IN ORIGINAL

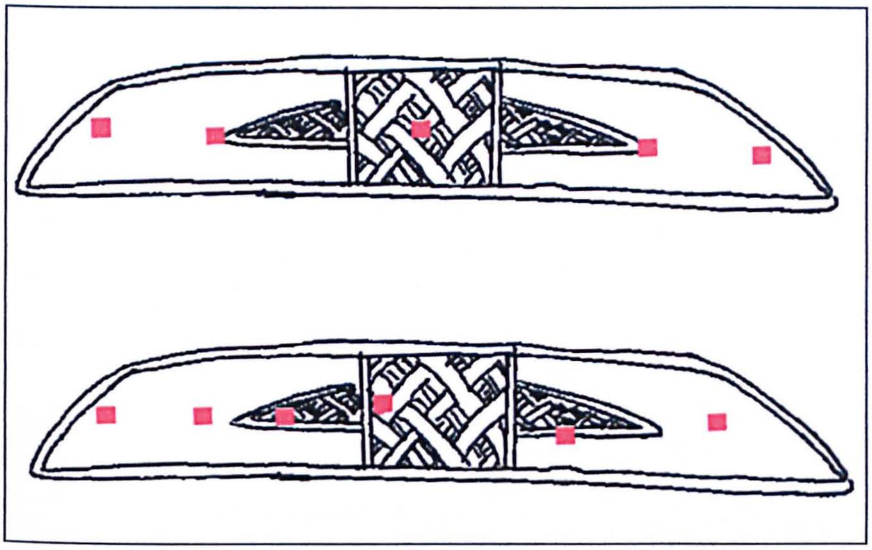
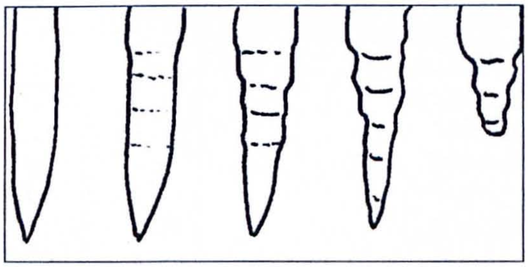


Figure 4. 21 Assessment of quality: rivet–ornament interference



1 2 3 4 5

Figure 4. 22 Assessment of use wear: tooth beading

Figures for Chapter 5

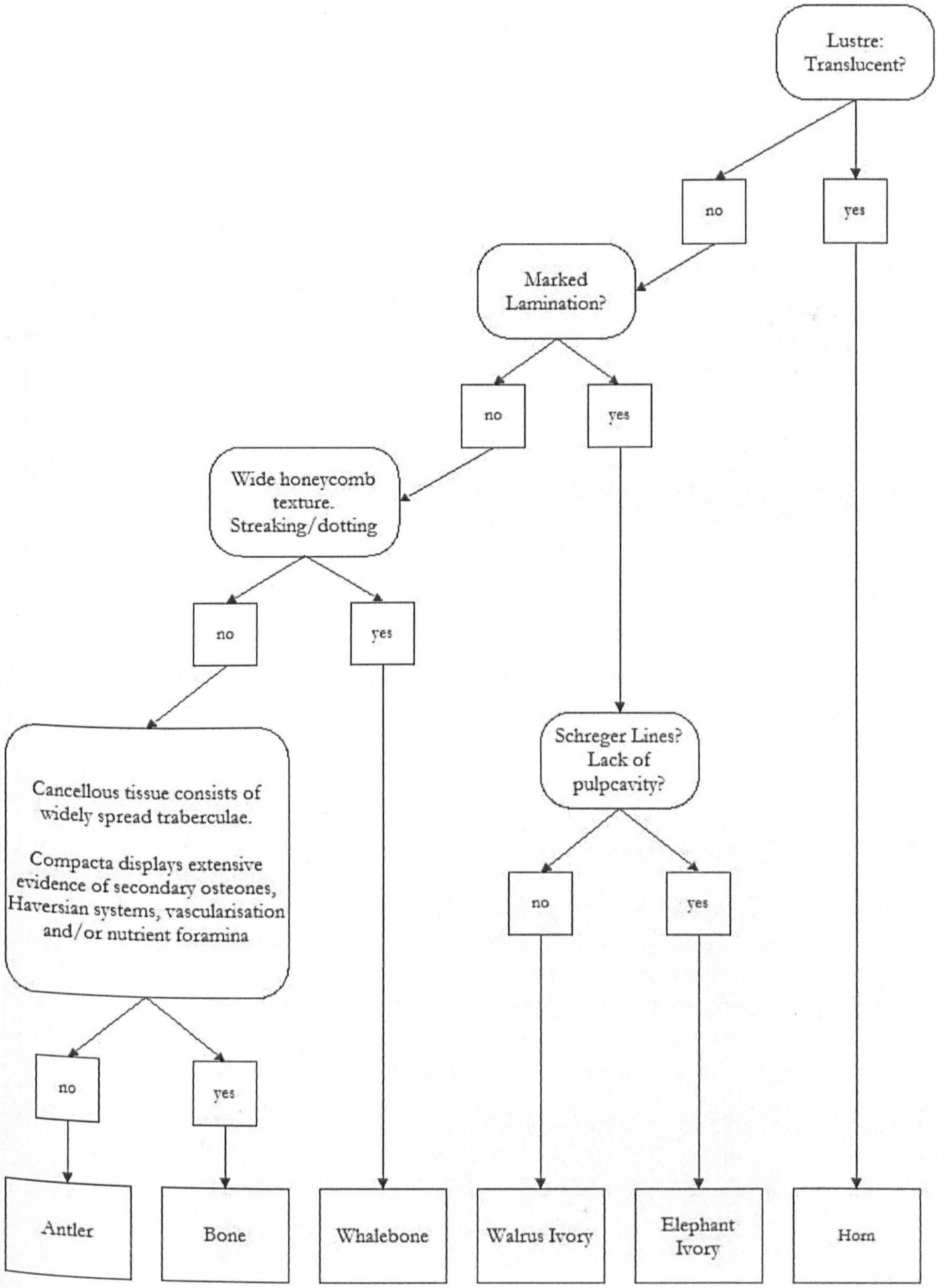


Figure 5. 1 Key for the identification of 'skeletal' materials, based on personal experience and published literature reviewed in Chapter 5

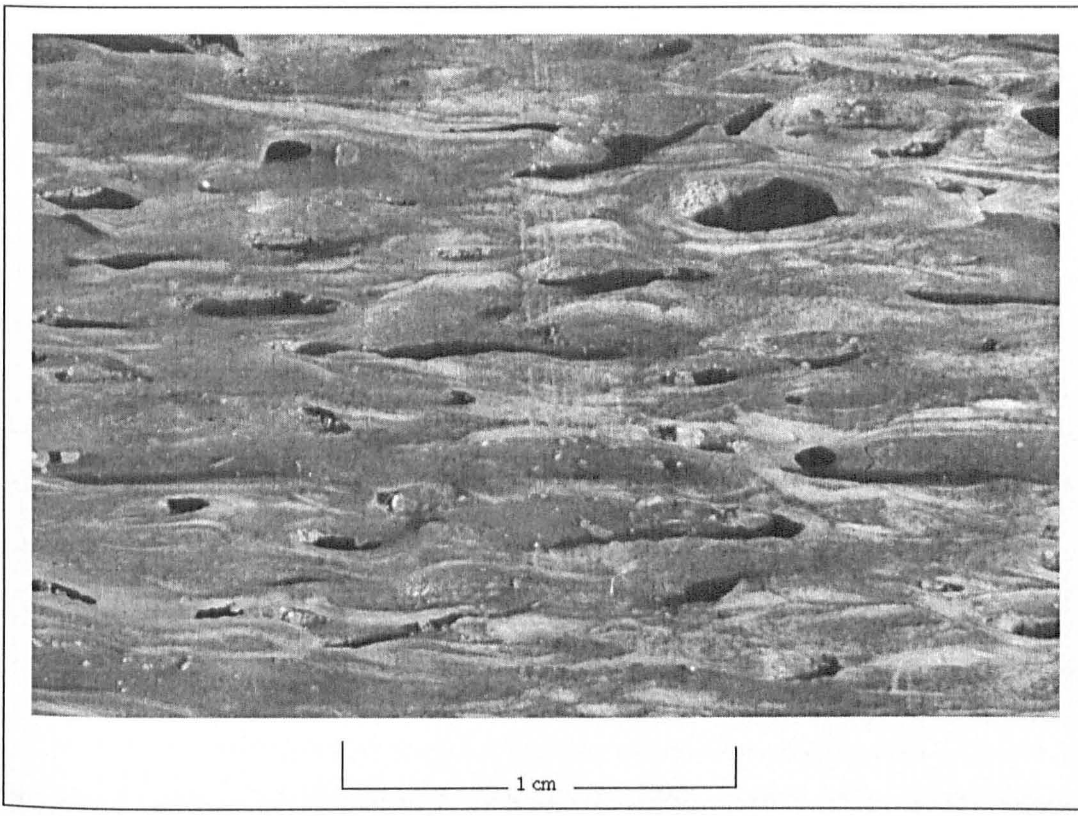


Figure 5. 2 Internal surface of cetacean bone (from a weaving baton from Quoygrew, Westray, Orkney)

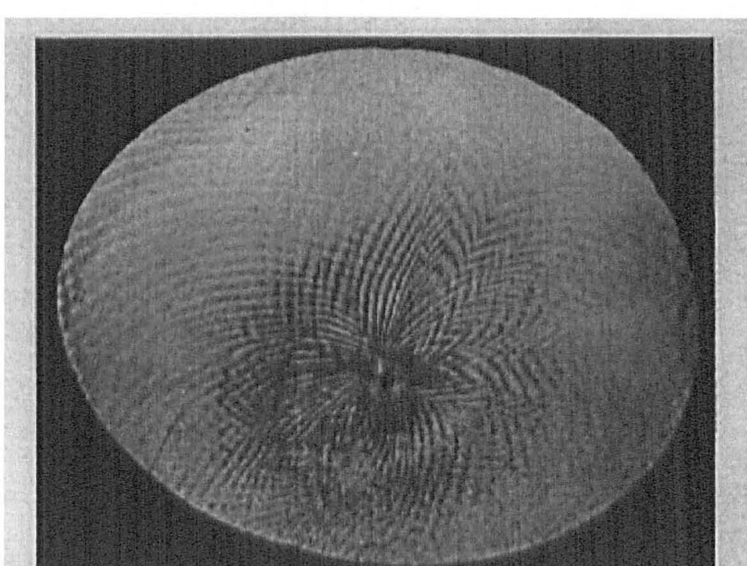


Figure 5. 3 Cross-section of elephant ivory, showing diagnostic 'engine-turning' (Penniman 1952: Plate I)

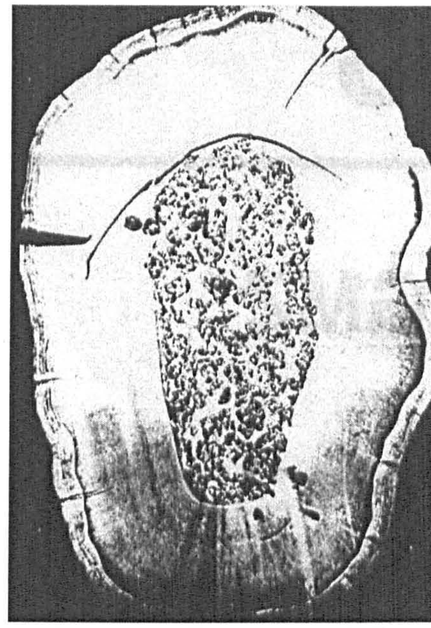


Figure 5. 4 Cross section of walrus ivory (Penniman 1952: Plate VIII). Note diagnostic structure of pulp cavity.

COLOUR IN ORIGINAL

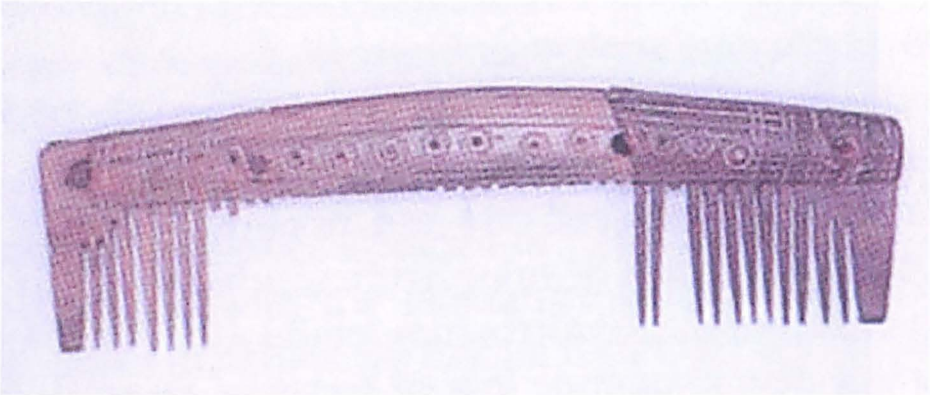


Figure 5. 5 Comb from York showing colour variation due to differential preservation (MacGregor et al. 1999: fig 867).

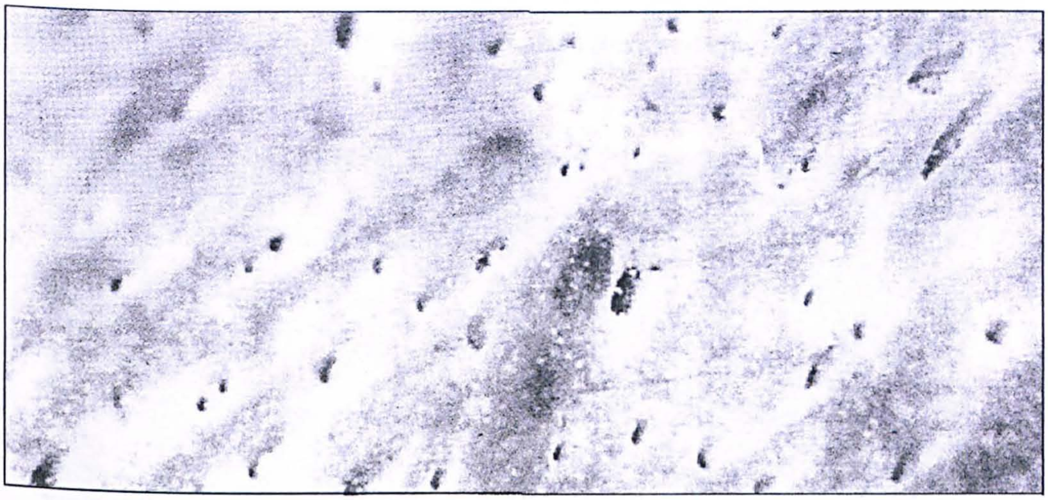


Figure 5. 6 Interior surface of longbone marrow cavity, showing nutrient foramina and undulose surface (O'Connor 1987: fig 3).

Scale ambiguous in original

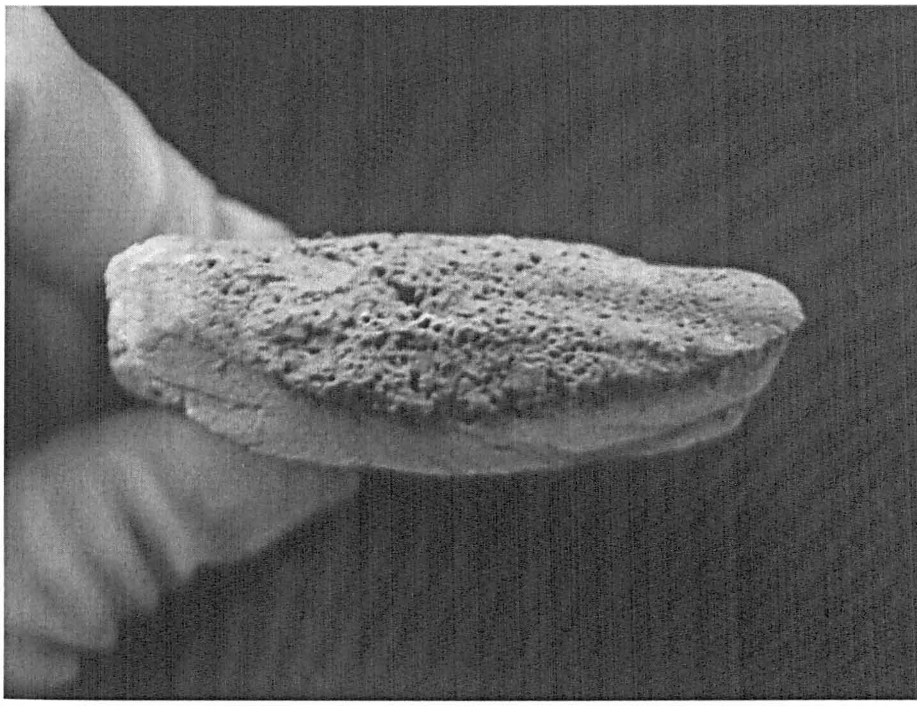


Figure 5. 7 Cross section of archaeological antler (red deer). Note curved edge of core.

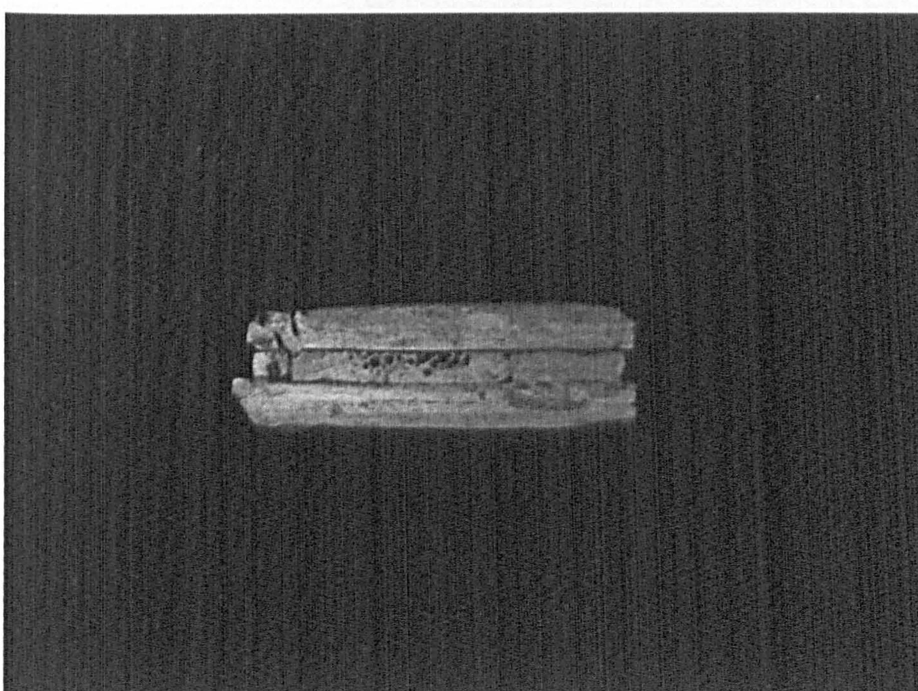


Figure 5. 8 Comb fragment from Lincoln with bone billets.
The 'M-shaped' edge of central cavity is indicative of the use of metapodial bones.

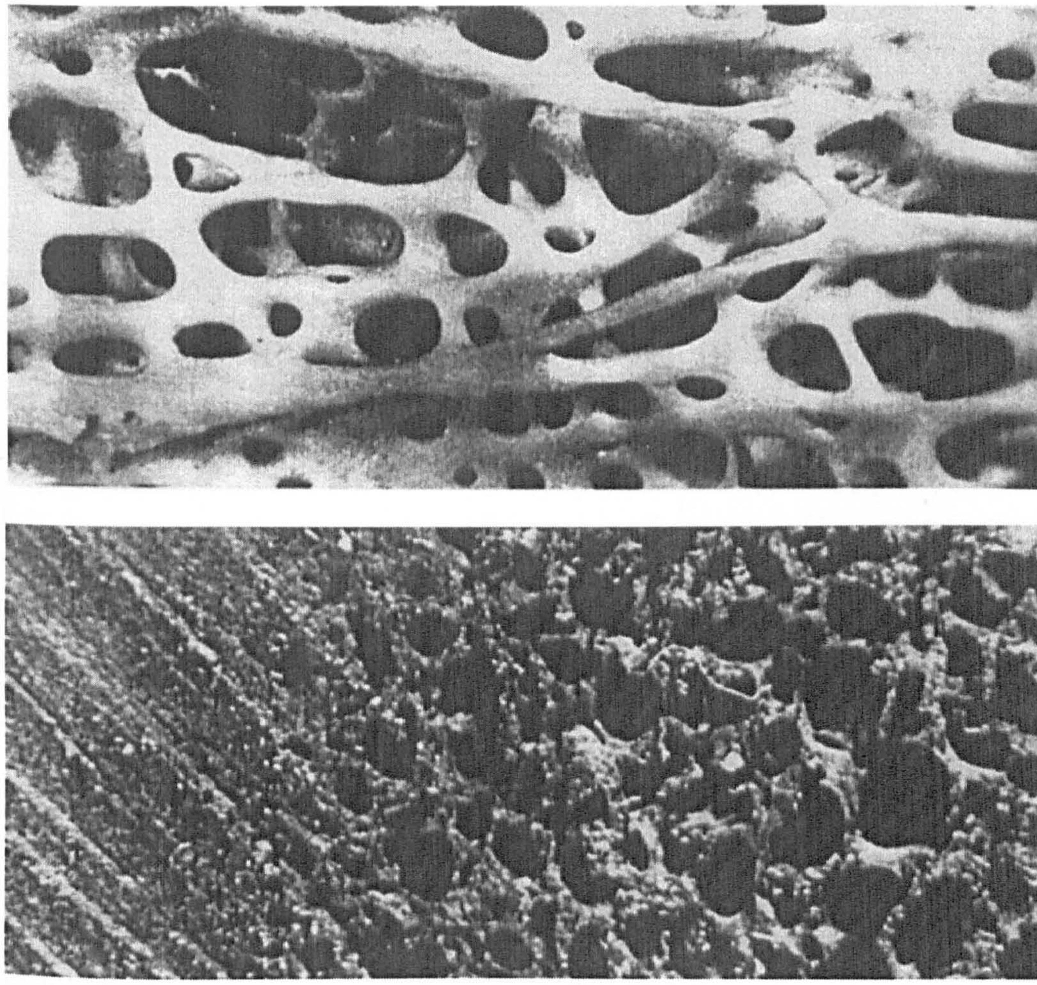


Figure 5. 9 (a) Cancellous tissue of bone and (b) porous core of antler (S O'Connor 1987: 9-10)

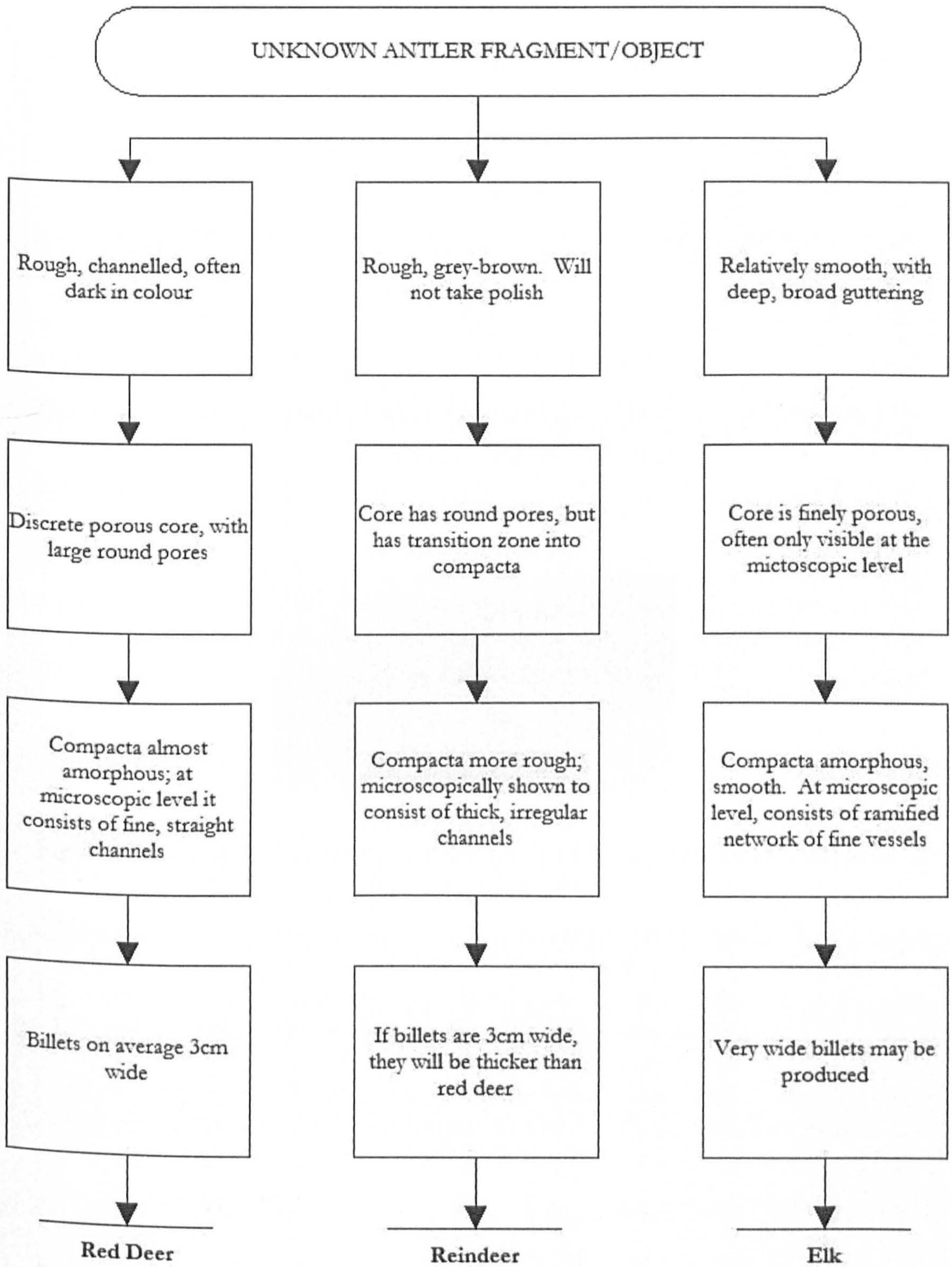


Figure 5. 10 Key for the identification of antler to species (based on descriptions in Smirnova 2005)

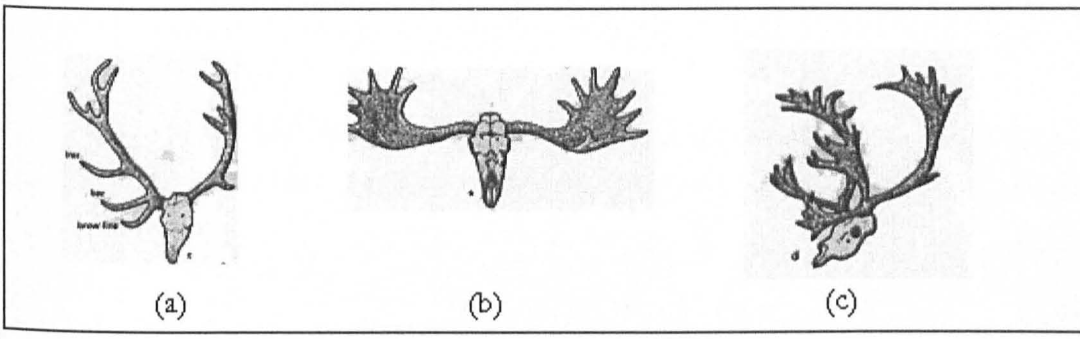


Figure 5. 11 a-c Gross morphology of antler (after MacGregor 1985: fig 13). (a) red deer (b) European elk (c) Reindeer.

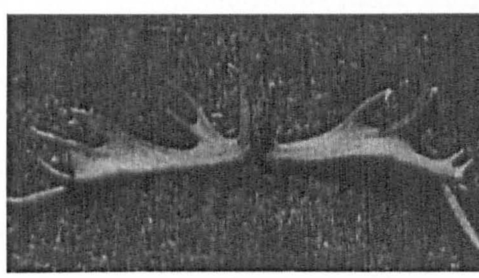


Figure 5. 12 Unusual example of red deer (wapiti) antler ('Deer' Magazine, nd.). Note palmation.

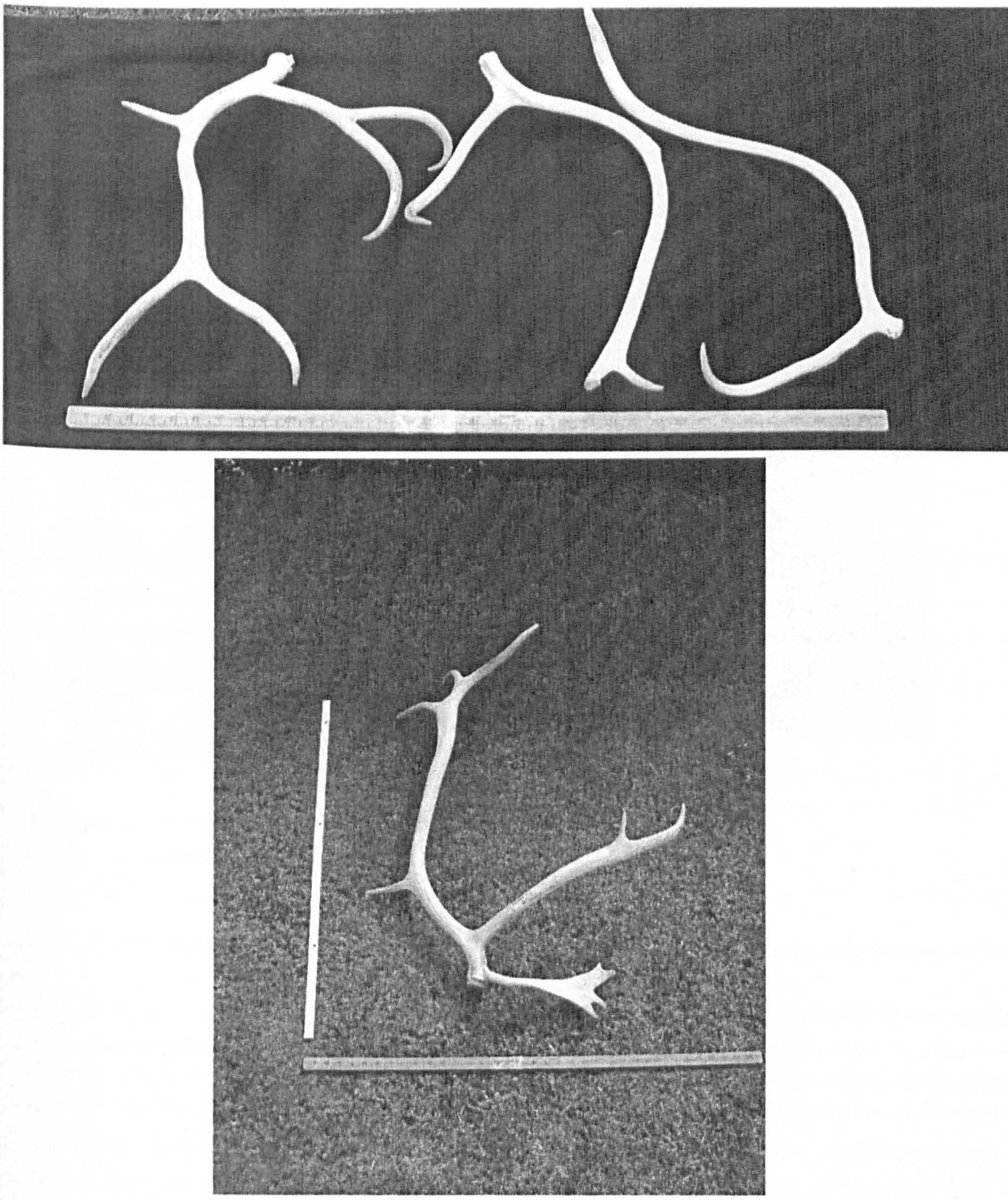
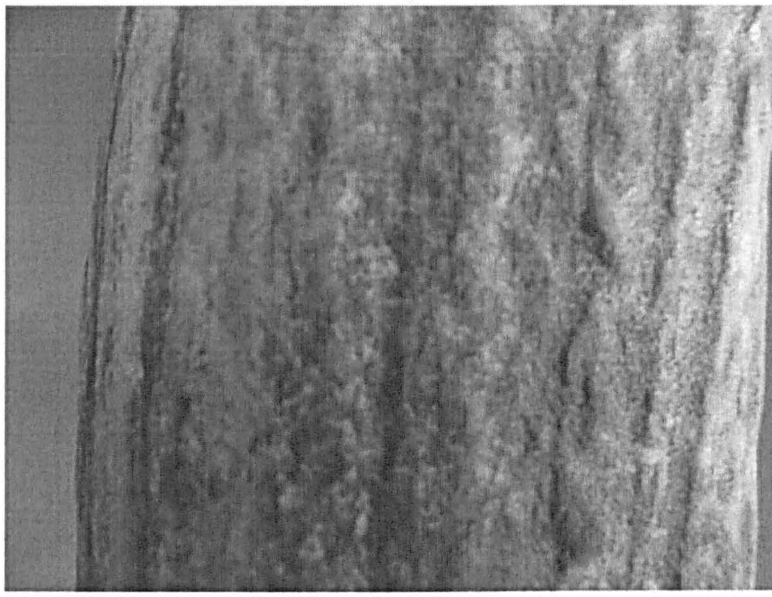


Figure 5. 13 Sexual dimorphism in female (top) and male (bottom) reindeer antler (Scale 90cm). Note relative complexity and length of male antler.

COLOUR IN ORIGINAL

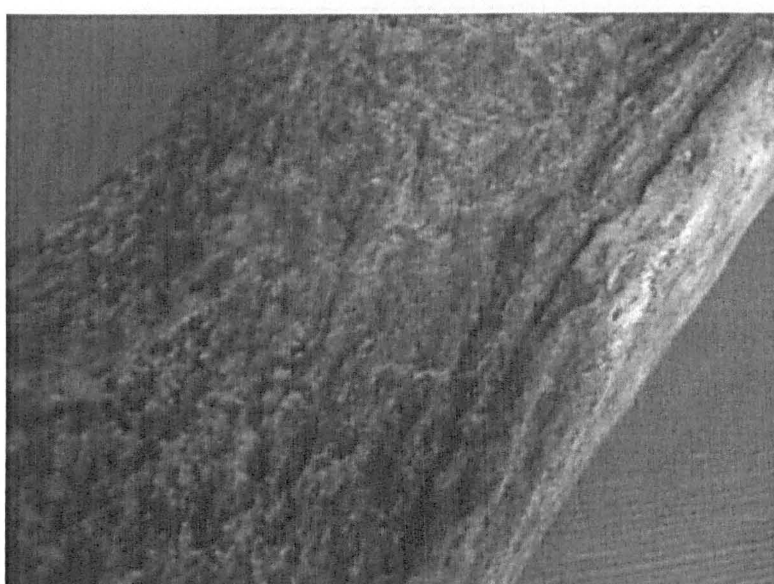
Figure 5. 14 Preservation of outer surface texture on a billet blank of red deer antler. Note distinctive roughness and channelling highlighted.

Red Deer



5cm

European Elk



10cm

Figure 5. 15 Surface grooving and channelling in red deer and elk antler

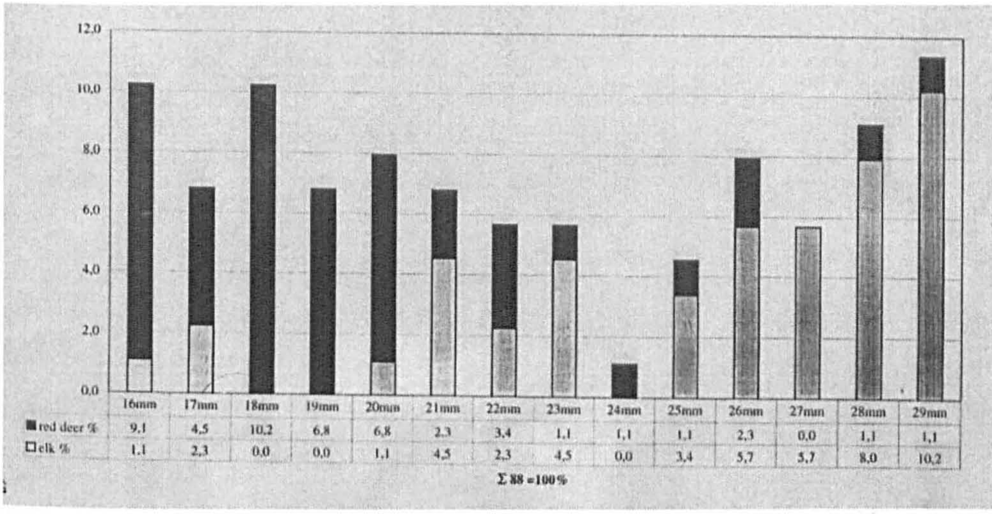


Figure 5. 16 Widths of elk and red deer billets at Novgorod (Smirnova 2005: fig 3.57).

Note that red deer antler billets are concentrated at the lower end of the size range, while elk antler billets are more common in the range between 25 and 30mm.

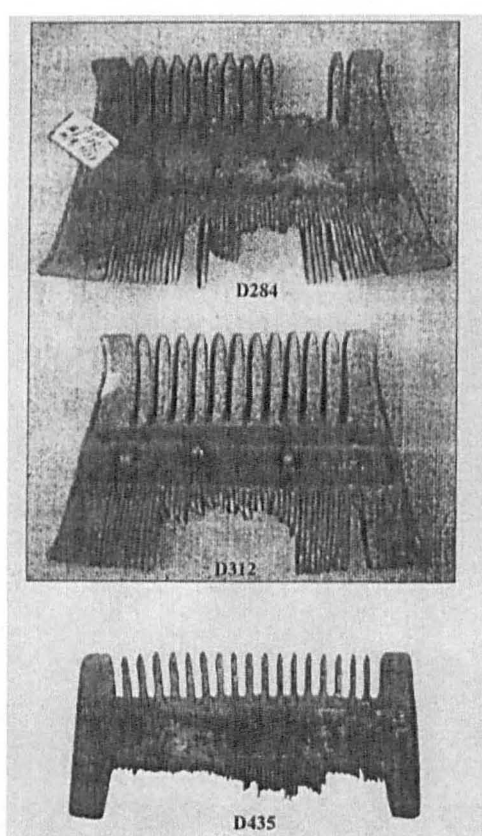


Figure 5. 17 Combs from Novgorod with very large, single billets of elk antler (Smirnova 2005: fig 6.3)

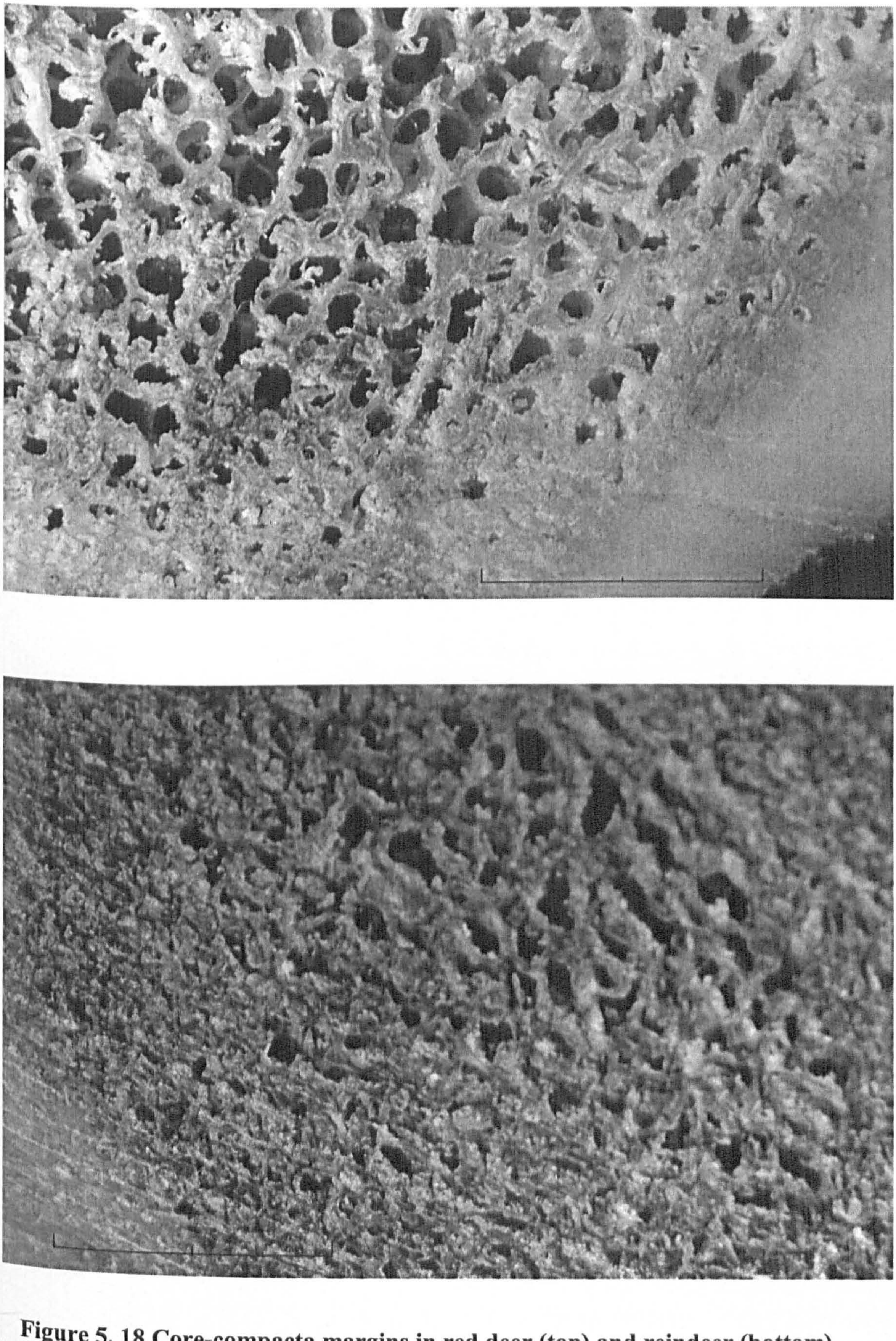


Figure 5. 18 Core-compacta margins in red deer (top) and reindeer (bottom).
Scale 2mm. Note extended 'semi-porous' zone in reindeer antler.

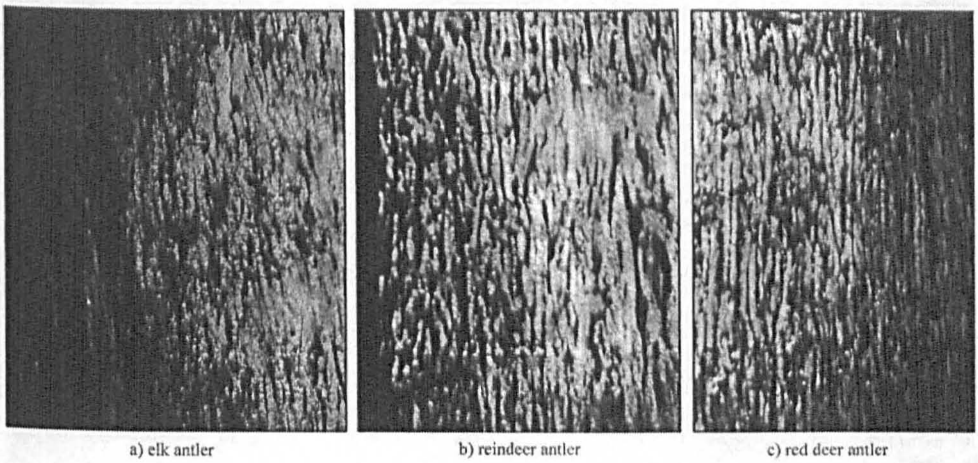


Figure 5. 19 Longitudinal sections to demonstrate differences in structure of compacta in elk, reindeer, and red deer antler (from Smirnova 2005: fig. 2.4)

Magnification x12.

Figure 5. 20 Specimens used in blind tests

From top down: sections; billet blanks; connecting plate blanks.

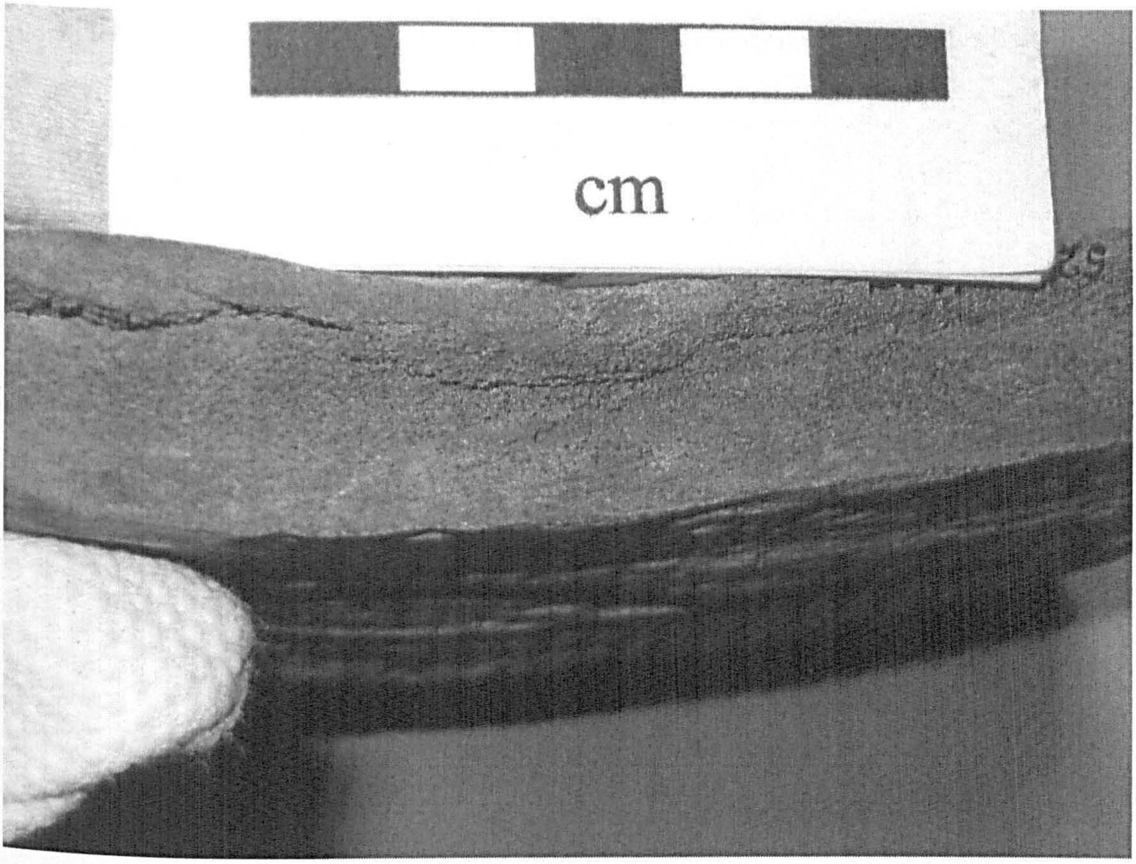


Figure 5. 21 Internal macrostructure of elk antler palmations.

This example from Birka demonstrates that porous structure may be preserved and visible in archaeological material. Porous core in palmated areas is fine, but more easily visible than in the tine tips.

Figures for Chapter 6

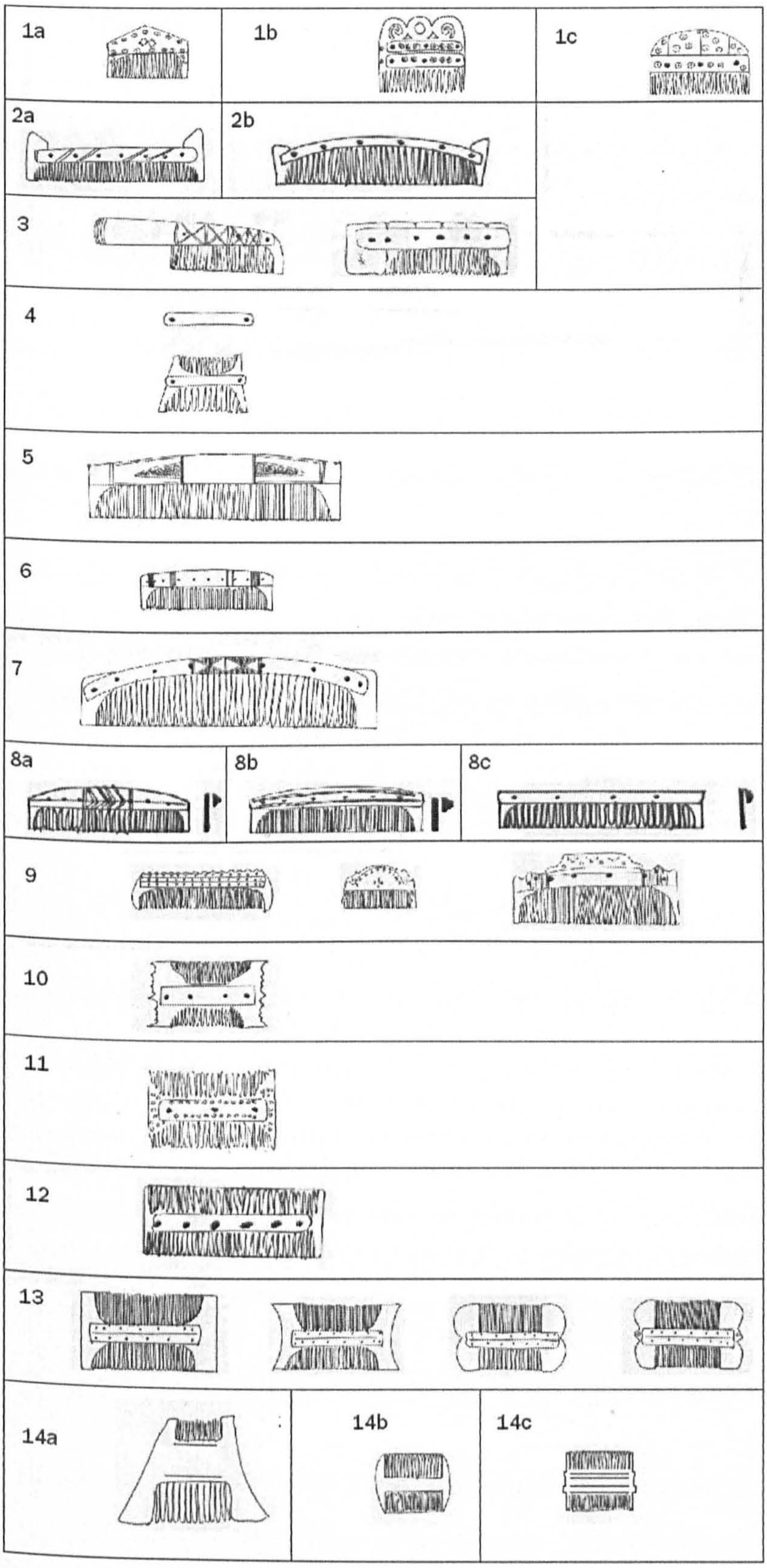


Figure 6. 1 The typology applied in the present work

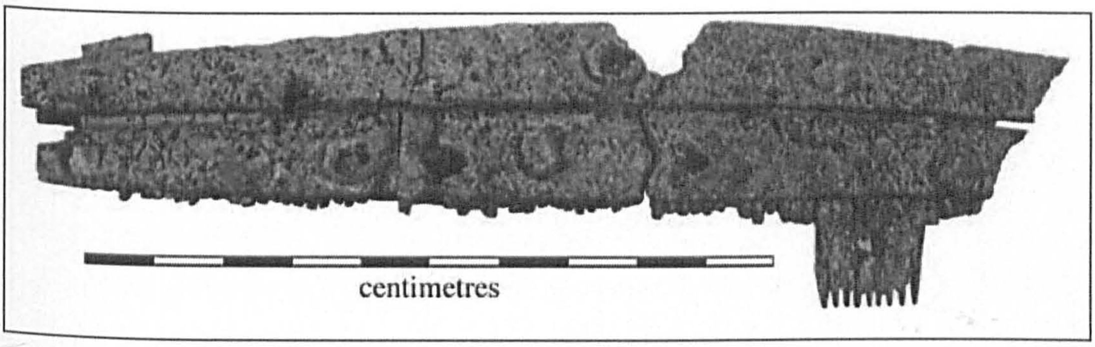


Figure 6. 2 Type 1b comb from Bluebridge Lane (photograph courtesy FAS)

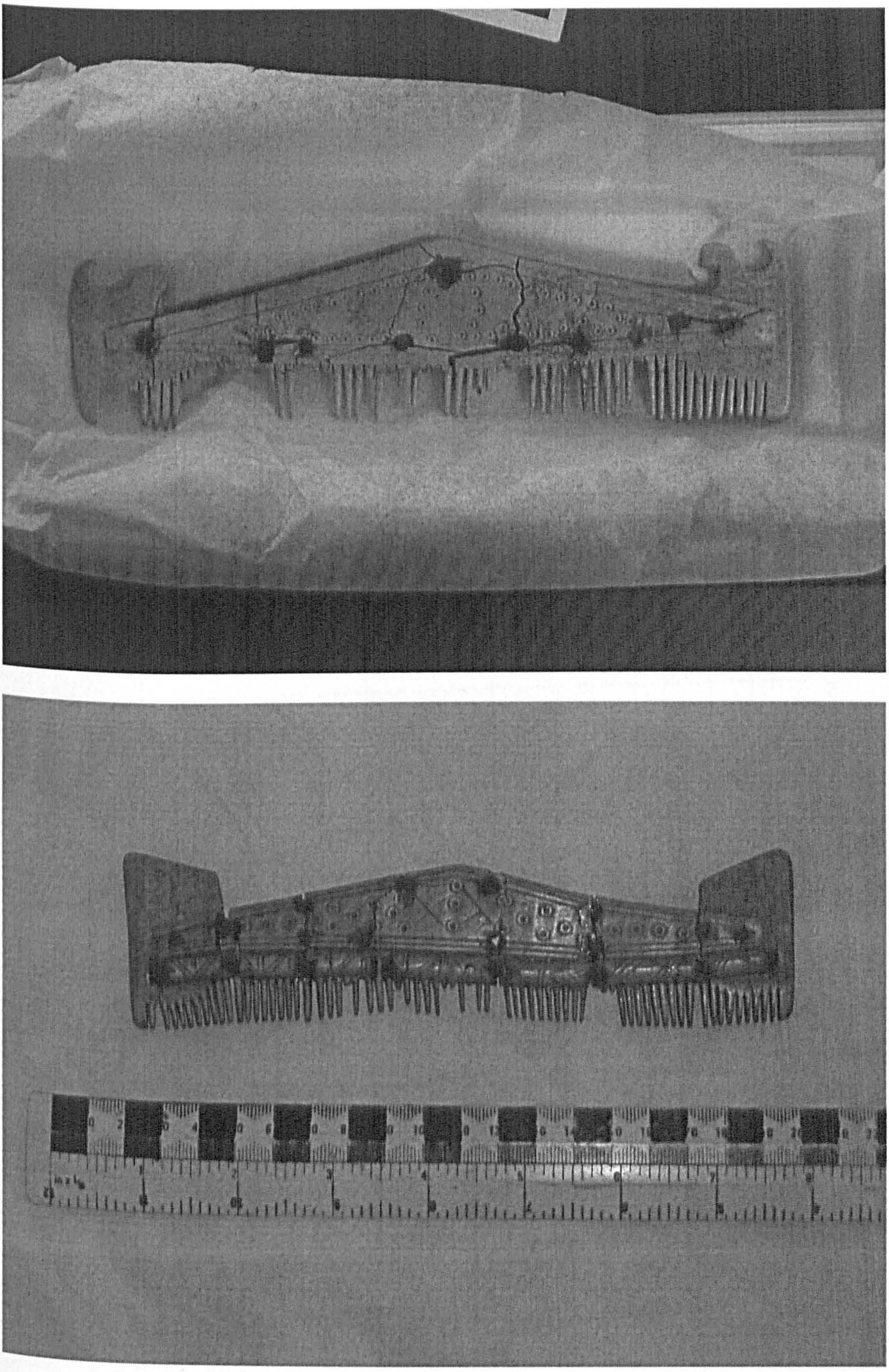


Figure 6. 3 'Hybrid' combs from Wharram (top) and Hayton (bottom)

COLOUR IN ORIGINAL

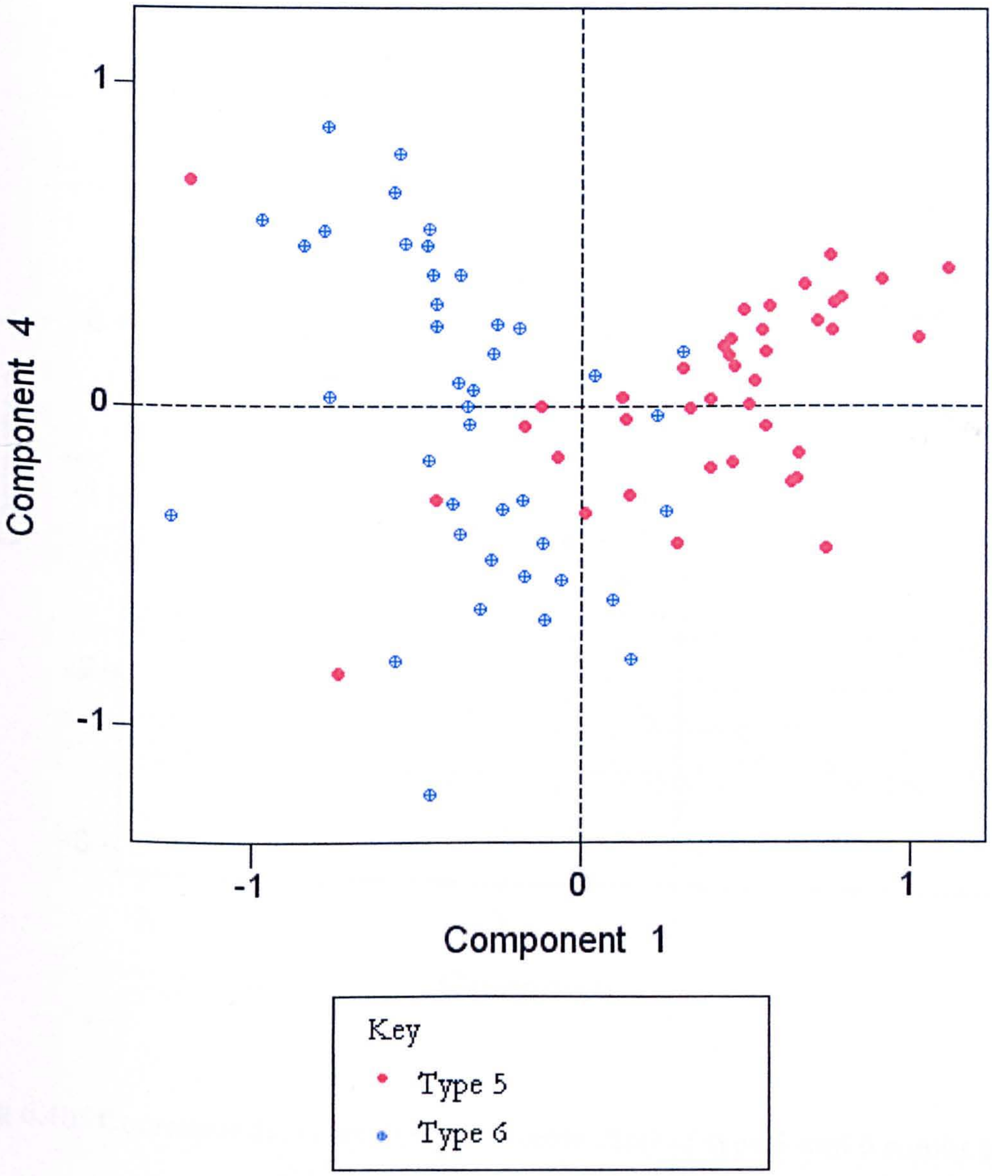


Figure 6. 4a: Correspondence analysis (object plot) of type 5 and 6 combs from Birka and associated gravefields.

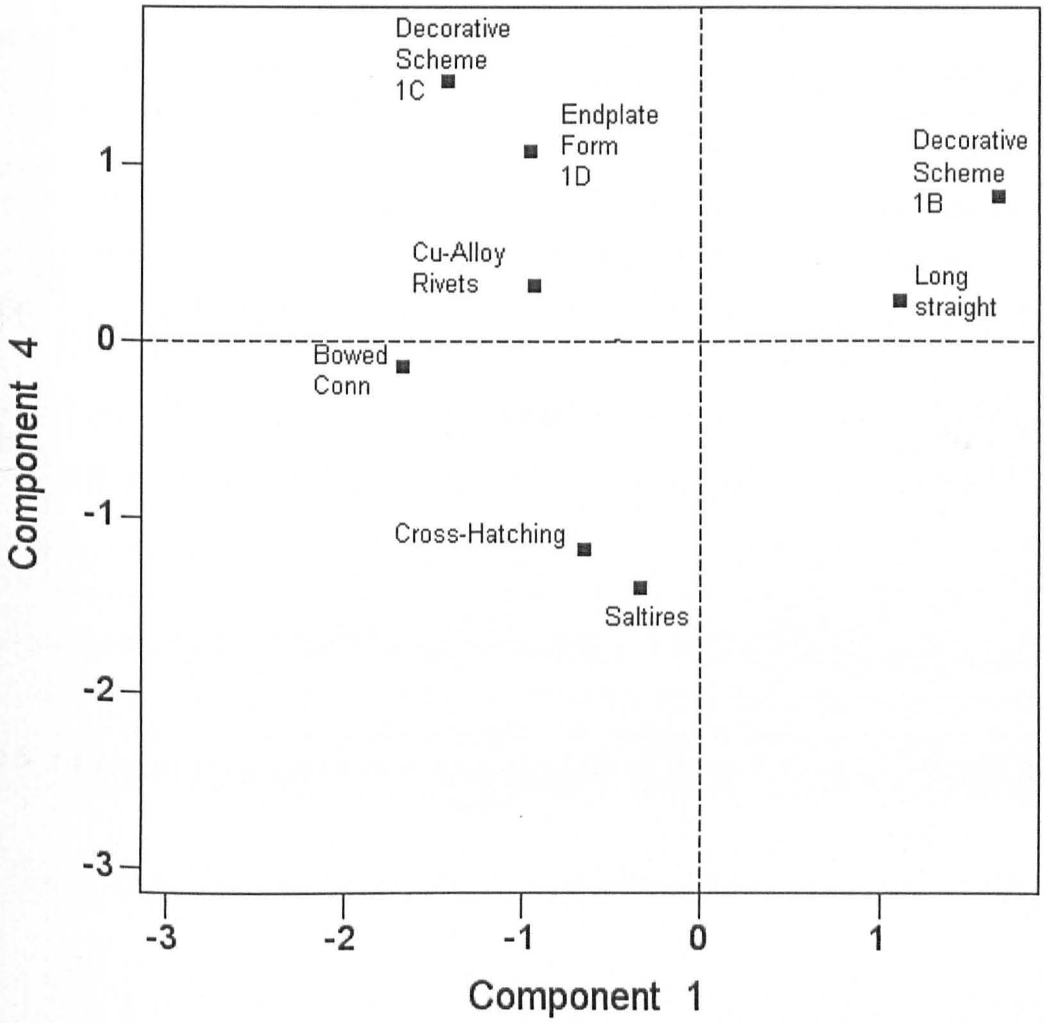


Fig 6.4b: Correspondence analysis (Variable Plot) of type 5 and 6 combs from Birka and associated gravefields.

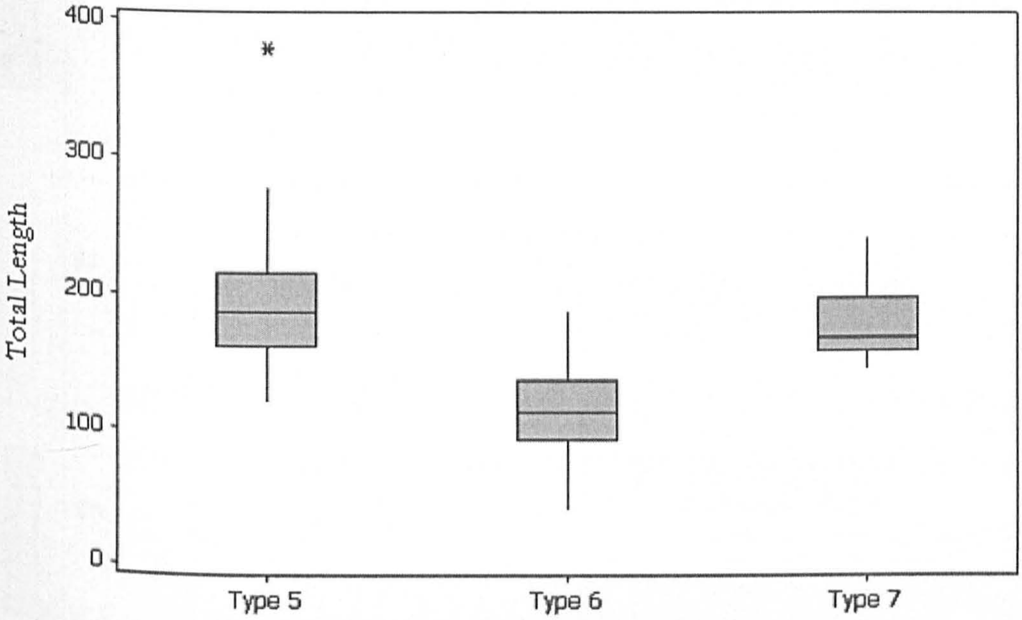


Figure 6. 5 Lengths of complete examples of combs of types 5, 6, and 7 (lengths in mm)

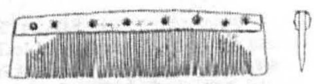
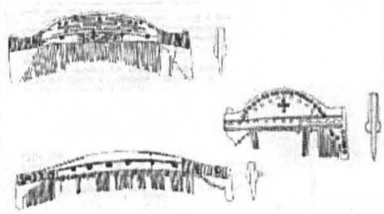
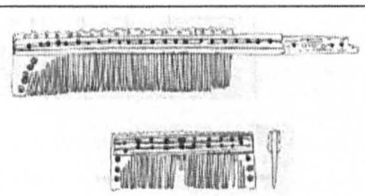
E1	Long, bowed form (Central riveting)	
E2	Long bowed form (Edge Riveting)	
E3	Straight/ plano-convex connecting plate section. Includes type 6.	
E4	Straight, with close-set copper alloy rivets	
E5	Plano-piriform section, may have ornamental copper plate or inlay	
E6	Various forms with ornately profiled backs	

Figure 6. 6 Wiberg's Oslo typology for late Viking Age and medieval single-sided combs (adapted after Wiberg 1985)

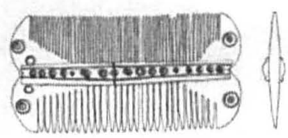
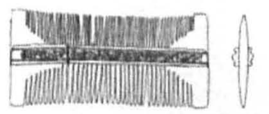
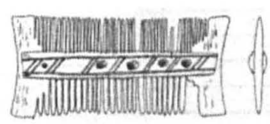
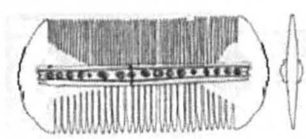
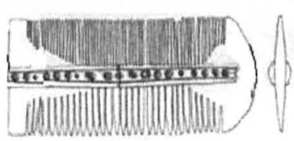
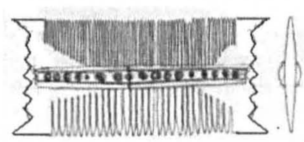
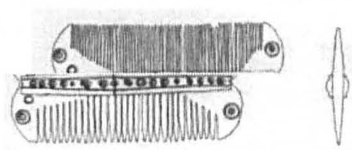
D1	Biconvex-ended	
D2	Straight-ended	
D3	Concave-ended	
D4	Convex-ended	
D5	Differing Ends	
D6	Complex, ornately profiled Ends	
D7	Offset-ended	

Figure 6. 7 Wiberg's Oslo typology for medieval double-sided combs (adapted after Wiberg 1985)

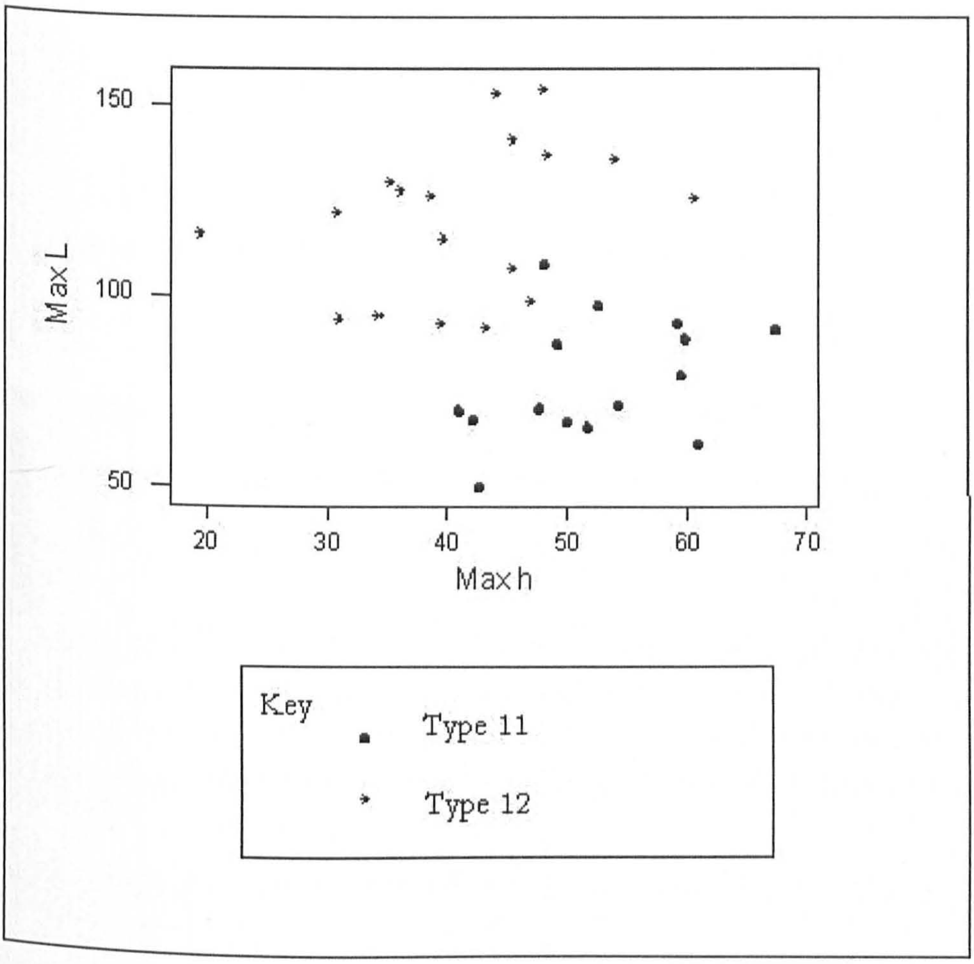


Figure 6. 8 Length : height distribution of type 11 and 12 combs (based on a sample from Scotland)

COLOUR IN ORIGINAL

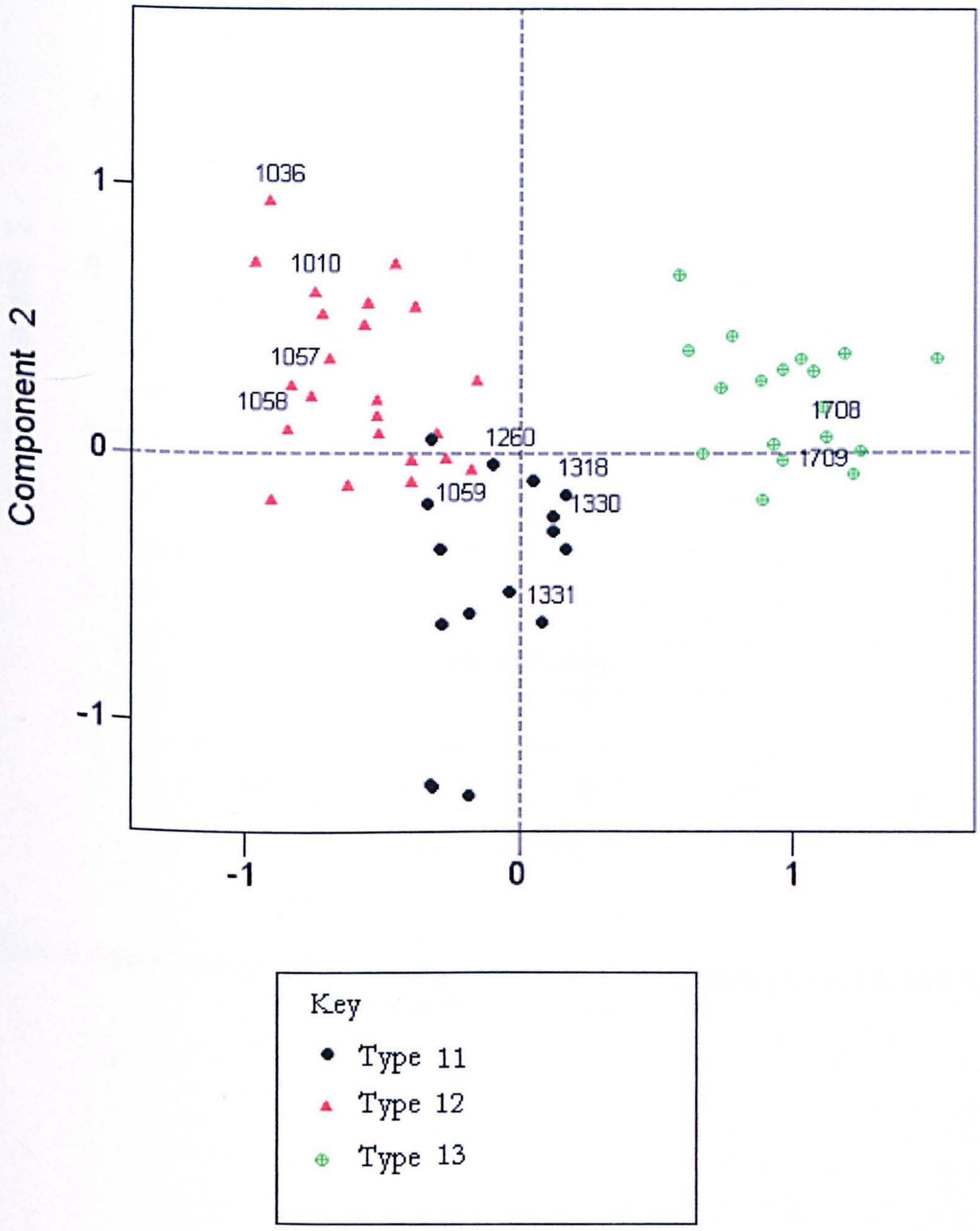


Figure 6. 9a: Correspondence analysis (object plot) for type 11 , 12, and 13 combs from Scotland

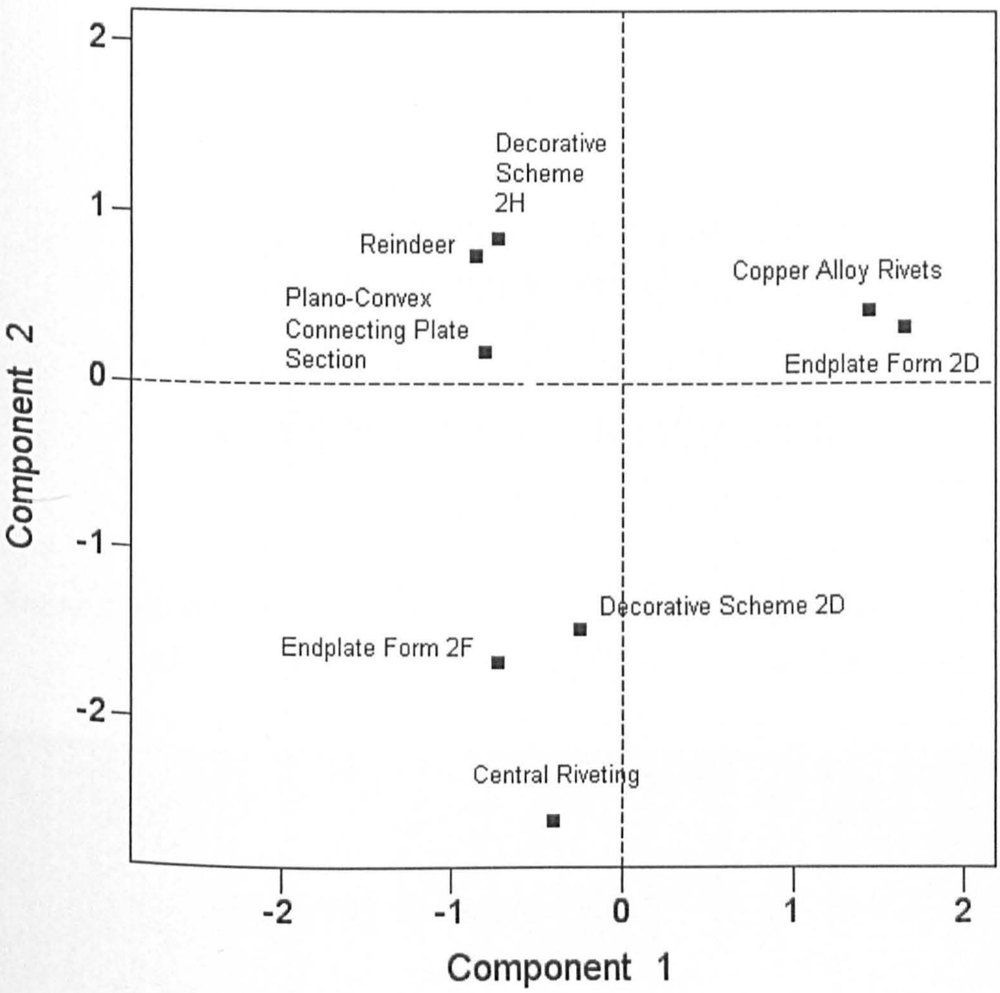


Figure 6.9b Correspondence analysis (variable plot) for type 11, 12, and 13 combs from Scotland

Figure 6. 10 Type 5 and 6 comb fragments from Kaupang (Skre and Stylegar 2004: fig 50)

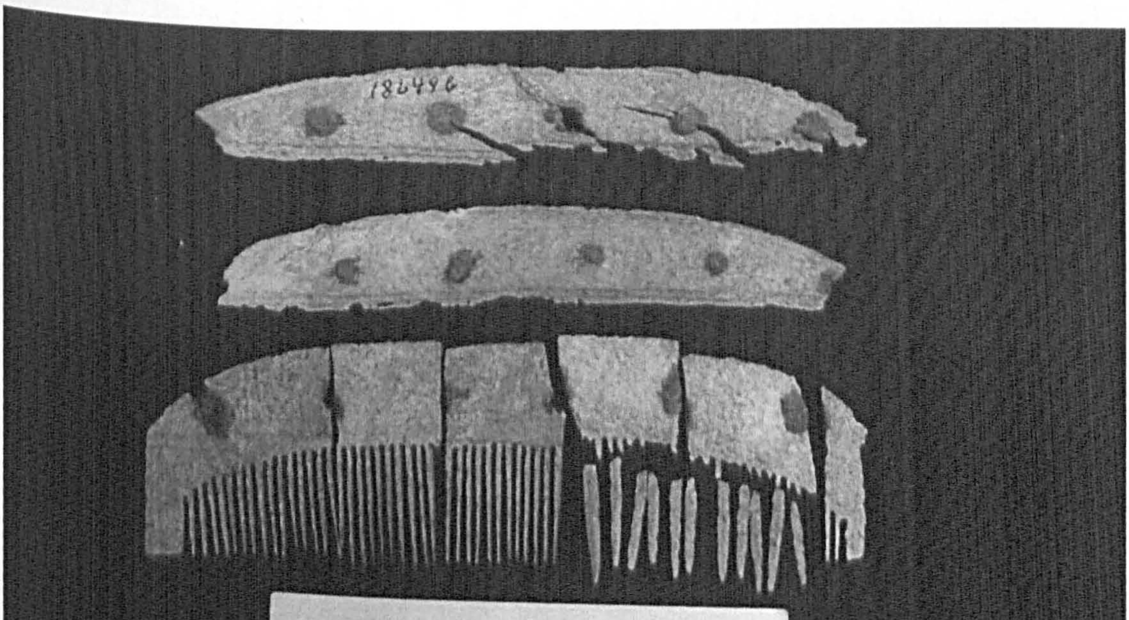


Figure 6. 11 A type 5 comb from the Trøndelag region, Norway

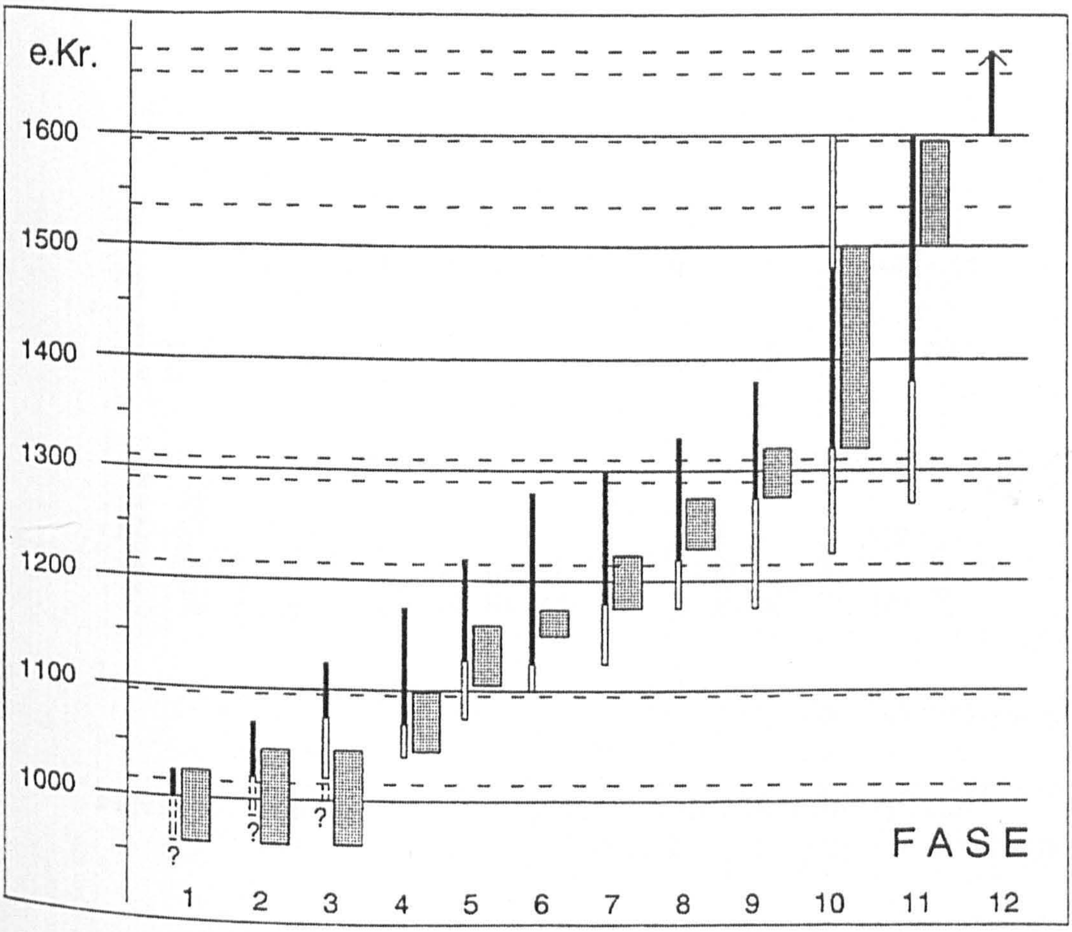


Figure 6. 12 Phasing for the Trondheim 'Library Site' (after Christophersen and Nordeide 1994: fig 24).

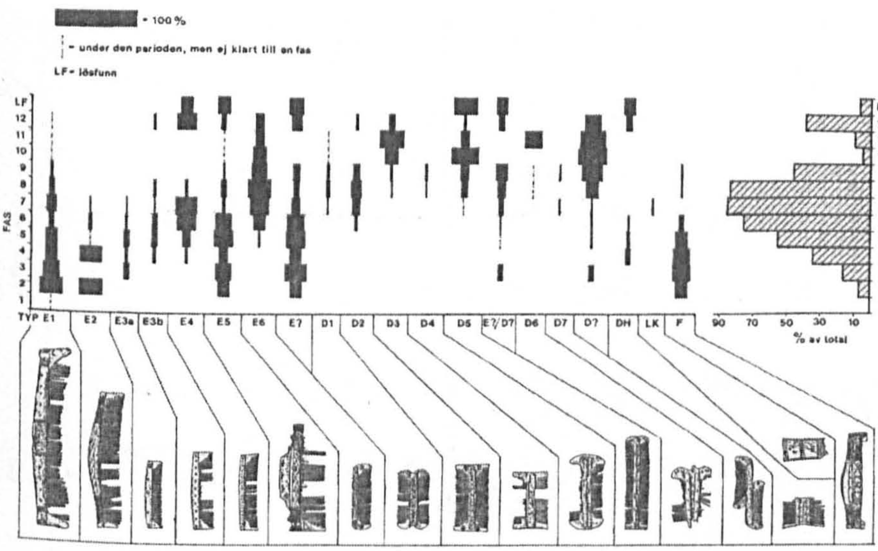


Fig. 44. Total mängd kammar fördelat på grupper och fas - procent.

Figure 6. 13 Comb chronology at the Trondheim 'Library Site'

COLOUR IN ORIGINAL

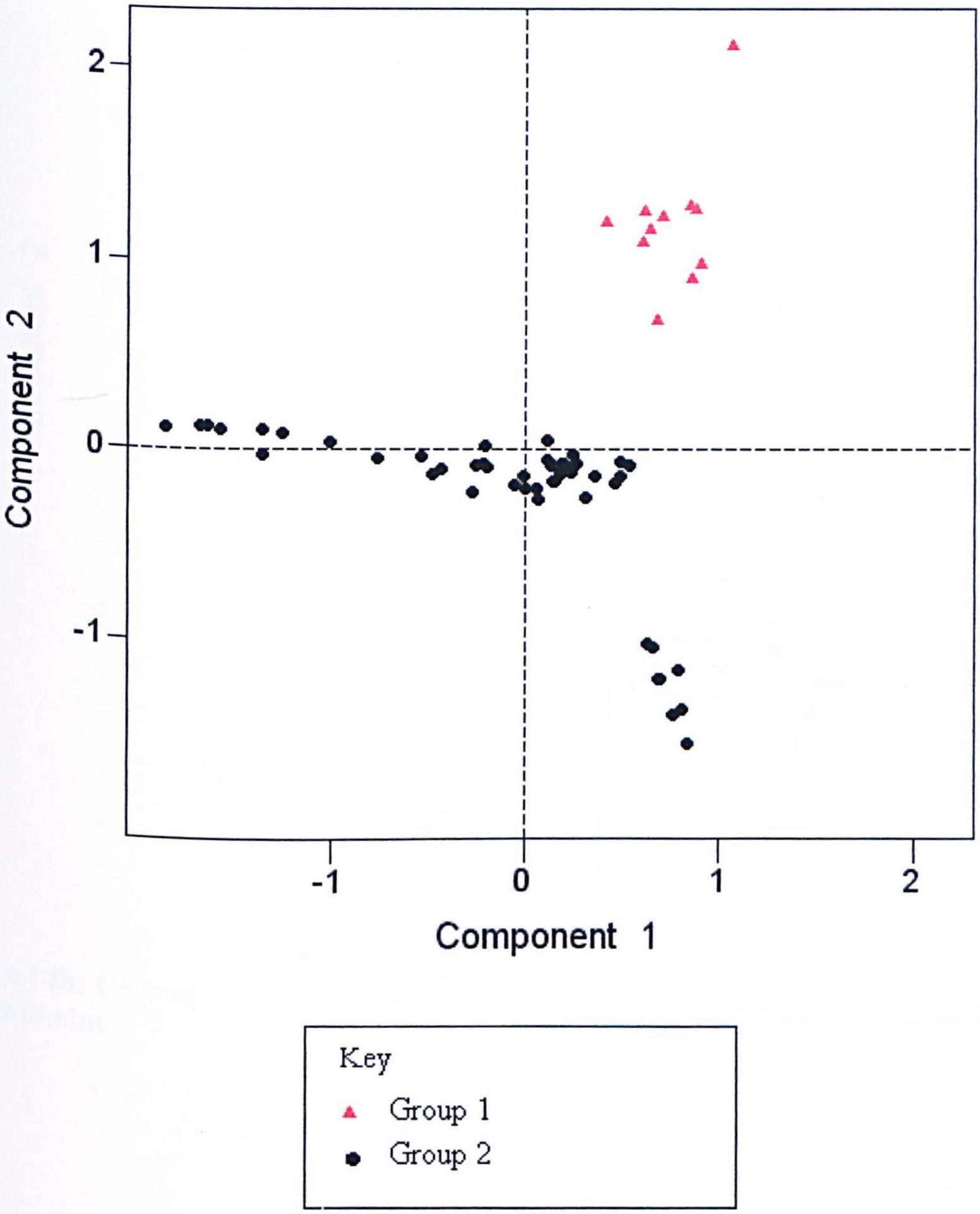


Figure 6. 14a Correspondence analysis (object plot) of type 9 and 13 combs from Trondheim

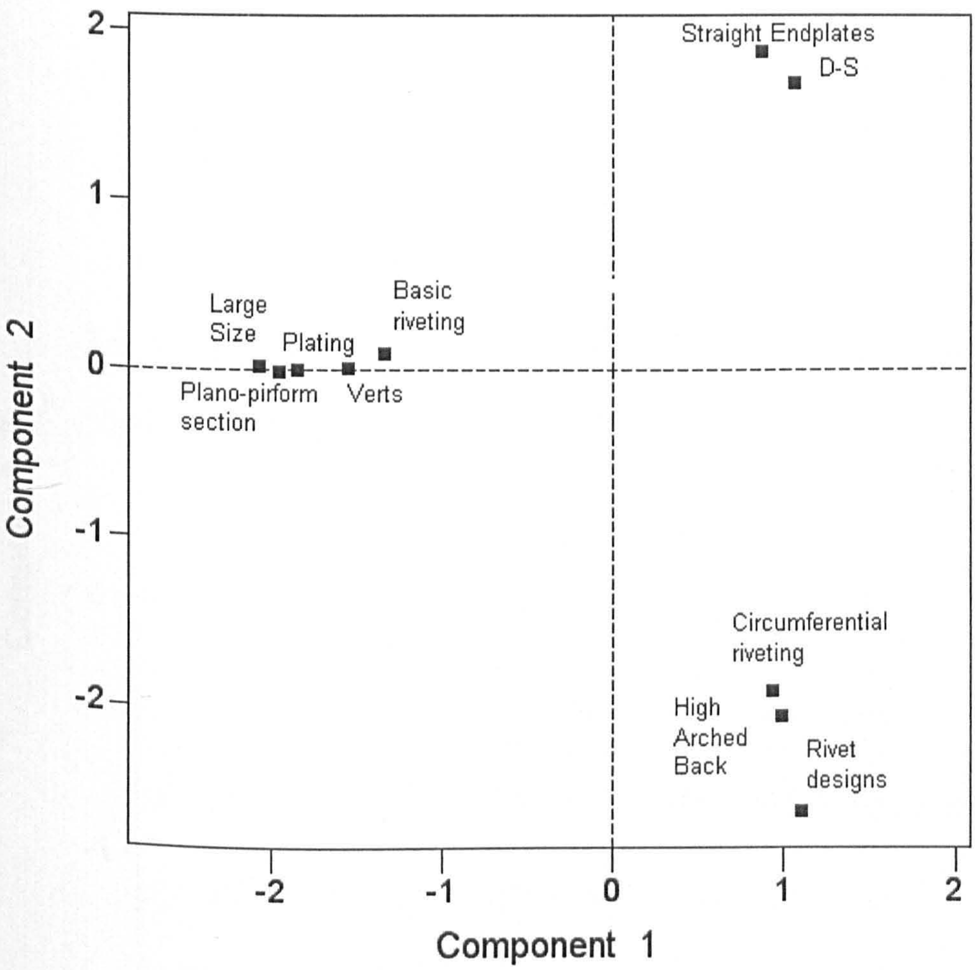


Fig 6.14b: Correspondence analysis (variable plot) of type 9 and 13 combs from Trondheim

COLOUR IN ORIGINAL

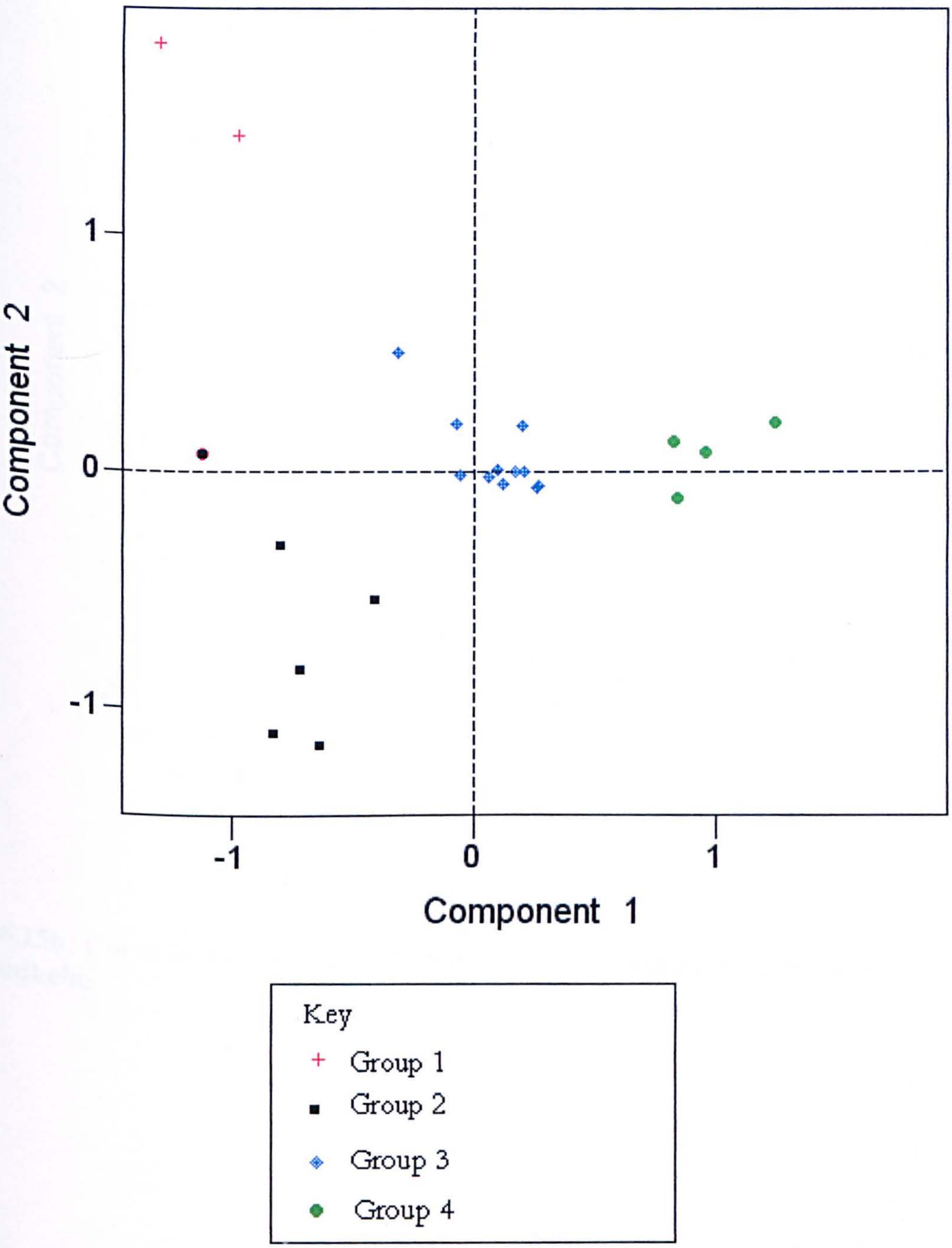


Figure 6. 15a: Correspondence Analysis (object plot) of type 9 combs from Trondheim.

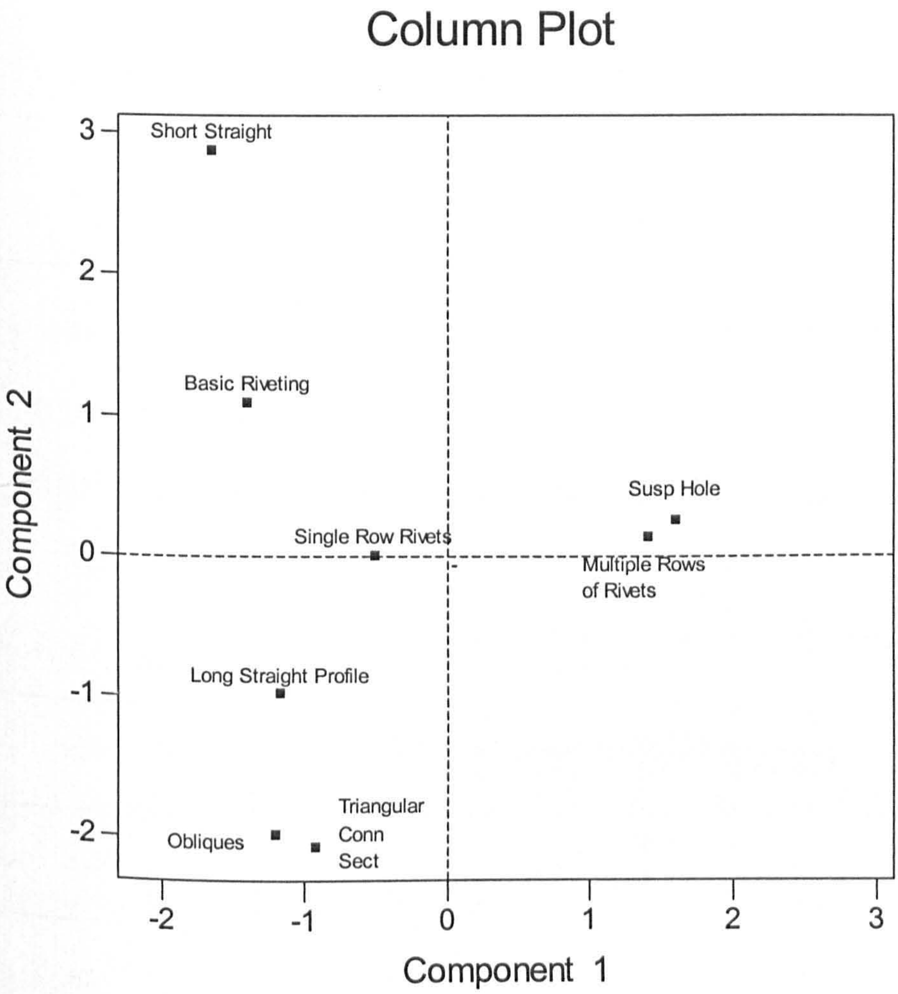


Fig 6.15b: Correspondence analysis (Variable Plot) of type 9 combs from Trondheim

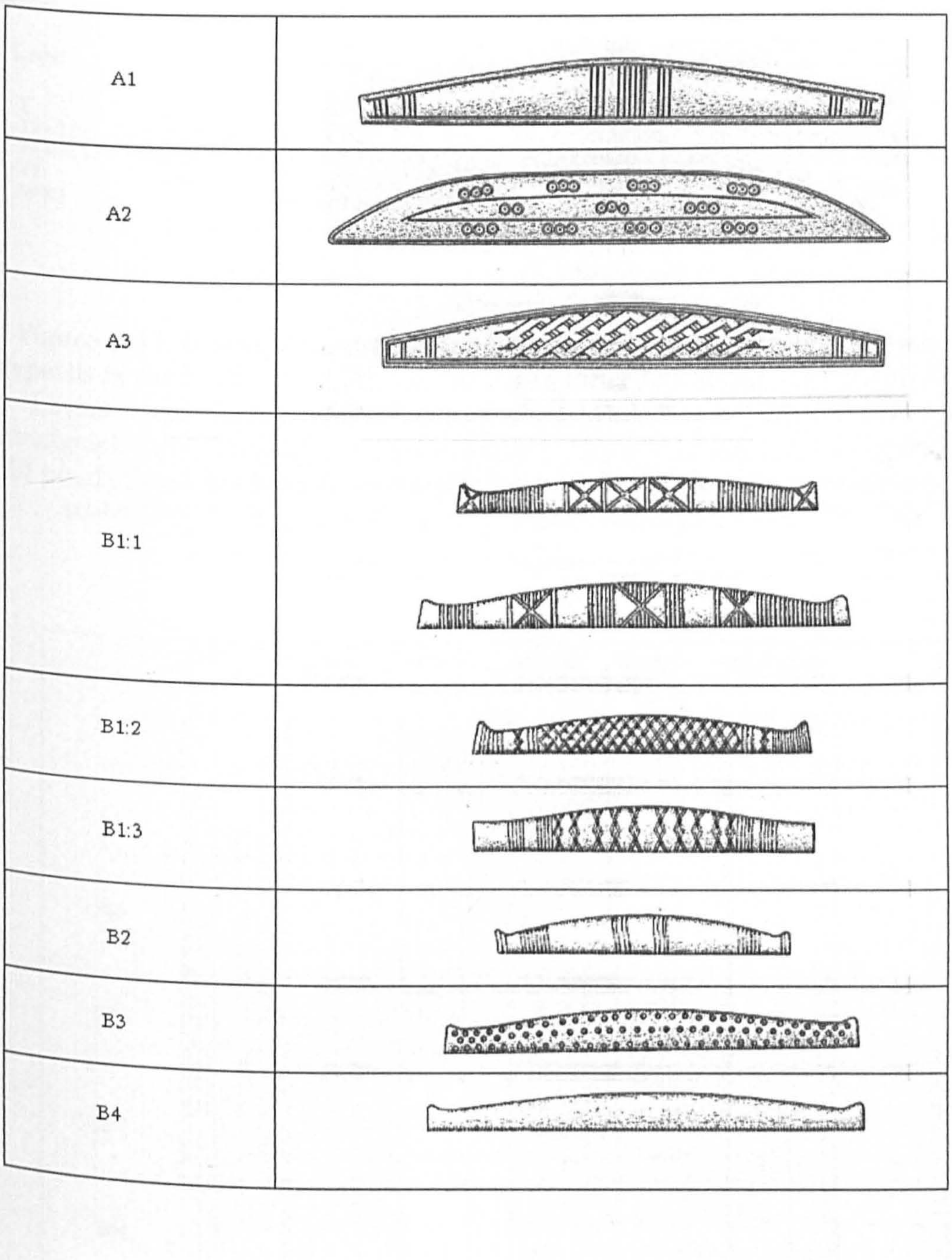


Figure 6. 16 Ambrosiani's (1981) Birka comb typology

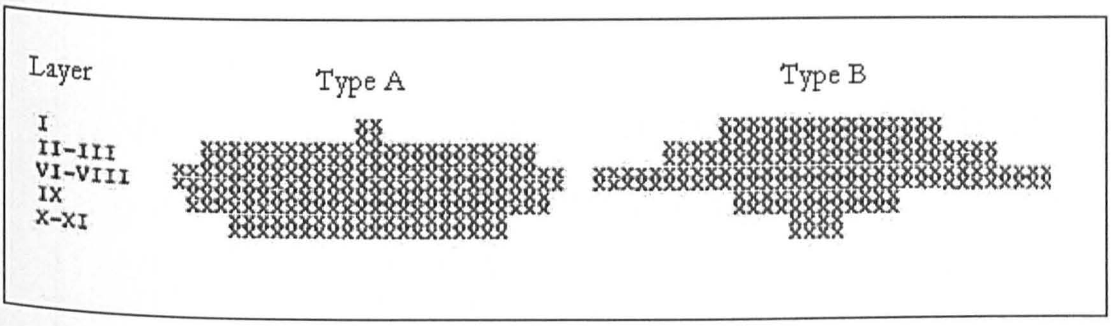


Figure 6. 17: Density (number of combs per 10m^3) of Ambrosiani's types in deposits in the harbour excavations at Birka (after Ambrosiani 1981: Abb 38). . Layers X and XI are stratigraphically earliest, while layers I, III, and IV were stratigraphically youngest, but were disturbed. Layer V is undated, and layers VI-VIII poorly dated, but layer IX contained finds datable to the early tenth century, and layers X-XI to the late ninth century (Ambrosiani and Clarke 1992: 74).

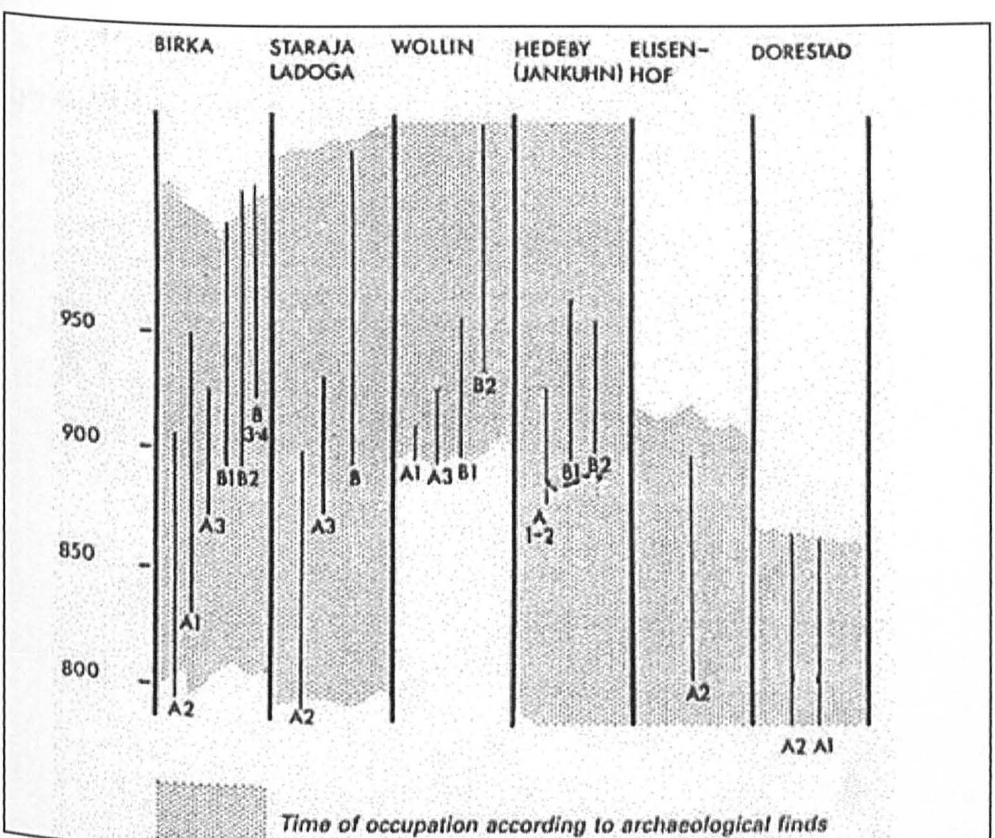


Figure 6. 18: The chronology of Ambrosiani's typology across Europe (Ambrosiani 1981: fig 10).

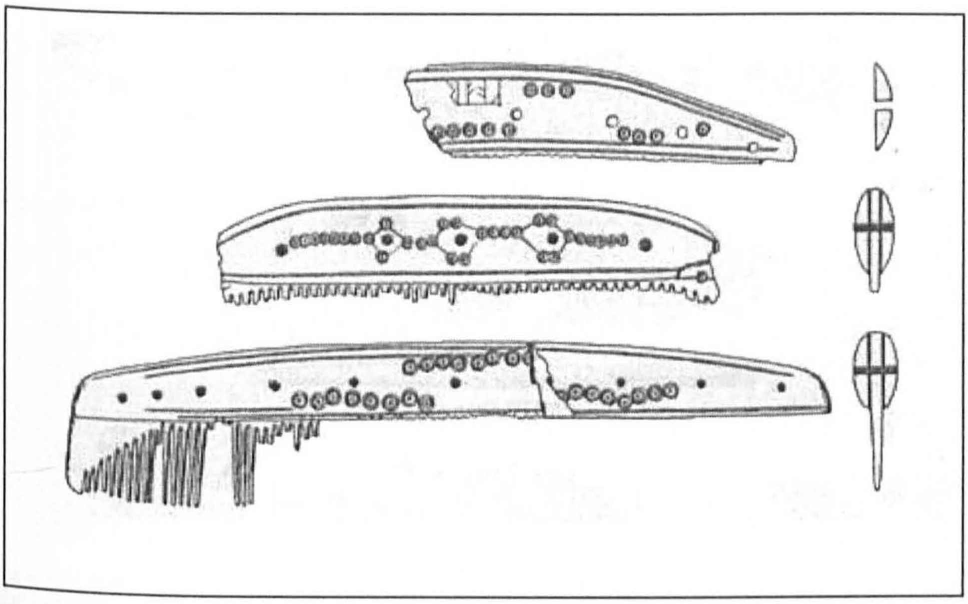


Figure 6. 19 Type 5 precursors (Tempel's '*Vorformen*') to Ambrosiani A (after Tempel 1979: abb 4)

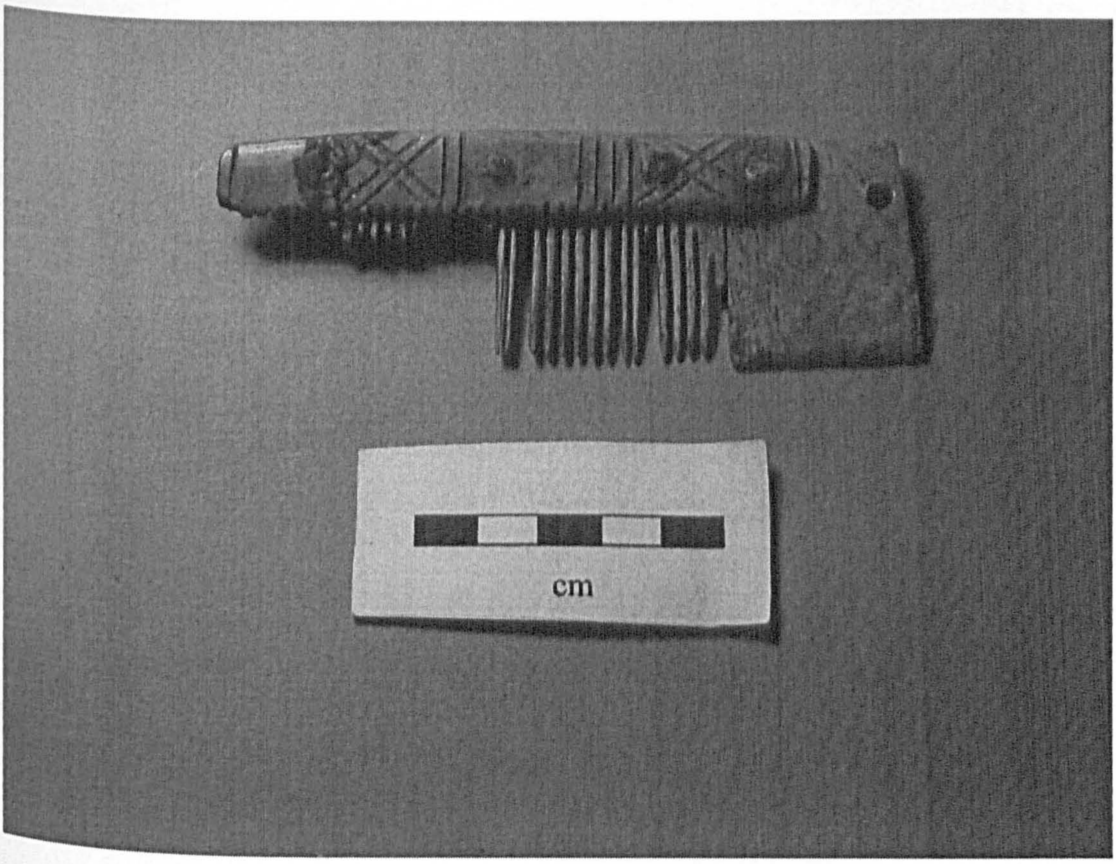


Figure 6. 20 Unusual combs from Birka (Top: type 5 variant; bottom: type 3 asymmetric comb)

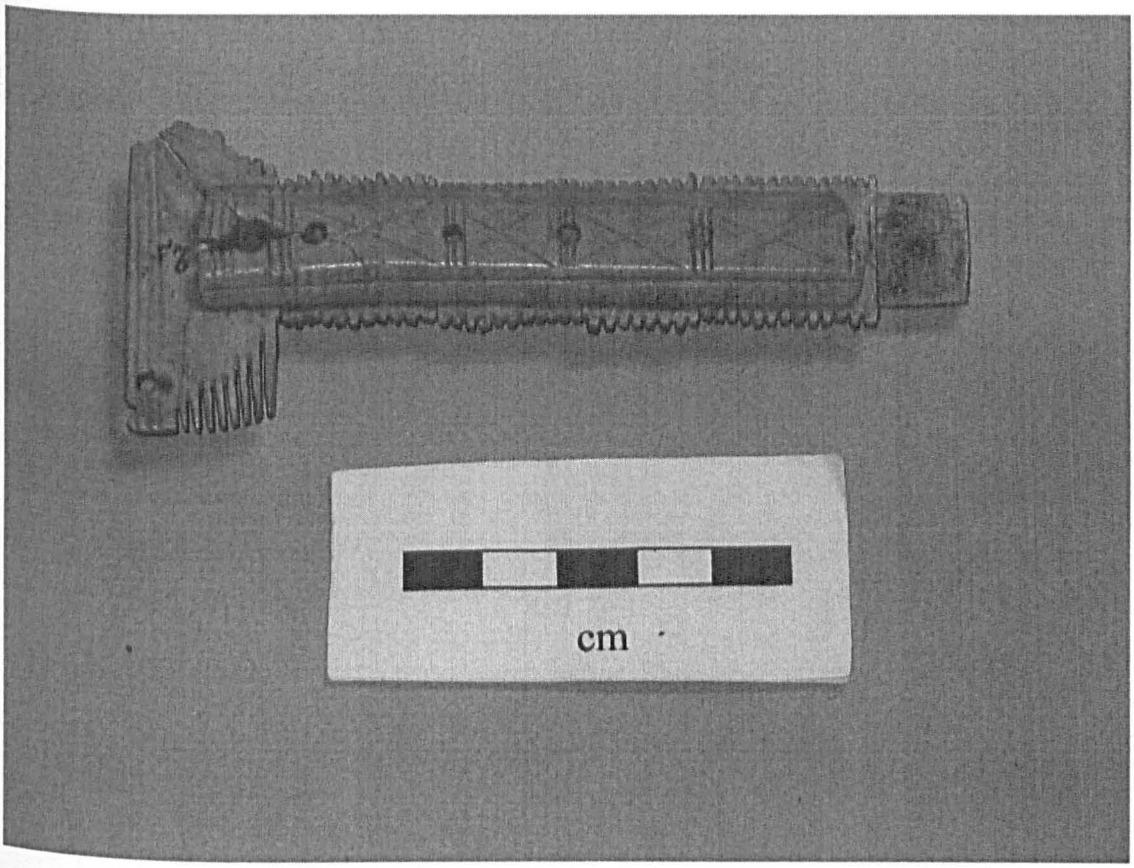


Figure 6. 21 Type 11 comb from Birka

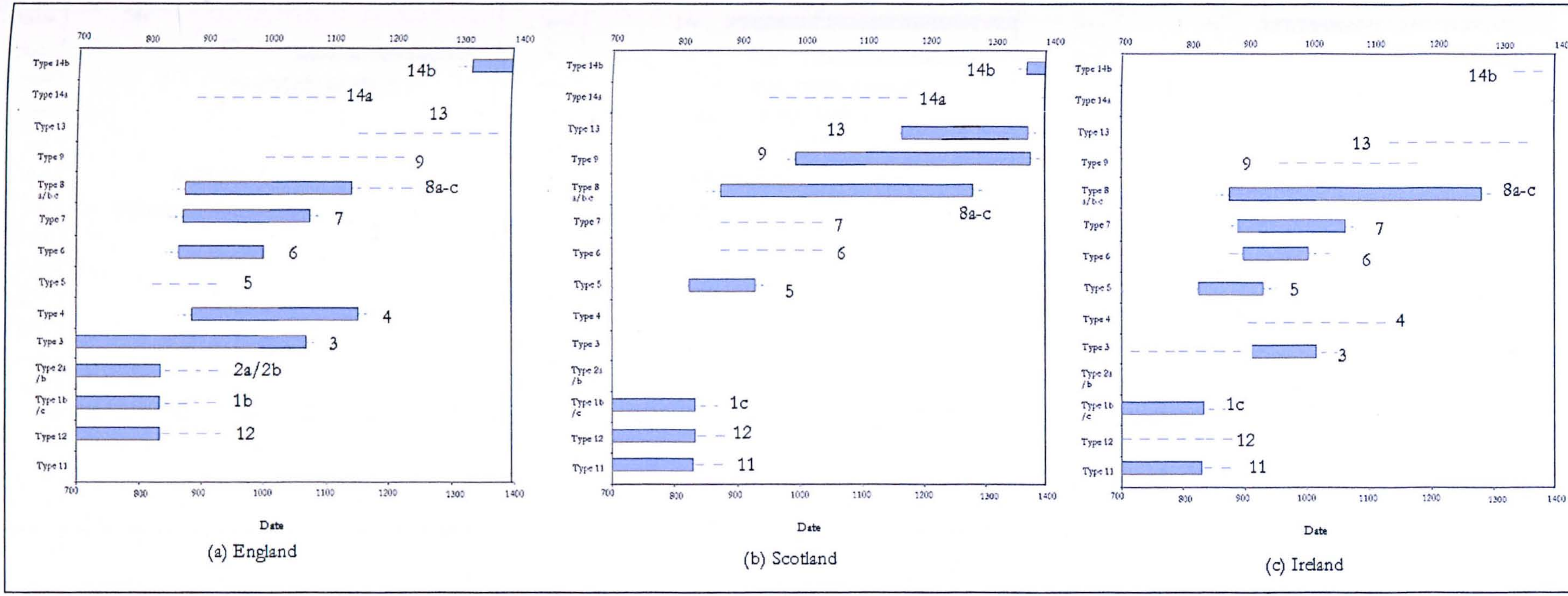


Figure 6.22 Timelines for various regions of Europe (continued overleaf).
Ranges are approximate, and based on published sequences from settlement and cemetery excavations

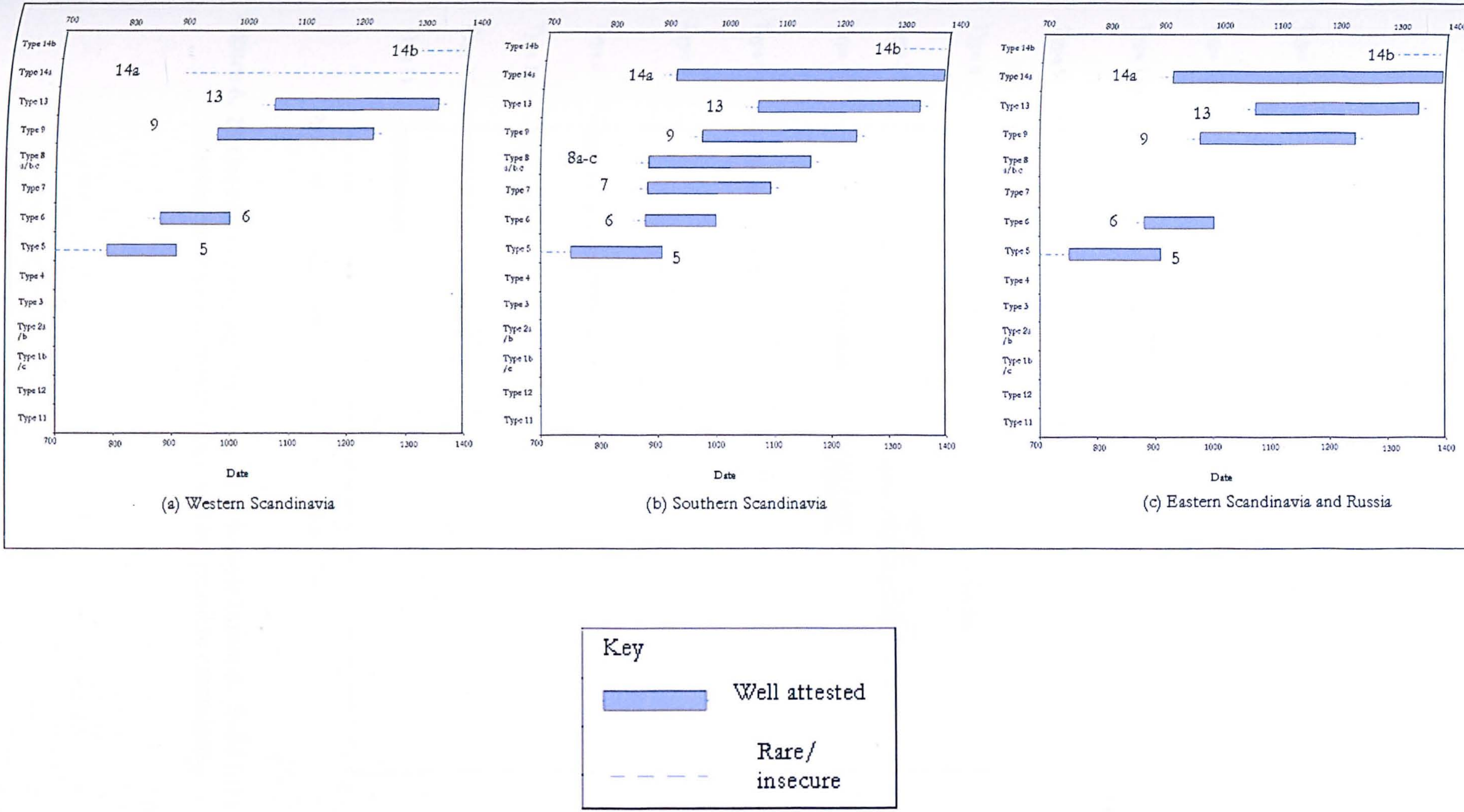


Figure 6.22 (cont) Timelines for various regions of Europe

COLOUR IN ORIGINAL

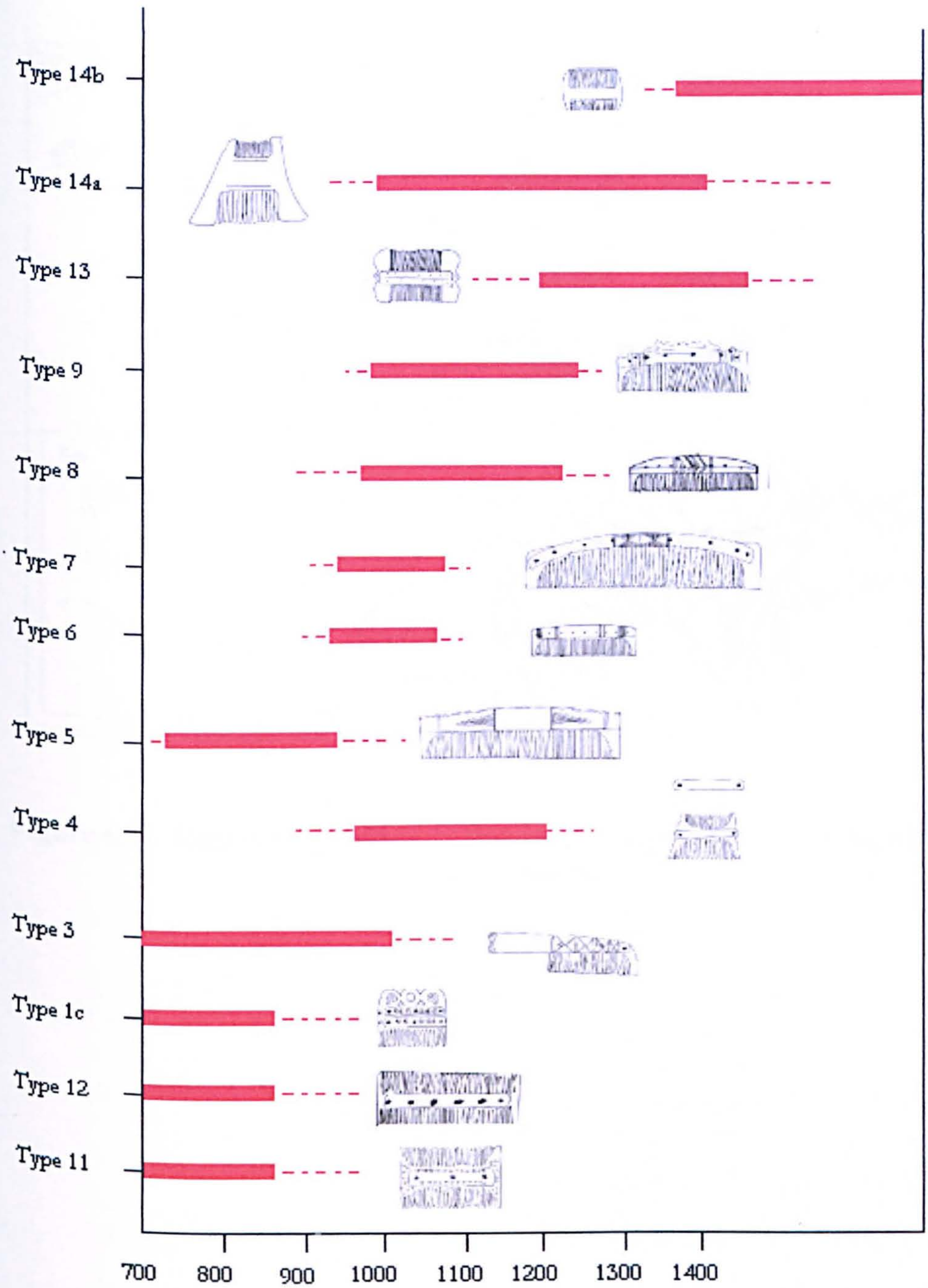


Figure 6. 23 Overall chronology for types of principle interest. Solid bars indicate known date ranges, broken lines indicate possible extensions.

COLOUR IN ORIGINAL

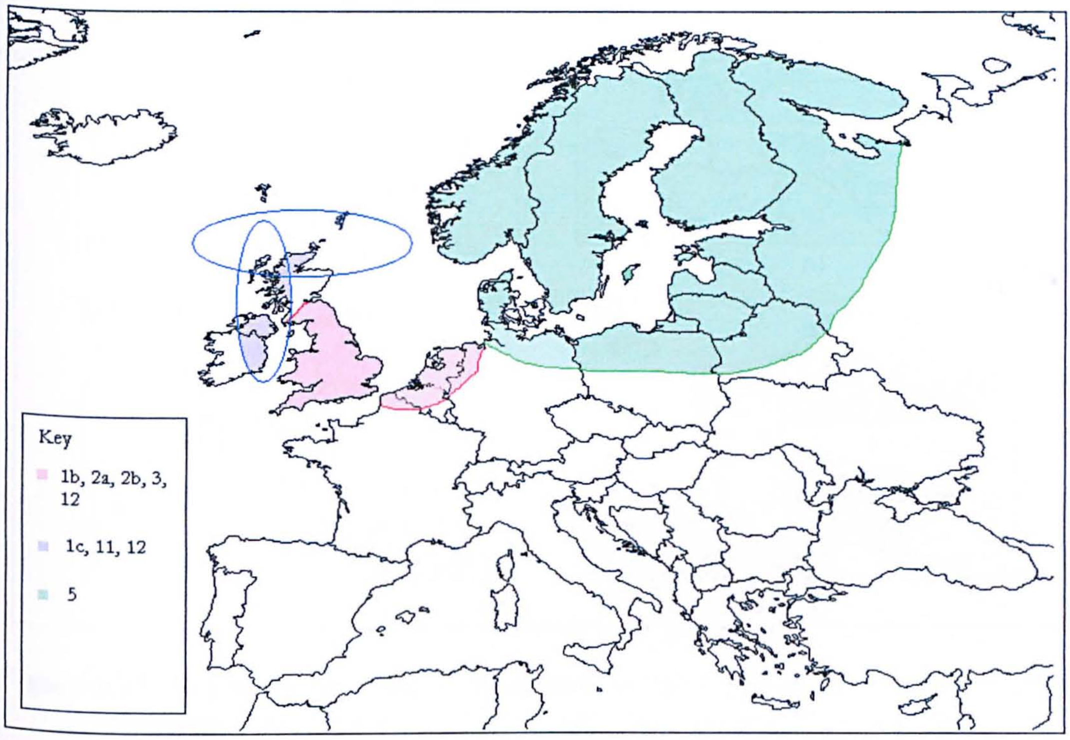


Figure 6.24 Regional variation in dominant comb types in the eighth and ninth centuries

COLOUR IN ORIGINAL

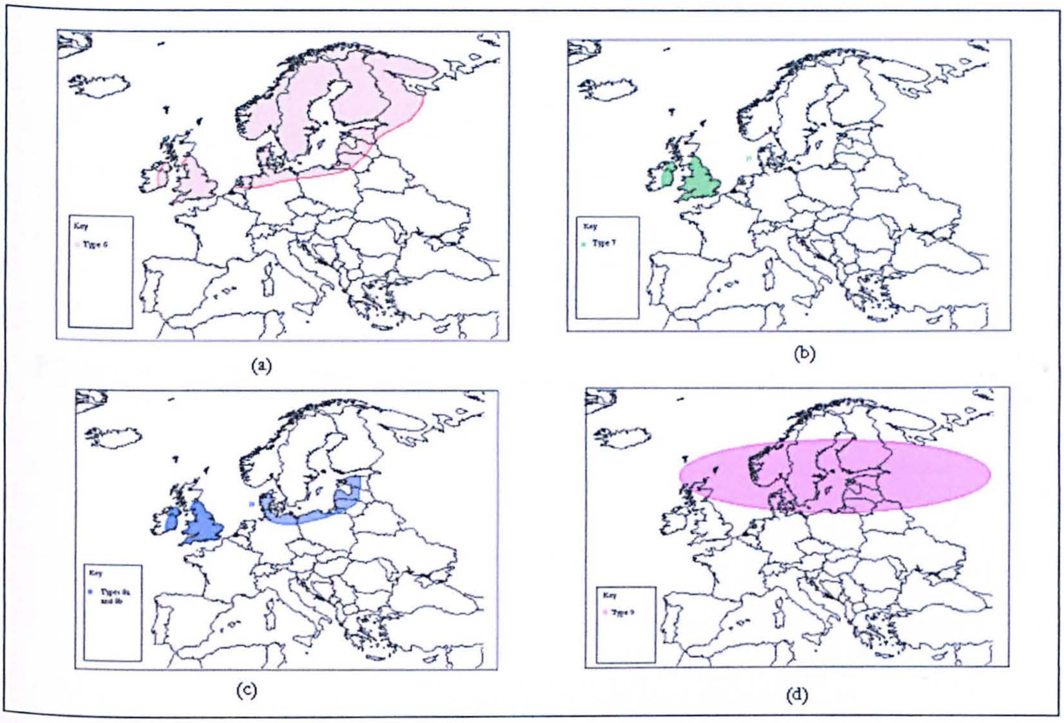


Figure 6.25 Regional variation in dominant comb types in the tenth to twelfth centuries. (a) Type 6, (b) Type 7, (c) Types 8a and 8b, (d) Type 9

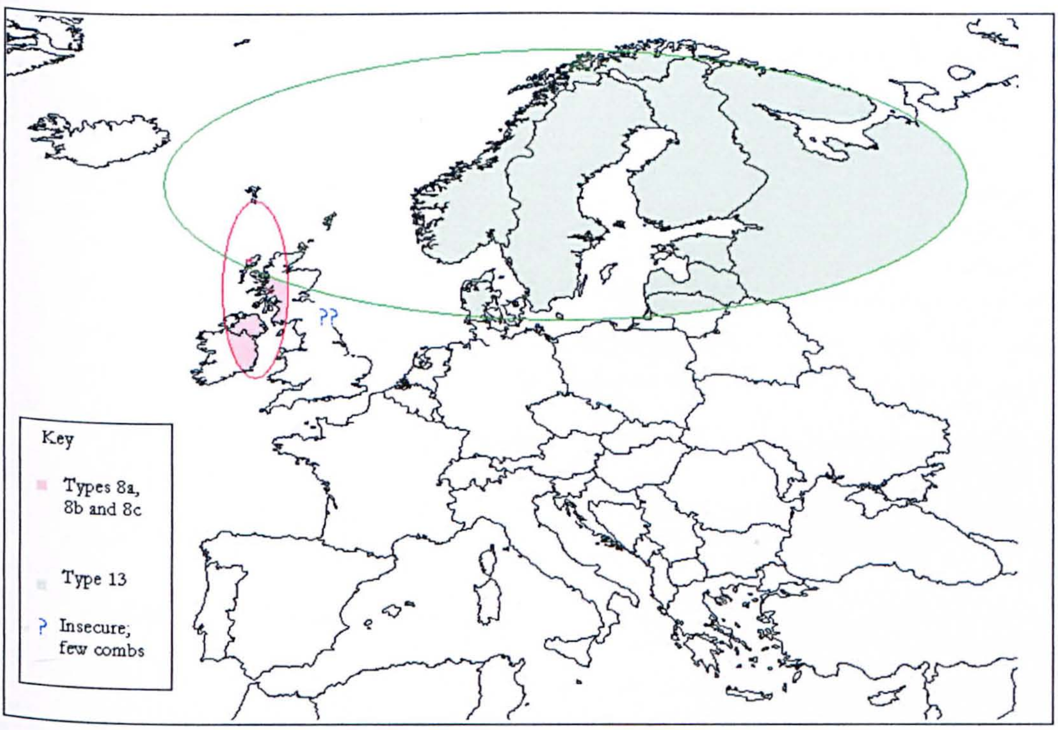


Figure 6. 26 Regional Variation in Dominant Comb Types in the Thirteenth and Fourteenth Centuries

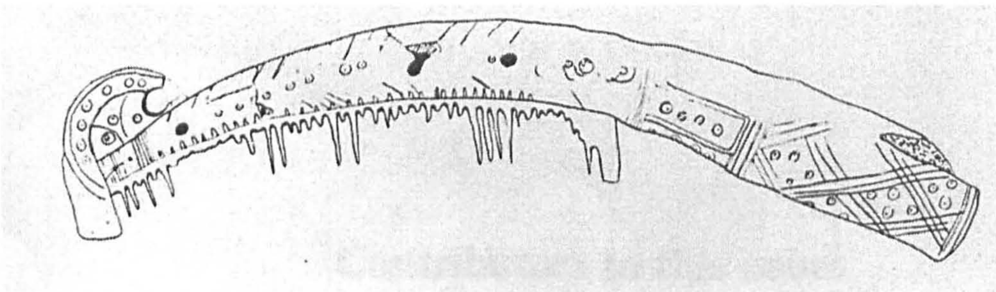
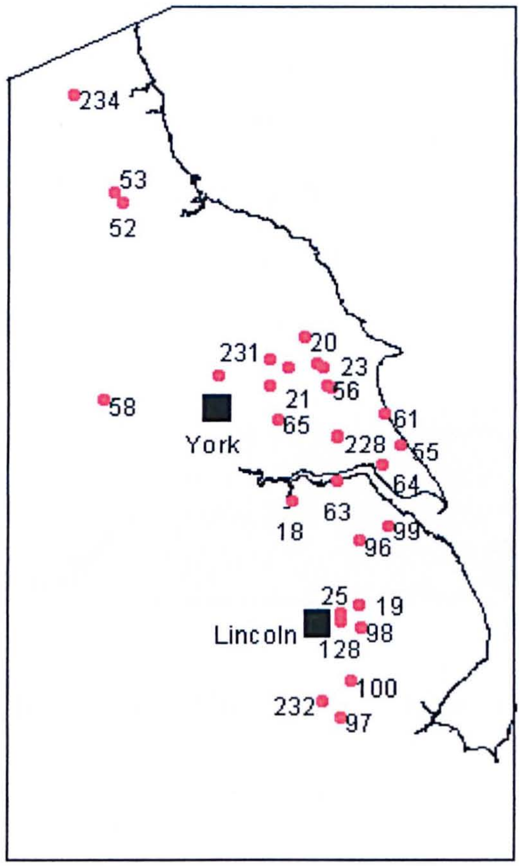


Figure 6. 27 'Merovingian' form of handled comb (Hodges 1980: fig 1).

Figures for Chapter 7

COLOUR IN ORIGINAL



Key

- 18: Flixborough
- 19: Goltho
- 20 West Heslerton
- 21 Wharram
- 23 Cottam
- 52 Saddler Street, Durham
- 53 Beaurepaire, Durham
- 54 Kelleythorpe
- 55 Gartom
- 56 Elmswell
- 58 Paddock Hill, Thwing
- 61 Hornsea
- 62 Cheesecake Hill
- 63 Castledyke South
- 64 Hedon
- 65 Hayton
- 96 Caistor
- 97 Baston
- 98 Bardney Abbet
- 99 Laceby
- 100 Ruskington
- 128 Nelson Road, Fiskerton
- 228 Beverley
- 231 Langton
- 232 Ancaster
- 234 Prudhoe Castle

Figure 7. 1 Sites and localities from which combs were recorded. Multiple sites are known from York and Lincoln (see **Appendix II**)

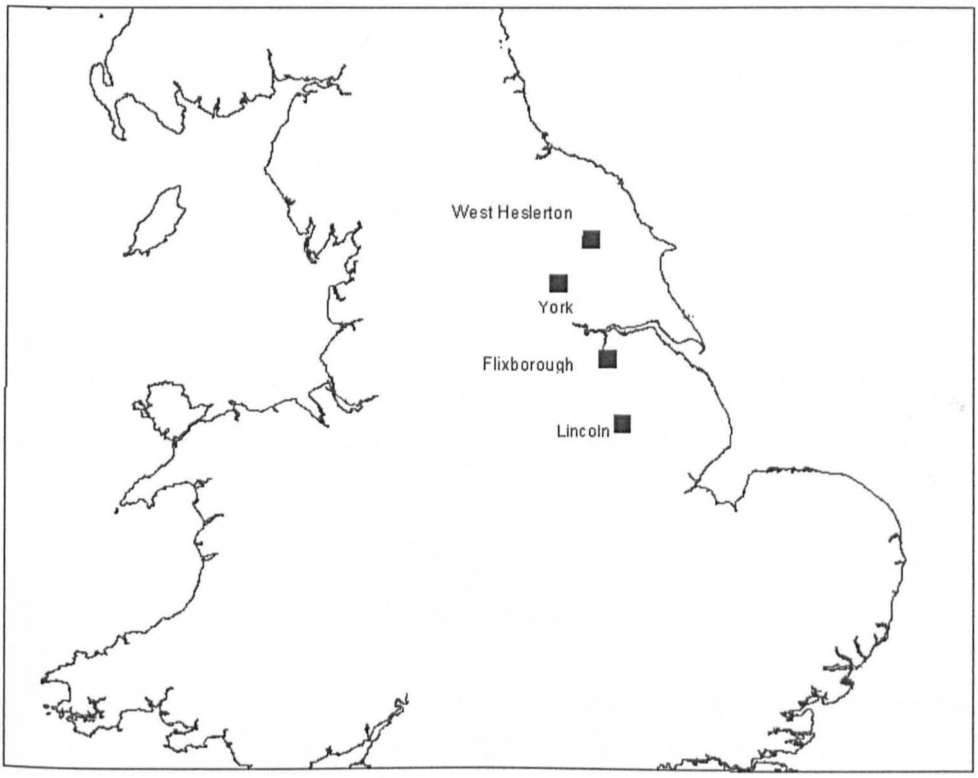


Figure 7. 2 Key Sites and localities mentioned in the text

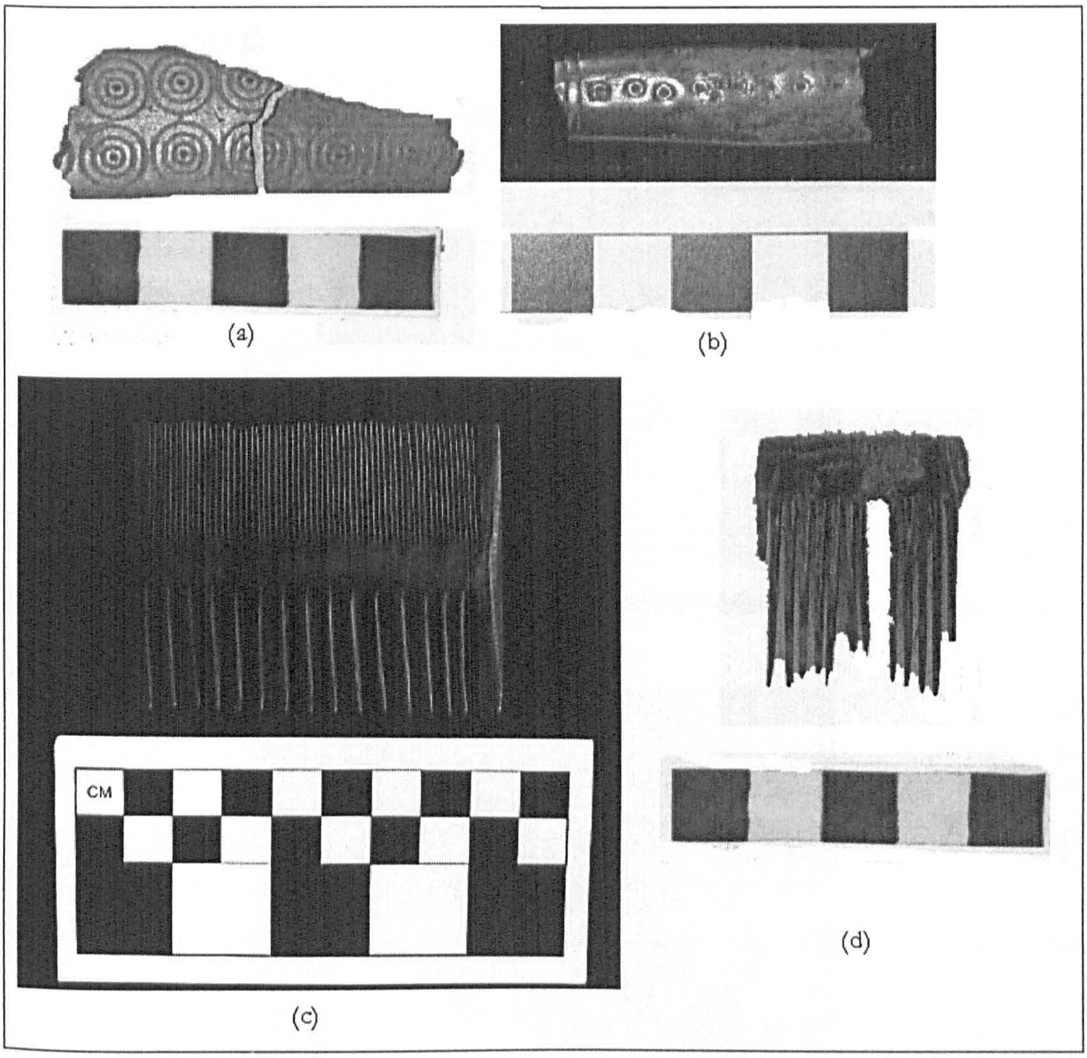


Figure 7. 3 Combs and objects recorded in the database, but not included in analyses (classified as ' non-comb' or 'other') (a) Decorative mount from Coppergate, York; (b) handle from Coppergate, York, (c) Wooden one-piece comb from York (precise provenance unknown); (d) No. 1147, tortoiseshell one-piece comb from Steep Hill, Lincoln

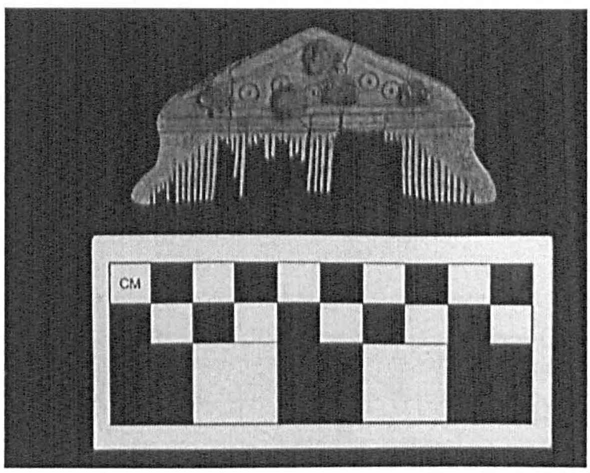


Figure 7. 4 Type 1a combs from northern England (top: no. 1930, Ancaster, Lincs ; bottom: 1520, Wellington Row, York)

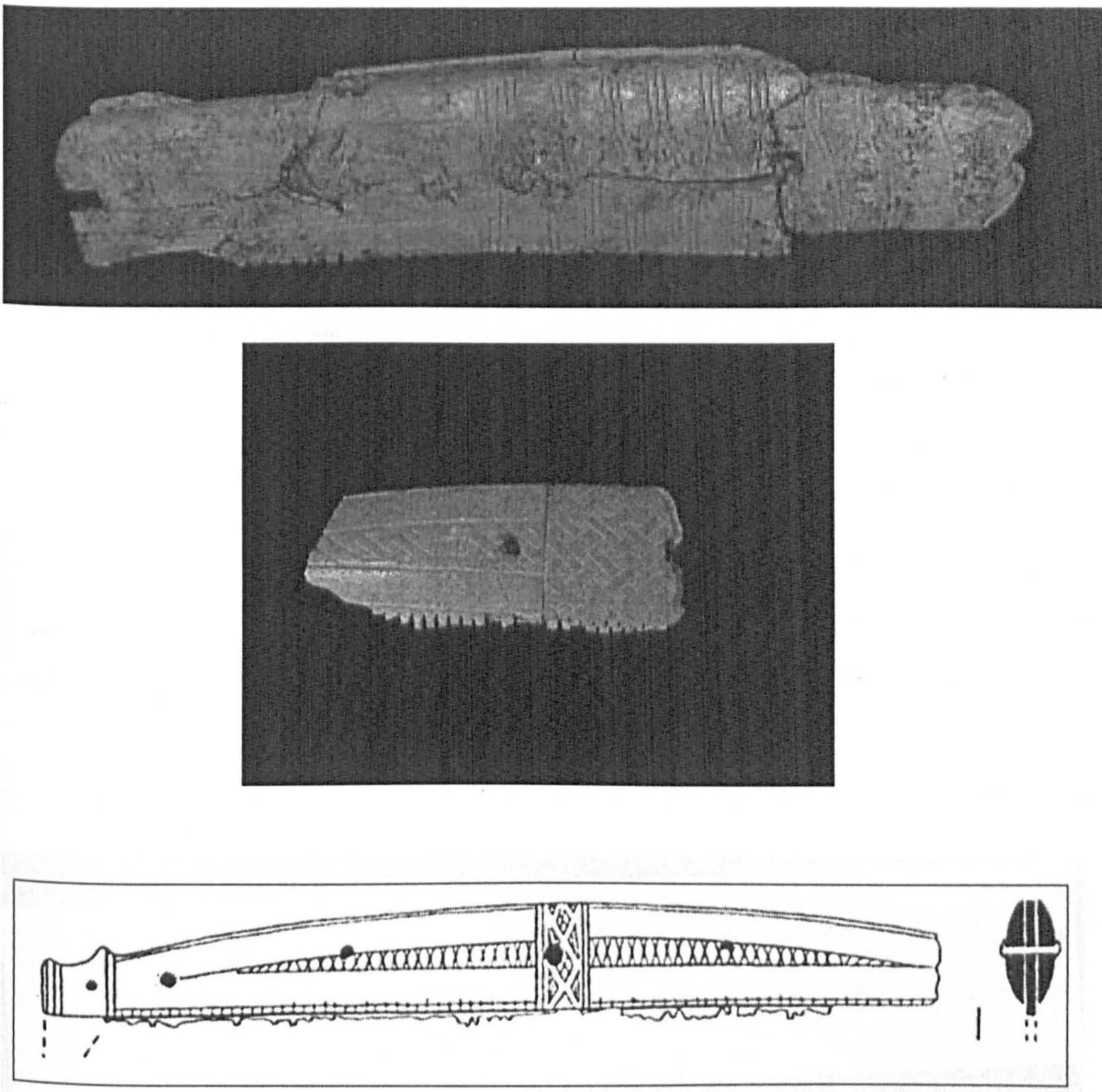


Figure 7. 5 Type 5 combs from Fishergate, York (no. 879), Caistor, Lincolnshire (1149), and Clifford Street (after Waterman 1959: fig 16.1)

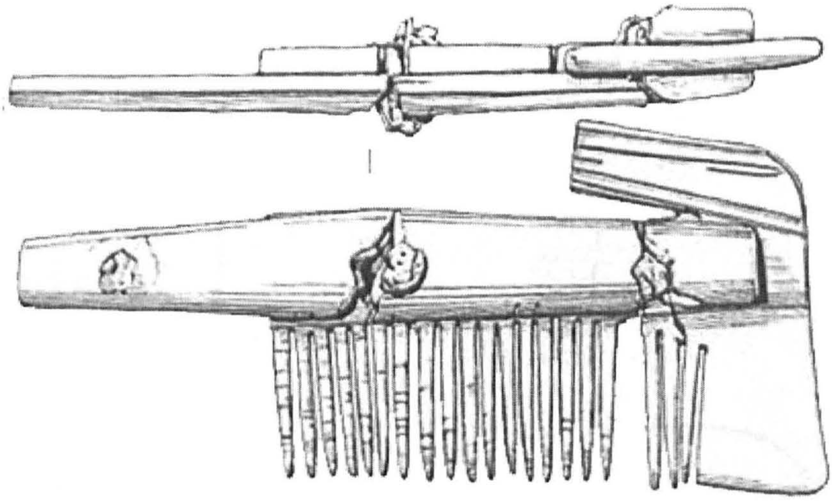


Figure 7. 6 Type 6 comb from Goltho (no. 2404; illustration from MacGregor 1987: fig 161.5)

COLOUR IN ORIGINAL

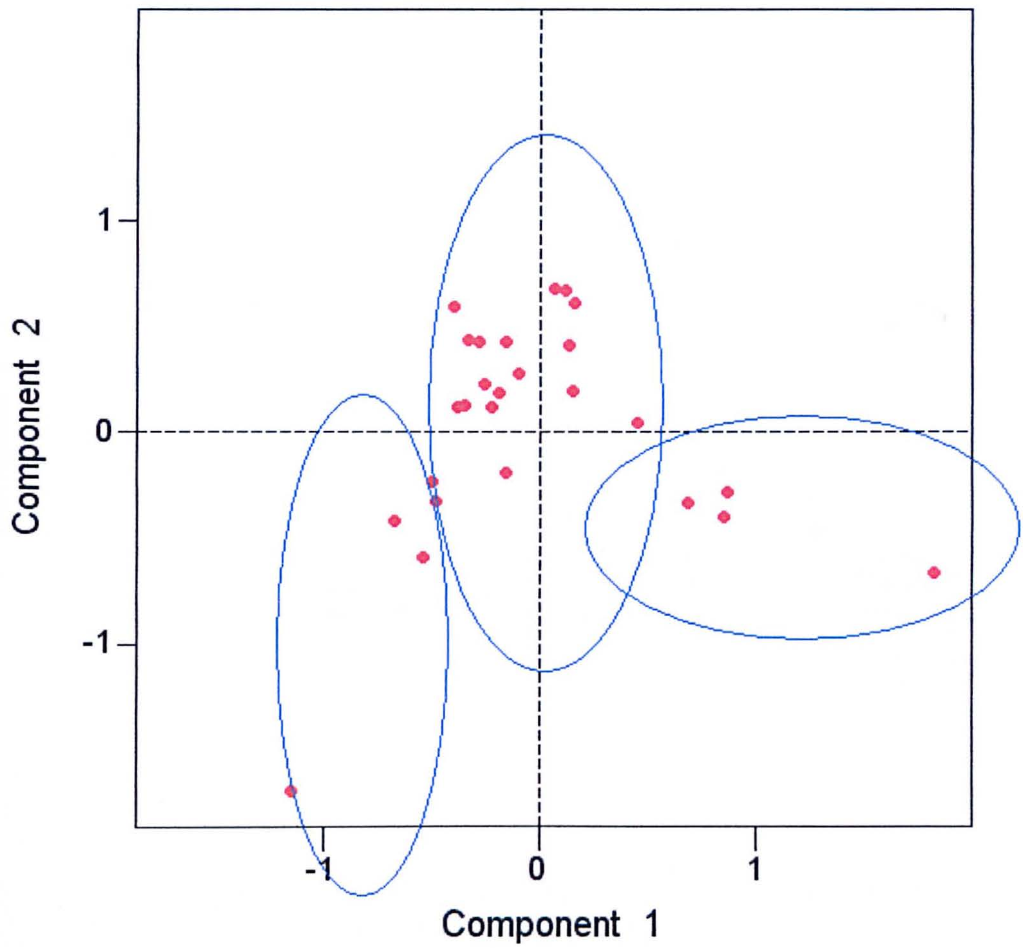


Figure 7. 7a Correspondence analysis of type 6 combs from northern England (object plot)

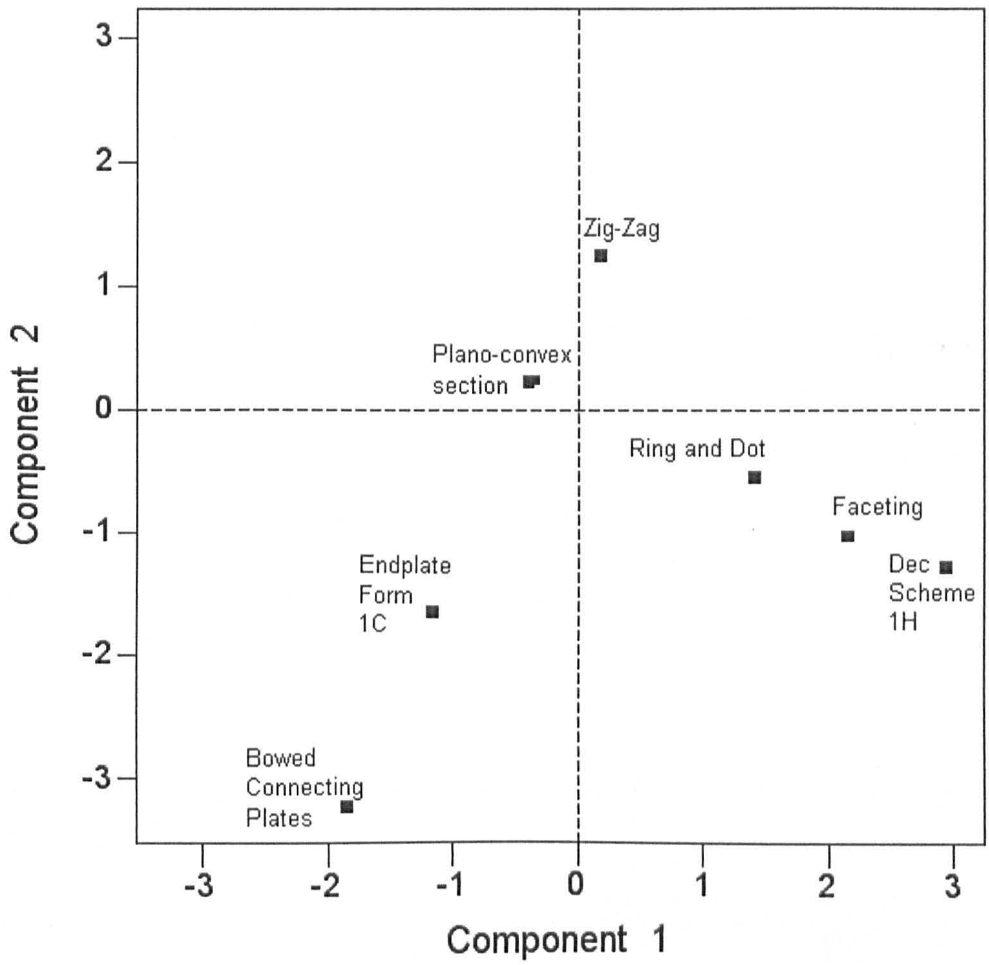


Figure 7. 7b: Correspondence analysis of type 6 combs from northern England sample (variable plot)

COLOUR IN ORIGINAL

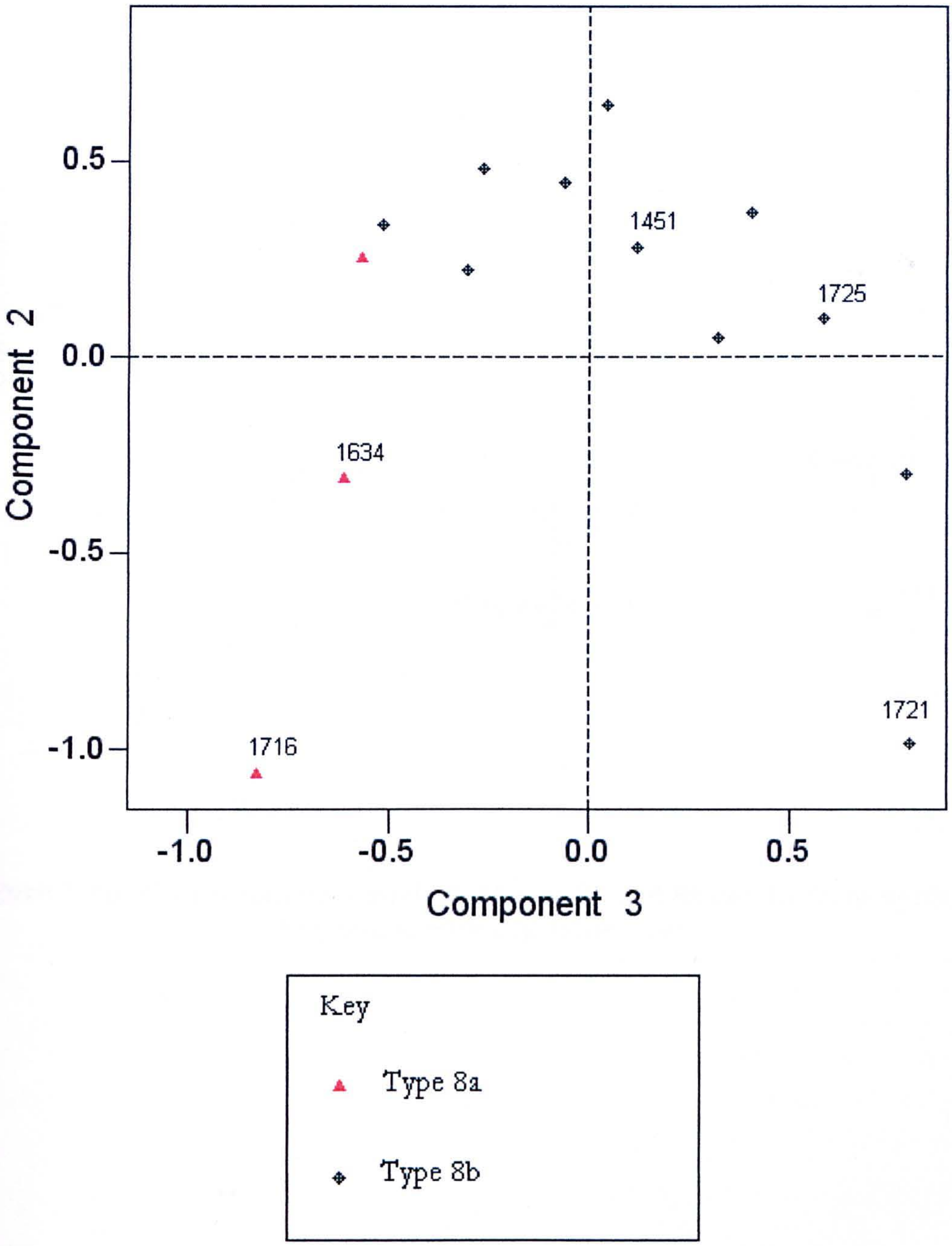


Figure 7. 8a: Correspondence analysis of type 8a and 8b combs from northern England sample (object plot)..

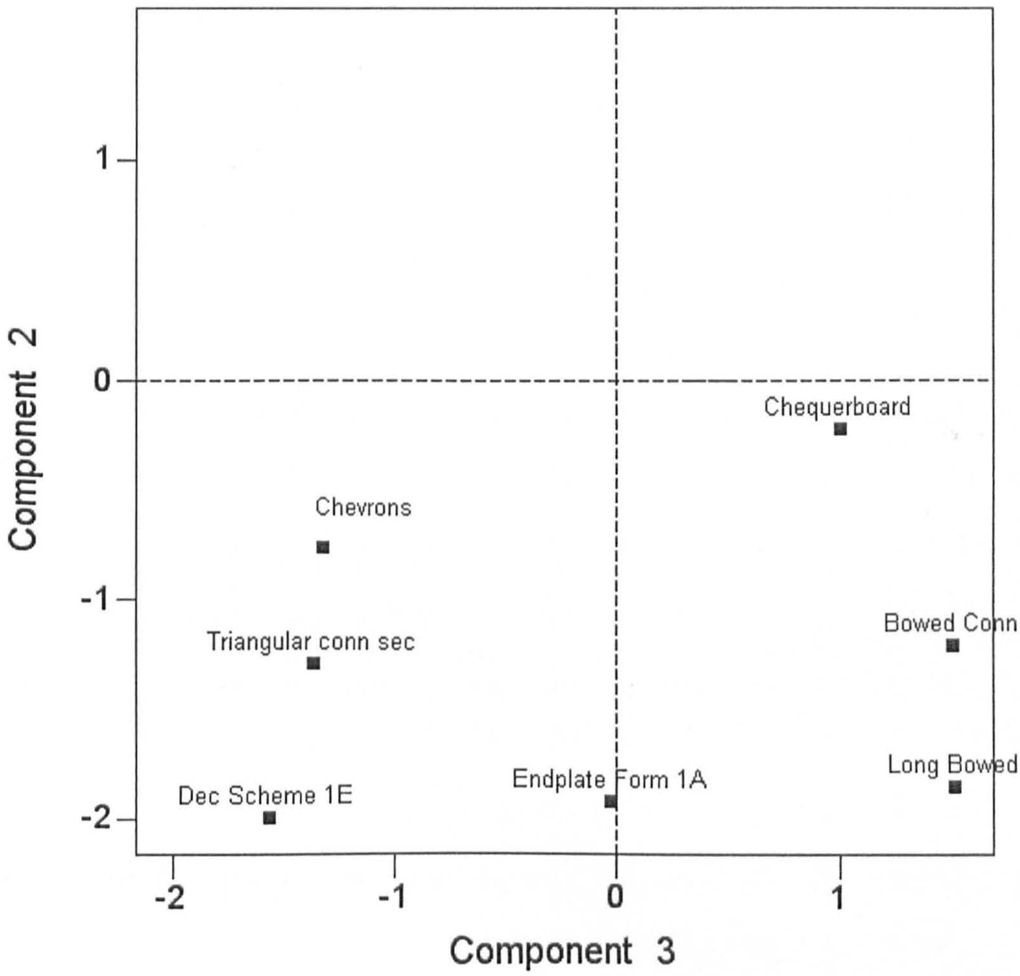
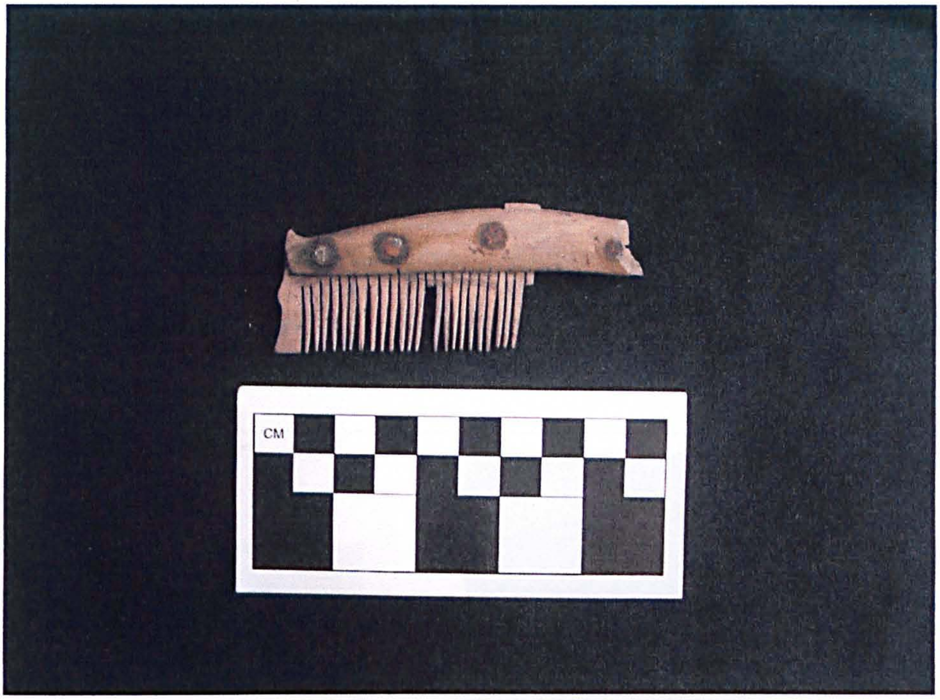


Figure 7. 8b: Correspondence analysis of type 8a and 8b combs from northern England sample (variable plot)

COLOUR IN ORIGINAL



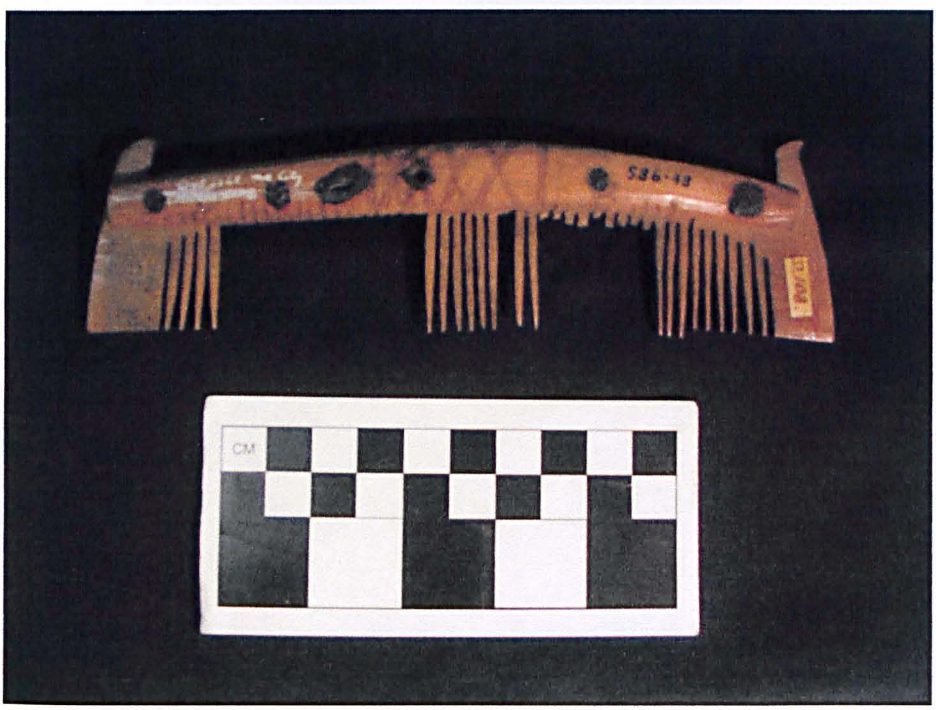


Figure 7. 9 Type 9 'imitation' combs from York (No. 1571, Clifford Street; 1487, unknown provenance)

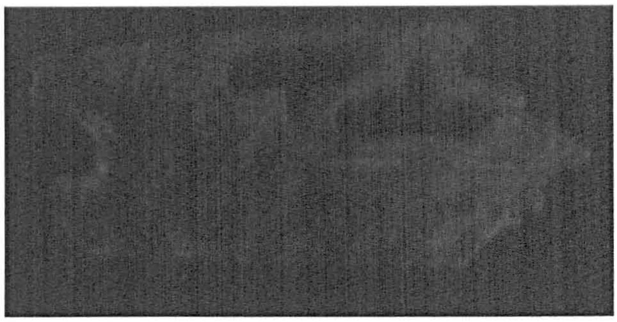


Figure 7. 10 Type 13 fragment from Lurk Lane, Beverley (no. 963)

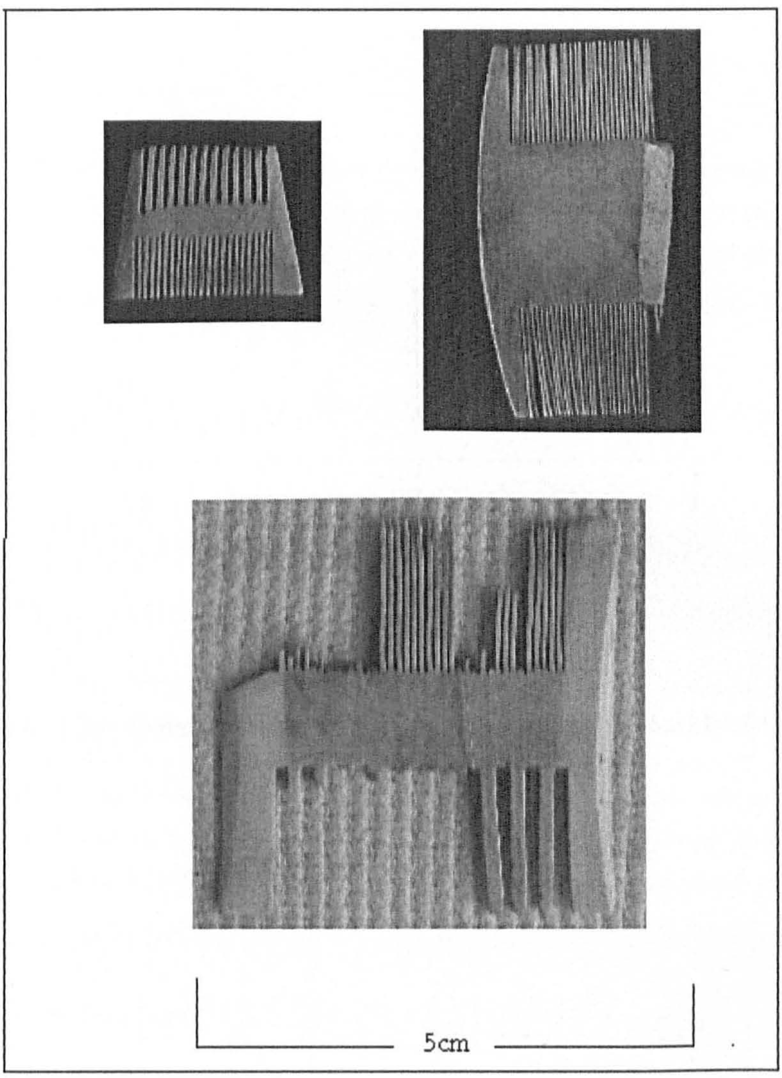


Figure 7. 11 Type 14b combs from northern England (No. 1630, Queen's Hotel, Micklegate, York; 1174, Saltergate, Lincoln; No. 944, Beaurepaire, Durham)

COLOUR IN ORIGINAL

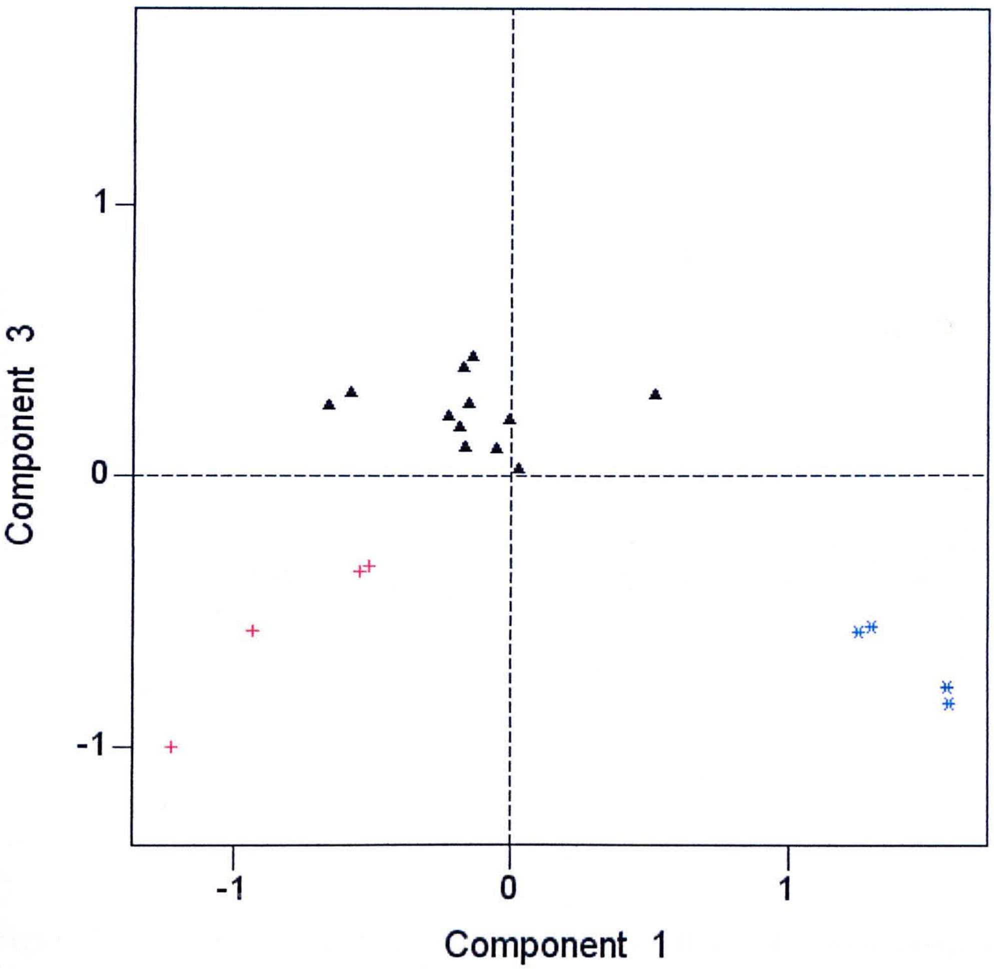


Figure 7. 12a: Correspondence analysis of type 14b combs from northern England sample (object plot)

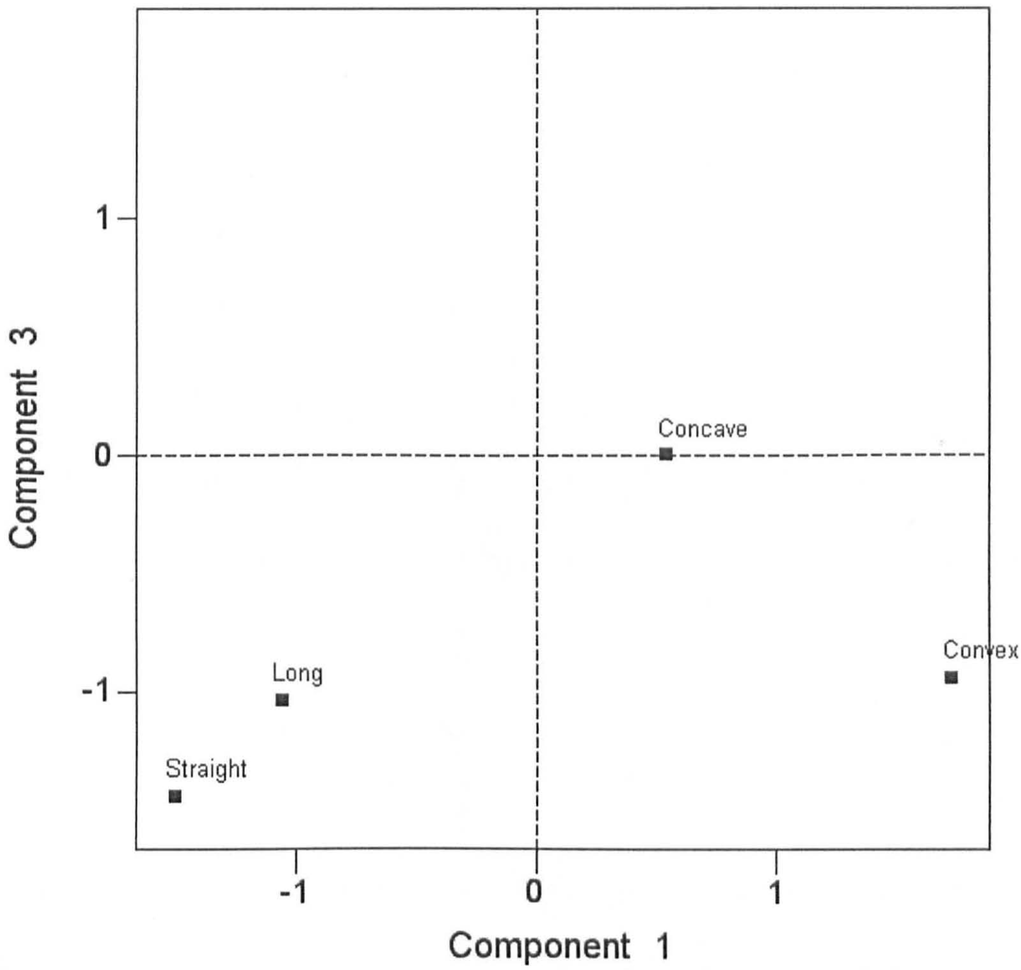


Figure 7. 12b: Correspondence analysis of type 14b combs from northern England sample (variable plot)

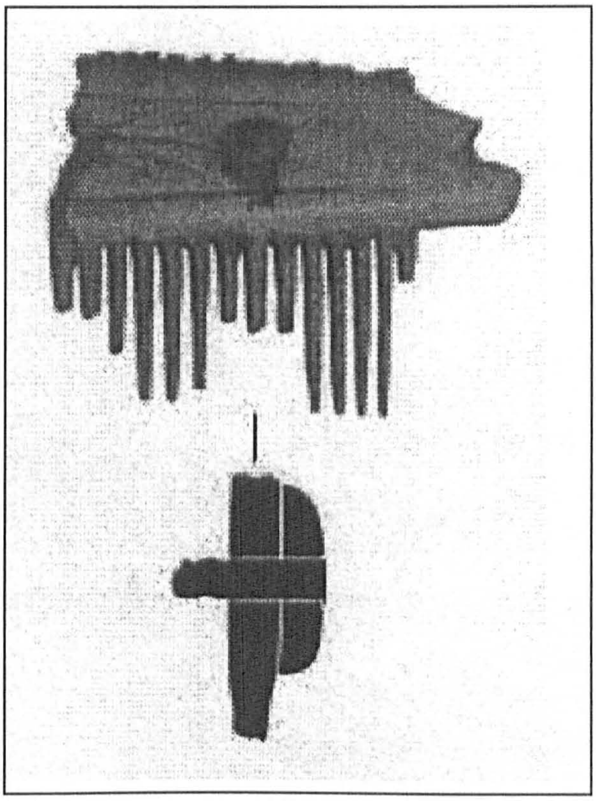


Figure 7. 13 Possible type 5 comb fragment from West Heslerton (No. 2047, image courtesy D. Powlesland)

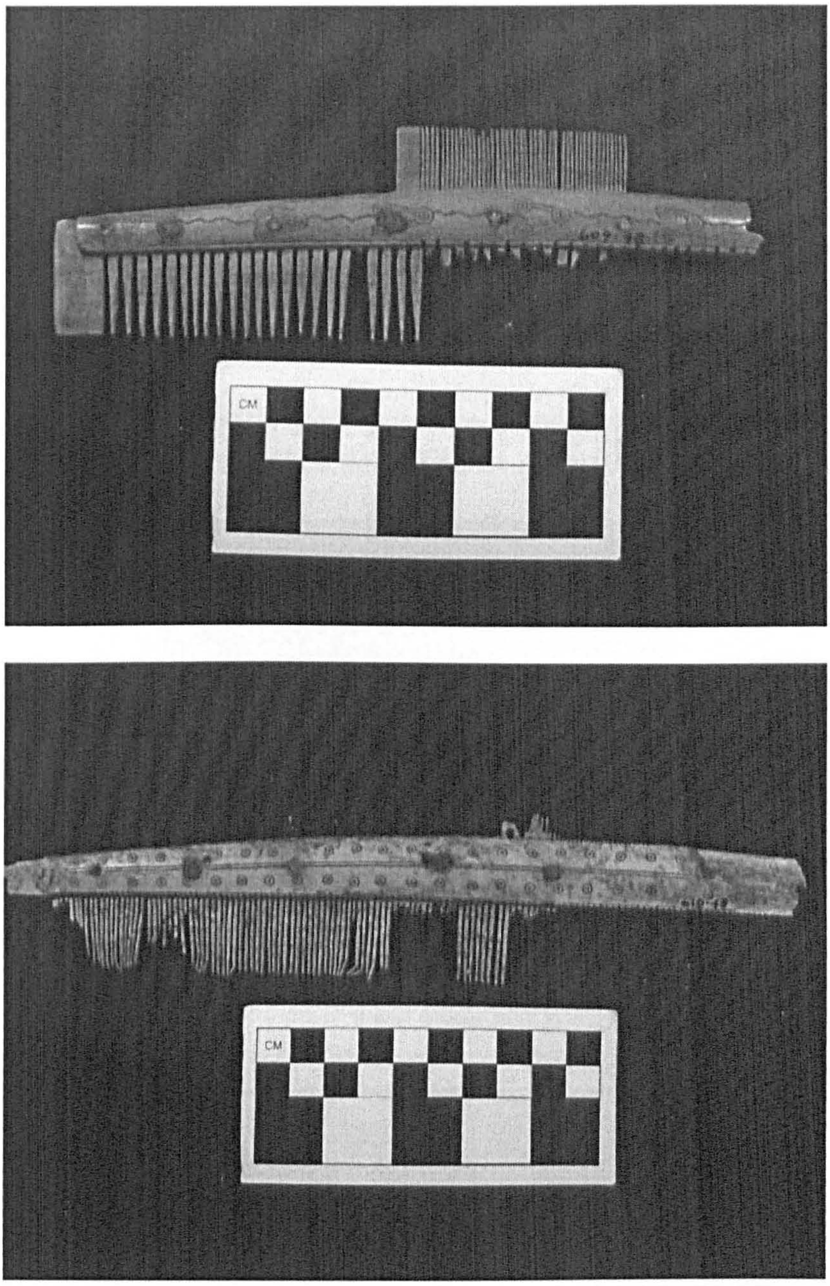


Figure 7. 14 'Semi-double' (type 7 and 8a) combs from York (Numbers 1494, 1495, provenance unknown)

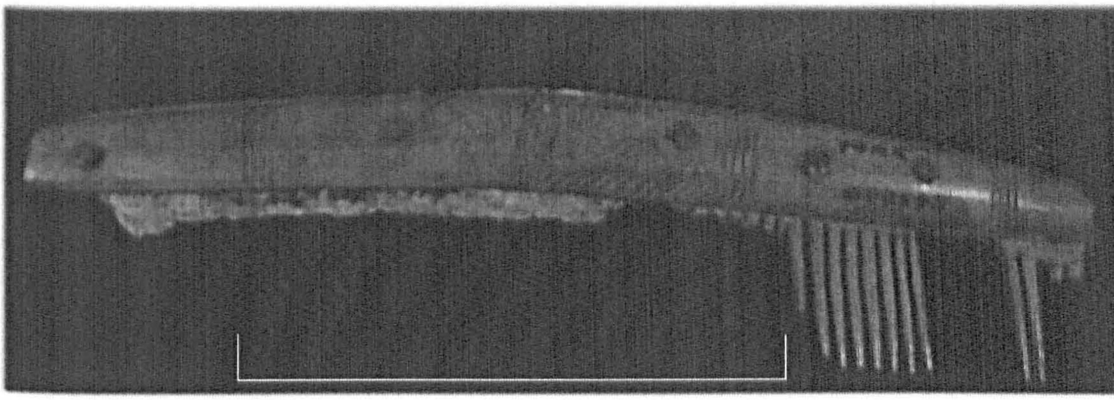


Figure 7. 15 Type 7 comb from York, with both antler and horn billets (No. 1506, provenance unknown; Scale is 10cm long)

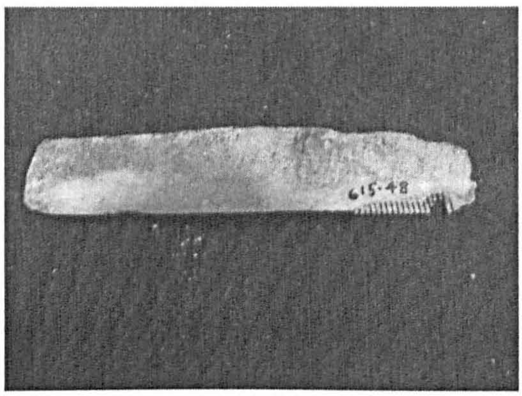


Figure 7. 16 Horn plate/ Comb from York (no. 1499, provenance unknown)

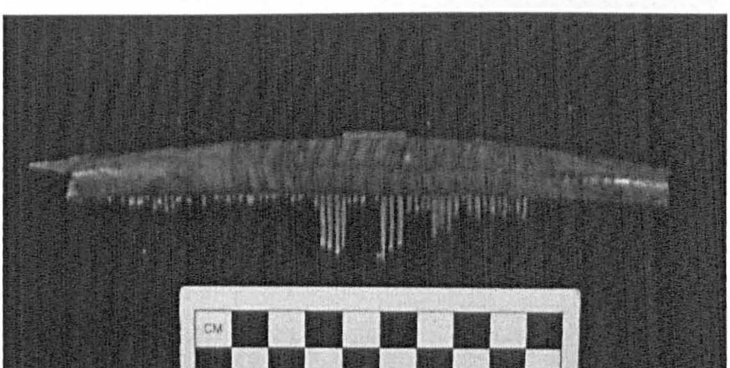


Figure 7. 17 Type 7 Comb with rudimentary faceting and chevron ornament (No. 1502, York, provenance unknown)

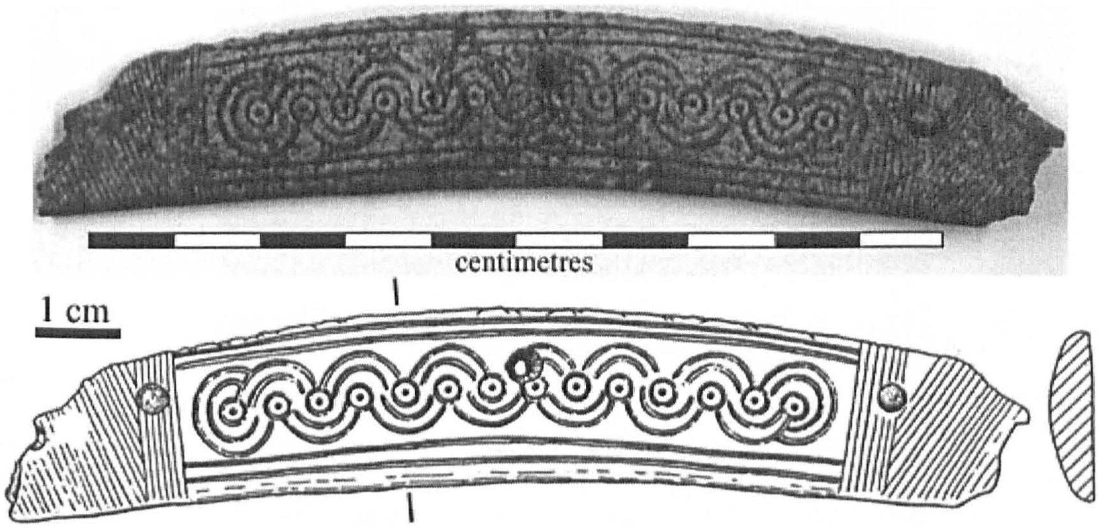


Figure 7. 18 Interconnecting chains of ring-and-dot from Blue Bridge Lane, York (No. 488; Image Courtesy *Field Archaeology Specialists*)

Figure 7. 19 Type 8a Comb and Case with Ring-and-Dot Ornament (no. 952, 953)

COLOUR IN ORIGINAL

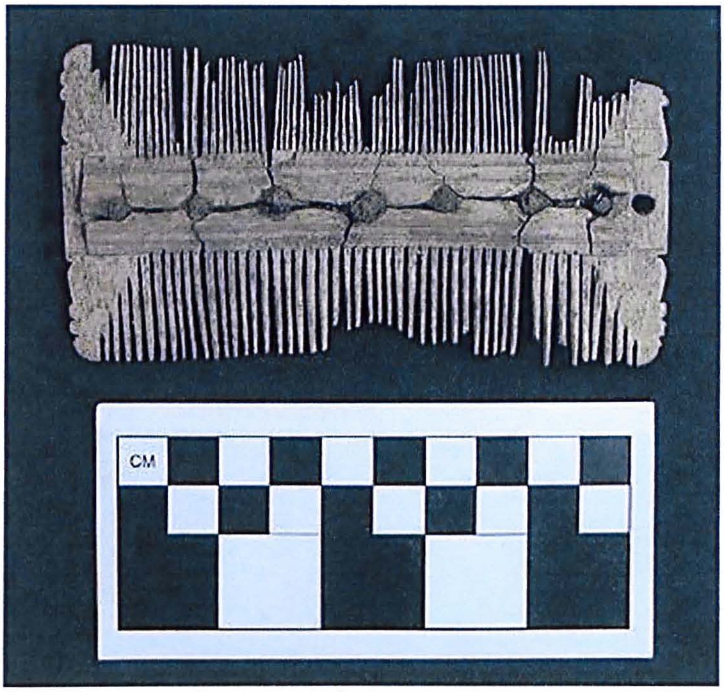


Figure 7. 20 Type 10 comb with decoratively arranged iron rivets (No. 1521, Wellington Row, York)

Figure 7. 21 Type 12 comb of cetacean bone (No. 588, Coppergate, York)

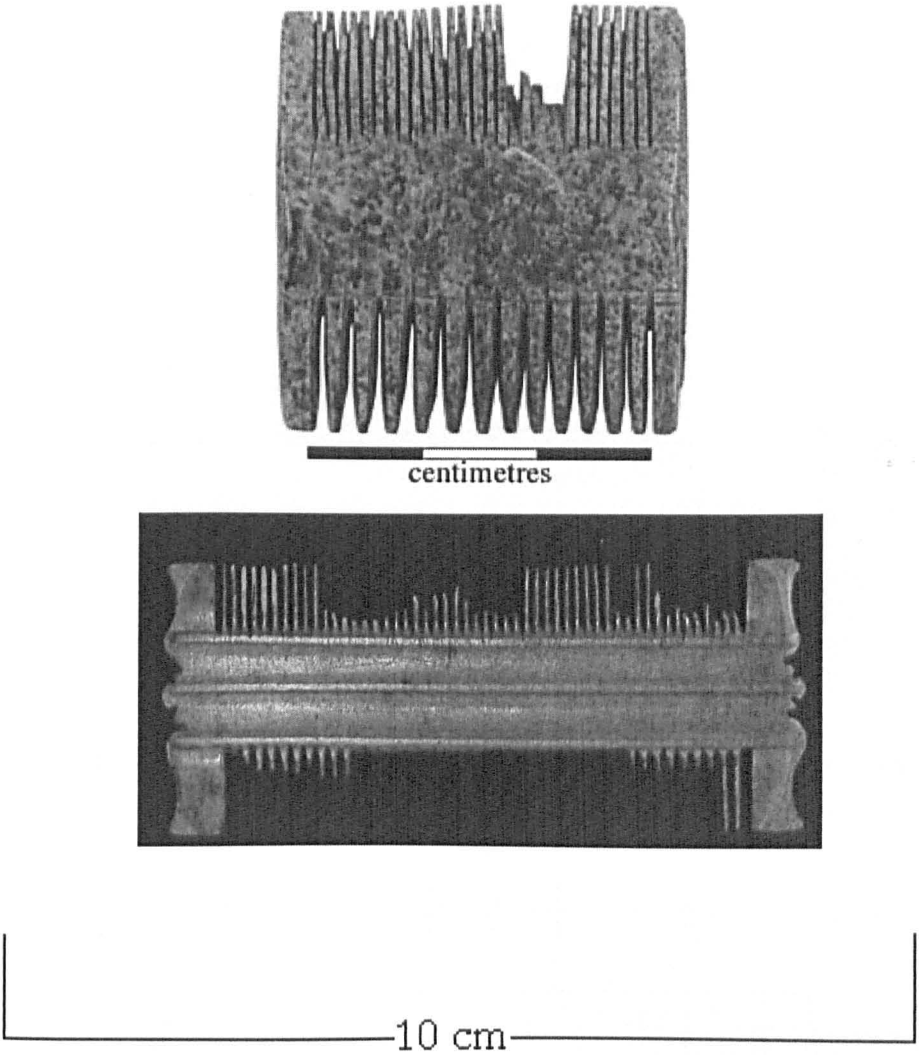


Figure 7. 22 Ivory One-piece combs from York. Top: type 14a (No. 2517, Fishergate House, image courtesy *Field Archaeology Specialists*); Bottom: type 14c (No. 720, the Bedern)

COLOUR IN ORIGINAL

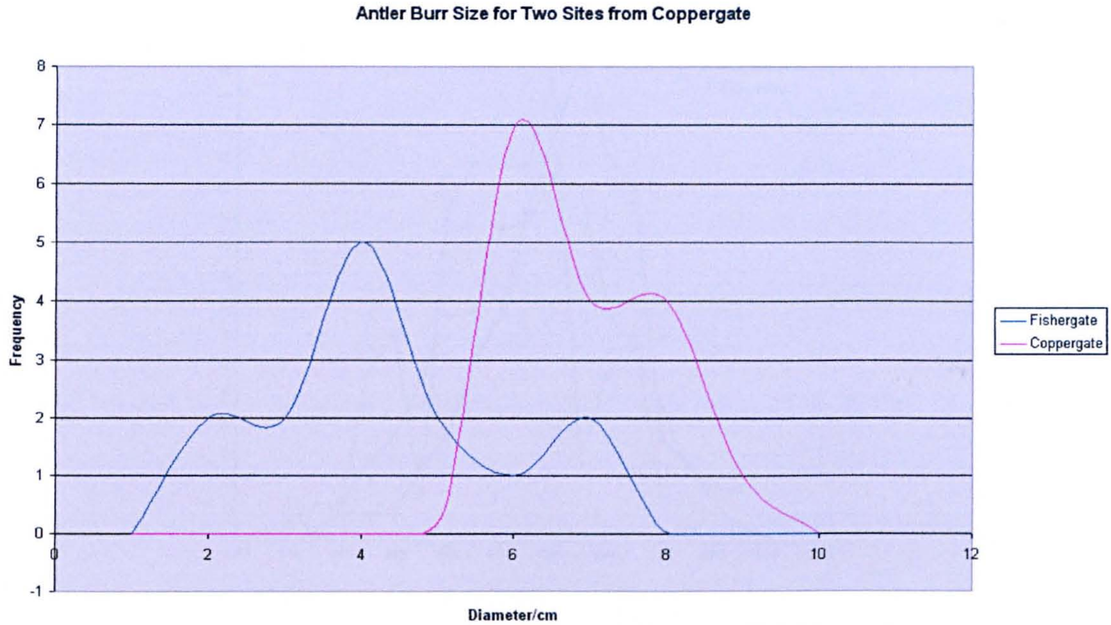


Figure 7. 23 Burr Sizes at Coppergate and Fishergate, York

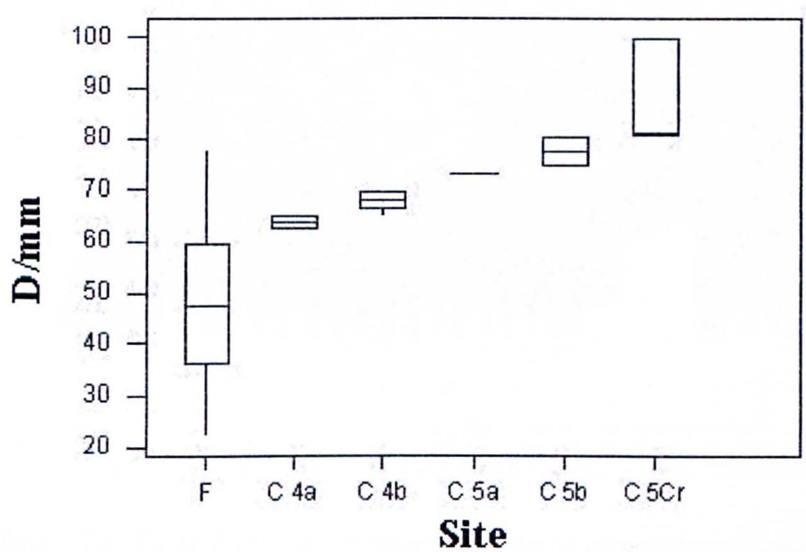


Figure 7. 24 Antler burr size in deposits from York.
F= Fishergate (N=14), C=Coppergate (N=16). 4a-5Cr relate to Coppergate phases (see Hall 1999: 1876).

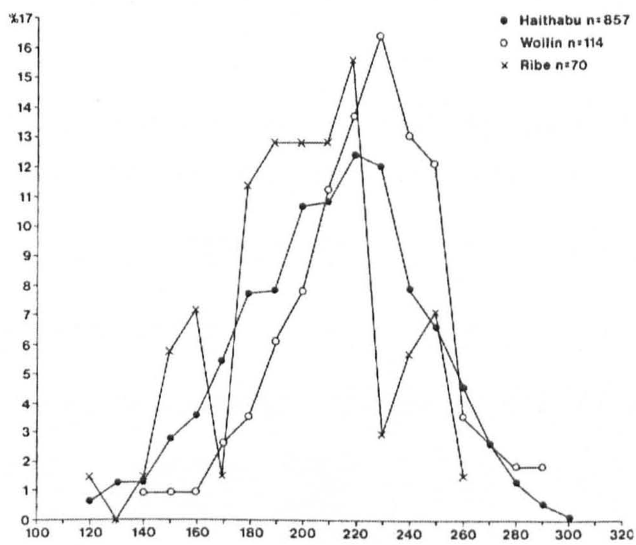


Figure 7. 25 Burr sizes (circumference/mm) from Haithabu, Wolin, and Ribe (Hatting 1991: fig 9).

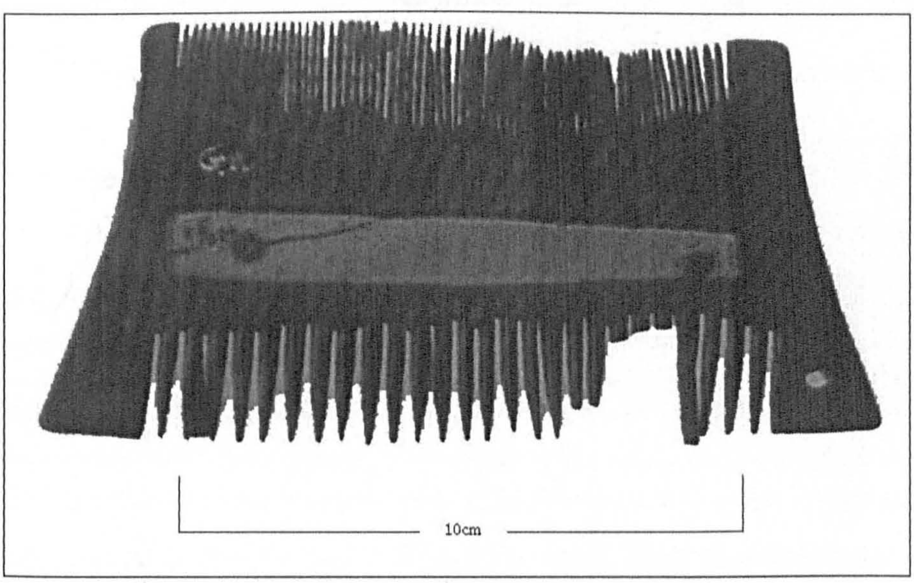


Figure 7.26 Type 4 riveted mount with horn component intact (Yorkshire Museum, not included in corpus)

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COLOUR IN ORIGINAL

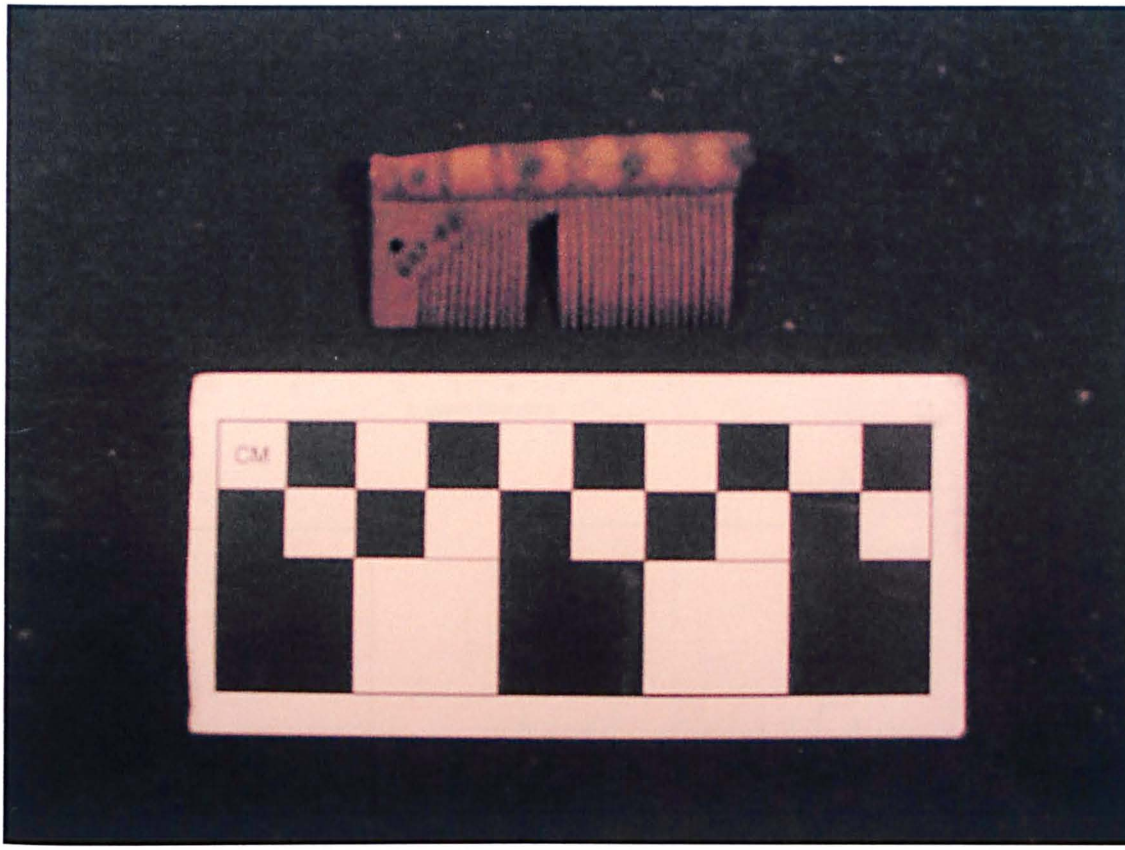


Figure 7. 27 Type 6 comb from York riveted with copper-alloy plated iron rivets (no. 1512, provenance unknown)

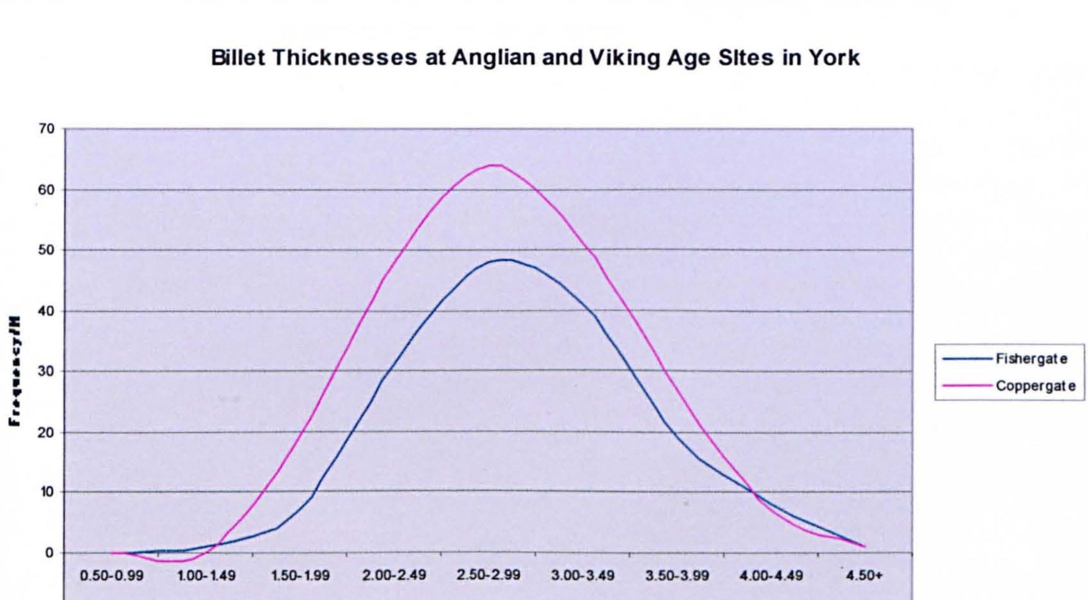


Figure 7. 28 Billet thickness curve for two sites in northern England

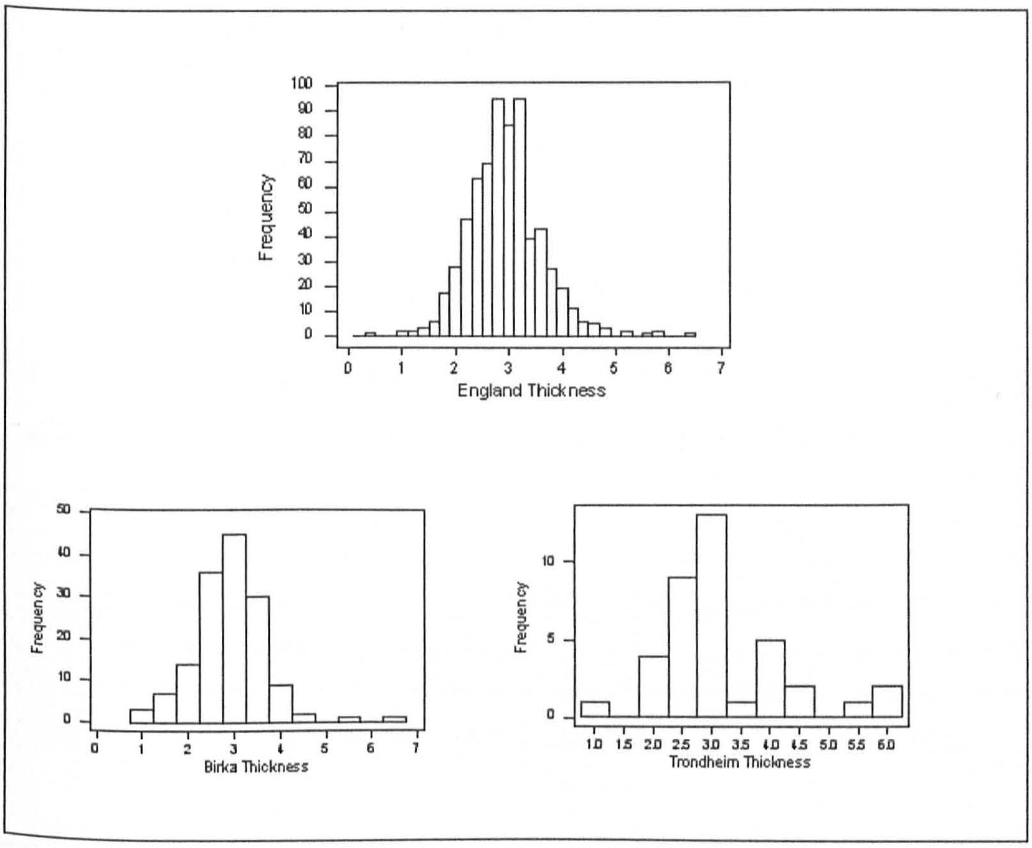


Figure 7. 29 Billet thickness histograms for northern England, Birka and Trondheim (scale in mm)

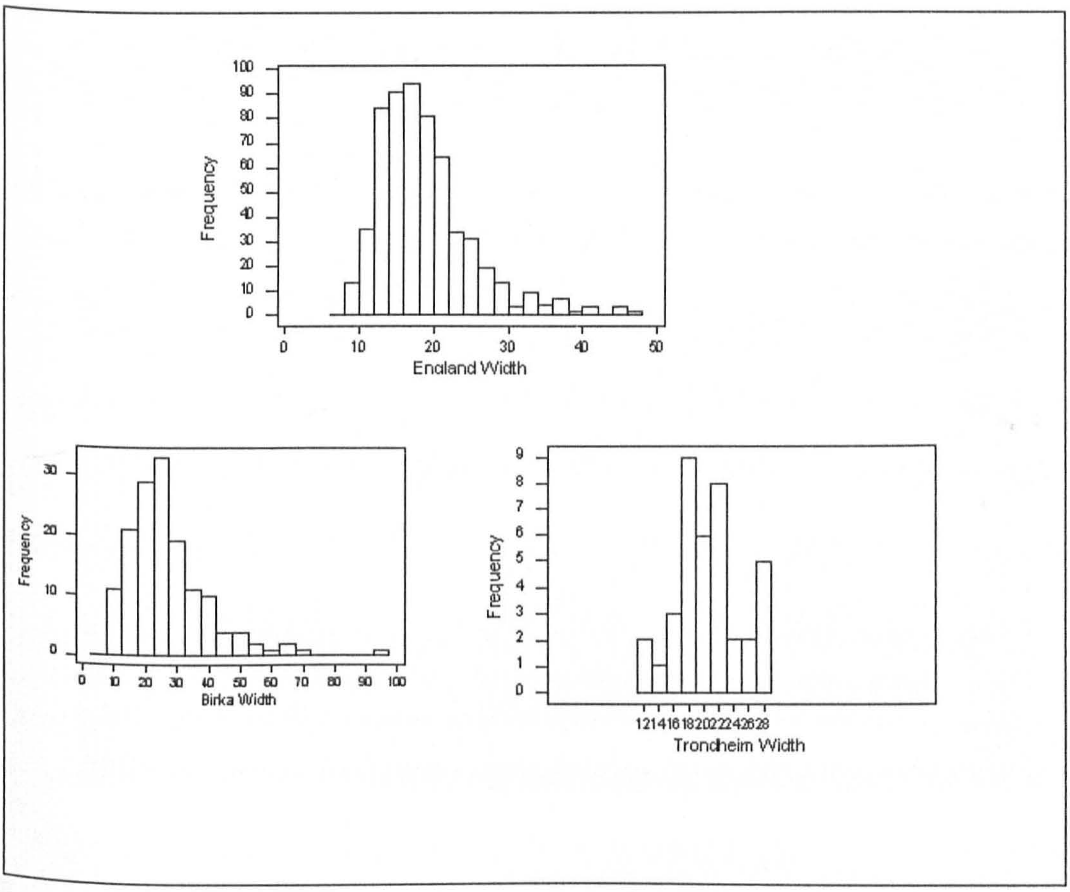


Figure 7. 30 Billet width histograms for northern England, Birka, and Trondheim (scale in mm)

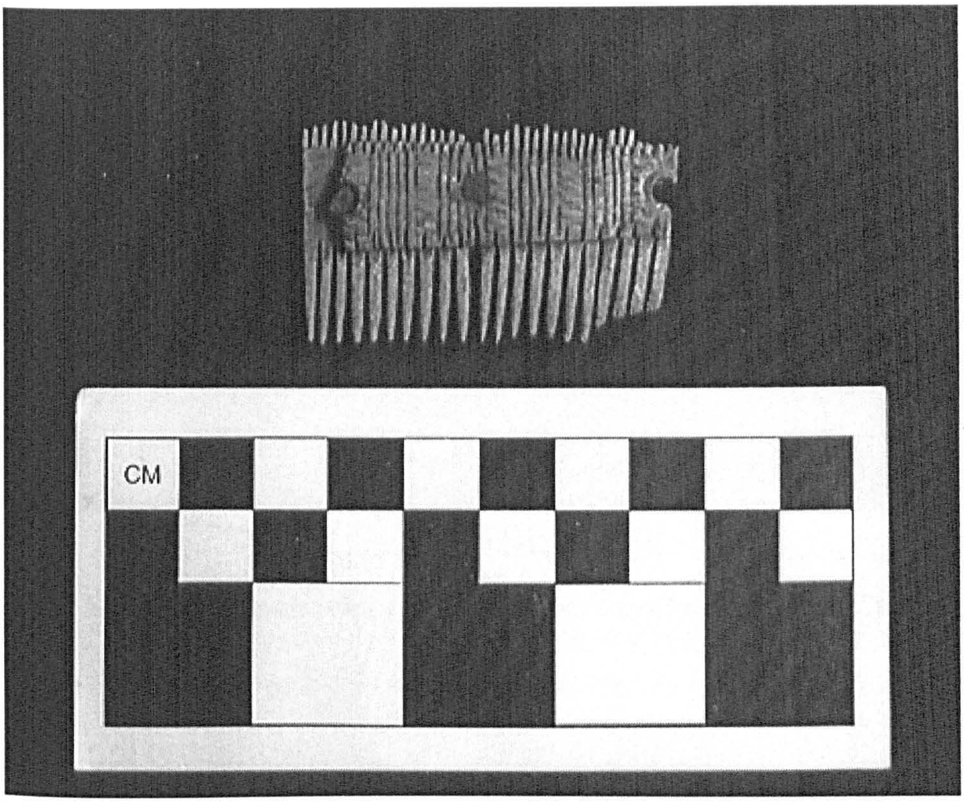


Figure 7. 31 Highly decorated double-sided comb (Type: 'Other', No. 1568, Clifford Street, York)

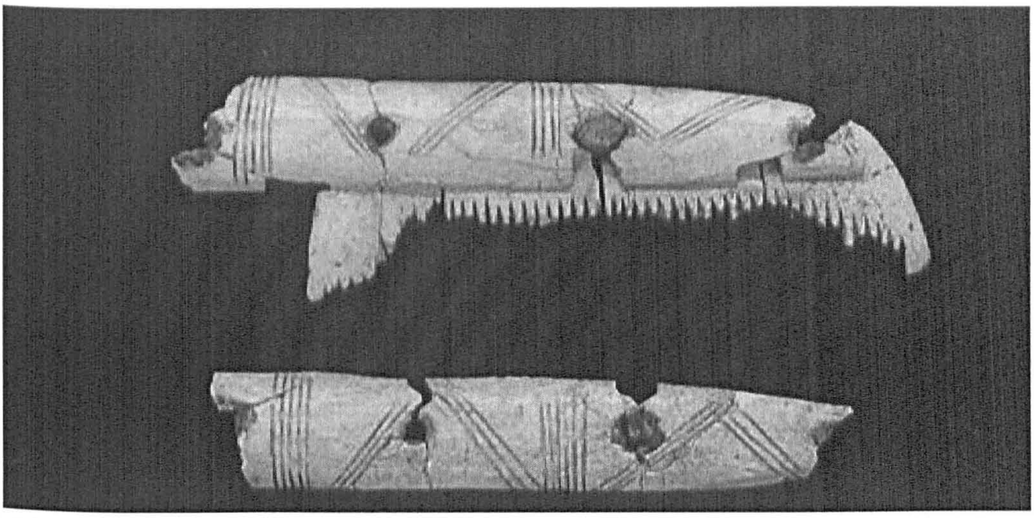
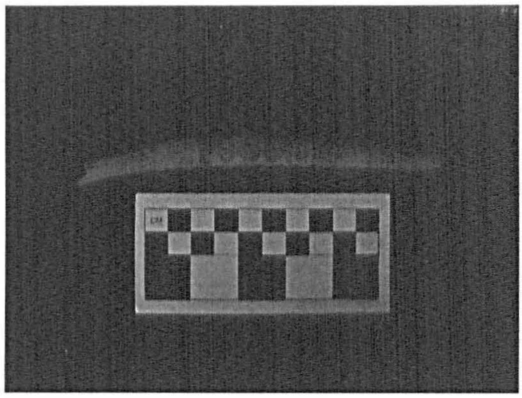
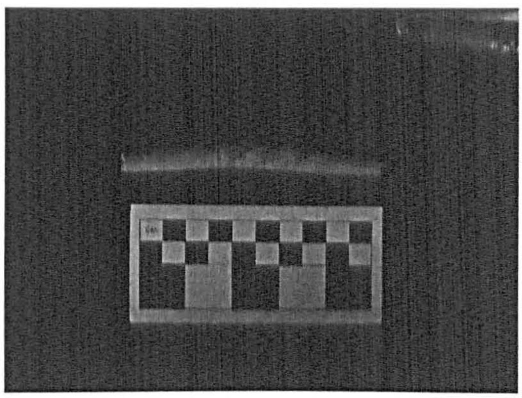


Figure 7. 32 Type 3 comb with crude, knife-cut ornament (No. 1426, Cottam, Yorkshire)

Figure 7. 33 Type 3 comb with high quality ornament (No. 983, Waterstone's, High Ousegate, York)





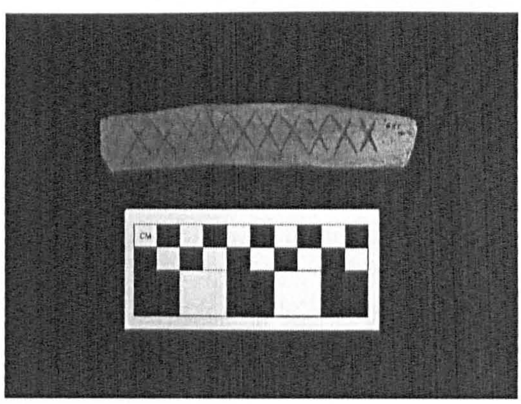


Figure 7. 34 Decorated blanks and a decorated rib (no. 1554) from Clifford Street, York

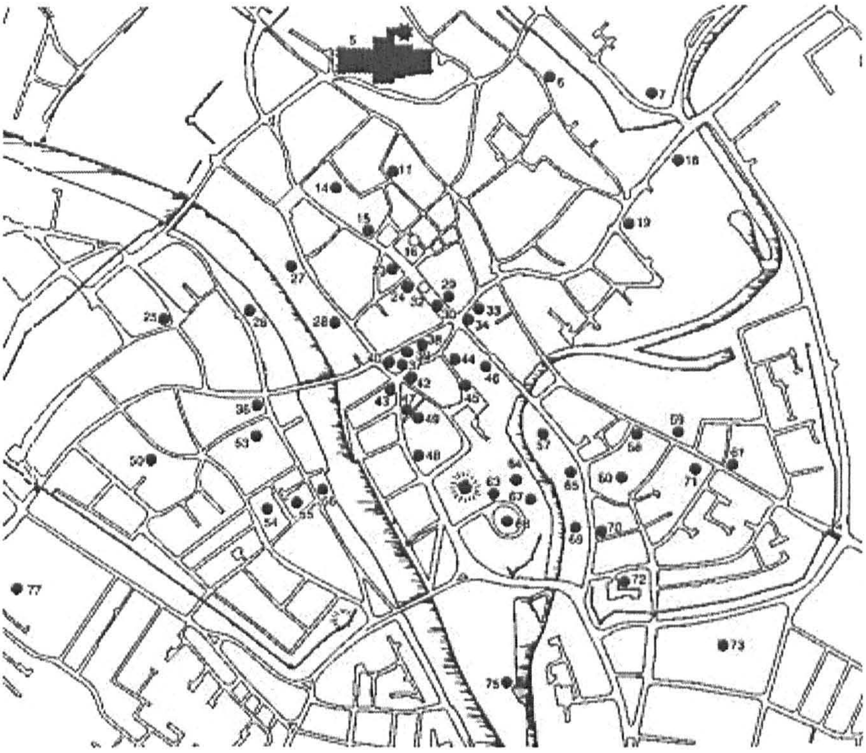


Figure 7. 35 Evidence for bone and antler-working in Viking Age York (from Mainman and Rogers 2004, fig 125)

COLOUR IN ORIGINAL

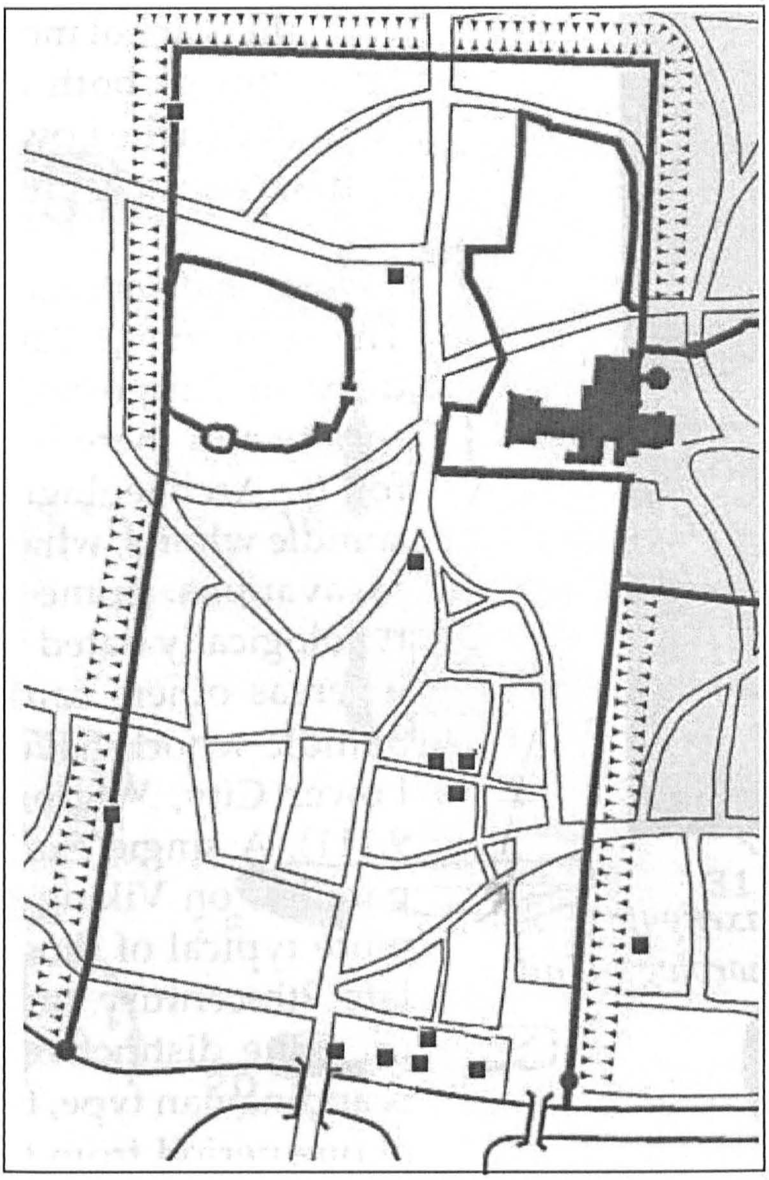


Figure 7. 36 Spatial distribution of antler-working waste in Lincoln

COLOUR IN ORIGINAL

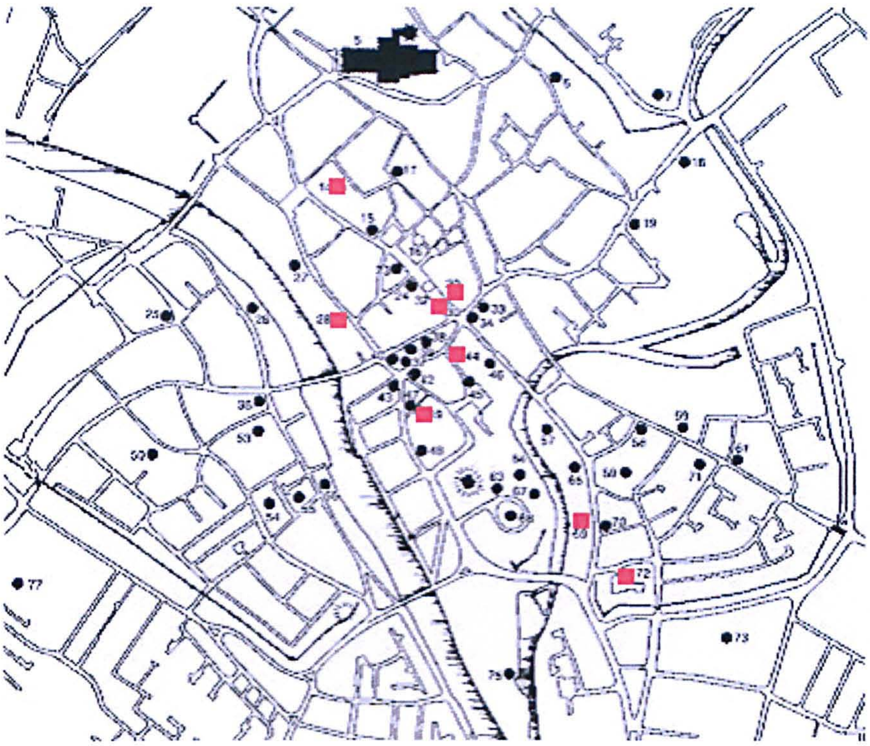
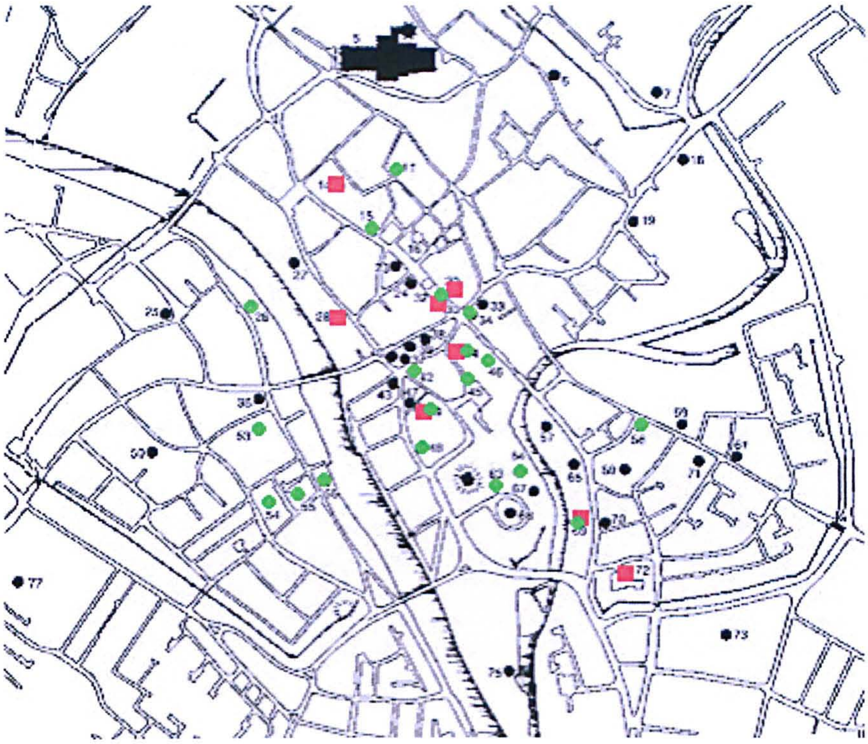


Figure 7. 37 Evidence for bone and antler-working with definite combmaking in Viking Age York (after Mainman and Rogers 2004, fig 125)

COLOUR IN ORIGINAL



Key

- ■ Combmaking
- ■ Textile Working
- ● Bone/antlerworking

Figure 7. 38 Evidence for Bone and Antler-working with definite combmaking and evidence for textile manufacture in Viking Age York (after Mainman and Rogers 2004, figs 125 and 128)

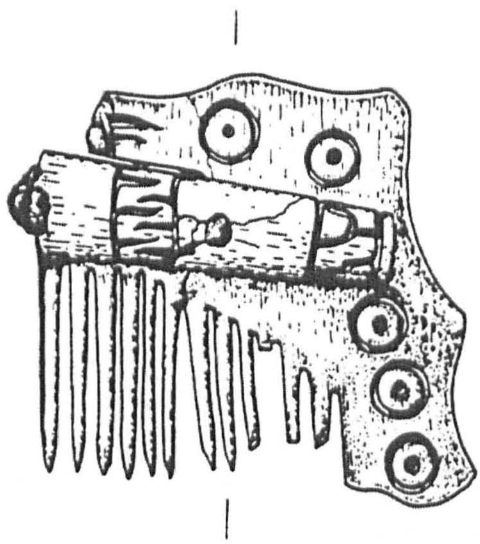


Figure 7. 39 Zoomorphic comb fragment from Flaxengate, Lincoln (no. 1128; Mann 1982: fig 3, no. 4)

Figures for Chapter 8

COLOUR IN ORIGINAL

Figure 8.1 Sites from which combs were recovered

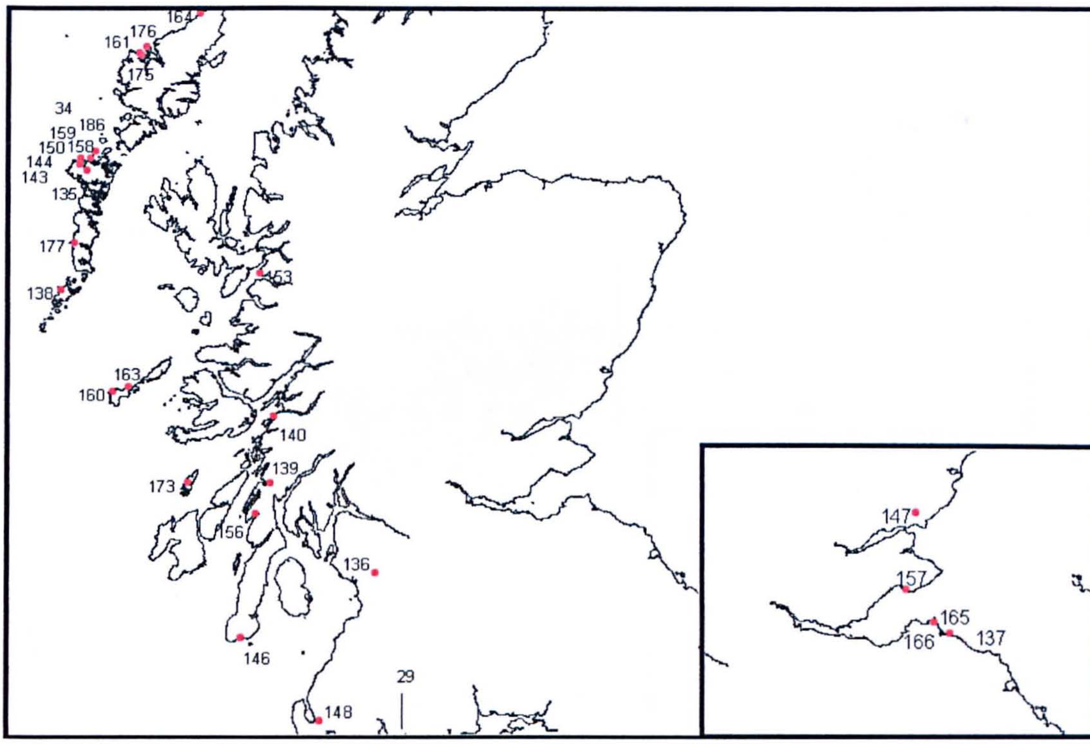


Figure 8.1a Sites in western and south-eastern Scotland. *Italicised* sites are those referred to in text, but not covered in the corpus

29	*Whithorn*	161	Cnip, Lewis
34	*Drimore Machair, South Uist*	163	Dun Mor Vaul
135	A' Cheardach Mhor, South Uist	164	Galson
136	Buiston	165	Ghegan Rock
137	Castle Park, Dunbar	166	North Berwick
139	Dunadd	173	Colonsay
138	Dun Cuier	175	Loch na Berie
140	Dunollie	176	Bostadh
143	Foshigarry	177	Bornish
144	Garry Iochdrach	186	Boreray, Lewis
146	Keil Cave	146	Keil Cave
147	Law Hills, Angus	147	Law Hills, Angus
148	Loch Inch-Crindil	172	Largo Bay
150	Old Cattlefold		
153	Rudha Chaisteach		
156	St Columba's Cave		
157	St Ford's Links		
158	*The Udal, North Uist*		
159	Bachda-Mor		
160	Balevullin		

COLOUR IN ORIGINAL

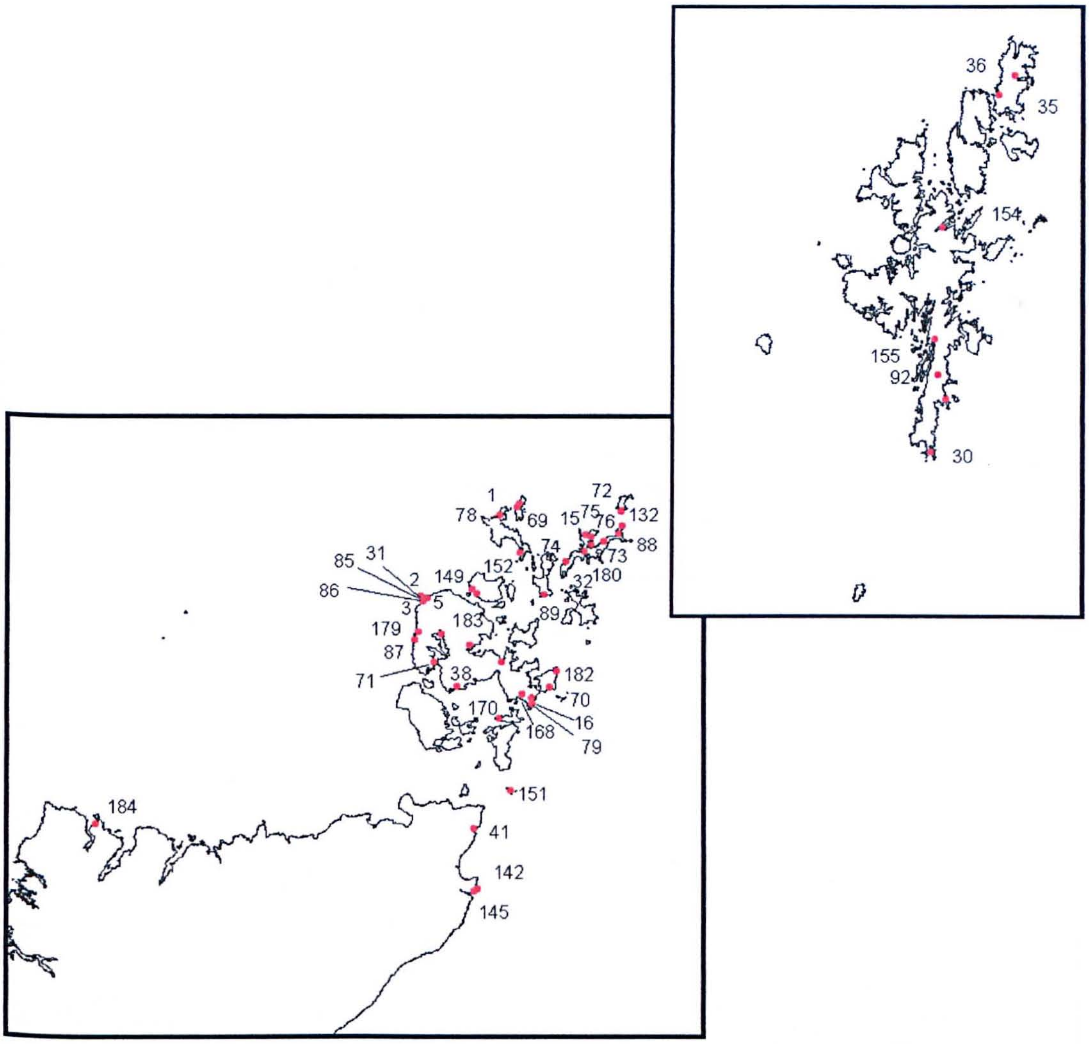


Figure 8. 1b Sites in northern Scotland

Key

1	Quoygrew, Westray	72	Howar, North Ronaldsay	142	Elsay		
2	Brough of Birsay	73	Ivar's Knowe, Sanday	145	Hillhead Broch		
3	Beachview, Birsay	74	Fea Hill, Sanday	149	Midhowe		
15	Scar, Sanday	75	*Northskaill, Sanday*	151	Pentland Skerries		
16	Skaill, Deerness	76	Tofts Ness, Sanday	152	Peterkirk		
30	Jarlshof	78	*Pierowall, Westray*	154	Sands of Breckon		
31	Saevar Howe	79	*Newark Bay*	155	Scalloway		
32	Pool, Sanday	85	Brough Road, Birsay	168	Lyking		
35	Underhoull, Unst	86	Buckquoy, Birsay	170	Burray		
36	Sandwick, Unst	87	Broch of Borwick	179	Skaill Bay, Sandwick		
38	Earl's Bu, Orphir	88	Galilee, Sanday	180	Brough of Lambaness		
41	Freswick Links	89	Stackel Brae, Eday	182	Brough of Deerness		
69	Munkerhouse, Papa Westray	92	Cunningsburgh	183	Westness, Rousay		
70	Big Meal Howe, Newark	132	Broch of Burrian	184	Balnakeil, Durness		
71	Howe, Stromness						

COLOUR IN ORIGINAL

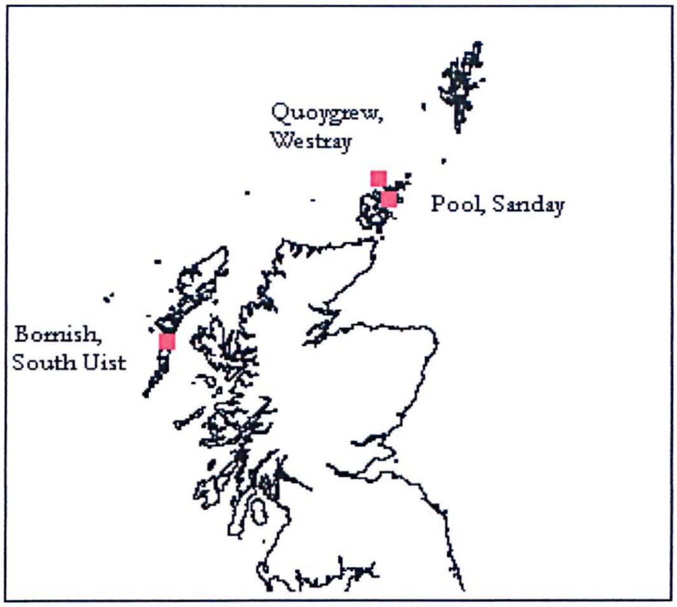


Figure 8. 2 Key sites from which well-dated combs were recovered

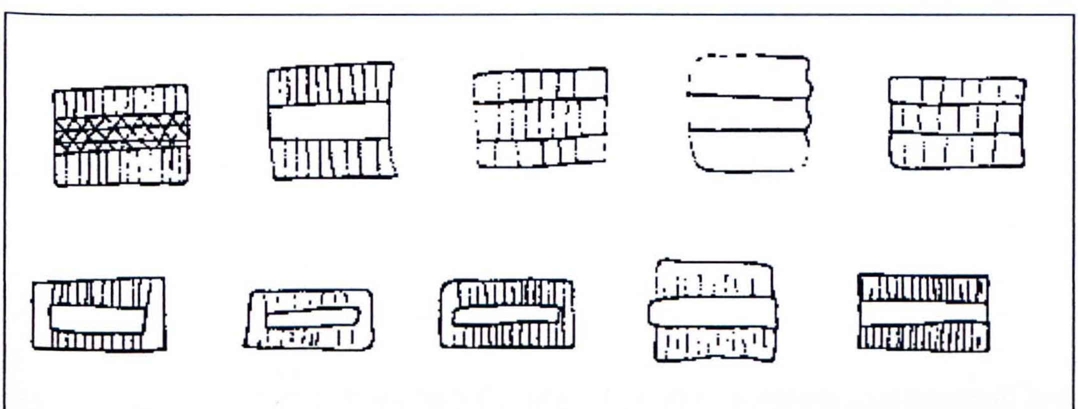


Figure 8. 3: Depictions of double-sided (type 11/12) combs on Pictish symbol stones (after Foster 1990: ill 9.6)

COLOUR IN ORIGINAL

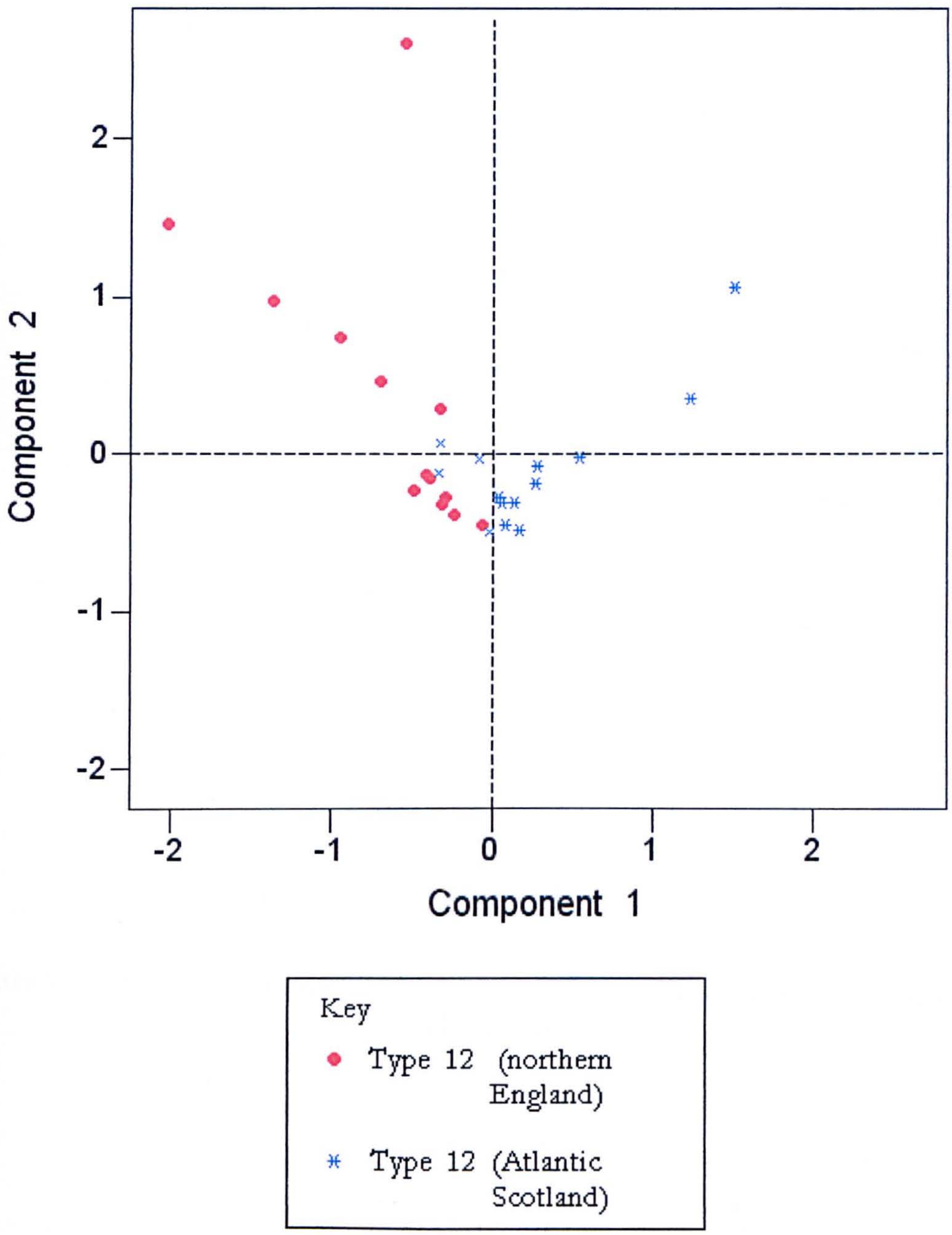


Figure 8. 4a Correspondence analysis (object plot) of English and Scottish type 12 combs

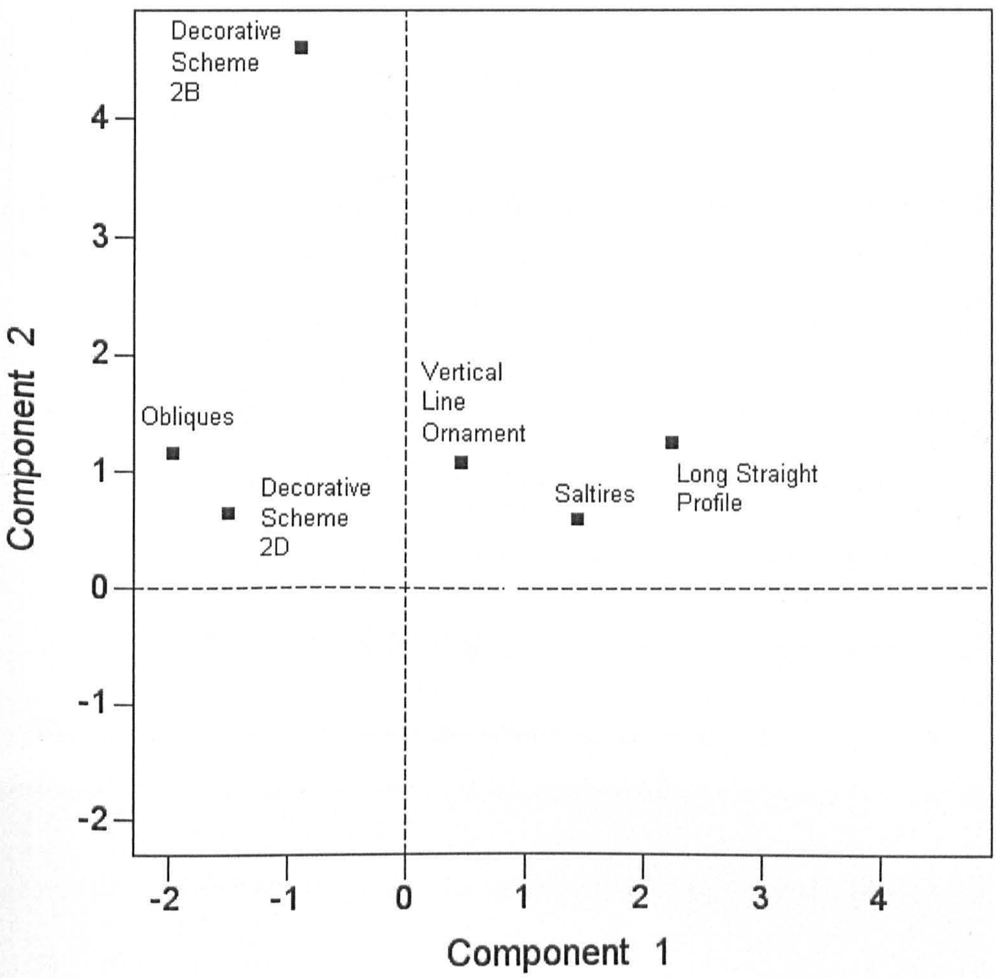


Figure 8. 4b Correspondence analysis (variable plot) of English and Scottish type 12 Combs

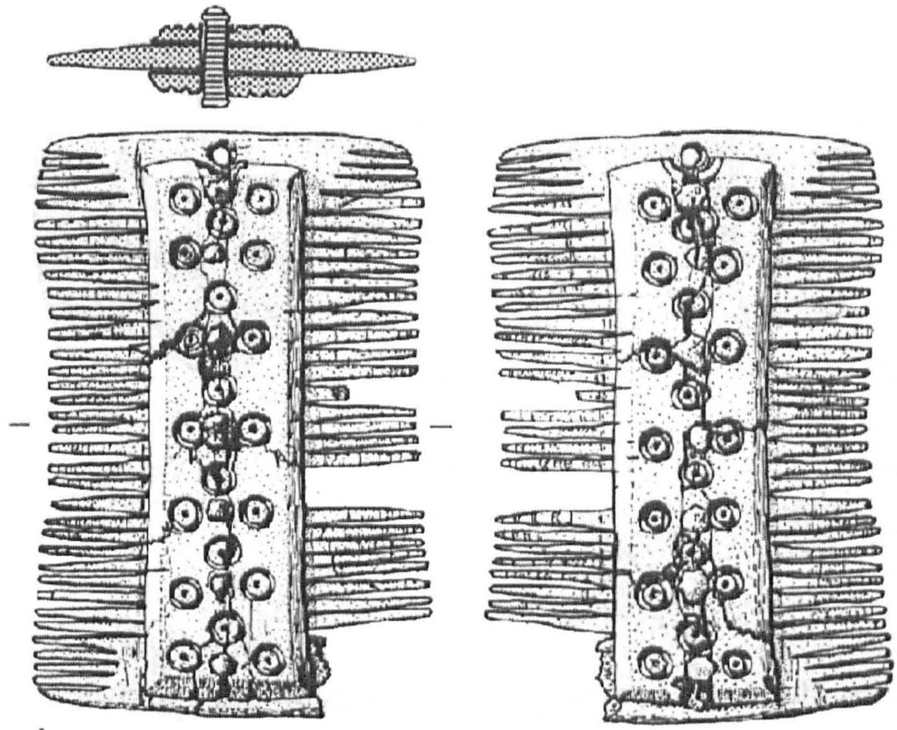


Figure 8. 5 Type 11 comb from Scalloway (Smith 1998: fig 100, no. 2397)

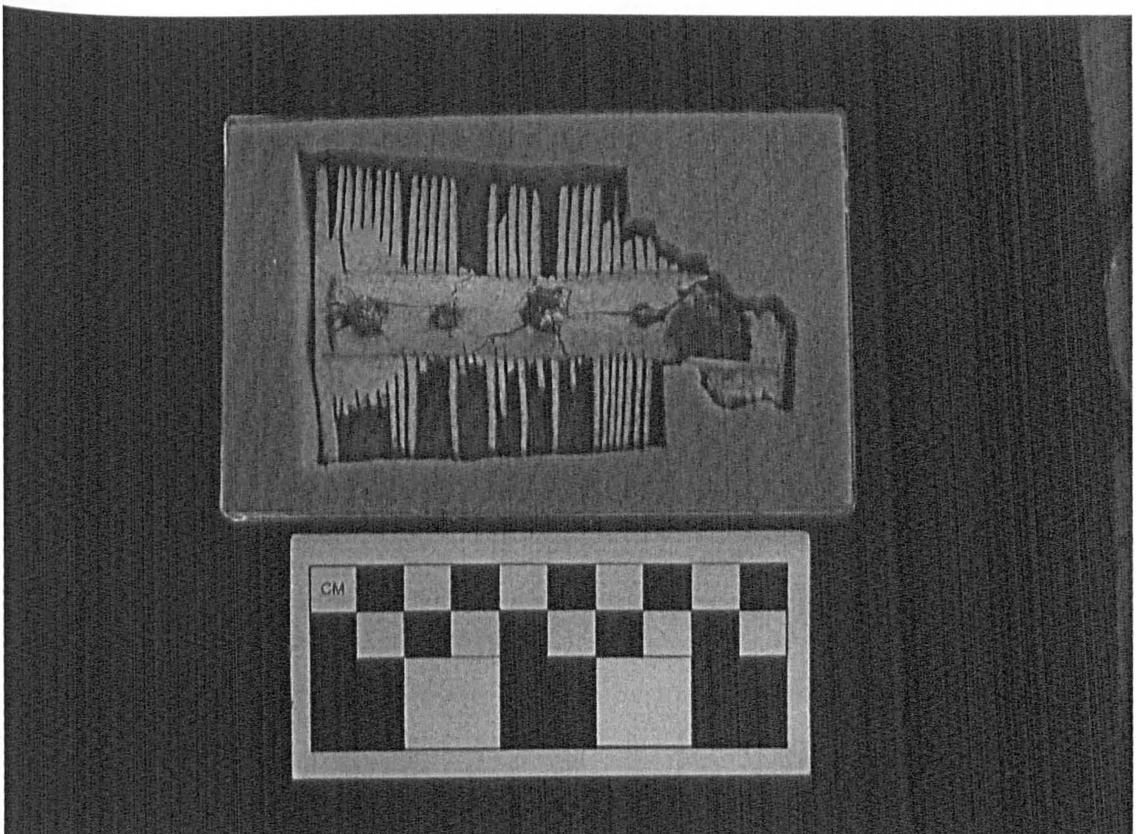


Figure 8. 6 Type 11 comb from Bornish (no. 1707)

COLOUR IN ORIGINAL

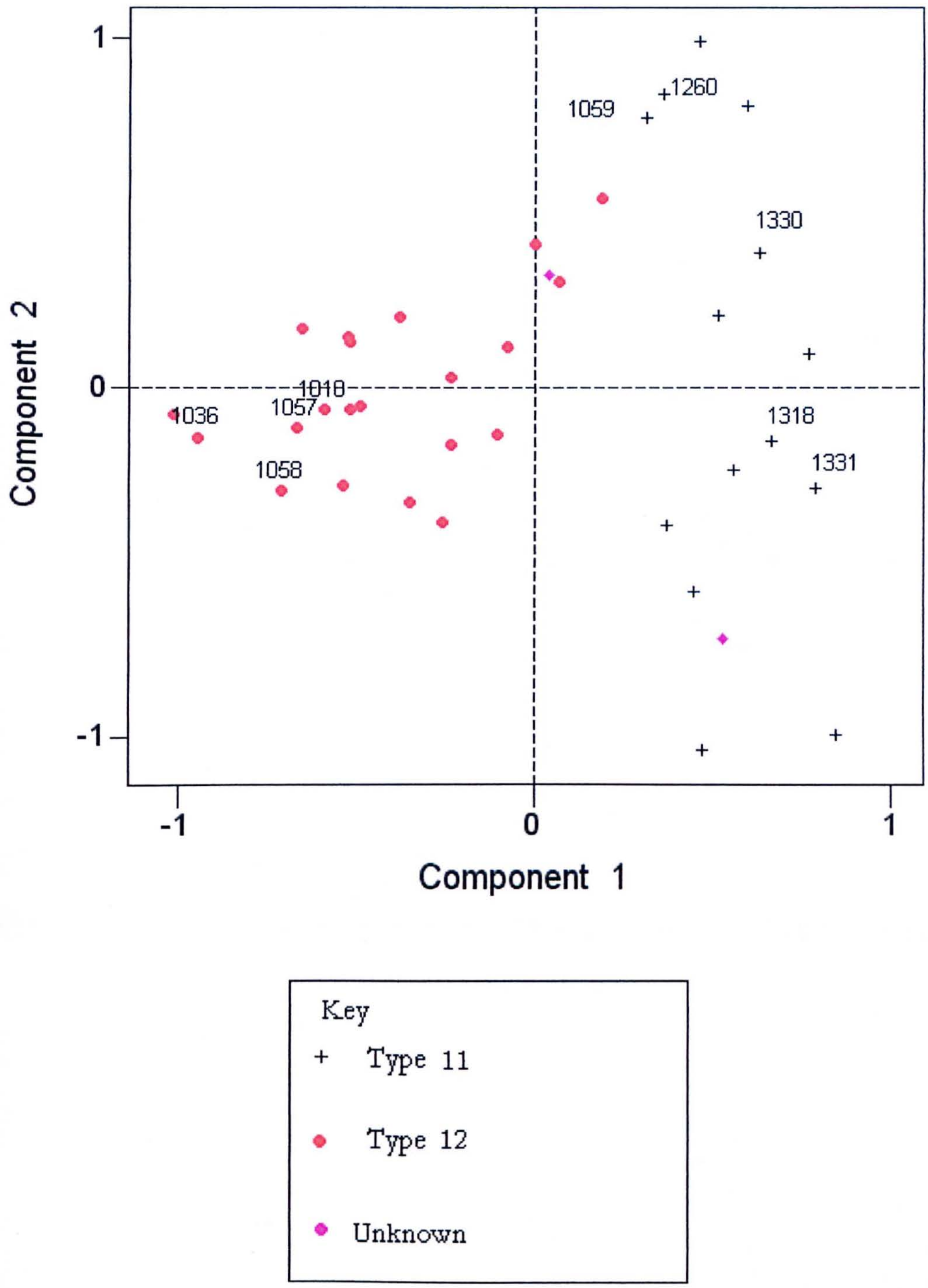


Figure 8. 7a Correspondence analysis (object plot) of type 11 and 12 combs in Scotland

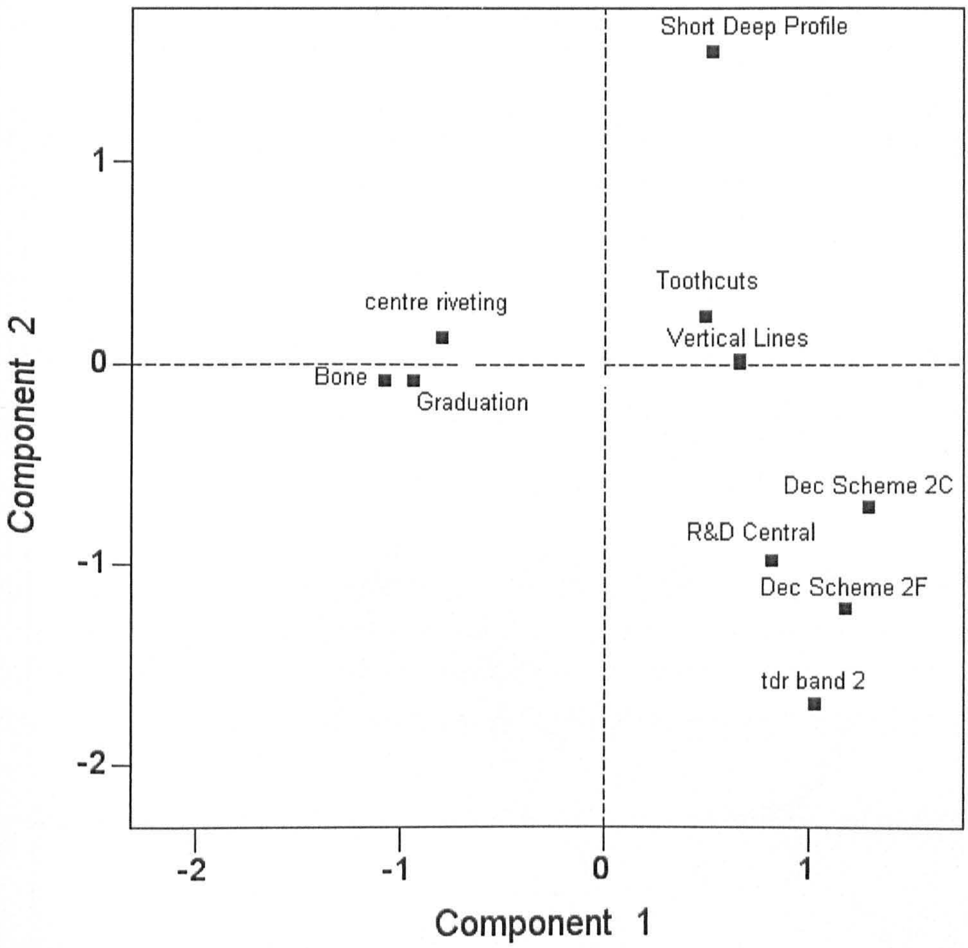


Figure 8. 7b Correspondence analysis (variable plot) of type 11 and 12 combs in Scotland

COLOUR IN ORIGINAL

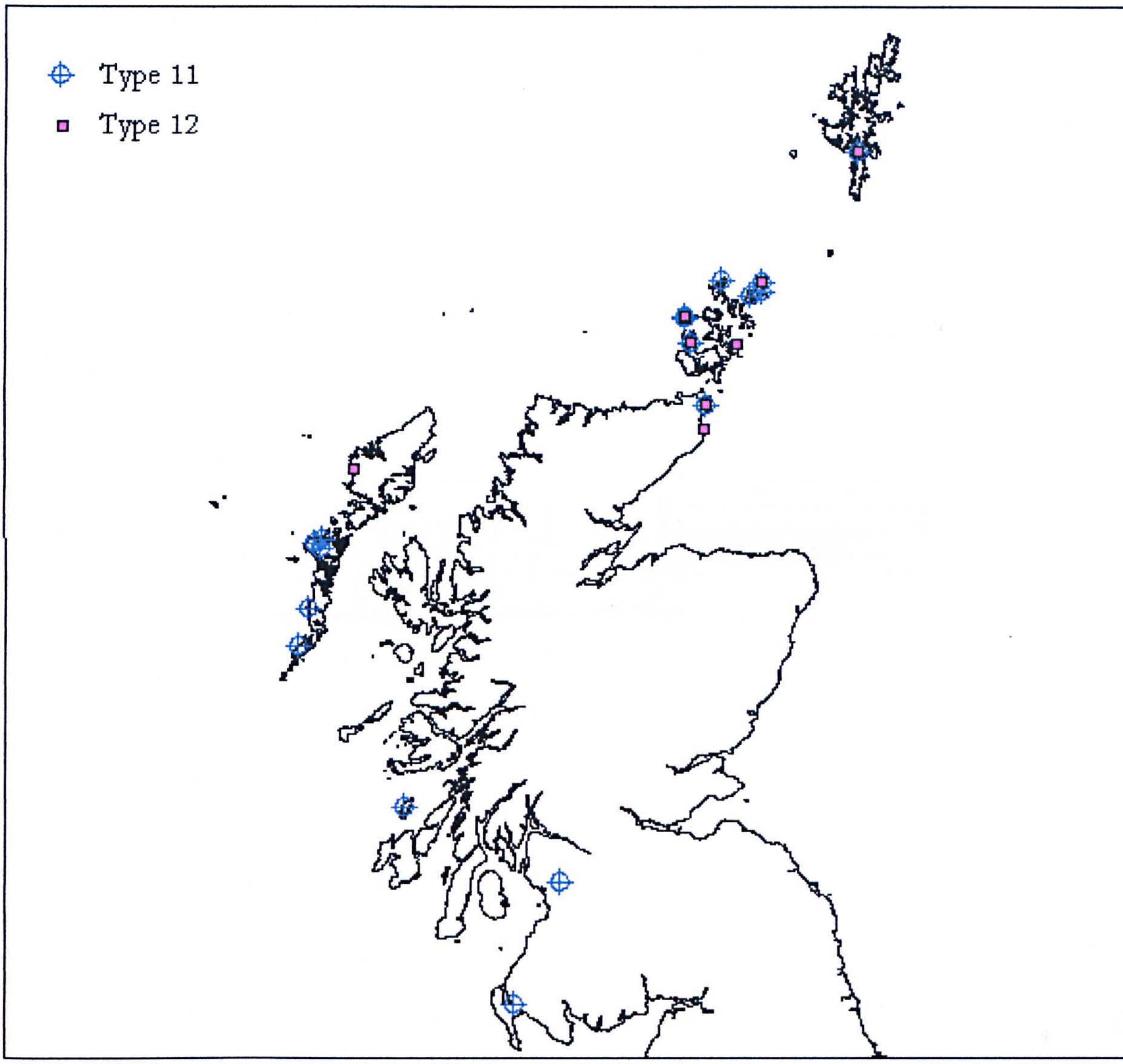


Figure 8. 8 Distribution of types 11 and 12 in Atlantic Scotland (large fragments and complete combs in study sample only)

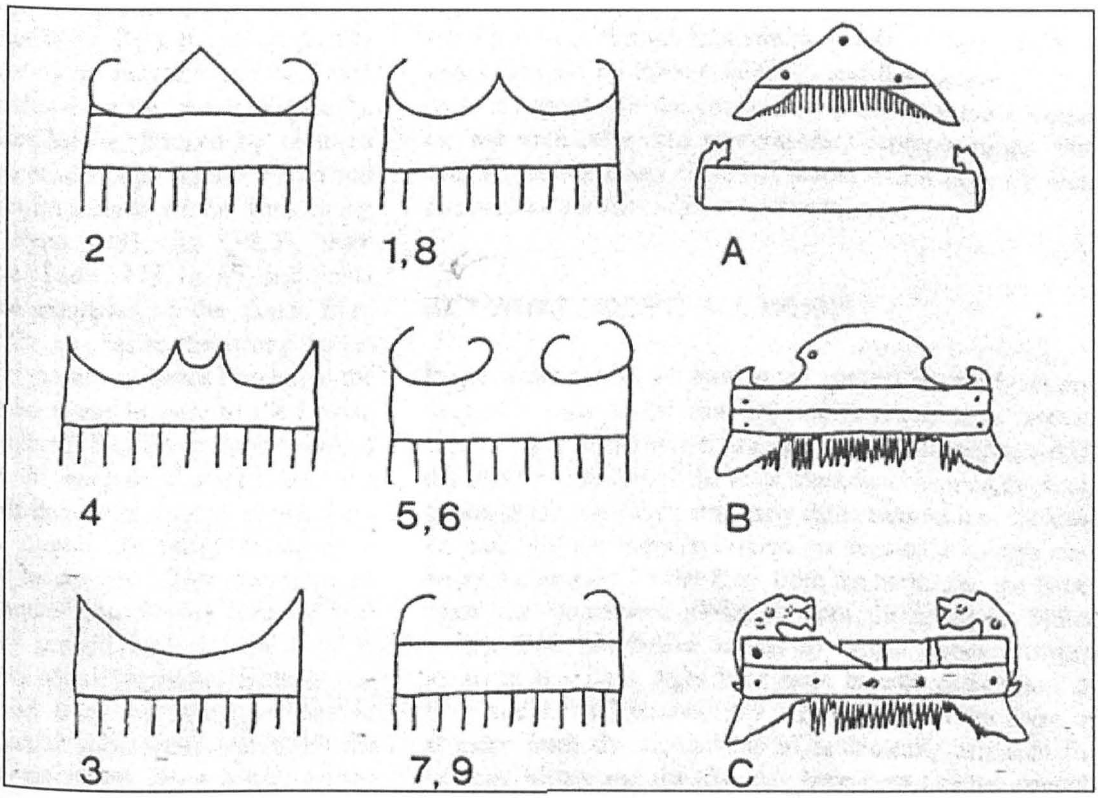


Figure 8. 9 Pictish symbol stones and type 1b combs (Smith 2000: fig 2)

COLOUR IN ORIGINAL

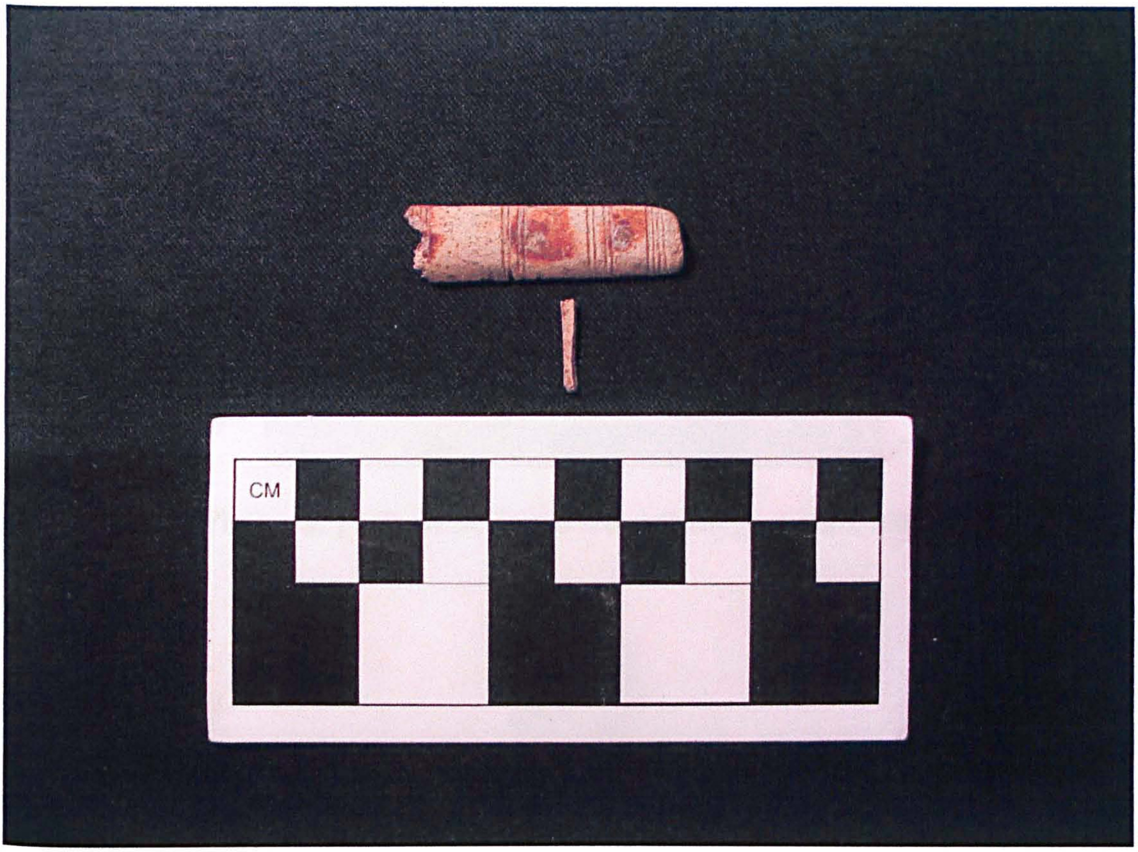


Figure 8. 10 Possible type 6 comb from Quoygrew (no. 2458)

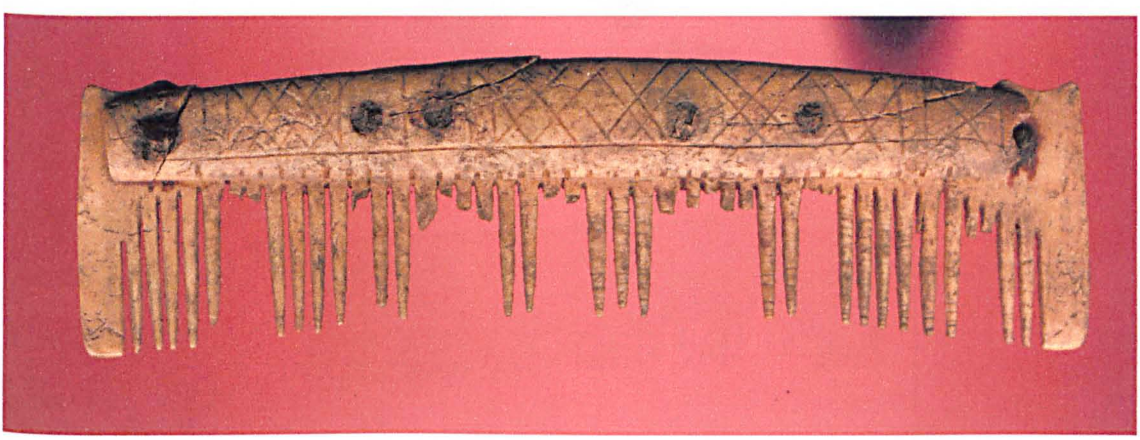


Figure 8. 11 Type 6 comb from Archerfield (not included in corpus, image courtesy Stephen Carter)

COLOUR IN ORIGINAL

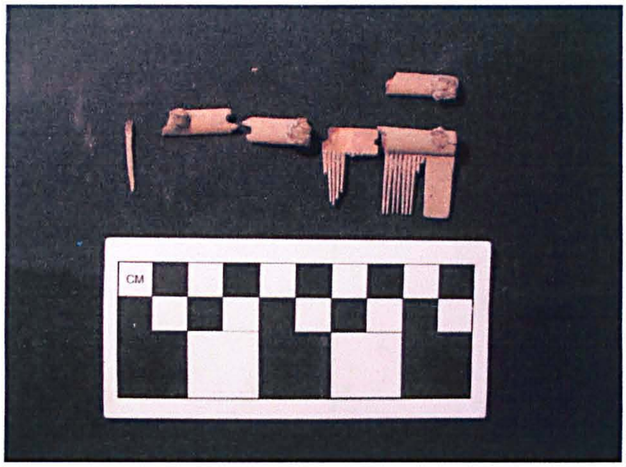


Figure 8. 12 Type 8c comb from Quoygrew (no. 2457)

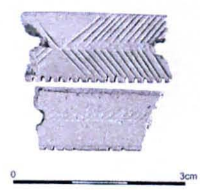


Figure 8. 13 Type 8a comb fragments from Bornish Mound 3 (Sharples 2005: fig. 99)

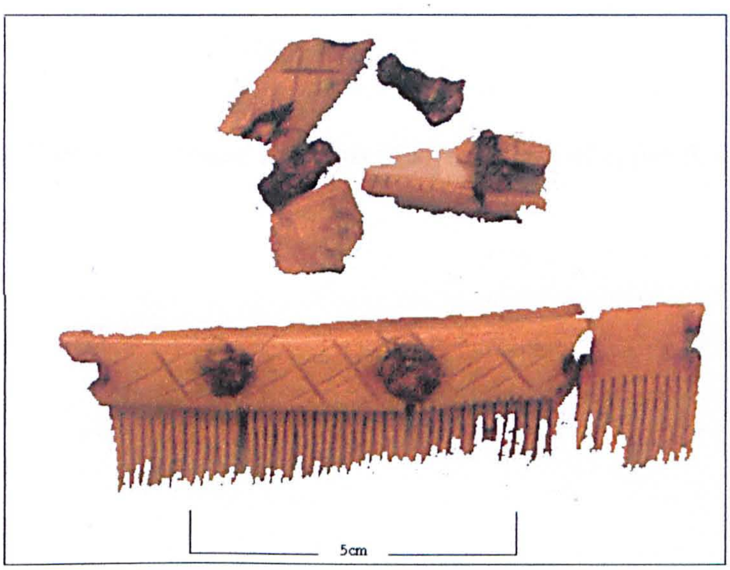


Figure 8. 14 Iron-riveted type 9 imitation from Bornish (no 1892)

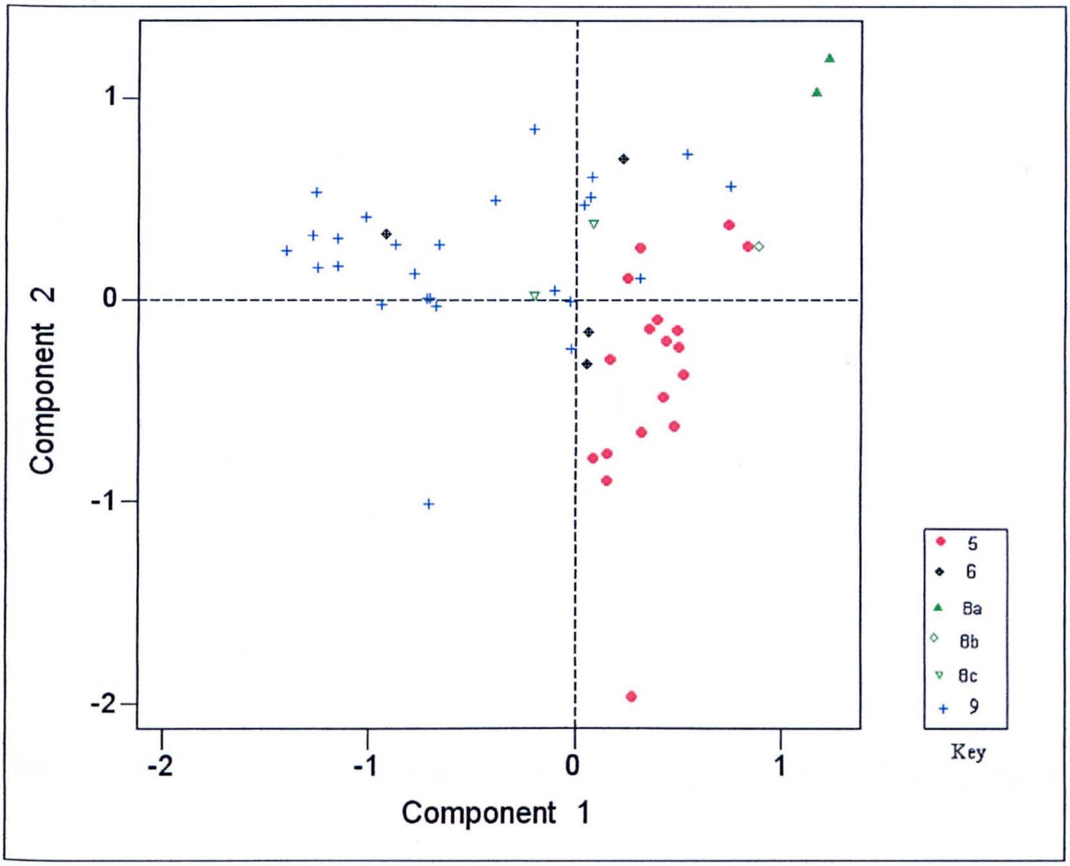


Figure 8. 15a Correspondence analysis (Object Plot) of types 5, 6, 8a, 8b, 8c, and 9

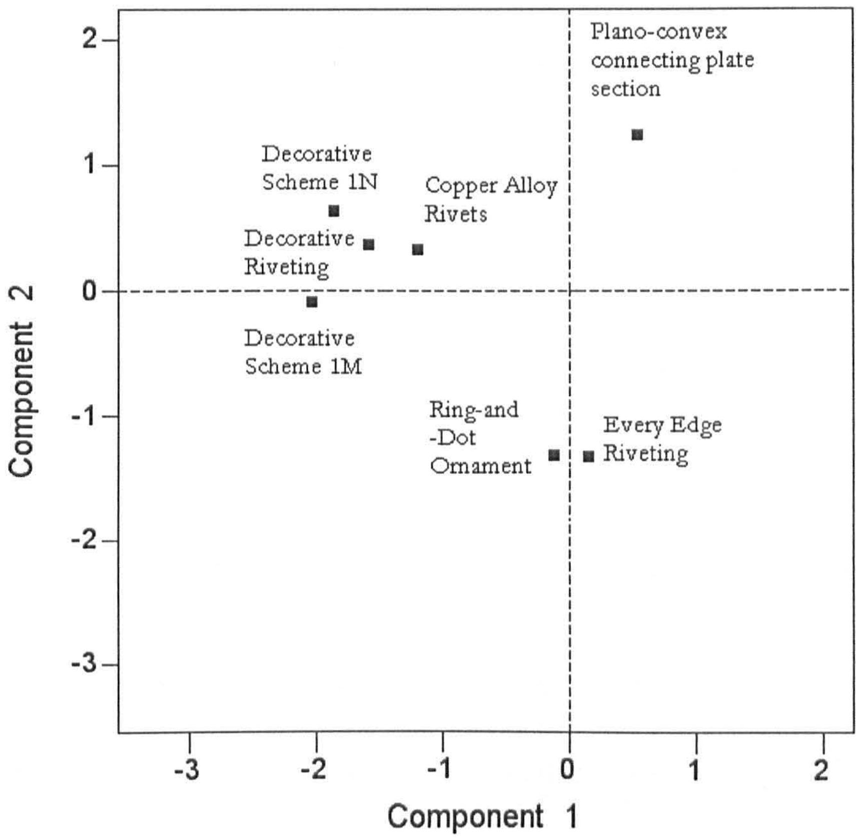


Figure 8. 15b Correspondence analysis (variable plot) of types 5, 6, 8a, 8b, 8c, and 9

COLOUR IN ORIGINAL

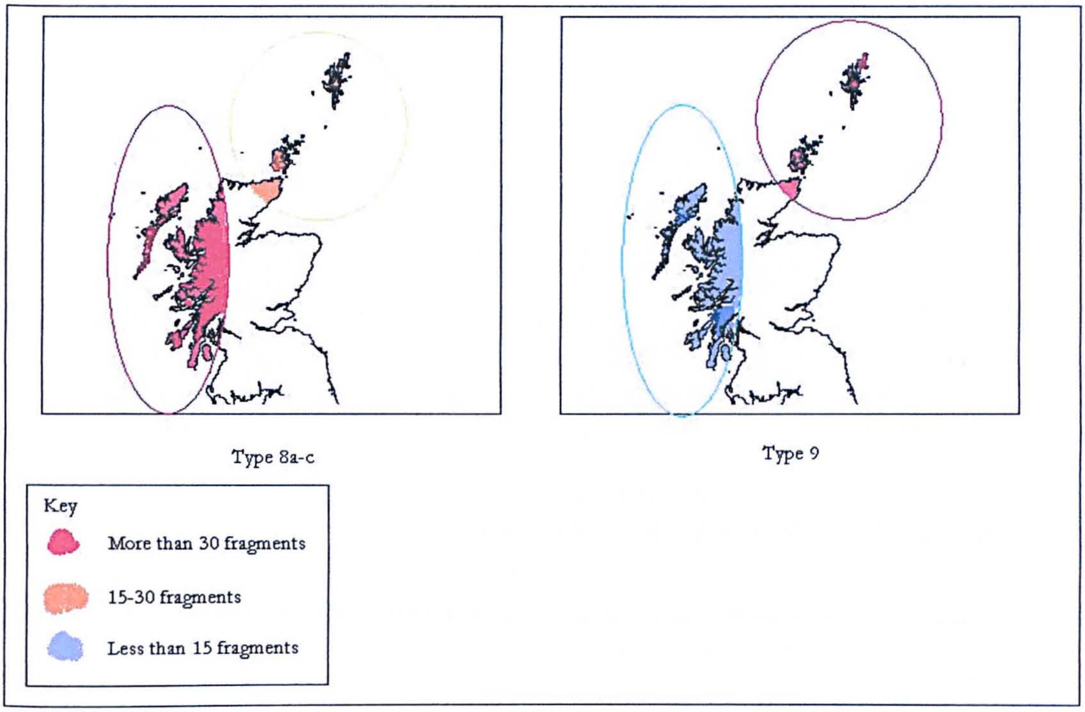


Figure 8. 16 Relative frequencies of type 8 and 9 combs in northern and western Scotland

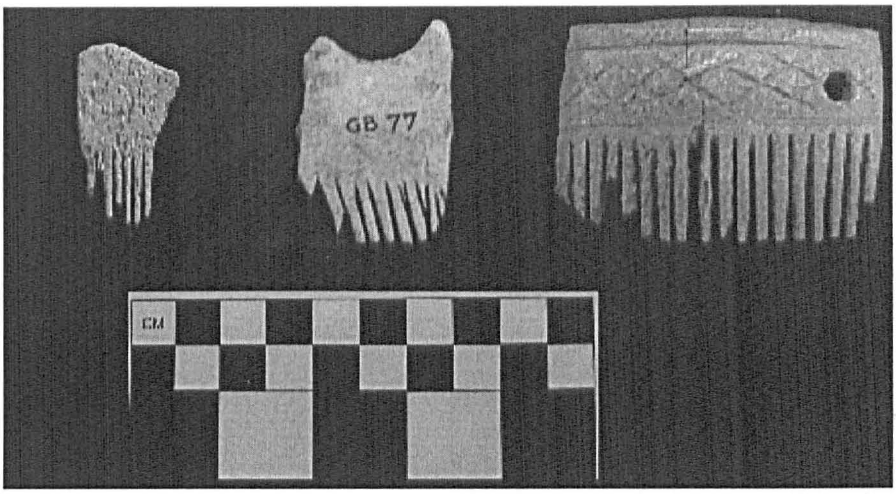


Figure 8. 17 'Other' types: One-piece rough combs (Right to left: no. 1097, Stackel Brae; no. 1099, Broch of Borwick,; no. 1083, Howe, Stromness)

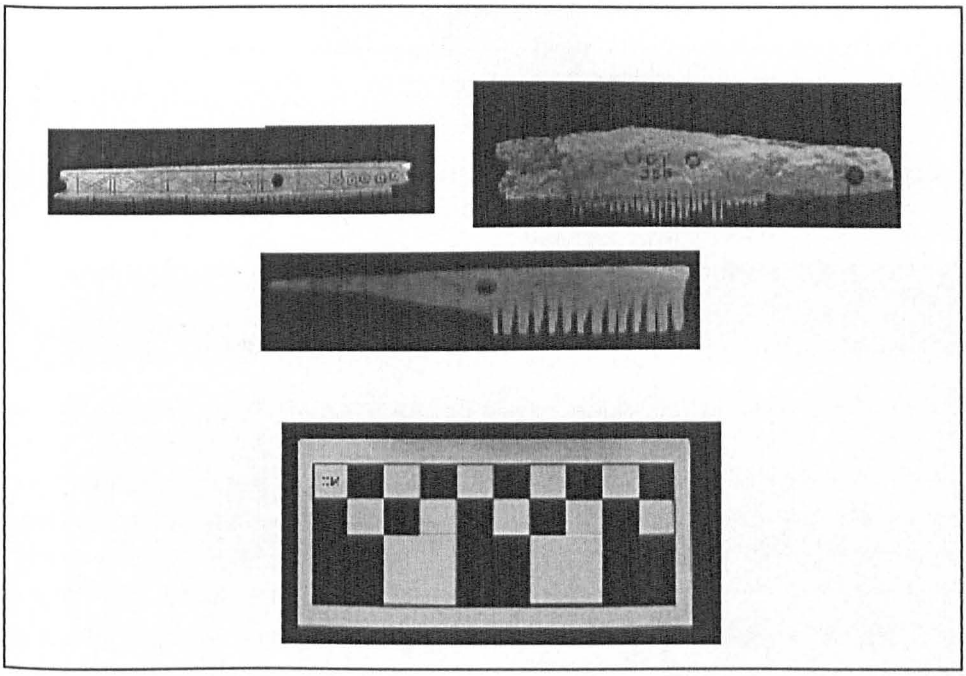


Figure 8. 18 'Other' types (no. 1748, Bornish; no. 1387, Old Cattlefold; no. 1416, Boreray)

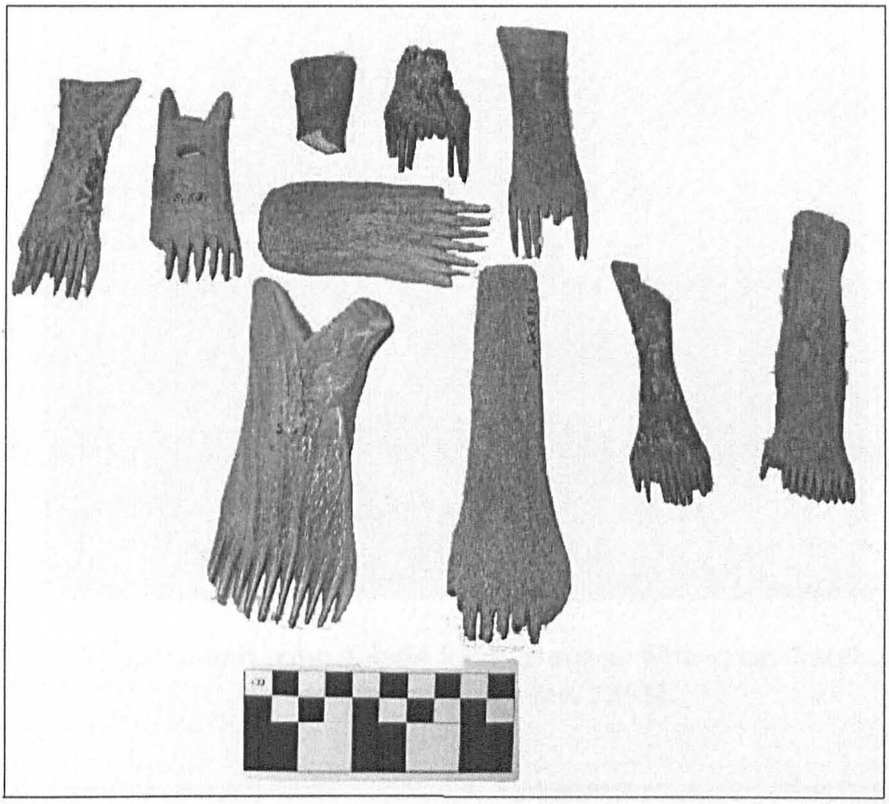


Figure 8. 19 A Selection of long-handled 'weaving' combs from sites in Atlantic Scotland (not recorded in corpus)

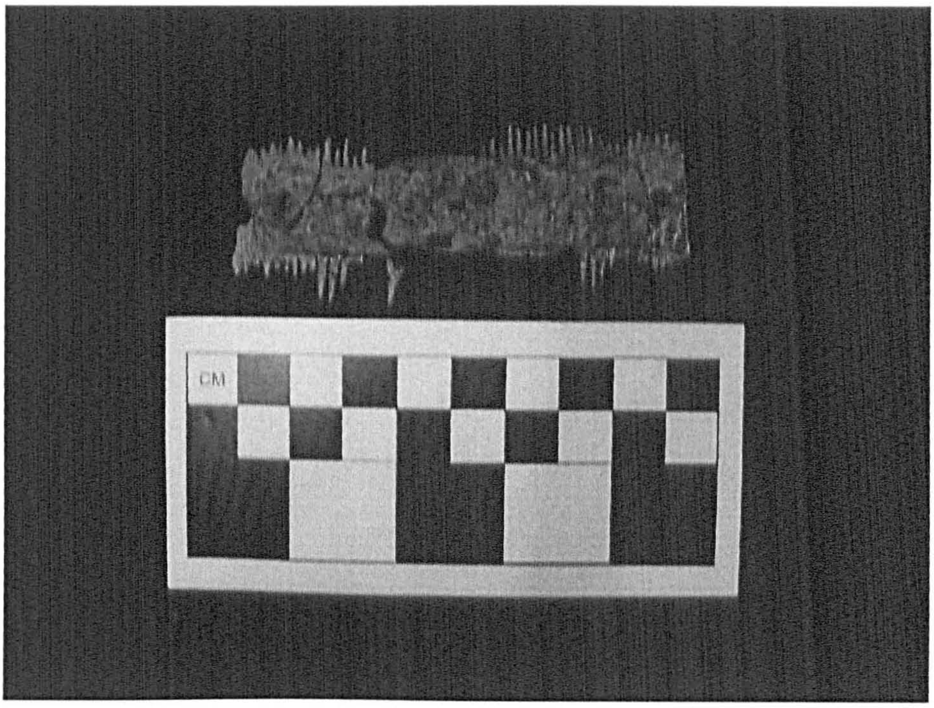


Figure 8. 20 A poorly preserved type 12 comb from Howe, Stromness (no. 1010)

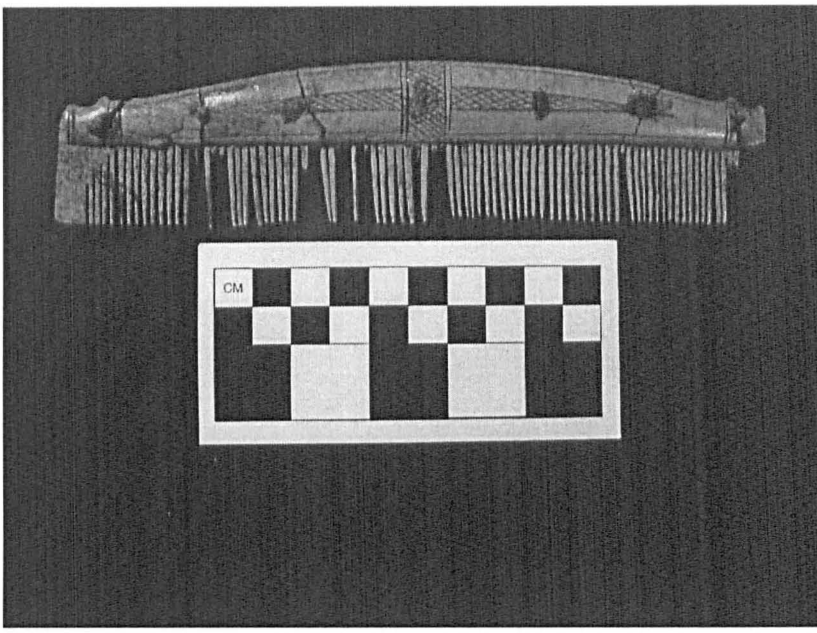


Figure 8. 21 Type 5 comb from Castle Park, Dunbar with cross-hatch ornament mimicking interlace (no. 1351)

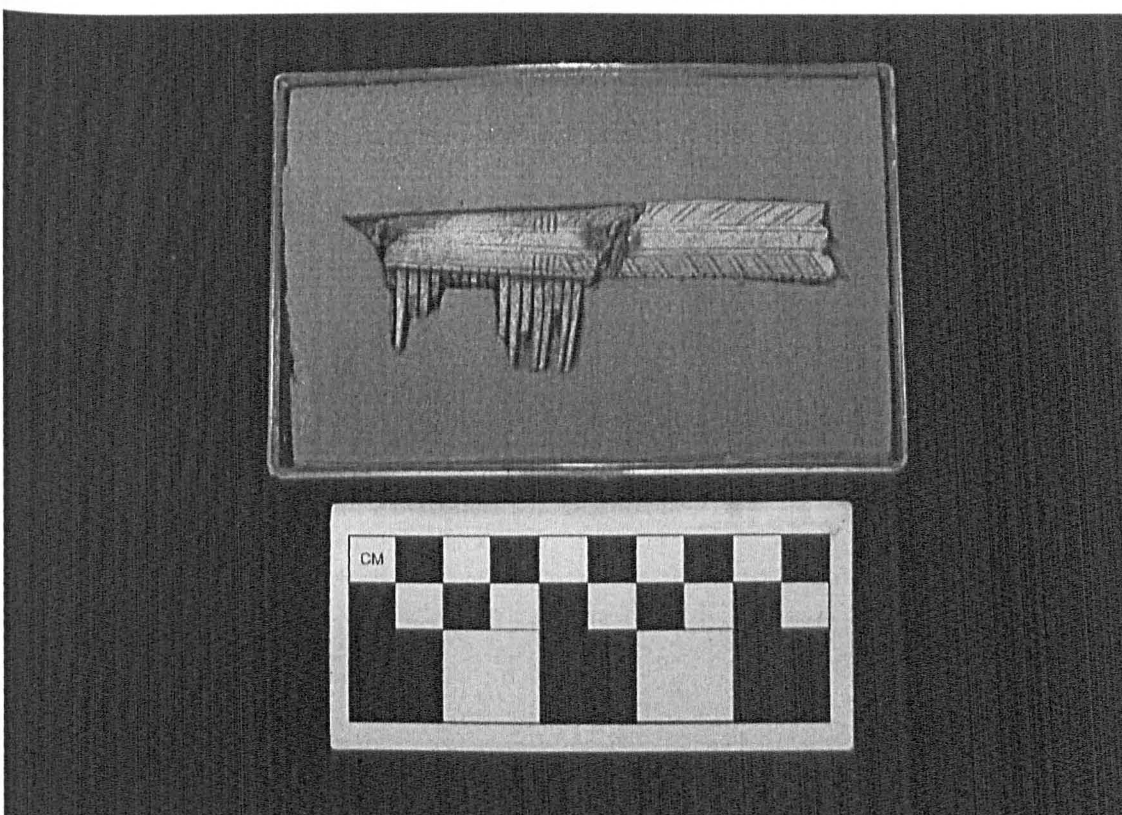


Figure 8. 22 Type 8 comb from Bornish with geometric ornament (no. 1887)

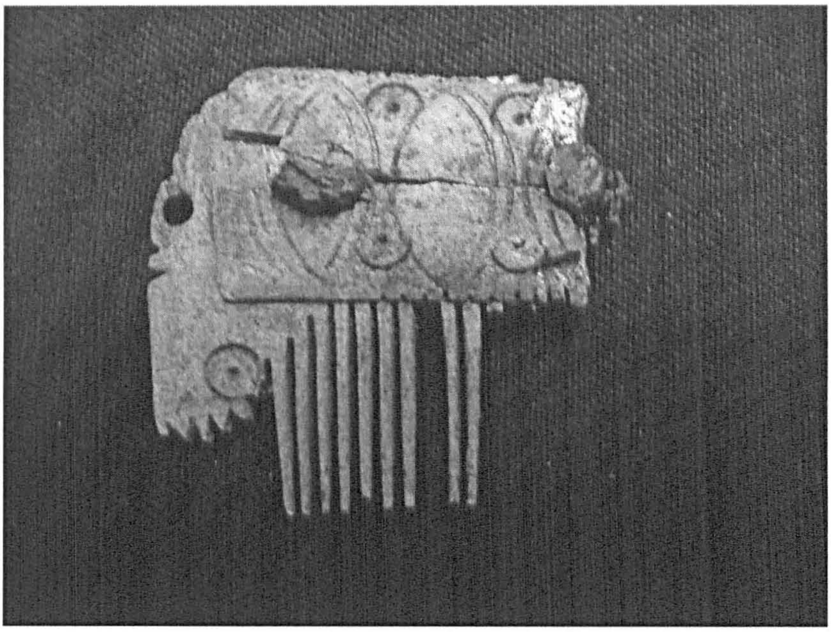


Figure 8. 23 Reworked type 11 comb with 'egg-and-dart' ornament from Skaill, Deerness (no. 1045).

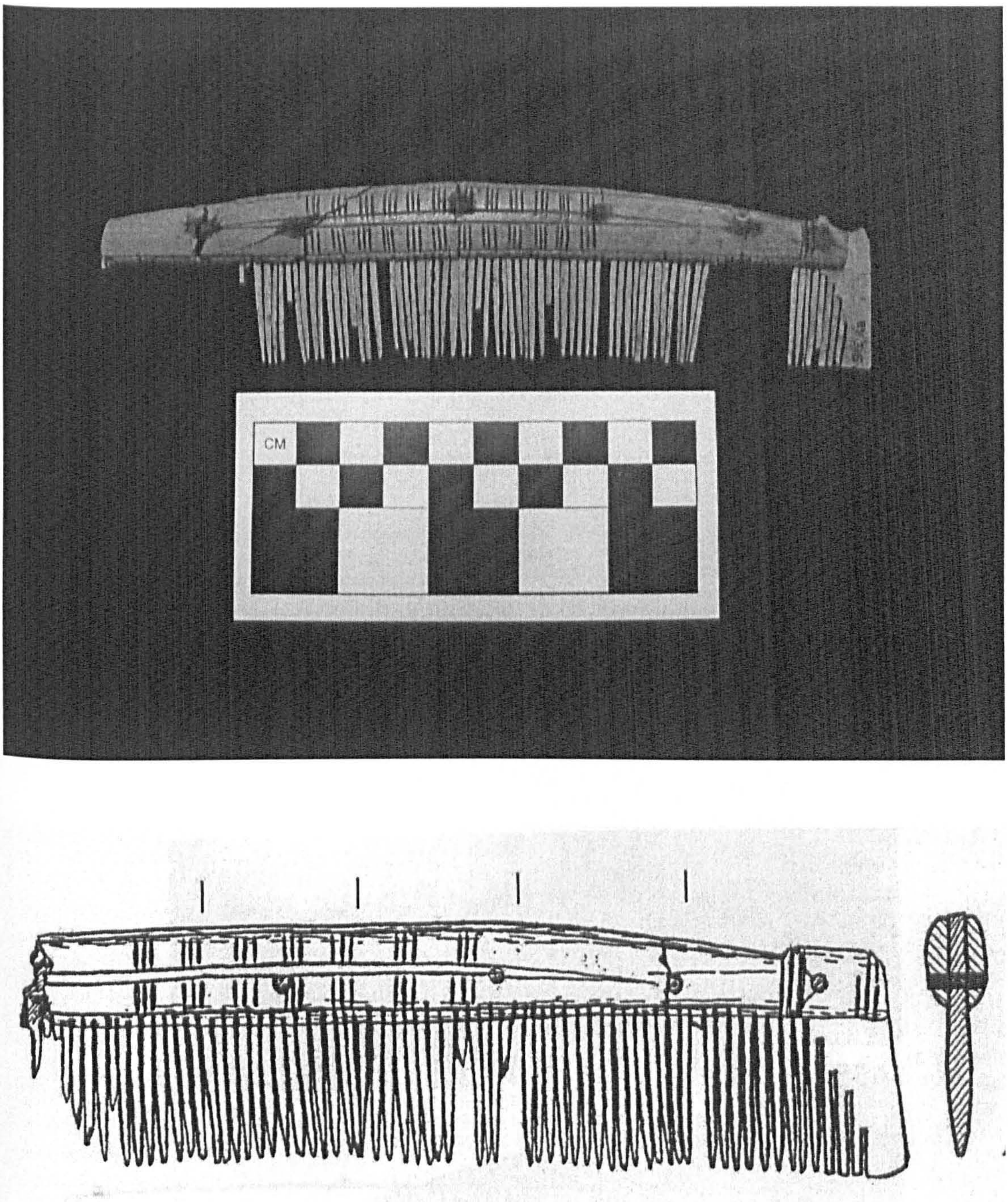


Figure 8. 24 Parallel type 5 combs from the Brough Road, Birsay (no. 1026) and Novgorod (Smirnova 2005: fig 3.12)

COLOUR IN ORIGINAL

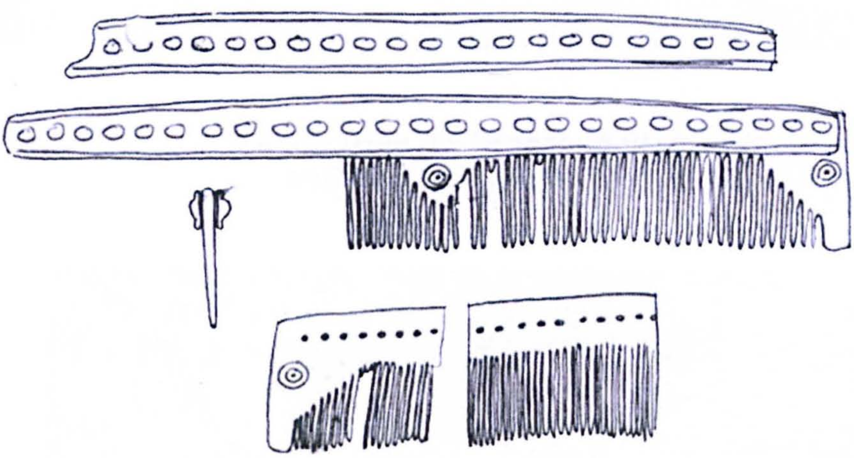


Figure 8. 25 Ornate type 9 comb from Skaill, Deerness (no. 1018), and a parallel from Trondheim (NTNU archive)

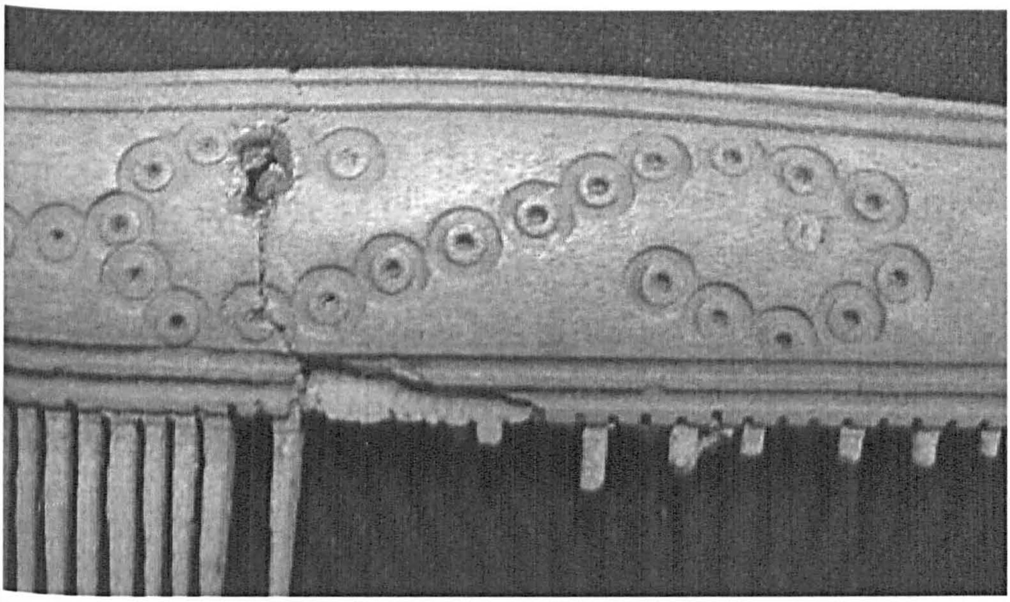


Figure 8. 26 Type 5 comb from the Brough of Birsay with recumbent-S Ring-and-Dot Arrangement (no. 1024)

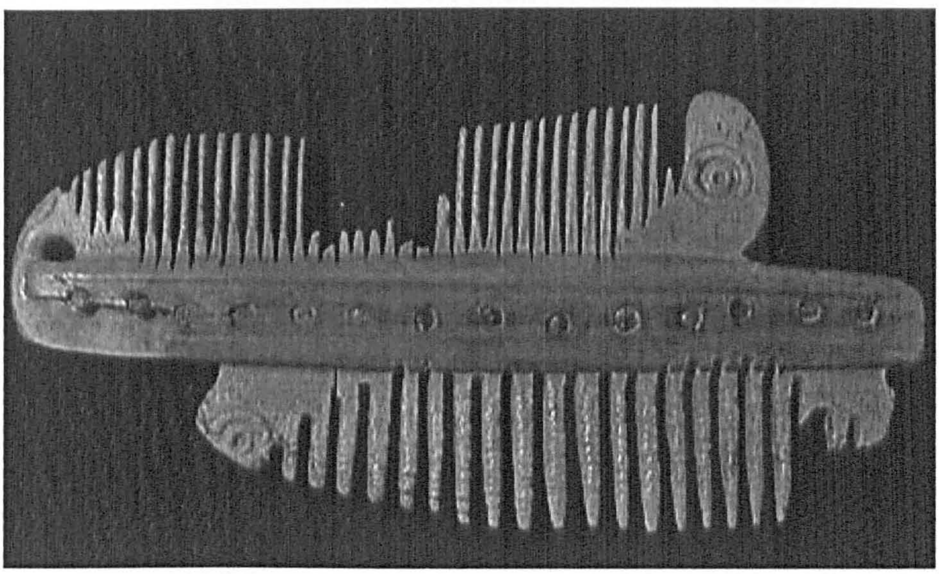


Figure 8. 27 Ring-and-dot as endplate decoration on a type 13 comb from Freswick Links (no. 1403)

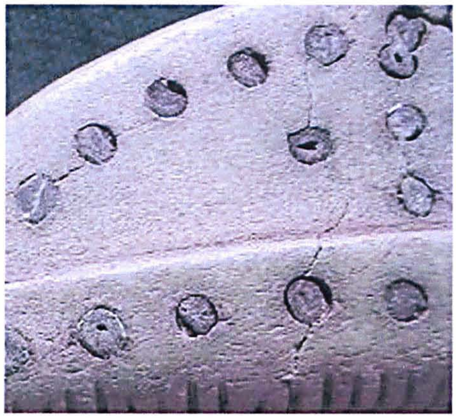


Figure 8. 28 Close-up of 'rivets' of rolled copper alloy sheet on a type 9 comb from Freswick Links

Figure 8. 29 Copper alloy-riveted type 6 comb with probable 'every edge' riveting (no. 1292, Jarlshof)

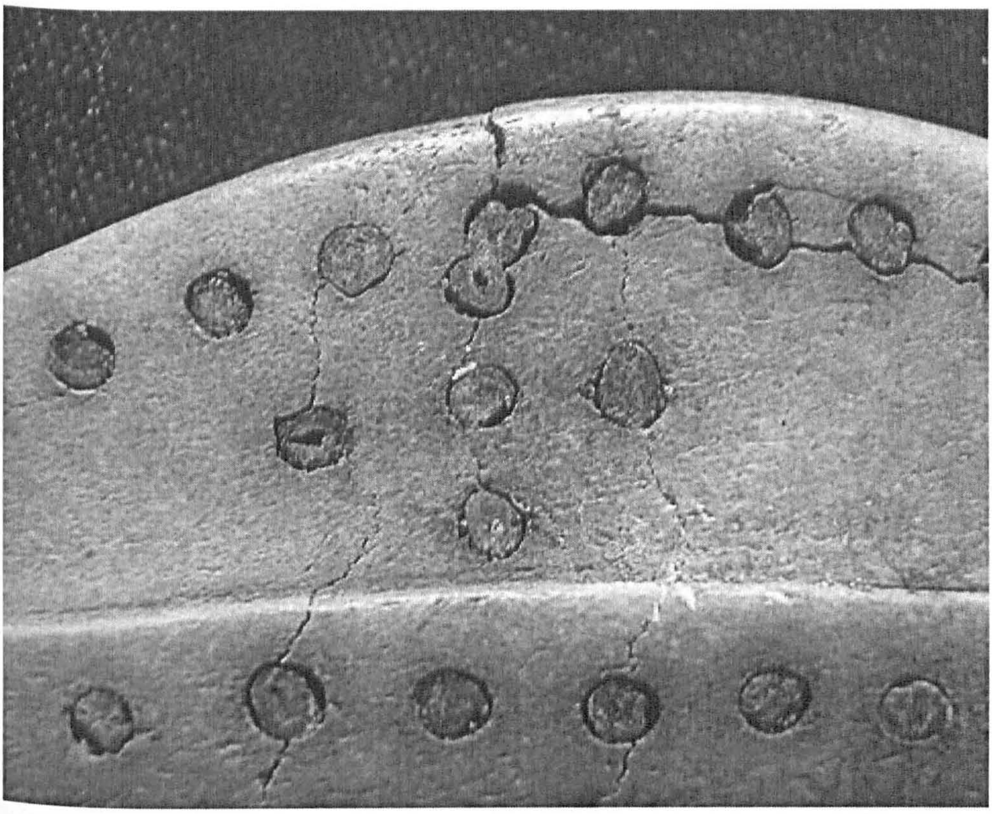


Figure 8. 30 Close-up of a type 9 comb to demonstrate the arrangement of rivets into a 'cross' motif

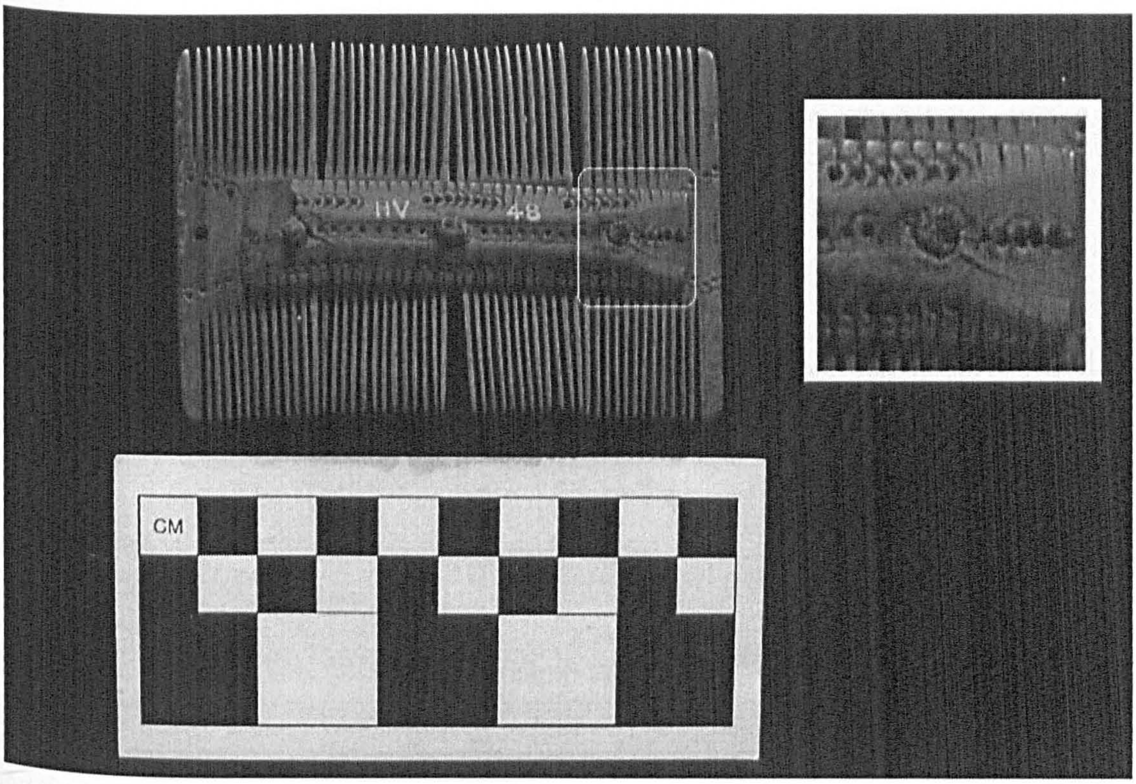


Figure 8. 31 Type 11 comb from Buiston crannog (no. 1330), featuring decorative tooth-cuts (inset)

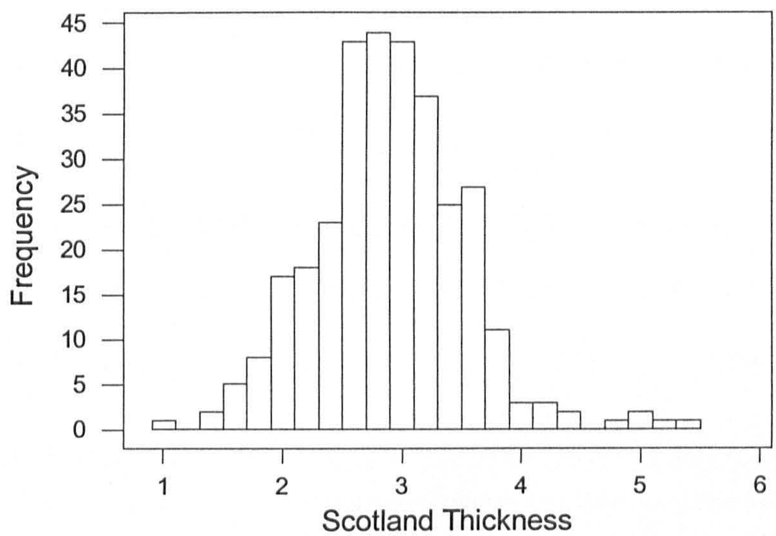


Figure 8. 32 Distribution of billet thicknesses in Scotland

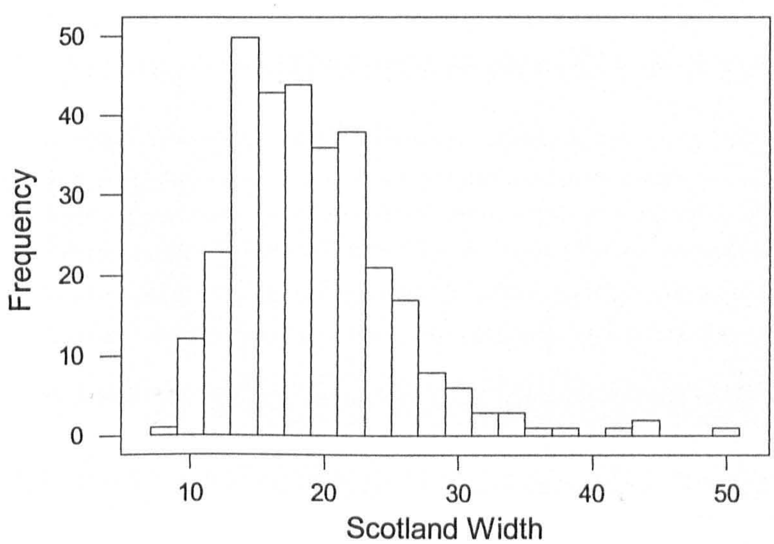


Figure 8. 33 Distribution of billet widths in Scotland

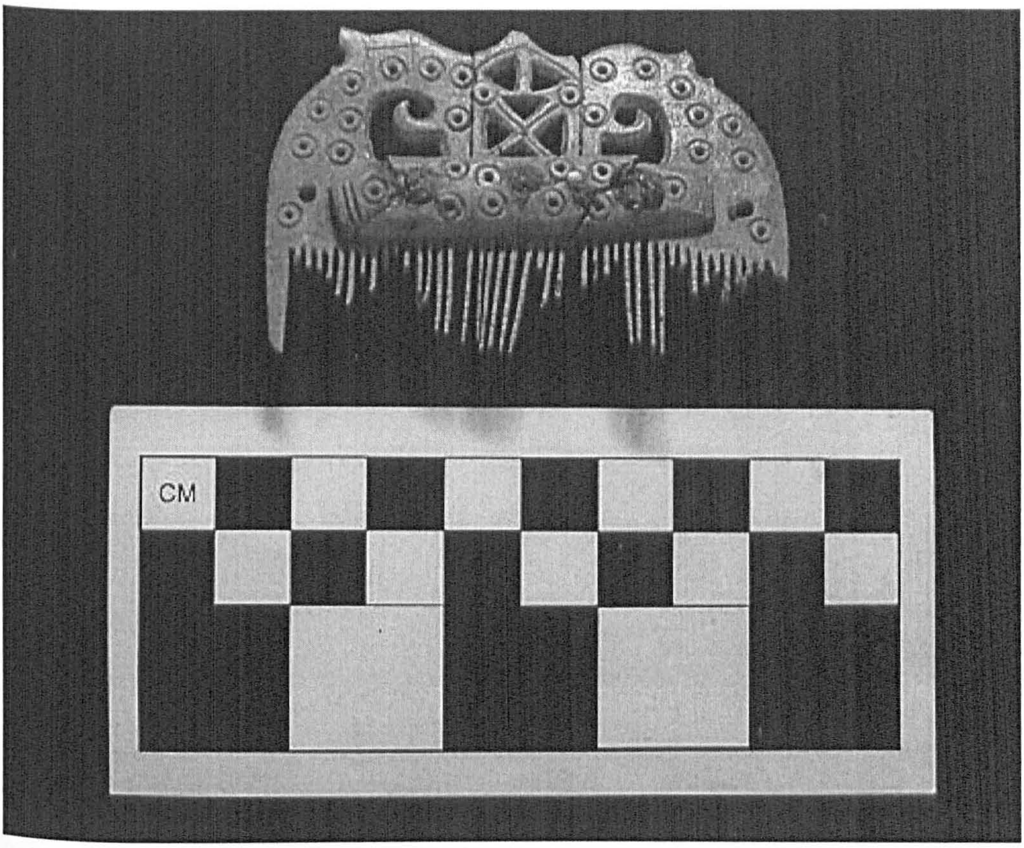


Figure 8. 34 High quality type 1c comb (no. 1317, Dun Cuier)

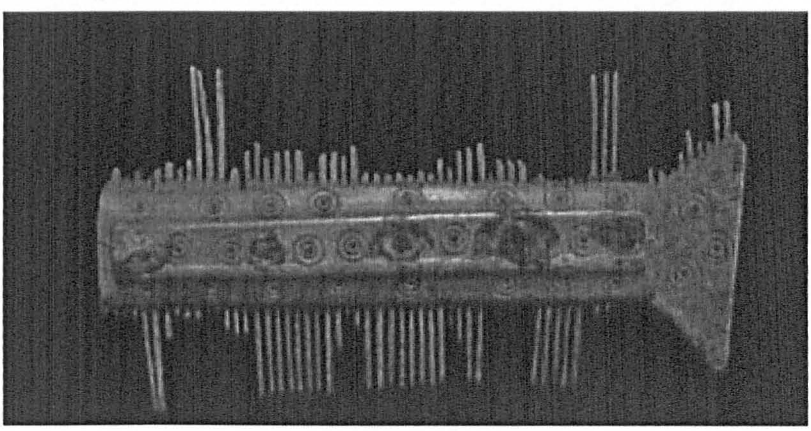


Figure 8. 35 High quality type 11 comb (no. 1035, Brough of Birsay)

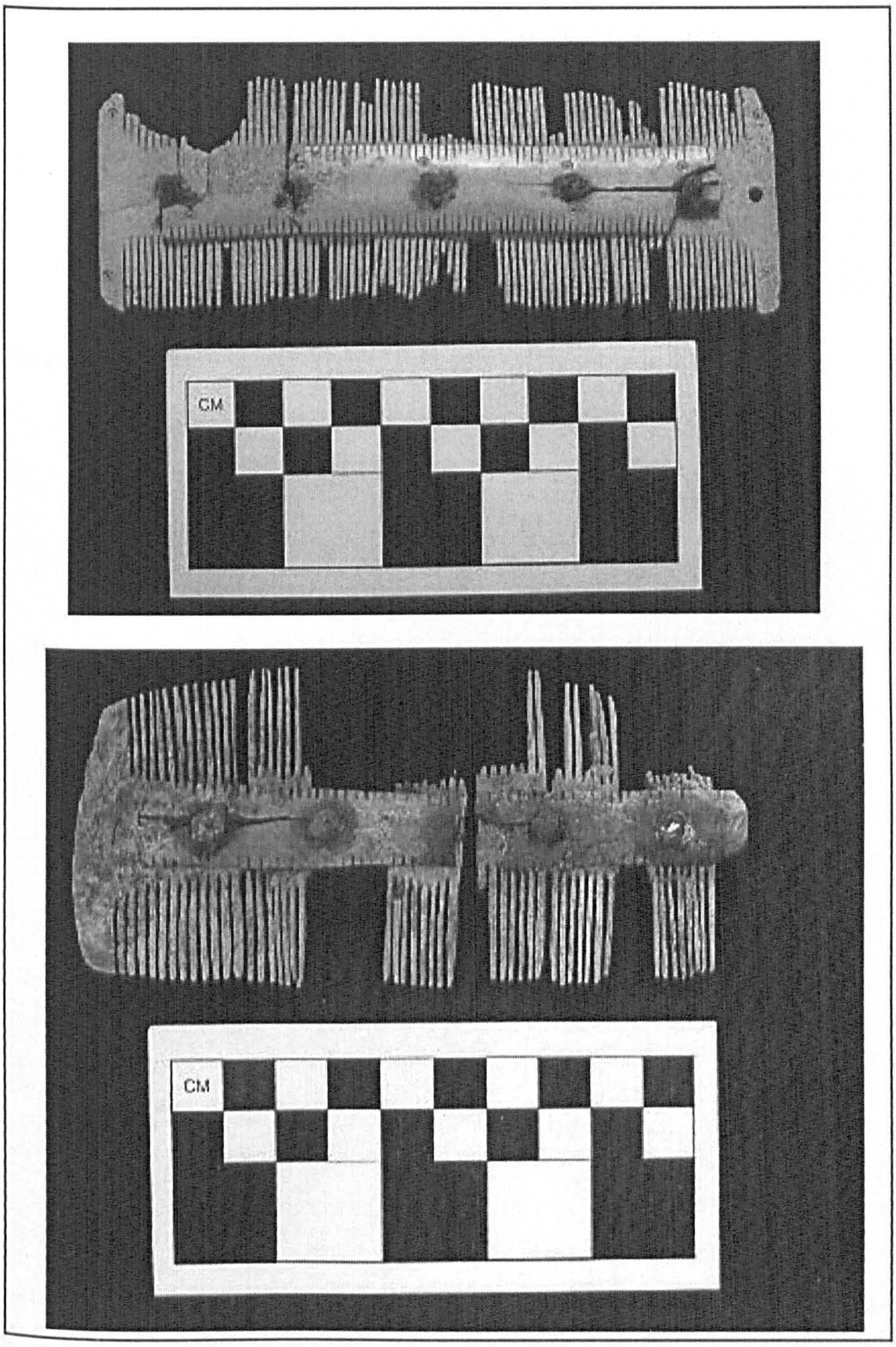


Figure 8. 36 Examples of type 12 combs from Scotland, demonstrating the range in quality of manufacture (top: no. 1258, Broch of Burrian) bottom: no. 1420, provenance unknown)

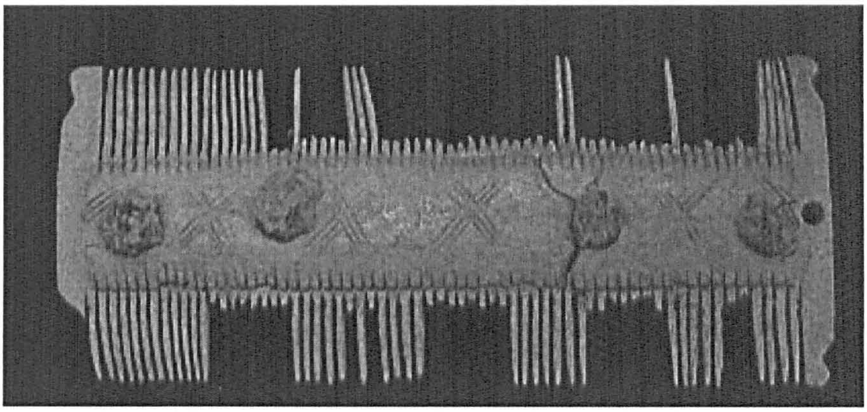


Figure 8. 37 Well-made type 12 comb with simple knife-cut decoration (no. 1058, Buckquoy)

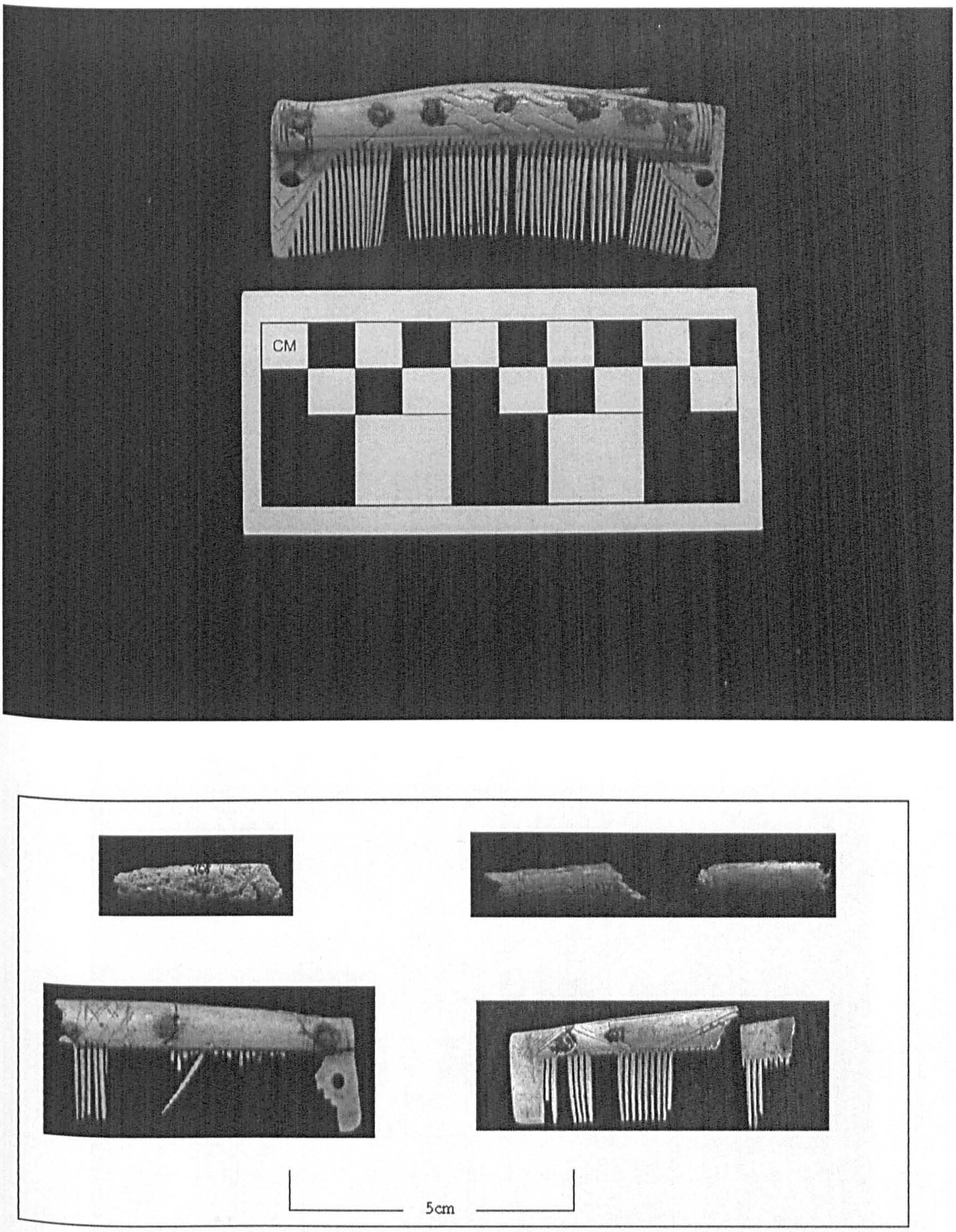


Figure 8. 38 Type 6 combs from Atlantic Scotland (top box: no. 1315, Skaill Bay, Sandwick. Lower box, upper row: numbers 1286 and 1287, Jarlshof; Lower box, lower row: no. 1075, Skaill, Deerness; no. 1750, Bornish)

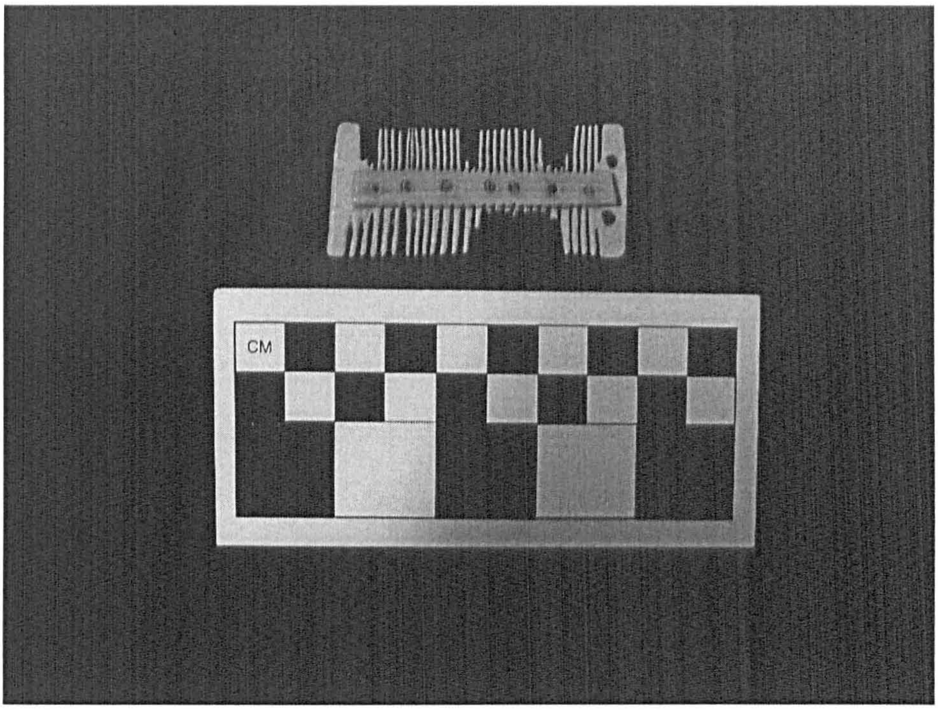


Figure 8. 39 Roughly-made type 13 (Wiberg D2) comb (no. 1408, Freswick Links)

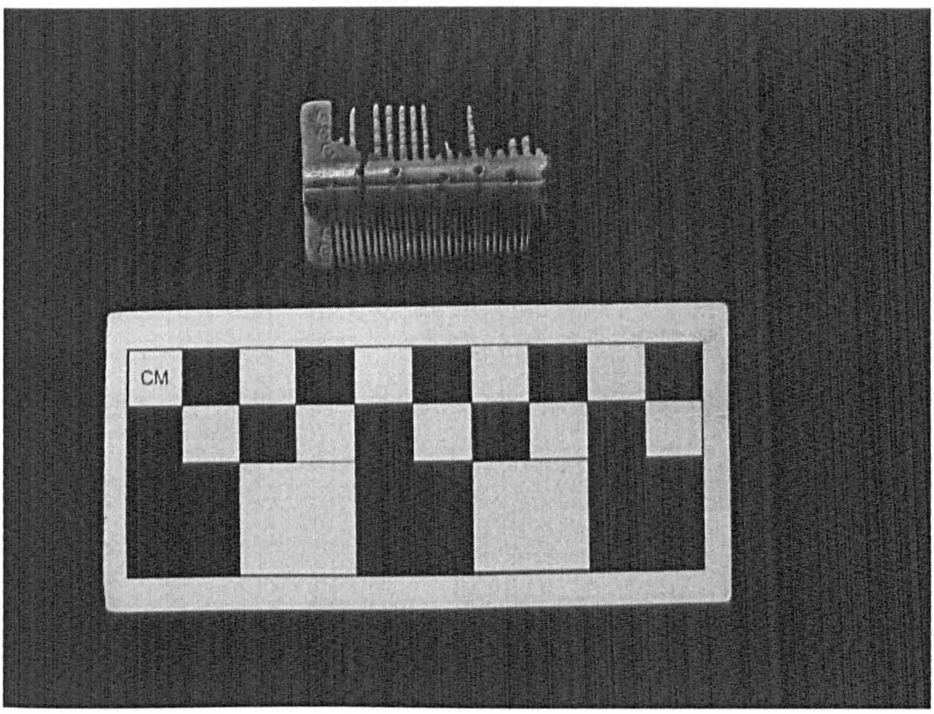


Figure 8. 40 Ornate type 13 (Wiberg D2) comb (no. 2466, Quoygrew)

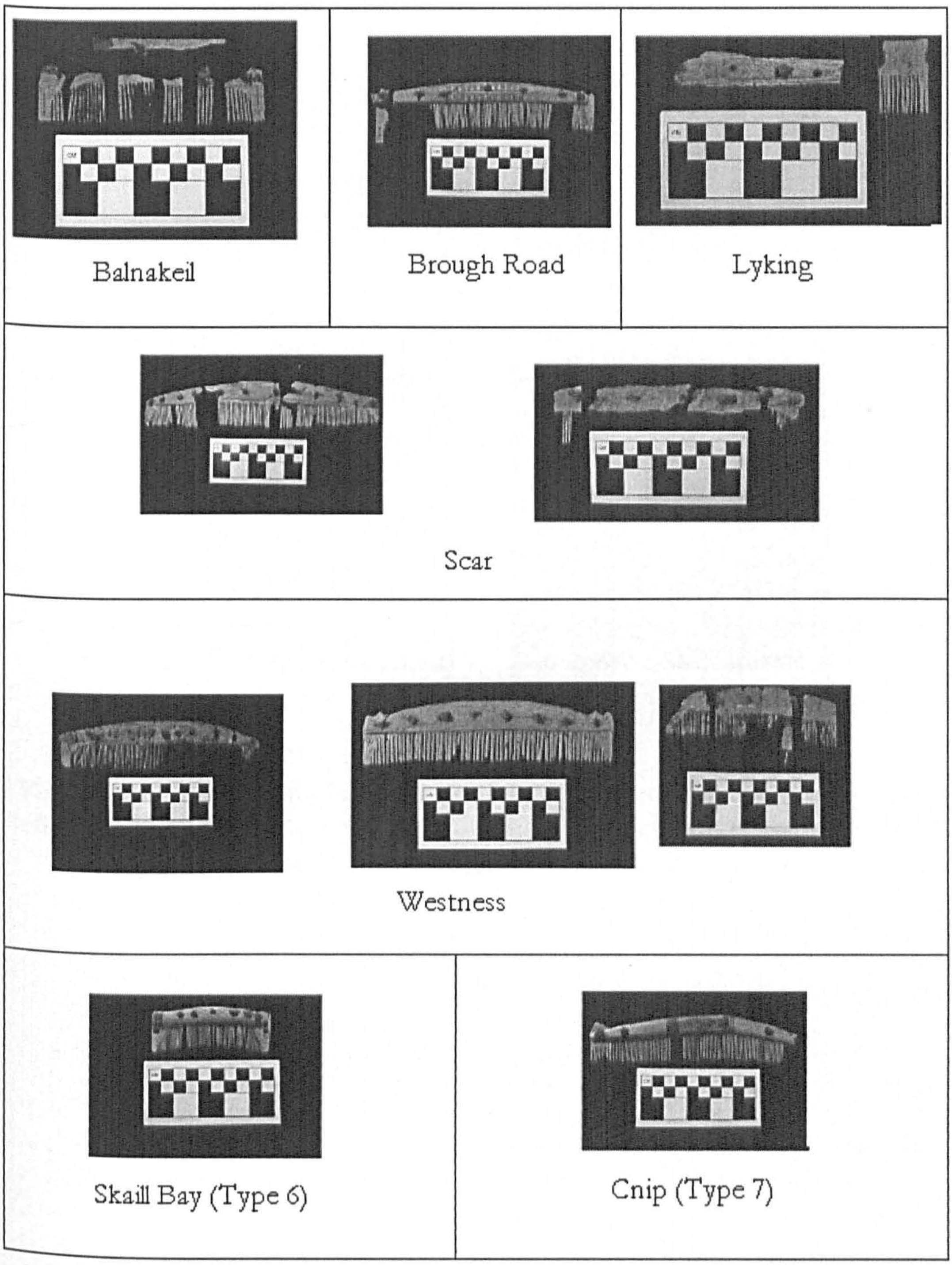


Fig 8. 41 Combs from graves in Scotland (numbers 1407; 1026; 1031; 1032; 1352; 1353; 1391; 1315; 1350)

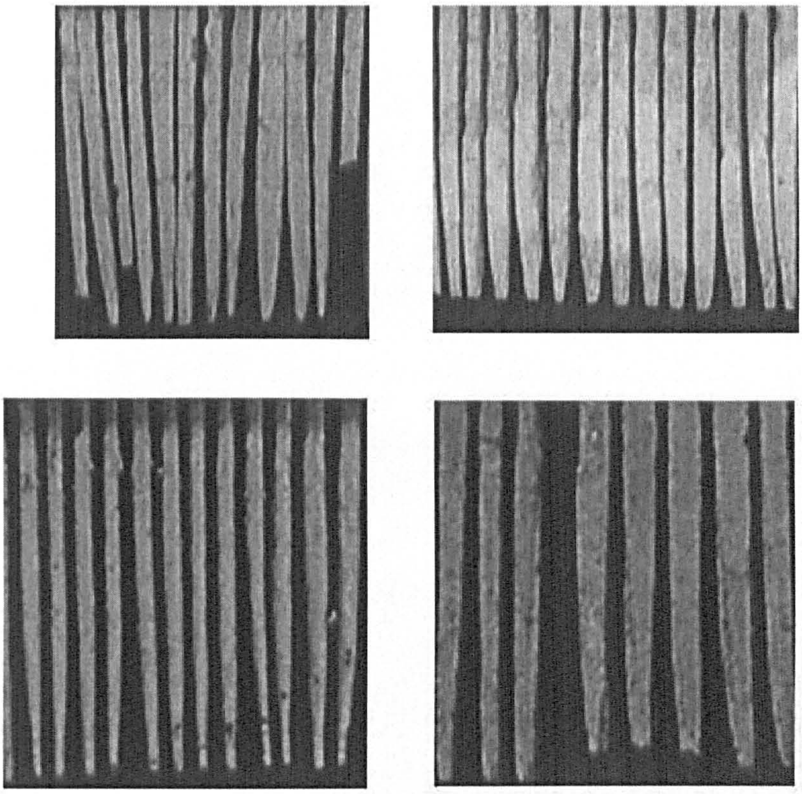


Figure 8. 42 Close-ups of unworn teeth on 'grave combs' (clockwise from top left: no. 1026, type 5, Brough Road; 1032, type 5, Scar adult male burial; 1350, type 5, Cnip; 1315, type 6, Skaill Bay).

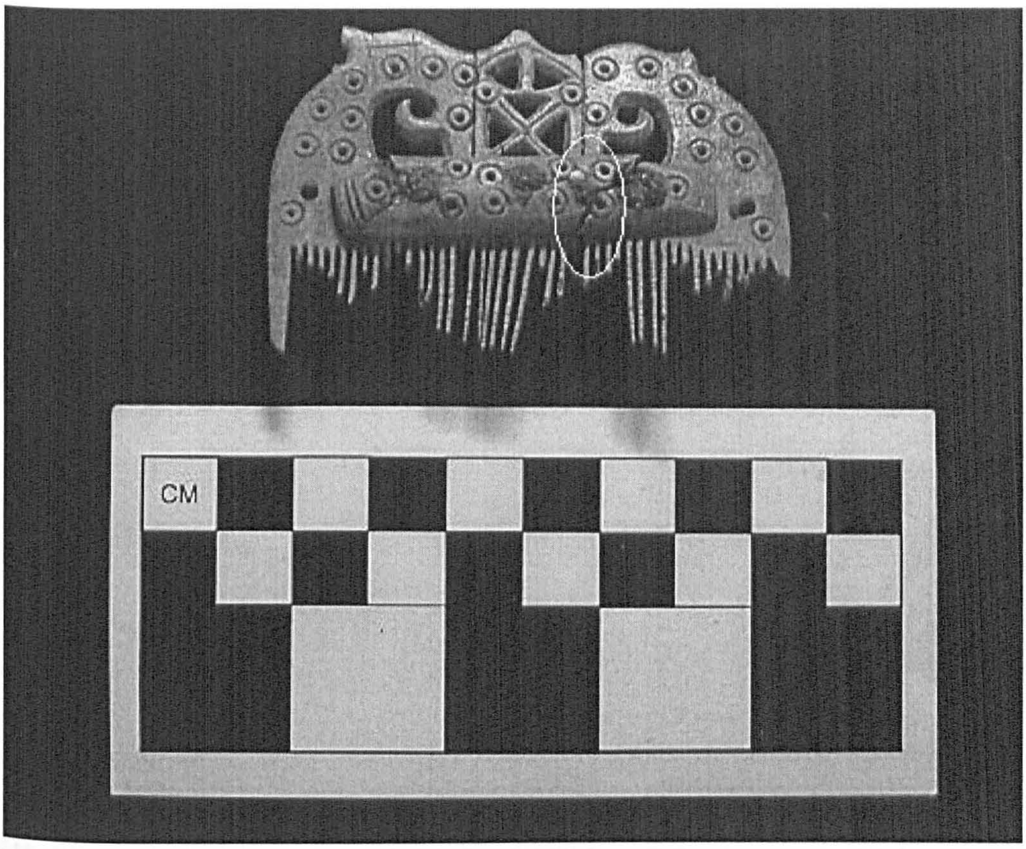


Figure 8. 43 Type 1c comb from Dun Cuier (no. 1317) with an extra rivet added, presumably as a repair

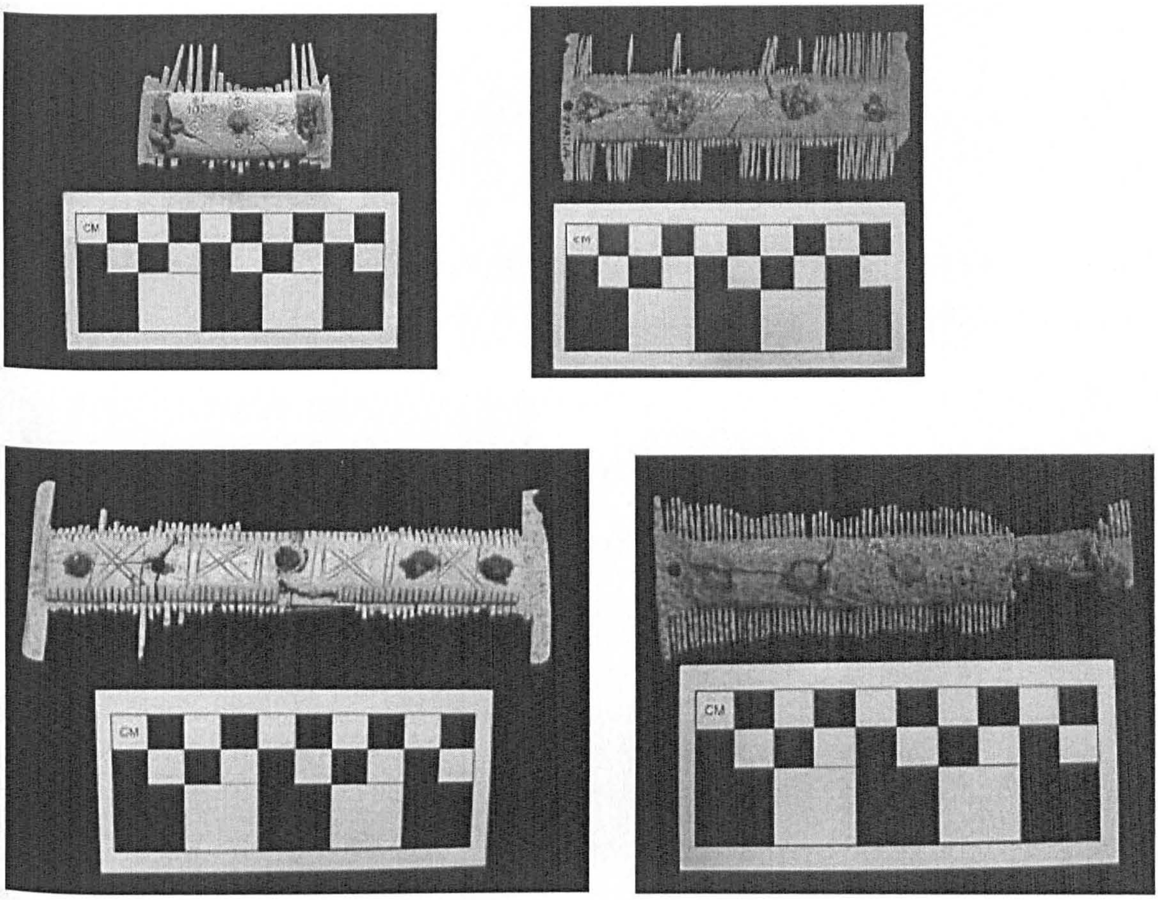


Figure 8. 44 Repair on combs of types 11 and 12 (Clockwise from top left: no. 1321, type 11, North Uist; no. 1058, type 12, Buckquoy; no. 1013, type 12, Skaill, Deerness; no. 999, type 12, Skaill, Deerness)

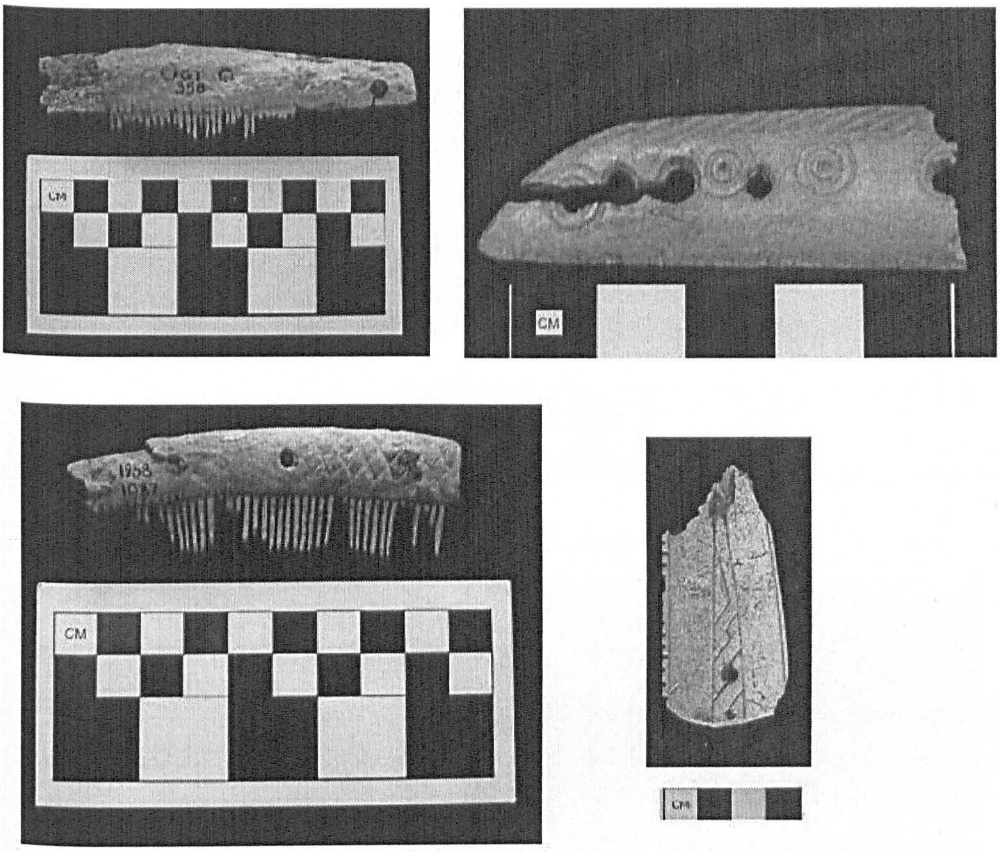


Figure 8. 45 Repairs/modifications made to combs of types 5 and 7

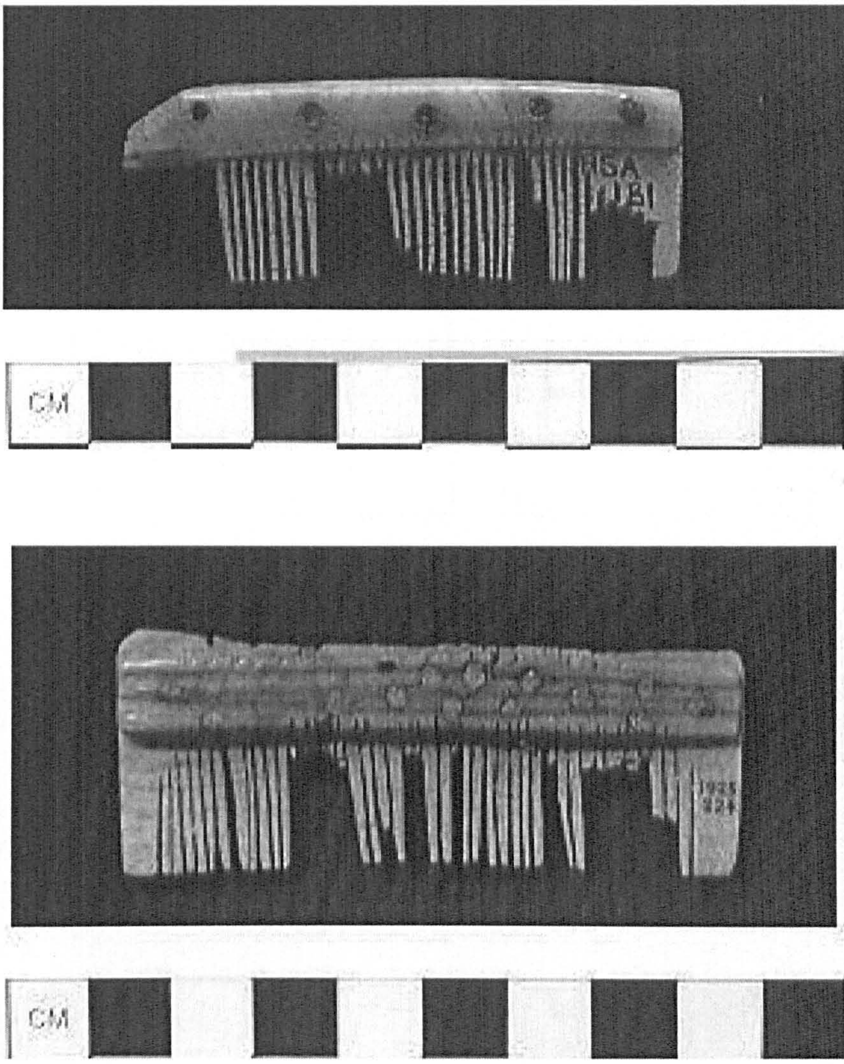
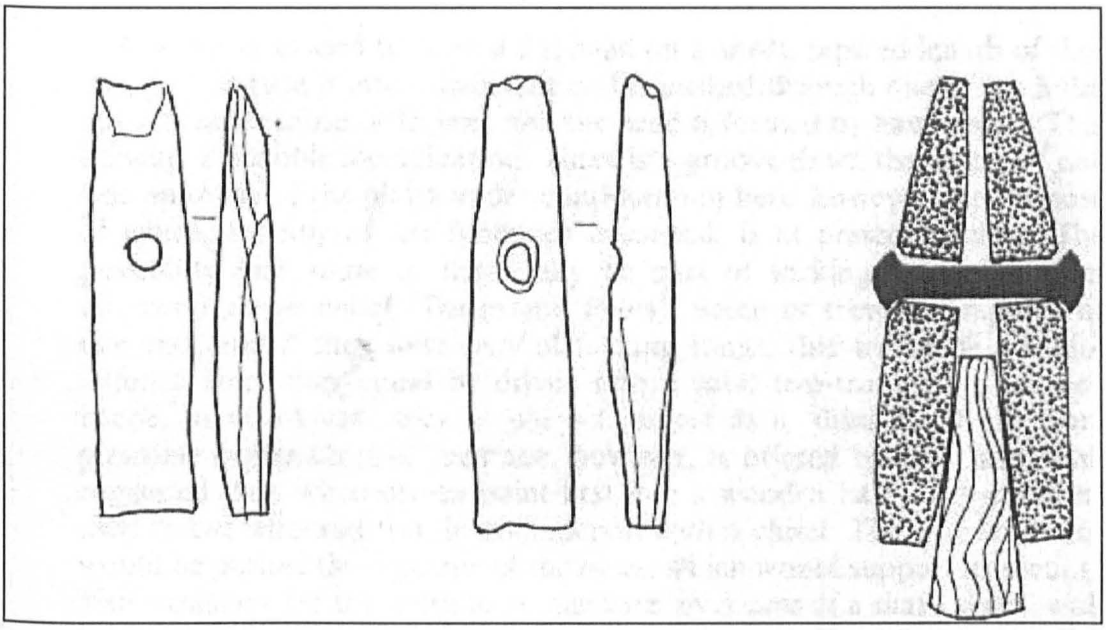


Figure 8. 46 Repair on combs of types 9 and 13 (Top: no 1275, type 9, Jarlshof , chamfered end; bottom: no. 1251, Type 9/13, Freswick Links (converted from type 13 into type 9)



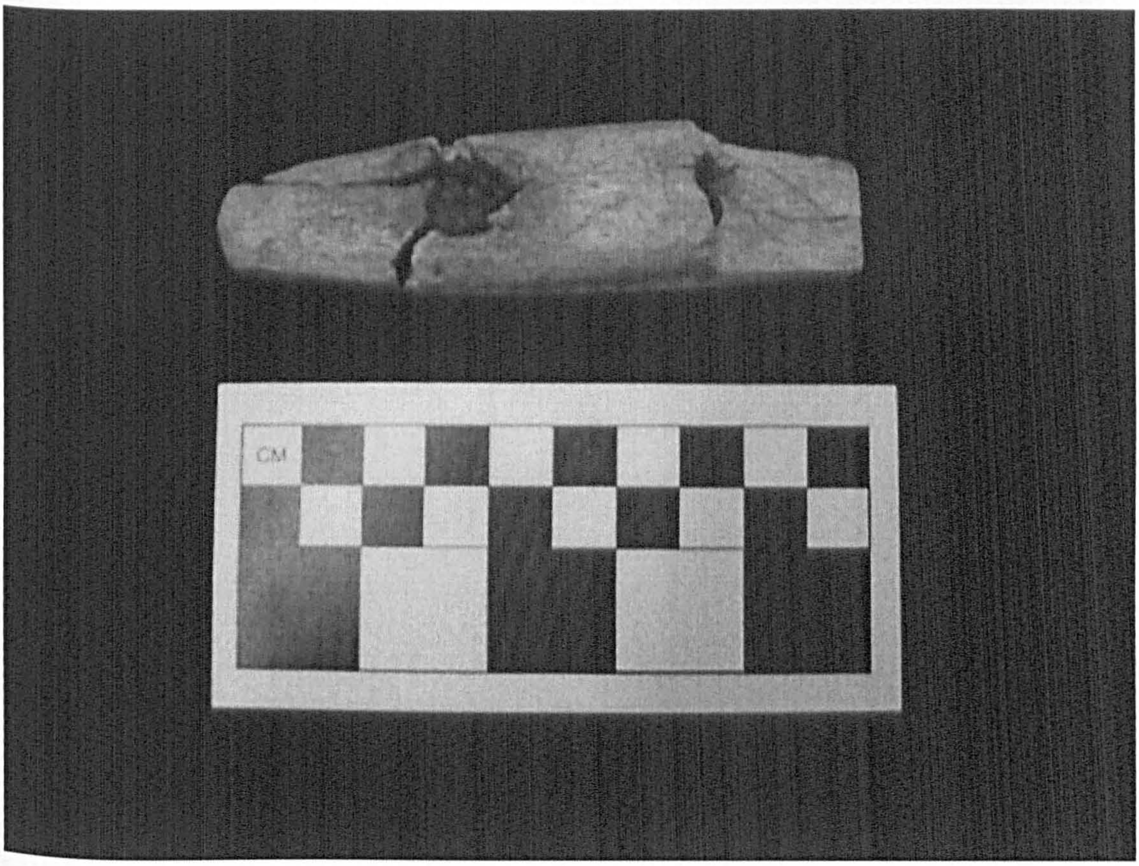


Figure 8. 47 Antler clamps, possibly for combmaking. Top from Coppergate, York (Coatsworth and Pinder 2002: fig 11). Bottom from Skaill, Deerness (Orkney).

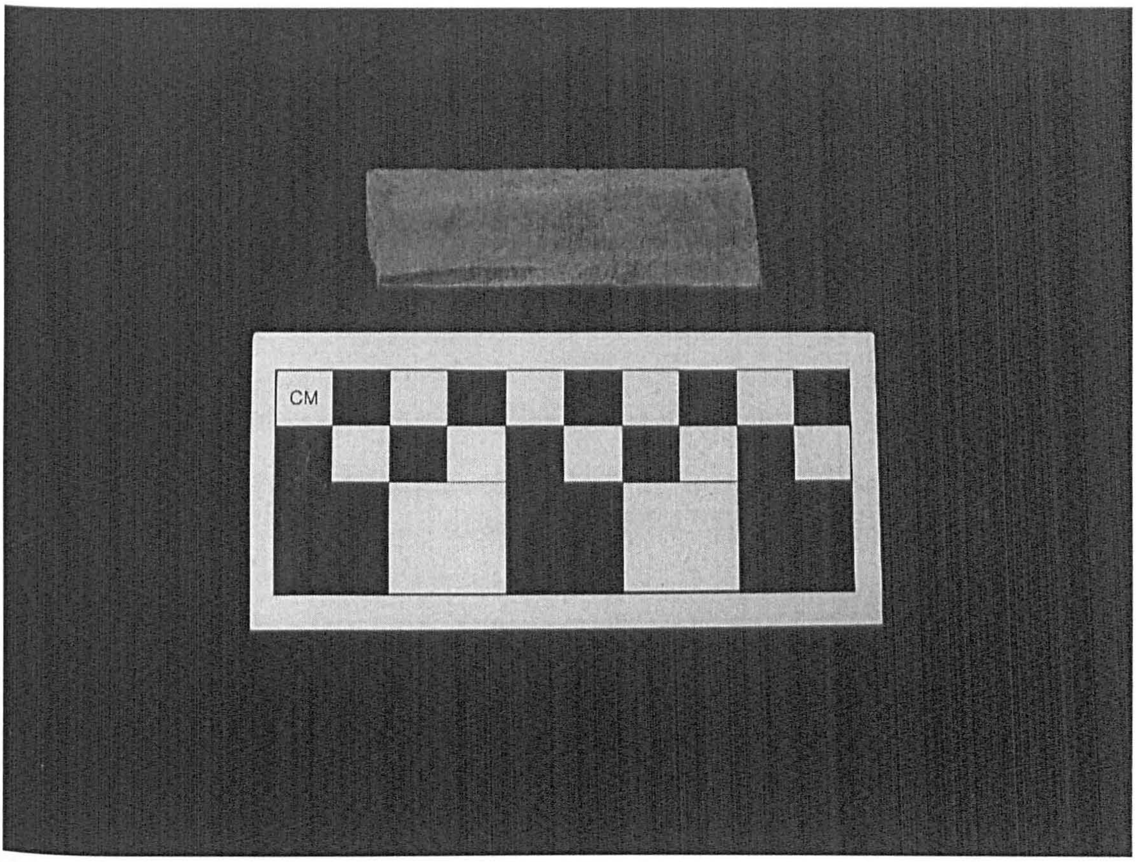


Figure 8. 48 Comb blank from Buiston Crannog (no. 1401)

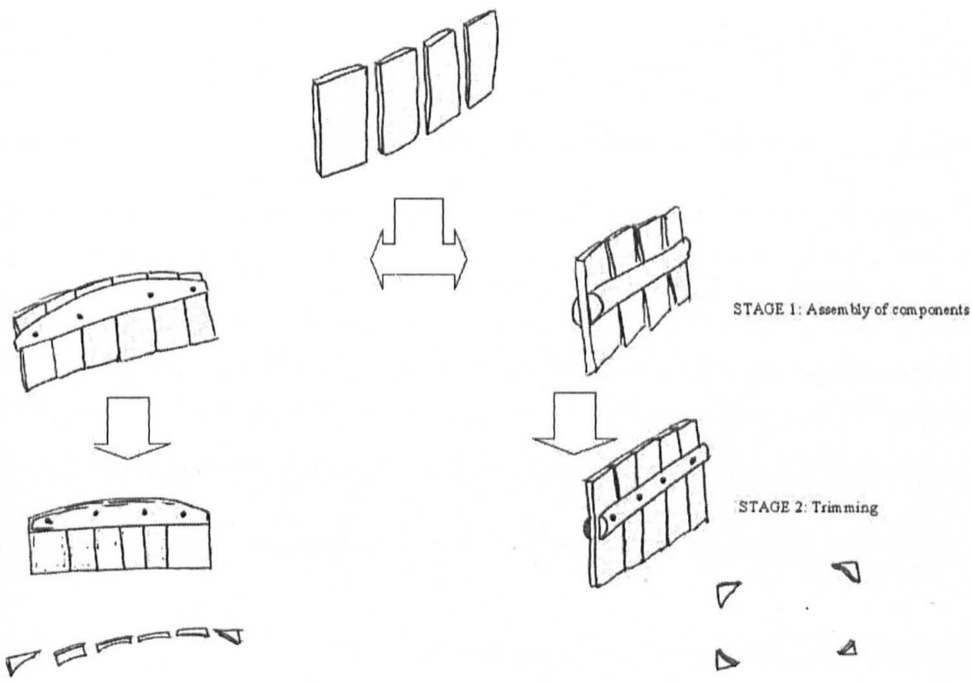


Figure 8. 49 Trimming a double-sided comb
(drawing S. Ashby)

COLOUR IN ORIGINAL

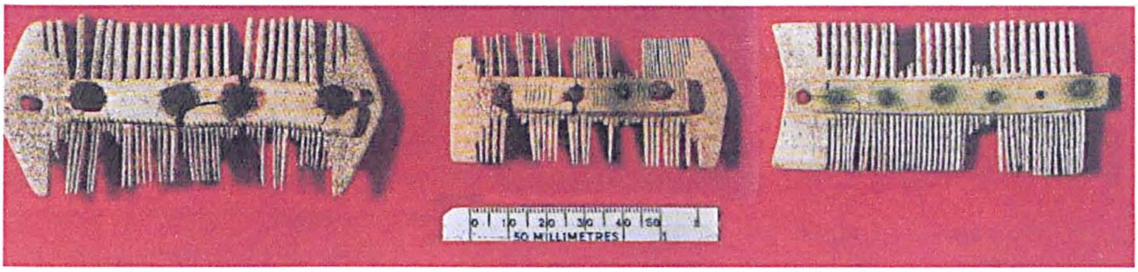


Figure 8. 50 Type 13 combs with copper alloy and iron rivets from the Udal (Crawford 1996: 88)

Figures for Chapter 9

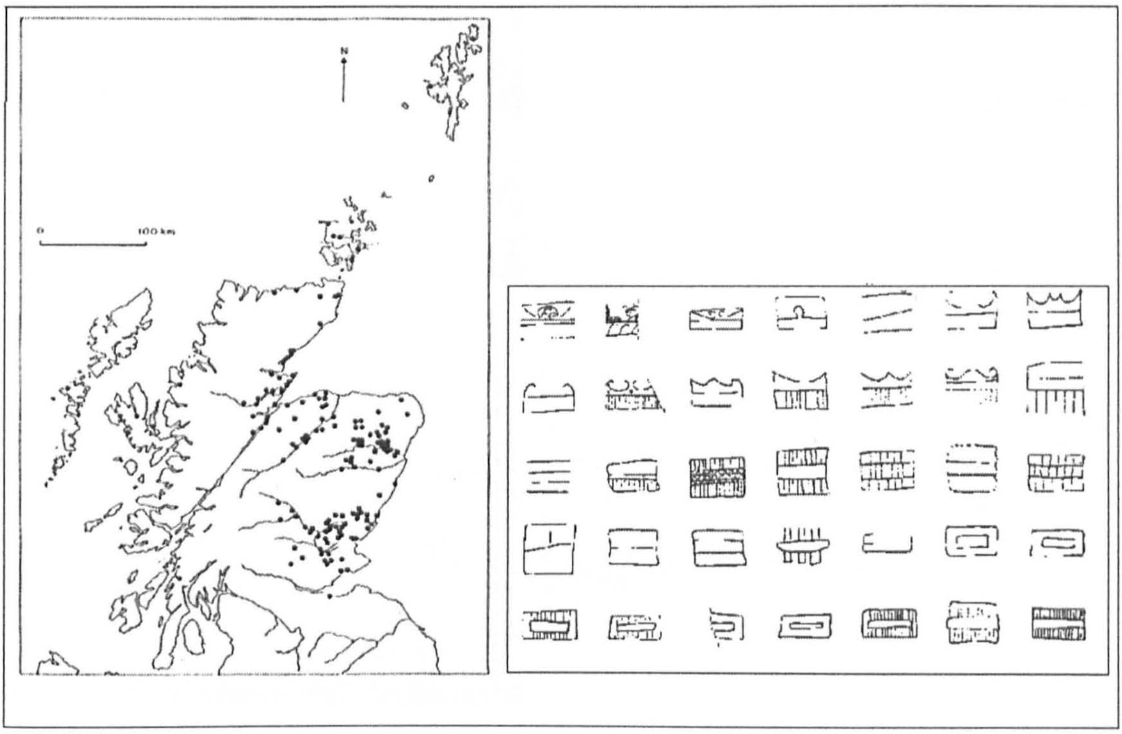
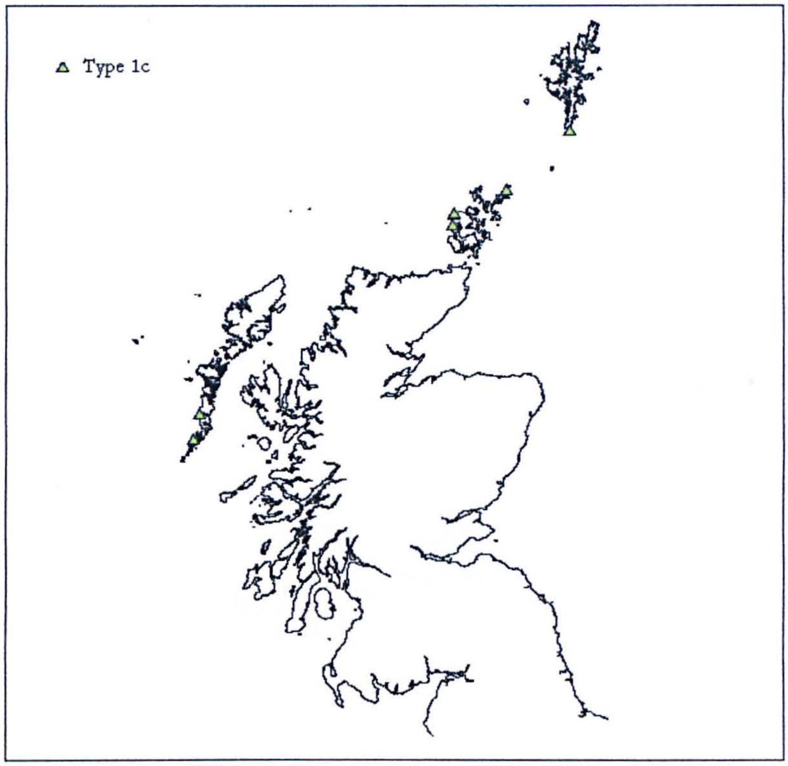


Figure 9. 1 Distribution of Class I and II symbol stones in Scotland (left) , and illustrations of associated 'comb' carvings (after Foster 1990: Ill 9.6 and 9.7)

COLOUR IN ORIGINAL



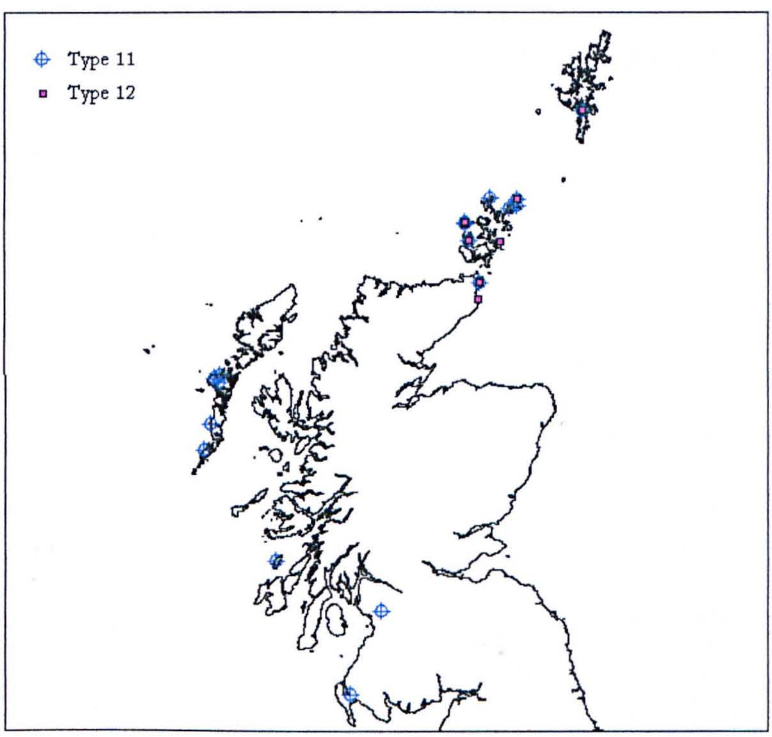


Figure 9. 2 Distributions of type 1c, 11, 12, and 5 combs in Scotland (cont. over)

COLOUR IN ORIGINAL

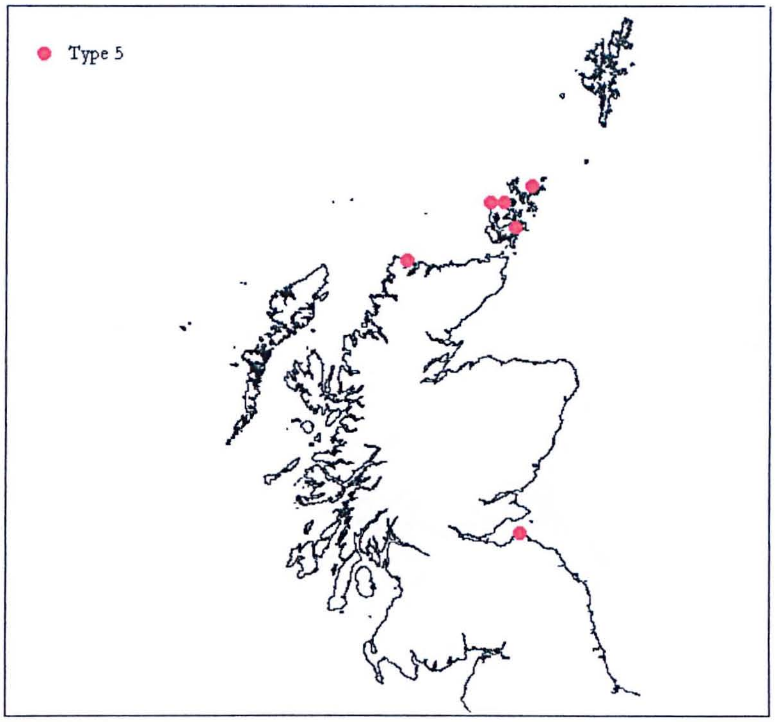
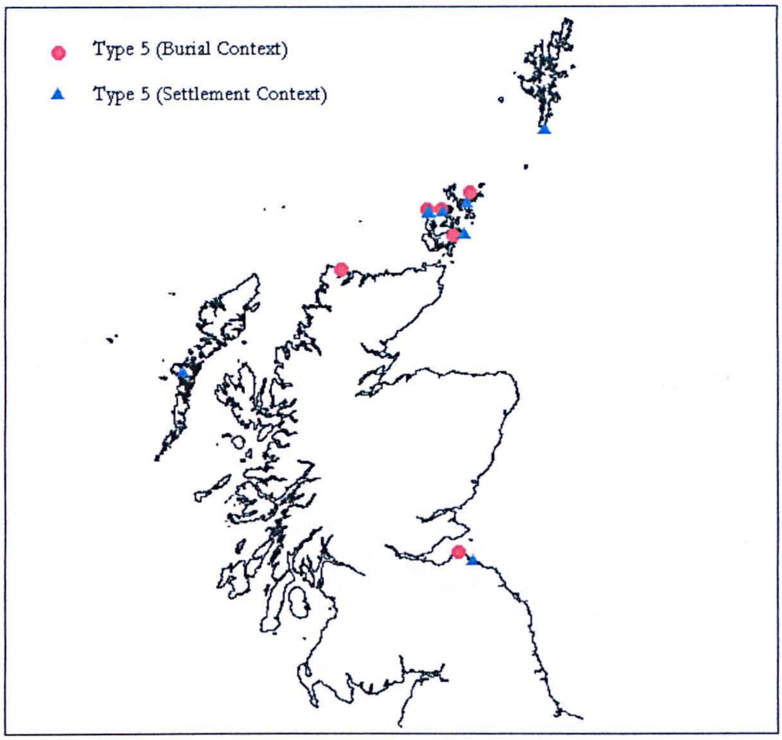


Figure 9. 2 (cont.) Distributions of Type 1c, 11, 12, and 5 combs in Scotland

COLOUR IN ORIGINAL



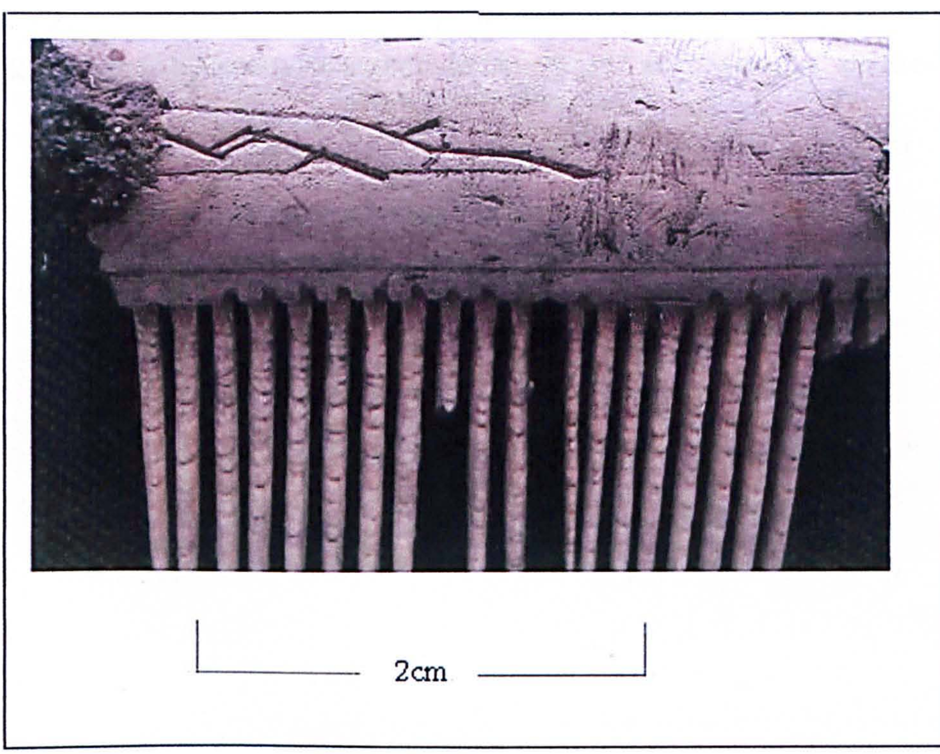


Figure 9. 3 (top) Distributions of type 5 combs from burials and settlements in Scotland, and (bottom) an example from a settlement context at Jarlshof, showing wear (no. 1264).

COLOUR IN ORIGINAL

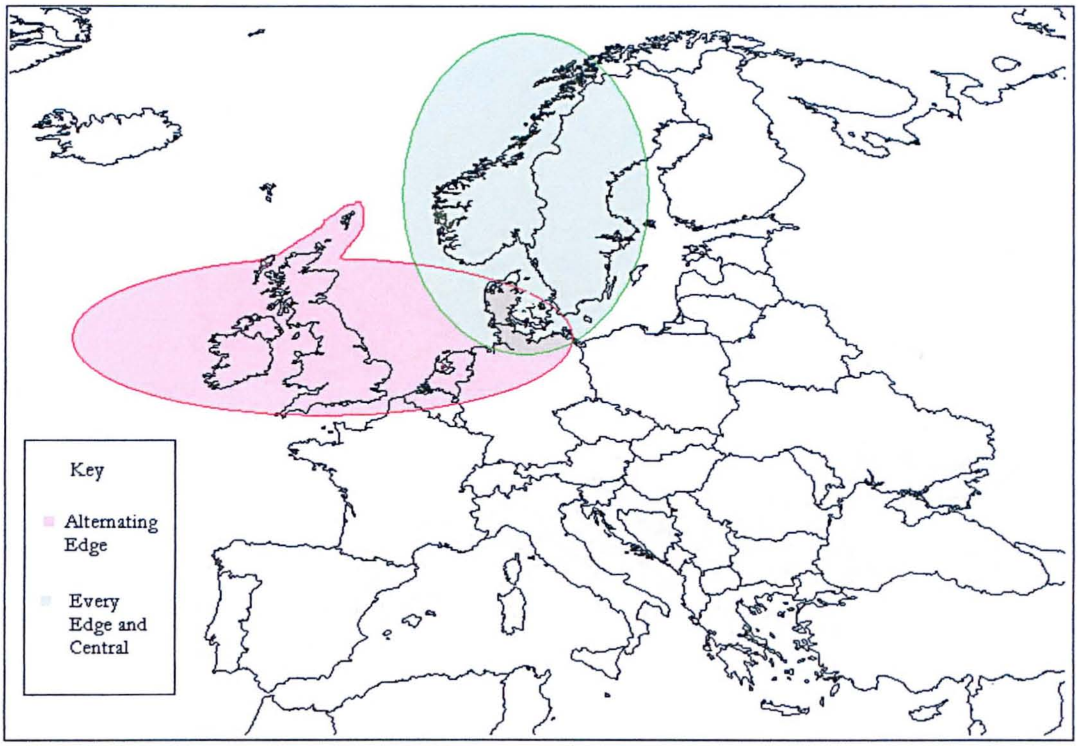


Figure 9. 4 Approximate extents of 'northern' and 'western' methods of riveting attachment.

COLOUR IN ORIGINAL

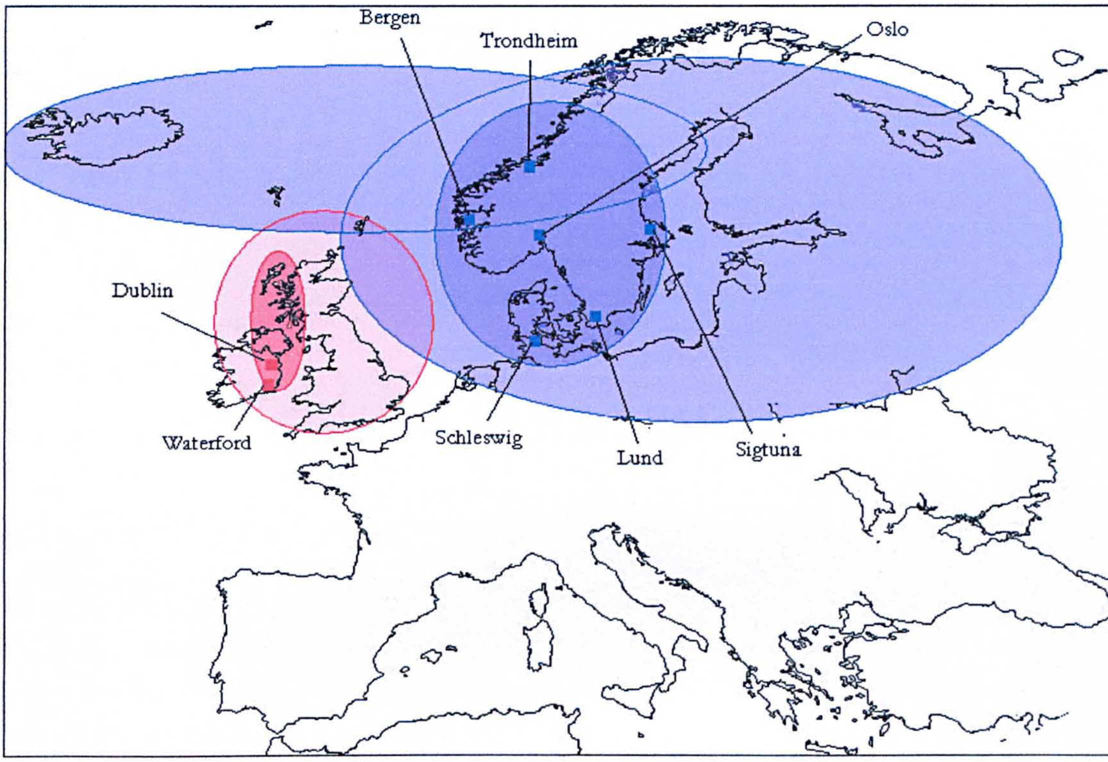


Figure 9. 5 Centres of comb manufacture and associated 'zones' (areas of dispersion) in the medieval period

Figure 9. 6 Figures from the Brough of Birsay Stone (after Curle 1982: ill 59). Note contrasting hairstyles of 'leader' and 'followers'.

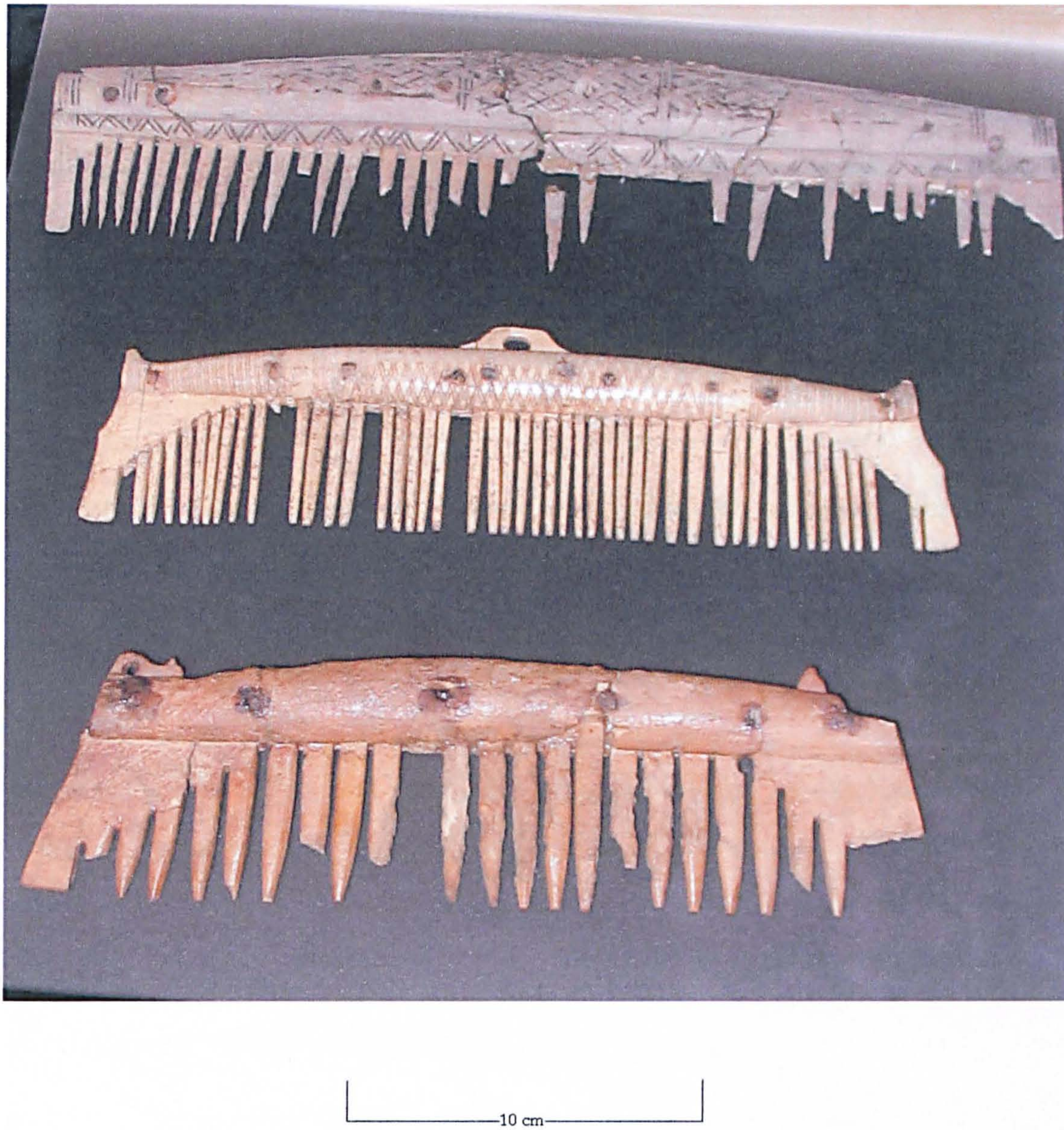


Figure 9. 7 'Horse' combs from Birka (numbers 268; 269, 270)

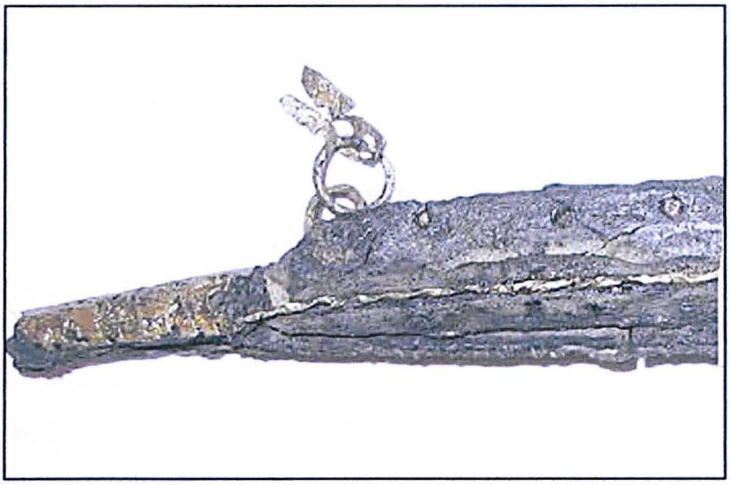


Figure 9. 8 Ornate type 9 comb from Trondheim with suspension chain (no. 2417)

Figure 9. 9 Unusual designs on connecting plates of a type 5 comb from Birka (no. 114)

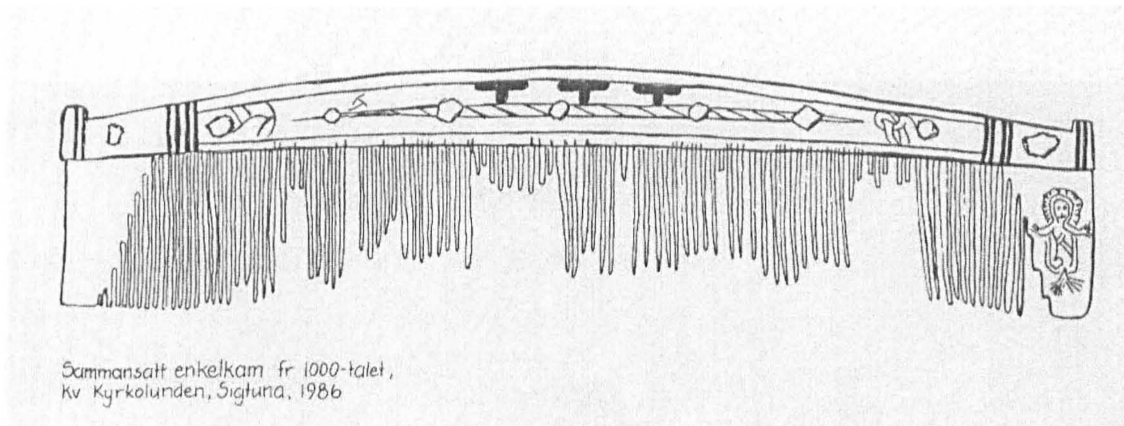


Figure 9. 10 The Sigtuna 'Christ' comb (Tesch 1987: fig. 8)

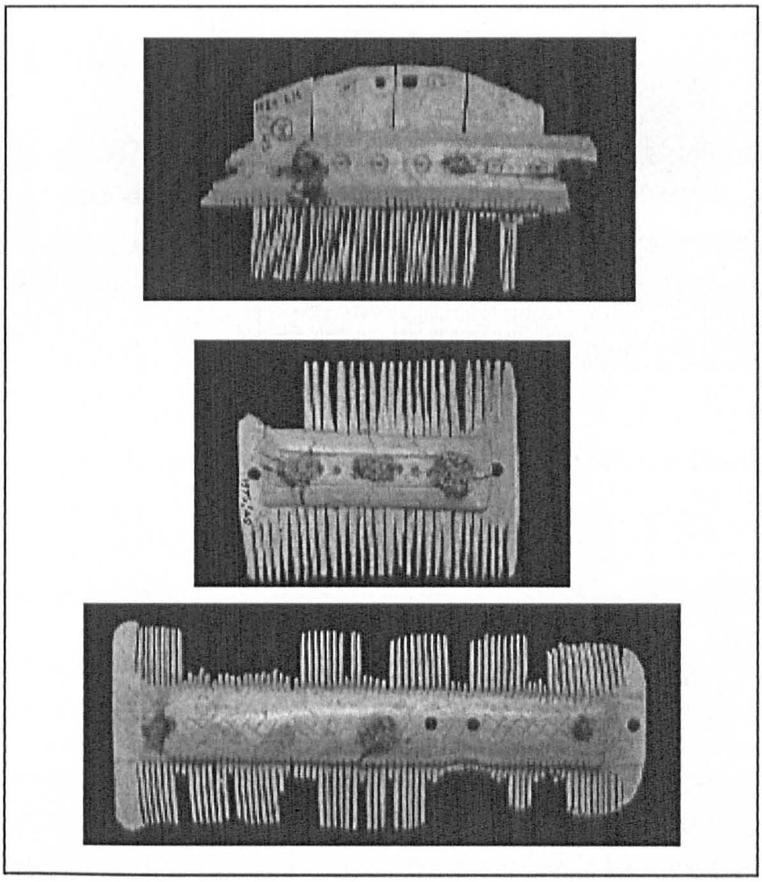


Figure 9. 11 Type 11, 12 and 1c combs with suspension holes (numbers 1033, 1059, and 1036)

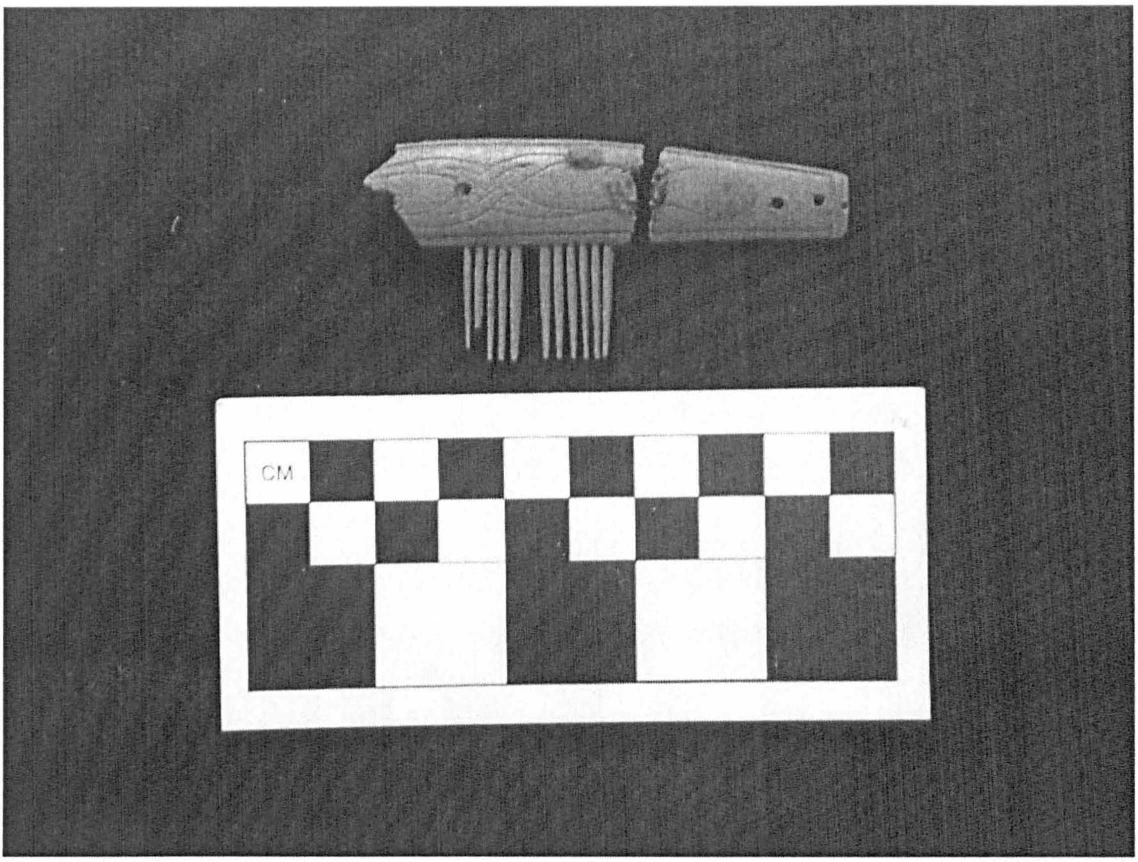
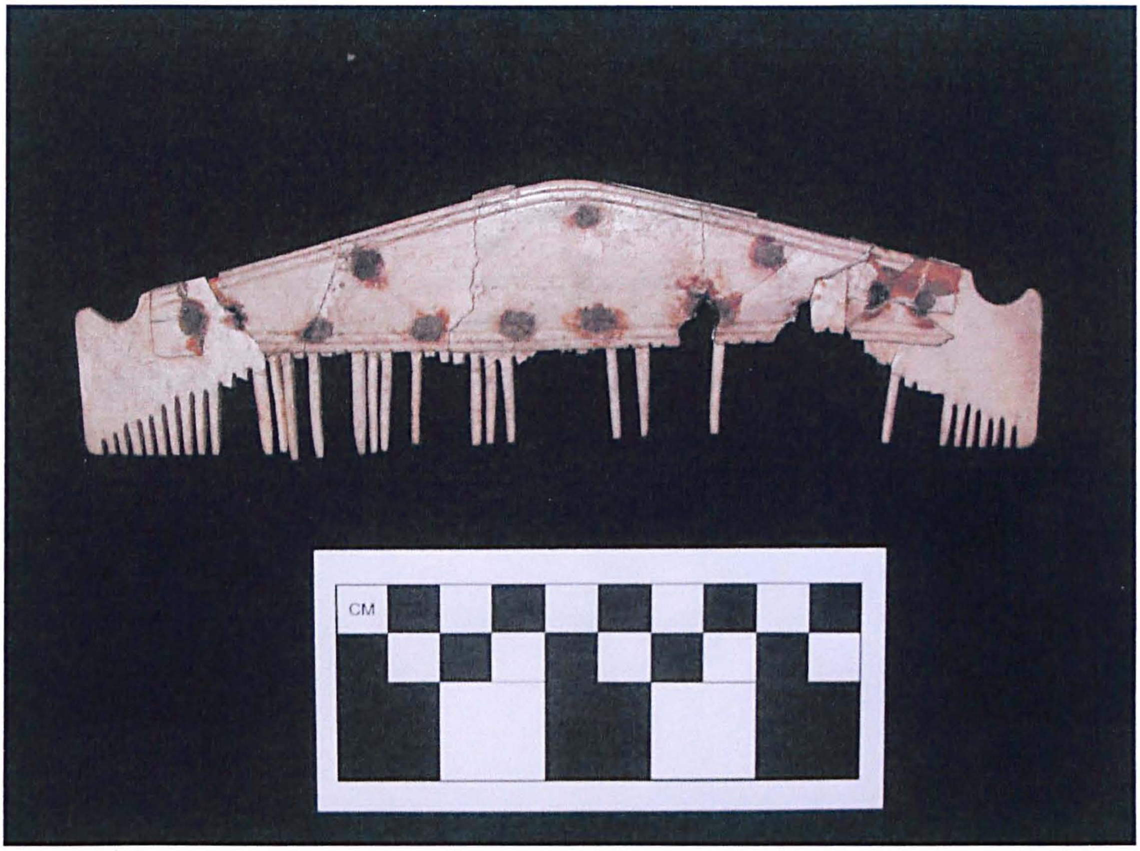
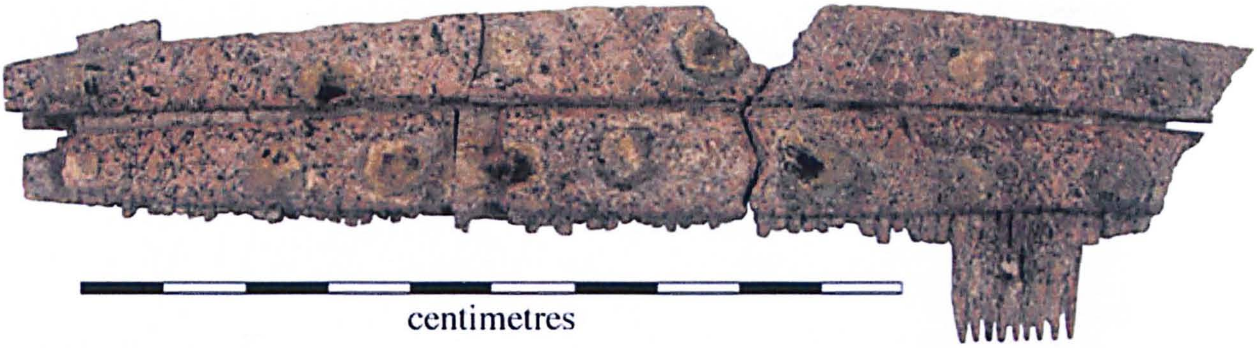


Figure 9. 12 Type 5 Comb with unusual ornament, from the Brough of Birsay (no. 1235).

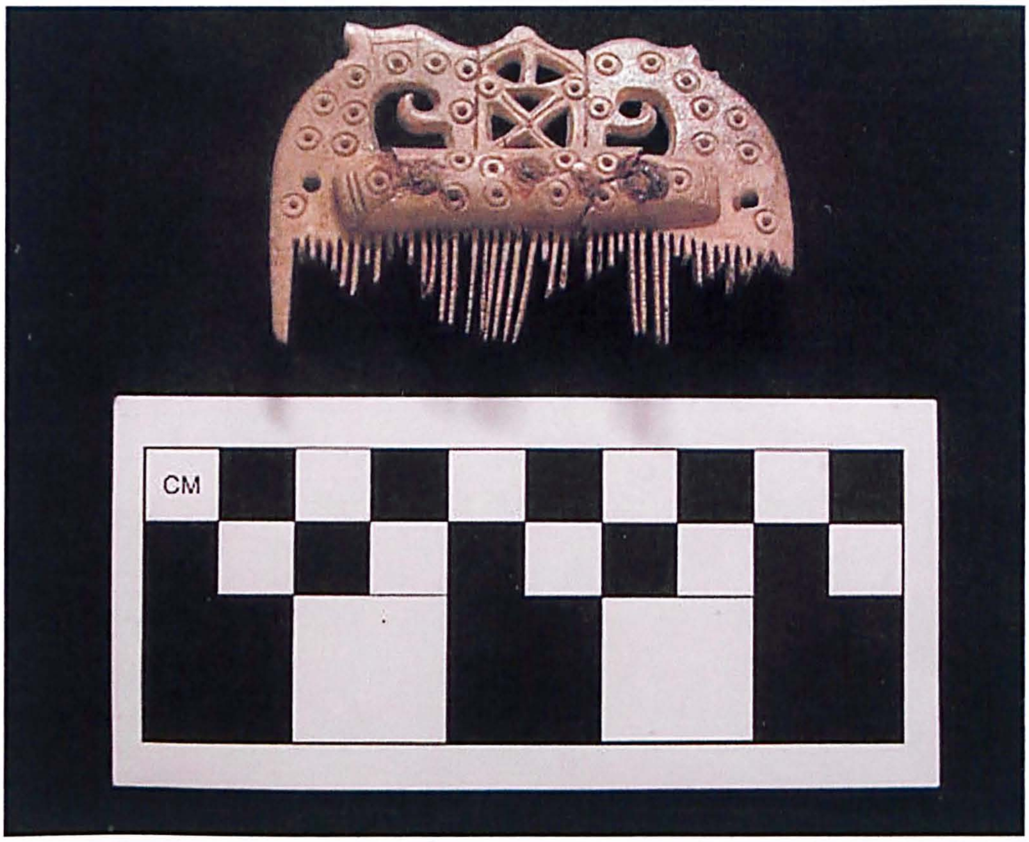
Plates of Types



Type 1a (North Elmham)

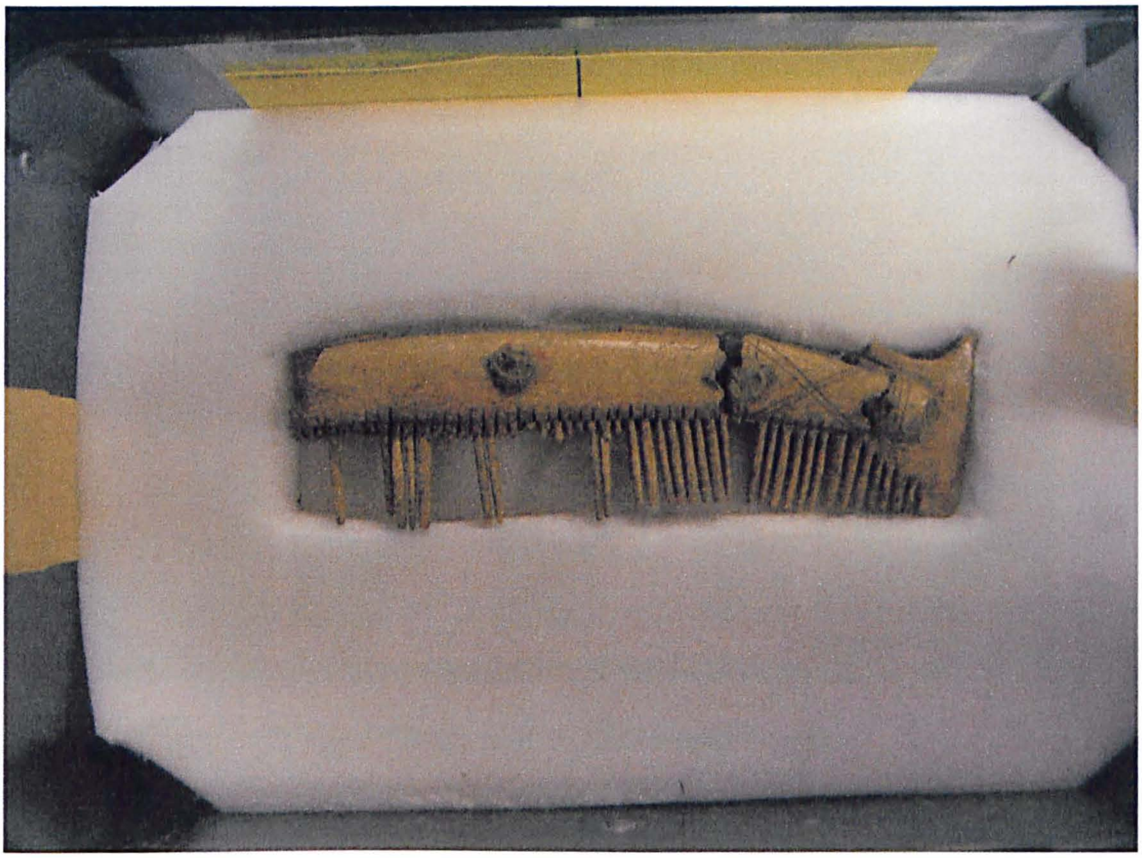


Type 1b (Fishergate House, courtesy FAS).

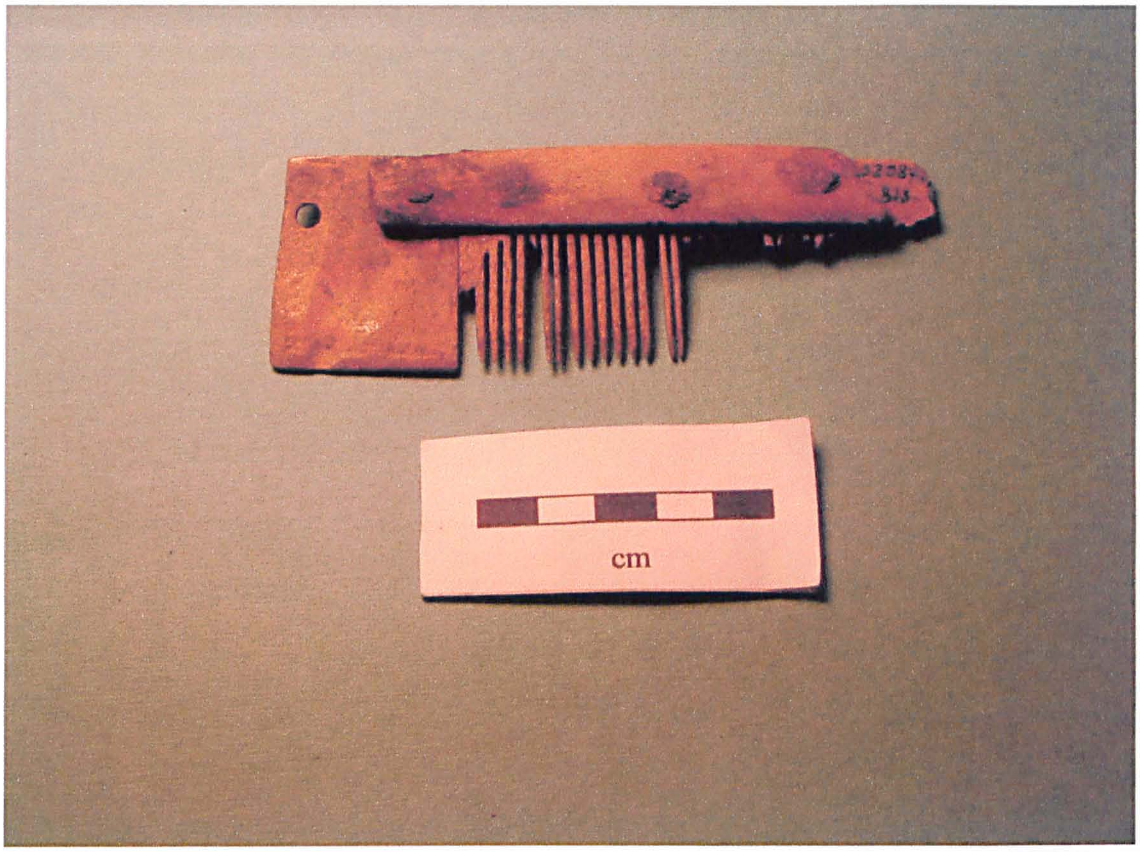


Type 1c (Dun Cuier, Western Isles)

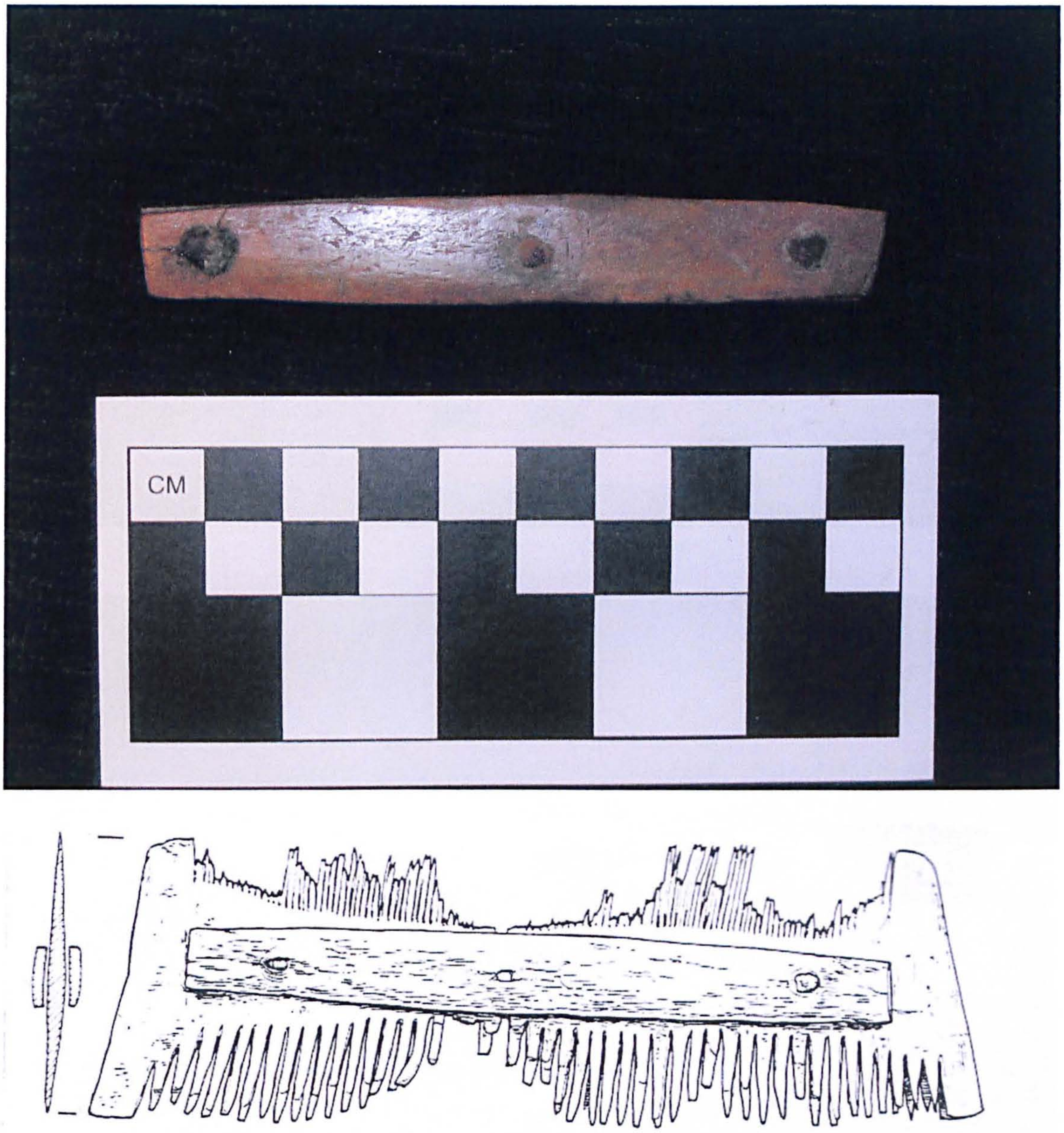
Type 2a (Wharram)



Type 2b (Wharram)



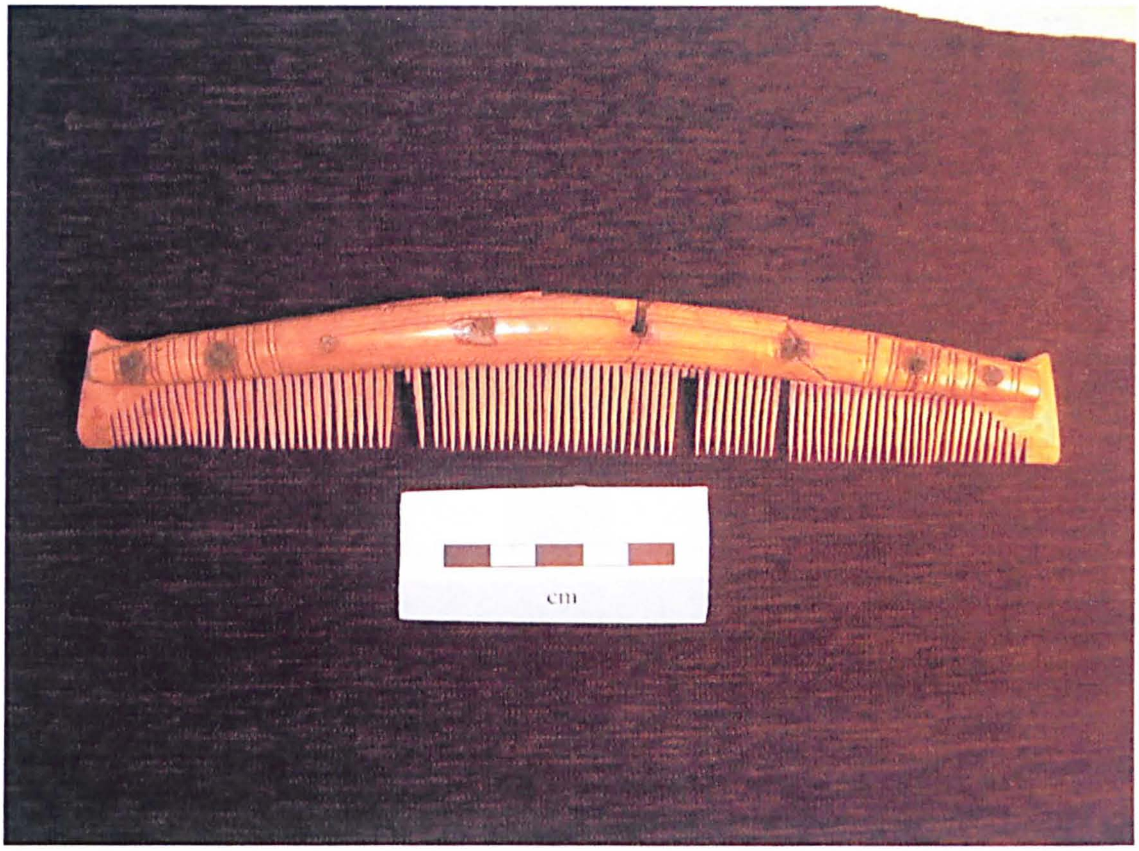
Type 3 (Birka and High Ousegate, York)



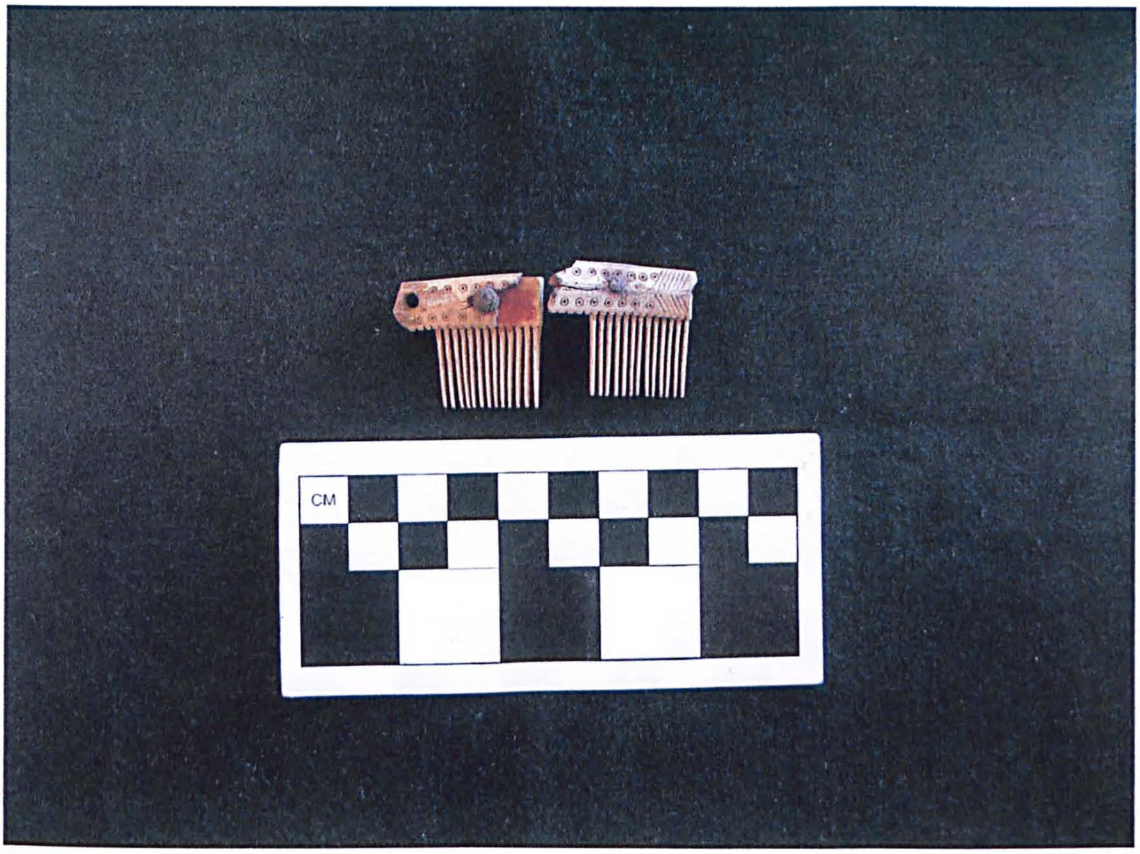
Type 4 (Coppergate and London, from McGregor 1985)

Type 5 (Birka)

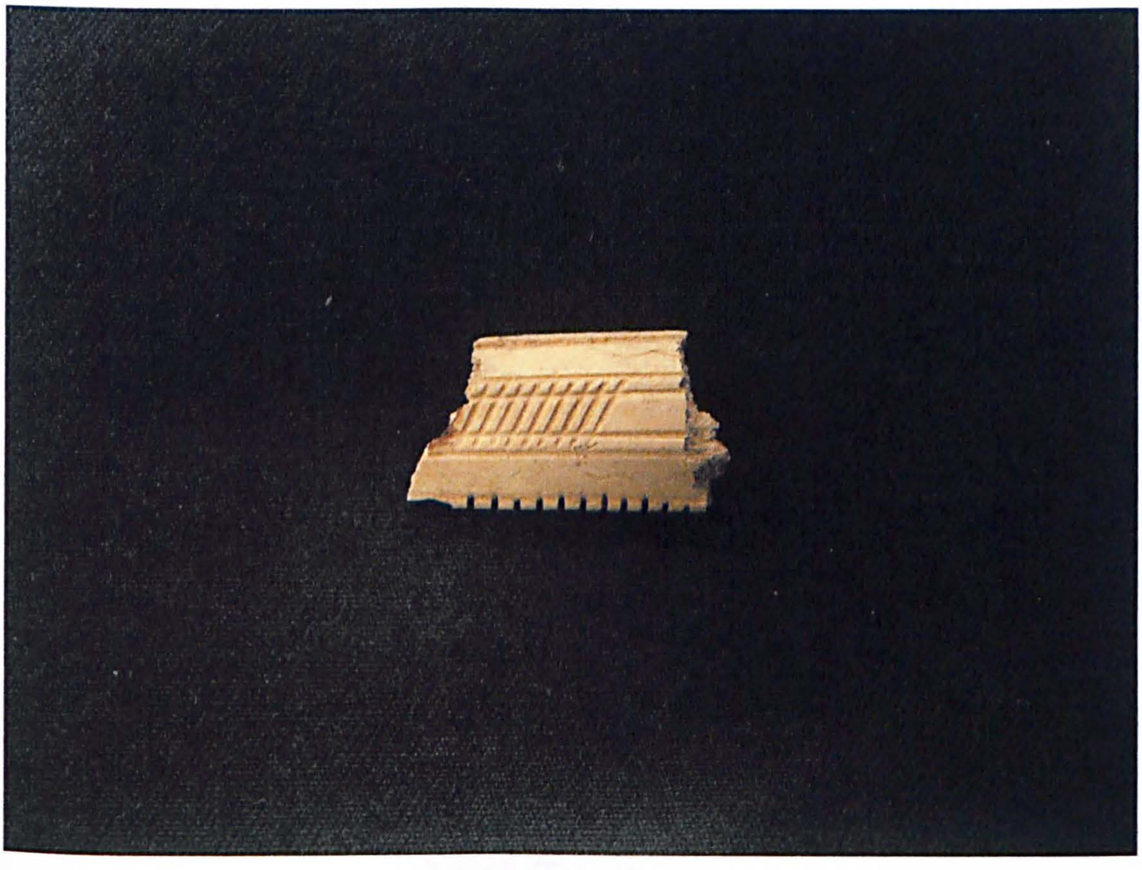
Type 6 (Birka)



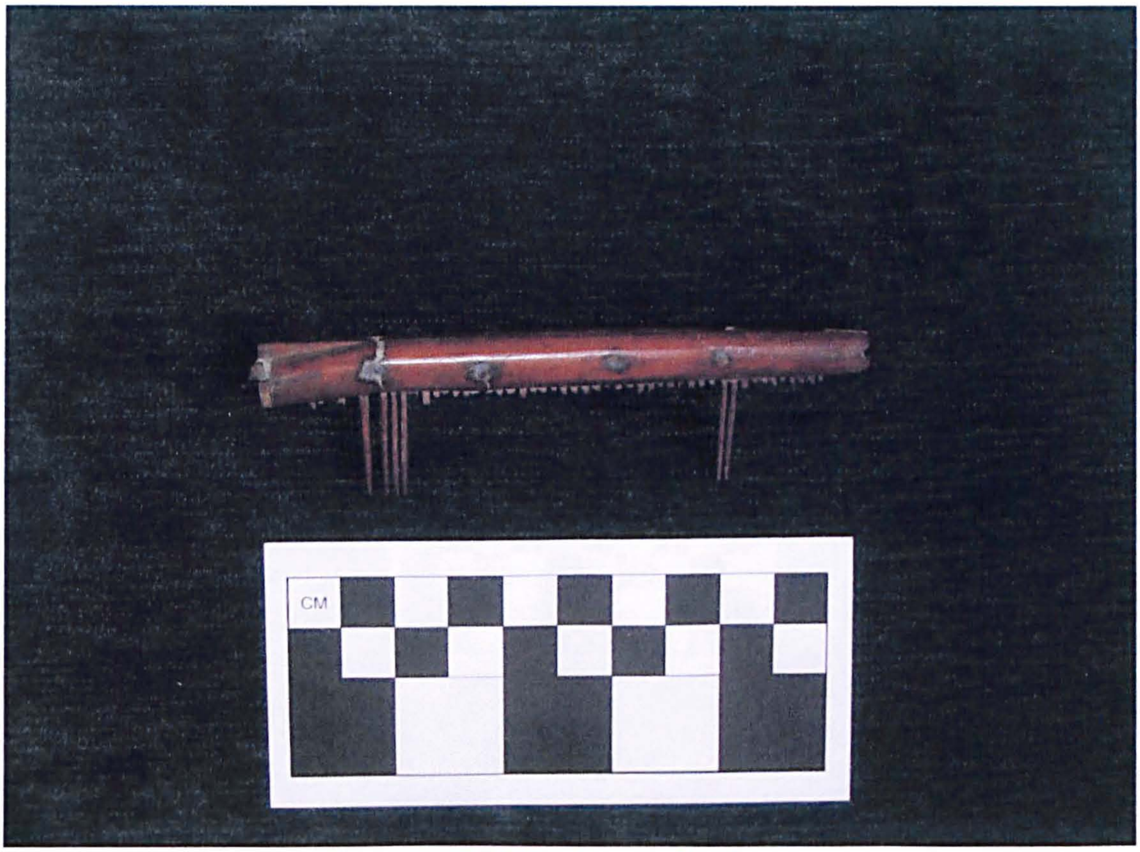
Type 7 (Coppergate)



Type 8a (Bornais)

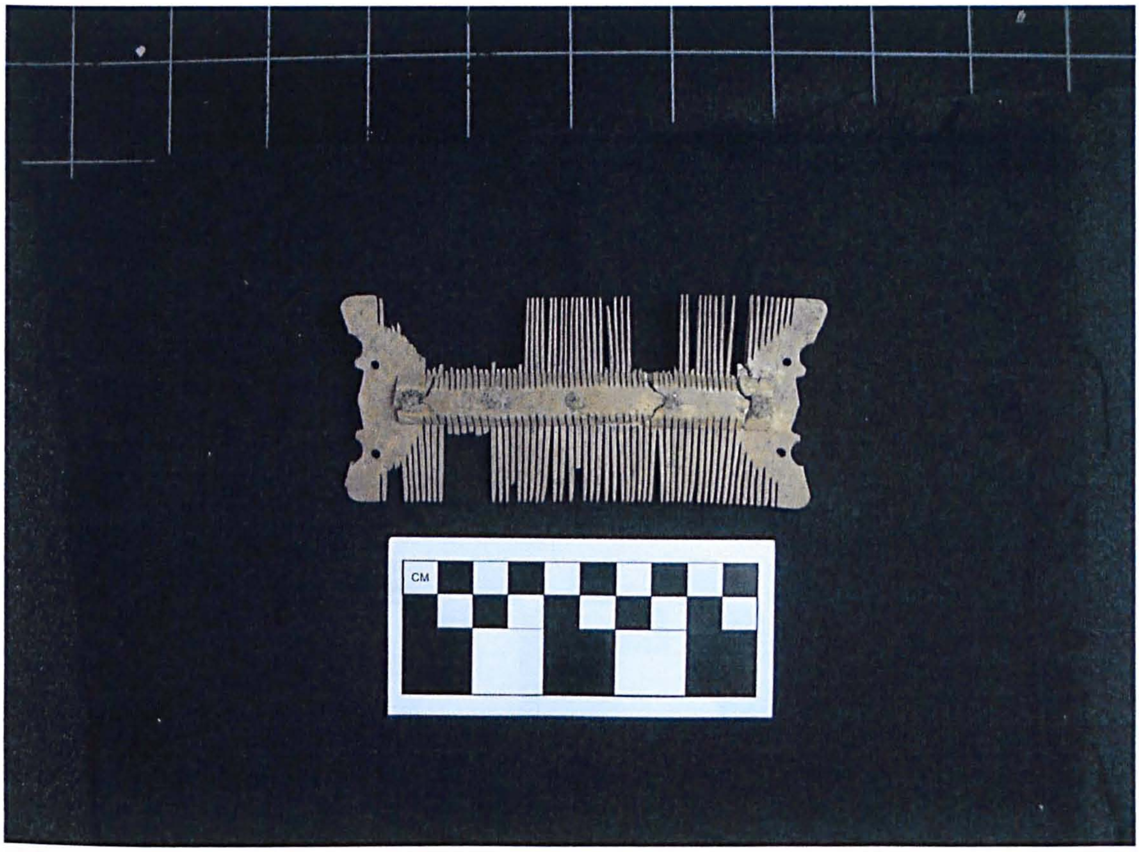


Type 8b (Bornais)

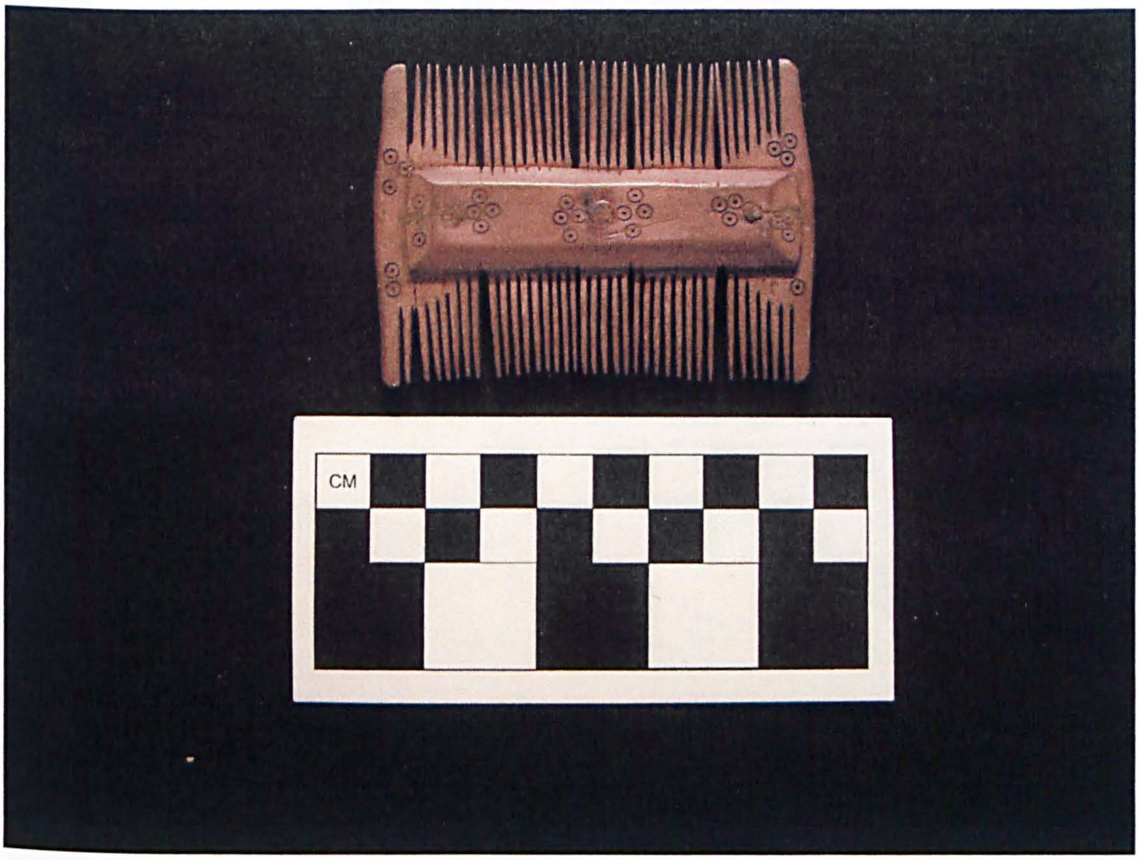


Type 8c (Saddler Street, Durham)

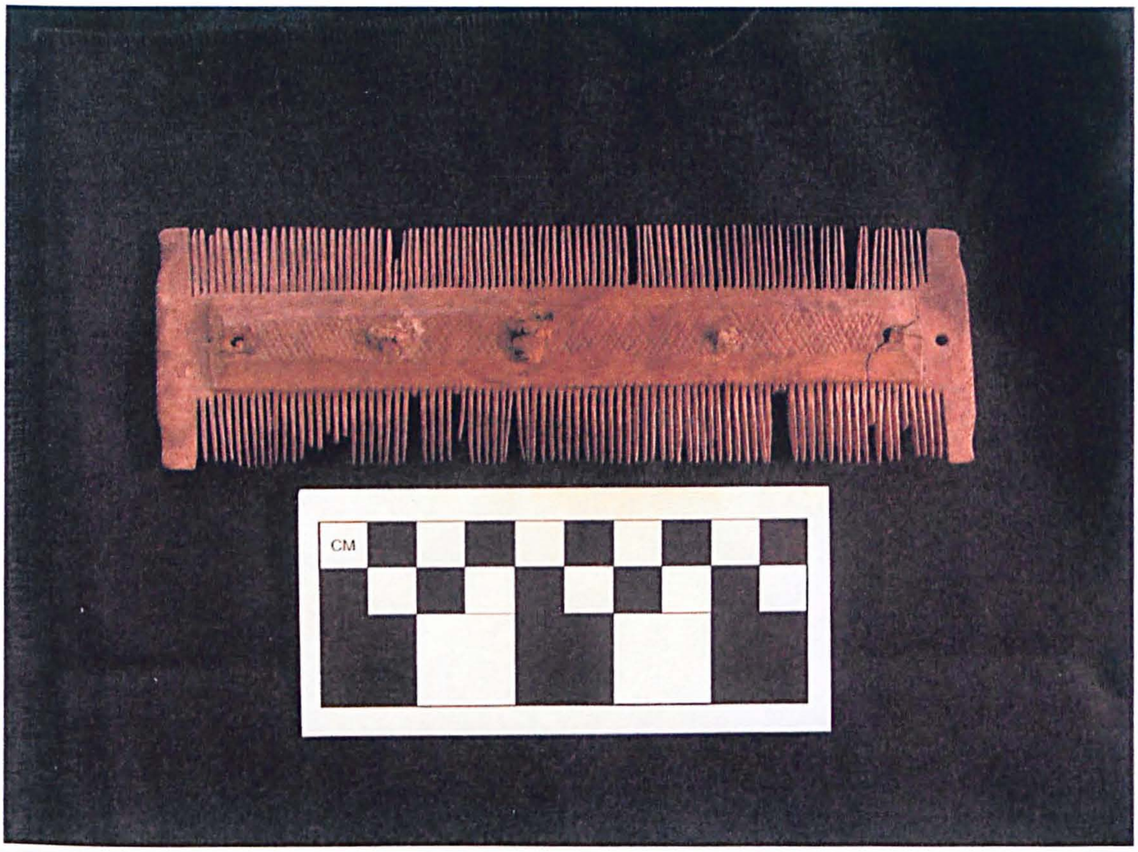
Type 9 (Trondheim)



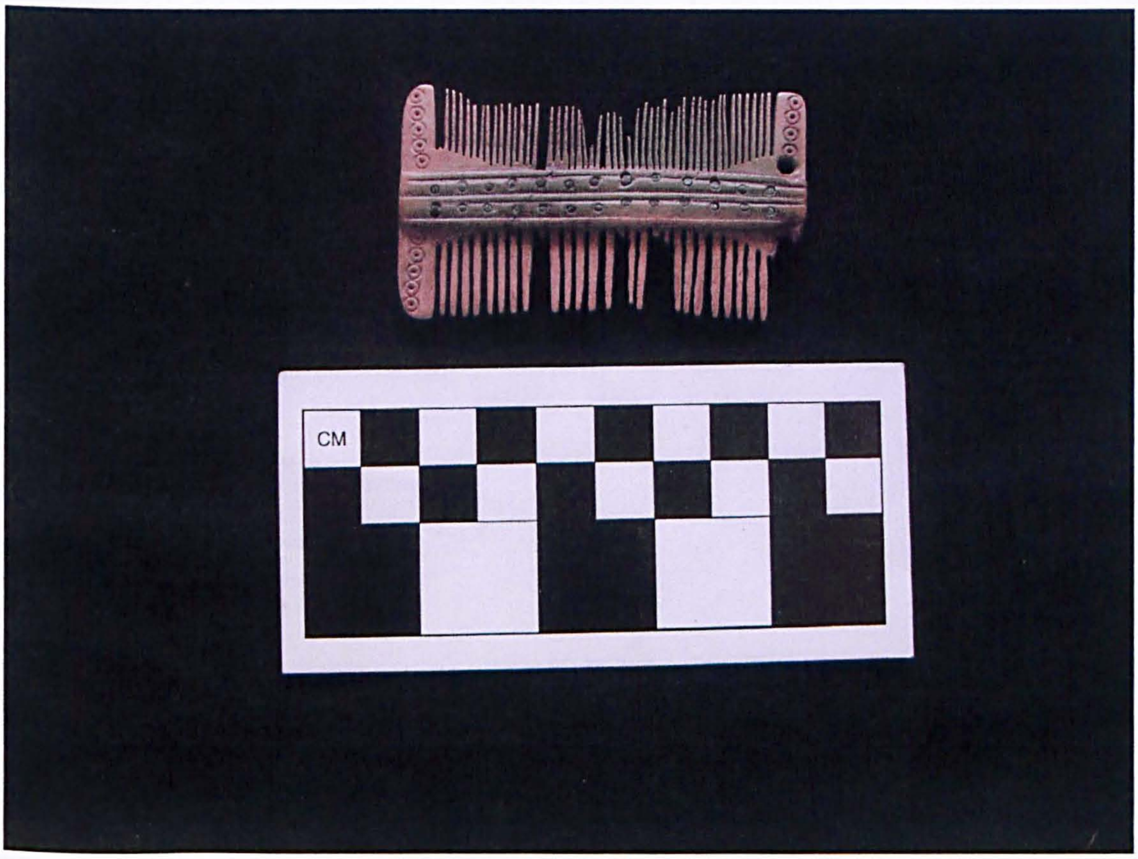
Type 10 (Wellington Row, York)



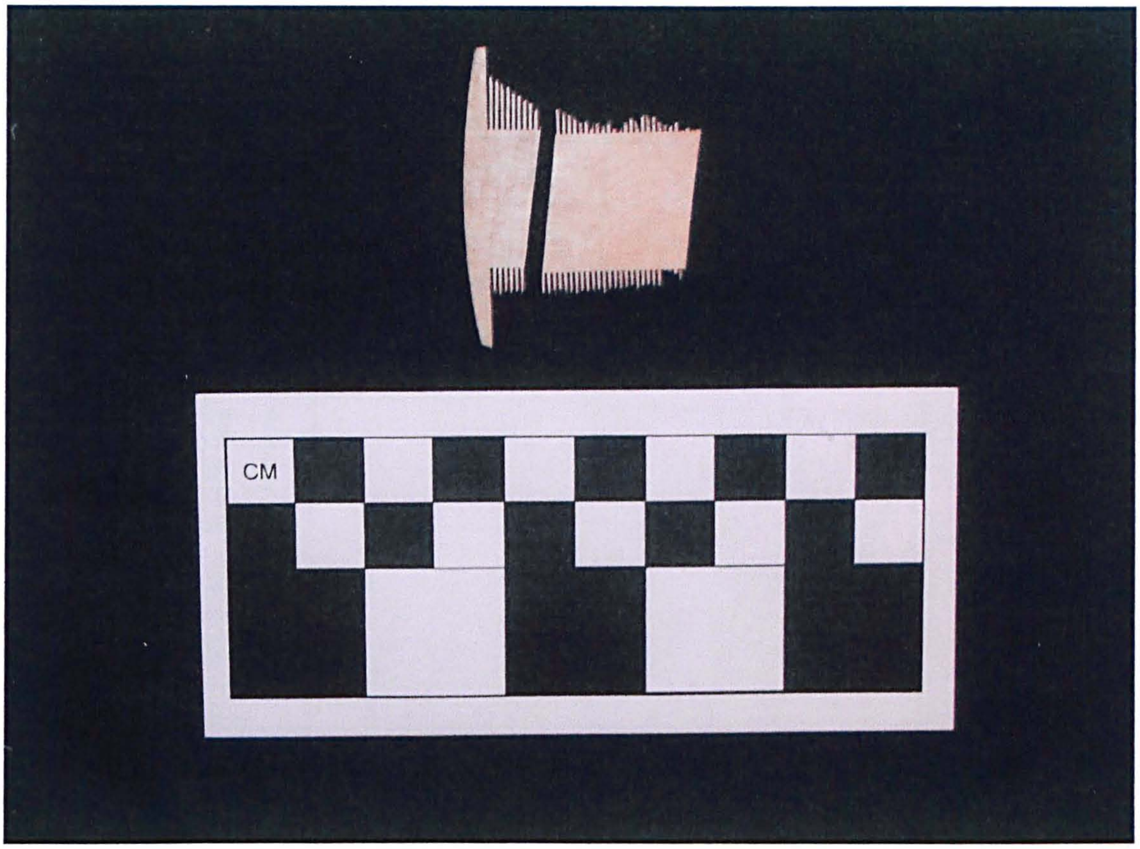
Type 11 (Buiston Crannog)



Type 12 (Castle Car Park, York)



Type 13 (Freswick Links, Caithness)



Type 14b (The Bedern, York)

Simple/ Comp	S-S / D-S	Other Structural Features	Common Ornament	Range	Commonly Supposed Origins	Dates
Simp	S	Heavy, round-backed	Ring-and-dot; piercing	NE Europe, Scandinavia	'Germanic'	1st –4th century
Simp	D	Frequently boxwood	-	Mediterranean; Northern Europe	Roman	'Roman'
Simp	D	Ivory /bone	Highly ornate	European	'Liturgical combs'	Early medieval-Romanesque
Comp	S	high, rounded backs, recalling the form of simple combs	Sparse; ring-and-dot	European		2nd - 6th centuries
Comp	S	Triangular, frequently with zoomorphic and other decorative projections from back	Ring-and-dot motifs, border lines, zig-zag and chevron ornament	European		Late 3rd - 8th century AD.
Comp	S	Rectangular back with central 'handle' projection	Simple	East of Rhine		4th - 8th century
Comp	S	Rectangular, sometimes with central handle. Barred (extra connecting plate on one side) Sweeping, zoomorphic terminals	Ring-and-dot motifs on connecting plate; bands of incised lines on paired bars.	Europe (esp. Netherlands and England)	'Frisian'	4th – 5th century
Comp	S	Double-barring on at least one side; Upper bar may be curved	Incised ornament in central area	Europe, but rare in Scandinavia	Frisian /Anglo-Saxon	5th-8th century
Comp	S	Asymmetrical; connecting plates are two halves of an antler tine. Last tooth plate is handle	Examples also known in bone, bronze and iron	European, common in Frisian area	'Frisian'	Not given

Table 2.1 (cont.) Some recognised comb types, based on MacGregor's (1985) classification.

Simple/ Comp	S-S / D-S	Other Structural Features	Common Ornament	Range	Commonly Supposed Origins	Dates
Comp	S	'Hog-backed'; concavo-convex profile; 'winged' endplates	Ring-and-dot; incisions	British Isles, Frisian area	England	7th - 8th centuries, Viking Age
Comp	S	High-backed, narrow endplates, zoomorphic backs	Ring-and-dot	Ireland, Scottish Isles	'Celtic'	5th - 8th centuries
Comp	S	Long, arched backs. Ambrosiani' A and 'B' combs. Flat (A) or Round (B) connecting plate cross sections	Incised lines; ring-and-dot; interlace; lozenges	Scandinavia, northern Europe, British Isles, European Russia	Broad	9th-11th century
Comp	S	As above, but connecting plates are faceted and trapezoidal in section. Some bone	Pairs of longitudinal incised lines and symmetrical patterning, or chequer design.	European	Broad.	8th century to 'Viking Age'
Comp	S	Rectangular cross section connecting plates, straight back. Much variation in form of end plates. Occasional bronze rivets. Commonly bone.	Longitudinal lines	Scandinavia, the British Isles and Germany.		10th-13th centuries
Comp	S	High, arched backs; deep, flat connecting plates with 'false ribs' (see glossary) at the bottom. Occasional close-set, bronze rivets	Open areas perforated (T-shapes)	Mainly Scandinavia, some in British Isles	'Scandinavian'	12th-13th century
Comp	S	Handled. Two long antler plaques as connecting plates, or a slot cut into an intact antler tine. Rare wooden versions are known	Incised lines; often only on one side	Mainly Frisian area and England	'Frisian'	Early medieval

Table 2.1 (cont.) Some recognised comb types, based on MacGregor's (1985) classification (continued overleaf).

Simple/ Comp	S-S / D-S	Other Structural Features	Common Ornament	Range	Commonly Supposed Origins	Dates
Comp	D	Short in relation to depth. Single or double pair of flat connecting plates with bevelled edges or grooved profiles. Differentiated teeth (see glossary)	Central area pierced, decorative ends, sometimes zoomorphic	European	'Roman'	Roman period
Comp	D	Elongated. Sometimes double connecting plates, together or apart	elaborate endplates; narrow range of decorative motifs (lines/ ring-and-dot); central area may be perforated	European		Post-Roman ('Dark Age')
Comp	Mix	'semi-double'. Single-sided, but with a small set of teeth above the comb back	Not given	Europe, Frisian area		Carolingian/ 8th century
Comp	D	Like Roman double-sided types, with deep, flat connecting plates. Sinuously profiled endplates. See Curle (1982) types	Perforations	Ireland, Atlantic Scotland, Wales	'Celtic'	3rd-9th century
Comp	D	Long, with plano-convex connecting plates	Not given	Scandinavia, British Isles	'Scandinavian'	Viking Age / more common Post-Viking Age
Comp	D	Variety of styles and arrangements of connecting plates, shorter than Viking Age types. Some have offset tooth rows. Decorative endplates	Various; perforations	European		Post-Viking Age

Table 2.1 (cont.) Some recognised comb types, based on MacGregor's (1985) classification.

Dunlevy Class	Morphology	Primary Date Range
A	Simple S-S, High Back	Roman –10^{th} C
B	Comp D-S, Flat, C-shaped, or trapezoidal section connecting plates	3^{rd}-10^{th} C
C	Comp S-S, High Back	4^{th}/5^{th} –7^{th} C
D	Comp D-S, wide teeth, straight ends, thick connecting plates. May be fixed with bone pegs	5^{th}-10^{th} C
E	Comp D-S, 2 pairs connecting plates. Heavily ornamented central panels and endplates	Before 9^{th}-10^{th} C
F	Comp S-S, arched backs.	9^{th}-12^{th} C
G	Comp S-S, long, straight back. Many rivets. (Ornate subclass)	9^{th}-13^{th} C (11^{th}-13thC)
H	Comp D-S, undecorated, concave ends.	12^{th} C
J	Simple D-S, undecorated, horn, bone, ivory and wood.	10^{th}/11^{th} -17^{th} C
K	Simple S-S, coarse, widely-spaced teeth	Postmedieval

Table 2.2: Dunlevy's (1988) Irish typology (subclasses and associated date ranges are appended in parentheses).

Classification	Sides	Form	Decoration
Pictish	Single	High-Backed	Variable
Pictish	Double (Type A)	Short. Thick, bevelled connecting plates. Graduated teeth	Highly decorated
Native	Double (Type B)	Long. Shallow, unbevelled connecting plates. Ungraduated teeth	Less ornate
Norse	Single	Long. Plano-convex connecting plates.	Ring-and-dot; borderlines; crosshatching; 'coiled rope'; interlace

Table 2.3: A summary of Curle's (1982) Brough of Birsay typology

Site	Dominant Material	Other Materials	Locally Available Antler Source	Data source
Bergen	Reindeer	Unknown	Reindeer (on Hardangervidda)	Ekmann 1973; Hansen 2005: 159 (identifications by A-K Hufthammer)
Birka	Elk	Red Deer, Reindeer	Elk	Ambrosiani 1981, personal investigation
Dorestad	Red Deer	Unknown	Red Deer	Clason 1980; Prummel 1980
Dublin	Red Deer	Unknown	Red Deer	O' Riordáin 1976: 137
Gotland	Red Deer	Elk	None	Lietha 1997; Carlsson 1999; Carlsson n.d.
Haithabu	Red Deer	Reindeer, Elk, Roe Deer, Bone	Red Deer, Elk	Reichstein 1969; Ulbricht 1978
Hamwic	Bone	Red Deer	Red Deer	Riddler 1992, 2001, Riddler and Trzaska-Nartowski 2003
Kungahälla	Reindeer	Elk, Red Deer, Bone.	Elk, some Red Deer	Vretemark 1991, 1997, 2001

Table 2.4 (cont.) Raw materials used at key European sites (based on waste deposits) (continued overleaf)

Site	Dominant Material	Other Materials	Locally Available Antler Source	Data source
London	Bone, Red Deer	Unknown	Red Deer	Riddler 1990, Blackmore 2003
Lund	Red Deer	Bone (Minor other Antler, Horn)	Red Deer	Christopherse n 1980a; Vretemark 1997.
Northampton	Red Deer	Unknown	Red Deer	Oakley and Harman 1979
Novgorod	Elk	Red Deer, Reindeer	Elk	Smirnova 2005
Oslo	Reindeer	None identified	Elk, Reindeer (on Hardangervidda)	Lie 1988; Wiberg 1979: 61
Ribe	Red Deer	Bone, Elk	Red Deer	Ambrosiani 1981; see also Bencard *et al.* 2004
Ryric Gorodische	Elk	Unknown	Elk	Smirnova 2005
Schleswig	Bone	Red Deer	Red Deer	Ulbricht 1980, 1984
Sigtuna	Elk	Unknown	Elk	Ros 1992
Skara	Elk	Minor Red Deer, Reindeer, Roe Deer	Elk, some Red Deer	Vretemark 1990; 1997
Staraja Ladoga	Elk	Unknown	Elk	Davidan 1977; Smirnova 2005
Thetford	Bone	Red Deer	Red Deer	Riddler 2004
Trondheim	Reindeer	Unknown	Elk, Reindeer (in Dovre)	Flodin 1989, personal investigation
Winchester	Bone	Red Deer	Red Deer	Biddle 1990, Galloway 1990a
York	Red Deer	Bone	Red Deer	Rogers 1993; Phillips *et al.* 1995; MacGregor and Mainman 1999

Table 2.4 (cont.) Raw materials used at key European sites (based on waste deposits)

Justification for Itinerancy Model	Evaluation
N-S Switch in Trade Dynamics thought unlikely	Undemonstrated; assumption
Homogeneity of European Corpus	Undemonstrated; not yet fully studied
Small Size of Waste Deposits	Undemonstrated; based on negative evidence

Table 2.5: Summary reassessment of Ambrosiani's model

Site	Riveting Materials	Riveting Methods	Data Source
Bergen	Copper Alloy	Central, Decorative	Hansen 2005
Birka	Iron, Copper Alloy	Every Edge, Alternating Edge	Ambrosiani 1981; personal survey
Gotland	Iron, Copper Alloy	Every Edge, Decorative	Carlsson 2002
Haithabu	Iron	Alternating Edge, Every Edge, Decorative	Tempel 1969; Ulbricht 1978
Hamwic	Iron	Alternating Edge	Addyman and Hill 1969: 75 and fig. 31
Novgorod	Iron, Copper Alloy	Central, Every Edge, Alternating Edge, Decorative	Smirnova 2005
Oslo	Copper Alloy	Every Edge, Central, Decorative	Wiberg 1977, 1979, 1987
Trondheim	Copper alloy	Every Edge, Central, Decorative	Flodin 1989a; unpublished data provided by P Galloway
York	Iron	Alternating Edge	MacGregor 1999

Table 2.6 Manufacturing methods at key European sites. See Glossary for explanation of riveting terms. Dublin, Waterford, and Lincoln are not yet published in sufficient detail to warrant inclusion herein.

Primary Identification	Second Level Identification
Indet Bone/Antler	
Bone	Rib/Metapodial/Scapula
Antler	Red Deer/ Reindeer/Elk
Ivory	Walrus/Elephant
Whale Bone	
Horn	

Table 4.1: Possible raw material identifications

Attribute	Possible Entries
Type	1-14 (see Chapter 6, **fig. 6.1**)
Conn Plate Cross Section	Plano-Convex/ Triangular/ Trapezoidal/ Flat/ Plano-Piriform/ Complex (**fig. 4.4**)
Conn Plate Profile	Rectangular/ Plano-Convex/ Bowed/ 'Cigar'/ Double/ 'False Ribbed' (**fig. 4.5**)
Endplate Profile	1A-F; 2A-F (see below, **figs 4.6** and **4.7**)
Overall Form	Long Straight/ Long Bowed/ Short Straight/ Short Bowed (**fig. 4.8**)
Decorative Motifs (all recorded)	Vertical Lines / Ring-and-dot/ Interlace / Saltire/ Cross/ Diamond/ Cross-Hatch/ Geometric/ Egg and Dart/ Openwork (**fig. 4.9**)
Decorative Arrangement of Motifs	Horizontal Line/ Vertical Line/ Oblique Line/ Interconnected String/ Triangle Design/ Cross Design / I Design/ T Design / Inverted T Design / Figure-8 Design/ Recumbent-S Design / Isolated or Clustered, (**fig. 4.10**)
Decorated Area	Covered/ Connecting Plate/ Endplate/ Billet Backs
Decorative Scheme	1A-R; 2A-H (see below, **figs 4.11** and **4.12**)

Table 4.2: Form and ornament attributes recorded (see Glossary for definitions)

Scheme	Description	Common on Types	Type Examples
1A	Central Field	5, 6, 7, 8	Jarlshof
1B	Horizontal Panels	6, 7, 8a, 8b	York, Bornais
1C	Term dec only	5, 6	York
1D	Central Motif	5, 6	Skaill Bay
1E	Multiple Motifs	11, 12, 2d, 5, 6	Buckquoy
1F	Blank Central Field, external dec	8a, 8b	-
1G	Multiple fields, covered	8a, 8b	York
1H	Single line of motifs	11, 12, 5, 8	York
1J	Alternating lines of motifs	5	Birka
1K	Parallel lines of motifs	11, 12, 5	-
1L	Infilled border	1	Baston
1M	Rivet and groove	9	Freswick Links
1N	Rivet only	9	Skaill, Deerness
1P	Highly Ornate, covered comb	2d	Dun Cuier
1Q	Handled, multiple fields	3	Waterstone's, York
1R	Blank	2a, 8c, 9	Saddler St, Durham
2A	Multiple Fields, covered	11, 12	Skaill, Deerness
2B	Multiple Fields, alternating	11, 12	Skaill, Deerness
2C	Covered	11	Buiston Crannog
2D	Multiple Lines of Motifs	11, 12, 13	North Uist
2E	Multiple Motifs	11, 12	Buckquoy
2F	Horizontal Panels	13	Brough of Birsay
2G	Rivet and Groove	13	Freswick Links
2H	Blank	12, 13, 14	Buckquoy

Table 4.3 Decorative schemes

Variable	Possible Entries
Billet Height	Metric/mm
Billet Width	Metric/mm
Billet Thickness	Metric/mm
Connecting Plate Height	Metric/mm
Connecting Plate Width	Metric/mm
Connecting Plate Thickness	Metric/mm
Tooth Density	n/10mm
Tooth Differentiation Ratio	td^{p} / td^{d}
Tooth Gradation	Yes/No
Tooth profile	Straight/ Tapering /
Tooth cross-section	Rectangular/ Round/Lenticular
Rivet Material	Iron/ Copper Alloy/ Bone/ Mixed
Riveting Style	Every/ Alternate/Central/ Mixed/ Decorative (single, vertical, multiple, offset, motifs)

Table 4.4: Variables used in the assessment of method of manufacture

Variable	Possible Entries
Form: Degree of Symmetry	1(Excellent) – 5 (Poor)
Form: Evenness of Tooth Separation	1(Excellent) – 5 (Poor)
Decoration: Degree of Symmetry	1(Excellent) – 5 (Poor)
Decoration: Clarity of Design (**fig. 4.17**)	1(Excellent) – 5 (Poor)
Riveting: Degree of Symmetry	1(Excellent) – 5 (Poor)
Riveting: Level of Disruption / Integration of Decorative Scheme (**fig. 4.18**)	1(Excellent) – 5 (Poor)

Table 4.5 Variables used to assess quality score

Wear Level	Criteria
0 (No Wear)	Unfinished, clearly never used. No evidence of repair.
1 (Slight Wear)	No visible sign of use, or striations just visible with hand lens. May show no surface damage. No evidence of repair.
2 (Minor Wear)	Beading only visible with hand lens. May show little surface damage. No evidence of repair.
3 (Average Wear)	Beading observable with naked eye. May display some surface damage. No evidence of repair.
4 (Severe Wear)	Severe beading, and related tooth loss. May display considerable surface damage and/or evidence of repair.
5 (Extreme Wear)	Extreme beading and extensive tooth loss. May display massive surface damage and/or evidence of repair.

Table 4.6 System for scoring use wear

Repair/Alteration	Recognition Criteria
Conversion of comb form	Evidence for removal of teeth/ mismatched comb elements
Fitting of new billets or rivets	Rivets of different materials/ rivets corrupting decorative layout/ billets of radically different dimensions
Fitting of new connecting plates	Mismatch of form or ornament on connecting plates, chamfered areas of billet exposed beneath connecting plates/ disturbance of endplate ornament
Adaptation of connecting plates following breakage	Chamfered terminals, asymmetry.

Table 4.7 Criteria used in the recognition of repair.

Single-Sided Simple Combs	Double-Sided Simple Combs	Single-Sided Composite Combs	Double-Sided Composite Combs
Excavation and Storage Details			
Comb ID Number	Comb ID Number	Comb ID Number	Comb ID Number
Curation Details	Curation Details	Curation Details	Curation Details
Archive Number	Archive Number	Archive Number	Archive Number
Site	Site	Site	Site
Excavators	Excavators	Excavators	Excavators
Excavation Date	Excavation Date	Excavation Date	Excavation Date
Context No.	Context No.	Context No.	Context No.
Context Details	Context Details	Context Details	Context Details
Date	Date	Date	Date
Dating Technique	Dating Technique	Dating Technique	Dating Technique
Associated Finds	Associated Finds	Associated Finds	Associated Finds
Details of Form and Preservation			
Fragment	Fragment	Fragment	Fragment
Preservation (*e.g.* burnt/fragmented)	Preservation	Preservation	Preservation
Basic Form	Basic Form	Basic Form	Basic Form
Top Width	Top Width	Top Width	Top Width
Base Width	Base Width	Base Width	Base Width
Max Height	Max Height	Max Height	Max Height
Min Height	Min Height	Min Height	Min Height
End profiles	End profiles	End profiles	End profiles
		Number of Connecting Plates	Number of Connecting Plates
-	-	Connecting Plate X-Sectional Profile	Connecting Plate X-Sectional Profile
-	-	Connecting Plate Shape	Connecting Plate Shape
Raw Material Use			
Raw material	Raw material	Raw material	Raw material
Means of Raw Material Identification	Means of Raw Material Identification	Means of Raw Material Identification	Means of Raw Material Identification

Table 4. 8 Summary of variables recorded in the survey (cont. overleaf).
See glossary for definition of terms used)

Ornament			
Decorative motifs	Decorative motifs	Decorative motifs	Decorative motifs
Arrangement of decorative motifs	Arrangement of decorative motifs	Arrangement of decorative motifs	Arrangement of decorative motifs
Decorative Scheme	Decorative Scheme	Decorative Scheme	Decorative Scheme
Method of Manufacture			
		Number of Billets	Number of Billets
		Height of Billets	Height of Billets
		Width of Billets	Width of Billets
		Thickness of Billets	Thickness of Billets
		Number of Rivets	Number of Rivets
		Rivet material	Rivet material
		Position of Rivets	Position of Rivets
Number of Complete Teeth	Number of Complete Teeth (on each side)	Number of Complete Teeth	Number of Complete Teeth (on each side)
Density of Teeth per 10mm	Density of Teeth per 10mm (on each side)	Density of Teeth per 10mm	Density of Teeth per 10mm (on each side)
	Tooth Density Ratio (*tdr*)	-	Tooth Density Ratio (*tdr*)
Quality of Manufacture			
Quality of manufacture score	Quality of manufacture score	Quality of manufacture score	Quality of manufacture score
Overall Symmetry	Overall Symmetry	Overall Symmetry	Overall Symmetry
Quality of Ornament	Quality of Ornament	Quality of Ornament	Quality of Ornament
		Rivet Interference	Rivet Interference
		Rivet Evenness	Rivet Evenness
Tooth evenness	Tooth evenness (top and bottom)	Tooth evenness	Tooth evenness (top and bottom)
Wear and Repair			
Degree of Tooth Beading and Wear	Degree of Tooth Beading and Wear	Degree of Tooth Beading and Wear	Degree of Tooth Beading and Wear
Repair	Repair	Repair	Repair
Breakage	Breakage	Breakage	Breakage

Table 4. 8 (cont.) Summary of variables recorded in the survey (See Glossary for definition of terms used)

Species	*Fragment*	Total Number Specimens	N/ % Correctly Identified	N/ % Unidentifiable	N/ % Incorrectly Identified
Cervus elaphus	Billet Blank	13	10 (77%)	3 (23%)	0%
Cervus elaphus	Conn Plate (compacta)	11	6 (55%)	2 (18%)	3 (27%)
Cervus elaphus	Conn Plate Blank	11	7 (64%)	1 (9%)	3 (27%)
Cervus elaphus	Section	6	6 (100%)	0%	0%
Cervus elaphus	Part-Worked Frag	3	3 (100%)	0%	0%
Cervus elaphus	Unworked Frag	4	4 (100%)	0%	0%
Rangifer tarandus	Billet Blank	5	4 (80%)	1 (20%)	0%
Rangifer tarandus	Conn Plate (compacta)	13	5 (38%)	4 (31%)	4 (31%)
Rangifer tarandus	Conn Plate Blank	13	9 (69%)	1 (8%)	3 (23%)
Rangifer tarandus	Section	10	9 (90%)	0%	1 (10%)
Rangifer tarandus	Part-Worked Frag	2	1 (50%)	1 (50%)	0%
Rangifer tarandus	Unworked Frag	2	2 (100%)	0%	0 (0%)
Alces alces	Billet Blank	10	1 (10%)	8 (80%)	1(10%)
Alces alces	Conn Plate (compacta)	7	2 (29%)	3 (42%)	2 (29%)
Alces alces	Conn Plate Blank	7	7 (100%)	0%	0%
Alces alces	Section	4	4 (100%)	0%	0%
Alces alces	Part-Worked Frag	2	2 (100%)	0%	0%
Alces alces	Unworked Frag	2	1 (50%)	1 (50%)	0%

Table 5.1 Summary data from preliminary blind test

Species	*Fragment*	Number Specimens in Test	Total Number Identifications	N (%) Correctly Identified	N/ % Unidentifiable	N/ % Incorrectly Identified
Cervus elaphus	Billet Blank	3	30	27 (90%)	1 (3.33%)	2 (6.67%)
Cervus elaphus	Conn Plate Blank	4	40	38 (95%)	0	2 (5%)
Cervus elaphus	Section	3	30	20 (66.67%)	1 (3.33%)	9 (30%)
Rangifer tarandus	Billet Blank	3	30	26 (86.67%)	0	4 (13.33%)
Rangifer tarandus	Conn Plate Blank	4	40	40 (100%)	0	0
Rangifer tarandus	Section	3	30	28 (93.33%)	0	2 (6.67%)
Alces alces	Billet Blank	3	30	28 (93.33%)	1 (3.33%)	1 (3.33%)
Alces alces	Conn Plate Blank	4	40	39(97.50%)	0	1 (2.50%)
Alces alces	Section	3	30	30 (100%)	0	0
Total		30	300	276 (92%)	3 (1%)	21 (7%)

Table 5.2: Results of blind test replications

Sample Group	Average Score (N=30)	Correctly Identified	Incorrectly Identified	Indeterminate
Experts (n=5)	27.40	137 (91.33%)	13 (8.67%)	
Non-Experts (n=5)	27.64	138 (92.13%)	11 (7.21%)	1 (0.66%)
All Volunteers (n=10)	27.64	276 (92%)	24 (8%)	

Table 5.3 Summary of results from blind test replications

Criterion	Red Deer	Reindeer	European Elk	Validity
Gross Morphology	Branched. No palmation.	Palmations. Brow shovels.	Heavily palmated. Massive.	Good.
Size (available compacta)	Small/medium.	Small/medium.	Large.	Supporting evidence only. Difficult to quantify.
Surface Texture	Narrow grooves.	Smooth.	Broad channels and ridges.	Good.
Compacta Structure	Amorphous.	Rough.	Ramified.	Poor.
Porous Core	Coarse. Round pores.	Fine-Medium. Round pores.	Fine. Elongate pores.	Good. Difficult to quantify.
Compacta – Core Margin	Discrete.	Gradational.	Discrete.	Good.

Table 5.4 Evaluation of various diagnostic criteria on the basis of blind tests.

Type	Description	Concordance
1a	Triangular/zoomorphic/round-backed single-sided composite combs with iron rivets.	
1b	Double-barred single-sided composite combs. Iron rivets.	Dunlevy Class E
1c	Curle high-backed single-sided composite combs. Iron rivets.	Curle's 'high-backed' combs; Foster type 4; Dunlevy Class C
2a	Single-sided composite combs with connecting plates that are flat in section. Iron rivets.	
2b	Hogbacked/winged single-sided composite combs. Iron rivets.	
3	Handled/asymmetric composite combs (usually single-sided). Iron rivets.	Tempel type 13; Dunlevy class F2 handled variant
4	Riveted mount (assumed double-sided composite). Iron rivets.	
5	Large single-sided composite combs with plano-convex profile, and shallow plano-convex section. Iron rivets.	Ambrosiani Type A; Tempel types 1,2,3; Dunlevy class F1; Luik single-sided group I: 1
6	Small single-sided composite combs with plano-convex profile, and deep plano-convex section. Iron or copper alloy rivets.	Ambrosiani Type B; Tempel types 4,6. Dunlevy class F2 (short); Luik single-sided group I: 2
7	Long (over 170mm) single-sided composite combs with deep plano-convex sections. May have connecting plates of concavo-convex profile. Iron rivets.	Dunlevy Class F2 (long)

Table 6.1: Typology to be used in this thesis (cont. overleaf).

Type	Description	Concordance
8a	Single-sided composite combs with connecting plates of triangular section. Iron rivets.	Dunlevy Class F3/Tempel Type 7
8b	Single-sided composite combs with connecting plates of trapezoidal section. Iron rivets.	Dunlevy Class F3/ Tempel Type 7
8c	Single-sided composite combs with straight connecting plates of plano-convex section, undecorated. Iron rivets.	Dunlevy Class G (*cf* Wiberg types E3 and E4; see below)
9	Single-sided composite combs with no or minimal incised decoration. Copper-alloy rivets, often applied decoratively, and in large numbers.	Wiberg Type E (see table 6.3 for subdivision)
10	Ornate double-sided composite combs with denticulated ends. Iron rivets.	Dunlevy Class B
11	Short, highly ornamented double-sided composite combs with graduated, undifferentiated teeth (see Glossary). Connecting plates frequently display bevelled edges. Iron rivets.	Curle type A; Foster type 5; Dunlevy Class B, D1, D2
12	Long double-sided composite combs with rudimentary ornament, and undifferentiated, usually ungraduated teeth. Iron rivets.	Curle type B; Foster type 6
13	Double-sided composite combs with minimal decoration and differentiated teeth, Copper alloy rivets, often applied decoratively, and in large numbers.	Flodin/Wiberg Type D; Dunlevy Classes D3, H; Luik Group III: 1-6; (see table 6.4 for subdivision)
14a	One piece, single or double-sided combs. Variable in size, shape and section (often trapezoidal in profile or diamond-shaped in section), but may be of considerable thickness. No rivets.	Luik Group II
14b	Small, one piece, single or double-sided combs, largely lacking ornament. Usually rectangular in profile, occasionally with simple convex or concave ends. No rivets.	Dunlevy Class J; Luik Group II
14c	Small, ornate one piece double-sided combs. May have 'sculpted' ornament, or elaborately profiled ends	

Table 6.1 (cont.) : Typology to be used in this thesis

Variable	Contribution to Axis 1	Contribution to Axis 4
Long Straight Profile	0.154	0.011
Copper Alloy Rivets	0.106	0.020
Decorative Scheme 1B	0.071	0.029
Bowed Connecting Plate Profile	0.062	0.001
Cross-Hatching	0.024	0.127
Saltires	0.004	0.123
Decorative Scheme 1C	0.043	0.076
Endplate Form 1D	0.042	0.065

Table 6. 2: Main contributions to correspondence analysis in Fig. 6.4

Wiberg Type	Description
E1	Long, ornate combs, including skeuomorphs of type 5, with 'central' riveting.
E2	Long, ornate combs, including skeuomorphs of type 5, with 'edge riveting'.
E3	Combs with straight or plano-convex backs and 'basic' riveting. Incorporates type 6, and direct equivalents of type 8c.
E4	Combs with straight or plano-convex backs, with close-set 'decorative' rivets.
E5	Combs with connecting plates of plano-piriform section, 'false ribs', and decorative copper alloy plating'.
E6	Combs with ornately profiled connecting plates.

Table 6.3 Type 9 internal classification (after Wiberg 1977)

Wiberg Type	Key Attributes
E5-1	Incised Line Ornament, Metal Plating
E5-2	Openwork T-motifs and metal inlay
E5-3	Ring-and-Dot
E5-4	Interlace ornament? Iron rivets. Rare.
E5-5	Little decoration

Table 6.4 Type 9 internal classification (Wiberg's type E5)

Type	Description	Phase	Date Range	Concordance with Luik (1998)
D1	Combs with biconvex endplates	7-9	Late 12th- early 14th century	Group III: 5
D2	Combs with straight endplates	6-9	Mid 12th- early 14th century	Group III: 1
D3	Combs with concave endplates	8-12	Mid 13th – post-16th century	Group III: 2
D4	Combs with convex endplates	8-9	Mid 13th- early 14th century	Group III: 4
D5	Combs with unmatching endplates	8-12, plus surface finds	Mid 13th – post-16th century	-
D6	Combs with complex or ornately profiled endplates	11, (insecure in 8-9)	Early 14th – late 15th century	-
D7	Combs with offset toothrows and endplates	7-9	Late 12th – early 14th century	-

Table 6.5 Type 13 internal Classification. Phasing and dating relates to the large corpus of secure combs from Trondheim (Flodin 1989; Christophersen and Nordeide 1994).

Variable	Contribution to Axis 1	Contribution to Axis 2
Decorative Scheme 2H	0.129	0.022
Copper Alloy Rivets	0.129	0.022
Plano-convex connecting plate section	0.056	0.006
Endplate Form 2D	0.056	0.004
Central Riveting	0.002	0.136
Decorative Scheme 2D	0.001	0.071
Endplate Form 2F	0.006	0.055
Reindeer	0.036	0.052

Table 6.6: Major contributions to correspondence analysis in fig. 6.9

Site	Date Range (contexts containing combs)	Types	Published Source
Bergen	Viking Age to Medieval	3, ?6, 9, 13, 14a, 14b	Grieg 1933; Hodges 1980; Hansen 2005; Unpublished data provided by P Galloway and G Hansen
Birka	Pre-Viking to Viking Age	3, 5, 6, 11	Arbman 1943; Ambrosiani 1981; personal survey
Dinas Powys	Pre-Viking Age	10	Alcock 1963
Dublin	Viking Age to Medieval	5,6,7, 8a, 8b, 8c, 14b	O' Riordáin 1976a; Dunlevy 1988; Coughlan 2000: 206; Hayden and Walsh 1997; O' Riordáin 1998
Irish spotfinds, crannogs and other sites	Pre-Viking Age to Medieval	1c, 1c, 11, 5, 6, 7, 8a, 8b, 8c, 13, ?12, 14b	Wilde 1861; Hencken 1936, 1942, 1950; Eogan 1974; Dunlevy 1988
Eketorp	Viking Age to Medieval	8a, 9, 13, 14a	Borg 1998
Estonia (inc. Tallinn, Varbola hillfort)	Viking Age to medieval	5, 6, 9, 13, 14a	Luik 1998a, 1999, 2001, 2005
Exeter	Medieval	8b, 14	Allan 1984
Frisian terpen	Pre-Viking Age to medieval	1a, 1b, 2b, 3, 5, 13	Roes 1963
Gotland (inc Paviken and Fröjel)	Viking Age to medieval	5, 6, 9, 13, 14a	Carlsson 1999; Carlsson 2002
Haithabu	Late 8th-late 11th century	3, 5, 6, 7, 8a, 8b, 14b	Tempel 1970; Ulbricht 1978
Hamwic	Pre-Viking Age	2b, 3, 12	Addyman and Hill 1969; Holdsworth 1976; Riddler and Andrews 1997; Riddler and Trzaska-Nartowski 2003
Helgö	Viking Age	5,6	Holmqvist 1961; Sander 1997
Kaupang	Pre-Viking to Viking Age; mid-8th- end 9th century	5, 6	Skre and Stylegar 2004

Table 6.7: Comb types recorded from excavations at key European sites (continued overleaf). Query-marked entries (*e.g.* '?6') relate to 'probable' identifications based on ambiguous published text or illustrations.

Site	Date Range (contexts containing combs)	Types	Published Source
Kungahälla	Viking Age to Medieval	9, 13	Rytter 1991
Lincoln	Viking Age to medieval	3,4,6,7,8a	Mann 1982
London	Viking Age to medieval	3, 4, 5, 7, 8a, 8b, 9, 12	Riddler 1990; Blackmore 2003; Smith 1909, unpublished data provided by Ian Riddler
Lund	Viking Age to Medieval	6, 9, 13, 14a	Persson 1976; see also Christophersen 1980a
Norwich	Medieval	4, 14b	Williams 1994; Margeson 2002
Northampton	Viking Age to Medieval	?6, 7, ?8b, 14b	Oakley and Harman 1979
Novgorod	Viking Age to Medieval	5, 6, 7, 8b, 9, 13, 14a	Smirnova 2005
Oslo	Viking Age to medieval	6, 9, 13, 14a	Schia 1979, 1987a; Wiberg 1987; Schia 1988
Poland (various sites)	Viking Age	6,7,8a,8b	Cnotliwy 1956; Kurnatowska 1977
Ribe	Pre-Viking Age to medieval	5, 13, 14.	Ambrosiani 1981
Ryric Gorodische	Viking Age to Medieval	5, 6, 13, 14a	Smirnova 2005
Schleswig	Viking Age To Medieval	9, 13, 14a, 14b	Ulbricht 1980, 1984a
Sigtuna	Viking Age to Medieval	?6, 9, 13, 14a, 14b, 14c	Personal survey; Ros 1990
Skara	Viking Age to Medieval	6, 9, 13, 14a	Vretemark 1990
Staraja Ladoga	Pre-Viking to Viking Age	5, 6, 14a	Hilczerowna 1966; Davidan 1977; Smirnova 2005
Thetford	Viking Age to Medieval	3/7, 4, 5, 14b	Rogerson and Dallas 1984; Dallas 1993; Riddler 2004
Trondheim	Viking Age to Medieval	6, 9,13, 14a and b	Long 1975; Flodin 1989; Personal survey; Unpublished data provided by P. Galloway
Trøndelag Graves and Spot Finds	Pre-Viking to Viking Age	5	Personal Survey
Waterford	Medieval	8c, 13	Hurley and Scully 1997
Winchester	Pre-Viking to Medieval	1b, 3, 4, 7, 8b, 12, 14b	Adams and Sheppard 1990; Biddle 1990a, b; Galloway 1990a, b;
York	Pre-Viking to Medieval	1b, 2a, 2b, 3,4, 6, 7, 8a, 8b, 8c, 9, 10, 12, 13, 14b,	Rogers 1993; MacGregor 1995; MacGregor 1999

Table 6.7 (cont.): Comb types recorded from excavations at key European sites. Query-marked entries (*e.g.* '?6') relate to 'probable' identifications based on ambiguous published text or illustrations.

Type 6	Type 9	Type 13	Type 14a	Type 14b	Other	Case	Unknown
9	86	13	4	2	2	10	5

Table 6.8: Type distribution in sample from Trondheim (based on archive, all large fragments or complete combs).

Type	Phase	Main Date Range
9 (round backed and false-ribbed/ Flodin E5)	2-9	Late tenth/ early eleventh century – early fourteenth century
9 (long bowed/ Flodin E1/2)	2-9	Late tenth/early eleventh century- early fourteenth centuries, less common after early-thirteenth century
9 (short straight/ Flodin E3)	3-8	Late tenth to mid thirteenth century
9 (straight, closely-set rivets /Flodin E4)	4-8	Mid-eleventh to mid-thirteenth century
9 (straight, ornately profiled connecting plates/ Flodin E6	6-12	Mid-twelfth century to end of sequence
13 (offset/ Flodin D7)	7, 9	Late twelfth to early fourteenth century, rare
13 (straight-ended/ Flodin D2)	6-9	Mid-twelfth-early fourteenth century
13 (biconvex-ended/ Flodin D1)	7-9	Late twelfth to early fourteenth century, rare.
13 (concave-ended/ Flodin D3)	8-12	Mid-thirteenth century to end of sequence, common from early fourteenth century
13 (convex-ended/ Flodin D4)	8-9	Mid-thirteenth to early fourteenth century, rare.

Table 6.9 Chronology of type 9 and 13 combs from Trondheim (combs whose ranges are designated 'to end of sequence' persist into poorly understood post-16th century phases.

Variable	Contribution to Axis 1	Contribution to Axis 2
Large Size (over 150mm)	0.129	0.000
Plano-Piriform Section	0.117	0.000
Copper-Alloy Plating	0.116	0.000
Vertical Line Ornament	0.107	0.000
Basic Riveting	0.105	0.001
Double-sided	0.038	0.184
Circumferential Riveting	0.026	0.156
High Arched Back	0.026	0.156
Straight-endplate (Form 2A)	0.023	0.150
Rivets designs (e.g. crosses)	0.017	0.101

Table 6. 10: Main contributing variables to correspondence analysis of type 9 and 13 combs from Trondheim (fig. 6.14)

Variable	Contribution to Axis 1	Contribution to Axis 2
Long Straight Profile	0.149	0.154
Basic Riveting	0.122	0.115
Multiple Riveting	0.122	0.002
Single Row Rivets	0.082	0.000
Susp Hole	0.072	0.003
Short Straight	0.085	0.392
Triangular Conn Sect	0.013	0.101
Obliques	0.022	0.092

Table 6.11: Main contributing variables to correspondence analysis of type 9 Combs from Trondheim (fig. 6.15)

Type	Type 2a	Type 2b	Type 3	Type 5	Type 6	Type 11
Frequency	4	2	3	80	110	1

Table 6.12 Type distribution at Birka, based on sample studied by the present author

Site Name	Region	Site Type	Date Range (contexts yielding combs)
Bardney Abbey	Lincolnshire	Monastic	Medieval
Castledyke South, Barton on Humber	Lincolnshire	Cemetery	Pre-Viking
Baston	Lincolnshire	Cemetery	Pre-Viking
Beverley (Eastgate)	Yorkshire	Ecclesiastical Establishment	Viking Age
Beverley (Lurk Lane)	Yorkshire	Ecclesiastical Establishment	Viking Age
Caistor	Lincolnshire	Unknown	Insecure Provenance
Cheesecake Hill, Driffield	Yorkshire	Burial	Pre-Viking
Cottam	Yorkshire	Small Settlement	Pre-Viking to Viking Age
Durham (Saddler Street)	Northumberland	Large Settlement	Medieval
Durham (Beaurepaire, Bear Park)	Northumberland	Large Settlement	Medieval
Elmswell	Yorkshire	Settlement	Pre-Viking
Garton (Green Lane Crossing)	Yorkshire	Cemetery	Pre-Viking
Hornsea	Yorkshire	Small settlement	Pre-Viking
Hedon	Yorkshire	Small settlement	Medieval
Hayton	Yorkshire	Small settlement	Pre-Viking
Kelleythorpe, Driffield	Yorkshire	Burial	Pre-Viking
Laceby	Lincolnshire	Cemetery	Pre-Viking
Lincoln (various sites)	Lincolnshire	Large Settlement	Pre-Viking - medieval
Nelson Road, Fiskerton	Lincolnshire	Small Settlement	Unknown
Paddock Hill, Thwing	Yorkshire	Small Settlement	Pre-Viking
Ruskington	Lincolnshire	Cemetery	Pre-Viking
York (various sites)	Yorkshire	Large Settlement	Pre-Viking - medieval
Wharram	Yorkshire	Small Settlement	Pre-Viking - medieval
West Heslerton	Yorkshire	Small Settlement	Pre-Viking

Table 7.1: Localities from which combs are known.

See **Appendix II** for a full list of sites.

Types	1a	1b	1c	2a	2b	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14a	14b	14c	O	I	Total
Frequency (Large Fragments & Complete Combs)	7	2		5	15	16	26	2	25	42	5	9	4	4	3		41		2	11	1	10	5	235
Frequency (Small & Tiny Fragments)	11	10		45	35	29	35	4	30	29	13	11	2	4	6		199	2		13		12	419	909
Total	**18**	**12**		**50**	**50**	**45**	**61**	**6**	**55**	**71**	**18**	**20**	**6**	**8**	**9**		**240**	**2**	**2**	**24**	**1**	**22**	**424**	**1144**

Non-Combs	Cases	Waste	**Total**
	23	40	**63**
8	5	241	**253**
8	26	281	**315**

Table 7.2: Total numbers of combs in northern England study area.

Key= O=Other, I=Indeterminate.

Note: 'Non-combs', 'Cases' and 'waste' not to be included in future analyses; shown here only for reference.

Variable	Contribution to Axis 1	Contribution to Axis 2
Ring-and-dot	0.102	0.021
Dec Scheme 1H	0.092	0.024
Endplate Form 1C	0.044	0.123
Zigzags	0.001	0.071

Table 7.3: Main contributions to correspondence analysis of type 6 combs (Fig. 7.7)

Variable	Contribution to Axis 2	Contribution to Axis 3
Endplate Form 1A	0.207	0.000
Dec Scheme 1E	0.112	0.070
Bowed connecting plates	0.082	0.130
Chequerboard motifs	0.005	0.114
Triangular Section	0.093	0.106
Chevron motifs	0.032	0.100

Table 7.4: Main contributions to correspondence analysis of type 8 combs (Fig. 7.8)

Variable	Contribution to Axis 1	Contribution to Axis 3
Convex End Profile	0.415	0.209
Concave End Profile	0.114	0.000
Straight End Profile	0.127	0.197
Elongate Shape	0.095	0.152
Thick Cross Section	0.020	0.314

Table 7.5: Main contributions to correspondence analysis of type 14b combs (Fig. 7.12)

	1a	1b	1c	2a	2b	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14 a	14 b	14 c	O	I	Total
Period 1 (Natural subsoil)																								
Period 2 (1^{st}-4^{th} Century)																							(2)	(2)
Period 3a (1^{st} part of 8^{th} Century)					(2)	(1)	(1)		(1)														(6)	(11)
Period 3b(Later 8^{th} Century)							(2)										(1)					(1)	(12)	(16)
Period 3c (1^{st} half of 9^{th} Century)				(1)	(1)	**1**																	(6)	**1** (8)
Period 3z (8^{th}-9^{th} Century)		(1)															(1)						(9)	(11)
Period 4a (Late 10^{th}/ 1^{st} half of 11^{th} Century)																	(1)							(1)
Period 4b (Mid – 11^{th} - ?mid – 12^{th} Century)				(1)																			(1)	(2)
Period 4c (Later 11^{th} or 12^{th} Century)																								
Period 4d (12^{th} Century)																							(2)	(2)
Period 4z (11^{th} – 12^{th} Century)		(2)		(2)	(1)	(1)											(1)						(14)	(21)

Table 7.6 Type distribution at 46-54 Fishergate, York (continued overleaf)

	1a	1b	1c	2a	2b	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14 a	14 b	14 c	O	I	Total
Period 5 (1142/3 – 1195)																								
Period 6a (1195 – late 13th Century)		(1)		(2)	(1)		(1)	(1)	(1)		(1)	(1)					(2)						(12)	(23)
Period 6b (Late 13th – early 14th Century)								**1***									(1)					(1*)	(3*)	**1** (5)
Period 6c (early – mid 14th Century) – **Period 10** (c.1900-1984) and unstrat																							(2)	(2)
Total		(4)		(6)	(5)	**1** (2)	(4)	**1** (1)	(2)		(1)	(1)					(7)					(2)	(69)	**2** (104)

Table 7.6 (cont.) Type distribution at 46-54 Fishergate, York (small and tiny fragments in parentheses).

*** = phase 6a-b, insecure**

Type	1a	1b	1c	2a	2b	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14b	O	I	Total
Frequency	**1** (4)				**5** (13)	(2)		**1**									**25** (86)				**3** (78)	**35** (183)

Table 7.7: Type distribution at West Heslerton (all identifiable fragments).

Phasing not available, but all are 'Pre-Viking'

	1a	1b	1c	2a	2b	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14b	Total
Pre-Viking (8th– 9th Century) Phases 0 to 5A					9	1											13			23
Viking Age and Medieval (10th –12th Century) (Phases 5B to 7)					2	3											17			22
Unstrat							1													1
Total					11		1										30			56

Table 7.8 Type distribution at Flixborough (all identifiable fragments).

Based on data provided by M. Foreman.

	1a	1b	1c	2a	2b	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14b	Other	Indet	Total
Period 1 (late 1st-late 4th Century or later)																						
Period 2 (5th –mid 9th Century				(1)																		(1)
Period 3 (Mid 9th - ate 9th/early 10th century)	**1**			(2)	**1**	**1** (2)	**1**										1 (2)				(7)	**5** (13)
Period 4A (late 9th/ early 10th Century – c. 930/5						(1)	(1)	(1)	**1** (1)	**1**		**1**									(6)	**3** (10)
Period 4B (c.930/5-c.975)	**1**			**1** (3)			**9** (4)		**9** (5)	**4** (5)		**1** (2)					(6)				(25)	**25** (50)
Period 5A (c.975)						(1)	**3** (1)		**1**	**1** (4)	(1)						(1)				(5)	**5** (13)
Period 5B (c.975-early/mid 11th Century)				(1)	(1)	(4)	**4** (3)		**4** (4)	**5** (5)	**1** (1)	(1)		(1)			**1** (1)				(15)	**15** (35)
Period 5Cf (Mid-later 11th Century)										**1**												**1**
Period 5Cr (Mid-later 11th Century)				(1)		**1**	**1** (1)		(1)	)	**1**	(1)									(6)	**3** (9)
Period 6 (Later 11th – 16th Century							**1** (3)		**2** (4)	**7**	(3)	**2** (1)		(1)			(2)	(1)		(6)	(24)	**12** (51)
Insecure/Unstrat /Modern					**1**				**2**	**3**										(1)	(5)	**6** (11)
	2			1 (8)	2 (1)	2 (8)	19 (13)	(1)	19 (17)	22 (24)	2 (5)	4 (3)		**(2)**			2 (12)	(1)		(7)	(93)	75 (195)

Table 7.9: Type distribution at 16-22 Coppergate, York (small and tiny fragments in parentheses).

	1a	1b	1c	2a	2b	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14a	14b	14c	O	I	Total
Late 9th Century									(2)															(2)
900-1060/70										(1)														(1)
930/40-970																							(2)	(2)
930/40-1000/10																							(1)	(1)
970-1060/70							(1)			(1)														(2)
1000/10-1060/70																								
1040-1060/70																							(1)	(1)
1060/70-1080/90																								
1080/90-1100																								
1140-1160										(1)														(1)
Unstrat											(1)													(1)
Total							(1)		(2)	(3)	(1)												(4)	(11)

Table 7.10 Type distribution at Flaxengate, Lincoln (small and tiny fragments in parentheses)

	1a	1b	1c	2a	2b	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14a	14b	14c	O	W	Indet	Total
Broadgate East																								(2)	(2)
Dane's Terrace						(1)														(1)			(1)	(4)	(7)
Flaxengate							(2)		(2)	(2)	(2)												(1)	(5)	(14)
Grantham Place							1 (1)																	(1)	1 (2)
Greyfriar's Library							(1)																		(1)
Holmes Grain Warehouse							1																		1
Hungate																	(1)								(1)
Saltergate/Silver Street		(1)					1 (1)							1						(1)			(5)	(1)	2 (9)
Michaelgate							1																		1
St Benedict's							(2)			1														(1)	1 (3)
St Mark's Church																								(1)	(1)
St Mark's East						(1)													1					(1)	1 (2)
St Mary's Guildhall							1																		1
Steep Hill							1				(1)											1		(1)	2 (2)
Swan Street																								(2)	(2)
West Parade																								(1)	(1)
Unknown Provenance									1	(1)		(1)								1				(1)	2 (3)
Total		(1)				(2)	6 (7)		1 (2)	1 (3)	(3)	(1)		1			(1)			2 (2)		1	(7)	(21)	12 (50)

Table 7.11 Type distribution at various sites in Lincoln (small and tiny fragments in parentheses)

Type	Ring & Dot	Vertical Line	Saltire/ Diamond/ Hatch	Interlace	Zoomorphism	Openwork	Horizontal Line	Marginal Line	Geo-metrics	Total
1a	**3** (2)	**3**	**1** (2)		**1**		**2** (1)	**5** (2)	**2** (1)	**17** (8)
1b	**1** (4)	**1**	**1** (1)		(1)			**1**	**1** (1)	**5** (7)
1c										
2a	(2)	**3** (20)	**3** (15)				(4)	**1** (2)	(5)	**7** (48)
2b	**7** (9)	**13** (22)	**4** (10)		**2** (1)		**2** (1)	(2)	**7** (4)	**35** (49)
3	**3** (3)	**16** (17)	**6** (2)				**2** (1)		**8** (9)	**35** (32)
4		(1)							(1)	(2)
5		**1** (2)		(2)			**1** (3)	(2)		**2** (9)
6	**1** (2)	**18** (16)	**7** (5)				**4** (2)	**2**	**13** (4)	**45** (29)
7	**1**	**34** (20)	**19** (14)	**1**			**3** (5)	**2**	**16** (8)	**76** (47)
8a	**3** (3)	**4** (6)	(1)			(1)	**3** (9)	**1** (1)	**2** (10)	**13** (31)
8b	**4** (2)	**5** (3)	**1** (3)				**1** (7)	(1)	**1** (5)	**12** (21)
8c							**1**			**1**
9	(1)	**3** (1)	**2**	**1**		**1** (1)	**1** (1)			**8** (4)
10	(3)	**1** (1)	(1)			**1**	**2** (2)	(1)		**4** (8)
11										
12	**13** (24)	**9** (23)					**8** (14)	**3**	**4** (4)	**37** (65)
13	(1)	(1)	**5** (13)			(1)	(2)			**5** (18)
14a										
14b										
14c							**1**			**1**
Other	**2** (8)	**2** (5)	**1** (1)				(2)	(2)	**2** (1)	**7** (19)
Indet	**3** (41)	**5** (72)	**1** (34)			(1)	(17)	(2)	(21)	**9** (188)
Total	**41** (105)	**114** (210)	**41** (102)	**2** (2)	**3** (2)	**2** (4)	**31** (71)	**15** (15)	**56** (74)	**305** (585)

Table 7.12: Distribution of decorative motifs by comb type (large fragments and complete combs Only). There may be multiple motifs on a single comb

Phase	Rin g &	Vertica l Line	Geom etric	Saltire/ Hatch/	Interla ce	Zoom orphis	Open-work	Horiz Line	Margin al Line	Total
Period 1 (Natural subsoil)										
Period 2 (1st-4th Century)										
Period 3a (1st part of 8th Century)		(3)	(2)	(1)						(6)
Period 3b(Later 8th Century)	(1)	(4)						(1)		(6)
Period 3c (1st half of 9th Century)	**1** (1)	**1** (3)	(1)	(1)						**2** (6)
Period 3z (8th-9th Century)	(2)	(3)		(4)						(9)
Period 4a (Late 10th/ 1st half of 11th Century)										
Period 4b (Mid – 11th - ?mid – 12th Century)			(1)							(1)
Period 4c (Later 11th or 12th Century)										
Period 4d (12th Century)		(1)								(1)
Period 4z (11th – 12th Century)	(3)	(12)	(5)	(4)						(24)

Table 7.13: Distribution of decorative motifs by phase at 46-54 Fishergate (small and tiny fragments in parentheses) (continued overleaf)

Phase	R & D	Vert Line	Geometric	Saltire/ Hatch/	Inter-lace	Zoo-morph	Open-work	Horiz Line	Margin Line	Total
Period 5 (1142/3 – 1195)										
Period 6a (1195 – late 13th Century)	(2)	**1** (8)*	**1** (3)	(4)					(5)	**2** (22)
Period 6b (Late 13th – early 14th Century)										
Period 6c (early – mid 14th Century) – **Period 10** (c.1900-1984)		(1)		**1**						**1** (1)
Total	**1** (9)	**2** (35)	**1** (12)	**1** (14)				(1)	(5)	**5** (76)

Table 7.13 (cont.): Distribution of decorative motifs by phase at 46-54 Fishergate (small and tiny fragments in parentheses)

* = 3 fragments attributed to phase 6a/6b

Phase	Ring & Dot	Vert Line	Geo-metric	Saltire/ Diamond/ Hatch	Inter-lace	Zoo-morphism	Open work	Horiz Line	Marginal Line	Total
3	**1** (1)	**3** (3)	**3**	**1** (2)					**1**	**9** (6)
4A		**1** (3)	**1** (2)	**2**	(1)			**1** (2)		**5** (8)
4B	**1** (1)	**11** (6)	**10** (4)	**2** (5)				**1** (3)	**1**	**26** (19)
5A		**2** (4)	**2** (3)	**1** (1)				(1)		**5** (9)
5B	**1** (5)	**9** (14)	**2** (6)	**5** (5)	**1**			(4)	**1**	**19** (34)
5Cf		**1**		**1**						**2**
5Cr	**1**	**2** (5)	**2** (3)	**1** (3)						**6** (11)
6	**4** (12)	**8** (7)	**5** (4)	**2** (3)				**2** (6)		**21** (32)
Unstrat		**5** (3)	**2** (1)	**5** (3)				(1)		**12** (8)
Total	**8** (19)	**42** (45)	**27** (23)	**20** (22)	**1** (1)			**4** (17)	**3**	**105** (127)

Table 7.14: Distribution of decorative motifs by phase at 16-24 Coppergate (small and tiny fragments in parentheses)

Type	Ring & Dot	Vertical Line	Geometric	Saltire/ Diamond/ Hatch	Interlace	Zoomorphism	Openwork	Horizontal Line	Marginal Line	Total
Frequency	46	46	9	15	1	1		30	2	150

Table 7.15: Distribution of decorative motifs by phase at West Heslerton (all fragments)

	Ring & Dot	Vertica l Line	Geom etric	Saltire / Diam/ X-Hatch	Inter-lace	Zoo-morph	Open-work	Horiz Line	Margin al Line	Total
Broadgate East										
Dane's Terrace										
Flaxengate (late 9th to mid-12th century)	(2)		(5)	(1)		(1)		(4)		(13)
Grantham Place										
Greyfriar's Library										
Holmes Grain Warehouse										
Hungate										
Saltergate/ Silver Street		1						1		2
St Benedict's		1	1							2
St Mark's Church										
St Mark's East										
St Mary's Guildhall										
Michaelgate										
Steep Hill			(2)					(2)		(4)
Swan Street										
West Parade										
No provenance		1	1	(2)				1 (1)		3 (3)
Total	(2)	3	2 (7)	(3)		(1)		2 (7)		7 (20)

Table 7.16: Distribution of decorative motifs in Lincoln (large fragments and complete combs only)

	Ring & Dot	Vertical Line	Geometric	Saltire/ Diamond	Interlace	Zoomorphism	Open-work	Horiz Line	Marginal Line	Total
Pre-Viking (8th– 9th Century) Phases 0 to 5A		2		1						3
Viking Age and Medieval (10th –12th Century) (Phases 5B to 7)	1	9	2	7						19
Unstrat		7	2	2	1			3		15
Total	1	18	4	10	1			3		37

Table 7.17: Distribution of decorative motifs by phase at Flixborough (all fragments)

Type	Figure 8	Parallel Lines	Single Line	Vertical Lines	Inter-connected	Line with tangent	Complex	Covered	Saltire terminals	Geometric	Covered	Isolated	Unknown	Total
1a			**1**				**1** (2)						**1**	**3** (2)
1b					(1)								**1** (3)	**1** (4)
1c														
2a		(1)											(1)	(2)
2b			(1)		**2** (2)			**1**		**1**			**3** (6)	**7** (9)
3			**2**			**1** (1)				(2)			(3)	**3** (6)
4														
5														
6			**1**										(1)	**1** (1)
7						**1**								**1**
8a		**1** (2)				(1)							**1**	**2** (3)
8b		(1)	**1** (1)			**1**				**1**			**1**	**4** (2)
8c														

Table 7.18: Distribution of ring-and-dot arrangements by type for northern England (small and tiny fragments in parentheses). See fig. 4.10 for definitions (continued overleaf).

Type	Figure 8	Parallel Lines	Single Line	Vertical Lines	Inter-connected	Line with tangent	Complex	Covered	Saltire terminals	Geometric	Covered	Isolated	Unknown	Total
9			(1)											(1)
10		(1)								(1)		(1)		(3)
11														
12		**3**(1)	**2**(4)				**1**						**7** (19)	**13** (24)
13			(1)											(1)
14a														
14b														
14c														
Other					(1)	**1**			**1** (1)		(2)			**2** (4)
Indet													**3** (41)	**3** (41)
Total		**4** (6)	**7** (8)		**2** (4)	**4** (2)	**2** (2)	**1**	**1** (1)	**2** (3)	(2)	(1)	**20** (74)	**41** (105)

Table 7.18 (cont.) : Distribution of ring-and-dot arrangements by type for northern England (small and tiny fragments in parentheses).

Phase	Figure 8	Parallel Lines	Single Line	Vertical Lines	Inter-connected	Wheel	Covered	Saltire terminals	Square & centre	Isolated/ clustered	Total
Period 1 (Natural subsoil)											
Period 2 (1st-4th Century)											
Period 3a (1st part of 8th Century)											
Period 3b(Later 8th Century)				(1)							(1)
Period 3c (1st half of 9th Century)			**1**	(1)							**1** (1)
Period 3z (8th-9th Century)			(1)							(1)	(2)

Table 7.19: Ring-and-dot arrangements at 46-54 Fishergate by phase (continued overleaf)

Phase	Figure 8	Parallel Lines	Single Line	Vertical Lines	Inter-connected	Wheel	Covered	Saltire terminals	Square & centre	Isolated/ clustered	Total
Period 4a (Late 10th/ 1st half of 11th Century)											
Period 4b (Mid – 11th - ?mid – 12th Century)											
Period 4c (Later 11th or 12th Century)											
Period 4d (12th Century)											
Period 4z (11th – 12th Century)					(2)						(2)
Period 5 (1142/3 – 1195)											
Period 6a (1195 – late 13th Century)										(1*)	(1)
Period 6b (Late 13th – early 14th Century)											
Period 6c (early – mid 14th Century) – **Period 10** (c.1900-1984)											
Total			**1** (1)	(2)	(2)					(2)	**1** (7)

Table 7.19 (cont.): Ring-and-dot arrangements at 46-54 Fishergate by phase. * 6a or 6b

Phase	Figure 8	Parallel Lines	Single Line	Vertical Lines	Inter-connected	Line with tangent	Complex	Covered	Saltire terminals	Geometric	Unknown	Total
1												
2												
3					(1)						**1**	**1** (1)
4A												
4B										**1**	(1)	**1** (1)
5A												
5B			1 (2)								(3)	**1** (5)
5Cf												
5Cr											**1**	**1**
6		1	(6)			2		(1)			**1** (5)	**4** (12)
Unstrat												
Total		1	1 (8)		(1)	2		(1)		**1**	**3** (9)	**8** (19)

Table 7.20: Ring-and-dot arrangements at 16-24 Coppergate by phase (small and tiny fragments in parentheses)

Type	1A	1B	1C	1D	1E	1F	1G	1H	1J	1K	1L	1M	1N	1P	1Q	1R	2A	2B	2C	2D	2E	2F	2G	2H	Unknown	Total
10																							1	2		3
11																										
12																	1	3	1	4	8	6		13	5	41
1a	1						1			1	4															7
1b							1																			2
1c																										
2a				1		2										2										5
2b	1		1			2	7	1						1		2									1	16
3	1														13										2	16
4																24									1	26
5	1																								1	2
6	12	6	1				4									1									1	25
7	31	2			4	2		1								2										42
8a	2	2																							1	6
8b		9																								9
8c		1														3										4
9	2												1			1										4
13																										
14a																								2		2
14b																								11		11
14c																										1
Other	2	1			1											4									2	9
Indet	2																							1	3	6
Total	55	21	2	1	5	6	13	2	0	1	4	0	1	1	13	39	1	3	1	4	8	6	1	29	17	235

Table 7.21: Distribution of decorative schemes by type in northern England sample (large and complete fragments only).

Phase	1A	1B	1C	1D	1E	1F	1G	1H	1J	1K	1L	1M	1N	1P	1Q	1R	2A	2B	2C	2D	2E	2F	2G	2H	Unknown	Total
1																										
2																										
3							1				1				1	1						1				5
4A	1	2																								3
4B	8	5				1	1									10										25
5A	2															2									1	5
5B	7	1					1									4					1				1	15
6	4	3			1											2									2	12
Unstrat	8				1											1										10
Total	30	11			2	2	3				1				1	20					1	1			4	75

Table 7.22: Distribution of decorative schemes by phase at 16-24 Coppergate (large and complete fragments only).

Type	Probably Red Deer	Probably Reindeer	Probably Elk	Total Antler (inc indet antler)	Bone	Other Material	Indeterminate Material	Total
1a	1			3 (1)	2 (4)		2 (6)	6 (11)
1b	1			1 (3)	1 (4)		(3)	2 (10)
1c								
2a	(7)			1 (13)	4 (31)		(1)	5 (45)
2b	5 (8)			9 (16)	(6)		6 (13)	15 (35)
3	6 (3)			7 (5)	6 (19)		3 (5)	16 (29)
4	1 (1)			1 (3)	25 (30)		(2)	26 (35)
5	(2)			2 (4)			1	2 (4)
6	15 (11)			25 (22)	(6)		(2)	25 (30)
7	22 (16)			37 (29)	1		4	42 (29)
8a	5 (6)			5 (11)	(2)			5 (13)
8b	3 (4)			6 (9)	(1)		(1)	9 (11)
8c	3			3 (1)			1 (1)	4 (2)
9	2			2 (4)			2	4 (4)
10	(2)			3 (4)	(2)			3 (6)
11								
12	3 (17)			4 (54)	5 (5)	1	31 (140)	41 (199)
13				(2)				(2)
14a						2		2
14b					7 (7)	2 (4)	2 (2)	11 (13)
14c						1		1
Other	2 (2)			3 (3)	3 (56)	3 (3)	(27)	9
Unknown	(69)			(209)	(70)		5 (140)	5 (419)
Total	69 (148)			112 (393)	54 (243)	9 (7)	58 (344)	235 (909)

Table 7.23: Distribution of raw materials by type in combs from northern England sample (small and tiny fragments in parentheses)

Phase	Probably Red Deer	Probably Reindeer	Probably Elk	Total Antler (inc indet antler)	Bone	Other Material	Indeterminate Material	Total
Period 1 (Natural subsoil)								
Period 2 (1^{st}-4^{th} Century)				(2)				(2)
Period 3a (1^{st} part of 8^{th} Century)	(3)			(6)	(1)		(2)	(9)
Period 3b(Later 8^{th} Century)	(8)			(5)	(7)			(12)
Period 3c (1^{st} half of 9^{th} Century)	(2)			(6)	**1**			**1** (6)
Period 3z (8^{th}-9^{th} Century)	(2)			(10)	(4)			(14)
Period 4a (Late 10^{th}/ 1^{st} half of 11^{th} Century)								
Period 4b (Mid – 11^{th} - ?mid – 12^{th} Century)	(1)			(3)				(3)
Period 4c (Later 11^{th} or 12^{th} Century)								
Period 4d (12^{th} Century)					(1)		(1)	(2)
Period 4z (11^{th} – 12^{th} Century)	(4)			(17)	(12)		(1)	(30)

Table 7.24 (cont.): Stratigraphic distribution of raw materials in combs from 46-54 Fishergate (small and tiny fragments in parentheses)
***= Phase6a//6b).**
(continued overleaf)

Phase	Probably Red Deer	Probably Reindeer	Probably Elk	Total Antler (inc indet antler)	Bone	Other Material	Indeterminate Material	Total
Period 5 (1142/3 – 1195)								
Period 6a (1195 – late 13th Century)	(6)			(14)	(6)		(2)	(22)
Period 6b (Late 13th – early 14th Century)				**1***	(1)			**1** (1)
Period 6c (early – mid 14th Century) – **Period 10** (c.1900-1984)								
Total	(26)			**1** (63)	**1** (32)		(6)	**2** (104)

Table 7.24: Stratigraphic distribution of raw materials in combs from 46-54 Fishergate (small and tiny fragments in parentheses)

***= Phase6a//6b**

Phase	Probably Red Deer	Probably Reindeer	Probably Elk	Total Antler (inc indet antler)	Bone	Other Material	Indeterminate Material	Total
3	**2** (5)			**4** (10)	**1** (3)			**5** (13)
4A	**3** (1)			**3**(8)	(1)		(1)	**3** (10)
4B	**7** (16)			**15** (41)	**10** (7)		(2)	**25** (50)
5A	**2** (5)			**2** (7)	**3** (1)			**5** (8)
5B	**6** (17)			**10** (23)	**4** (7)	**1**		**15** (30)
5Cf				**1**				**1**
5Cr	**1** (3)			**2** (9)	**1** (1)		(1)	**3** (11)
6	**6** (15)			**8** (37)	**2** (9)			**10** (46)
Unstrat	**5** (8)			**7** (11)				**8**(18)
Total	**30** (70)			**47** (146)	**21** (29)	**1**	(4)	**75** (195)

Table 7.25: Stratigraphic distribution of raw materials in combs from 16-24 Coppergate (small and tiny fragments in parentheses)

	Probably Red Deer	Probably Reindeer	Probably Elk	Total Antler (inc indet antler)	Bone	Other Material	Indeterminate Material	Total
Broadgate East	(1)			(1)	(1)			(2)
Dane's Terrace	(3)			(4)		(1)		(5)
Grantham Place					**1** (2)			**1** (2)
Flaxengate	(2)			(8)	(6)			(14)
Greyfriar's Library					(1)			(1)
Holmes Grain Warehouse					**1**			**1**
Hungate				(1)				(1)
Michaelgate					**1**			**1**
Saltergate/Silver Street				(1)	**1** (4)	(1)	**1**	**2** (6)
St Benedict's				(1)	(2)		**1**	**1** (3)
St Mark's Church					(1)			(1)
St Mark's East					**1** (1)	(1)		**1** (2)
St Mary's Guildhall					**1**			**1**
Steep Hill					**1** (2)	**1**		**2** (2)
Swan Street				(1)			(1)	(2)
West Parade	(1)			(1)				(1)
Unknown Provenance	**1**			**1**			**1**	**2**
Total	**1** (7)			**1** (18)	**7** (18)	**1** (3)	**3** (1)	**12** (36)

Table 7.26: Raw materials in combs from sites in Lincoln (Small and Tiny Fragments in Parentheses)

Site	Red Deer	Reindeer	Elk	All Antler	Bone	Other	Indet Material	Total
46-54 Fishergate, Fishergate House and Blue Bridge Lane	31			56	66	1	5	128
16-24 Coppergate	54			75	8		10	93
Clifford Street	17			18	1			19
Other York	9			17	2			19
Total	111			166	77	1	15	259

Table 7.27: Raw material use in waste samples from a number of pre-viking and Viking Age sites in York

Type	Iron	Copper Alloy	Unknown N/A	Total
Type 1a	**7** (9)		(2)	**7** (11)
Type 1b	**1** (2)		(7)	**1** (9)
Type 1c				
Type 2a	**5**(17)		(28)	**5** (45)
Type 2b	**15** (14)		(21)	**15** (35)
Type 3	**15** (16)		(13)	**16** (29)
Type 4	**17** (10)		**7** (26)	**24** (36)
Type 5	**2** (2)		(2)	**2** (4)
Type 6	**24** (18)	(1)*	**1** (12)	**25** (30)
Type 7	**42** (22)		(7)	**42** (29)
Type 8a	**5** (8)		(5)	**5** (13)
Type 8b	**9** (8)		(3)	**9** (11)
Type 8c	**3** (2)	**1**		**4** (2)
Type 9	**3** (2)	**1** (2)		**4** (4)
Type 10	**3** (5)		(1)	**3** (6)
Type 11				
Type 12	**10** (41)		**31** (158)	**41** (199)
Type 13		(1*)	(1)	(2)
Type 14a				
Type 14b				
Type 14c				
Other	**4** (5)		**5** (7)	**10** (12)
Unknown	(90)		**5** (329)	**5** (419)
Total	**165** (261)	**2** (4)	**49**(622)	**235** (909)

Table 7.28: Variation in rivet materials according to type in combs from northern England sample (small and tiny fragments in parentheses).

*XRF analysis shows rivets to be composed of iron, and plated with copper alloy

Phase	**Iron**	**Copper Alloy**	*Unknown N/A*	*Total*
Period 1 (Natural subsoil)				
Period 2 (1^{st}-4^{th} Century)			(2)	(2)
Period 3a (1^{st} part of 8^{th} Century)	(3)		(6)	(9)
Period 3b(Later 8^{th} Century)	(3)		(17)	
Period 3c (1^{st} half of 9^{th} Century)	**1** (1)		(8)	**1** (9)
Period 3z (8^{th}-9^{th} Century)	(2)		(11)	(13)
Period 4a (Late 10^{th}/ 1^{st} half of 11^{th} Century)				
Period 4b (Mid – 11^{th} - ?mid – 12^{th} Century)	(1)		(2)	(3)
Period 4c (Later 11^{th} or 12^{th} Century)				
Period 4d (12^{th} Century)			(2)	(2)
Period 4z (11^{th} – 12^{th} Century)	(3)		(27)	(30)
Period 5 (1142/3 – 1195)				
Period 6a (1195 – late 13^{th} Century)	**1*** (2)		(21)	**1** (23)
Period 6b (Late 13^{th} – early 14^{th} Century)			(1)	(1)
Period 6c (early – mid 14^{th} Century) – **Period 10** (c.1900-1984)	(1)			(1)
Total				**2** (104)

Table 7.29: Rivet materials by phase at 46-54 Fishergate (small and tiny fragments in parentheses)

Phase	Iron	Copper Alloy	Unknown N/A	Total
3	**5** (3)		(10)	**5** (13)
4A	**3** (2)		(8)	**3** (10)
4B	**22** (16)		**3** (34)	**25** (50)
5A	**5** (7)		(6)	**5** (13)
5B	**14** (17)		**1** (18)	**15** (35)
5Cf	(1)			(1)
5Cr	**3** (5)		(4)	**3** (9)
6	**9** (8)	(1*)	**1** (42)	**12** (51)
Modern/ Unstrat	**6** (6)		(7)	**6** (13)
Total	**67** (65)	(1)	**5** (129)	**75** (195)

Table 7.30: Rivet materials by phase at 16-24 Coppergate (Small and tiny fragments in parentheses).

* XRF analysis shows rivets to be composed of iron, and plated with copper alloy (Sonia O'Connor *per comm.*)

Phase	Iron	Copper Alloy	*Unknown/N/A*	*Total*
Broadgate East			(2)	(2)
Dane's Terrace	(4)		(1)	(5)
Flaxengate	(12)		(2)	(14)
Grantham Place	**1**		(2)	**1** (2)
Greyfriar's Library			(1)	(1)
Holmes Grain Warehouse	**1**			**1**
Hungate			(1)	(1)
Michaelgate			**1**	**1**
Saltergate/Silver Street	(1)	**1**	**1** (3)	**2** (4)
St Benedict's	**1**		(3)	**1** (3)
St Mark's Church			(1)	(1)
St Mark's East	(1)		**1**	**1** (1)
St Mary's Guildhall			**1**	**1**
Steep Hill	(1)		(1)	(2)
Swan Street	(2)		**2**	**2** (2)
West Parade			(1)	(1)
No Provenance	**1** (1)		**1** (2)	**2** (3)
Total	**4** (22)	**1**	**7** (20)	**12** (42)

Table 7.31: Rivet materials in Lincoln (small and tiny fragments in parentheses)

Type	Alternating	Central	Decorative	Every Edge	Other	Mixed	Unknown/ N/A	Total
1a	2		1	1	1	1	1	7
1b			1			1		2
1c								
2a	2			1		1	1	5
2b	6			1			8	15
3	7			2		1	6	16
4					22		4	26
5				1			1	2
6	10	3	1	5		3	3	25
7	37			3		2		42
8a	3			1			1	5
8b	4					2	3	9
8c	2			1		1		4
9	2		1	1				4
10						1	2	3
11								
12	5			4		3	29	41
13								
14a							2	2
14b							11	11
14c							1	1
Other				2		1	7	10
Indet							5	5
Total	80	3	4	23	23	17	85	235

Table 7.32: Riveting Techniques in Combs from England (large fragments and complete combs only)

Phase	Alternating	Central	Decorative	Every Edge	Other	Mixed	Unknown/ N/A	Total
Period 1 (Natural subsoil)								
Period 2 (1st-4th Century)								
Period 3a (1st part of 8th Century)								
Period 3b(Later 8th Century)	1							1
Period 3c (1st half of 9th Century)								
Period 3z (8th-9th Century)								
Period 4a (Late 10th/ 1st half of 11th Century)								
Period 4b (Mid – 11th - ?mid – 12th Century)								
Period 4c (Later 11th or 12th Century)								
Period 4d (12th Century)								
Period 4z (11th – 12th Century)								
Period 5 (1142/3 – 1195)								
Period 6a (1195 – late 13th Century)								
Period 6b (Late 13th – early 14th Century)				1*				1
Period 6c (early – mid 14th Century) – **Period 10** (c.1900-1984)								
Total	1			1				2

Table 7.33: Riveting techniques by phase at Fishergate (large fragments and complete combs only)

*6a/b insecure

Phase	Alternating	Central	Decorative	Every Edge	Other	Mixed	Unknown/ N/A	Total
3	2			1	1		1	5
4A	2					1		3
4B	6	2		2	7	4	4	25
5A	2				2		1	5
5B	9	1			3	1	1	15
5Cf				1				1
5Cr	1			1	1			3
6	6			2	1		3	12
Unstrat	4			2				6
Total	33	3	0	9	15	6	8	75

Table 7.34: Riveting techniques by phase at Coppergate (Large Fragments and Complete Combs Only)

Phase	Alternating	Central	Decorative	Every Edge	Other	Mixed	Unknown/ N/A	Total
Broadgate East								
Dane's Terrace								
Flaxengate								
Grantham Place					1			1
Greyfriar's Library								
Holmes Grain Warehouse					1			1
Hungate								
Michaelgate					1			1
Saltergate/Silver Street				1	1			2
St Benedict's	1							1
St Mark's Church								
St Mark's East							1	1
St Mary's Guildhall					1			1
Steep Hill					1		1	2
Swan Street								
West Parade								
Unknown Provenance				1			1	2
Total	1			2	6		3	12

Table 7.35:Riveting techniques by site at Lincoln (large fragments and complete combs only)

Type	Q1	Q2	Q3	Q4	Q5	Q unknown	Total
Type 10		**3** (5)	(1)				**3** (6)
Type 11							
Type 12		**6** (9)	**5** (32)	(3)		**30** (155)	**41** (199)
Type 1a		**5** (2)	**1**			**1** (9)	**7** (11)
Type 1b		**2** (7)	(2)	(1)			**2** (10)
Type 2a		**1** (5)	**2** (37)	**2** (4)		(3)	**5** (49)
Type 2b	1	**5** (8)	**2** (10)	(4)		**7** (13)	**15** (35)
Type 3		**4** (3)	**8** (14)	**1** (2)		**3** (10)	**16** (29)
Type 4			**20** (27)			**6** (8)	**26** (35)
Type 5		(2)		**1** (1)		**1** (1)	**2** (4)
Type 6		**4** (7)	**14** (16)	**4**		**3** (7)	**25** (30)
Type 7		**8** (5)	**27** (20)	**1** (3)		**6** (1)	**42** (29)
Type 8a		**3** (5)	**1** (8)	**1**			**5** (13)
Type 8b		**4** (2)	**5** (5)			(4)	**9** (11)
Type 8c		**1**	**3** (2)				**4** (2)
Type 9		**2** (4)	**1**	**1**			**4** (4)
Type 13		(2)					(2)
Type 14a		**2**					**2**
Type 14b		**10** (9)	**1** (1)			(3)	**11** (13)
Type 14c		**1**					**1**
Other		**3** (3)	**6** (3)			(1)	**9** (7)
Unknown		(49)	(120)	(8)		**6** (243)	**6** (420)
Total	1	**64** (128)	**56** (279)	**11** (23)		**63** (429)	**235** (909)

Table 7.36: Quality of manufacture in combs of various types in northern England sample (small and tiny fragments in parentheses)

Phase	Q1	Q2	Q3	Q4	Q5	Q unknown	Total
Period 1 (Natural subsoil)							
Period 2 (1st-4th Century)			(1)			(1)	(2)
Period 3a (1st part of 8th Century)		(2)	(5)			(2)	(9)
Period 3b(Later 8th Century)			(12)			(8)	(20)
Period 3c (1st half of 9th Century)		**1**	(3)	(1)		(6)	**1** (10)
Period 3z (8th-9th Century)		(3)	(5)	(1)		(5)	(14)
Period 4a (Late 10th/ 1st half of 11th Century)							
Period 4b (Mid – 11th - ?mid – 12th Century)		(1)	(2)				(3)
Period 4c (Later 11th or 12th Century)							
Period 4d (12th Century)			(1)			(1)	(2)
Period 4z (11th – 12th Century)		(4)	(19)	(1)		(6)	(30)

Table 7.37: Quality by phase at 46-54 Fishergate (small and tiny fragments in parentheses)
Continued Overleaf

Phase	Q1	Q2	Q3	Q4	Q5	Q unknown	Total
Period 5 (1142/3 – 1195)							
Period 6a (1195 – late 13th Century)		(2)	(14)	(3)		(4)	(23)
Period 6b (Late 13th – early 14th Century)				**1***		(1,1*)	**1** (2)
Period 6c (early – mid 14th Century) – **Period 10** (c.1900-1984) and unstrat		(2)	(7)				(9)
Total		**1** (14)	(69)	**1** (6)		(35)	**2** (104)

Table 7.37 (cont.): Quality by phase at 46-54 Fishergate (Small and Tiny Fragments in Parentheses)

***6a/b insecure**

Phase	Q1	Q2	Q3	Q4	Q5	Q unknown	Total
3		**3** (4)	**2** (7)			(2)	**5** (13)
4A		**3** (1)	(7)			(2)	**3** (10)
4B		**5** (8)	**15** (23)	**2**		**3** (19)	**25** (50)
5A		(1)	**1** (8)			**4** (4)	**5** (13)
5B		(10)	**10** (17)	**1** (2)		**5** (9)	**16** (38)
5Cf						**1**	**1**
5Cr		**1** (2)	**2** (4)	(1)		(4)	**3** (12)
6		**2** (13)	**6** (16)	(1)		**2** (12)	**8** (42)
Unstrat		**1**	**5** (6)	(1)		**1**(5)	**7** (12)
Total		**15** (42)	**41** (88)	**3** (4)		**16** (63)	**75** (205)

Table 7.38: Quality by phase at 16-24 Coppergate (small and tiny fragments in parentheses)

Phase	Q1	Q2	Q3	Q4	Q5	Q unknown	Total
Broadgate East			(3)				(3)
Dane's Terrace		**1** (2)	(2)			(1)	(5)
Grantham Place		(1)	**1** (1)				**1** (2)
Flaxengate		(2)	(7)	(1)			
Greyfriar's Library			(1)				(1)
Holmes Grain Warehouse			**1**				**1**
Hungate			(1)				(1)
Michaelgate			**1**				
Saltergate/Silver Street		1 (2)	**1** (2)				**3** (4)
St Benedict's			**1** (1)			(2)	**1** (3)
St Mark's Church						(1)	(1)
St Mark's East		**1**	(1)				**1** (1)
St Mary's Guildhall			**1**				**1**
Steep Hill		**1**	**1** (2)				**2** (2)
Swan Street			(1)			(1)	(2)
West Parade						(1)	(1)
Unknown Provenance		**2** (3)	(1)				
Total		**4** (10)	**7** (23)	(1)		(6)	**12** (40)

Table 7.39: Quality by phase at Lincoln (small and tiny fragments in parentheses)

	Excellent	Good	Medium	Poor	Unknown	Total
Coppergate	**8** (11)	**40** (72)	**4**	**9** (7)	**4** (113)	**65** (203)
Lincoln (various sites)	(4)	**3** (7)		(3)	(28)	**3** (42)
Wharram	**1** (1)	**1** (9)	(4)	**2** (3)	(49)	**4** (66)
Cottam		(1)	**1**	(2)	**1** (1)	**2** (4)
Paddock Hill	(1)	**3** (2)		(4)	(2)	**3** (9)
Total	**9** (17)	**47** (91)	**5** (4)	**11** (19)	**5** (193)	**77** (324)

Table 7.40 Quality of ornament at a selection of small and large settlement sites (small and tiny fragments in parentheses)

Type	W0	W1	W2	W3	W4	W5	$W_{unknown}$	Total
1a	-	-	1	2	2	-	2	7
1b	-	-	-	1	-	-	1	2
1c	-	-	-	-	-	-	-	
2a	-	-	-	2	-	-	3	5
2b	-	-	4	3	1	-	7	15
3	-	-	2	3	2	1	8	16
4	-	-	-	-	-	-	26	26
5	-	-	-	1	-	-	1	2
6	-	-	8	11	2	-	4	25
7	-	1	11	23	2	-	5	42
8a	-	2	1-	2	-	-	1	5
8b	-	-	4	1	1	-	3	9
8c	-	-	1	3	-	-	-	4
9	-	1	2	-	1	-	-	4
10	-	-	2	1				3
11	-	-	-	-	-	-	-	
12	-	-	5	3	1	-	32	41
13	-	-	-	-	-	-	-	
14a							2	2
14b	-		4	4	2	-	1	11
14c				1				1
Other		3	1	2			3	9
Unknown				1			5	6
Total		7	46	64	14	1	104	235

Table 7.41: Use wear by type in northern England sample (large fragments and complete combs only)

Phase	W1	W2	W3	W4	W5	W unknown	Total
Broadgate East							
Dane's Terrace		1					
Flaxengate							
Grantham Place						1	1
Greyfriar's Library							
Holmes Grain Warehouse						1	1
Hungate							
Michaelgate						1	1
Saltergate/Silver Street	1					1	2
St Benedict's						1	1
St Mark's Church							
St Mark's East						1	1
St Mary's Guildhall						1	1
Steep Hill						2	2
Swan Street							
West Parade							
Unknown Provenance		1	1				2
Total	1	2	1			9	12

Table 7.42 Use wear by phase at Lincoln (large fragments and complete combs only)

Phase	W1	W2	W3	W4	W5	W unknown	Total
Period 1 (Natural subsoil)							
Period 2 (1st-4th Century)							
Period 3a (1st part of 8th Century)							
Period 3b(Later 8th Century)						1	1
Period 3c (1st half of 9th Century)							
Period 3z (8th-9th Century)							
Period 4a (Late 10th/ 1st half of 11th Century)							
Period 4b (Mid – 11th - ?mid – 12th Century)							
Period 4c (Later 11th or 12th Century)							
Period 4d (12th Century)							
Period 4z (11th – 12th Century)							

Table 7.43: Use wear by phase at 46-54 Fishergate (large fragments and complete combs only)

Phase	W1	W2	W3	W4	W5	W unknown	Total
Period 5 (1142/3 – 1195)							
Period 6a (1195 – late 13th Century)							
Period 6b (Late 13th – early 14th Century)							
Period 6c (early – mid 14th Century) – **Period 10** (c.1900-1984)						1	1
Total						1	2

Table 7.43: Use wear by phase at 46-54 Fishergate (large fragments and complete combs only)

Phase	W1	W2	W3	W4	W5	W unknown	Total
3		2	2			1	5
4A		1	1			1	3
4B		3	5	2		15	25
5A			2			3	5
5B	1	4	5			5	15
5Cf		1					1
5Cr	1			1		1	3
6	1	1	6			2	10
Unstrat		4	1	1		1	7
Total	3	16	22	4		27	75

Table 7.44: Use wear by phase at 16-24 Coppergate (large fragments and complete combs only)

Site Database Number	Site	Combmaking?	Textile-making?
5	York Minster		No
6	1-5 Aldwark		No
7	Jewbury		No
11	12-18 Swinegate		Yes- sp whorls
14	Little Stonegate/ Davygate	Yes	No
15	17-21 Davygate		Yes –poss bone tool
16	Silver Street		No
18	Peasholme Green		No
19	Haymarket, Peasholme Green		No
23	16 Parliament Street		No
24	11-13 Parliament Street		No
25	24-30 Tanner Row		No
26	North Street, pumping station		Yes – multiple tools, various materials
27	13-17 Coney Street		No
28	39-41 Coney Street	Yes	No
29	44-45 Parliament Street	Yes	No
30	Parliament, Sewer Trench	Yes	Yes – multiple tools
32	Parliament Street/ Pavement		No
33	22 Pavement		No
34	6-8 Pavement		Yes – multiple tools, various materials
37	5 Coppergate		No
38	20-21 High Ousegate		No
39	25-27 High Ousegate		No
40	High Ousegate		No
42	Castlegate/ Coppergate		Yes – multiple tools, various materials
43	2 Clifford Street		No
44	16-22 Coppergate	Yes	Yes– multiple tools, various materials
45	Coppergate Watching Brief		yes– multiple tools, various materials
46	22 Piccadilly		Yes-single loomweight
47	5-13 Clifford Street		No
48	23 Clifford Street		Yes –single loomweight fragment
49	Clifford Street	Yes	Yes – multiple tools, various materials
50	Trinity Lane, Ideal Laundry		No
53	Skeldergate, NCP Car Park		Yes –single sp whorl
54	37 Bishophill Senior		Yes - – multiple tools, various materials

Table 7.45: Sites in York with evidence for various crafts in Viking-Age levels (continued overleaf)

Site Database Number	Site	Combmaking?	Textile-making?
55	58-59 Skeldergate		Yes- – multiple tools, various materials
56	Skeldergate, Albion Wharf		Yes –pin beater
57	38 Piccadilly		No
58	41-49 Walmgate		Yes – spindle whorl. Pin beater
59	76-82 Walmgate		No
60	George Street		No
61	104-112 Walmgate		No
63	York Castle, Car Park 1		Yes – spindle whorl
64	York Castle, Car Park 2		Yes - loomweights
65	50 Piccadilly		No
67	York Castle Yard, former female prison		No
68	York Castle/ Eye of York		No
69	84 Piccadilly	Yes	Yes- sp w
70	41 Piccadilly		No
71	Margaret Street, St George's School		No
72	Leadmill Lane	Yes	No
73	Paragon Street/ Kent Street		no
77	35-41 Blossom Street		no

Table 7.45 (cont.): Sites in York with evidence for various crafts in Viking-Age levels

Site Name	Site Number	Region	Site Category	Date Range	Comb Types
1	A'Cheardach Mhor, South Uist	W	Settlement	Pre-Viking Age	unknown
2	Bachda-Mor	W	Settlement		unknown
3	Balnakeil, Durness, Sutherland	N	Burial	Viking Age	5
4	Beachview, Birsay	N	Settlement	Medieval	8a, 9, unknown
5	Big Meal Howe, Newark, Deerness	N			Other
6	Boreray, Lewis	W			Other
7	Bornish	W	Settlement	Viking Age to medieval	1c, 5, 6 , 7 8a, 8b, 8c, 9, 11, 13, Other, Unknown, Waste
8	Bostadh	W	Settlement	Pre-Viking Age to Viking Age	Unknown
9	Broch of Borwick	N	Settlement	Pre-Viking Age	1c, Other
10	Broch of Burrian	N	Settlement		1c, 11, 12, 13, Other, Unknown
11	Brough of Birsay	N	Settlement	Pre-Viking Age to Medieval	1c, 5, 8a, 8b, 9, 11, 12, unknown.

Table 8.1: Sites from Scotland mentioned in the text (continued below)

Site Name	Site Number	Region	Site Category	Date Range	Comb Types
12	Brough of Deerness	N	Settlement		12
13	Brough of Lambaness	N			11
14	Brough Road, Birsay	N	Settlement	Viking Age	1c, 5, unknown.
15	Buckquoy, Birsay	N	Settlement	Pre-Viking Age to Viking Age	1c, 11, 12, unknown
16	Buiston	S	Settlement	Pre-Viking Age	11, unknown, waste
17	Castle Park, Dunbar	S	Settlement	Pre-Viking Age to Medieval	5
18	Cnip	W	Burial	Viking Age	7
19	Colonsay	W	Unknown	Unknown	11
20	Cunningsburgh	N	Unknown	Unknown	9
21	Dun Cuier	W	Settlement	Pre-Viking Age	1c, 11, unknown
22	Dunadd	W	Settlement		11, unknown
23	Earl's Bu	N	Settlement	Medieval	Case
24	Elsay	N	Settlement	Pre-Viking Age	Unknown
25	Fea Hill, Sanday	N	Unknown	Unknown	14b
26	Foshigarry	W	Settlement	Pre-Viking Age	11
27	Freswick Links	N	Settlement	Medieval	9, 11, 12, 13, unknown
28	Galilee, Sanday	N	Unknown	Unknown	9, 11, unknown
29	Garry Iochdrach	W	Settlement	Pre-Viking	11
30	Ghegan Rock	S	Unknown	Unknown	Unknown
31	Hillhead Broch, Caithness	N	Settlement	Pre-Viking Age	12
32	Howar, North Ronaldsay	N	Unknown	Unknown	13
33	Howe, Stromness	N	Settlement	Pre-Viking	11, 12, Other, Unknown

Table 8.1 (cont.): Sites from Scotland mentioned in the text (continued overleaf)

Site Name	Site Number	Region	Site Category	Date Range	Comb Types
34	Ivar's Knowe, near Hillside, Sanday	N	Unknown	Unknown	9
35	Jarlshof	N	Settlement	Pre-Viking Age to medieval	5, 6, 7, 8a, 8b, 8c, 9, 13, 14a, Unknown
36	Keil Cave	W	Unknown	Unknown	5, 10, unknown
37	Law Hills, Angus	S	Unknown	Unknown	Unknown
38	Loch Inch-Crindil	W	Settlement	Pre-Viking	11
39	Lyking	N	Burial	Viking Age	5
40	Midhowe	N	Settlement	Pre-Viking Age	Unknown
41	Munkerhouse, Papa Westray	N	Settlement	Pre-Viking Age	1c
42	North Berwick	S	Settlement	Viking Age to Medieval	5
43	Northskaill, Sanday	N	Settlement/ ?Burial	Viking Age to Medieval	13
44	Pentland Skerries	N	Unknown	Unknown	13
45	Pool, Sanday	N	Settlement	Pre-Viking Age to Medieval	1c, 5, 8b, 9, 13, 14a, Case, Unknown
46	Quoygrew	N	Settlement	Viking Age to Medieval	6, 8a, 8c, 9, 13, 14b, case unknown.
47	Rudha Chaisteach	W	Settlement	Pre-Viking	11
48	Saevar Howe, Birsay	N	Settlement	Pre-Viking to Viking Age	1c, 5, 11, 12, unknown.
49	Sands of Breckon	N	Settlement	Medieval	13
50	Sandwick, Unst	N	Settlement	Viking Age to Medieval	1c, 6, 9, 13, Case, unknown
51	Scalloway	N	Settlement	Pre-Viking Age to Viking Age	5, 11, 12, Case.
53	Scar, Sanday	N	Burial	Viking Age	5

Table 8.1 (cont.): Sites from Scotland mentioned in the text (continued overleaf)

Site Name	Site Number	Region	Site Category	Date Range	Comb Types
54	Skaill Bay, Sandwick	N	Burial	Viking Age	6
55	Skaill, Deerness	N	Settlement	Pre-Viking Age to medieval	1c, 5, 6, 8c, 9, 12, 13, 14b, unknown.
56	St Boniface Church, Papa Westray	N	Settlement	Pre-Viking	Other
57	St Columba's Cave	W	Unknown	Unknown	14b
58	St Ford's Links	S	Unknown	Unknown	11, Unknown.
59	Stackel Brae, Eday	N	Settlement	Pre-Viking Age	Other
60	Tofts Ness, Sanday	N	Settlemeny	Viking Age to Medieval	9
61	Udal	W	Settlement	Pre-Viking Age to Medieval	11.
62	Westness, Rousay	N	Settlement and Burials	Pre-Viking Age to Viking Age	5, 8a, Unknown.

Table 8.1 (cont.): Sites mentioned in the text

Site	Code	Source	Uncalibrated Date (bp)	Original Calibrated date	Other Previous Recalibrations	2004 Calibrated Date (2σ)
Bornish	OxA-10274	Cattle bone, sand underlying house, Mound 3	1004±32	AD 980-1160 (Marshall 2005: 153).	-	AD 970 - 1160
Bornish	OxA-10292	Carbonised seed, House floor level, Mound 3	590 ±50	AD 1290-1440 (Marshall 2005: 153)	-	AD 1290-1430
Bornish	OxA-10304	Carbonised seed, House floor level, Mound 3	660 ±50	1270-1410 (Marshall 2005: 153)	-	AD 1270-1410
Brough Road			1240 ± 85	AD 600-915 (Morris 1996b: 123)	AD 782-1016 (Barrett *et al.* 2000a)	-
Howe	GU-1749	Wood charcoal, Phase 8, stage 4	1565 ±45	AD 428-549 (Carter 1994)	-	AD 400-600
Howe	GU-1757	Animal Bone, Phase 8, Stage 10	1450 ± 50	AD 560-655 (Carter 1994)	-	AD 460-530
Howe	GU-2347	Animal bone, Phase 8, Stage 5	1170 ± 50	AD 785-962 (Carter 1994)	-	AD 710-990

Table 8.2: Radiocarbon dates referred to in the text (continued below)

Site	Code	Source	Uncalibrated Date (bp)	Original Calibrated date	Other Previous Recalibrations	2004 Calibrated Date (2σ)
Pool	GU 2000	Phase 6.7	1480 ± 50	AD 430-660 (Hunter *in prep*)		AD 430-660
Pool	GU 1809	Phase 6.7	1330 ± 55	AD 600-820 (Hunter *in prep*)		AD 600-820
Pool	GU 2001	Phase 6.7	1320 ± 55	AD 610-870 (Hunter *in prep*)		AD 610-870
Pool	GU 2002	Phase 7.1	1250 ± 50	AD 681-852 (1σ) (Hunter, *et al.* 1993: 280)	-	AD 660-890
Pool	GU 1807	Phase 7.1	1105 ±70	AD 882-1004 (1σ) (Hunter, *et al.* 1993: 280)	-	AD 710-1050
Pool	GU 2004	Phase 7.1	1270 ±55	AD 671-788 (1σ) (Hunter, *et al.* 1993: 280)	-	AD 650-880
Pool	GU 1810	Phase 7.2	1270 ±50	AD 673-786 (1σ) (Hunter, *et al.* 1993: 281)		AD 660-880
Pool	GU 2003	Phase 7.2	1185 ±50	AD 778-893 (1σ) (Hunter, *et al.* 1993: 281)		AD 690-980
Pool	GU 2241	Phase 7.2	1160 ±50	AD 789-954 (1σ) (Hunter, *et al.* 1993: 281)		AD 710-990
Pool	GU 2006	Phase 7.2	1160 ±50	AD 789-954 (1σ) (Hunter, *et al.* 1993: 281)		AD 710-990
Pool	GU 2005	Phase 7.2	1090 ±50	AD 891-1000 (1σ) (Hunter, *et al.* 1993: 281)		AD 810-1030
Pool	unknown	Phase 8.2	Unknown	11th – 12th Century (Hunter pers comm..)		11th – 12th Century

Table 8.2 (cont.): Radiocarbon dates referred to in the text (continued below)

Site	Code	Source	Uncalibrated Date (bp)	Original Calibrated date	Other Previous Recalibrations	2004 Calibrated Date (2σ)
Quoygrew	AA-50702	Pig skull, base of farm mound	1130 ±35	AD 782-995 (Barrett 2005)	-	AD 780-990
Quoygrew	AA-39135	Horse pelvis from farm mound mammal/fish interface	905 ±60	AD 1004-1262 (Barrett 2005)	-	AD 1020-1260
Quoygrew	AA-52329, AA-52330, AA-52331, AA-52332	Cereal grains near base of fish midden	877 ±45, 833 ±38, 832 ±49, 946 ±53,	AD 1066-1223 (combined) (Barrett and Gerrard 2004; Barrett and Richards 2004; Barrett 2005)	-	AD 1050-1230 (combined)
Quoygrew	AA-52327	Cereal grain, near top of fish midden	587 ±64	AD 1284-1439 (Barrett 2005)	-	AD 1280-1440
Saevar Howe	GU 1400	Charcoal, Phase Iib	1200 ±90	760 ±90 (Hedges 1983)		AD 660-1010
Saevar Howe	GU 1402	Charcoal, Phase IIa	1260 ± 60	715±78 (Hedges 1983)		AD 650-900
Scalloway	AA-13804	Block 5.2	1225 ±60	AD 660-960 (Sharples 1998)		AD 660-960
Scalloway	AA-13803	Block 6.2	1275 ±55	AD 650-880 (Sharples 1998: 84)		AD 650-880
Scar	AA-12597	Burial 133	1155 ±60	See Owen and Dalland 1999b	AD 693-1016 (Barrett, *et al.* 2000a)	AD 710-1020

Table 8.2 (cont.): Radiocarbon dates referred to in the text (continued below)

Site	Code	Source	Uncalibrated Date (bp)	Original Calibrated date	Other Previous Recalibrations	2004 Calibrated Date (2σ)
Scar	AA-12596	Burial 134	1040 ±60	See Owen and Dalland 1999b	AD 889-1157 (Barrett, *et al.* 2000a)	AD 880-1160
Scar	AA-12595	Burial 135	940 ±75	See Owen and Dalland 1999b	AD 978-1260 (Barrett, *et al.* 2000a)	AD 970-1260

Table 8.2 (cont.): Radiocarbon dates referred to in the text

Type	1a	1b	1c	2a	2b	2c	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14a	14b	14c	Other	Unknown	**Total**
Frequency (Large/ Complete)			13						21	4	5	3	2	5	29	1	18	21	30	2	4		8	8	**174**
Frequency (Small/Tiny)			16						22	7	1	20	13	18	23	1	22	7	19		1		6	250	**426**
Total			**29**						**43**	**11**	**6**	**23**	**15**	**23**	**52**	**2**	**40**	**28**	**49**	**2**	**5**		**14**	**258**	**600**

Table 8.3 Distribution of comb types in Scotland.

Database also includes 6 comb cases and 8 pieces of waste.

	1a	1b	1c	2a	2b	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14a	14b	14c	Other	Unknown	**Total**
Northern Scotland			**12** (14)					**17** (15)	**3** (4)	**2**	**1** (7)	(4)	**2** (2)	**28** (21)		**9** (9)	**20** (6)	**27** (17)	**2**	**2** (1)		**5** (1)	**5** (101)	**135** (202)
Western Scotland			**1** (2)					**1** (6)	**1** (3)	**3** (1)	**2** (13)	**2** (9)	**3** (16)	**1** (1)	(1)	**6** (11)		**3** (3)				**2** (3)	**1** (148)	**26** (217)
South-East and elsewhere								**2**								**4** (1)	**1**			**2**			**2** (3)	**11** (4)
Total			**13** (16)					**20** (21)	**4** (7)	**5** (1)	**3** (20)	**2** (13)	**5** (18)	**29** (22)	(1)	**19** (21)	**21** (6)	**30** (20)	**2** -	**4** (1)		**7** (4)	**8** (258)	**172** (428)

Table 8.4 Distribution of comb types in Scotland's regions

	1a	1b	1c	2a	2b	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14a	14b	14c	Other	Unknown	Total
Freswick Links														7 (5)		(1)	1 (1)	13 (4)					2 (9)	23 (20)
Brough of Birsay			5 (4)					1 (1)				(1)		1		2 (1)	5 (1)						(16)	14 (24)
Buckquoy			1 (2)													1	2 (1)						(9)	4 (12)
Saevar Howe			1 (2)					(1)								1	2						1 (5)	4 (8)
Skaill, Deerness			1 (4)					1	1 (1)				(1)	1			6 (2)	1		1			(15)	12 (23)

Table 8.5 Comb type distributions at some of Atlantic Scotland's key sites (small and tiny fragments in parentheses) (continued overleaf)

	1a	1b	1c	2a	2b	3	4	5	6	7	8a	8b	8c	9	10	11	12	13	14a	14b	14c	Other	Unknown	Total
Pool			1					4 (3)				(2)		2				2 (1)		1			2	12 (4)
Quoygrew									(1)			(2)	(1)	4 (2)				1 (8)			(1)			5 (15)
Jarlshof								4 (6)	1 (2)	2	1 (2)	(1)	2	7 (4)				4 (4)		1			(9)	22 (28)
Scalloway								(1)								1	(2)					1		2 (3)
Bornish			(1)					1 (4)	1 (3)	1 (1)	2 (12)	2 (9)	3 (16)	1 (1)		1 (1)		3 (3)				1 (1)	(118)	16 (170)
Howe																1 (1)	1					1 (3)		3 (4)

Table 8.5 Comb type distributions at some of Atlantic Scotland's key sites (small and tiny fragments in parentheses)

Type	Number of Tiny Fragments	Number of Small Fragments	Number of Large Fragments	Number of Complete Combs
1c, 11, 12	8	5	3	4
5, 6	1	1		

Table 8.6: Fragmentation of combs in the 'Lower Norse Horizon' at the Brough of Birsay

Variable	Contribution to Axis 1	Contribution to Axis 2
Decorative Scheme 2D	0.116	0.025
Long Straight Profile	0.102	0.039
Decorative Scheme 2B	0.008	0.256
Vertical Line Ornament	0.013	0.086

Table 8.7: Important contributions to correspondence analysis in Fig. 8.4 (type 12)

Site	Comb Number	Ashby Number	Comb Type	Phase	Date	Basis of Date
Howe	SF 798	1084	12	Late Phase 8, stage ambiguous	Postdates stage 4, C14-dated to AD 400-600, and stage 5, C14-dated to AD AD 710-990, though the latter date is problematic.	Radiocarbon (2σ)
	SF 1138	1010	12	Late Phase 8, stage ambiguous	As above.	Radiocarbon (2σ)
	SF 4376	1081	11	Late Phase 8 (stage 8)	Undated, but possibly Norse. Predates stage 10, C14-dated to AD 460-530, though this date is problematic	Radiocarbon (2σ), but phase very long-lived.

Table 8.8 Comb types 11 and 12 from secure contexts in Scotland (continued below)

Site	Comb Number	Ashby Number	Comb Type	Phase	Date	Basis of Date
Saevar Howe	3	1036	12	Phase Ib	Prob pre-9th C	Stratigraphy
Buckquoy	53	1058	12	Phase IV	'Norse'	Stratigraphy/Architectural Typology/ Sealed by 10^{th} C Coin
	55	1057	12	Phase V	'Norse'	Stratigraphy/Architectural Typology/ Sealed by 10^{th} C Coin
Bornish	SF 5469	1707	11	Mound 2	c.8^{th} century	Stratigraphy
Scalloway	SF 3598	2397	11	Late Phase 3	c. AD 650-900	Radiocarbon (2σ)
Bostadh	Various	N/A	12	Various	Pre 'Viking Age'	Architectural Typology/ Small Finds

Table 8.8 (cont.) Comb types 11 and 12 from secure contexts in Scotland

Frequency	Balnakiel	Lyking	Scar	Westness	Brough Road	**Total**
	(1)	**(2)**	**2**	**3**	**1**	**6** (3)

Table 8.9: Type 5 combs from graves (small and tiny fragments in parentheses)

Two separately recorded fragments from Lyking clearly relate to the same comb. To these combs, one may also add an example from a possible grave in North Berwick in the southern mainland (see above).

Bornish	Brough of Birsay	Castle Park, Dunbar	Jarlshof	Pool	Saevar Howe	Scalloway	Skaill, Deerness	Westness (Settlement)	North Uist	Bornish	**Total**
1 (4)	**1** (1)	**1**	**4** (6)	**4** (3)	(1)	(1)	**1**	(1)	(2)	(1)	**12** (20)

Table 8.10: Type 5 combs from settlements. (Small and tiny fragments in parentheses)

Comb Type	Site	Comb Number	Phase	Date	Details / Basis of Dating	Source
5	Balnakiel	1407	Inhumation Grave	c.AD 850-950	Overall date for pagan graves in Scotland	Graham-Campbell and Batey 1998: 154
5	Bornish	1805	unknown (reworked object)	Awaits publication	Mound 2, context 596. Fragment is reworked.	Sharples *pers comm.*
5	Scar	1031,1032	Inhumation Grave	Late 9th-late 10th C	Radiocarbon, artefactual typology	Owen and Dalland 1999a
5	Brough Road	1026	Inhumation Grave DT	AD 782-1016	Radiocarbon	Morris 1996c: 123

Table 8.11: Type 5, 6, and 7 combs from secure contexts in Scotland (continued below)

Comb Type	Site	Comb Number	Phase	Date	Details / Basis of Dating	Source
5	Kilpheder	N/A	Phase 3	11^{th} Century	Radiocarbon	Parker-Pearson *pers comm.*
5	Pool	N/A	Settlement-phase 7.1	AD 660-890; 650-880; 710-1050 (2 σ)	Multiple Radiocarbon dates (see table 8.2)	Hunter, *et al.* 1993
5	Westness	1352, 1353, 1391	Inhumation Graves	c.AD 850-950	Cemetery radiocarbon-dated to between 5^{th} and 10th C AD, with pagan graves probably from c. AD 850-950. Various finds, including 8^{th} and 9^{th} C metalwork	Graham-Campbell and Batey 1998: 135-138; Barrett and Richards 2004
6	Bornish	1750, 1759	Mound 2 and 2A contexts	Awaits publication. 10^{th} 14^{th} C	Stratigraphy and associated finds	Sharples 1997
6	Skaill Bay	1315	Inhumation Grave	c.AD 850-950	Overall date for pagan graves in Scotland	Graham-Campbell and Batey 1998: 154
7	Cnip	1350	Inhumation Grave	10^{th} C	Artefactual Typology	Welander *et al.* 1987

Table 8.11: Type 5, 6, and 7 combs from secure contexts in Scotland

Comb Type	Site	Phase	Date	Basis of Dating
8a,b,c	Bornish	Mounds 2, 2A, and 3	Awaits publication. 10^{th}-14^{th} C	Radiocarbon
8a,b	Kilpheder	1-9	11^{th}-13^{th} C	Radiocarbon
8b	Pool	8.2	11^{th}-12^{th} C	Radiocarbon
8a, 8c	Quoygrew	2-3	11^{th}-12^{th} C	Radiocarbon

Table 8.12: Type 8 combs from secure contexts in Scotland

Ashby Number	Find number	Comb Type (with subtype)	Site	Phase	Date	Basis of Dating
2513	PL 0308	9 (E4)	Pool	8.2	c.11^{th}-12^{th} C	Radiocarbon, stratigraphy
2514	PL 1700	9 (E6)	Pool	8.2.2	c.11^{th}-12^{th} C	Radiocarbon, stratigraphy
2468	61509	9 (E5-3)	Quoygrew	3.2-3.6	c.12^{th}-13^{th} C	Radiocarbon, stratigraphy
2469	62139	9 (E5-1)	Quoygrew	2	c. 11^{th} –12^{th} C	Radiocarbon, stratigraphy
2470	62185 and 62341	9 (E4)	Quoygrew	2	c. 11^{th} –12^{th} C	Radiocarbon, stratigraphy
2473	62125	9 (E4)	Quoygrew	2	c. 11^{th} –12^{th} C	Radiocarbon, stratigraphy

Table 8.13: Type 9 combs from secure contexts in Scotland

Variable	Contribution to Axis 1	Contribution to Axis 2
Decorative Riveting	0.162	0.011
Copper Alloy Rivets	0.143	0.014
Decorative Scheme 1M	0.096	0.000
Decorative Scheme 1N	0.080	0.011
'Every Edge' Riveting	0.001	0.099
Plano-Convex Connecting Plate Profile	0.012	0.079
Ring-and-Dot Motifs	0.000	0.068

Table 8.14: Main contributions to correspondence analysis in Fig. 8.15 (Types 5, 6, 8, and 9)

Ashby Number	Find number	Comb Type (with subtype)	Site	Phase	Date	Basis of Dating
1015	PL 4495	13 (D3)	Pool	8.2.2	c.11th-12th C	Radiocarbon
1016	PL 4480	13 (D2)	Pool	8.2.2	c.11th-12th C	Radiocarbon
1056	PL 4482	13 (unknown)	Pool	8.2.2	c.11th-12th C	Radiocarbon
2466	61910	13 (D1)	Quoygrew	3.2	c.13thC	Radiocarbon
1708	2987	13 (D1)	Bornish	Mound 2A	Awaiting publication; c. 11th-14th century	-
1709	1308	13 (D2)	Bornish	Mound 2	Awaiting publication; c. 11th-14th century	-
1747	2917 and 2918	13 (unknown)	Bornish	Mound 2A	Awaiting publication; c. 11th-14th century	-
1833	2216	13 (unknown)	Bornish	Mound 2A	Awaiting publication; c. 11th-14th century	-
1842	2166	13 (D3)	Bornish	Mound 2	Awaiting publication; c. 11th-14th century	-
1885	4944	13 (D2)	Bornish	Mound 2	Awaiting publication; c. 11th-14th century	-

Table 8.15: Type 13 combs from secure contexts in Scotland

Type	Probably Red Deer	Probably Reindeer	Probably Elk	All Antler (inc Indet Antler	Bone	Other	Unknown	Total
1a								
1b								
1c	1 (1)	3 (5)		8 (14)	2		2	12 (14)
2a								
2b								
3								
4								
5		5 (5)		15 (12)			2 (4)	17 (16)
6	(1)	1		3 (4)				3 (4)
7		1		2				2
8a		1		1 (7)				1 (7)
8b				(5)				(4)
8c	1			2 (2)				2 (2)
9	1 (5)	9 (4)		(14)	1 (1)		8 (7)	23 (8)
10								
11	1 (3)	(1)		7 (6)	1		1	9 (6)
12	1	13 (2)		19 (4)			1	20 (4)
13	1 (2)	3 (1)		13 (8)	4 (2)		10 (7)	27 (17)
14a								
14b					(1)	2		2 (1)
14c								
Other				3	2 (1)	1 (1)		6 (2)
Unknown	(2)	1 (15)		2 (71)	(6)		3 (23)	2 (100)
Total	6 (14)	37 (33)		75 (147)	10 (11)	3 (1)	27 (41)	135 (202)

Table 8.16: Raw material use in combs from northern Scotland (small and tiny fragments in parentheses)

Type	Probably Red Deer	Probably Reindeer	Probably Elk	All Antler (inc Indet Antler	Bone	Other	Unknown	Total
1a								
1b								
1c				**1** (1)			(1)	**1** (2)
2a								
2b								
3								
4								
5	(1)			(5)			(1)	(6)
6	(1)			(1)	(2)		**1**	**1** (3)
7	**1** (1)			**1** (1)	**1**		**1**	**3** (1)
8a	**2** (8)			**2** (11)	(2)			**2** (13)
8b	(5)			**2** (8)			(1)	**2** (9)
8c	(6)			**1** (13)	**1**		**1** (3)	**3** (16)
9	(1)			(1)	**1**			**1** (1)
10							(1)	(1)
11	**2** (5)			**2** (8)	**2** (1)		**2** (2)	**6** (11)
12								
13	**1**			**1** (1)	**2** (2)			**3** (3)
14a								
14b								
14c								
Other	(1)			**1** (2)	**1** (1)		(1)	**2** (4)
Unknown	(34)			**1** (80)	(15)		(49)	**1** (144)
Total	6	0	0	12	8	0	6	**26** (217)

Table 8.17: Raw material use in combs from Western Scotland (small and tiny fragments in parentheses)

Database Number	Small Finds Number	Comb Type	Date	Context Details	Site	Raw Materials
1086	307	12	AD 428-549	Late Phase 8	Howe	Indet antler
1087	SF308	11/12	AD 428-549	Late Phase 8	Howe	Indet antler
1083	4907	Other	Pre AD 300	Late Phase 7	Howe	Indet antler
1084	798	12	AD 428-549	Late Phase 8	Howe	Indet antler
1010	1138	12	AD 428-549	Late Phase 8	Howe	Indet antler
1081	4376	11	c.6th C	Latest Phase 8	Howe	Indet antler
1036	3	12	c. 8th C	Ib	Saevar Howe	Indet Antler
1093	267	11 or 12	AD 625-895	Pictish/Norse interface	Brough Rd 2	Indet antler
1002	550	11 or 12	5th-8th C	Site 6 south, level 1,3	Skaill, Deerness	Indet antler

Table 8.18: Raw materials in combs from secure 'early' contexts

Type	R and D	Vertical Lines	Horizontal Lines	Marginal Lines	Geometric	Saltires/ Diamonds/ Hatching	Interlace	Zoomorphism/ ornate sculpting	Openwork
1a									
1b									
1c	8 (13)	1 (1)	1	(1)	1 (1)	1 (1)		2 (4)	6
2a									
2b									
3									
4									
5	5	8 (8)	1	12 (12)	2	5	5 (4)	4 (3)	
6		3 (5)	1 (1)	1 (2)	1 (2)	1 (2)	1		
7		3			(1)	3 (1)			
8a	(5)	1 (2)	3 (13)	(10)	1 (10)				
8b	(1)	2	2 (5)	(6)	2 (9)		(1)		
8c		(1)							
9	2 (6)	(3)	10 (1)	1	(4)	1 (1)		2	
10	1	1		1	1			(1)	1
11	16 (18)	1 (2)	3 (1)	1 (1)	1 (3)	(2)			
12	8 (2)	4 (1)			2 (1)	6			
13	10 (4)		19 (6)		1			1	
14a									
14b			3						
14c									
Other	1	1	2 (1)		(1)	1 (1)			
Unknown	3 (33)	(25)	(6)	(11)	2(9)	2 (12)	(1)		(1)
Total	54 (82)	25 (48)	45 (31)	16 (43)	14 (39)	20 (20)	6 (6)	9 (8)	7 (1)

Table 8.19: Decorative motifs on combs from Scotland (small and tiny fragments in parentheses)

Site	Site Type	Incised Line	Ring and Dot	Interlace	Cross-hatching (imitating interlace)	Other
Balnakiel	Grave					
Lyking	Grave		(1)			
Scar	Grave		2			
Westness	Grave		2			
Cnip	Grave	1				
Brough Road	Grave	1				
North Berwick	?Grave			1		
Bornish	Settlement				1 (2)	
Brough of Birsay	Settlement	1				(1)
Castle Park, Dunbar	Settlement				1	
Jarlshof	Settlement	(1)		3 (2)		
Pool	Settlement	4		1	1	2
Saevar Howe	Settlement					
Scalloway	Settlement					
Skaill, Deerness	Settlement				1	
Westness	Settlement					
North Uist	Settlement					
Total		7 (1)	4 (1)	5 (2)	3 (2)	(1)

Table 8.20: Decorative motifs on Type 5 combs (small and tiny fragments in parentheses). Note that there may be multiple motifs per comb.

	Horiz Line	Parallel Horiz Line	Line with Tangent	Oblique Line	I-motif	Figure 8	Recumbent S	Geometric	Covered	Isolated	Clustered	Unknown	
1a													
1b													
1c	3							1	3				7
2a													
2b													
3													
4													
5				1			3			1			5
6													
7													
8a													
8b													
8c													
9			2								1	1	4

Table 8.21 Ring-and-Dot arrangements on combs from Scotland (large fragments and complete combs only).
Continued overleaf

	Horiz Line	Parallel Horiz Line	Line with Tangent	Oblique Line	I-motif	Figure 8	Recumbent S	Geometric	Covered	Isolated	Clustered	Unknown	**Total**
10	1												1
11	4	6	1									1	12
12	2	1	2					1				1	7
13	2									7	1		10
14a													
14b													
14c													
Other	1												1
Unknown	1											2	3
Total	14	7	5	1			3	2	3	8	2	4	50

Table 8.21 (cont.) Ring-and-dot arrangements on combs from Scotland (large fragments and complete combs only)

Type	Ring & Dot	Vertical Line	Geometric	Saltire/ Diamond/ X-Hatch	Interlace	Zoomorphism/Sculpt	Openwork	Horizontal Line	Marginal Line	Total
1a										
1b										
1c	6 (12)	(1)	2	1 (1)		1 (4)	6	1	(1)	17
2a										
2b										
3										
4										
5	4 (1)	9 (7)	4	2	3 (2)	(3)		2	10 (7)	34
6		2 (4)		1 (2)				1 (1)	(1)	4
7		1		2						3
8a	(1)							1 (7)	(3)	1
8b					(1)			(1)	(1)	
8c		(1)								
9	4 (5)	3 (3)	1	1		1		12 (1)	1	23
10										
11	7 (8)	1 (1)		(1)				3 (1)	1	12
12	7 (2)	4 (1)	2 (1)	7				12		32
13	8 (4)							21 (6)		29
14a								1		1
14b								2		2
14c										
Other			1	2				2		5
Unknown	2 (18)	(12)		1 (5)	(1)		(1)	(1)		3
Total	38 (51)	20 (30)	10 (1)	17 (9)	3 (3)	2 (7)	6 (1)	58 (18)	12 (13)	166

Table 8.22 Motifs by type in northern Scotland (small and tiny fragments in parentheses)

Type	Ring & Dot	Vertical Line	Geometric	Saltire/ Diamond/ X-Hatch	Interlace	Zoomorphism/Sculpt	Openwork	Horizontal Line	Marginal Line	Total
1a										
1b										
1c	1 (1)	1				1	1			4 (1)
2a										
2b										
3										
4										
5		1 (1)		1	(2)					2 (3)
6		1 (1)	1 (1)						1 (5)	3 (7)
7		2		2 (1)					(1)	4 (3)
8a	(4)	1 (2)	1 (1)					2 (6)	(7)	4 (18)
8b	(1)	2	2 (2)					2 (4)	(5)	6 (12)
8c										
9	(1)			1 (1)						1 (2)
10							(1)			(1)
11	4 (9)		1	(1)					(1)	5 (11)
12										
13	2		1					2		5
14a										
14b										
14c										
Other	1	1	(1)	1						3 (1)
Unknown	(14)	(12)	1 (2)	1 (7)				(4)	(11)	2 (50)
Total	8 (30)	9 (16)	7 (7)	6 (10)	(2)	1	1 (1)	6 (14)	1 (30)	39 (110)

Table 8.23 Motifs by type in western Scotland (small and tiny fragments in parentheses)

	1A	1B	1C	1D	1E	1F	1G	1H	1J	1K	1L	1M	1N	1P	1Q	1R	2A	2B	2C	2D	2E	2F	2G	2H	Unknown	Total
Type 1a																										
Type 1b																										
Type 1c					2			4		1				3		2										12
Type 2a																										
Type 2b																										
Type 3																										
Type 4																										
Type 5	8			4	3						1														3	19
Type 6	1	1		1												1										4
Type 7	4																									4
Type 8a	1	1			1																					3
Type 8b		2																								2
Type 8c														1		5										6
Type 9	1	3										7	9													20
Type 10																						1				1
Type 11																			4	4	6	1		4		19
Type 12																		1		3	10			7		21
Type 13																					1		23	1		25
Type 14a																										
Type 14b																								5		5
Type 14c																										
Other																										
Unknown		2					1										4					2		1	5	15
Total	15	9	0	5	6	0	1	4	0	1	1	7	9	4	0	8	4	1	4	7	17	4	23	18	8	156

Table 8.24: Decorative schemes on combs from Scotland

	Iron	Copper Alloy	Other	Mixed	Unknown
1a					
1b					
1c	**13** (11)				(5)
2a					
2b					
3					
4					
5	**21** (19)				(3)
6	**3** (5)	**1**			(1)
7	**5** (1)				
8a	**3** (16)				(4)
8b	**2** (12)				(1)
8c	**5** (18)				
9	**1**	**28** (23)			
10	**1** (1)				
11	**18** (22)				
12	**20** (3)			**1**	(3)
13	(1)	**30** (16)			(3)
14a					**2**
14b					**4** (1)
14c					
Other	**1** (1)			**7** (1)	(4)
Unknown	**6** (206)	(4)			**2** (36)
Total	**129** (316)	**29** (43)		**8** (1)	**8** (61)

Table 8.25: Rivet materials in combs from Scotland (small and tiny fragments in parentheses)

	Alternating	Central	Decorative	Every Edge	Mixed	Other	Unknown
1a							
1b							
1c	5	1		1	3		2
2a							
2b							
3							
4							
5	5	1		4	2		5
6				1	1		1
7	1				1		
8a					1		
8b							
8c	1						1
9		1	19	2	1		5
10							
11	2	3		1	1	1	1
12	13			3	1		3
13		1	24	1			1
14a							2
14b							2
14c							
Other							6
Unknown	1			1			3
Total	28	7	43	14	11	1	32

Table 8.26: Riveting techniques in combs from northern Scotland (large fragments and complete combs only)

	Alternating	Central	Decorative	Every Edge	Mixed	Other	Unknown
1a							
1b							
1c		1					
2a							
2b							
3							
4							
5							1
6					1		
7	3						
8a	2						
8b	2						
8c	2			1			
9				1			
10							
11		2		2	2		
12							
13			2	1			
14a							
14b							
14c							
Other							2
Unknown				1			
Total	9	3	2	6	3		3

Table 8.27: Riveting techniques in combs from western Scotland (large fragments and complete combs only)

To the above tables one may also add nine combs from sites in southern Scotland, and one type 12 comb of unknown provenance, with 'every edge' riveting.

	Decorative	Every Edge	Random	Asymmetric	Mixed	None	Unknown	Total
1a								
1b								
1c	3	2	4	1			2	12
2a								
2b								
3								
4								
5	4	4			1		8	17
6	2						1	3
7		1	1					2
8a	1							1
8b								
8c	1	1						2
9	3	15	3				7	28
10								
11	1	2	4				2	9
12	7	8	2		1	1	1	20
13	1	5	11	1			5	23
14a							2	2
14b							2	2
14c								
Other							6	6
Unknown		1	1				3	5
Total	23	39	26	2	2	1	39	132

Table 8.28: Tooth-cutting on combs from northern Scotland (large and complete combs only)

	Decorative	Every Edge	Random	Asymmetric	Mixed	None	Unknown	Total
1a								
1b								
1c						1		1
2a								0
2b								0
3								0
4								0
5		1						1
6								0
7			2				1	3
8a	2							2
8b	1	1						2
8c		3						3
9		1						1
10								0
11	1	3	2					6
12								0
13		1	2					3
14a								0
14b								0
14c								0
Other			1				1	2
Unknown	1							1
Total	5	10	7	0	0	1	2	25

Table 8.29: Tooth-cutting on combs from western Scotland (large and complete combs only)

	Q1	Q2	Q3	Q4	Q5	Q unknown	Total
1c							
1b							
1c		**6** (8)	**4** (2)	**1**		**1** (4)	**12** (14)
2a							
2b							
3							
4							
5		**8** (5)	**5** (1)			**4** (10)	**17** (16)
6		**2**	**1** (4)				**3** (4)
7		**1**	**1**				2
8a			**1** (6)			(1)	**1** (7)
8b		(1)	(1)			(2)	(4)
8c		(1)	**2** (1)				**2** (2)
9	**1**	**10** (6)	**12** (10)			**5** (6)	**28** (22)
10							
11		**5** (4)	**4** (4)	(1)			**9** (9)
12		**4**	**13** (1)	**2**		**1** (5)	**20** (6)
13		**10** (5)	**7** (4)	**5** (2)		**5** (6)	**27** (17)
14a		**1**				**1**	**2**
14b		**2**				(1)	**2** (1)
14c							
Other		**1**	**4** (1)	**1**			**6** (1)
Unknown		(15)	**1** (18)	(4)		**4** (63)	**5** (100)
Total	**1**	**46** (53)	**55** (53)	**9** (7)		**21** (98)	**135** (202)

Table 8.30: Quality in combs from northern Scotland (small and tiny fragments in parentheses)

	Q1	Q2	Q3	Q4	Q5	Q unknown	Total
1a							
1b							
1c	**1**	(1)				(1)	**1** (2)
2a							
2b							
3							
4							
5		**1** (2)	(2)			(2)	**1** (6)
6		**1**	(3)				**1** (3)
7		**2**	**1** (1)				**3** (1)
8a		(2)	**2** (9)	(1)		(1)	**2** (13)
8b		**1** (1)	**1** (7)			(1)	**2** (9)
8c			**3** (13)			(3)	**3** (16)
9			(1)	**1**			**1** (1)
10		(1)					(1)
11		**3** (6)	**2** (4)	**1**		(2)	**6** (12)
12							
13		**2**	(2)			**1** (1)	**3** (3)
14a							
14b							
14c							
Other		(2)	**3** (1)	(1)			**3** (4)
Unknown		(9)	**1** (20)	(2)		(112)	**1** (143)
Total	**1**	**10** (24)	**13** (63)	**2** (4)		(136)	**26** (217)

Table 8.31: Quality in combs from western Scotland (small and tiny fragments in parentheses)

Type 5	Q1	Q2	Q3	Q4	Q5	Qunknown
		11	5			2

Table 8.32: Quality in type 5 combs from Atlantic Scotland

Type 5	Q1	Q2	Q3	Q4	Q5	Qunknown
	8	15	9	0	2	1

Table 8.33: Quality in type 5 combs from Birka

Type	W0	W1	W2	W3	W4	W5	WUnknown	Total
1a								
1b								
1c			3	6	1		2	12
2a								
2b								
3								
4								
5		7	3	4			3	17
6		1	1				1	3
7					1		1	2
8a				1				1
8b								
8c				1			1	2
9		1	2	13	1		11	28
10								
11		1		6			2	9
12			1	10	4		5	20
13			2	13	3		9	27
14a			1				1	2
14b		2						2
14c								
Other			2	1			3	6
Unknown				2			3	5
Total		12	15	57	10		42	136

Table 8.34: Use wear on combs from northern Scotland (large fragments and complete combs only)

Type	W0	W1	W2	W3	W4	W5	$W_{Unknown}$	Total
1a								
1b								
1c			1					1
2a								
2b								
3								
4								
5							1	1
6			1					1
7		1	1				1	3
8a			1				1	2
8b			2					2
8c			1	1			1	3
9				1				1
10								
11			2	3			1	6
12								
13				1	2			3
14a								
14b								
14c								
Other			1				1	2
Unknown			1					1
Total		1	11	6	2		6	26

Table 8.35: Use Wear on Combs from Western Scotland (large fragments and complete combs only)

Site Ref	Date	Comb No	Comb Type	Preservation	Quality Score	Wear Score
Brough Road		1026	5	Good	3	1
Scar		1031	5	Medium	2	1
Scar		1032	5	Poor	2	Unknown
Skaill Bay		1315	6	Good	2	1
Cnip		1350	7	Good	2	1
Westness		1352	5	Good	2	1
Westness		1353	5	Medium	2	1
Westness		1391	5	Medium	2	1
Balnakeil		1407	5	Poor	Unknown	Unknown

Table 8.36: Use wear on 'grave' combs

Wear Score	N/Grave Contexts	N/Non-Grave Contexts
1	7	0
2	0	4
3	0	4
4	0	1
5	0	0
Unknown	3	4

Table 8.37: Use wear on type 5 combs from contexts of differing character

Date Period	Northern Coast and Isles		Western Coast and Isles	
	Dominant Types	*Other Points*	*Dominant Types*	*Other Points*
Pre-Viking Age (pre-9th century)	1c, 11,12	'Other' types (*e.g* one piece single-sided forms); long handled 'weaving' combs (not covered herein)	1c, 11	12 rare (only recorded at Bostadh, not included herein; Other' types (one piece);long handled 'weaving' combs (not covered herein)
9th century Interface Phase	5	1c, 11, 12 may persist	5	Status of 1c and 11 unclear; lacking excavations of 9th century settlements
Viking Age (10th-11th century)	9	8a-c present; 6, 7 uncommon; 14a uncommon	8 a-c dominant	9 uncommon, 14a absent. 6,7 uncommon.
Medieval (12th-15th century)	9, 13	14a, 14b uncommon	8a-c dominant	14a, 14b absent; 9 and 13 rare, though possibly manufactured at Bornish

Table 8.38: Overview of typological patterning in Scottish sample

	Buildings	**Waste Deposits**	**Raw Materials**	**Comb Form and Style**	**Method of Manufacture**	**Quality of Manufacture**
Factory	Permanent	Very Large, Rare	Local and Imported	Consistent over very large areas	Conservative	Middling/Good
Workshop	Permanent	Large, frequent	Local	Regional Variation	Conservative	Good/Excellent
Itinerancy	Permanent or Temporary	Intermediate, frequent	Mainly Local, some imported	Consistent over large areas, with some variants	Conservative	Good/Excellent
Homebased	Permanent	Small, very frequent	Local Only	Consistent, based on local trends	Random	Poor

Table 9.1 Possible models of production, and the evidence that may characterise them

Appendix I: Glossary

The definitions of a number of important methodological and theoretical terms are expressed below. For some terms, no fixed consensus of definition exists; in such cases definitions refer only to the use of terminology in the present work. Where appropriate, the reader is referred to established scholarship.

Assertive Style
That component of style that is associated with the individual, and is conditioned by social interaction (see Weissner 1983).

Billet
Relates to composite combs, and those comb components into which teeth are cut. It is a broad term that includes both **toothplates** and **endplates.**

Butterfly Comb. See **Fishtail Comb.**

Composite Comb
A comb consisting of 3 or more components, usually of bone or antler. Typically this will include between two and four **connecting plates,** and a number (usually three or more) **billets.**

Connecting Plate (also Side Plate; Bar; Rib)
Relates to composite combs. Those plates (of bone or antler) that lie longitudinally along either side of the **billets,** and through which rivets are fixed. Often decorated. Some combs have paired connecting plates, with two non each side of the comb, while others (often referred to as 'barred combs') feature two thin connecting plates on the obverse side, and a single, wide connecting plate on the reverse. The equivalent terms 'side plate', 'bar', and 'rib' are ambiguous, and as such are avoided in the present work.

Double-sided (*cf* Single-Sided; Semi-double) Comb
Relates to one-piece and composite combs. A double-sided comb has a set of teeth along the complete length of two of its edges.

Differentiation (of teeth)

Relates to **double-sided** (**one-piece** and **composite**) combs. If the teeth of a double-sided comb are more finely cut on one edge than the other, they are said to be differentiated. The popularity of combs with differentiated and non-differentiated teeth shows chronological patterning, and variations may relate to both function and aesthetics.

'Display-Side' Convention. While most composite combs feature ornament on both connecting plates (and the two plates often match), in a number of cases, decoration occurs only on one side. The decorated side was presumably made visible when the comb was worn on the person. Such a convention is known to occur on certain type 1b ('barred zoomorphic') and type 3 (handled) combs, and has been considered to be a 'Frisian' decorative tradition.

Emblemic Style.

That component of style that communicates recognisable symbolism regarding group membership (Weissner 1983).

Endplates

Relates to composite comb. These **billets**, situated at the comb terminals, may feature tooth **graduation**, as well as incised ornament and decorative profiling. They are frequently fixed with additional rivets. They may act as a handle, and also fulfil an important stylistic role, as they may be distinctively shaped.

Exchange (*cf* **Trade**)

Exchange may be defined as the spatial distribution of materials between individuals and social groups (Earle 1982:2). It is a broad concept, and its employment suggests generalisation. In many cases, it is not the goods changing hands that are important, but the act of exchange in itself, as this creates and reinforces social bonds (see Mauss 1925). Moreover, it is not limited to the exchange of material goods, as information and ideas may equally be exchanged.

Fishtail (also **Butterfly**) **Comb**

A particular form of double-sided composite comb, in which the endplates have a biconvex profile (see Clarke and Heald 2002).

Graduation (of teeth) Also **Gradation.**

Relates to all combs. Towards the ends of many combs (in the **endplates** of a **composite comb**), the depth to which teeth are cut decreases incrementally, such that an aesthetically pleasing sub-triangular zone is created, which may be filled with incised ornament.

Hogbacked (also **Winged) Comb.**

Composite single-sided combs with connecting plates of marked concavo-convex (bowed) section, often accompanied by large, flared endplates. There is no meaningful connection with 'hogback' sculpture.

Horse Comb (see **Monumental Comb)**

Liturgical Comb

Imprecise term, frequently applied to highly ornate ivory combs (see MacGregor 1985 for a brief review). The identification probably has it basis in documentary references to the exchange of combs amongst the ecclesiastical elite (*e.g.* Sorrell 1996), though their use in the liturgy itself cannot be confirmed prior to the late Middle Ages, and their precise role is insecure. All in all, the utility of the term in the classification of combs is limited, as it is based on a functional assumption rather than identifiable physical characteristics. Indeed, some highly-accomplished ivory combs feature secular imagery (*e.g.* Higgit 1987), while combs with known ecclesiastical connections are not invariably ornate (*e.g.* Lasko 1956). Thus, the term is not applied herein.

Long-Handled (also **Weaving) Comb.**

Combs, frequently of antler or whale bone, of unknown purpose, and common in Iron Age sites across Europe (*e.g.* Tuohy 1992), including both England (Tuohy 1999); and Scotland (MacGregor 1975). They are not included in the present study.

Monumental (also **Horse) Comb**

Very large, ornate combs (variants of type 5 according to the present classification), known from large Viking Age sites in Scandinavia (*e.g.* Ambrosiani 1981). Their use is ambiguous; they have popularly been referred to as 'horse combs', but one can be certain that they had a role that was more than simply hygienic. Their size, and coarse tooth gauge are indicative of a more symbolic role, perhaps in the communication of status, or the negotiation of reciprocal relationships. No such combs are known from the British Isles.

Nit Comb
Imprecise term, frequently applied to small, fine-toothed medieval and later combs. To date the use of combs in controlling lice is not widely confirmed (though see Mumcuoglu and Zias 1989; Schelvis 1992; 1994). The utility of this term in the classification of combs is limited, as it is based on a functional assumption rather than identifiable physical characteristics. Thus, it is not applied herein.

One-piece (also **Simple**) **Comb**
Refers to both **single-sided** and **double-sided** combs. These combs are cut from a single piece of raw material, frequently ivory, bone, or antler, though boxwood and horn examples are also known. There are diverse in dimensions, morphology, and ornament, though form is fundamentally controlled by raw materials. The equivalent term 'simple' is ambiguous, and is not applied herein.

Riveted Mount
Uniformly-produced strips of bone, riveted together with iron rivets, and often marked with toothcuts. Common at Viking Age sites in England (*e.g.*; Biddle 1990; MacGregor *et al.* 1999; Riddler 2004), they are herein interpreted as the remains of inexpensive combs originally characterised by large billets of perishable materials such as horn.

Semi-Double Comb
Composite combs of forms fitting into types 1-9, but with an additional row of teeth extending part way down the back of the comb. Examples fit into types 7 and 8 according to the claasification applied herein.

Side Plate. See **Connecting Plate.**

Simple Comb. See **One-Piece Comb.**

Single-Sided Comb (*cf* **Double-Sided Comb; Semi-Double Comb**)

Refers to both **one-piece** and **composite** combs. A single-sided comb has a set of teeth along only one of its edges.

Style. "…formal variation in material culture that transmits information about personal and social identity" (Weissner 1983: 256).

Tooth

Differentiation (see above)

Graduation (see above)

Toothplate (*cf* **billet; endplate**)

Relates to composite combs. Those billets *between* the endplates. Frequently undecorated, though their backs may be marked with incised line or ring-and-dot ornament.

Trade (*cf* **Exchange**)

The term 'trade' is often used to characterise commercial transactions, rather than those interactions primarily intended to perpetuate social bonds. This definition is applied herein, where it is taken to be a specific term, and does not incorporate methods of exchange such as gift exchange or tribute extraction.

Weaving Comb (see **Long-Handled Comb**)

Winged Comb (see **Hogbacked Comb**)

Appendix II: Site Details

Northern England

York

The topography of early medieval York has been well-covered by Richard Hall, in his recent (2004) synthesis, but a brief recapitulation is appropriate herein, while some comment on the lesser-known, unpublished sites is also necessary (see also Tweddle et al. 1999). Moreover, in order to determine the level of chronological resolution achievable in the following analyses, where possible one must scrutinise site sequences for stratigraphic integrity and dating.

Evidence for early medieval York gathered prior to the era of rescue archaeology is reviewed by Waterman (1959), and a number of combs are illustrated in this paper, though few context details are given. The Yorkshire Museum holds a number of such combs for which details regarding provenance vary considerably. Many relate to interventions in the area around **Clifford Street, Coppergate**, and **Pavement**, while others are spotfinds from elsewhere in the city, including sites such as the railway station and the city walls (see for instance Moulden and Tweddle 1986). Still others have no location details whatsoever. Moreover, many of these combs are well-preserved and of unusual form, and one might suggest that a large number of apparently less interesting combs have been lost or discarded. This all means that while these combs are useful in adding to the corpus, in and of themselves they can actually tell us little. Thus, for securely dated material we are reliant on the many rescue excavations (and watching briefs) carried out in York over the last 30 years or so. These are too numerous (combs come from 52 known sites) to discuss individually, and herein it will suffice to introduce the largest and most well-excavated assemblages.

It is helpful to briefly consider the topography of early medieval York. One should note that pre-viking and Viking Age settlement was necessarily influenced by the remains (standing or otherwise) of the Roman occupation. Indeed, the basic geometry of the present day streetplan owes much to its Roman antecedent. The legionary fortress or principia had once stood in the north of the present city centre, and though there are some signs of Viking Age activity in this area, there is little evidence of intensive settlement. It is notable that it was this area that was chosen for the construction of the medieval minster churches, and it is likely that their pre-viking or Viking Age antecedent lies somewhere close by (perhaps in the Minster gardens, see Carver 1995). The colonia to the west of the Ouse has traditionally been seen as similarly unoccupied (Waterman 1959: 69), though a more recent survey suggests that activity did take place here during the Viking Age (Moulden and Tweddle 1986). In the Middle Ages, development took place on some scale, respecting existing streetplans in many cases, but also along new alignments. Thus, evidence for medieval occupation can be found across much of the area covered by the modern city.

With York's overall topography now outlined, it is germane to discuss some of the more important sites in a little detail. The key 8th-9th century sites are in the **Fishergate** area, close to the confluence of the rivers Ouse and Foss. In particular, excavations at **46-54 Fishergate** are extremely important (Rogers 1993), while these have been augmented by more recent interventions at nearby **Blue Bridge Lane** and **Fishergate House**, just to the south (Spall and Toop 2005). At 46-54 Fishergate, following Roman activity, occupation seems to have extended (albeit intermittently) from the start of the 8th century until the middle of the 9th (dated on the basis of coinage and pottery (Kemp 1993: 1211). Recorded structures include a number of 'hall' buildings, and properties were laid out with boundary ditches and pallisades, which together with evidence for organised road maintenance, may suggest some level of centralised organisation (Kemp 1993: 1206). Imported goods and ceramics are known, and there is some suggestion of an active pre-Viking monetary economy (Hall 2004: 490). In addition to bone and antlerworking, a number of crafts are evidenced, though they may have been on a small scale. The faunal assemblage is indicative of a rather restricted diet, perhaps suggesting provisioning via redistribution administered on behalf of some authority (O'Connor 1991: 276-284).

At **Fishergate House** and **Blue Bridge Lane**, a series of pits were dated - using coins and ceramics - to between the 7th and 9th century, though internal sequencing of pits was not possible (Spall and Toop 2005). Bone and antler waste, textile implements, and hammerscale indicate craftworking activity on the site during this period, though there is also evidence for domestic occupation. Thus, these recent investigations suggest that the craft and trade settlement first discovered at **46-54 Fishergate** was laterally extensive, though just how large it was is unknown. The distribution of 'Anglian' finds across York (Tweddle et al. 1999) is suggestive of more widespread activity and settlement, but there is little architectural support for these assertions as yet, and Hall has rightly questioned the equation of 'Anglian' style (particularly in portable material culture) with pre-Viking topography (see Hall 2004: 489). Excavations at the **Barbican Centre, Paragon Street**, demonstrated that this area lay beyond the rather disarticulated pre-viking settlement evidenced at **Fishergate**, but at **Lead Mill Lane**, combmaking waste originally thought to relate to the manufacture of Viking Age comb cases for type 6 combs (Hall 2004: 494) may just as likely indicate the construction of flat-sided bone combs (type 2a) , better-dated to the pre-Viking period (Riddler 2001:66). Nonetheless, the central area of the trading settlement seems to have been rather restricted, and disarticulated from the ecclesiastical or administrative centres that may have existed in the principia area. Thus, Eoforwic cannot be defined as an emporium in the same way as can the much larger settlements at Hamwic or Lundenwic (Spall and Toop 2005). Later 9th to 11th-century occupation in the Fishergate area is more difficult to identify, but ceramics such as Torksey ware are suggestive of some level of activity , while the presence of a cemetery, a series of pits, and a small number of buildings including a possible wooden church, suggests that the area may have been reinvented as a peripheral residential zone when trade moved upriver to **Coppergate** (Kemp 1993; Spall and Toop 2005).

Elsewhere in Viking Age York, evidence for occupation within the fortress area is predominantly in the south-east, though this is in part a reflection of archaeological activity (Hall 2004: 493). Craft-working seems to have taken place in one of the old barrack buildings in the west of the principia (Carver 1995: 193; Hall 2004: 493), though this may have had an ecclesiastical rather than public context. More emphatic evidence for trade and industry comes from the area to the south-east, in the area north of Ouse Bridge. Here, sites on **Coppergate** and **Pavement** have provided impressive evidence for a burgeoning 10th century centre of craft and trade (9th-century activity is less intense).

The site at **16-22 Coppergate** is worthy of particular attention. Here, evidence was found for intermittent activity between the Roman and postmedieval eras, but the extensive waterlogged Viking Age deposits have drawn most attention. A number of 9th-century pits were identified, and from the mid-10th century there is evidence for a well-defined plot layout, with each of the four excavated tenements preserving remains of post and wattle buildings, and later storied or basemented structures. On the basis of excavated waste materials, the tenements seem to have belonged to, or were rented by, a range of craftsmen, including iron-workers, woodworkers, textile manufacturers, and possibly glass-workers, as well as combmakers. A number of structures were dated by dendrochronology, but much of the site's chronology is dependent on artefacts; particularly coins and ceramics. The site stratigraphy is somewhat complicated by the sequence of pitdigging and ground-levelling that seems to have taken place in the steeply sloping yards behind the street frontages. Moreover, in the absence of a full publication of the excavation, the extent of the problems of residuality and redeposition are difficult to assess. Nonetheless, the site is of fundamental importance to any understanding of Viking Age industry, and it is appropriate to proceed cautiously, accepting that chronological resolution will at times be poor.

Close to **Coppergate,** recent exploratory interventions at **Hungate** have recovered a small quantity of combmaking waste, and further excavation will surely produce larger quantities of material. At the **ABC Cinema site, 22 Piccadilly,** there is further evidence for Viking Age activity, in particular the reclamation of land from the river Foss, and a number of comb fragments were recovered from this locality. At the **Jewson's site, 41 Piccadilly,** pits containing combmaking waste dated to the 11th-12th centuries were uncovered close to the surface, while combmaking was one of several crafts identified during 19th century investigations on **Clifford Street**. The deposits here were dated to the 10th -11th century, on the basis of a number of finds and a single 11th century coin (Waterman 1959: 68).

A number of small interventions have taken place along **Parliament Street**. Upon replacement of a Victorian sewer, a watching brief uncovered Roman deposits, overlain by organic layers of 'presumed' Viking Age date, within which were found fragments of antler waste and comb blanks, as well as a single composite comb (Tweddle 1986: 178, 230). Similar material was discovered from 12th century deposits (based on ceramics) at the nearby **Midland Bank site (11-13 Parliament)**, while there is a single fragment of comb from excavations undertaken beneath the Church of **All Saints Pavement**, where thick organic layers were again tentatively identified as pre-viking/Viking Age in date. Notably, here they contained a single ringed pin. At **Lloyd's Bank, 6-8 Pavement,** excavators recovered a good sequence of domestic timber buildings, complete with floor levels and middens that they dated to between the 9th and 11th centuries. Bone and antler waste were recorded, as well as a small number of comb fragments.

Small collections of combs come from a large number of other interventions around the city (Appendix II). Key amongst these are the collections from excavations close to **Ousebridge,** including the **Waterstone's store** at **28-29, High Ousegate** (Macnab and McComish 2004), and earlier investigations on the same street. At these sites antler tines and working waste have been uncovered from levels thought to date to the Viking Age. Other smaller, less published, sites with fewer combs also require brief mention; they include a number in the **Bishophill** area, and those at the **Castle Car Park (Clifford Street), Coney Street,** and the **Jewbury cemetery.** A full gazetteer is provided in Appendix II.

Above Roman levels at the **Bedern,** there are a number of features of probable pre-viking and Viking Age date, but a lack of dated finds makes them difficult to interpret, and the most well-understood phases are the later medieval ones. Medieval and postmedieval activity has been located across the city, at many of the above sites, as well as others such as **Union Terrace, Lord Mayors Walk,** and a number of sites on **Skeldergate.** Moreover, the medieval topography of York is well attested in both standing buildings and documentary records (see for instance Stell 2003; Wilson and Mee 1998; Wilson and Mee 2005).

Little excavation has been undertaken to the east of the Foss or west of the Ouse, though investigations on **Walmgate,** an important entry road into the settlement from the east, is of some note. A number of sites along the street have produced evidence for occupation from the 10th century onward, and while some seem domestic in character, others indicate that industrial activities took place (see Hall 2004: 494; Macnab 2003). Excavations in **Clementhorpe** identified timber buildings tentatively identified as pre-viking, though the lack of associated finds means that the structures could be dated to any time between the 4th century and the Viking Age (Tweddle et al. 1999: 193). Combs from this area are of Viking Age and medieval types.

To the west, there are hints of Viking Age activity at **Skeldergate** (where there is some evidence for comb manufacture) and **Wellington Row,** but these are not yet well-understood (Hall 2004: 495). Similarly, excavations on **Micklegate**, particularly at the **Queens Hotel** (no. 1-9), have demonstrated the presence of 10th century buildings respecting the road layout, but there was no evidence of craft activity. Indeed, despite the apparent wealth of sites such as **St Mary Bishophill Senior** (Stocker 2000: 203-205), evidence for trade in the 10th and 11th centuries seems strangely lacking at present, though investigations at the **North Street Pumping Station** were indicative of the construction of a beaching area (Hall 2004: 495). The area is thus of key importance for future investigations.

Further out, there is documentary and archaeological evidence for a possible pre-12th century religious institution at **Clementhorpe** (Hall 2004: 495), and a small number of combs were found at this site.

Yorkshire

Beyond York itself, combs were recorded from a number of key sites in Yorkshire, with spotfinds from the reoccupied Roman fort at **Hayton**, as well as medieval contexts at **Ripon** and **Hedon**. A small collection is also known from excavations in **Beverley**, East Yorkshire (see Armstrong et al. 1991; Evans and Tomlinson 1992). At the **Eastgate** site, where medieval tenements and evidence for craftworking were identified, a small number of comb fragments were found in unstratified deposits and reworked late 11th to 12th century levels (Evans and Tomlinson 1992). More closely dated material comes from phases 4-7 (9th – 14th centuries) at **Lurk Lane**, where structures related to Beverley's Saxon monastery, as well as later medieval halls, were excavated (Armstrong et al. 1991). A number of type 1a combs were collected from Early Anglian cemeteries and secondary burials such as **Kelleythorpe, Cheesecake Hill**, and **Garton Green Lane Crossing** in East Yorkshire (see Mortimer 1905). The value of these small collections is in the cumulative creation of a large dataset. However, a few sites in Yorkshire provide larger collections and more detailed information, and are thus of considerable interest in their own right. These key sites are **West Heslerton, Wharram, Cottam**, and **Paddock Hill, Thwing.**

At **West Heslerton**, extensive excavations undertaken over a 25 year period allowed the identification of a multiperiod landscape that included an Early Anglian cemetery and an associated settlement dated (on finds and architecture) to between the 5th and 9th centuries (Haughton and Powlesland 1999; Powlesland 2003). The topography of the settlement seems to have been planned in advance, and structures identified included timber halls and sunken floor buildings.

At **Wharram**, an extensive programme of research and publication has been in place over a 50 year period, revealing finds and architectural remains dating to from the pre-Roman era to the postmedieval period (Andrews and Milne 1979; Rahtz and Watts 1983; Rahtz et al. 1986; Hayfield 1987; Bell and Beresford 1988; Wrathmell 1989; Milne and Richards 1992; Stamper and Croft 2000; Rahtz and Watts 2004). In the Middle Saxon period, the area seems to have been occupied by small, dispersed settlements, and there are hints of a high status foundation (Richards 1992). There is a possible Mid/Late Saxon watermill south of the church (Richards 1992: 92), but for our purposes the key sites are on the plateau; sites 39, 94, 95 and 60, where Middle Saxon sunken-featured buildings have been excavated, and in the **'South Manor'** area (Stamper and Croft 2000), where timber structures and industrial activity have been identified. Site 39 is of particular note, as the excavation of the Grubenhaus here recovered an unusual, largely complete 'winged' comb (applying the typology used herein, a type 1a/2b *hybrid*). The dating of this comb has proved contentious, and there is the possibility of some long-term curation (MacGregor 1992; Dickinson 1992). However, the greatest number of comb fragments comes from the South Manor site. Here, activity is recorded between the pre-Roman and late medieval periods, with extensive structural evidence for Middle Saxon occupation, and the 9th to 10th centuries well-represented by finds (Stamper and Croft 2000: 37). However, few of the comb fragments seem to be in their original context; many occur in the Norman and later medieval phases 5-6, though are clearly of Anglo-Saxon form (types 2 ,3, and 12).

At **Cottam**, East Yorkshire, survey and excavation uncovered evidence for an 8th-9th century enclosure – perhaps part of a royal multiple estate, accompanied by a nearby 10th-century manor. The large number of metal finds known from the site allow it to be categorised as one of the controversial 'productive sites', but there is limited evidence for either industry or exchange, and the excavators make it clear that the site's economy was driven by farming (Richards 2001). A small number of combs are known from the site.

The upland site of **Paddock Hill, Thwing,** is yet to be published in detail. However, we may note briefly that following prehistoric activity, the site became an important administrative centre from the 8th century, apparently associated with a Middle Saxon cemetery. Excavations have revealed a number of building structures, including a central hall of some size, while occupation debris includes 9th/10th-century pottery, industrial debris and domestic items, in addition to the comb collection (see Richards 1992: 89; Naylor 2004: 32)

Lincolnshire

In addition to the large Yorkshire corpus, a number of combs were recorded from Lincolnshire. Sites in the city of Lincoln were particularly important. Few of these have been fully published, but where possible some background information will be provided herein: At **Flaxengate** (Perring 1981; Mann 1982; O'Connor 1982; Adams Gilmour 1988), excavations revealed evidence for occupation from the early Viking Age, though finds of Middle Saxon pottery are suggestive of earlier settlement nearby (Adams Gilmour 1988: 55). Together with numismatic, ceramic, and archaeomagnetic dating, the sequence of 51 timber buildings allowed the construction of a chronology of occupation on the site, stretching from the late 9th century until the early 13th. Excavations along **Saltergate** and **Silver Street** were also key, providing evidence for 10th-century industry including pottery production and ironworking. Smaller collections come from a number of sites in the city, such as **West Parade, Grantham Place, Dane's Terrace,** and the **'Waterside'** investigations (see Jones et al. 2003). While individually these collections are rather uninformative, and details of their excavation are unpublished, when viewed together as a corpus they constitute a useful dataset.

Outside of the town, a number of combs are known from excavations and spotfinds in Lincoln's hinterland. As was the case for Yorkshire, a number of type 1a combs were collected from Anglian cemeteries (e.g. **Ancaster, Baston, Ruskington**), while individual finds came from a variety of 'rural' sites including **Caistor, Laceby; Nelson Road, Fiskerton,** while a find from medieval **Bardney Abbey** is also of note.

Other Lincolnshire sites included high status - and possibly monastic - site of **Flixborough**, and the 9th-12th century fortified manorial site of **Goltho**, though the study of these sites is dependent upon published records (see Chapter 7).

Durham

Beyond Yorkshire and Lincolnshire, combs are poorly represented in north-east England. The site that one might expect to offer greatest potential, the upland settlement at **Simy Folds, County Durham**, was, for taphonomic reasons, distinctly lacking in combs (Coggins et al. 1983). However, a comb is known from **Prudhoe Castle,** Tyndale, and two medieval sites in Durham itself are of note: **Saddler Street,** where evidence for 10th-13th century workshops and tenements was uncovered, and **Beaurepaire,** a later medieval retreat for Durham's Dean and Chapter.

Atlantic Scotland

A number of sites produced five or more comb fragments that could be identified to type. Such sites include **Bornais** (South Uist), **Jarlshof** and **Sandwick North** (Shetland), the **Brough of Birsay, Buckquoy, Saevar Howe** (Birsay Bay area, Orkney) **Skaill, Deerness** (East Mainland, Orkney), **Pool** (Sanday, Orkney), **Quoygrew** (Westray, Orkney) the **Broch of Burrian** (North Ronaldsay, Orkney), and **Freswick Links** (Caithness). Other important sites that could not be studied in detail for various reasons, may be referred to in the text. These include the **Udal** in South Uist, the **Pierowall** cemetery, Westray, Orkney, and **Whithorn**, in Galloway. In addition, material from **Kilpheder** (South Uist) was studied, but not recorded in detail, while published data from the **Scalloway** collections were used..

In addition, there are a number of sites that have produced small numbers of combs, but which are nonetheless fundamental to our understanding of the Scottish chronology, or are notable as geographical outliers. For example, furnished burials such as that at **Scar**, Sanday, and **Westness**, Rousay, provide sealed contexts complete with suites of dateable artefactual material, while combs from Dunbar and North Berwick in south-east Scotland considerably stretch the distributional ranges of particular comb forms. Finally, there are a large number of antiquarian spotfinds, single finds from excavations, and combs of insecure provenance.

Settlements in Caithness

Though Caithness has long been a focus of attention in the study of Iron Age, Viking, and medieval Scotland (refs), the number of combs from this region is small, with Freswick Links the only settlement site of note. **Freswick** has a long history of excavation, being dug intermittently over almost a century from the 1890s. The most notable interventions were by Alexander Curle in the 1930s, V Gordon Childe in the 1940s, while Batey and Morris undertook important rescue excavations in midden material in the late 1970s. This rather disjointed approach, together with a focus on building structures and possible systematic error error in the earlier projects, means that stratigraphy is, for all intents and purposes, absent. Much of the material probably relates to the Late Norse period, though it is possible that Viking Age deposits and structures have been lost to the sea.

Settlements in Orkney

The situation at **Buckquoy** (Ritchie 1977; Brundle *et al.* 2003) is a little clearer, though residuality may still be a problem. Overlying a group of cellular Late Iron Age buildings, there are the remains of three Viking Age houses. Though termed 'early', 'middle', and 'late', they probably all date to the ninth century, given that the sequence is sealed by a burial - coin-dated to the mid-tenth century - cut into the settlement mound. These buildings are seen as Norse, given their rectilinear form, though they preserve 'Pictish' material culture, including pins and combs, in their floor levels. Though there are no notable finds that clearly date to the 'Early Norse' phase, the 'Middle Norse', in particular, contains a mixed 'Norse-Pictish' assemblage. This pattern continues into the 'Late' phase, though here the assemblage seems to have suffered from disturbance. Nonetheless, Buckquoy remains the key site for evidence of the persistence of 'Iron Age' artefacts into levels associated with Norse settlement.

One of the most important and well-known sites in this corpus, certainly in terms of its impact on our understanding of culture contact, is the **Brough of Birsay**. The site complex consists of a Late Norse church, and a series of subrectangular Viking Age buildings, in some areas overlying Iron Age structures. The site has been subject to extensive investigation since the 1930s, but little has been published of the early work, and interpretation relies on the information presented in the finds report (Curle 1982). From this, it is clear that the site lacks clear stratigraphy, with structures and related deposits being broadly grouped together as the Pictish, Lower Norse, Middle Norse, and Upper Norse horizons. Only Area II at the Brough of Birsay has any stratigraphy, and even here phasing is rather coarse. All other areas are phased only by reference to Area II (Curle 1982: 15).

However, in the 1970s, John Hunter and Christopher Morris began to excavate relatively undisturbed areas, in which they discovered a Late Iron Age–Viking Age sequence of structures, with continuous occupation throughout the eighth century, and two of three excavation areas evidencing a possible hiatus prior to Norse colonisation. Norse occupation does not seem to have extended into the twelfth century; the only (non-comb) evidence of later activity is a single sherd of green glaze pottery (Hunter

1986: 143; *cf* chapter 9 this thesis). The use of radiocarbon dating in these excavations is of fundamental importance, though 'Norse' features were still identified using architectural and artefactual typology (Hunter 1986: 60, 102). Nonetheless, the bulk of the comb material (all bar two small fragments) was recovered in earlier interventions, and though Hunter and Morris' investigation clarified the overall sequence of the site, it has not been possible to reconcile Curle's artefacts with secure stratigraphic contexts.

Morris also undertook a number of excavations in the Birsay Bay area (Donaldson *et al.* 1981; Morris 1996a, 1996b). Beside the **Brough Road** he found a number of Iron Age structures, including a cellular 'figure 8' type house, and cairn burials. Little else in terms of structures was recorded, but finds include bone pins and fragments of amber.

At nearby **Beachview**, he found a farm mound overlain by a stone building that seemed to have been abandoned and used as a refuse dump. The sequence dates as Viking-Late Norse, with diagnostically 'Norse' material culture including highly fragmented combs of types 5, 8 and 9, and sherds of steatite, while radiocarbon dates take in the period between the late tenth and early fifteenth centuries.

At **Saevar Howe**, also in Birsay, John Hedges (building on original antiquarian excavations by Farrer), ascertained the presence of both Late Iron Age and Viking Age settlements (the latter overlying the former), as well as a later cemetery. In detail, Hedges found 3 structures (defining his Phase II) that he identified as Viking Age buildings, overlying an unclear sequence of probable Late Iron Age precursors (Phase I). Hedges notes a clear stratigraphic break, probably relating to abandonment, between the two phases.

The site of **Skaill, Deerness**, on Orkney's East Mainland, was subject to a prolonged programme of excavation between 1963 and 1981, but the unfortunate death of the excavator, Peter Gelling, meant that the site was eventually published by Simon Buteux. The approach taken by Buteux and his fellow contributors was a critical one, but their work was nonetheless hindered by their limited involvement in earlier stages of the project, and, to some extent, incomplete records. This is to the detriment of the stratigraphic reconstruction of the site, and it seems inadvisable to rely too heavily upon the detail of the Skaill sequences.

Nonetheless, the excavations do provide some coarse chronology, as a number of individual sites were excavated at Skaill. Together they evidence an extremely long-lived settlement, from the Early Iron Age into the modern era (G-C and Batey: 168-171), and differences in comb types recorded at each site have the potential to contribute to our chronological study. Of the 6 sites identified in the area, Sites 1, 2, and 6 are of most interest herein. The northernmost of the sites is **Site 6**, which is of 'Early Iron Age-Pictish' date, with no evidence of Norse material culture apparent.

At some remove to the south-east of Site 6, lies Gelling's **Site 2**, at which he noted the construction of rectilinear buildings. Unfortunately, the stratigraphy at Site 2 is extremely ambiguous, as dateable artefacts are rarely directly associated with structures (Edwards 1997: 76), but, broadly speaking, 'Pictish' comb types seem limited to the lower levels, while type 5 combs are found only closer to the top. Gelling dated the earliest house structure to the pre-Viking Iron Age, on the basis of its 'Pictish' artefact assemblage, and seeing a lack of finds dateable to the ninth century anywhere at Skaill, suggested a 'clean break' and downturn in material culture upon Norse colonisation. However, since the time of excavation a greater range of comparanda has become available. Using this evidence, Edwards (1997: 76-77) suggests that a ninth-century date is perhaps more likely, though this is largely on the basis of type 12 combs, so if we use them for dating herein we are in danger of creating a circular argument. Thus, at present, neither case can be proven.

Later phases in the sequence produced large numbers of Norse artefacts, including combs and pins, and Edwards (1997: 77) suggests that the site may have been occupied between the eighth or ninth and eleventh or twelfth centuries. Still further south, **Site 4** is even more typically 'Norse', including several phases of architectural remains, some of which may be of later Viking Age date, while excavation **at Site 1** was limited, though structures here were dated to the 11th and 12th centuries. Precise dating is not possible, but one might expect settlement here to postdate the Viking Age.

John Hunter's 1980s excavations at the multi-period site of **Pool**, Sanday, are important as they were undertaken according to relatively high standards, and thus have the potential to provide high resolution stratigraphic and chronological data. The site is not yet fully published, but some provisional statements may be made on the basis of interim reports (Hunter and Dockrill 1982; Hunter 1990; Hunter *et al.* 1993). Activity at the site is recorded back to the Neolithic, and Late Iron Age structures include a roundhouse, cellular buildings, and a rectangular paved courtyard.

There was an 'interface' phase, in which irregular buildings contained artefacts of both 'native' (*e.g.* hipped pins) and 'Norse' origin. The first ostensible Viking Age phase (radiocarbon-dated to the late eighth or early ninth century) consists of site levelling, and the construction of a sub-rectangular structure. Artefacts from within this building were of both 'native' and 'Norse' types, but included steatite vessel fragments, while flax was also present (Graham-Campbell and Batey 1998: 171). Following this, further structures were built. There is grass-tempered pottery throughout- even in pre-Norse phases, so the ostensible Late Norse origin of this ceramic type is not valid.

The site of **Quoygrew** (Nether Trenabie) on Westray, Orkney is also key. Here, following preliminary investigation by Sarah Colley in 1978, excavation conducted between 1997 and 2002 uncovered evidence for extremely long-lived buildings, as well as a farm mound and coastal fish midden, and a plaggen infield. There is no known pre-Norse settlement here, but there is a more or less continuous record of settlement between the 9th/10th and 17th centuries. Moreover, the site has been excavated as part of a long-term ongoing research project in which systematic sampling was seen as key to understanding chronological and spatial patterning around the site. This has helped to reveal an extensive, well-preserved and relatively clear stratigraphic sequence of structures, floors and middens, much of which is supported by radiocarbon dates, while a programme of archaeomagnetic dating was undertaken on the extensive sequence of hearths. Again, the site has not yet been published in full, but a number of interim reports have been produced (Barrett and O'Connor 2000; Barrett and Moore 2001; Barrett *et al.* 2001b; Barrett 2002; Barrett and Gerrard 2002, 2004).

Finally, a large collection of bone and antler artefacts, including combs, comes from the **Broch of Burrian**, North Ronaldsay (Traill 1890; MacGregor 1975). On the basis of formal parallels, these have been largely accepted as being of Iron Age date, though there is little stratigraphy to speak of (MacGregor 1975: 70), and the absence of any evidence for a Scandinavian presence (at least until the Late Norse period) prevents us from arguing that they date to before c.AD 800.

Settlements in Shetland

On the basis of its large comb corpus, **Jarlshof** is another potentially important site (see Hamilton 1956). However, like Skaill, it lacks stratigraphic integrity. The problems with Jarlshof's stratigraphy and dating have been well-covered (see Morris 1985: 213; Bigelow 1992: 10; Graham-Campbell and Batey 1998: 155-160), and it is unnecessary to revisit the detail herein, but it suffices to say that precise dating is confounded by a long excavation history involving several directors, including an early phase of excavation for which good records do not exist. This has led to some insecurity in the relationships between structures and middens. As floor deposits are often disturbed, dating is reliant upon finds recovered from these middens, but unfortunately waste disposal seems to have often taken place at some physical remove from the buildings, thus clouding relationships. Moreover, in many cases Hamilton dates phases quite closely (to 50 year periods in some cases), when on the bases of the often generic finds, such precision seems difficult to justify. Indeed, based on the coocurrence of comb types and other finds, there seems to be a certain degree of residuality, and it has been suggested that much of the sequence is actually younger than Hamilton proposed (Morris 1985: 213; Bigelow 1992: 10).

The site of **Sandwick**, on Unst, Shetland consists of 3 areas. The most southerly was excavated by Gerald Bigelow in the late 1970s, and structural remains consist of a rectilinear building and enclosure, though a Late Iron Age burial cairn is also known from nearby (Graham-Campbell and Batey 1998: 184-185). However, a large part of the artefact corpus, including the combs, relates to the 'North' site, which was being rapidly eroded, and was thus subject to a rescue excavation directed by Steffan Stumman Hansen in 1995. The nature of the site meant that detailed stratigraphic analysis was impossible. Nonetheless, on the basis of the artefact corpus, and what remained of the structures, Stumman Hansen dated the settlement to the period between the 11th and 13th centuries.

At **Scalloway**, in Shetland, a largely Iron Age sequence is evidenced, starting with the construction of a broch, followed by its destruction and the erection of outbuildings, and eventual Late Iron Age contraction to a small settlement with figure-of-eight houses. Finally, there seems to have been an episode of stone-robbing, probably during the tenth century, together with other activity; possibly fish processing. An extensive programme of radiocarbon-dating was undertaken, revealing a number of stratigraphic blocks to be of Viking Age date, though the implications of this have yet to be fully considered (but see Barrett *et al.* 2001a: 148).

Old Scatness, Shetland is worthy of mention for the sake of completeness, as it is an important multiphase site. Sited close to Jarlshof, Scatness was excavated between 1995 and 2003 under the direction of Steve Dockrill, with the aim of clarifying the archaeology of this part of southern Shetland, through a focus on systematic excavation and environmental sampling. Again, this provides an opportunity to refine the chronology of the late prehistoric and early medieval Northern Isles. Architectural remains on the site included a broch, as well as later Iron Age buildings including wheelhouses, cellular buildings, and ancillary structures. The 'Pictish' finds assemblage is noteworthy, including a painted pebble as well as a number of carvings, while Viking-Age activity is evidenced by a range of artefacts recovered from middens, including large numbers of steatite sherds. Strangely, however, the site produced few combs. Those that were preserved (double-sided types 11 or 12) were poorly preserved and heavily fragmented (J. Bond *pers comm.*), suggesting that the situation has at least some taphonomic basis.

Settlements in the Western Isles

Moving west, the most important Iron Age excavation is that at **Bostadh**, Berneray, Lewis. Here, a series of multicellular structures is preserved, with each building phase preserving the 'ghosts' of earlier constructions. The settlement is dated to between the 3rd or 4th century AD and the 8th or 9th, though this is based upon a combination of artefactual and architectural typology. The site is as yet unpublished, and the combs unavailable for study, but data were provided by the project's director, Tim Neighbour, and the small worked bone and antler waste assemblage was available for recording. The site has a 'Viking Age' phase (identified by the presence of a rectilinear structure stratigraphically separated from the earlier multicellular buildings), but all comb material was recorded from the earlier levels. Even here, the number of combs is small (6 largely complete combs and 10 fragments), but the site is nonetheless remarkable for its collection of manufacturing debris. This will be the subject of discussion later in this chapter.

There are few sites of early Viking Age (*ie* 9th century) date in the Western Isles, leading some (*e.g.* Parker Pearson *et al.* 2004a: 129) to speculate on a late Norse settlement here.

However, apart from the furnished burials known from the Isles (of which those containing combs will be discussed below), there is at least one settlement site that might be dated to this phase. In a rescue excavation at **Drimore Machair**, on South Uist, MacLaren (1974) uncovered an apparently short-lived longhouse structure, which perhaps formed part of a larger complex of buildings. It is difficult to be sure if there was a pre-Norse phase here, though elements of the architecture are suggestive of an earlier style. However, given the considerable impact of stone robbing, and the rapidity of the excavation, the stratigraphy is poor, while the artefact collection is equally impoverished, with only a single comb recorded. A 9th or early 10th century occupation seems feasible, but this cannot be confirmed.

There is much more evidence for settlement in the later Viking Age and Late Norse period. An important recent investigation is that which took place at **Kilpheder**, South Uist. Following initial investigations (Lethbridge 1952), a large scale research project was undertaken, and though yet to reach full publication, important information has been accessed from interim reports (Parker Pearson *et al.* 2004b), and conversations with the project staff (particular thanks to Mike Parker Pearson and Caroline Paterson). The site dates to between c. AD 1000 and 1300, and consists of the remains of a single farmstead, buried within a large settlement mound on the west coast of South Uist. The site has been carefully excavated, with all floor levels systematically sampled in an effort to record spatial and chronological variability within the settlement. A corpus of c.75 combs and fragments was collected, making the Kilpheder sequence a small, but very important study for the chronology of the Viking Age and Late Norse period. The site has not yet been published in full, but the collection was available for view, and data has been provided by the project staff.

The excavation of part of an extensive mound complex at nearby **Bornais**, South Uist, led to the discovery of an important multi-phase site, again particularly notable for its Norse levels (eleventh to thirteenth centuries). Preservation at the site is extremely good, allowing the correlation of floor levels and middens, and, like at Kilpheder, environmental sampling was figured into the research design, allowing the collection of a large number of well-provenanced combs and fragments. An extensive programme of radiocarbon-dating was also undertaken, providing absolute dates within which to frame the sequence.

Most of the mounds are yet to be published, but some comment is appropriate nonetheless. Mounds 2, 2A, and 3 are of most interest herein. An eleventh century Norse farmstead was uncovered in Mound 2, overlying evidence for Late Iron Age occupation, while mounds 2A and 3 bear evidence of activity over the following centuries. While Mound 2 seems to represent a twelfth-century expansion onto arable land, this new area becoming the focus of various manufacturing activities, in Mound 3 the remains of a lower status farmstead were uncovered, with a relatively impoverished artefactual assemblage. Together, the 3 mounds provide an important sequence running from the late Viking Age into the Late Norse period. Sharples (2000) speculates that earlier Viking Age phases lie under the remaining mounds on the site.

Furnished Graves

A large cemetery at the **Links of Pierowall**, Westray (Orkney) was found by 19th century antiquarians. Unfortunately, most of the finds (including the combs) are now lost, and records are muddled. Thankfully, Thorsteinsson (1968) has synthesised the data, though the situation is still not clear. Thorsteinsson suggests that a minimum of 17 burials were excavated, though a number of goods could not be assigned to particular graves. A better-understood - though as yet unpublished – Viking Age cemetery is that at **Westness**, Rousay (Orkney). Here, a large cemetery containing 32 burials, and spanning 200 years from the 7th century (radiocarbon-dated) was excavated. It incorporated both Christian and Pagan graves, the latter including boat burials, and containing a range of grave goods including weapons, decorative metalwork, beads, and textile tools, as well as combs.

In addition to these relatively large cemeteries, a number of smaller grave groups and individual burials are known. Those from which combs are known include graves at **Balnakiel** in Caithness, **Scar**, the **Brough Road**, and **Skaill Bay** in Orkney, and **Cnip** in the Western Isles. At **Balnakiel**, the burial of a juvenile/adolescent (probable) male was accompanied by a spearhead, a sword in the remains of its scabbard, a knife, shield boss, glass and amber beads, a 'Celtic' brooch, a strapend, antler gaming pieces, needle case, and a fish hook, as well as an antler comb and a number of less clearly identifiable objects. The burial is dated to the late 9th century on typological grounds (C. Paterson *pers comm.*), but is unusual in some respects, and will be the subject of further discussion in Chapter 9.

Perhaps the most well known grave in Atlantic Scotland, the boat grave at **Scar**, Sanday (Orkney) is arguably also the most problematic, as a precise date seems unattainable. Radiocarbon dates on skeletal remains are widely divergent, but together might suggest that the bodies were inhumed sometime between AD 895 and 1030 (Owen and Dalland 1999b: 164) However, the 11^{th} century is later than one might expect for such a lavishly furnished grave; many of Scotland's other pagan graves have been radiocarbon dated to the ninth and tenth centuries, and in all probability relate to the period between AD 850 and 950 [Graham-Campbell and Batey 1998: 154; Barrett *et al.* 2000: 10]. Moreover, stylistic dating of the artefacts in the Scar grave suggest an earlier date, though they are also internally inconsistent, perhaps due in part to the disparate ages at death of the graves occupants (Owen and Dalland 1999b: 159-161). The authors suggest that the truth lies somewhere between the two. That is to say that they put it somewhere between c. AD 875 and 950, and probably before c. AD 920 (Owen and Dalland 1999b: 165). However, this estimate is arrived through logical argument rather than direct evidence, and is dependent in large part upon the comb found close to the male skeleton (Owen and Dalland 1999b: 161). As such, the use of this date to refine our comb chronology would be circular. Instead, on the basis of the range of goods and the radiocarbon dating, a date of somewhere between the late ninth and late tenth centuries seems as precise as is possible.

The 'grave comb' from **Skaill Bay**, Sandwick (Orkney) is also problematic. Here, antiquarian excavation of a cairn burial revealed the body of a man inhumed with goods including a spear, knife, and whetstone, as well as a comb and case (Graham-Campbell and Batey 1998: 59). The burial was originally dated to c.AD 800 (see Graham-Campbell and Batey 1998: 153), but, based on current artefactual typology, this cannot be accurate, and a date between the end of the 9^{th} and the mid-10th century seems more fitting. Moreover, the nature of the burial is unclear; the presence of a number of disarticulated animal bones may indicate that it was cut into a midden or settlement mound (Graham-Campbell and Batey 1998: 59), but the lack of good records renders any such speculation inadvisable. However, more recent investigations on a site near the Brough Road (in the Birsay Bay area of the Orkney Mainland) led to the recognition of a Viking burial that seems to have been dug into a midden while it was still in use

(Morris 1996c: 114). The inhumation has clearly been disturbed by animal turbation, such that a comb was found apparently between the jaws of the associated skeleton, and the skeleton's relationship with a knife, nails, and other unidentified iron objects cannot be ascertained. The skeleton was radiocarbon-dated to 1240 +/- 85bp (calibrated c. AD 650-980 at 2σ using latest curve Morris 1996c: 123)

At **Cnip** (Lewis, Western Isles), a very richly adorned female burial was excavated in 1979 (Welander *et al.* 1987). Unfortunately the intervention was not undertaken by archaeologists, though basic details of layout were recorded. On the basis of the large finds assemblage (including a ringed pin, a buckle and strapend, a sickle, a knife, a whetstone, a collection of beads and a pair of tortoise brooches), the burial was dated to the 10th century.

In addition to these *relatively* well-recorded graves, one might note further, inscure examples. These include a poorly preserved comb, found together with a spearhead and buckle, at **Lyking**, Orkney. The findgroup may relate to a furnished cremation burial, but its discovery is unfortunately poorly recorded. One should also briefly note a burial at **Ardvonrig**, Barra, Western Isles, where a type 5 comb (now in the British Museum, and not included in this survey) was accompanied by a pair of shears, scallop shell, and, if antiquarian reports are to be believed, a sword (C.Paterson *pers comm.*.). The Museum of Scotland also holds a comb from **Barra**, believed to be from a cist burial on the island, but this is uncertain (Caroline Paterson notes doubts regarding both the security of the comb's provenance and the identification of its context). Thus, in this thesis, the comb is considered unprovenanced.

Appendix III. Raw Material Study: Like for Like Investigations

"...Variation in antler construction combines in the least reliable manner all the effects of sexual, developmental and individual variation that can be imagined"

(Webb 2000: 62)

The key factors likely to affect antler growth and development are discussed below. One should point out that the division into categories is primarily one of convenience; it is reasonable to separately consider each of these many variables. However, some are clearly related. For example, the relationship between environment and nutrition must be a close (but complex) one, and it may also be that different sexes respond to malnutrition in different ways (see for instance Clutton-Brock 1989: 2; Horwitz and Smith 1990). Nonetheless, some categorisation was necessary, and it is hoped that the divisions used herein prove useful.

Variation Within A Single Antler

Arguably the greatest influence on the internal structure of an antler object is the position within the antler from which it was cut. Most notably, the proportion of the thickness of antler taken up by porous core is extremely variable. Unfortunately, little has been written in the biological, zoological, or archaeological literature that is of great help in addressing this issue. Thus, investigation necessarily involves a practical, empirical approach.

Nonetheless, some broad points may be made concerning the macrostructure of antlers. It is widely accepted that in normal deer of most species, the proportion of porous core is greatest at the base of the beam and in the burr itself. More distal areas contain less porous material, with tine tips frequently consisting entirely of compacta. It should be noted that porous material near to the burr may often still be useful for manufacturing purposes, as it is frequently less porous than core in other areas of the antler (Smirnova *pers comm.*). These suggestions are investigated practically in my own material, and additional variation is closely searched for (see below).

Variation Between Individuals

In addition to this within-antler variation, we must consider differences between individuals. Many physical attributes of deer vary considerably between individual animals (Mitchell *et al.* 1977: 41). However, some components of individual variation may be controllable, at least to a degree, and it is herein hoped that the study of a large amount of material facilitates assessment of the influence of this phenomenon on our identification criteria.

For example, the age of the animal from which antler was taken may have an influence. Age is related to overall morphology, as antler size and complexity increase until a peak is reached (at around 9-11 years in *C. elaphus*), before the beginning of a slow decline known as 'going back' (see Mitchell *et al.* 1977: 39, Table 8). Clearly then, we must consider the possibility that age also affects internal structure.

Related to this is the developmental stage of the antler itself. As antler grows afresh each year, its gross morphology goes through a period of change (see MacEwen 1920; Chapman 1975: 135-141). Thus, antler taken from deer via hunting may vary in its properties depending upon the point in the antler cycle at which the animal was slaughtered. In practice, it could be argued that this is unlikely to present a major problem, as in western Europe at least, most archaeological deposits of manufacturing waste consist very largely of shed antler, and therefore represent a roughly uniform state of annual development (see chapter 2). However, given the ambiguity as to the proportion of original waste build up that these deposits represent (again, see Chapter 2), it is worth considering this variable more closely. It is also notable that waste deposits from medieval Novgorod, Russia, are dominated by *butchered* antler (Smirnova 1997: 139).

In most species of deer, only males normally bear antlers. However, in reindeer these structures are present in both males (bulls), and females (cows). The reason for this is unclear (although see Li *et al.* 2003), but it nonetheless represents another component of morphological – and possibly structural – variation that must be accounted for.

Hormonal cycles affect bone growth in many taxa (*e.g.* Horwitz and Smith 1990), and they clearly have an important role in antlerogenesis (Harrison Matthews 1971: 376-77; Chapman 1975; Goss 1995). Thus, in female reindeer it is possible that pregnancy and lactation may have an effect on antler formation, though a search of the zoological literature uncovered few studies of such phenomena. Penniman (1952: 35-36) does consider such influences to be important in the formation of antler, but his evidence is rather anecdotal. Nonetheless, it is a variable that must be borne in mind when considering any differences between the antlers of individual female reindeer.

Hormones are also important in male deer, and as castration is known to have an impact on the overall development of antlers, it may also affect internal structure and histology (see for instance MacEwen 1920: 32, 104-105; Bubenik 1990: 281-283; Goss 1995; Kierdorf *et al.* 1995: 38-39). This should therefore be taken into consideration, but again Penniman (1952: 35-36) appears to be one of few to have considered the importance of such phenomena to the antiquarian or archaeologist. Unfortunately it was impossible to obtain castrate antler for the purposes of these tests, so this variable has to go somewhat uncontrolled for. However, this is unlikely to be a major problem, as although there are anthropological accounts of castration being employed by present day reindeer pastoralists (see Took 2004: 7-8), I know of no record of early medieval deer castration, and any such level of park management seems unlikely to have developed by our period of interest. Indeed, archaeological analyses of prehistoric and medieval reindeer exploitation have stressed the importance of wild animals as opposed to domestic stock (*e.g.* Hambleton and Rowley-Conwy 1997; papers in Jackson and Thacker 1997), and although there are ethnohistoric allusions to the herding of 'tame' reindeer (Ross 1940: 20-21), I have yet to find explicit historical references to castration, while Odner (Odner 1985: 5) claims that the 'subsistence pattern of reindeer-herding belongs to the Post-Reformation Period'.

Disease and trauma can also affect antler morphology. Apart from direct damage to the antlers and pedicles themselves (see MacEwen 1920: 23-26), abnormality occasionally seems to be related to genital damage or underdevelopment. The swept-back morphology of cromie antlers (MacEwen 1920: 27-31), and the soft, unmineralised overgrowths known that characterise perruque heads(Page 1971: 39; Luxmoore 1980: 59-60) may form in this way. Furthermore, parasites such as liver fluke may affect antlerogenesis, and corkscrew antlers are often thought to be related to such endoparasitic infestation (Luxmoore 1980: 60), though some studies have refuted this, and it has been suggested that they are the result of a 'hereditary disturbance in calcium metabolism' (see Chapman 1975: 151). All in all, it seems that the subject is not well understood, and while some pathological malformation may be identifiable, less clear cut cases might be relatively common and not recognised as abnormal (*cf* King and Ulijaszek 1999:175-6; Eveleth and Tanner 1990:191-2).

Variation Between Populations

There is also a great deal of variation at the higher, inter-population level. Comparative studies of populations across the globe have demonstrated that there is much variation in antler size and gross morphology within *Cervus elaphus*; notably there is a north-west to south-east increase in both body and antler size across Europe. While some of this variation may be genotypic, it seems likely that at least some component of antler development is environmentally linked (see Mitchell *et al.* 1977: 2-3; Luxmoore 1980: 61; Clutton-Brock 1989: 13, 71). Indeed, environment has been demonstrated to have an effect on the growth and development of antler (see Asleson *et al.* 1997; Schmidt *et al.* 2001), and it is notable that many of the relatively small red deer of Britain live in areas of atypical habitat. In Scotland they tend to occupy exposed, highland areas with poor soils, and young animals removed and reared away from this environment have been seen to reach greater size (Mitchell *et al.* 1977: 5, 9; Clutton-Brock 1989: 2). Moreover, Scottish red deer populations from woodland and park habitats have been reported to grow larger antlers than those that occupy the hills (Whitehead 1964; Mitchell *et al.* 1977: 41; Clutton-Brock 1989: 59).

It may be that nutrition has a very marked impact on antler formation (see for example Azorit *et al.* 2002; Kruuk *et al.* 2002), particularly as antlers have a low growth priority relative to other elements of a deer's body (Clutton-Brock 1989: 62; see also Chapman 1975: 141-145). However, the relationship between nutrition and antlerogenesis is not well understood. Asleson *et al.* (1997) found that protein restriction had no consistent effect on number of points, degree of spread, main beam length or circumference in their sample population of white-tailed deer (*Odocoileus virginianus*). However, it is likely that other nutritional components, such as calcium and phosphorous, are important in antler growth (Chapman 1975: 141; Mitchell *et al.* 1977: 9; see also Goss 1995; Asleson *et al.* 1996; Kierdorf *et al.* 2000).

It has been suggested that red deer stags with extremely well-developed antlers and supernumary points may owe such morphology to a high plane of nutrition (see for example Chapman 1975: 152; Whitehead 1964: 62). Controlled experimental work has shown that an increase in nutritional plane at a formative period may lead to accelerated and amplified antler growth (Arman 1971, cited in Mitchell *et al.* 1977:44; Clutton-Brock 1989: 59, 62). Contrary to popular sporting belief (see for example Luxmoore 1980: 60), it has also been postulated that the reason for the hummel's lack of antlers is not genetic, but relates to poor nutrition in the early stages of life, and a consequent failure to grow pedicles (Clutton-Brock 1989: 62; Lincoln and Fletcher 1984). Chapman (1975: 132) has also noted that harsh environmental conditions may lead to delayed pedicle formation.

Nutrition is thus clearly important, but reaching a consensus is difficult, as much evidence is anecdotal, while laboratory experiments do not always adequately account for the effects of weather and outside activity (Mitchell *et al.* 1977: 10). This is a problem, as while climate clearly affects the availability and quality of food in an area (see Clutton-Brock 1989: 79-83, 135-136), it may also have a more direct effect on deer development. Temperature and weather conditions impact metabolism, as well as activity and shelter seeking behaviour, which in turn have implications for energy consumption and heat stress (Mitchell *et al.* 1977: 16-17; see also Clutton-Brock 1989: 59, 89-91). Population density and competition for resources may also conceivably be important (Mitchell *et al.* 1977: 19, 45; Schmidt *et al.* 2001; Clutton-Brock *et al.* 1984; but see Clutton-Brock 1989: 113; Azorit *et al.* 2002). The effect of such phenomena on an animal's condition and performance, and in particular how stress might impact antler growth, are relatively poorly understood.

Exposure to sunlight may be an important factor, as photoperiod is known to be an important consideration in the hormonal and behavioural cycles of deer (Goss 1969; Chapman 1975: 148; Mitchell *et al.* 1977: 3). Indeed, this factor is bound up with that of nutrition, as the deer's food intake seems to fluctuate seasonally (Mitchell *et al.* 1977: 9; Luxmoore 1980: 20-26; see also Muir and Sykes 1988). Indeed, it may be that inter-population differences in nutrition are lost beneath this seasonal imprint (Rob Symmonds *pers comm.*).

Although strictly separate species, in certain situations it appears that red deer may hybridise with Sika deer (*Cervus nippon*). This has been observed in captivity and in the wild, in various countries, most notably in the Lake District of northern England (Lowe and Gardiner 1975) and the Scottish highlands (McNally 1969; Clutton-Brock 1989:

173-175). Indeed, some have raised concerns as to the long-term genetic purity of Scottish stock as a whole (Clutton-Brock 1989: 177). However, it is difficult to assess the level of problems of interbreeding, given the inadequate documentation of introductions and translocations, and the lack of understanding of the consequences of hybridisation in deer (Mitchell *et al.* 1977: 2; see also Whitehead 1964: 371-395). Taking into consideration the particular conditions required for interbreeding to occur, it may be possible to rule out the effects of this process as a major influence on the integrity of the sample. Nonetheless, preliminary investigations into the possibilities of this problem are undertaken, and antler material used in the tests described below is taken from a number of disparate sources in order to provide something of a control for this, and other factors (see below).

A number of other variables may be considered to be of interest, although their influence is arguably marginal. For instance, it might be claimed that shed and butchered antler progress through different taphonomic pathways, perhaps relating to the period during which they are exposed to the elements, or to the closing of blood vessels (recall that Ambrosiani [1981: figs 54-57] noted that blood vessels were still visible in elk antler years after shedding). However, it seems unlikely that such influences would have a significant effect on internal structure, and, given the constraints placed on this research by its very nature as a thesis, they are not explored in depth herein.

Accounting for Variation

When studying the differences between the antler of various species, it is important that we consider the effects of the variables discussed above. In this section, the means by which these factors were dealt with in exploratory and blind tests are considered. Antler from a range of sources in England, Scotland and Scandinavia was analysed (see Appendix III for details):

- Cairngorm Reindeer Centre, Inverness, Scotland
- Donington Castle Deer Park, East Midlands, England
- Highland Wildlife Park, Inverness, Scotland
- Marwell Zoological Park, Hampshire, England
- Paradise Wildlife Park, Hertfordshire, England
- Raby Castle Deerpark, County Durham, England
- Selsey Lodge Farm, Essex, England
- Skanes Djurpark, Sweden

Antler to be studied in these tests was cut and processed by the author and Mr. Michael Ashby. Cutting proceeded with the use of a heavy steel saw, workbench and vice. It was necessary to frequently replace saw blades, as some of the antler (notably that of large red deer and elk) was particularly hard and dense. Following initial cutting, surfaces were filed and sandpapered smooth, so as to give a smooth finish and remove any pores that may have closed up due to the heat produced during the sawing process. All fragments were numbered using paint and permanent marker, with numbers indexed by antler, source, species, sex, and developmental stage, in a simple Microsoft Access relational database.

Morphology

To attempt to control for this large factor of variation, material from all parts of antler were analysed. Material from various positions on individual antlers (crowns, all tine tips, all tine bases, beam fragments, burrs) was compared first to material from elsewhere on the same rack, and later to material from various positions on the antler of other individuals.

This exercise was worthwhile, as a number of unexpected phenomena were noted. Early in the analysis, variation in the colour of compacta became apparent. While elk and red deer antler were quite consistent, displaying a homogeneous white finish, reindeer compacta was frequently mottled, and varied in tone from cream to brown and purple. It also seemed notable that the darker purple areas tended to be concentrated at the proximal end of the antler, close to the burr. Published references to such patterns are unknown to me, but conversations with a contemporary combmaker, revealed that he was aware of this phenomenon (Jim Glazzard, pers comm.).

Moreover, significant variation in macrostructure was discovered, but this variation did not always conform to the patterns pointed out by previous workers. For instance, contrary to the proposals of Ambrosiani (1981:124), antler close to the burr was rarely dominated by porous core, and frequently displayed a considerable thickness of compacta. This pattern was present in all species. Moreover, this core seemed less porous than the same material in more distal positions. Thus, a substantial quantity of workable material could be taken from close to the antler base. Progressing distally, compacta became thicker, until ultimately at the tine tips of elk antler there was no compacta at all. Conversely, in red and reindeer antler, a small area of porous core was often visible even within c.20mm of the tine tips.

Moreover, it was notable that while palms of elk antler seemed to consist almost entirely of compacta, the smaller reindeer palmations were overwhelmingly dominated by porous material, probably rendering them useless in comb manufacture. This was an unexpected finding, and its significance remains to be ascertained.

Nonetheless, although much variation in internal structure was discovered, none of this negated the utility of the basic properties outlined by Lyuba Smirnova (see above). For instance, the sharpness of the transition from porous core to compacta was ever-present in red deer, while the transition zone was ubiquitous in reindeer. Some variation was present in the core of elk antler; while its pores were everywhere too fine to be observed with the naked eye, in tines the core itself was only barely recognisable without the aid of a microscope, such was the thickness of compacta and uniformity (on the macro-scale) of the cancellous material. This contrasted sharply with the case in red deer, in which the porous core was visible and voluminous even in the tines; a phenomenon previously recognised by Ambrosiani (1981: fig 57).

Age

A random selection of antler was studied, with no selection for age. While some material (*i.e.* that which was taken from captive animals in zoos, and all elk material) came from animals of known age, much was collected from the ground, and thus its stage of maturity was not precisely known. It would be foolhardy to attempt to estimate absolute ages for this material, as although age does have a major effect on antler size and shape, so do genetic, environmental, and social/behavioural influences (such as population density and resource competition). Another difficulty is the fact that antlers tend to recede in the years beyond the deer's prime (see Mitchell *et al.* 1977: 39), thus creating the danger of confusion between young and senescent animals, although stalkers claim that antlers which have 'gone back' can be recognised through the presence of knobs or small points (Luxmoore 1980: 62).

Nonetheless, there is clearly some need for classification. Thus, antlers were divided into *poorly developed* and *well developed* categories. This classification is necessarily somewhat subjective. In an attempt to minimise bias, a range of measurements were defined afresh, as no generally accepted measurement criteria were known, despite the widespread sporting methods of deer quality assessment (see for example Page 1971: 38-39; Luxmoore 1980: 54-62; Mitchell *et al.* 1977: 37). These methods seem a little unreliable, and are certainly dependent on experience. Thus, criteria used by stalkers such as colour and roughness of surface (see Luxmoore 1980: 62) were not explicitly applied, as they were deemed to be too arbitrary, subject to too many factors unrelated to age, and restricted in that they are species specific. Furthermore, use of the terminology of the deer stalker (for example *switches*, for deer with antlers lacking points, *knobbers, for* second tear stags, and *royals*, for stags with 12 antler points) was avoided (see Luxmoore 1980 for a guide to such terms). Instead, the following, ostensibly more objective criteria were applied:

- Greatest (Outside) Length from burr to tip (measured with a tape measure)
- Maximum Basal Beam Thickness (measured with digital calipers)
- Basal Beam Circumference (measured with a tape measure)

- Number of Points
- Palmation (present or absent)
- Mass (measured using a hanging balance)

In practice, it was found that some of these measurements were of limited utility; the recording of mass and number of points in particular was confounded by the incompleteness of some of the material. Thus, classification was based primarily upon the 'greatest length' measurement.

Quantitative differences were visible once measurement had been carried out, and were therefore used in class division (see table III:i). Classification was still a little arbitrary, as it was not thought sensible to apply categories with pre-defined quantitative limits. Some antlers were incomplete and thus immeasurable, and while their exclusion would have seriously damaged the viability of the tests, they were given their own category, so that they could be studied separately. A further problem stemmed from the fact that those antlers taken from butchered deer represented an earlier stage in the antler cycle than the majority of the material. These were also given their own category. Nonetheless, some classification was necessary, and an attempt to break the material up into developmental classes was made.

Red Deer

	Poorly Developed	Well Developed
Greatest Length	<600mm	>600mm

Reindeer

Male

	Poorly Developed	Well Developed
Greatest Length	<700mm	>700mm

Female

	Poorly Developed	Well Developed
Greatest Length	<400mm	>400mm

Elk

Measurements were taken from elk, but were not used in development determination, as (a) much of the material was fragmentary, and (b) the donors provided approximate ages for the animals from which the antler came. The material represents five different animals, including two complete antlers from animals of 2-3 years old, and several pieces from mature animals.

Table III: i Classification of Modern Antler Material

Once these distinctions had been made, controlled investigations into the importance of age were undertaken, with material from animals of different stages of maturity, but from the same source and species, undergoing comparison. Analysis was carried out on a 'like-for-like' basis, with beam fragments being compared to one another, tines to one another, burrs to one another and crowns to one another. Furthermore, tine tips and bases were analysed independently, and both transverse and longitudinal sections were compared. Although the age classes drawn up are somewhat arbitrary, in practice it was not difficult to distinguish between well and poorly developed antlers. Furthermore, it was possible to recognise juvenile and immature antlers within the *Poorly Developed* class.

As a separate study, a small amount of red deer and reindeer material from animals of known age, and all elk material was compared in terms of macrostructure and other criteria. These tests together showed that although there was some variation, particularly in the definition of the porous core, it was not sufficient to overshadow interspecies differences.

Period of Antler Cycle

Although the majority of the test material was shed, a small quantity of butchered red deer antler was available. Comparisons were made between butchered and shed antler, again on a like for like basis, but no evidence of genuine difference was recorded, other than that the area of porous core close to the burr was slightly more irregularly shaped in the butchered material. This may perhaps relate to its relatively early stage of development, but it is notable that this phenomenon was not noted in more distal parts of the antler. Of course, it is impossible to be sure of the differences between antler from deer at different stages of the antler cycle without actively slaughtering animals frequently throughout their development. Clearly this was out of the question, but the absence of consistent recorded differences in the material that was analysed may act as some reassurance that this variable is not a major concern. Though the butchered material in the sample was fairly well formed in terms of morphology and hardness, and therefore probably unlikely to represent the earliest stages of antler growth, its is nonetheless notable that this material showed few discernable differences from their cast equivalents.

Sex

Antlers from both male and female reindeer were studied. Although there was some intra-sex variation in morphology, the antlers of a mature bull proved unmistakable. Moreover, despite considerable variation in size, those phenomena considered to be 'reindeer specific' were consistent between sexes. In both bull and cow antler, a distinct transition zone of semi-porous material was identifiable. Furthermore, male and female reindeer antlers showed far more similarity to each other in terms of compacta organisation, surface colour and texture than they did to other species.

Environment

Clearly, it was not possible to control nutrition to such an extent that we could precisely assess the role of nutrition. Quite apart from any justifiable ethical objections, such a time-consuming biological study would be beyond the scope of this archaeological thesis. Nonetheless, it is hoped that some level of nutritional variation has been incorporated into this study through the use of antler from a large number of sources in England, Scotland and Scandinavia. Antler from the different sources was compared, again on a like-for-like basis, but no major differences were consistently recognised. However, we cannot rule out the possibility that severe malnutrition or elevated feeding might have an effect. . Moreover, it might be suggested that the developmental categories applied in order to understand age-related variation (see above) are as indicative of nutrition as they are of age; if this is so, then no significant differences in macrostructure between animals of different levels of nutrition were noted.

Furthermore, material was taken from both wildlife parks and zoos. Antler from zoos was compared as a group to that from wildlife parks, in an attempt to see if differences in mode of captivity had any effect on gross or internal morphology. Captivity in a zoo environment is believed to affect skeletal morphology in other animals (see O'Regan 2002: 15), and although it would be impossible to prove the action of similar processes on the antler of captive deer in this very small survey, it was hoped that any such effects would be noted if present. No such phenomena were recorded.

Pathology

One notable anomaly was recorded. An antler from a young (approximately 4 year old) reindeer cow from Paradise Wildlife Park, England, had clearly been cast, yet retained some vestiges of velvet. It is likely that this was related to some hormonal disturbance. Nonetheless, its internal macrostructure seemed unaffected.

Otherwise, none of the antlers collected showed any sign of pathology, nor was any disease reported to me by any of the donor authorities. Nonetheless, it seems possible that some of the material may have been affected by such factors. It is hoped that the acquisition of material from a number of sources, and from several individuals at each source, has limited any bias related to disease. At least, there seems no reason to suspect prejudice in any particular direction.

Genetic Variation

Inter-population variation was controlled for through the acquisition of antler from a variety of disparate sources, as detailed above in the sections on *Environment* and *Pathology*. In practice, it proved impossible to isolate these two variables and any genotypic variation, but it is hoped that the inclusion of such a wide variety of material in open and blind tests has helped to control for them to some extent.

The question of 'genetic purity' of *C. elaphus* stocks was controlled for by using red deer antler from Scotland and England. However, we cannot guarantee the genetic history of even the English deer (see Lowe and Gardiner 1975). This problem is thus impossible to account for completely. It is hoped that analysis of material from all over England and Scotland, including the south of England (where interbreeding arguably seems to be less of a problem) has helped to alleviate the severity of the problem. Notably, analysis of gross morphology and macrostructure did not lead to the recognition of any significant quantifiable differences between Scottish and English red deer antler. Furthermore, a brief study of *C. elaphus*, *C.nippon* and hybrid antler material from the Natural History Museum (London) showed no indication that the influence of Sika might facilitate the confusion of red deer antler with that of either reindeer or elk; little difference in the macrostructure of *C. elaphus and C. nippon* was noted. It thus seems safe to assume that hybridisation is not a major confound.

Summary

It is not possible in the context of an archaeology research degree to definitively account for all of these factors; a literature has been building up on their effects for some considerable time now, and is still lacking any sort of consensus. Thus, in the absence of definitive scientific proof of the validity of the basis for this technique, the approach taken herein is twofold:

- Through like-for-like controlled comparisons, taking into account as many factors as possible (see above).
- Through repeated blind identification tests on material representing a range of states on all variables.

Thus, it was possible to demonstrate whether or not species distinctions were viable for antler material.

Results:

In order to test the techniques defined by Smirnova, and to identify any further useful criteria, or problems, an investigation of macrostructural variation in the three species of interest was undertaken. A collection of modern antler was subjected to microscopic analysis (see table 1). It was not possible to regulate the factors of age, pathology, or environment to any realistic extent, given the nature of the materials available, and the ethical constraints of modern zoological research. Nonetheless, some level of control was achieved, and the results were of interest. Further verification of the techniques of identification will take place in blind test replication studies.

Antler Sources

Raby Castle Deerpark, County Durham, England	(Red Deer)
Donington Castle Deerpark, Notts, England	(Red Deer)
Marwell Zoological Park, Hampshire, England	(Reindeer)
Paradise Wildlife Park, Hertfordshire, England	(Reindeer)
Selsey Lodge, southern England	(Red Deer)
Cairngorm Reindeer Centre, Inverness-shire, Scotland	(Red Deer and Reindeer)
Highland Wildlife Park, Inverness-shire, Scotland	(Red Deer and Reindeer)
Skanes Djurpark, southern Sweden	(Reindeer and Elk)

Antler was collected from a number of sources in England, Scotland and Sweden (see above). Each antler was assigned a reference number, and information relating to that particular antler was recorded in a database (MS Access). Where available, details about the herd and particular animals were also recorded (see table III: ii). Thus, some antlers came complete with a history, including known age, sex, time of shedding etc. Data on others were less complete. Measurements were taken, and morphology studied, so that any variations related to sex, age, nutrition, or pathology, rather than species might be identified through like-for-like comparisons. These investigations are outlined in the Methodology chapter of this thesis (see attached). No significant variations were recognised.

Antler Ref No.	Source	Species	Sex	Age (years)	Development Category
1	Raby Castle	Red Deer	M		Good
2	Raby Castle	Red Deer	M		Good
3	Raby Castle	Red Deer	M		Poor
4	Raby Castle	Red Deer	M		Poor
5	Raby Castle	Red Deer	M		Poor
6	Raby Castle	Red Deer	M		Poor
7	Cairngorm Reindeer Centre	Reindeer	M		Poor
8	Cairngorm Reindeer Centre	Reindeer	F		Good
9	Cairngorm Reindeer Centre	Red Deer	M		Poor
10	Marwell Zoo	Reindeer	M	7	Poor
11	Marwell Zoo	Reindeer	M	7	Poor
12	Paradise Wildlife Park	Reindeer	F	4	Poor
13	Paradise Wildlife Park	Reindeer	F	4	Poor
14	Paradise Wildlife Park	Reindeer	F	4	Poor
15	Skanes Djurpark	Elk	M	2-3	Poor
16	Skanes Djurpark	Elk	M	2-3	Poor
17	Skanes Djurpark	Elk	M		?

18	Skanes Djurpark	Elk	M		?
19	Skanes Djurpark	Elk	M		?
20	Skanes Djurpark	Elk	M		Poor
21	Skanes Djurpark	Elk	M		?
22	Selsey Lodge	Red Deer	M	3	Poor
23	Cairngorm Reindeer Centre	Red Deer	M		Poor
24	Cairngorm Reindeer Centre	Reindeer	M		Good
25	Cairngorm Reindeer Centre	Reindeer	F		Poor
26	Highland Wildlife Park	Reindeer	M		Good
27	Highland Wildlife Park	Reindeer	M		Good
28	Highland Wildlife Park	Reindeer	F		Good
29	Highland Wildlife Park	Reindeer	F		Good
30	Highland Wildlife Park	Reindeer	F		Good
31	Highland Wildlife Park	Red Deer	M		Good
32	Highland Wildlife Park	Red Deer	M		Good
33	Highland Wildlife Park	Red Deer	M		Good

34	Donington Park	Red Deer	M		Good
35	Donington Park	Red Deer	M		Good

Table III: ii   Modern Antler Used in Investigation

Results

Results are summarised in table III: iii, and discussed below.

Variable	Visible effect upon Compacta-Core Transition	Other perceived effects
Morphological Position	Infilling at burr	Dimensions
Age	None	Dimensions, morphological complexity, compacta mottling
Sex	None	Dimensions, complexity
Environment	None	Dimensions, complexity
Pathology/ Butchery	None	velvet retention/ core porosity, surface colour

Table III: iii Summary of Results

The first stage of the analysis was to investigate the possibility of macrostructural variation within a single antler, based on morphological position. This was achieved through the comparison of burrs with basal and, upper beam sections, tine bases and tips, and palmated areas. The same process was applied to samples of red deer, reindeer and elk antler.

In all three species, there was some infilling at the burr, causing a somewhat diffuse boundary. However, for the rest of the antler, the boundary between core and compacta is consistent, and though the quantity of useable compacta diminishes as the beam as a whole thins, the ratio of core to compacta does not tend to change significantly in areas other than the tine tips.

Variation relating to age was investigated via the comparison of burrs from old and young animals of each species. This process was then repeated for basal beams, upper beams, tine bases and tips, and palmated areas. Unfortunately, it was not feasible to estimate age on the basis of antler size or morphology. However, it was possible to divide the sample into broad categories, as there was a clear bimodality in the size distribution (based on antlers for which total length was known). Furthermore, some antlers were of animals of known age, and shed at a known date.

In red deer, no consistent differences were recognised between development classes. Comparing the two classes, it became clear that there was no macrostructural difference; the phenomena merely occurred on different scales. The very coarse porosity visible in the cores of some large, well-developed antlers was not present in any of the poorly developed examples, but the fundamental structure was the same. Moreover, the discrete boundary between core and compacta was a constant.

In reindeer, although some antler belonging to the 'poorly developed' category had a finely porous core, in these cases they were still distinguishable from that of elk. Moreover, the semi-porous transition zone was always present. Comparing those reindeer of known age (two antlers from the same 7 year old male, and three antlers from three 4-year old female individuals), although there were obvious differences in size and gross morphology, macrostructure seemed consistent between the two divisions. While the young antlers contained darker mottling in the compacta, structure and relative proportions showed no consistent differences.

In elk, poorly developed antler exhibited a dark ring around the edge of the core area, probably relating to the extent of blood vessels. No such band was noted in well-developed antlers, although whole antlers from well-developed elk were unavailable for analysis. Nonetheless, no structural differences were noted between antler from elk of different ages, and the fine texture of the core area was a constant. Thus, all in all, there is no reason to suspect that age has any major effect on this phenomenon as a criterion of identification.

Females grow antlers only in reindeer. For this species, burrs, basal beams, upper beams, tine bases and tips, and palmated areas were all subjected to like-for-like inter-sex comparisons. Reindeer cow antler is, in the main, smaller, and less strongly built than bull antler. It has a smaller cross section, is frequently much shorter in length and less complex in morphology than mature bull antler. However, the ratios of core to compacta, and the changes in this along the length of antler, are similar in male and female examples, while the transition from porous core to compacta seems *to be diffuse in both.*

In order to investigate any variation that might relate to environmental, population, or genetic influences, burrs from red deer from one locality were closely compared with burrs from red deer from all other localities. This process was then repeated for basal beams, upper beams, tine bases and tips, and palmated areas. The entire procedure was then repeated for reindeer and elk specimens. Particular attention was paid to any variations between English and Scottish sources, the north and the south, Britain and Scandinavia, and zoos and deerparks. The morphological and macrostructural influence of Sika (*Cervus nippon*) was also investigated.

To note the effect of variations in environmental conditions such as climate, nutrition and population pressure, and genetic influences such as isolation, interbreeding, hybridisation etc, the material was compared based on its provenance. First, material from individual sources was compared, but no consistent patterns relating to particular parks were noted. Thus, it seemed sensible to increase the frame of reference by comparing differences between antler collected in northern and southern Britain; this could at least be used to investigate the possibility of different levels of red deer-Sika deer hybridisation. The northern cohort included all material from Scotland and

Northumberland, while the Southern sample included that from the English Midland and southern counties.

This comparison showed no real differences between red deer from northern and southern Britain in terms of macrostructure, though Scottish examples in particular tended to be large and well-developed in terms of gross morphology. This could relate to differences in habitat and mode of captivity, but may simply be an artefact of the sampling strategy of the collectors from whom I gained material. Whatever, it is significant that these perceived differences were not reflected in internal macrostructure.

Concerning reindeer, the English sample size was small, but examples from Scotland nonetheless seem much more complex in terms of gross morphology than those in southern England; this may relate to environmental factors, as it is generally acknowledged that there the area in which the animals can roam in the highlands of Scotland is greater than the restricted parkland available to English populations.

Thus, there is no evidence of geographical variation in the macrostructure of British red deer or reindeer antler. Furthermore, no significant structural differences were noted between British and Swedish-sourced reindeer antler. It thus seems unlikely that geographical provenance has any important bearing on internal macrostructure of antler.

Given the space afforded to cervids in modern zoos and wildlife parks, it seems unlikely that captivity was a major bias on the tests. Nonetheless, one interesting observation was the fact that male reindeer antler from Marwell Zoological Park, although quite large, dense, and strong, showed a lack of complexity. In particular, when compared with the large male antlers from the Highland Wildlife Park, they seem simple, but more strongly built. This could perhaps relate to plane of nutrition. Nonetheless, no real differences in macrostructure were noted, except that the core areas in those antlers from Marwell were particularly finely porous.

It was also important to assess the impact of hormonal or pathological influences upon the sample. Two of the three specimens from females of known age (4 years) are clearly shed rather than butchered, yet retain vestiges of velvet. The precise cause of this phenomena is unknown to me, but clearly the abrasion intended to remove the dried, dead skin was insuffìcent (Terry O'Connor, *pers comm*). It may be notable that these antlers belonged to captive reindeer; perhaps their environment did not provide the requisite vegetation on which antlers coming out of velvet could be rubbed.

Some red deer (e.g. specimens 1 and 2) exhibited minor palmation, but this is insufficient to justify positing any Sika influence. Other than this, no real malformation, pathology, or symptoms of hormonal disturbance were noted.

Examination of the single example of butchered antler in the collection (red deer no. 23) showed a very distinctive surface texture, with a deep brown colour and very deep, consistent surface channelling. The reason for this is unclear. More important herein, though, is the fact that internal macrostructure seemed very similar to that of shed antler. Obviously, it is impossible to categorically state that macrostructure does not develop or change through during antlerogenesis; such a statement would necessarily be based on controlled analysis of antler representing known stages of development. Nonetheless, nothing in my investigations contradicts this assertion.

Discussion

It seems that the basic identification criteria stand up to this level of analysis. Surface texture is a reliable manner of differentiating species, as red deer and reindeer textures are diagnostic. However, such features are not frequently preserved in artefacts, and other criteria must be utilised.

The structure of the compacta has not been discussed thus far. The reason for this is that diagnostic features could not be identified. While to a certain degree the compact structure of red deer antler does seem more regular and organised than that of reindeer, this proved impossible to quantify, and the degree of overlap was so marked that any fixed watershed between the two species would be an arbitrary contrivance. Moreover, the compact structure of elk was very difficult to observe even at a magnification of 10x with a movable light source. All in all, the structure of compact tissue in modern antler cannot be readily used as a means of species differentiation. It is possible that diagenetic staining would render identification more straightforward, but at the present time there is no justification for the application of this methodology.

Conversely, the nature of the porous core is quite reliable as a criterion. For example, the fine porosity of elk antler core material is distinctive. However, differentiation between the cores of red deer and reindeer is more difficult, as there seem to be no consistently observable characteristics (although quantification via image analysis may help). Nonetheless, the presence of a semi-porous transition zone in reindeer, and its absence in red deer might prove useful. Problems with this criterion are the possibility of confusion between the semi-porous zone in reindeer and the core itself in distal elk antler tines. If enough is preserved, the two may be distinguished, but if only vestiges are preserved in artefacts, and the morphology of the core itself is not visible, then there may be problems.

Palmate areas of elk antler have a coarser porosity than that present in the tines, and one which – when only present in small quantities- could be confused with the peripheral areas of red deer or reindeer core. Where such palmation has been used, its identification may become one of probability rather than one of absolutes. Thus, a small reference collection is essential in differentiating species, and one must always err on the side of caution. Identifications should be qualified with terms such as 'probably', and supporting criteria should be used where possible (e.g. size of component, surface texture, compacta structure etc).

Another difficulty is created by the fact that near the burr of all species, resorption from the pedicle may take place, causing a sort of secondary infilling. Should this be seen in red deer antler, it may be mistaken for the semi-porous zone in reindeer. Again, this should only occur if sufficient morphology is not preserved. However, consistent recurrence of semi-porosity in many objects would, on the basis of probability, suggest the use of reindeer antler, as the resorption phenomena only occur at the antler base and pedicle.

Thus, all in all, a tripartite system of identification seems appropriate. Where gross external morphology or outer surface texture are preserved, a *definite* species identification may be provided. Where surface texture is not present, but core or transition zone macrostructure is preserved and visible, a *probable* identification should be made. Criteria such as component size, compacta structure, texture and colour may be used to support such assertions, but are insufficient criteria for identification in their own right. Thus, where gross morphology, surface texture, or core-compacta macrostructure are not preserved, an *indeterminate* assignation should be made. Further clarification is dependent upon blind tests and replications (Chapter 5).

It has been shown that the zooarchaeological basis for the species-level identification of antler is fundamentally sound. Of course, that is not to say that the assessments made by Rolf Lie are correct. The next step is to test these criteria in blind replication tests.