ANTLER ARTIFACTS FROM THE NEOLITHIC LAKESIDE SETTLEMENT ANARGHIRI IXB, WESTERN MACEDONIA, GREECE

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To Tina
(For always being there for me…)

To the prehistoric inhabitants of Anarghiri IXb
(I spent two years trying to understand your thoughts and actions)

Abstract

The thesis addresses antler working and antler artifacts from the Neolithic lakeside settlement of Anarghiri IXb which is located in the Four Lakes region in Western Macedonia, Greece.

This research contributes to our current understanding of the antler working in the Neolithic lakeside settlements of Western Macedonia in Greece by examining the biggest so far unearthed assemblage in Greece. The goal of this research is to establish a typology of the collected worked antler assemblage, to reveal the preferences of raw material, to reconstruct the manufacturing stages of the artifacts and to highlight the differences of antler exploitation in the habitation phases of the settlement.

The study that was conducted from 2016 to 2018 brought to light interesting aspects concerning the use of antler in various everyday activities. Red deer antler prevails in the assemblage diachronically and antler was used mainly for the manufacture of tools that were used in woodworking activities or soil digging. Moreover, antler was used for the manufacture of hunting and fishing equipment and for the shaping of personal ornaments such as pendants and rings. A big part of the assemblage consists of blanks and waste material which shows that part of the manufacture was held inside the settlement. The attribution of the artifacts to the habitation phases of the settlements provided interesting information about the continuity of various tool forms and more importantly it provided a worked antler typology from the end of the 6th mil BC to the end of the 5th mil BC.

Keywords: Antler artifacts, tools, ornaments, lakeside settlement, pile dwellings, Neolithic Greece, Anarghiri IXb, Amindeon, Western Macedonia

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Table of contents

Abstract i

Acknowledgements ii

Table of contents iv

List of figures vii

List of tables xii

List of plates xiii

Chapter 1 - Introduction 1

1.1.Introduction 2

1.2. Aims of the study 2

1.3.Limitations and difficulties of the study 2

1.4. Structure of the thesis 3

Chapter 2 - Artifacts and prehistoric technology 5

2.1. Artifacts and their function 6

2.2. The notion of technology 8

2.3. Archaeological approaches to technology- The notion of chaîne opératoire 9

Chapter 3 - Deer and their antler 11

3.1. Red deer and roe Deer 12

3.1.1. The red deer (Cervus elaphus) 12

3.1.2. The roe Deer (Capreolus Capreolus) 14

3.2. Red deer antler and roe deer antler 16

3.2.1. Red deer antler 16

3.2.2. Roe deer antler 19

3.3. The physical and mechanical properties of the antler 20

3.3.1. Physical Properties of the antler 20

3.3.2. Mechanical properties of the antler 21

3.4. Use of antler from deer 22

Chapter 4 - Prehistoric worked bone and antler studies : literature review.. 23

4.1. The study of the prehistoric worked bone and antler industries in Europe 24

4.2. History research of prehistoric osseous artifacts in Greece.. 25

Chapter 5 - The chronological framework of the Neolithic period in Greece 28

Chapter 6 - Geographical context and research history in Western Macedonia 34

6.1 .Geography of Western Macedonia 35

6.2. Research history of the Neolithic period in Western Macedonia 35

Chapter 7 - The prehistoric lakeside settlement of Anarghiri IXb... 46

7.1. History of research and site location 47

7.2. Chronology and stratigraphy.. 47

Chapter 8 - Antler working techniques 55

Chapter 9 - The antler artifacts 61

9.1. Introduction.. 62

9.2. The methodology.. 62

9.3. Raw material 63

9.4. Typology.. 64

9.5. Chronological and spatial distribution of the artifacts 67

9.6. Analysis of the artifact categories 68

9.6.1. Semi and completely manufactured items 68

9.6.1.1. Tools... 68

Sleeves 68

Handles 105

Bevel ended tools 106

Picks... 125

Adzes 143

Axes 144

Needles 154

Fragments of perforated tools of undefined function 157

Retouching tools 161

9.6.1.2. Hunting - fishing Equipment and weapons 164

Harpoon heads.. 165

Harpoons 170

Archer thumb rings ... 171

Fish hooks ... 179

Mace heads ... 179

Projectile points ... 181

9.6.1.3. Eating and mixing food equipment ... 185

Spoons ... 185

9.6.1.4. Ornaments ... 187

Pendants ... 187

Rings ... 194

9.6.1.5. Artifacts of undefined function ... 195

9.6.2. Blanks/Raw material ... 199

9.6.3. Waste ... 204

Chapter 10 - Research results and conclusions ... 208

10.1. Research results ... 209

10.1.1. Raw material preferences ... 209

10.1.2. Typologies over time ... 212

10.1.3. Craft activities ... 214

10.1.4.The Anarghiri IXb assemblage in the wider region ... 216

10.2. Conclusion ... 220

10.3. Future research strategies ... 221

References ... 222

Plates ... 264

Annex - Catalogue of the artifacts ... 275

List of figures

Figure 3.1 Red deer (Photograph by Elizabeth Dack. Used under kind permission)....13
Figure 3.2. Geographical distribution of the red deer (Lovari et al. 2008)....13
Figure 3.3. Roe deer (Photograph by Elizabeth Dack. Used under kind permission)....14
Figure 3.4. Geographical distribution of roe deer (Image Source) http://maps.iucnredlist.org/map.html?id=42395)....15
Figure 3.5. Roe deer annual cycle (Source: Deer Iniative 2008b)....15
Figure 3.6. Biological cycle of the Red deer (Source:The Deer Initiative 2008a)....17
Figure 3.7. Growth of Red Deer Antler (Suter 1981,fig.12)....17
Figure 3.8. Red deer antler morphology (Modified after Suter 1981, fig.5)....18
Figure 3.9. Structure of the red deer antler (Modified after Baumann and Maury 2013, fig.1)....18
Figure 3.10. Roe deer antler development (Page 1971:38)....19
Figure 3.11. Roe deer antler (Modified Suter 1981, fig.6)....19
Figure 3.12. Antler casting process (Wislocki and Waldo 1953 in Muir 1985:4)....
Figure 6.1. Map of Greece with its administrative regions (Map source: www.d-maps.com)....44
Figure 6.2. Map of the most important Neolithic settlements mentioned in the text (1.Servia, 2.ToumpaKremasti Koiladas, 3.Kleitos, 4.Megalo Nisi Galanis, 5.Mavropigi-Filotsairi, 6.Dispilio, 7.Avgi) (Map source: www.d-maps.com)....45
Figure 7.1. The location of Anarghiri IXab settlement and the adjacent area. (Modified after: https://upload.wikimedia.org/wikipedia/commons/1/1c/Dimos_Florinas_-_Florina_prefecture%2C_Greece_-_political_map_-_municipality_level.svg)....49
Figure 7.2. Map with the most important excavated sites in the area of the Four Lakes region in the Amindeon basin (Chrysostomou et al. 2015, fig.3)....50
Figure 7.3. Excavated areas of the Anarghiri IXb settlement (Drawing: Tryfonas Giagkoulis)....51
Figure 7.4. Calibrated C14 dates from charred wood samples....52
Figure 7.5. Calibrated C14 dates from structural wood (piles)....53
Figure 7.6. Stratigraphic layers I to V from a) the northern part and b) from the southern part of the settlement (Image synthesis: C. Arampatzis, St. Papadopoulou, T. Giagkoulis)....54
Figure 8.1. a.Percussion technique (David 2004, fig.4),....58
b,c. Anarghiri IXb. Percussion traces on a semi-finished sleeve....58
Figure 8.2. Flexion breakage (David 2004, fig.8)....58
Figure 8.3. a.Sawing technique (David 2004, fig.4), b.Anarghiri IXb. Sawing traces on antler waste....58
Figure 8.4. a.Scraping technique (David 2004, fig.4), b.Grinding technique (David 2004, fig.4), c.Anarghiri IXb. Grinding traces on antler projectile point....59
Figure 8.5. Anarghiri IXb. Socket for stone tool shaped through hollowing....59
Figure 8.6. a.Boring technique (David 2004, fig.4), b.Anarghiri IXb.Boring perforation....60
Figure 8.7. a.Bow drilling (David 2004, fig.4), b.Shaft hole shaped through bow drilling....60
Figure 8.8. a.Incision (David 2004, fig.4), b.Anarghiri IXb. Incised decoration on antler pendant....60
Figure 9.1. Raw material used for the manufacture of sleeves....70
Figure 9.2. Flowchart with the classification criteria and the main categories of the sleeves....73
Figure 9.3. Sleeves on basal parts (Type I), a) Subtype Ia, b) Subtype Ib, c) Subtype Ic, d) Subtype Id (Dark grey area: shaft hole, dotted area: socket hole)....74
Figure 9.4. Localization of the use wear traces in the burr base, a.central, b) marginal,c) whole base covered (modified after Averbouh and Bodu 2002, fig.5)....77

Figure 9.5. Type I sleeves. a, Used burr base, b. Unused burr base 77
Figure 9.6. Sleeve subtype Ia, a.Origin of the raw material, b. Metrical analysis 79
Figure 9.7. a,b. Different views of the tool, c. View of the shaft hole area 80
Figure 9.8. Late Neolithic sleeve subtype Ia (A9b.KE139), Semi-finished tool.a,b. Different views of the tool, c.View of the non shaped socket, d. View of the unfinished shaft hole 81
Figure 9.9.Late Neolithic subtype sleeve Ia (A9b.KE251), semi-finished tool.(Black arrow: shaft hole drilling attempt, grey arrow: detachment attempt percussion traces) 81
Figure 9.10. Final Neolithic subtype Ia sleeve. View of the slightly drilled shaft hole 85
Figure 9.11. Final Neolithic subtype Ia sleeve (A9b.KE286). Semi-finished tool with slightly drilled shaft hole 85
Figure 9.12. Final Neolithic subtype Ia sleeve (A9b.KE126) 86
Figure 9.13. Final Neolithic subtype sleeve Ia (A9b.KE146) a,b.Different views of the tool, c. Detail from the shaft hole 87
Figure 9.14. Sleeve subtype Ia (Final Neolithic), a-c. Sockets for stone tools 88
Figure 9.15. Sleeve sutype Ib.a.Origin of raw material, b.Metrical analysis of the subtype Ib sleeves 89
Figure 9.16. Subtype Ib sleeve (A9b.KE016). Semi-finished tool shaped on unshed red deer antler a. Different views of the tool, b. View of the undrilled socket, c. Manufacture traces in the base of the tool 90
Figure 9.17. Subtype Ib sleeve (A9b.KE272), a-b. Different views of the tool, c. Detail of the shaft hole area.......91
Figure 9.18. Subtype Ib sleeve (Final Neolithic). Semi drilled shaft hole of round cross section 93
Figure 9.19. Subtype Ib sleeve (Final Neolithic). Percussion traces around the socket hole..................................94
Figure 9.20. a.Origin of the raw material, b. Metrical analysis of the subtype Ic sleeves 95
Figure 9.21. Final Neolithic sleeve subtype Ic (A9b.KE46) (the white lines indicate the shaft hole position) 95
Figure 9.22. Final Neolithic subtype Ic sleeve (A9b.KE268) 96
Figure 9.23. Sleeve subtype Id, a. Origin of the raw material, b. Metrical analysis..96
Figure 9.24. Final Neolithic subtype Id sleeve (A9b.KE253).Semi finished tool.(The arrow indicates the position of the shaft hole shaping attempt) 97
Figure 9.25. Type II sleeves. a.Origin of the raw material, b.Metrical analysis 98
Figure 9.26. Type II sleeve on beam segment with shaft hole (A9b.KE257) 100
Figure 9.27. Socketed sleeves. a. Origin of the raw material, b.Metrical analysis. 100
Figure 9.28. a.Socketed sleeve with inserted stone tool (A9b.KE080), b.View of the socket, c.View of the hafting hole 101
Figure 9.29. Manufacture sequence of the perforating sleeves..103
Figure 9.30. a,b.Perforating sleeves. Socket details. a.Late Neolithic, b.Final Neolithic.......................................104
Figure 9.31. a.Hafting method of the perforating sleeve (after Billamboz 1977; Billamboz and Schlichtherle 1985, Gross-Klee and Schibler 1995), b.Late Neolithic perforating sleeve (A9b.KE150), c.Final Neolithic perforating sleeve (A9b.KE147 104
Figure 9.32. Final Neolithic handle with socket for stone tool (A9b.KE164)...105
Figure 9.33. Relationship between the active ends and the raw material in the formation of the categories.....107
Figure 9.34. Types of beveled tools. a.Unifacial internal beveled tool, b.Unifacial lateral beveled tool, c. Bifacial lateral beveled tool (After Camps-Fabrer and Ramseyer 1998,fig.2) 111
Figure 9.35. Parts of the unifacial and bifacial bevel ended tools on tines..112
Figure 9.36. Manufacturing sequence of the unifacial internal beveled tools on tines 113
Figure 9.37.a.Unifacial internal beveled tool on tine (A9B.KE057, scale 1:1),b,c.Details of the active end 114
Figure 9.38. Manufacturing sequence of the unifacial lateral beveled tools on tines...115
Figure 9.39. a.Unifacial lateral tool scale (A9B.KE062,scale 1:2), b.Detail of its active end, c.Manufacturing traces and chipping on active end 116
Figure 9.40. Manufacture sequence of the bifacial beveled tools on tines 119

Figure 9.41. a,b.Late Neolithic bifacial beveled tool (A9b.KE061) with visible manufacture traces on the basal part, c. Detail of the active end....121
Figure 9.42. a.Different views of a Final Neolithic bifacial beveled tool (A9b.KE084,) b. Grinded and polished basal part of the tool, c-d. Details of the active end....122
Figure 9.43. a-c.Final Neolithic bifacial bevel ended tools and details of their active end (a. A9b.KE047, b. A9b.KE042, c.A9b.KE058)....123
Figure 9.44. Possible tool movements across worked material of the A9b.KE061 tool a) Vertically to the worked material, b) Diagonially to the worked material....124
Figure 9.45. Metrical analysis of the picks shaped on tines....127
Figure 9.46. Localization of the antler tine (modified after Werning 1983 and Riedel 2013)....127
Figure 9.47. Percussion traces around the shaft hole....128
Figure 9.48. Late Neolithic half preserved pick on tine (A9b.KE143)....129
Figure 9.49. Late Neolithic pick (A9B.KE160). Detail of the semi-finished shaft hole.....129
Figure 9.50. Final Neolithic pick on tine with half preserved shaft hole (A9B.KE093)....130
Figure 9.51. Final Neolithic picks. Round shaft holes from completely manufactured picks on tines....132
Figure 9.52. Final Neolithic picks on tines. a. Semi-finished shaft hole with round cross section (A9b.KE051), b.Slightly shaped finished shaft hole of oval cross section (A9b.KE092)....134
Figure 9.53. Final Neolithic semi manufactured pick on tine with unfinished oval shaft hole (A9b.KE235)....134
Figure 9.54. Manufacture sequence of the picks on tine from the Final Neolithic/Early Bronze Age disturbed layers.....135
Figure 9.55. Final Neolithic/Early Brone Age picks on tines. a.Semi-finished tool (A9b.KE006) , b.Completely manufactured (A9b.KE098)....136
Figure 9.56. Picks on tines from the FN/EBA disturbed layer. Semi finished shaft holes with round cross section....136
Figure 9.57. Final Neolithic pick on basal and beam segment (A9b.KE 212)....138
Figure 9.58. Picks on basal and beam segment on unshed antler. Manufacture sequence....139
Figure 9.59. Pick on basal and beam segment. Detail of the shaft hole.....139
Figure 9.60. Pick on beam segment (A9b.KE025). a,b. Different views of the tool, c.View of the unfinished shaft hole....140
Figure 9.61. Pick shaped on crown (A9b.KE149)....141
Figure 9.62. Pick shaped on crown (A9b.KE149). a.Detail of the crown tine, b.Detail of the shaft hole....142
Figure 9.63. Late Neolithic adze (A9b.KE 243)....143
Figure 9.64. a,b.Final Neolithic adzes (a:A9b.KE178, b:A9b.KE271)....144
Figure 9.65. Final Neolithic type A axe shaped on tine (A9b.KE023)....146
Figure 9.66. Final Neolithic type B1 axe (A9b.KE175)....148
Figure 9.67. Detail of the shaft hole of the A9b.KE175 axe....149
Figure 9.68. Late Neolithic type B beam axe (A9b.KE052)....149
Figure 9.69. Beam axe type B2. a.Detail of the flattened active edge and the small part of the coronet, b. Close view of antler base/axe edge....150
Figure 9.70. Final Neolithic type B2 beam axe (A9b.KE221)....151
Figure 9.71. Final Neolithic type B3 beam axe (A9b.KE222)....152
Figure 9.72. Handheld axe Type B4 on junction (the dotted area indicates the worked area) (A9b.KE041)....153
Figure 9.73.a.Needle subtype IA1, b.Close view of the thread hole, c.View of the pointed end, d. Similar needle from Steinhausen – Sennweid, Switzerland (Elbiali 1990), e.Similar needle from Delley - Portalban II,Switzerland (Ramseyer 1987) (items d and e are not in scale)....155
Figure 9.74. Semi finished subtype IA2 needle (A9b.KE040)....156

Figure 9.75. Fragments of perforated basal segments of undefined function (a A9b.KE014, b.A9b.KE111)......... 159
Figure 9.76. Fragment of perforated beam segment of undefined function (A9b.KE133)................................... 160
Figure 9.77. Fragment of perforated tine of undefined function (A9b.KE085)... 161
Figure 9.78. Final Neolithic retouching tool on tine (A9b.KE029) 163
Figure 9.79. Final Neolithic antler hammer (A9b.KE287)... 163
Figure 9.80. Morphology of the harpoon head 166
Figure 9.81. Harpoon heads. a.Semi finished item (Type A),b.Semi finished item (Type B),c.Completely manufactured but half preserved (Type C) (arrows indicate the holes in the proximal parts) 166
Figure 9.82. Harpoon heads.a.Manufacture traces on a semi finished item, b.Grinding traces in the lateral side of the proximal part.. 167
Figure 9.83. Harpoon head line holes.a.Unfinished, b.Completed.. 167
Figure 9.84. Distal part of a harpoon head with grinding traces and polish on the tip 168
Figure 9.85. a-b.Unmodified and unused harpoon head tips.. 168
Figure 9.86. a, b. Use wear traces on the tip of the harpoon heads,c.Harpoon head from Divostin with similar traces on its tip (modified after Lyneis 1988,fig.10.2.a) 169
Figure 9.87. a.Possible reconstructions of the antler harpoon, b,c Similar barbed harpoons from Egolzwil 3 and Montilier/Platzbünden (Wyss 1994; Ramseyer 1995) 170
Figure 9.88. Type HR2 harpoon (A9b.KE323) 171
Figure 9.89. Close view of the HR2 harpoon barb.. 171
Figure 9.90. Different views of a thumb ring and its major parts 172
Figure 9.91. Thumb ring technique (Photograph by Martin Groeber. Used under kind permission) 173
Figure 9.92. Close view of the thumb ring (Photograph by Martin Groeber. Used under kind permission)......... 173
Figure 9.93. Metrical analysis of the thumb rings. a Type I, b. Type II 174
Figure 9.94. Type I thumb ring (A9b.KE280)... 175
Figure 9.95. Type II thumb ring (A9b.KE283).. 175
Figure 9.96. Type II thumb rings 176
Figure 9.97. Type II thumb ring (A9b.KE276). Manufacture and use wear traces 177
Figure 9.98. Type II thumb ring (A9b.KE277).Manufacture and use wear traces 177
Figure 9.99. Type II thumb ring (A9b.KE277).. 178
Figure 9.100. Final Neolithic semi finished fish hook (A9b.KE019) 179
Figure 9.101. a.Final Neolithic mace head (A9B.KE322), b.Macehead from Montilier/Portalban (after Ramseyer 1985, fig.5.4.).. 180
Figure 9.102. Final Neolithic projectile points. a.Type I, b. Type II, c.Type III, d.Type IV, e.Type V 181
Figure 9.103. a.Type I projectile point (A9B.KE291), b.Detail of the distal part, c.Detail of the tang.................. 182
Figure 9.104. a.Type II projectile point (A9B.KE295), b.Type III projectile point (A9B.KE292) 183
Figure 9.105. Projectile point hafting methods. a.Fixing the point into the wooden shaft, b.Fixing and fastening the point into the wooden shaft (modified after Knecht 2000,fig.12) 184
Figure 9.106. a.Proximal part of the Type II projectile point, b.Proximal part of the type III projectile point...... 184
Figure 9.107. a.Projectile point from the FN/EBA layers, b.Possible hafting method (after Petillon 2009, fig.1a) 185
Figure 9.108. Final Neolithic antler spoon (A9b.KE305) 186
Figure 9.109. Antler spoon. Detail of the bowl 186
Figure 9.110. a.Undecorated pendant (A9b.KK020), b. Pendant decorated with incisions (A9b.KK001) 188
Figure 9.111. a-c. Incised decoration motifs on pendants (not in scale)... 188
Figure 9.112. Partially preserved antler ring idols (a.A9b.KK023, b.A9b.KK019).. 189

Figure 9.113. a.Harpoon head in the transformation process of becoming an ornament (scale 1:2)(A9B.KK007), b. First stage of the transformation of the blunt tip, c. Broken hole line/suspension hole. 190
Figure 9.114. a. Harpoon transformed to pendant (A9b.KK008), b. Detail of the transformed distal part, c. Finished pendant A9b.KK003) 191
Figure 9.115. a-f. Transformation stages of the harpoon head to pendant (items not in scale)............................191
Figure 9.116. Anarghiri III. Pendants from harpoon heads...192
Figure 9.117. Pendants. a.Type IV, b.Type V, c.Type VI, d.Type VII (a,b scale 1:2, c,d – scale 1:1) 193
Figure 9.118. a, b. Tine tips of unknown function with flat base (a. A9b.KE298, b.A9b.KΔ023) 196
Figure 9.119. Fragments of artifacts of undefined function (a. A9b.KΔ065, b A9b.KΔ016, c. A9B.KE299, d.A9B.KE321)...197
Figure 9.120. Fragmented item of undefined function (shaft straightner?) (A9b.KE310).....................................198
Figure 9.121. Blanks on tines (a. A9b.KΔ042, b. A9b.KΔ111) 200
Figure 9.122. a,b.Tine-raw material for the extraction of rings 201
Figure 9.123. a,b.Raw material for the extraction of rings...202
Figure 9.124. a,b.Blanks on basal segments (a. A9b.KΔ002, b. A9b.KΔ128) 202
Figure 9.125. Raw material on basal segment (A9b.KΔ089)..203
Figure 9.126. Final Neolithic waste on basal segment (A9b.KΔ033) 206
Figure 9.127. Waste on basal segments. a.shed antler (A9b.KΔ127), b.unshed antler (A9b.KΔ052) 207

List of tables

Table 5.1. Chronological scheme used in this thesis (after Andreou et al.1996; Γαλλής 1996; Παπαδημητρίου 2010; Reingruber et al.2017) 31
Table 7.1. Stratigraphic layers and their attribution in chronological periods 48
Table 9.1. Percentage of the deer species antler found in the assemblage 63
Table 9.2. Percentage of red deer antler elements in the assemblage 64
Table 9.3. General categories of the worked antler assemblage 64
Table 9.4. Categorization of the semi and completely manufactured items 66
Table 9.5. Chronological distribution of the artifacts 67
Table 9.6. Chronological distribution of the raw material used for sleeves 70
Table 9.7. Chronological distribution of the four main sleeve types 71
Table 9.8. Type I. Sleeves on basal parts. Subcategories and their quantity 75
Table 9.9. Chronological distribution of the subcategories of the type I sleeves 75
Table 9.10. Sleeve Type I. Chronological distribution and manufacture status of the four subtypes 76
Table 9.11. Percentage of the type I sleeves with used and unused base 76
Table 9.12. Sleeve I subtypes used as hammers and localization of use wear traces in their base (CA: central area, MA: marginal area, WA: whole area) 78
Table 9.13. Sleeve subtype Ia, Late Neolithic. Preservation and manufacture status 79
Table 9.14. Sleeve subtype Ia, Final Neolithic. Preservation and manufacture status 82
Table 9.15. Sleeve Type Ia (Final Neolithic). Shaft holes cross sections 83
Table 9.16. Sleeve subtype Ib, Final Neolithic. Manufacture and preservation status 91
Table 9.17. Sleeve Type Ib (Final Neolithic). Shaft hole cross sections 92
Table 9.18. Sleeve subtype Ib, Final Neolithic.Length and diametre of the shaft holes with round cross section. 93
Table 9.19. Categories of the bevel ended tools 106
Table 9.20. Chronological distribution of the bevel ended tools. (UBT: Unifacial bevel ended tools shaped on tines, UBB: Unifacial bevel ended tools shaped on beam segments, UBBB: Unifacial bevel ended tools shaped on basal and beam segments, BBT : Bifacial bevel ended tools shaped on tines) 108
Table 9.21. Chronological distribution of bevel ended tools shaped on red and roe deer antler 109
Table 9.22 Chronological distribution of the raw material on beveled tools shaped on red deer antler 109
Table 9.23. Chronologicall distribution of the unifacial bevel ended tools (UBT: Unifacial bevel ended tools shaped on tines, UBB: Unifacial bevel ended tools shaped on beam segments, UBBB: Unifacial bevel ended tools shaped on basal and beam segments) 110
Table 9.24. Unifacial bevel ended tools on tines. Chronological distribution of the two subcategories 111
Table 9.25. Subcategories of the picks 125
Table 9.26. Manufacture and preservation status of the picks shaped on tine 126
Table 9.27. Final Neolithic Picks. Shaft holes with round cross section. Manufacture and preservation status. .131
Table 9.28. Final Neolithic picks. Shaft holes with round cross section. Comparison between the different shaping techniques and the perforation type (BR: Boring, BDR: Bow Drilling, PER+DR: Percussion and Drilling) 132
Table 9.29. Picks on tines. Shaft holes with round cross section. 133

Table 9.30. Picks on tines. Chronological distribution of the completely manufactured and semi-finished tools........137
Table 9.31. Chronological distribution of the axe types........145
Table 9.32. Axes shaped one tines. Preservation and manufacture status per habitation phase........145
Table 9.33. Chronological distribution of the beam axe types........147
Table 9.34. Chronological distribution of woodworking tools........153
Table 9.35. Needle types........154
Table 9.36. Chronological distribution of the perforated tool fragments........157
Table 9.37. Chronological distribution of hunting-fishing equipment and weapons........164
Table 9.38. Chronological distribution of the thumb ring types........174
Table 9.39. Chronological distribution of the projectile point types........181
Table 9.40. Tine tips. Relationship between the length and the diametre of the base........196
Table 9.41. Tine tips. Length and weight relationship........197
Table 9.42. Raw material of the blanks/raw material........199
Table 9.43. Blanks/raw material on red deer antler. Chronological distribution of the blanks per habitation phase........199
Table 9.44. Waste material per element (BM:beam segments, TN: tines, TJ: T-junction, CR:crown, BS:basal segment). All elements are coming from red deer antler........204
Table 9.45. Red deer antler waste material and its chronological distribution (BM:beam segments, TN: tines, TJ: T-junction, CR:crown, BS:basal segment)........205
Table 10.1. Semi finished and completed items on red deer antler.Artifact distribution according to raw material........210
Table 10.2. Semi finished and completed artifacts on red deer........... Chronological distribution according to raw material........210
Table 10.3. Chronological distribution of the Items on shed and unshed antler........211
Table 10.4. Chronological distribution of the studied material........212
Table 10.5. Chronological distribution of the artifacts according to their manufacture state........212
Table 10.6. Chronological distribution of the three main categories........213
Table 10.7. Chronological distribution of the tools according to their inferred function........215
Table 10.8. Chronological distribution of the tool types........215
Table 10.9. Quantity of antler artifacts from Neolithic settlements from Northern Greece........217

List of plates

Plate I. Sleeves on basal segments a. A9b.KE202, b.A9b.KE088, c. A9b.KE190, d. A9b.KE223........265
Plate II. Sleeves on basal segments a. A9b.KE096, b. A9b.KE223, c. A9b.KE272, d. A9b.KE46........266
Plate III. Picks on tines a. A9b.KE094, b. A9b.KE008, c. A9b.KE00........267
Plate IV. Picks on tines a. A9b.KE093, b. A9b.KE171, Pick on basal segment c.A9b.KE264........268
Plate V. Bifacial bevel ended tools on tines a. A9b.KE050, b. A9b.KE074, c. A9b.KE058, d. A9b.KE123, e. A9b.KE151 (a-d in 1:2, e in 1:1)........269
Plate VI. Axes a. A9B.KE046, b. A9b.KE079, c. A9b.KE138........270
Plate VII. Retouching tools a.A9b.KE029, b. A9B.KE134........271
Plate VIII. Waste on basal segments a.A9b.KΔ007, b. A9b.KΔ033, c. A9b.KΔ052........272
Plate IX. Waste on basal segments a.A9b.KΔ081, b. A9b.KΔ088........273
Plate X. Waste on tine and beam segments a.A9b.KΔ102, b. A9b.KΔ063........274

Chapter 1 - Introduction

1.1. Introduction

The present dissertation examines the antler artifacts from the Neolithic lakeside settlement of Anarghiri IXb which is situated in the Four Lakes region in Western Macedonia in Greece. Although the last fifty years the research of the prehistoric past of the region has been progressed significantly, so far the studies concerning the osseous and mainly the antler artifacts from the Neolithic settlements of the region are still in their infancy. This thesis has come about in recognition of this gap in our understanding of the antler working in the Neolithic lakeside settlements of the 5th and 4th mil BC in this region.

1.2. Aims of the study

This thesis has the following aims:

1. To establish a typology of the antler artifacts of the settlement. The rather big quantity of the collected artifacts gives a first chance opportunity for the establishment of a typology that could serve as the basis for the creation of a typology of all antler artifacts in Western Macedonia,

2. To study of the technological choices of the artisans and the reconstruction of the manufacture stages of the artifacts,

3. To explore the raw material preferences in terms of species and elements during the Late and Final Neolithic habitation phases,

4. To investigate the chronological distribution of the assemblage. The correlation of the artifacts with the settlements' habitation phases could provide significant information about the choices of the settlements inhabitants through time concerning the antler exploitation, the preferred raw material andartifacts types, the technological choices and the activities that these artifacts were used for,

5. To place the Anarghiri IXb worked antler assemblage within a wider framework and to compare it with assemblages from other prehistoric settlements of Northern Greece.

1.3. Limitations and difficulties of the study

The study of the antler artifacts from Anarghiri IXb was limited due to several factors that although they were rather crucial for the research, however they didn't affect dramatically or diminish its validity.

One very important factor that delimitates the conclusions of the study is related with the partially excavated settlement area. As it will be described in chapter 7,the settlement of Anarghiri IXb was partially investigated and only the trenches in the periphery of the settlement were excavated to the natural soil while the trenches in the centre of the settlement were partially excavated and in most of these trenches only the Final Neolithic layers were revealed. As one can imagine, this resulted in a blurry picture of the Neolithic habitation of the settlement and also in a difficulty for the author to compare the artifacts from the habitation phases of the settlement.

Moreover, the lack of studies concerning the spatial organization of the settlements brought a restriction in the interpretation concerning the spatial distribution of the artifacts. Since so far there haven't been recognized any spatial units (structures or houses), it is not possible to recognize any antler working or discard places.

The lack of prior research on worked antler assemblages in Greece and in the neighboring countries poses some difficulties in the analysis and in the comparison of the Anarghiri IXb assemblage with others since the comparable material is very limited. In the cases of assemblages from neighboring countries, like Republic of Northern Macedonia or Albania, the difficulty lies to the fact that the few excavation reports or publications, where there could be a mention for the existence of antler artifacts, are rarely written in English making the bibliographic research even more difficult.

The fourth factor is related to the lack of financial support and of laboratory facilities. Due to the lack of funding and high power microscope, there weren't conducted any experimental approaches that could enrich our knowledge about the function of some of the studied artifact categories.

1.4. Structure of the thesis

In order to correspond to the aims of the study which were described above, this thesis is organised into ten chapters (including this introductory chapter). These chapters contribute to the setting of the main research questions, the analysis of the relevant data and their synthetic approach.

Chapter 1 presents the aims of the study alongside its limitations. The chapter 2 reviews briefly the literature concerning the notion of technology and the chaîne opératoire approach. Chapter 3 provides information about the deer and the physical properties of their antler. In chapter 4 there is a literature review about the research history of Neolithic osseous artifacts in Europe and in Greece. Chapter 5 deals with the chronological framework of the Neolithic period in Greece while chapter 6 provides a brief outline of the research history of the Neolithic period in Western Macedonia. Chapter 7 presents the so far available data from the Neolithic settlement of Anarghri IXb mainly concerning the history of research in the settlement, its' stratigraphy and its' chronological framework. Chapter 8 presents in short the manufacturing techniques that are mentioned in chapter 9 which is the biggest chapter of the thesis and it contains the analysis of the study of the antler artifacts. This chapter presents the methodology of the study, the proposed typology and the analysis of the typological categories with a brief mention on the manufacture process and use of the artifacts. The last chapter, chapter 10, contains the synthesis of the thesis which is accompanied by a catalogue of all artifact types and plates of the most characteristic artifacts from all categories.

Chapter 2 -Artifacts and prehistoric technology

"We are the centuries... We have your eoliths and your mesoliths and your neoliths. We have your Babylons and your Pompeiis, your Caesars and your chromium-plated (vital-ingredient impregnated) artifacts..."

Walter M. Miller Jr., A Canticle for Leibowitz

2.1. Artifacts and their function

Humans are surrounded by their material culture and they are living in a world full of artifacts. Through artifacts they define their world, as "people structure and arrange their homes and workspaces, filled with the artefacts of everyday activities" (Hollenback and Schiffer 2014:314).

There are many definitions for the term "artifact". The online version of The Stanford Encyclopedia of Philosophy defines the artifact "as an object that has been intentionally made or produced for a certain purpose[1]" (Hilpinen 2011) while that of the online Merriam–Webster Dictionary as "a usually simple object (such as a tool or ornament) showing human workmanship or modification as distinguished from a natural object; and especially: "an object remaining from a particular period " and "something characteristic of or resulting from a particular human institution, period, trend, or individual [2]". According to one of the lately proposed definitions, artifacts do not exist in nature per se and they are not produced by nature. They are artificial and they are the mental and physical work of an artifex (Dellantonio et al. 2013:408-409). Although it has been suggested that only human-made objects could be considered as artifacts (Thomasson 2009), some argue that this class could also include objects made by animals (Gould 2009).

The function of the artifacts is one of the most important aspects of their study. Although it has been suggested that humans don't categorize artifacts according to their function (Sloman and Malt 2003), it seems that most researchers agree that their function is the basic criterion for their categorization. Artifacts are categorized according to their function (Dellantonio et al. 2013:408; Hilpinen 2011; Kelemen and Carey 2009; Bloom 1996, 1998) as they have been created in order to serve some purpose(s). Kelemen and Carey have stated that "..an artifact is intentionally created by a designer to fulfill some function. The intended function is the factor which determines the artifact's surface properties, the actual uses it can serve (the intended function as well as others), and its kind. In that sense, the original intended function is the artifact's essence" (Kelemen and Carey 2009:214). The physical form of the object and our intuition about the creator's intent of its function play a significant role in our categorization of the artifacts (Bloom 1998:87). The function of artifacts has a special interest in the archaeology because through the study of the function of the artifacts archaeologists can decipher the life ways and form of thought of vanished cultures (Preston 2000:22).

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[1] http://plato.stanford.edu/archives/win2011/entries/artifact
[2] https://www.merriam-webster.com/dictionary/artifact

It has been proposed that the artifacts have several different types of function. They may have various roles in order to satisfy the variety of human goals (Crilly 2010:6-7; Richins 1994). It has been suggested that the artifacts can fulfill "functional" and non-functional, "symbolic" needs. Crilly (2010:8) believes that the functional role of the artifact can be related to the satisfaction of instrumental goals and that the other roles are related to the satisfaction of social, sensory and psychological goals while Chilton (1999:1) believes that through the manufacture, use, discard and reuse of an artifact are 'constitutive processes' that make culture.

Hannson (2006) suggests that there should be a distinction between practical and non –practical functions of the artifacts. Searle (1995:21) suggested the existence of a special class function, the 'status function'. He believed that "..people collectively impose functions on artefacts where those functions cannot be achieved solely in virtue of the artefacts' physical properties or behaviours" (Crilly 2010:10). Roozenburg and Eekels define function as a concept which includes five elements: the 'technical', the 'ergonomic', the 'aesthetic', the 'semantic' and the 'social' (Roozenburg and Eekels 1995:57 in Crilly 2010).

The most known theories about the function of the artifacts are those of Binford and Schiffer. In his classic paper "Archaeology as Anthropology", Binford expressed the idea that the material culture could be distinguished into three big categories: the technomic artifacts, the sociotechnic artifacts and the ideotechnic artifacts (1962:219). According to Binford, the technomic " signifies those artifacts having their primary functional context in coping directly with the physical environment" (ibid), the sociotechnic artifacts "were the material elements having their primary functional context in the social sub-systems of the total cultural system"(ibid) and the ideotechnic artifacts "have their primary functional context in the ideological component of the social system" and " these are the items which signify and symbolize the ideological rationalizations for the social system and further provide the symbolic milieu in which individuals are enculturated, a necessity if they are to take their place as functional participantis in the social system" (ibid.219-220).

Schiffer proposed a classification of the artifacts according to their embodied function and distinguished three different types of function: technofunction, sociofunction and ideofunction (1992:9-12). He suggested that the technofunction is the utilitarian function of the artifact; the sociofunction is related with the manifestation of social facts while the ideofunction is related with more abstract ideas like beliefs or values (ibid.9-12). Artifacts can have one or more functions at the same time. An item can have technofunction and sociofunction simultaneously. Also their function is not fixed. Artifacts can have fluid identities and they can constantly lose or acquire functions (Preston 2000:31).

2.2. The notion of technology

The understanding of the prehistoric human behavior relies mainly in the study of the prehistoric technology. The importance that was given to the study of the technology was very high. The first researches about the technological evolution of the humans, especially the studies related to lithic technology, led to the assumption that the evolution of the prehistoric human behavior is strongly related to the evolution of the prehistoric technology. As a result, the classification of the human era periods has been based to the evolution of the technology and from the 18th century these periods have been named after the technological characteristics of each period. The terms " Paleolithic period", "Neolithic period", "Bronze Age period" along with their sub-phases are indicative of the importance that researchers have given to the technology in order to define the human evolution throughout the centuries.

The word "technology" derives its meaning from the Greek words τέχνη (techni) and λόγος (logos). Techni means skill or craft and its literal meaning is: "discussion about the skills or crafts". According to the online version of Collins dictionary: "Technology refers to methods, systems, and devices which are the result of scientific knowledge being used for practical purposes"[3] while the online version of the Cambridge Dictionary defines technology as: "the study and knowledge of) the practical, especially industrial, use of scientific discoveries[4]**".**

Technology should not only be seen from a practical or technical point of view. Technology must not viewed in its narrow sense as "the techniques and materials used in the primary production of objects (Dietler and Herbich 1998: 237) alongside with the skill, the labor and the finished product. According to Ellul (1980), technology can also be seen as the mediator between humans beings and the natural environment or as a facilitator that enables humans to do what they couldn't do on their own, without any unaided means (ibid:34).

Recent studies suggest that technology has tight links to the society and it's a social construct. For Marcia-Anne Dobres the technology is always and everywhere socially constituted (2000:96), it is the "social practice and the processing of the material world: it is an ever unfolding and intersubjective dynamic that is not reducible to activites of artifact making and use" (ibid.96) and it is "no less than a materially grounded arena in which social interaction and contestation mediate the "becoming" of social agents and their artifacts" (Dobres 1999:138). Miller (2007:4) is on the same ground as she defines technology as a "set of actions and relationships: from production itself, to the organization of the production process, to the entire cultural system of processes and practices associated with production

[3] https://www.collinsdictionary.com/dictionary/english/technology Last visit 05/12/2016
[4] https://dictionary.cambridge.org/dictionary/english/technology Last visit 05/12/2016

and consumption". Schiffer and Skibo (1987:595) believe that technology comprises of the artifacts, the processes and the knowledge for the manufacture and use of the artifacts that is transmitted intergenerationally.

2.3. Archaeological approaches to technology-The notion of chaîne opératoire

The study of the prehistoric technology was one of the ways towards the understanding of the prehistoric human behavior. At first the study of the prehistoric artifacts was based on the constructions of typologies that were based on the morphology of the artifacts (Dobres 2000). It was evident that it was missing the link between the artifacts and their manufacturers or their users and the mental activities and the social structures that contributed to their manufacture.

From the 1950's till today there seems to be a more complex and interdisciplinary approach of the prehistoric technology. One of the new approaches of the tangible remnants of the prehistoric technology / or of the prehistoric artifacts / is the notion of the "chaîne opératoire" a term that was used first for the description of the stone tools manufacture but later its use was expanded to artifacts from different materials (Bleed 2001:106).

The chaîne opératoire is an interpretive tool that have been developed for the study of the prehistoric technology. The term of the "chaîne opératoire" was appeared in France and was systematically developed by Andre Leroi-Gourhan (Leroi-Gourhan 1964), who was the first to discuss its usefulness and the positive outcome of its use in archaeology (Audouze 2002:287). It seems that Leroi-Gourhan's thought on this matter was influenced by the work of Marcel Mauss. As early as the 1930's the French ethnologist/anthropologist Marcel Mauss had developed the idea of a manufacturing sequence that consists of various transformation stages of the product (Audouze 2002:287).

So far there is not a standard definition of the chaîne opératoire. Some researchers have concentrated on the technical aspect of the term while some others are trying to incorporate a cognitive aspect into their definitions for this term. The *chaîne opératoire of* an artifact «encompasses all the successive processes, from the procurement of raw material until it is discarded, passing through all the stages of manufacture and use of the different components. The concept of *chaîne opératoire* makes it possible to « structure man's use of materials by placing each artefact in a technical context, and offers a methodological framework for each level of interpretation» (Inizan et al.1999:14). Perles (1987:23) describes chaîne opératoire as "a succession of mental operations and technical gestures, in order to satisfy a need (immediate or not), according to a preexisting project" while Lemmonier (1992:26) believes that the chaîne operatoire is the "series of operations involved in any transformation of matter (including our own body) by human beings." One of the most integrated definitions is the one provided by Sellet (1993:106) who believes that "the *chaîne opératoire* aims to describe and understand all cultural transformations that a specific raw material had to go through. It is a chronological segmentation of actions and mental processes required in the manufacture of an artifact and in its maintenance into the technical system of a prehistoric group. The initial stage of the chain is raw material procurement and the final stage is the discard of the artifact."

Through chaîne opératoire researchers can move beyond simple and sterile typologies (Dobres 2000:167) and they can reconstruct the "biography" of the artifacts: the successive processes of the raw materials' transformation to an artifact,, its use and final discard. Also, the chaîne opératoire can be viewed as a framework through which researchers can understand 'the meaningful links and chains between people and products, between artifice and artifacts, and between gestures and gadgets' (Dobres 2010:107). Through this approach the researchers can search for alternate techniques and discover more about the knowledge and skill level of the artisans, their intentions and their failure during the manufacture process and also to know more about the physical, mechanical and chemical properties of the raw material (Dobres 2000)

Though such an approach the researchers can study the step of choices made by the artisan from the procurement of the raw material to its use and discard. The researchers examine the choices concerning the raw material choices such the source of the material, the variability and the alteration of the material and the environmental resources that led to the choice of a particular raw material (Inizan et al. 1999:15). They also examine the physical actions taken during the manufacture process and they try to find the cognitive reasoning behind them (ibid.15). These physical actions are related to psychomotor actions, so the body and the hand act to the brain transmitted orders and they are studies through experimental methods (ibid.15). The function of the artifacts can be determined through experimentation and use wear analysis and comparison of the ones that were experimentally manufactured to the archaeological ones (Semenov 1964; Campana 1989; Keeley 1980).

Chapter 3 - Deer and their antler

"Your growing antlers,' Bambi continued, 'are proof of your intimate place in the forest, for of all the things that live and grow only the trees and the deer shed their foliage each year and replace it more strongly, more magnificently, in the spring.

Each year the trees grow larger and put on more leaves. And so you too increase in size and wear a larger, stronger crown".

Felix Salten, Bambi's Children

3.1. Red deer and roe Deer

3.1.1. The red deer (Cervus elaphus)

The red deer (*Cervus Elaphus*, Linaeus 1758) (fig.3.1) is a hoofed ruminant mammal and it belongs to the order Artiodactyla and to the Cervidae family, which consists of 17 genera and has almost 53 species (Price et al.2005:604, Wilson and Reeder 2005). It is considered one of the most widespread and studied wild life species and it can be found worldwide in North America, Europe and Asia, Siberia. Lately, it has been imported to South America, to Australia and New Zealand (fig.3.2) (Nowak 1991; Hall 1981; Lovari et al.2008; Wilson and Mittermeier 2011).

The red deer body size and weight varies highly and is considered as an environmental indicator. It can change in response to the available climatic conditions and the available vegetation (Walvius 1961; Langvatn and Albon 1986). The height of the male red deer ranges from 1,75m to 2,30m while the female is rather shorter with its height ranging from 1,60m to 2,10m (Geist 1998). There have been noticed large differences in the body weight between the two sexes (Langvatn and Albon 1986; Solberg et al. 2012).The typical weight for female red deer (5-13 years old) usually ranges from 100 to 140 kg and for the male red deer between 180-210 kg (7-10 years old) (Langvatn and Albon 1986) but it has been also suggested that the weight of the male can range from 110 to 478.6 kg (Geist 1998:349-350).

Red deer gives usually single births and the multiple pregnancies are very rare (Mitchell et al.1977:3). Observations on modern red deer groups showed that the ruting (mating) season lasts from September to November (Lincoln and Guiness 1973). Pregnancy lasts the whole winter and calves are born between late May and late June (Mitchell et al.1977:3; Loe et al.2005). The maximum life-span of the red deer is almost 20 years (Mitchell et al.1977:3).

It is considered as a species that can adapt to a rather wide range of environments and to different climatic and vegetation zones (Straus 1981). It has been noted that they rarely immigrate (McCullough 1969 in Steele 2002:36) but they usually move in their local environment as a response to the climatic condition and to food availability (Adams 1982) and that they move to higher elevations in the summer (Adams 1982). Red deer rarely occupy large, dense forests (Mitchell et al.1977:3). Their ideal living environment is wooded areas with a protective forest with some open areas where they can graze and browse (Steele 2002:34) and they prefer to 'stay close to the forest-steppe slopes with meadows covered with grass' (Flerov 1952 in Mitchell et al.1977:8). In woodland areas, they usually eat shrub and tree shoots and in other environments they consume grasses, sedges and *shrubs* (Lovari et al.2008:4-5).

Figure 3.1 Red deer (Photograph by Elizabeth Dack. Used under kind permission)

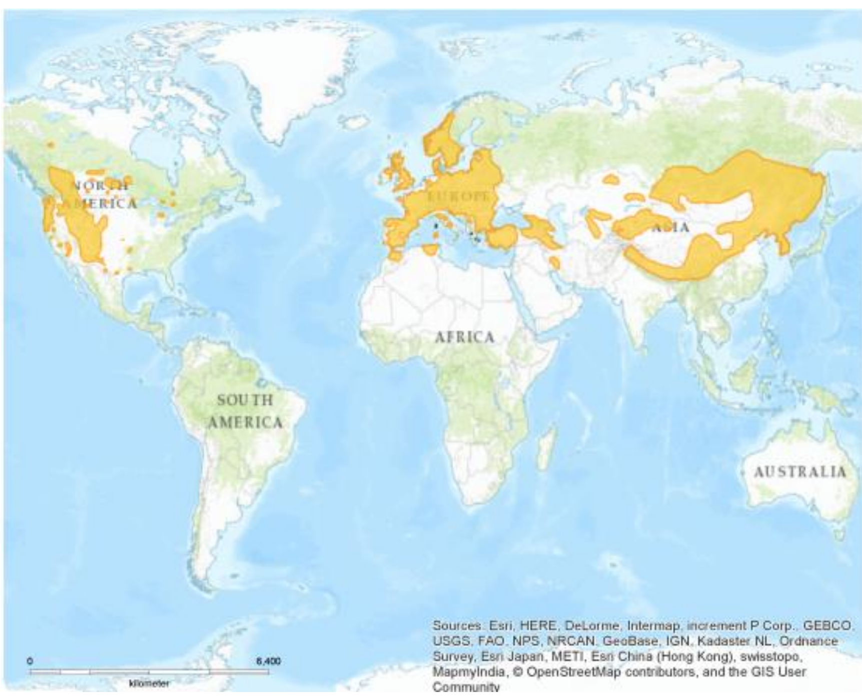

Figure 3.2 Geographical distribution of the red deer (Lovari et al. 2008)

Red deer are considered social animals and they usually live in matriarchical groups (Clutton-Brock 1974). The size of the group is variable from small groups of 5-10 individuals to rather large groups of thousands (Boyle 1990 in Steele 2002:36). It is believed that the group size is dependent to many factors like food availability, weather conditions and season

(Mitchell et al 1977:20). It has been noted that hinds (female deer) form groups that consist of a matriarch, her daughters and other dependent deer of both sexes (Mitchell et al.1977:19) but most of the year the males live separately from the females. The adult males usually live alone or in rather small groups (Knight 1970 ?) and they get close to the female herds in late summer and during the rutting season these males challenge the dominant male of the herd in order to become the harem holder (Lovari et al.2008:5; Steele 2002:36).

3.1.2. The roe Deer (Capreolus Capreolus)

The European roe deer (Capreolus Capreolus, Linaeus 1758) belongs to the Cervidae family like the red deer (fig.3.3). It can be found throughout Europe and partly in European Russia and it is now extinct from Lebanon and Israel, the islands of Ireland, Cyprus, Sardinia, Corsica and other small islands (Lovari et al.2016; Danilkin, 1996; Wilson and Reeder 2005; Sempere et al., 1996). It can also be found in the area of Caucasus, Turkey, northern Iraq, northern Iran and northern Syria (Lovari et al.2016) (fig3.4). Roe deer is rather small compared to the red deer. Its body length varies from 0.95 to 1.35m and its weight ranges from 15 to 35 kgs (Macdonald & Barrett 2001).

Figure 3.3 Roe deer (Photograph by Elizabeth Dack. Used under kind permission)

Roe deer prefer woodland landscapes with mixed or coniferous forests but also it can occupy a wide range of areas like arable lands, pasture, moorlands and marshes (Stubbe 1999; Linnell et al.1998). In late autumn and winter, roe deer form herds which are not stable and vary in size. Their grouping can be affected by many factors like food availability or the environment (Maublanc et al.1987). These groups consist mostly of one or two females, their offspring and some males that are allowed to join the herds (Linnell et al.1998). Roe deer ruts in the summer and has a rather long gestation period that can last up to 9 months and so the fawns are born in the spring, from May to early June (fig.3.5) (Goss 1983:22,28). The average life-span of the animal is about 10 years (Pikula et al.1985).

Figure 3.4.Geographical distribution of roe deer
(Image Source : http://maps.iucnredlist.org/map.html?id=42395)

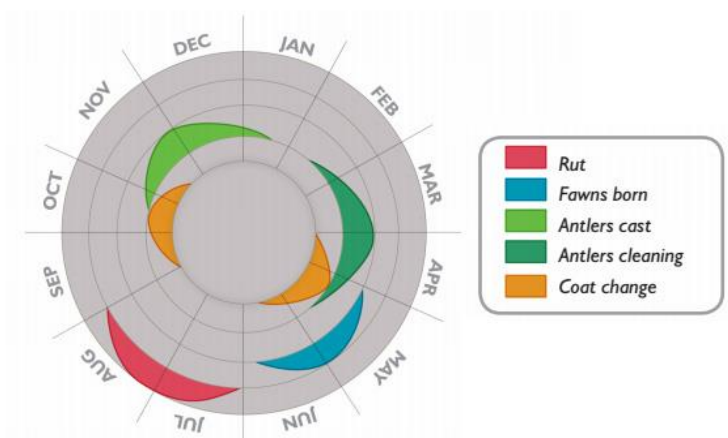

Figure 3.5 Roe deer annual cycle (Source: Deer Iniative 2008b)

3.2. Red deer antler and roe deer antler

3.2.1. Red deer antler

The red deer antler growth cycle begins in spring (Chapman 1975) or early summer when the testosterone levels are low (Foxon 1991:47). At the end of summer these levels stop rising and the velvet gets rubbed off by the deer while the antlers remain in the head of the deer over winter (ibid.47). It is believed that the growth and the shape of antler is affected by some environmental factors like the photoperiod, the temperature and also the availability of food (Muir 1985:9-21). Red deer shed their antlers in spring, from mid-March to end of June (fig.3.6). There are a lot of factors such as weather and age (Clutton-Brock et al. 1982) that can affect the shedding date, so it's rather difficult to predict the shedding dates.

At first, the fawn develops the pedicle on the frontal bony part of the skull and later, in its second year, the antler starts to develop in the pedicle (Goss and Powell 1985; Kierdorf and Kierdorf 2002:22). In its first form it is a spike-like antler (Hall 2015:124) and after its shedding, it is replaced next year by a new antler, more branchy and it is replaced later and in the following years by more branched antlers (Hall 2015:124)(fig.3.7).

The red deer antler consists of three main elements: the pedicle, a long beam and the tines (fig.3.8). The pedicle is the junction between the pivot and the beam while the beam, or shaft, is the main branch that extends from the pivot (Crigel et al.2001). In the basal segment of the beam at the proximal end of the antler there is the burr and on top of it the coronet, a protruding ring that encircles the base (Foxon 1991:49; Jin 2010:149, fig.3). The tines are protruding forwards from the beam and the head of the deer (Picavet and Ballingad 2016:141; Crigel et al.2001). The first tine is called brow tine, the second one bez tine and the third one trez tine (Muir et al.1987). All of them are attached to the beam and the upper part of the antler is called crown and it consists of the royal tines (Muir et al.1987).

The structure of the antler is not the same in every species. The red deer antler has a thinner cortical tissue that covers the whole antler from the basal segment to the beam and the tines and the inner cancellous bone (Bouchud 1966, 1974; Chen et al.2009:695) (fig.3.9). The cancellous bone is porous, with channels somewhat aligned parallel to the long axis of the antler beam while the compact bone consists of osteons that have a laminated structure of concentric rings extending from the main channel (blood vessel) (Chen et al. 2009:695). The cortical bone is thicker on tines and less on the beam. The thickness of the compact bone decreases towards the antler crown and the thinnest compact bone is located at the point of the transition to the tines (Habel 1994 in Riedel et al.2004:198). Generally, the proportions of the cancellous bone to the cortical one vary and are dependent to various factors such as the species, the anatomical part, the age, the growing cycle and the diet of the deer (Bouchud 1966; MacGregor 1985:9-14, Clutton-Brock 1984:16-17; Averbouh 2000).

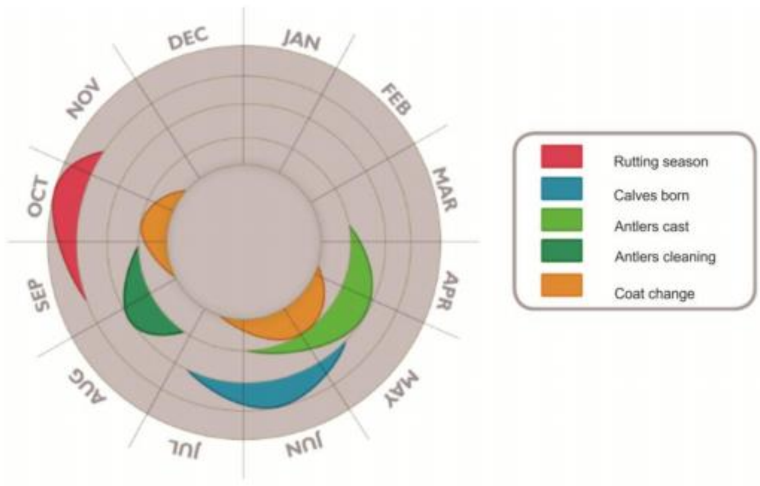

Figure 3.6 Biological cycle of the Red deer (Source:The Deer Initiative 2008a)

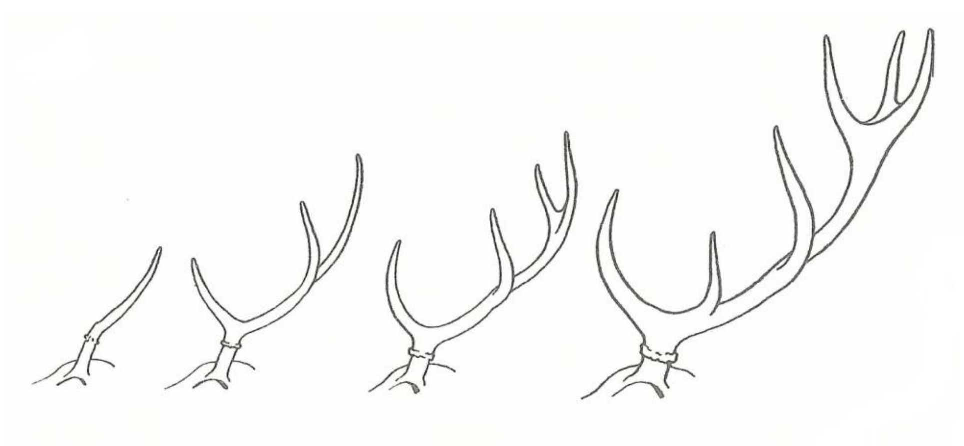

Figure 3.7.Growth of red deer antler (Suter 1981, fig.12)

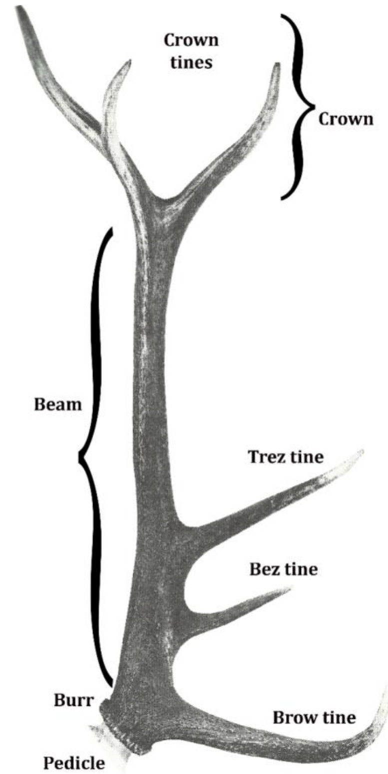

Figure 3.8. Red deer antler morphology (Modified after Suter 1981, fig.5)

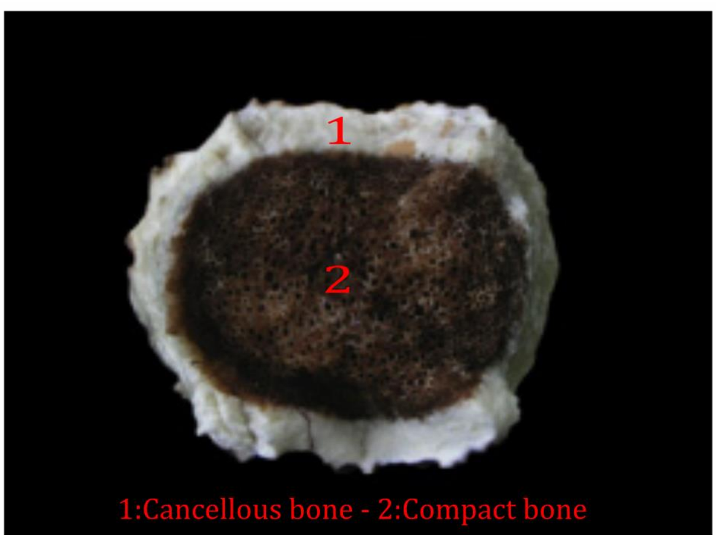

Figure 3.9. Structure of the red deer antler (Modified after Baumann and Maury 2013, fig.1)

3.2.2. Roe deer antler

As in red deer, only the male roe deer grows antler but the antler cycle between these two animals differs a lot. Unlike red deer, roe deer grow antlers throughout the winter months and it has been reported that they can grow antler twice per year (Goss 1983:28, fig.3.10).

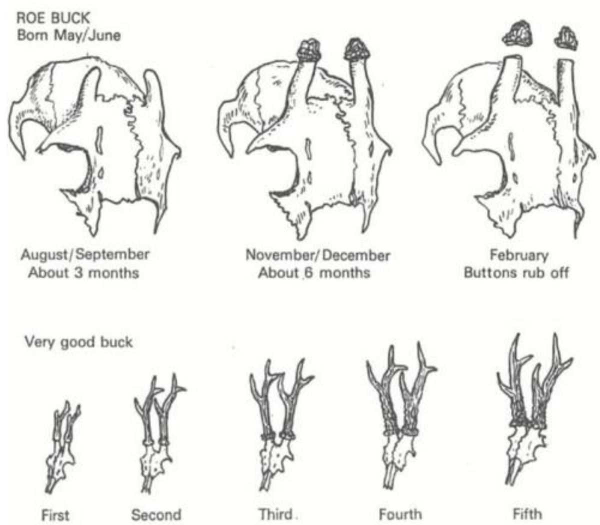

Figure 3.10. Roe deer antler development (Page 1971:38)

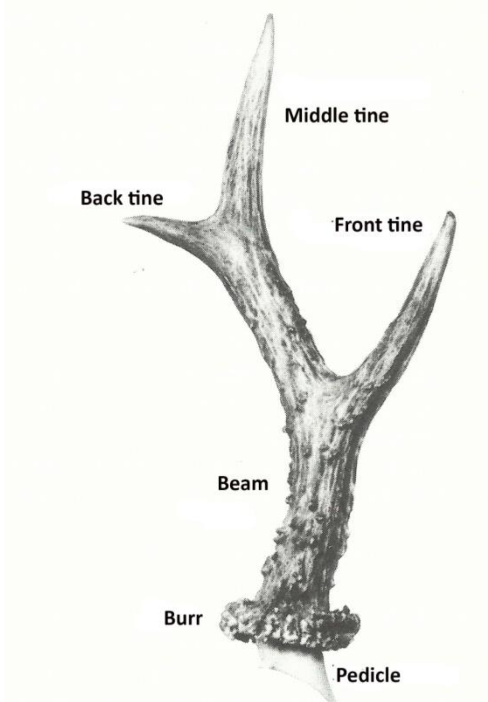

Figure 3.11. Roe deer antler (Modified Suter 1981, fig.6)

The antler development starts after their casting in November and December and the antlers grow until spring (Geist 1998:304, Goss 1983). A new set of antlers will appear in February and develop gradually. Each year the antlers become longer and thick and their development becomes complex gradually as the deer grows older (fig.3.10). The period of their growth lasts 81-93 days (Chapman 1975) and their average length is 17cm (Linnell et al.1998), much less compared to the red deer antler. It consists of a short beam and the tines that are not protruding forwards but mainly upwards (fig.3.10, 3.11).

3.3. The physical and mechanical properties of the antler

3.3.1. Physical Properties of the antler

Antlers are paired bony protuberances on the skulls on the majority of the Cervidae (deer) family and they are covered for some part of the year by velvet (Hall 2015:123) which feeds and protects the antler from drying. They are considered as weapons as they are used in rutting between the male deer (Goss 1983, Geist 1998)

Antlers are considered to be a sexual characteristic as only the male deer have antlers (Whitehead 1964; Goss 1983). However, it has been noted that some small deer species such as the Chinese water deer (Hydropotes) and and three species of musk deer (Moschus Moschiferus) do not produce antler (Whitehead 1972;, Muir 1985:2; Currey et al.2009:3985) and that reindeer (Rangifer tarandus) is the only deer species in which both sexes produce antlers, although much smaller in size and less impressive (Cornwall 1968:67-69, Davis 1987:59; Reitz and Wing 2008:63-63, Cegielski *et al.* 2006).

Antlers are attached to the skull through pedicle which is an extension of the frontal bone and grow and cast annually in about 100 days (Sedman 1993:36; Goss 1983; MacGregor 1985) through a rather standardized process (fig.3.12). In some cases, like the Indian Sambar Rusa unicolor, the antlers don't cast off each year and these deer can carry an antler set for several years (Hall 2015:123).

The antler is considered the only bone of the mammals that can be regenerated (Goss 1983: xiii; Chen et al 2009:693). It can regenerate very quickly, with a maximum rate of 2 to 4 cm per day and it is considered as one of the fastest growing tissues (Goss 1983; Modell 1969). The antler cycle of the cervids is closely related to the seasonal variation of sexual steroids (Bubenik 2006:275) as it grows during the period of low concentrations of reproductive hormones (Bubenik 2006:277) and it's an event that occurs strictly seasonally (Goss 1969).

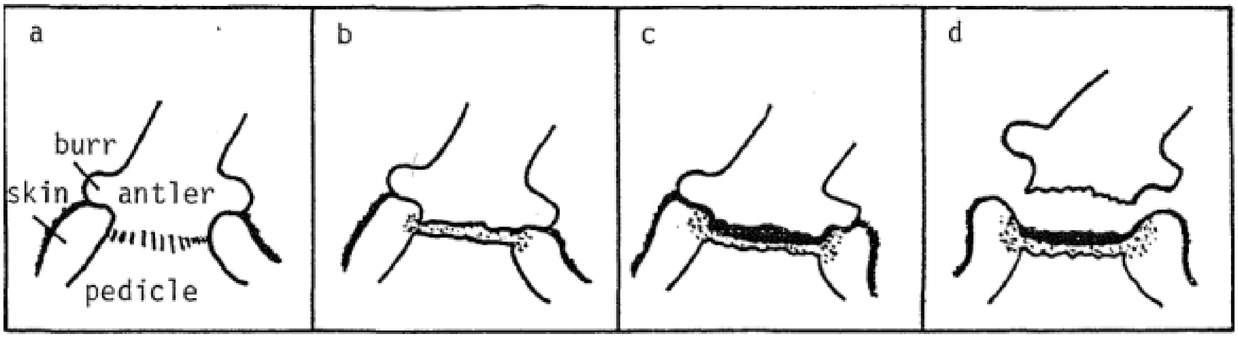

Figure 3.12. Antler casting process (Wislocki and Waldo 1953 in Muir 1985:4)

3.3.2. Mechanical properties of the antler

The composition of the antler is not very different from those of the other bones and it is considered a bone (Chapman 1975; Currey 2002). Although they have almost the same structure and composition as bones, they have a significant difference. Bones contain interior fluids such as blood and marrow and produce vital cell while antlers remove them from the body in order to grow (Chen et al.2008:216). In dry weight it consists mainly (60 %) of inorganic components (mostly phosphorus and calcium) and the rest 40 % are organic components (mainly collagen) (Rajaram and Ramanathan 1982).

Although bone and antler have almost the same composition, it has been found that their mechanical properties differ significantly. According to experiments (Currey 1979, 1990, 1999; MacGregor and Currey 1983; Zioupos et al.1994, 1996), that tested the hardness, the fatigue and the strength on mineralized tissue from various taxa, the antler had the lowest mineral content and the lowest elastic modulus of all tested bones and that the quantity of the mineral content is responsible for the elasticity and the toughness of the antler (Chen et al.2008:217). Nevertheless, it is very tough (Biewener and Bartram 1991:68) and so it can absorb the impact shock more easily when the deer are competing and fight with their antlers during the rutting season (Currey 2002:124). Also, this toughness made them very useful, not only to deer but also to humans, since they have been exploited since the Paleolithic period (Rigaud 2001; Wescott 1999).

3.4. Use of antler from deer

The male deer can use their antler in many ways in the intra sexual competition during the rutting season (Clutton-Brock 1982; Jin and Shipman 2010:93). Firstly the antlers can be used as visual weapons. The deer compare each other's antler size and sometimes one of the two competitors backs off if his antlers are smaller and their morphology less complex than those of his opponent (Jin and Shipman 2010:93). If neither retreats, then the deer lower their heads and start fighting using the antlers as weapons. Also, deer use the antlers in order to mark their territories by rubbing them against trees and bushes (ibid.93) or in order to thrash vegetation and make hollows in the ground (Foxon 1991:46).

Chapter 4 - Prehistoric worked bone and antler studies: literature review

4.1. The study of the prehistoric worked bone and antler industries in Europe

The following research review of the osseous artifacts is introductory and not comprehensive and therefore it is related mainly with the study of Neolithic and Bronze Age osseous artifacts and less of the Paleolithic assemblages.

Generally the osseous industries are amongst the most understudied artifact categories compared to pottery, stone tools or faunal assemblages. Until the 1960's the research of the bone artifacts in Europe was rather limited. Publications exclusively for osseous artifacts were rare and one could find only small chapters about this topic at the end of some excavations reports where worked bone was treated like the other small finds (Olsen 1984:25)

The establishment of typological systems has been one of the most important aspects of the analysis of the osseous artifacts. The work of Henrietta Camps-Fabrer in the 1960's marked the beginning of a new era in the research of the worked bone artifacts. Her work (Camps-Fabrer 1966) was based more on morphological criteria but she was one of the first to define a very detailed typology that became the basis for future works (Leroy-Prost 1973). She organized many meetings and workshops about the worked bones and published a series of volumes about worked bones from the Paleolithic to the Bronze Age (Camps-Fabrer 1977, 1979, and 1982). It won't be an exaggeration to say that she is the founder of the French school of the research of the worked bone industries (Commission *de nomenclature sur* l'industrie *de l'os* préhistorique) that is still active and publishes up to now several volumes on worked bone artifacts mainly on based on their functions or their manufacture state (Delporte et al. 1988; Patou 1986; Patou-Mathis 2002; Cattelain 1988; Camps-Fabrer et al.1990)

The typological studies of the osseous artifacts advanced significantly during the 1980s and 1990s due to work of Central European researchers. Billamboz (1977, 1982) was the first one to study Neolithic and Bronze Age worked antler industries from France and Switzerland. The work of Jörg Schibler and Peter Suter on the bone and antler artifacts (Schibler 1981; Suter 1981) from the Neolithic lakeside settlement of Twann in Switzerland affected significantly a lot of subsequent studies as their proposed typological systems are being used until today as a common typological system by many European researchers (Marinelli 1995; Stratouli 1998a; Tóth 2012; Choyke 2005). The research of Eva David and Isabelle Sidéra on the Mesolithic and Neolithic bone artifacts from various settlements in France provided a new look in the study of the osseous artifacts. Their work, although it gave useful detailed typologies, is characterized by a more technological approach (David 1999, 2003, 2004, 2007; Sidéra 1993, 1998, 2005) based on the traditional French approach.

The introduction of experimentation in the study of osseous artifacts defined the beginning of a new era since through this approach the researchers were able to reconstruct the manufacture process and to propose possible functions about the osseous tools. The study of the bone artifacts was advanced mainly due to the work of Sergei Semenov who set the basis for the experimentation and the function analysis of the tools. Semenov (Semenov 1964) introduced the experimental replication and the use wear analysis in lithic and worked bone studies. He suggested that these two fields alongside with the ethnographic observations could provide useful information about the manufacture of the tools (ibid.)

The experimental approaches, both technological and functional, increased gradually in the next decades (Aimar et al. 1998; Barge 1982, Campana 1989; Camps-Fabrer and D'Anna 1977; Christidou and Legrand 2005; Dauvois 1974; d'Errico 1991,1993, 1996; Legrand 2005,2007; Lemoine 1994,1997; Maigrot 2001,2003; Olsen 1984,2007; Peltier 1986; Schibler 2001; Senepart 1991; Sidéra 1993; Sidéra and Legrand 2006; Stordeur 1983,1986,1989) and approved to be a very helpful tool for the reconstruction of the past activities. Nevertheless, this kind of approach is not widely used as it is time consuming, it requires resources and materials for experimentation which are not easily available to all researchers or laboratories.

Although at first the study of the prehistoric osseous artifacts was limited in Central Europe, it seems that lately this kind of study is becoming more popular in Southern and Eastern Europe as the number of the publications and M.A./PhD theses concerning Neolithic and Bronze Ages has increased a lot. The last decades new research from Serbia (Bačkalov 1979; Russell 1990; Lyneis 1988; Vitezović 2007,2011,2013a-e,2016,2017), Bulgaria (Бояджиев 2014; Höglinger 1997; Lang 2005; Legrand and Sidera 2004; Zidarov 2005,2014; Sidera 2005,2011) Romania (Beldiman 2005,2007; Beldiman and Sztancs 2011; Beldiman et al.2012; Sztancs and Beldiman 2014; Sztancs et al. 2010,2013; Mărgărit et al.2009,2010, 2016), Hungary (Choyke 1984,1987,1997; Tóth 2012) and Turkey (Goodarzi-Tabrizi 1999; Griffits 2011; Marinelli 1995; Paul 2016; Paul and Ergogu 2017; Russell 2005, 2012,2013) is shedding new light to our knowledge about the prehistoric osseous industries.

4.2. History research of prehistoric osseous artifacts in Greece

The earliest report about prehistoric worked bone in Greece comes from the report of Dawkins about the bone tools from Palaikastro in Crete (Dawkins 1904-1905) while some years later Christos Tsountas describes some of the bone tools that he found in Sesklo and Dimini (Τσούντας 1908). He also classifies them and talks about their raw material, their manufacture and their possible function. His typological system was later used by Wace and Thompson (Wace and Thompson 1912) for the classification of the bone tools that were found in their research in Thessaly. After a hiatus of almost sixty years the next report about prehistoric bone tools can be found in the report from Franchthi Cave in Peloponesse (Jacobsen 1973).

The last 30 years there was an increase concerning the studies of prehistoric worked bone assemblages in Greece that followed the latest advances in the study of worked bone technology in Europe. The small and rather rare reports about the worked bone assemblages that were usually incorporated into bigger excavation reports were gradually substituted by bigger in length studies (Arabatzis 2013, 2016; Christidou 1997, 2001, 2005; Elster 2001, 2003; Στρατούλη 1987, 1997, 2000, 2002; Χρηστίδου 1992, 1998 Χατζούδη 2002).

At the same time a considerable amount of MA and Ph.D. theses, concerning worked bones assemblages from prehistoric, both Neolithic and Bronze Age, settlements, has been emerged showing the academic interest for this until recently underrated artifact category (Αραμπατζής 2006; Γιαννακοπούλου 2009; Moundrea-Agrafioti 1981; Stratouli 1998b, Χατζούδη 2001; Christidou 1999). The majority of these studies are related with worked bone, antler and tooth assemblages that are coming mainly from Neolithic settlements and less from Bronze Age settlements. A few of them are related with the Early Neolithic period of Thessaly (Moundrea-Agrafioti 1981) while the rest of them concern assemblages from Middle and Late Neolithic settlements of Thessaly (Moundrea-Agrafioti 1981, Stratouli 1998b), Northern Greece (Αραμπατζής 2006; Arabatzis 2013,2016; Christidou 1999, 2005; Isaakidou 2003; Sériadès 1992; Stratouli 1998a,1998b; Χατζούδη 2002; Χρηστίδου 1992, 2010). A limited number of studies are referring to assemblages from settlements from mainland Greece (Στρατούλη 1993; Leroy-Prost 1977), Southern Greece (Payne 1973, Στρατούλη 1997) and from settlements from the Aegean Sea islands (Γιαννακοπούλου 2009; Moundrea-Agrafioti 2011; Στρατούλη 1987, 1993). In most of the settlements the worked bone and antler assemblages are being comprised by 100-200 artifacts with an exception of a few cases with 600-700 artifacts (Elster 2001,2003) while in some cases the assemblages can contain more than 4000 artifacts (Arabatzis 2016b, 2017 2018). So far, there are a few studies concerning worked bone and antler assemblages from the prehistoric lakeside settlements of Western Macedonia (Arabatzis 2016; Στρατούλη 2002; Υφαντίδης 2002, 2018). These assemblages are rather small (no more than 1000 artifacts) and contain tools, anthropomorphic figurines, spindle whorls, fish hooks and projectile points[5]. It's noteworthy that these assemblages have been treated both typologically and technologically by all authors.

In almost all of the published assemblages of Northern Greece, the antler artifacts are quite limited and they are being treated as part of the osseous artifacts. With the exception

[5] Fotis Ifantidis studied the antler ornaments of Dispilio in his PhD thesis that was related with the ornaments of this settlement. In her report on the antler tools of the same settlement (Στρατούλη 2002) describes briefly the main typological categories but fails to mention the number of antler tools.

of Makriyalos (Isaakidou 2003) and Sitagroi (Elster 2001, 2003) where 161 antler artifacts were collected, most of the studied assemblages don't contain more than 50 antler artifacts (Nea Nikomideia: Stratouli 1998a; Servia:Stratouli 1998a; Megalo Nisi Galanis: Christidou 1999; Stavroupoli:Χατζούδη 2002; Dikili-Tash:Christidou 1999, Sériadès 1992).

So far, there are only two studies concerning only worked antler assemblages from Neolithic settlements. Moundrea-Agrafioti (1987) provided a brief typology of the hafted antler tools based on the collected assemblages from the Neolithic settlements of Thessaly. Although her analysis is not so exhaustive, it is the first one that treated this tool category in Greece. The most recent analysis of antler artifacts comes from Rozalia Christidou (Χρηστίδου 1998) who tried to compare the antler artifacts from two settlements from Northern Greece through a technological point of view.

Chapter 5 - The chronological framework of the Neolithic period in Greece

The chronological framework of the Neolithic period in Greece

The chronology of the Greek Neolithic is based mainly on the terminology that was applied for the study of the Neolithic settlements of Thessaly. This is not surprising because Thessaly was the area where the first systematic investigations of the Neolithic era in Greece in the 20th century were focused on. These investigations led to the creation of a chronological sequence of the Neolithic period of the area that was influenced by other chronological systems in the Balkans and in Europe. Until now, there is not a definite system that can be applied to the whole Greek territory since the time limits of the various proposed phases of the Greek Neolithic have not been clearly defined but there are various systems that can be mostly applied to specific regions. So far it's almost impossible to apply one chronological system to the whole Greek territory. Nevertheless, as the scope of this thesis is not to suggest a solution to this problem, in this subchapter an effort will be made in order to present briefly the chronological framework of the Neolithic period in Greece based on recent syntheses.

At the beginning of the 20th century, the excavation in two prehistoric settlements in Thessaly, Sesklo and Dimini, and the chronologies that were derived from the study of the pottery of these two sites, was the stepping stone for the establishment of a chronological system. Tsountas recognized three phases and according to his classification, the Neolithic period could be divided into two phases, Thessaly A and Thessaly B, and one more phase could be ascribed to the Early Bronze phase (Τσούντας 1908). Wace and Thompson, two English archaeologists who excavated in Thessaly a few years after Tsountas, followed his division and added one more phase - the Chalcolithic - between the Neolithic and the Bronze Age (Wace and Thompson 1912:22).

This chronological system remained unaltered for almost three decades. Much later Weinberg revised that system (1947:181) and proposed a tripartite division of the Neolithic period with the following phases: Early, Middle and Late Neolithic (1947: 171-176,181). He compared the material from Corinth with the one from Thessaly and he also (as Wace and Thompson) suggested the existence of a Chalcolithic phase between the Neolithic and the Bronze Age (1947:173)[6].

This system was partially revised in the next two decades based on their excavations in Thessaly by the two prolific researchers of the prehistory of Greece, Dimitrios Theocharis and Vladimir Milojčić. The latter divided the Neolithic to five phases (Milojčić 1950/51) and suggested that the first phase should be ascribed to the Early Neolithic, the next two to the Middle Neolithic, one to the Late Neolithic and the last one to the Chalcolithic (Milojčić 1950/51:1-90; Milojčić 1959:24; Wijnen 1981:3) and that the Early Neolithic should be

[6] The term Chalcolithic was also used by Greek prehistorians like Georgios Mylonas who had used it in 1928 in his review of the Neolithic period in Greece (Μυλωνάς 1928).

divided into three subphases (Fruhkeramik, Protosesklo, and Vorsesklo[7]) (Milojčić 1950/51, 1960).

Since then, this division became the basis of the chronological system that was used for the whole of Greek mainland and the islands. Various sub phases that were mainly related to regional assemblages were added to this system and all of them were supported with numerous new radiocarbon dates and studies of ceramic assemblages which contributed to relative chronology schemes that defined even more the time limits of each phase and sub phases (Thessaly: Milojčić and Hauptmann 1969; Hauptmann 1981; Otto 1985, Aegean: Renfrew 1972, Coleman 1992; Sampson 1993; Macedonia: Ασλάνης 1992, Peloponnese: Phelps 1975; Deutch 1978, Attica: Παντελίδου-Γκόφα 1997, generally for Greece: Treuil 1983; Treuil et al.1989).

In the last 30 years a number of new chronological syntheses had emerged concerning the Neolithic period of various parts of Greece (Thessaly, Macedonia, Crete). The chronological scheme of Demoule and Perles[8] (Demoule and Perles 1993) is still considered today as a sound basis for a refined system for the Northern Greece (Andreou et al 1996:3, table 1), which is widely accepted by everyone working especially in Northern Greece in the last 20 years. The chronology suggested by Gallis some years ago (Γαλλής 1996) was also based on Thessalian material as the other two systems proposed by scholars working for several years in the area (Alarm-Stern and Dousougli-Zachos 2015; Reingruber et al. 2017). The synthesis of Papadimitriou (Παπαδημητρίου 2010 :20) instead was based on material from almost the whole of Greece while Tomkins proposes a chronological scheme heavily formulated by excavations in Crete and the Aegean but it seems to apply for the mainland too (Tomkins 2009).

In almost all of these chronological systems, there are three main periods, the Early, Middle and Late Neolithic plus two additional controversial phases, the Aceramic or Preceramic phase and the Final/Chalcolithic period. The chronological system used in this thesis is bass on the most recently proposed schemes (Andreou et al.1996; Γαλλής 1996; Παπαδημητρίου 2010; Reingruber et al.2017) and it comprises of the following phases (table 5.1):

[7] Early Ceramic, ProtoSesklo, ProSesklo

[8] This chronological system was based on previous system and work that was presented a few years ago (Gallis and Demoule 1988, Demoule et al.1991)

Period Name	Dates in BC
Aceramic/Preceramic	7000-6700/6600
Early Neolithic	6700/6600-5800/5600
Middle Neolithic	5800/5600-5400/5300
Late Neolithic I	5400/5300-4900/4800
Late Neolithic II	4900/4800-4500
Chalcolithic/Final Neolithic	4500-3300/3100

Table 5.1.Chronological scheme used in this thesis (after Andreou et al.1996; Γαλλής 1996; Παπαδημητρίου 2010; Reingruber et al.2017)

The so called Aceramic or Preceramic phase covers the chronological period from 7000 to 6500 BC (Παπαδημητρίου 2010) or from 6800-6500 BC (Γαλλής 1996). Though controversial this phase which precedes the Early Neolithic period, has been proposed for Thessaly (Milojčić 1956a,1956b,1960,1973; Milojčić et al.1962; Θεοχάρης 1958,1967,1973; Wijen:1981; Θεοχάρης 1976), Peloponnese (Jacobsen 1969;Vitelli 1993; Perles 2001) and Crete (Evans 1964,1971; Efstratiou et al.2013; Tomkins 2007,2008; Douka et al.2017). This early phase represents a habitation layer with no pottery at all although the use of clay objects is common and the rare presence of sherds in these layers were attributed to stratigraphic disturbances due to post-depositional factors (Milojčić 1962:14; Vitelli 1993). Overall, the existence of a pre-pottery phase both in mainland and in Crete are usually either accepted and cautiously received or criticized and rejected; the relative bibliography is numerous and cover all different arguments (Bloedow 1991, 1992/93; Demoule and Perles 1993; Gimbutas 1974:282 Runnels 1995; Bailey 2000; Reingruber 2005, 2008, 2011, 2015; Reingruber and Thissen 2005, 2009).

The Early Neolithic (6800/6500-5800/5600 cal BC) is a rather long period and relatively quite well documented in Greece. Although the last 50 years the number of the EN sites have increased significantly, there is a lot of ground to cover in terms of the number of sites investigated and materials studied which relate to the Neolithic way of life in Greece and the issue of the indigenous or exogenous character of the period (Douka 2017; Perles 2001; Kotsakis 2001, 2002, 2003). Early Neolithic sites are less in number than any other Neolithic period in Greece and so far much better documented in Thessaly and in Macedonia than in the other parts of Greece.

The succeeding Middle Neolithic period is a rather short period in duration covering a time span of 300-500 years (5800/5600-5400/5300 cal BC)[9]. The Middle Neolithic period is represented by the settlement of Sesklo in Thessaly investigated in the past by Tsountas

[9] Cf Table 1

(1908), Theocharis (Θεοχάρης 1968, 1969, 1971, 1972, 1973β, 1976α, 1976β, 1977α, 1977β) and Kotsakis (Κωτσάκης 1981) and defined as "Sesklo Culture". During this period there seems to be only minor changes in architecture and settlement patterns with a continuation of traditions initiated in the Early Neolithic (Fowler 1997:243).

The following Late Neolithic period is the most well studied period of the Greek Neolithic. Recent excavations in the mainland and the Aegean islands have provided us with a vast amount of information regarding settlement patterns, architecture and everyday way of life. Moreover, pottery studies and radiocarbon dates have allowed researchers to construct new and more detailed chronological schemes for the phase. During this period, habitation is dense not only in Thessaly but also in other parts of Greece such as Macedonia and the Aegean islands, that had remained either sparsely populated or complete empty in the past (Παπαδημητρίου 2010:20). Settlement types are either flat (reaching the size of 100 acres) or tells, which were formed by superimposed layers of continuous habitation in the same area (ibid.20) while some settlements are marked by ditches and palisades (ibid.20); the period is, additionally, characterized by more complex forms of socioeconomic organization. From the 1950's the period of the Late Neolithic was subdivided into a number of phases which are based on various ceramic types. Theocharis recognized three Late Neolithic subphases (Θεοχάρης 1981) while Milojčić and Hauptmann (Hauptmann 1981; Milojčić and Hauptmann 1969) had suggested the existence of five. The system was revised by Otto who added some more subphases in the Late Neolithic (Otto:1985) as did Gallis and Demoule (Gallis and Demoule 1988). Coleman (1992) and Sampson (1993) based on data from their excavations in various Aegean sites, they proposed the division of the Late Neolithic into two subphases (Late Neolithic I and Late Neolithic II) and the division of the Late Neolithic I into two subphases (Late Neolithic Ia and Ib) (Sampson 1993). Almost all of the latest chronological schemes (Παπαδημητρίου 2010; Γαλλής 1992, 1996; Reingruber 2017) propose the existence of two Late Neolithic phases where Late Neolithic I lasts almost 500 years (from 5500/5400 to 5000/4800 BC and Late Neolithic II phase has a duration of 300 or 400 years and lasts until 4800 or 4500 BC[10].

Towards the end of the Late Neolithic period (from 4800 or 4500 BC until 3300 BC)[11] some major changes (introduction of metallurgy[12], new ceramic types, expansion of exchange networks, agricultural economy and ideology) there have recognized that led many researchers to distinguish a separate phase between the Late Neolithic period and Early Bronze Age. Weinberg (1970), Renfrew (1972), Diamant (1974) and Phelps (1976,

[10] The Late Neolithic I of Thessaly is also referred as the "Pre-Dimini" phase, the Late Neolithic II as "Classical Dimini" and the Final Neolithic/Chalcolithic as "Post-Dimini" phase (Θεοχάρης 1973, Γαλλής 1992, Γαλλής 1996)
[11] Most scholars believe that the beginning of the Chalcolithic should be placed at 4500 BC while Aslanis puts the beginning of this phase even higher, in 4800 BC (Ασλάνης 1993,1998,2007)
[12] McGeehan-Liritzis 1996;Ζάχος 2010

2004) introduced the term "Final Neolithic" to define these cultural horizons in the regions of Attica, Euboea, in some parts of the Cyclades and the Peloponnese. This terminology was accepted by some scholars (Vitelli 1993) but others believe that this phase should be called Late Neolithic and not defined as a separate phase (Coleman 1992; Sampson 1989, 1993).

For the same period, and especially for Thessaly and Northern Greece, the term "Chalcolithic" is also used, following a Balkan terminology[13]. This term was first used by Wace and Thompson[14] (1912:22) and later by scholars like Mylonas (1928), Weinberg (1947) and Milojčić (1959:24) who based their remarks on ceramic differentiations derived from excavated settlements. Over the years many scholars have expressed different opinions regarding the employment of the term "Chalcolithic" (Schachermeyr 1976; Demoule 1989; Treuil et al.1996). The criteria for the definition and use of this term in Northern Greece have been given by Aslanis (Ασλάνης 1993,2003) who states that the period lasts from 4800 to 3300/3200 BC [15] (Ασλάνης 1993:139, 2003) and it has distinctive social and economic features (2003:41). He also suggests that the term in order to be distinctive it has to represent "a group (an amount) of activities, different or differentiated from those of the previous Neolithic and the following Early Bronze Age periods" (2003:37) such as the introduction of metallurgy, craft specialization, wide range exchange networks and change in settlement patterns (introduction of palisades and systems of ditches in many settlements) that are seen in a great number of settlements in Northern Greece (Ασλάνης 1993:135-138).

In this thesis the use of this term is accepted for Northern Greece and Thessaly, it appears in the proposed timetable (table 5.1) alongside the term "Final Neolithic" and marks the period between 4800-3300/3200 BC. In the next chapter, which is related to the research of the Neolithic period in Western Macedonia, the term "Final Neolithic" will be extensively used as it is the most used term by scholars working in Northern Greece.

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[13] Over the years many studies have appeared in the Balkans concerning the Chalcolithic period or Eneolithic as it also known in these countries (for Romania:Dumitrescu 1982; Morintz and Roman 1968; Dragomir 1983; for Albania: Korkuti 1995; for Bulgaria: Gaul 1948; Sherratt 1981; Todorova 1978,1986,1995).

[14] Wace and Thompson reported also the existence of bronze items in the third layer in the settlement of Rachmani. According to them these items could not fit to either of the two phases B and C and therefore they should be included in another phase (Wace and Thompson 1912)

[15] For more information concerning the sub-phases of the Chalcolithic period and their duration see Aslanis 1993

Chapter 6 - Geographical context and research history in Western Macedonia

6.1. Geography of Western Macedonia

The administrative region of Western Macedonia is of the thirteen admistrative regions of Greece.It is surrounded by the administrative region of Epirus in the west, of Central Macedonia in the east and Thessaly in the south and it consists of the prefectures of FLorima, Kozani, Kastoria and Grevena[16].

The geographical region of Macedonia is one of the nine geographical regions of Greece. It is surrounded by the geographical region of Thrace in the East, the Epirus in the West and Thessaly in the South. The eastern physical border of the region is the river Nestos and its' western border the mountain range of Pindos. The northern limits of Macedonia are defined by the political borders with the countries of Bulgaria, Republic of Northern Macedonia and Albania while its coastal area is surrounded by the Aegean Sea.

The region of Western Macedonia can be characterized by a striking geographical diversity. The largest part of the area is mountainous and include the highlands of Grammos, Smolikas and Timfi which belong to the Pindus range and form the physical border with the region of Epirus. The mountain Voras is situated in the northern part of the region while the Vermion Mountain lies in the middle of Western Macedonia. The southern boundaries of Western Macedonia are marked by the Pierian Mountains which divide Western Macedonia from Thessaly. These mountains form a number of attractive basins which in the northern part of Western Macedonia are: the basin of Prespes and its lakes and the basins of Pelagonia and Eordaia with the four lakes of Zazari, Chimaditida, Petron and Vegoritida. In the western part of the region lies the basin of Orestida with the lake Orestias, the Basin of Upper Aliakmonas River and the basin of Kozani. The geophysical character of the region includes also the two long rivers of Aliakmonas and Axios which are crossing the Western Macedonia both ending in the Thermaic Gulf and the Aegean Sea.

6.2. Research history of the Neolithic period in Western Macedonia

The research of the prehistoric past in Western Macedonia is not independent of that of the the rest of Macedonia and Greece. Therefore this preview of the research history of the area cannot exclude references to the rest of the Macedonia. In this chapter, particular reference will be given to the research that concern the Neolithic period and the Early Bronze Age while there will be no mention at all to the research about the pre-Neolithic past of the area (fig. 6.2.)

The investigation of the prehistory of Western Macedonia and especially the Neolithic and the Bronze Age had started more than a century ago by small scale surveys, the opening

[16] http://www.kedke.gr/uploads2010/FEKB129211082010_kallikratis.pdf Last visit 04/01/2017

of trial trenches and a few short articles, which however was gradually transformed to a more meaningful research of the prehistoric past with large scale excavations, characterized by interdisciplinary approaches. Two phases of this kind of research can be distinguished. During the first phase, the majority of the research is not ascribed to Greek Archaeological Service but to the work of allied forces been in the area and to scholars from foreign schools that were working in the region from the end of 19th century until the 1930's.

In 1898 and 1899 the Russian Archaeological Instiute of Istanbul conducted a small scale excavation in the village of Patele (now Aghios Panteleimonas) in the Prefecture of Florina. In the cemetery that was lying some hundred metres north from the lake Vegoritida, the Russian archaeologists excavated 376 tombs that belong to the Early Iron Age (Ακαμάτη-Βελένη 1987:105, Heurtley 1939:100-105, Chrysostomou et al.2015). The research in the cemetery continued a century later (2001) with the investigation of 18 burial tombs that contained hundreds of burials (Chrysostomou et al.2015:27; Chrysostomou and Giagkoulis 2016:7)

The first excavations in Macedonia in the 20th century started during the First World War when the allied armies of the Salonica Campaign (French and British troops) had to dug out military trenches in prehistoric mounds outside of the city of Thessaloniki. The allied armies formed Archaeological Services with professional archaeologists that they conducted several surface surveys and small scale excavations in those mounds (Ρωμιοπουλου 2014). It is remarkable that some of the archaeologists that worked in these excavations during the war years, decided to return in the area after it's end to explore in more detail the prehistory of this archaeologically unexplored land (e.g Casson and Heurtley).

At the end of First World War, Stanley Casson and Walter Heurtley, both members of the British Archaeological School, excavated the sites of Tsaousitsa and Kilidir in Macedonia (Ρωμιοπούλου 2014:33). Casson considered his excavation to be the first "scientific" excavation in Western Macedonia (Casson 1919-21) and he quite regularly published the results of his work (Casson 1921, 1924, 1925, 1926a). His monograph *Macedonia, Thrace and Illyria* (1926) is the first synthesis of the Iron Age in the area (Wardle 2014:47). His work was followed by Walter Heurtley, who set the foundations for the research of the prehistory in Macedonia. He investigated several sites in Central and Western Macedonia between 1924 and 1931 (including Armenochori in the Florina Prefecture) and published the results of his research in 1939 under the title *Prehistoric Macedonia* (Heurtley 1939; Wardle 2014; Παππά 2014:110); it is a volume where he had listed all the known prehistoric settlements of the area. Moreover, Heurtley excavated the tell of Armenochori (modern Prefecture of Florina) in 1931 where he talked about three settlements. The lowest one (I) was dated to the Neolithic period while settlements II and III were ascribed to some late phases of the Early Bronze Age of the area (Heurtley 1939:59-60)

In the 1930's, Antonis Keramopoulos, professor of Archaeology at the University of Athens, surveyed too Western Macedonia and especially the areas of Kozani and Kastoria. He carried out surface surveys in the 1930's and excavated some sites in area of Tsotili (Kozani prefecture). He also started a small scale excavation - during 1938 and 1940 - in the Neolithic settlement of the Dispilio near to Lake Orestias (Κεραμόπουλος 1937, 1938). His excavation in Dispilio was the first lakeside settlement reported in Greece, a site which is still being excavated by the staff of the Department of Archaeology of the Aristotle University of Thessaloniki.

During the 1940's and 1950's there were no investigations in Macedonia conducted by the Greek Archaeological Service. The Second World War and the Civil War that followed together with the economic depression that tantalized the country were the main reasons for the halt of the investigations and excavations. However, there are some reports of small scale excavations by German soldiers during the German occupation of Greece in various sites in Macedonia (Ρωμιοπούλου 2014, Schachermeyr 1955).

A new period of research begins in the 1960's that is being continued until now. After a very long hiatus, slowly and gradually the number of the excavations in prehistoric settlements rises. Some sites that are going to be investigated are known from previous surface surveys but at the same time, a lot of newly found settlement are being investigated. Foreign scholars and agencies started a new era of collaboration with the Greek authorities and established joint expeditions in various sites in Macedonia. Also, the local Archaeological Services have conducted numerous excavations, mainly rescue, and at the same time, a lot of excavations of prehistoric settlements were led (and are still being led) by professors of the Aristotle University of Thessaloniki.

The Greek – British collaboration in Western Macedonia (Greek Archaeological Service and British School at Athens) that began with the excavation of the Early Neolithic settlement of Nea Nikomideia (Bintliff 1976; Pyke and Yiouni 1996; Rodden 1962,1964,1965) continued with the research of the settlement in Servia where Heurtley had collected some surface finds some decades ago (Heurtley 1932, 1939). The three seasons excavation (1971-1973), led by Cressida Ridley and Katerina Romiopoulou, revealed a settlement that was occupied during the Middle Neolithic, Late Neolithic and the Early Bronze Age and had affinities with other regions such as Thessaly, Eastern Macedonia and Albania (Ridley and Ρωμιοπούλου 1972,1973,1974; Ridley and Wardle 1979; Ridley et al 2000; Wardle and Βλαχοδημητροπούλου 2000; Wardle 2014).

From the 1980's until nowadays, the research of the prehistoric past in Macedonia has changed a lot. The department of History and Archaeology of the Aristotle University of Thessaloniki has conducted a lot of excavations in all over Macedonia. Most of them started in the 1980's and 1990's and are still being continued. Also, a lot of rescue excavations in

Western Macedonia, conducted by the local Archaeological Services, revealed a great number of prehistoric settlements, of whom a rather big number has been excavated or is still being excavated until today.

The majority of data concerning the Neolithic period, and especially the Late Neolithic period in Western Macedonia, comes from the investigation in the prefecture of Kozani. In the 1980's the local Archaeological Services initiated two research programs in the area. The first one, that was conducted in the area of the artificial lake of Polyphytos (Kitrini Limni basin[17]) and later covered the whole area of the middle zone of the Aliakmonas river, included surface surveys and trial excavations that had revealed more than 150 prehistoric settlements dated from the Early Neolithic to the Early Iron Age (Χονδρογιάννη-Μετόκη 1990, 1993, 1999, 2009a, 2012a, 2012b, 2012c, 2012d, 2014; Ζιώτα και Χονδρογιάννη-Μετόκη 1997; Καραμήτρου 2014). The available data show that there was an increase in the number of settlements during the Middle Neolithic, the Late Neolithic and also during the Bronze Age Χονδρογιάννη-Μετόκη 2007). In the Early and Middle Neolithic periods, settlements appear to be found in the plateaus or in areas of low elevation while in the next periods, Late Neolithic and Final Neolithic, settlements appear to be founded in hills or in high elevation areas (Χονδρογιάννη-Μετόκη 2009).

The aim of the second program was to record and excavate the settlements that were located in the expansion zone of the coal mines of the area of Mavropigi, Pontokomi and Kleitos and to study the paleoenvironment of the area (Καραμήτρου-Μεντεσίδη 1987; Φωτιάδης 1988).

Up to 1987 fourteen prehistoric sites were recorded in the area of the Kitrini Limni basin, One of them, the Megalo Nisi Galanis, was excavated from 1987 to 1989 and from 1993 to 1994 (Ζιώτα et al 1993; Fotiadis et al 2000:217). Rescue excavations at the site, that was located in a small mound in the Kitrini Limni basin, revealed the remains of a prehistoric settlement that was occupied from the end of the Middle to the end Early Final Neolithic periods and probably the Bronze Age (Φωτιάδης και Χονδρογιάννη 1997; Fotiadis et al.2000:218).

The site of Toumpa Kremasti Koiladas, that is situated 15 km northwest from the modern city of Kozani, was investigated in 1996, 1998 and in 1999 (Ζιώτα 2001, 539- 540; Χονδρογιάννη-Μετόκη 2001,2009:67-69). The rescue excavation in the slightly elevated mound revealed a settlement that was inhabited during the Late Neolithic and according to some indications also at the Early Bronze Age (Χονδρογιάννη-Μετόκη 2009b). Three ditches

[17] The basin of Kitrini Limni is situated in the area south of the modern city of Ptolemaida, between the mountains of Askion and Vermion. It is an area with an average altitude of 670-750m and until recently covered by marshes and called Sari-Gkiol (Turkish name that means Yellow Lake) (Καραμήτρου-Μεντεσίδη 2014:233).

and more than 300 pits of various sizes and depths that contained pottery sherds, fragments of clay architectural elements, human bones, animal bones, bone tools, ground stone tools, chipped stone tools and figurines (Χονδρογιάννη-Μετόκη 2009b) have been investigated.

One of the largest rescue excavations in Greece is that of Kleitos outside of the modern village with the same name. The excavations lasted 5 years (2006-2010) and there were revealed two neighboring settlements that covered an area of 23 acres and that can be dated to the late 6th mil BC and in the 5th mil BC (Χονδρογιάννη-Μετόκη 2010a; Ζιώτα et al. 2013; Ζιώτα 2009,2014a, 2014b:323). The settlement Kleitos 1 was a flat-extended settlement and it was inhabited during the Late Neolithic I (Ζιώτα 2014b:323) while the settlement Kleitos 2 was located on a low mound and it was inhabited during the Late Neolithic II and the Final Neolithic (ibid:327).

Many small scale rescue excavations enriched our knowledge about the prehistory of the area. The excavation at Pontokomi revealed some habitation layers from the Early and Middle Neolithic (Καραμήτρου-Μεντεσίδη 2002:626, 2014:237,244). In Kasiani Lavas Servion, Kriovrisi Kranidion, Toumpa Koilada Agiou Dimitriou, Paliampela Roditi, Xirolimni and in Varemenoi Goulon there have been also found Early Neolithic habitation layers (Καραμήτρου-Μεντεσίδη 1987, 2000,2001,2014; Ζιώτα-Χονδρογιάννη-Μετόκη 1997; Φωτιάδης και Χονδρογιάννη-Μετόκη 1997; Χονδρογιάννη-Μετόκη 1995, 2002,2004; Καραμήτρου-Μεντεσίδη et al.2014). Moreover, two Bronze Age cemeteries, one in Xeropigado (Ζιώτα 2007) and one in Tourla Goulon have been excavated (Ζιώτα και Χονδρογιάννη-Μετόκη 1997:36-40; Ζιώτα 2007).

The recent rescue excavations at Mavropigi-Fillotsairi revealed a settlement that belongs to the Early Neolithic (Καραμήτρου-Μεντεσίδη 2007a, 2014; Karamitrou-Mentessidi et al. 2013, 2015). According to the excavator, the settlement is 'so far the only fully exposed and systematically investigated Early Neolithic settlement in Greece' (Karamitrou-Mentessidi 2015:67). Three occupation phases have been recognized. The first one started in the early phases of the Early Neolithic, just after 6600 cal BC, the second one falls between 6400 and 6300 BC and the last one starts just before 6.200 BC and ends at around 5900 BC. (ibid: 68). It's noteworthy to mention that the absolute dates of Mavropigi-Fillotsairi fall into the same period with other Early Neolithic sites of Macedonia like Axos, Giannitsa B, Paliampela Kolindrou and Varemenoi Goulon in the Kitrini Limni basis (ibid:68, Maniatis 2014:207)[18].

In the Grevena prefecture the surface survey led by Nancy Wilkie from 1987-1990 gave important information about the habitation of the area. There have been found almost

[18] Karamitrou-Mentesidi believes that this settlement maybe earlier from the one at Pontokomi and Xirolimni (Καραμήτρου-Μεντεσίδη 2007a:524)

400 sites that date from the Early Neolithic period until modern times. At least 318 of them are assigned to prehistory (Wilkie 1993, 1999; Wilke and Savina 1992, 1997) with 13 of them belonging to the Early Neolithic (Wilkie 1993, 1999; Andreou et al.1996). Wilkie and Savina (1997) had noted the rather high number of the Early Neolithic sites, the small number of Middle and Late Neolithic sites and the rise the number of sites during the Late Bronze Age. Later, the number of the Early Neolithic sites has been increased (19) due to the intensive research by Karamitrou-Mentesidi in the area (Καραμήτρου–Μεντεσίδη 2007a:533-534). Although the Early Neolithic sites in Kozani and Grevena are more than 40, only a few of them so far have been excavated and usually in small scale (Καραμήτρου 2014:233,244-247). In Grevena, only two Early Neolithic sites have been investigated. These two partially excavated settlements in the area of Knidi - Kremastos and Matsouka Raxi – are situated in hilltops and they were both inhabited at the end of Early Neolithic (Τουφεξης 1998; Καραμητρου 2007b).

In the prefecture of Kastoria, there are at least five excavated Neolithic settlements. All of them belong to the Neolithic period and are situated near to Lake Orestias.

The research at the Neolithic settlement of Dispilio was relaunched in 1992 by the Department of History and Archaeology of Aristotle University of Thessaloniki and it is continued until nowadays. The excavations revealed a lakeside settlement that was inhabited during the Middle and Late Neolithic period (Φακορέλλης κα Μανιάτης 2002; Facorellis et al.2014; Χουρμουζιάδης 2002). There are some indications that the settlement was inhabited during the Early Neolithic (Σωφρονίδου 2002:205) and also in the Late Bronze Age and Iron Age (Σταυριδόπουλος & Σιάνος 2009:63). During the excavations, thousands of piles, post holes, clay architectural elements (hearths and ovens), bone tools and ornaments have been found (Χουρμουζιάδης 2002; Στρατούλη 2002; Υφαντίδης 2006; Χατζητουλούσης 2006). The settlement of Dispilio was the only lakeside settlement excavated in Greece until the beginning of the recent excavations at the lakeside settlements in the Amindeon area.

The excavations outside of the modern village of Avgi from 2002 to 2008 by the Archaeological Service of Pella (IZ' Ephoreia of Prehistoric and Classical Antiquities) brought into light a Neolithic settlement that was inhabited for almost 1000 years. The research revealed three habitation phases (Avgi I to III). The first habitation phase (Avgi I) can be ascribed to the late Middle Neolithic – Late Neolithic I period, the second one (Avgi II) to the Late Neolithic I-II period and the latest phase (Avgi III) to the Late Neolithic II period (Στρατούλη 2004,2006,2010,2011; Stratouli 2013).

Important information about the Neolithic past of the region comes from the rescue excavations at the sites of Kolokynthou and at Trita Koromilias. The excavation at Kolokynthou revealed part of a riverside settlement with two habitation phases, a late

Middle Neolithic /early Late Neolithic and third one that belongs to the Final Neolithic (Τσούγκαρης et al.2004). The first evidence from the research at Trita Koromilias is providing us with important information about a Late Neolithic settlement situated near to the old banks of the river Aliakmonas[19]. Moreover, a recent excavation at Piges Coromilias Cave revealed the use of this cave repeatedly by mobile groups at the final stages of the Middle Neolithic and at the beginning of the Late Neolithic and during the late and post-Byzantine period (Trantalidou et al.2011; Trantalidou and Andreasen 2015).

In the Florina Prefecture, the research of the prehistoric past had stopped in the 1930's with the excavation of Armenochori by Heurtley. Almost 50 years later, a surface survey that was conducted in the areas of Amindeon and Florina, raised considerably the number of the prehistoric settlements of the region (Τρανταλίδου 1989; Kokkinidou and Trantalidou 1991). In this survey, there is also a short mention to the lakeside settlements found in the area (Τρανταλίδου 1989:1595) that will be investigated two decades later.

Investigations during the 1990's were rather sparse with only two excavations carried out in prehistoric settlements. A rescue excavation outside of the village of Filotas near Amindeon brought to light the first Early Neolithic settlement in the area. The excavation of Armenochori was resumed after almost 60 years (Χρυσοστόμου 1998) and the new investigation confirmed the existence of the Final Neolithic layers that have been mentioned by Heurtely and were strongly criticized by Rene Treuil (1986). The excavation revealed seven successive layers from the Chalcolithic/Final Neolithic to the Middle Bronze Age. The eighth layer was ascribed to the Chalcolithic period, layers 3-7 to the Early Bronze Age and the second layer to the Middle Bronze Age (Χρυσοστόμου 1998:337). In the same decade, a rescue excavation outside of the modern village of Filotas near Amindeon brought to light the first Early Neolithic settlement in the area (Ζιώτα και Μοσχάκης 1997).

In the last fifteen years the expansion of the coal mining zone of the Public Power Corporation outside of the village of Anarghiri led to intense surface surveys and the carrying out of small and large scale rescue excavations in the area. So far there have been found at least 54 sites between the four lakes of the area (Petron, Zazari, Vegoritida and Chimaditida) that can be dated from the prehistoric to the late historic periods (Chrysostomou et al 2015:26). Systematic investigations have shown that during the Neolithic period the settlements were founded along the lakeshores, in low plateaus and in flat ground. Thirteen sites can be attributed to the Early Neolithic, fifteen sites belong to the Middle and Late Neolithic and twelve to the Final Neolithic period (Chrysostomou and Giagkoulis 2016:6). Moreover, during the Early and Middle Bronze Age there is an increase in the number of the

[19] http://www.archaiologia.gr/blog/2015/03/04/τρίτα-κορομηλιάς-μια-παραποτάμια-προ/ (Last visit 01/03/2017)

sites that are located in the lakeshores or in on low hills near nearby marshes (Chrysostomou et al 2015:26).

One of the most important aspects of this large scale research is the investigation in the lakeside settlements of the area in the south part of the prefecture. So far, eight permanent dwellings have been documented in the area around the modern town of Amindeon and there are indications that 19 more sites can be characterized as lakeside (ibid.26-27). The majority of these lakeside settlements are concentrated in the area north of the Lake Chimaditida and in its northern shore or in marshy areas in the plain close the lake (ibid.26).

Four dryland settlements (Sotiras V, Anarghiri IXa, Anarghiri XI, Anarghiri XIIIa) (ibid.26) have been so far excavated. The majority of them are situated in the area close to the village of Anarghiri, in the expansion zone of the coal mine. Their common characteristic is the existence of settlement delimitation features such as ditches (simple or complex) and circular or oval palisades (ibid.26).

The settlement of Anarghiri IXa was established in a low mound in the early 5th millennium BC in the marshy area of Lake Chimaditida (ibid.29). Besides the wooden palisade that encircled the settlement, the investigation yielded a destruction layer of a two storey building that can be dated to the second half of the 5th millennium BC (ibid.29).The study of the osseous artifacts showed that in this settlement took place a lot of productive activities e.g. leather and hide working and that its' inhabitants hunted and practiced fishing in the lakes of the area (Arabatzis 2016).

However, the oldest wetland settlement seems to be Limnochori II that was founded during the Middle Neolithic and it was inhabited until the Final Neolithic. There have been found dispersed wooden elements throughout the settlement that have been attributed to the Middle Neolithic habitation layers. During the Late Neolithic the structures were organized in groups of two or three in raised platforms in the lake while in the Final Neolithic the settlement transformed into a dryland one (ibid.28).

The wetland settlement of Anarghiri III was founded in the second half of the 6th millennium BC and it was abandoned at the end of the 4th millennium BC when the settlement became dryland (ibid.28) The investigation (two destruction layers and a wooden floor) showed that in the two storey structures of the settlement they all main household activities (cooking, grain grinding, storing and preparing of the food) took place while livestock was housed in the lowest floor (ibid.28).

Significant information about the habitation in the wetland environment in the area can be obtained from the research at the sites of Rodonas, Limnochori III, Anarghiri I and

Anarghiri IV. The settlement of Limnochori III was inhabited for almost 500 years in the Final Neolithic (ca. 4500-4000 BC) while its dwellings were built on a single platform (ibid.29). The limited investigation in Anarghiri IV revealed a settlement that was inhabited from the early 4th millennium BC to the late Byzantine period (ibid.29). The site of Anarghiri I was occupied during the Early Bronze Age and it was destroyed by fire at circa 2000 BC (ibid. 29) while the Rodonas II site was first inhabited in the early 5th millennium BC and its habitation lasted for almost 6000 years (ibid.29). One of the lately excavated lakeside settlements in the area is the site of Anarghiri IXb, which will be described in the next chapter.

Concluding, it seems that the Neolithic settlements in Western Macedonia appear almost at the same time as in Thessaly (Μανιάτης 2014:209-210). There seems to be a continuous habitation from the Early Neolithic to the Late Bronze Age (1700/1600-110/1050 BC). The number of settlements gradually increased especially during the Late Neolithic where there seems to be a concentration of settlements in the region of Kozani and Grevena. Settlements appear both in the plains and in high elevation areas but also in the wetlands especially during the Late Neolithic period. During the Final Neolithic/Chalcolithic period the habitation still continues (Andreou et al. 1996:202) but the radiocarbon dates show a gap in the habitation of the region in the 4th mil BC, a phenomenon that has been already observed in the whole area of Macedonia (Maniatis 2014).

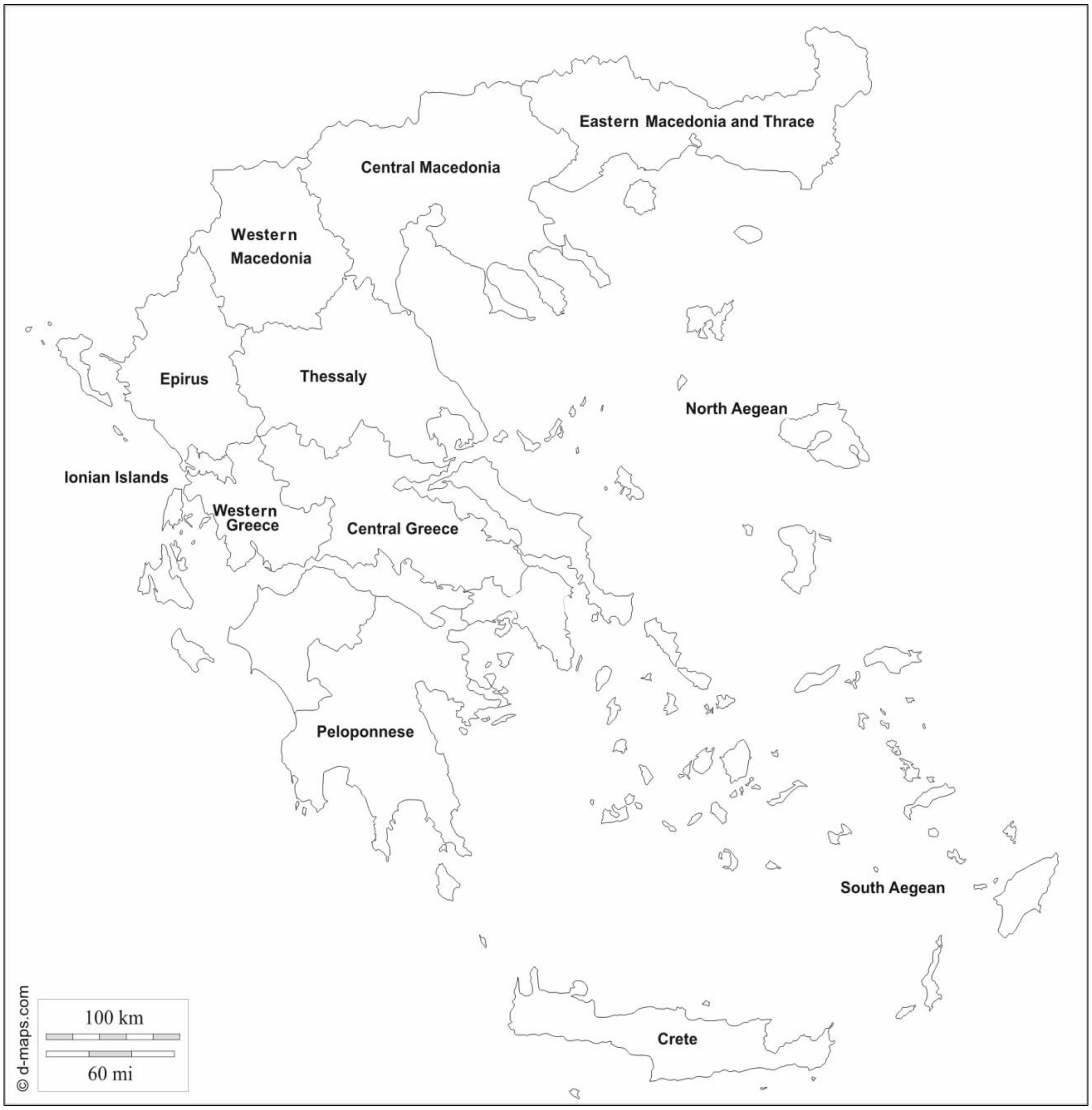


Figure 6.1. Map of Greece with its administrative regions (Map source: www.d-maps.com)

Figure 6.2. Map of the most important Neolithic settlements mentioned in the text (1.Servia, 2.Toumpa Kremasti Koiladas, 3.Kleitos, 4.Megalo Nisi Galanis, 5.Mavropigi-Filotsairi, 6.Dispilio, 7.Avgi) (Map source: www.d-maps.com).

Chapter 7 - The prehistoric lakeside settlement of Anarghiri IXb

7.1. History of research and site location

The last fifteen years the Archaeological Service of Florina has conducted extensive surface surveys and rescue excavations in the area of the Coal Mining Zone of Public Power Corporation S.A-Hella in the Amindeon basin which is situated in the southern part of the Prefecture of Florina in Western Macedonia. This enormous project, that came to an end in 2017, brought into light new evidence about the prehistoric habitation in Western Macedonia and especially in the Four Lakes region (Lake Zazari, Lake Petron, Lake Chimaditida, Lake Vegoritida) (Chrysostomou et al.2015). During this project 54 settlements have been found that are dated from the Early Neolithic to the late historic periods (ibid). Many of these settlements can be characterized as lakeside as they were established in the lakeshores or in the marshy areas of the above aforementioned lakes. (fig.7.1, fig.7.2).

One of the excavated settlements in the region of the Four Lakes is the Anarghiri IXb settlement, which is named after the modern nearby village of Anarghiri, it was situated in the northeastern banks of Lake Chimaditida that was probably bigger in size during the Neolithic period. The investigation started in July 2013 and it was continued with intervals until the end of 2017. During five excavation seasons, 17,410 square metres have been excavated with the main investigation been focused in the trenches that were located east of the modern drainage canal that rans diagonally through the settlement (fig.7.3.). The peripheral trenches were excavated down to the natural bedrock while the central trenches were partially excavated. Due to this excavation choice, the deep Late Neolithic layers situated in the centre of the settlement were barely excavated, making the study of the stratigraphy of the settlement a difficult task.

The excavation of the site yielded some impressive and unique architectural features in the periphery of the settlement, that are described as trackways (Giagkoulis in press) together with and thousands of portable finds such clay figurines, textile processing equipment, ground stone tools, chipped stone tools (Papadopoulou 2018) and bone artifacts (Arabatzis 2016b, 2017,2018).

7.2. Chronology and stratigraphy

The chronology of the settlement has so far been determined by a series of C^{14} dates derived from 80 charred wood samples and fragments obtained from piles from the architectural structures. These were dated with the AMS method in the University of Bern Laboratory in Switzerland. Radiocarbon dates (fig.7.4 and 7.5) show that the earliest habitation of the site should be assigned to a transitional phase between the Middle and Late Neolithic I period (c. 5500–5.400 cal BC). The succeeding Late Neolithic I period (c. 5.400/5300–4900/4800 cal

BC) is documented by a series of dates from almost all of the excavated areas and indicate the first systematic and extended wetland habitation phase of the settlement. The following Neolithic II period (c. 4900/4800-4600/4500 cal BC) is not so well documented since only 3-4 C^{14} dates can be attributed to this period. This apparent chronological gap could be interpreted either as a hiatus in the occupation of the site or as the result of the charred wood sampling process. The rest of the dates indicate an almost continuous habitation of the settlement during the Final Neolithic and throughout the second half of the 5th mil BC, ending around 4200 BC. It seems possible that during this phase, the habitation was moved to dry land although it must have been still close to the lake banks. Moreover, there is some scant evidence from the disturbed upper stratigraphic layers for a short habitation phase during the Early Bronze Age (3200-2200/2000 BC), characterized by the presence of a mixed Final Neolithic and Early Bronze Age archaeological deposit.

The final study of the stratigraphy of the site and the preliminary results that are presented below was a team work undertaken by the author, Stella Papadopoulou and Tryfon Giagkoulis, all of them long term members of the Anarghiri IXb excavation team and PhD candidates at the Institute of Archaeological Sciences in the University of Bern. Due to the large excavated area, the study involved selected trench profiles in the northern, central and southern parts of the settlement. According to the preliminary study of the stratigraphic sequence of these trenches, five layers have been observed on the settlement. The distribution of the C14 samples in these layers was of crucial importance in order to specify the difference chronological periods and habitation phases of the settlement. The first layer (**I**) is characterized by the presence of Early Bronze Age/ Final Neolithic pottery, the second (**II**) and third (**III**) layer are attributed to the Final Neolithic (Chalcolithic) period while the fourth (**IV**) and fifth (**V**) layers belong to the Late Neolithic period (table 7.1, fig.7.6).

Layer	Chronological period
I	FN/EBA
II	Final Neolithic
III	Final Neolithic
IV	Late Neolithic II (?)
V	Late Neolithic I

Table 7.1. Stratigraphic layers and their attribution in chronological periods

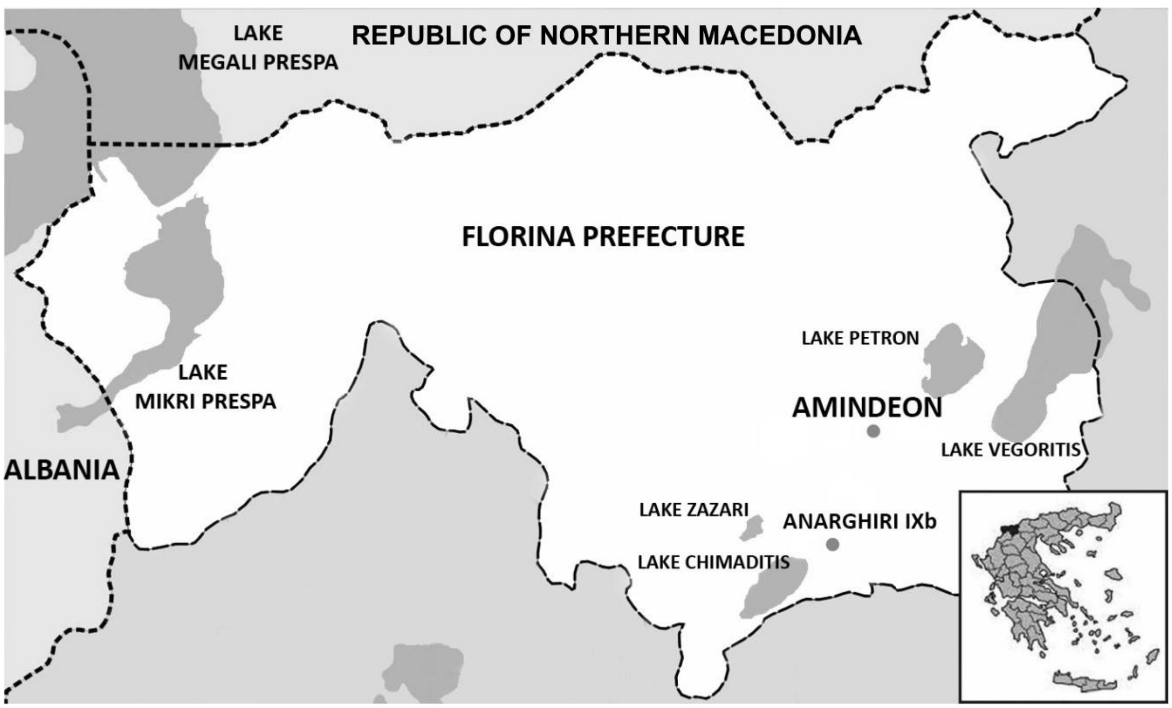


Figure 7.1.The location of Anarghiri IXab settlement and the adjacent area.
(Modified after: https://upload.wikimedia.org/wikipedia/commons/1/1c/Dimos_Florinas_-_Florina_prefecture%2C_Greece_-_political_map_-_municipality_level.svg)

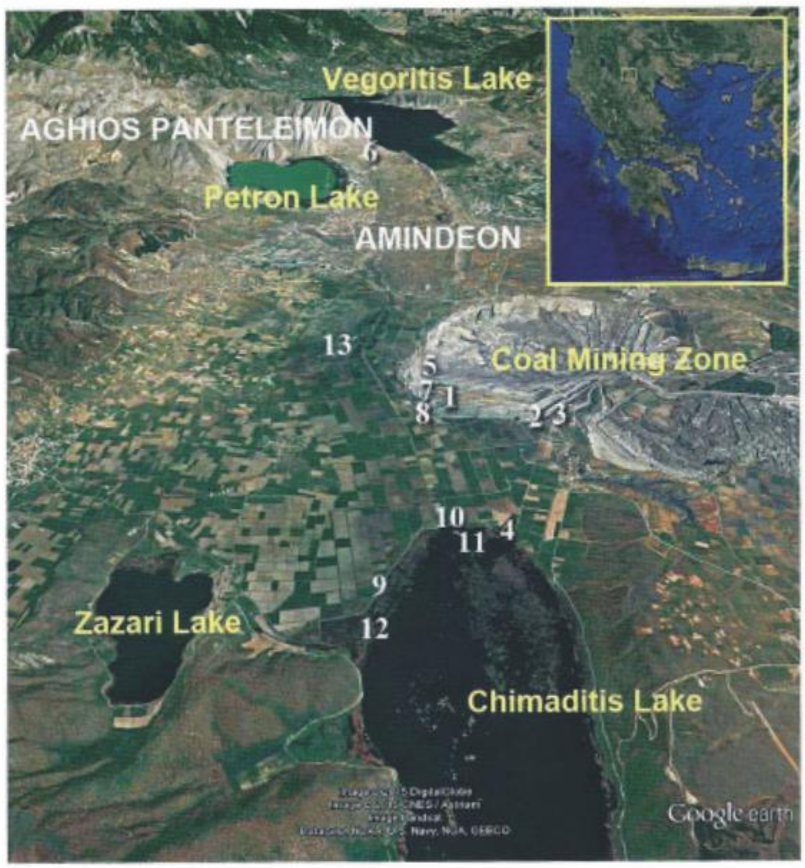


Figure 7.2. Map with the most important excavated sites in the area of the Four Lakes region in the Amindeon basin (Chrysostomou et al. 2015, fig.3)

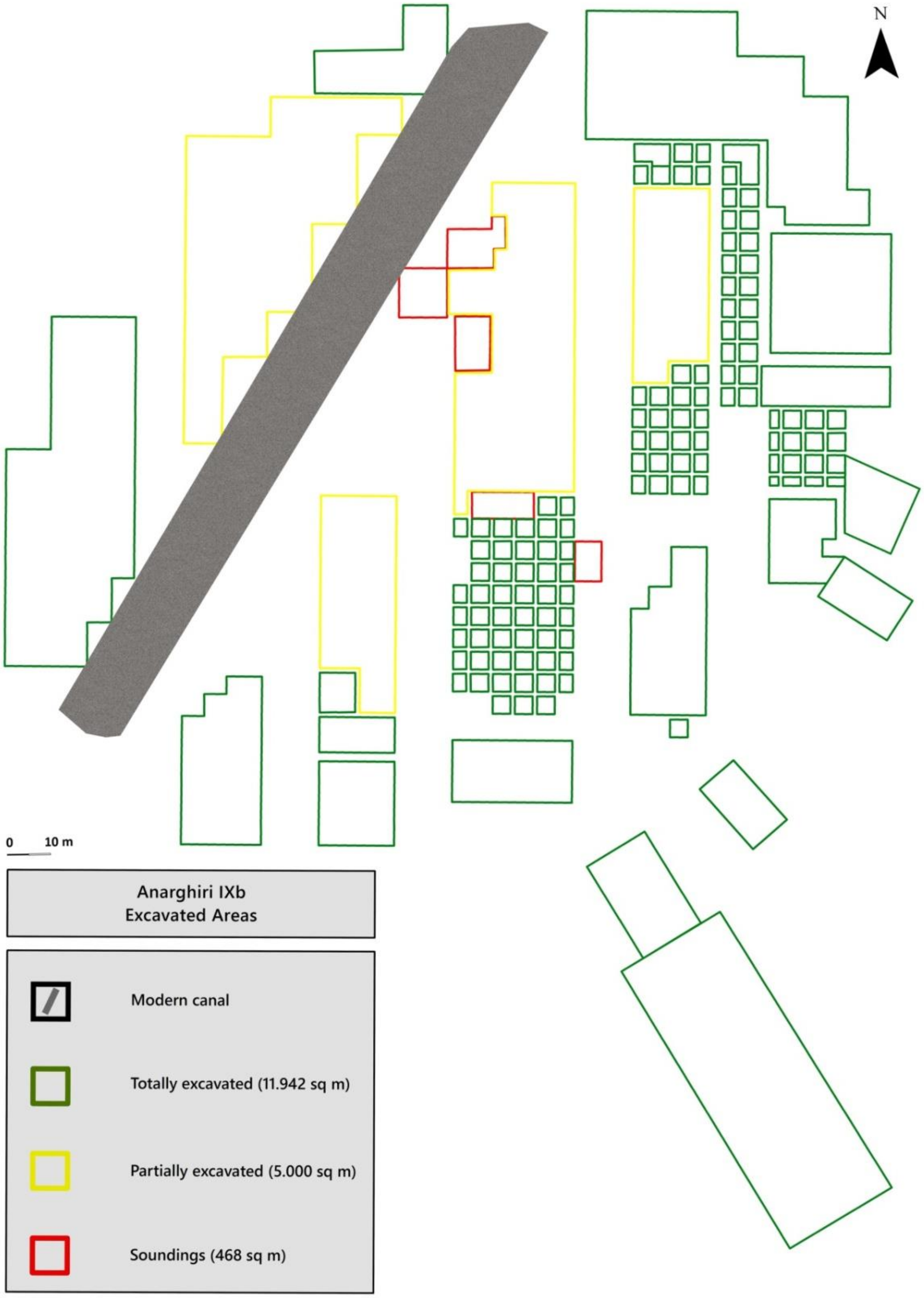


Figure 7.3. Excavated areas of the Anarghiri IXb settlement (Drawing: Tryfonas Giagkoulis)

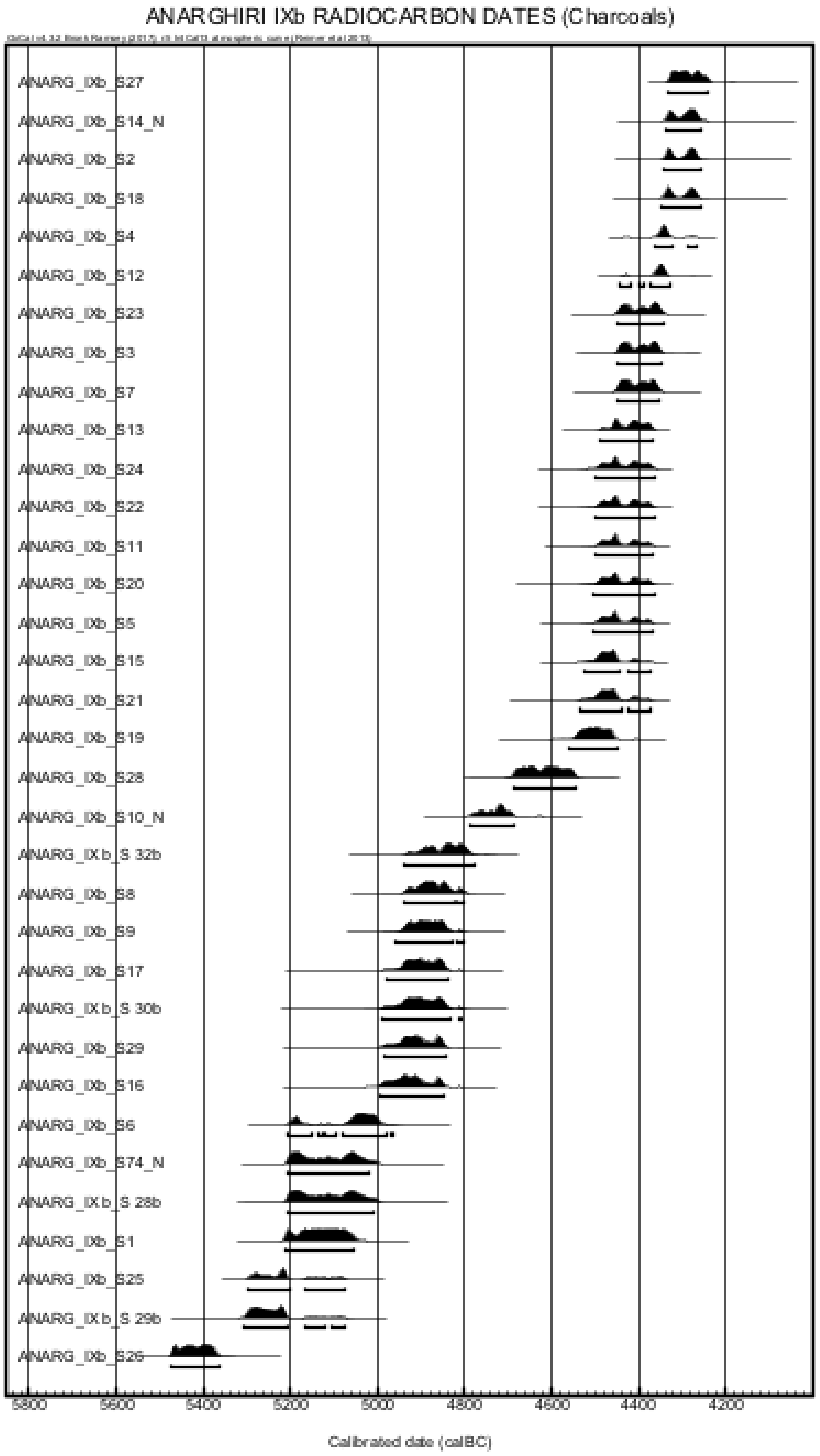


Figure 7.4. Calibrated C14 dates from charred wood samples

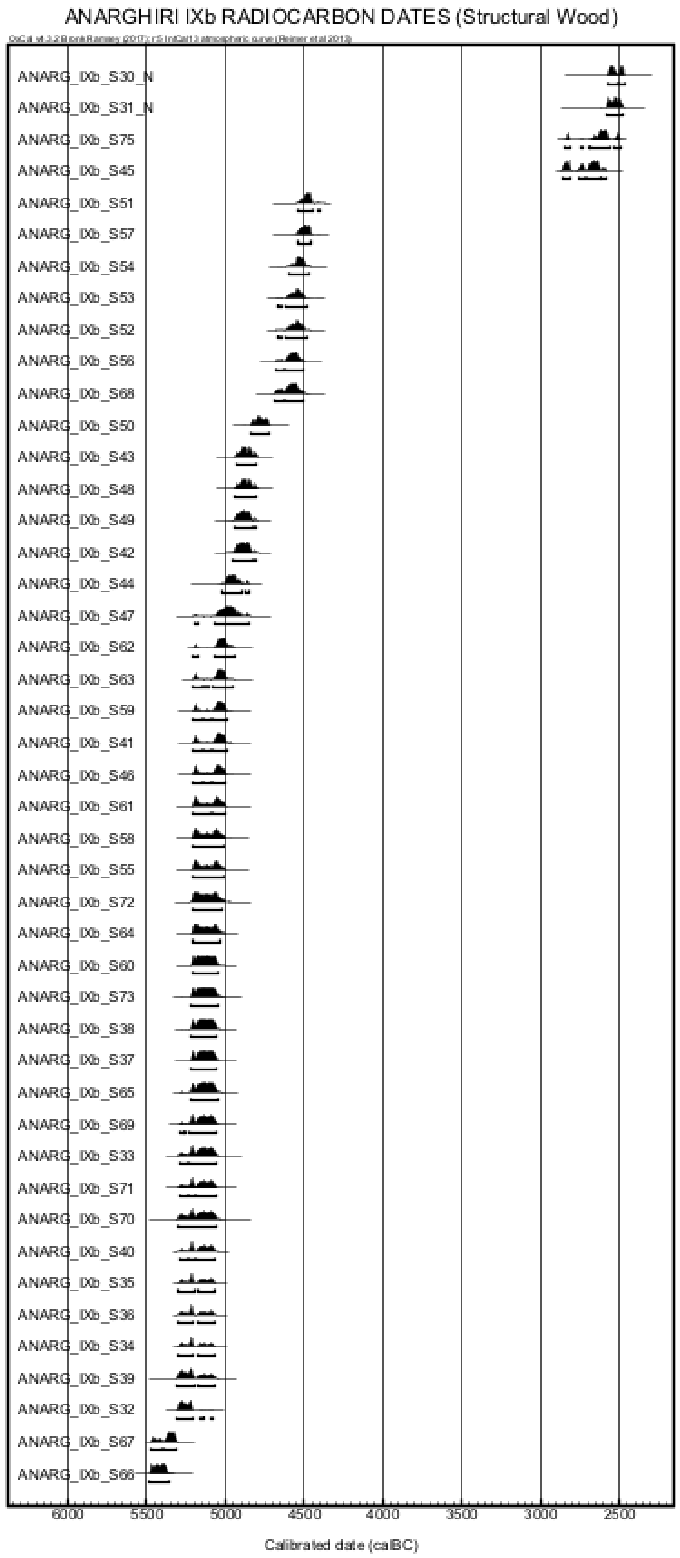


Figure 7.5. Calibrated C14 dates from structural wood (piles)

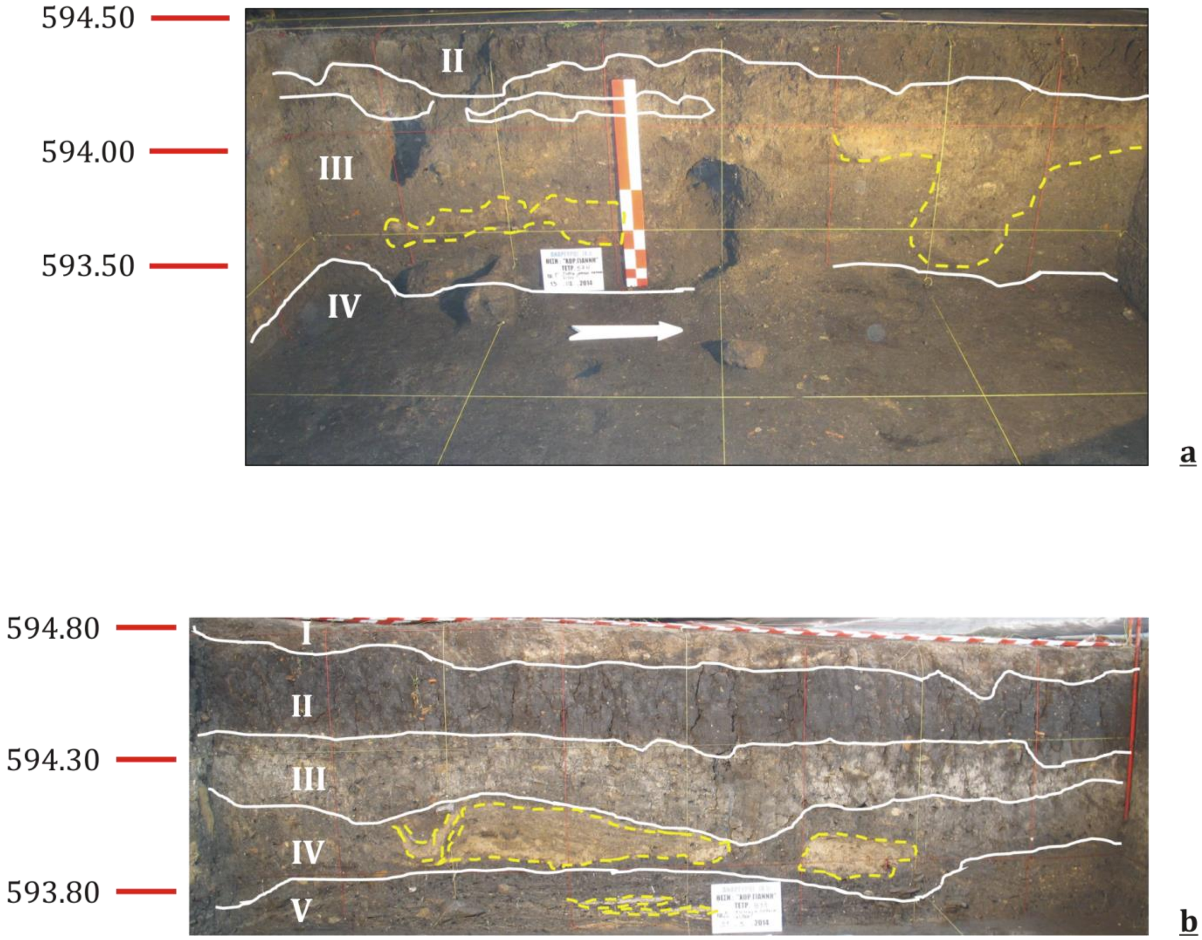


Figure 7.6. Stratigraphic layers I to V from a) the northern part and b) from the southern part of the settlement (Image synthesis: C. Arampatzis, St. Papadopoulou, T. Giagkoulis)

Chapter 8 - Antler working techniques

‘Technique is really personality.
That is the reason why the artist cannot teach it,
why the pupil cannot learn it, and why the aesthetic
critic can understand it’.
Oscar Wilde

The manufacture and the shaping of the antler artifacts required technical skills, often a lot of physical strength but mainly knowledge of all the widely known techniques. In this chapter, they are presented briefly the manufacture techniques that have been used in the Anarghiri IXb assemblage.

The most common techniques used for the extraction of the blank or for the preparation of the raw material are: the 'groove and splinter' technique, the percussion, the flexion breakage and sawing. In the case of Anarghiri IXb the most frequently used technique in the assemblage is the **percussion** technique. It required the use of a sharp edged stone tool, usually hafted, which was struck against the worked material usually at an acute angle. This technique was used mainly for the detachment of tines from the rest of the antler or of beam segments from the main beam. It was usually applied around the circumference of the worked material in order to prepare it for the application of the flexion breakage technique. In most cases, the outer part of the antler, the cortical bone, was gradually thinned through the percussion and then when the inner spongy tissue was reached, the antler was cut off at the desired length through the flexion breakage. The use of this technique is also attested in the manufacture of the sleeves as it was used in order to facilitate the shaping of the shaft holes as through this technique the manufacturer could gain time and effort by remove quickly the cortical bone before perforating the spongiosa (fig.8.1).

The '**groove and splinter**' technique was used already from the Upper Paleolithic and the Mesolithic period (Clark and Thompson 1953) and it is considered as the first technique that was used for the manufacture of antler tools (Baumann and Maury 2012:601). It is a rather controlled technique as it produces less waste (Olsen 1984) and in Anarghriri IXb was used mainly for the extraction of blanks that were mainly transformed into projectile points or chisels or for the longitudinal division of the raw material. In this technique, at first the manufacturer created two deep parallel grooves in the osseous element through a sharp edged tool and then through extraction of the incised area he obtained the blank (Averbouh, 2000:186; Averbouh and Petillon, 2011: 41; Goutas 2009).

The **flexion breakage** technique was employed to detach completely the blank from the antler. Usually the raw material was placed on an anvil and pressure was applied on one or two of its ends in order for a fracture to be created in the middle of the raw material (Elliot 2012; David 2004, fig.8) (fig.8.2).In Anarghiri IXb most of the picks were detached through this technique or through the combination of two techniques: percussion and flexion breakage.

The **sawing** technique is a rather common Neolithic technique, although not so common in the Anarghiri IXb assemblage, for cutting transversally the material. With the use of a flint tool the manufacturer was making a groove in the raw material and through repeated back and forth movement he was able to cut off the antler (fig.8.3). A variation of this technique includes the use of a wet abrasive fiber. At first, a groove was made through usually with a flint tool and then the fiber was placed inside the groove and it was moved repeatedly on the raw material until it reached the spongy tissue; and on that point it was easy to divide the material by fracturing it (Vitezović 2014:158; Beldiman 2005:38).

After the initial shaping the artifacts they were shaped through **scraping** or **grinding**. The scraping technique requires the use of a sharp edged tool which is applied with pressure into the osseous element. The tool is moving across the worked surface and long, linear and parallel striations are being created (David 2004; Elliot 2012) (fig.8.4.a). The grinding technique was used mainly for the leveling of the material surfaces. The osseous material is being pressured repeatedly onto a coarse material parallel, diagonially and transversally to its long axis. The result of this action is the creation of multiple, parallel, usually short (rarely long) striations in the surface of the worked material which are sometimes polished (fig.8.4.b,c).

The **hollowing** technique was used mainly for the manufacture of the sleeves. The spongy interior part of the antler was being removed, probably by a flint burin, and a socket was created in order to accommodate the edged stone tool (Riedel et al 2004:203) (fig.8.5).

The manufacture of shaft holes or suspension holes was usually performed with the **bow drilling** or with the **boring** technique. In the application of boring technique, the manufacturer often uses a flint borer which is being pressured transversally through the osseous material and it is rotated circularly in order to create the perforation. The most characteristic aspect of this kind of technique is the existence of widest and narrowest points with the widest being in the upper part of the perforation (Elliot 2012) (fig.8.6.a,b). The other technique, the bow drilling technique, is more composite than the previous one as it requires the existence of a stable, fixed drilling shaft like the one used for the Neolithic stone axe shaft hole drilling. At the end of the shaft it was attached a piece of de-pithed wood that could drill the osseous material (Riedel et al. 2004:203) and create straight, round holes (shaft holes or suspension holes) that don't leave any working traces in their outer entrance (ibid.)(fig.8.7.a,b)

Many of the items, especially the ornaments, are characterized by the presence of incised decoration. The **incision** technique is applied by pressing and moving a sharp or pointed tool across the surface of the worked material and through these two actions the manufacturer creates shallow or deep lines or dots in the antler surface (fig.8.8).

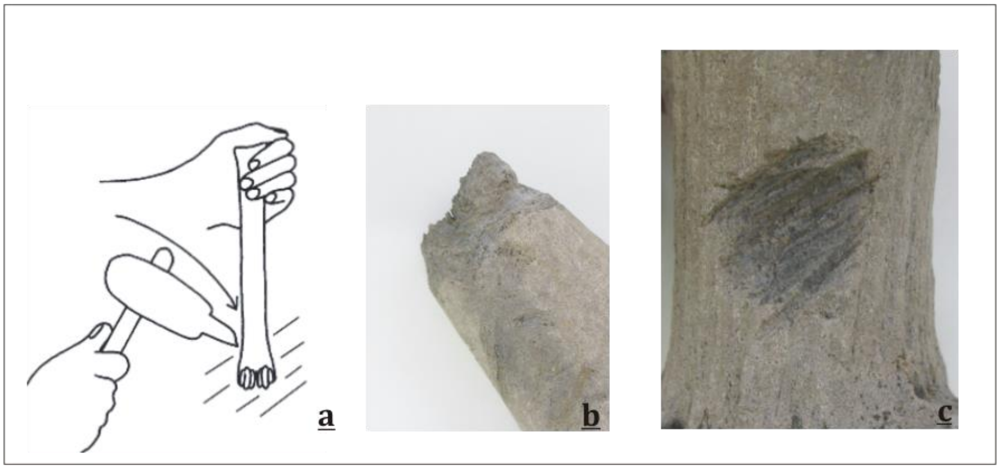


Figure 8.1. a.Percussion technique (David 2004, fig.4),
b,c. Anarghiri IXb. Percussion traces on a semi-finished sleeve

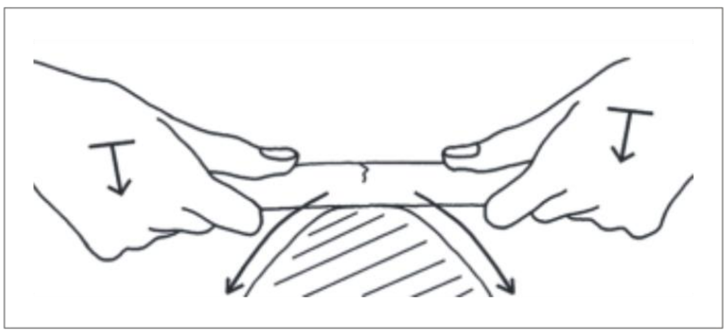


Figure 8.2. Flexion breakage (David 2004, fig.8)

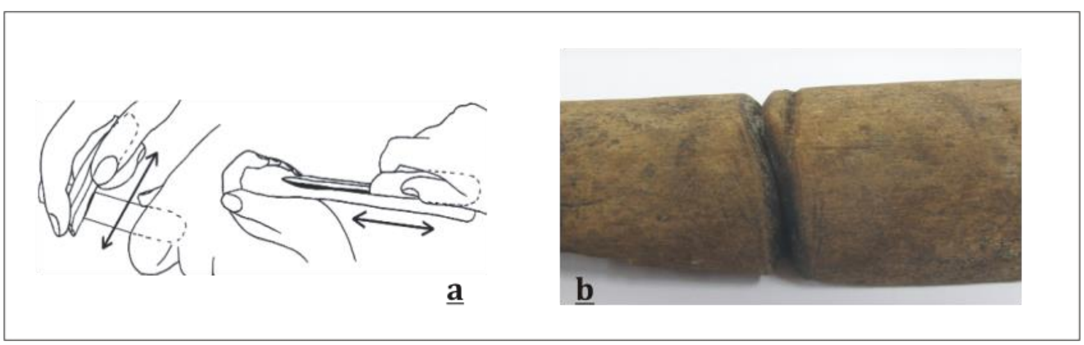


Figure 8.3. a.Sawing technique (David 2004, fig.4), b.Anarghiri IXb. Sawing traces on antler waste

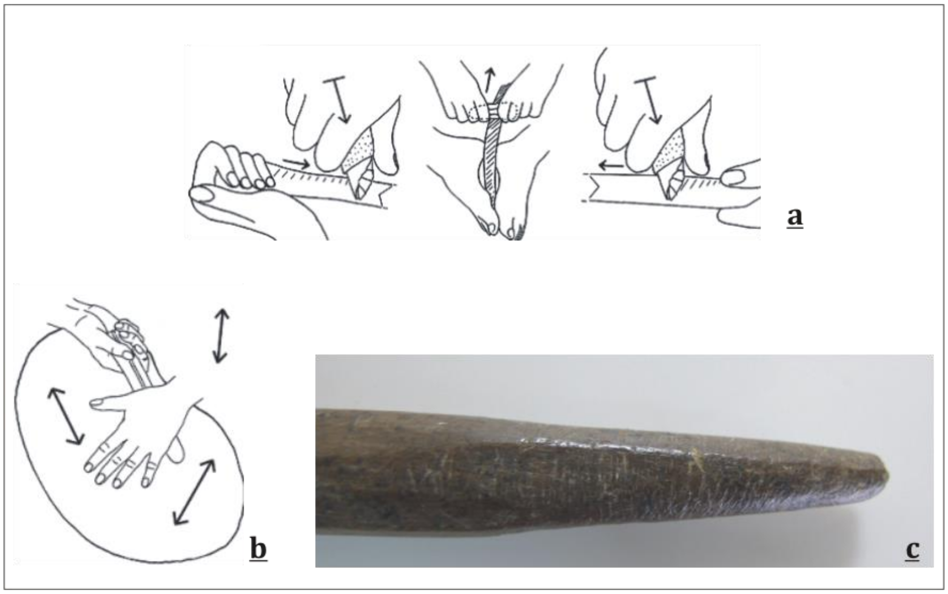


Figure 8.4. a.Scraping technique (David 2004, fig.4), b.Grinding technique (David 2004, fig.4), c.Anarghiri IXb. Grinding traces on antler projectile point

Figure 8.5. Anarghiri IXb. Socket for stone tool shaped through hollowing

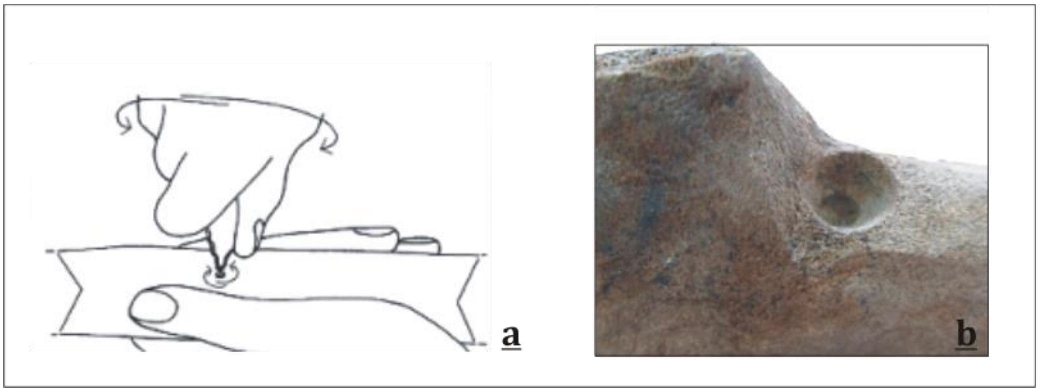


Figure 8.6. a.Boring technique (David 2004, fig.4), b.Anarghiri IXb.Boring perforation

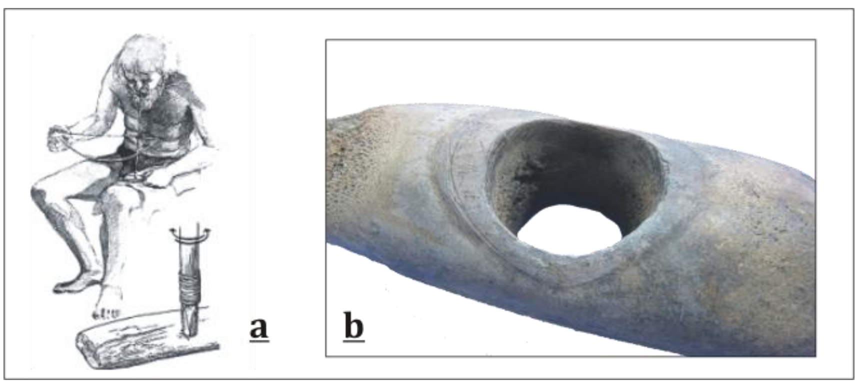


Figure 8.7. a.Bow drilling (David 2004, fig.4), b.Shaft hole shaped through bow drilling

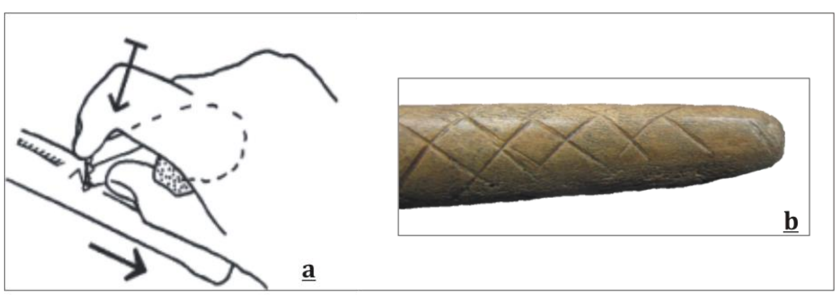


Figure 8.8. a.Incision (David 2004, fig.4), b.Anarghiri IXb. Incised decoration on antler pendant

Chapter 9 - The antler artifacts

"If we knew what it was we were doing, it would not be called research, would it?"
Albert Einstein

9.1. Introduction

The worked antler assemblage of Anargiri IXb consists of 488 artifacts which are currently stored in the warehouses of the Archaeological Service of Florina in the village of Aghios Panteleimonas. The assemblage consists mainly of items which were unearthed during the excavation seasons from 2013 to 2016. Only a few items are coming from the 2017 campaign since most of the antler artifacts from the 2017 excavation campaign lack secure information about their recovery place and therefore their inclusion in stratigraphic layers was not possible.

The majority of the under study assemblage was collected by hand during the excavation while the rest of it comes from the sorting of the zooarchaeological material. This task was undertaken by the author during three study seasons (2014-2016) in order to spot bone and antler artifacts which weren't collected during the excavation process. It's noteworthy that this procedure involved only the zooarchaeological material that yielded until October 2016 and that the zooarchaeological material that unearthed from October 2016 till November 2017 has not been yet investigated.

9.2. The methodology

The study of the artifacts was carried out in the facilities of the Archaeological Service of Florina in the village of Aghios Panteleimonas. A multi-stage procedure was designed for the documentation of the artifacts. This procedure involved the following steps: **a)** classification of each artifact in a group type and in subtypes if it was necessary, **b)** the recording of its contextual information, **c)** the identification of the raw material and recording of the measurements of the item and any other typological features, **d)** macroscopic and in some cases microscopic observation, **e)** photographic documentation of the artifacts, **f)** insertion of the data in a digital database.

The recording of the basic measurements and the typological features of the artifacts (perforations, socket holes, working edges, notches, line holes, suspension holes etc), was carried out by the use of calipers (metallic digital and plastic analogical). Also, a hand measurement tape was used when the size of the artifact was bigger than the caliper's range.

All artifacts were studied macroscopically and only a few selected items were studied microscopically under a low power magnification microscope provided by the local Archaeological Service and a self-owned digital USB microscope (2MP USB microscope with up to 100x magnification) that was connected to a laptop. Through the microscopic observation, it was possible to distinguish and to describe more efficiently some of the manufacturing and use wear traces that are being analyzed in the followings subchapters.

Unfortunately, the quality of the photos taken though the digital microscope was average and therefore it was decided not to include any microscope photos in the thesis.

The artifacts were photographed either individually or in groups when it was necessary. Each item was photographed from various views in different lighting conditions in order to have a good general view of the form and size of it. Finally, two photographs of each item were inserted in the database for a quick view of the artifacts during the analysis process.

For the documentation of the study, a digital database was developed through the program Filemaker Pro 14 where all data was sorted in relevant tables and fields. The use of this program was crucial as it gives the user the capability to create complex queries and to export all available data in charts as well as to incorporate photographs and files in PDF format in the database.

9.3. Raw material

The vast majority of the assemblage is shaped on red deer antler (98.77 %) whereas roe deer antler and fallow deer antler are slightly attested in the assemblage (1.03 % and 0.2 % respectively (table 9.1.). This great difference in the antler exploitation of these three species could be the result of ecological, practical or symbolic reasons or perhaps a combination of these reasons.

Species	**Percentage (%)**
Red deer	98.77
Roe deer	1.03
Fallow deer	0.2
Total	**100 %**

Table 9.1. Percentage of the deer species antler found in the assemblage

In the case of the red deer, there seems to be a preference on tines (39.005 %) and less on other elements. The second most exploited antler element is the beam (31.74 %) followed by the basal segment (28.01 %) and the crown (0.415 %). Also, a small number of items were shaped on basal and beam segments (0.83 %) (table 9.2).

Raw material	Percentage (%)
Tines	39.01%
Beam segments	31.74%
Basal segments	28.01%
Basal and beam segments	0.83%
Crown	0.42%
Total	**100%**

Table 9.2. Percentage of red deer antler elements in the assemblage

9.4. Typology

As it was stated in the introduction, the main aim of this thesis is the development of a typology for the antler artifacts from the prehistoric lakeside settlement Anarghiri IXb. The first step for the analysis of this diverse assemblage was to sort the collected items into general categories. Since the assemblage contains a lot of blanks and waste material, at first it was considered necessary to create a general classification which is based on the manufacture status of the items. The assemblage was divided into three main categories. The first category is related with the semi and completely manufactured items, the second consists of blanks and raw material and the waste material comprises the third category (table 9.3).

General typological categories	Quantity	%
Semi and Completely manufactured items	365	74.80
Blanks/Raw material	38	7.79
Waste	85	17.41
Total	**488**	**100**

Table 9.3. General categories of the worked antler assemblage

The blanks/raw material category consists of non-shaped antler fragments with stigmata from the debitage operation and whose size could allow for further processing into finished items (blanks) and antler fragments that could are too big to characterized as waste and they could be provide the basis for the extraction of raw material.

The waste material comprises mostly of antler fragments that they cannot be transformed to finished products either because they are manufacture debris or because they are fragments of tools that can't be repaired or recycled.

The category of semi and completely manufactured artifacts comprise the biggest general category and make up the 75 % of the total assemblage and contains items that are half finished or they are completed items. This category is subdivided into the following distinct artifact categories and their subcategories (table 9.4):

i. **Tools,**
ii. **Fishing/ hunting equipment and weapons,**
iii. **Ornaments,**
iv. **Eating and mixing food equipment**
v. **Items of undefined function**

The antler tools comprise the biggest and most diverse artifact category as it consists of ten subcategories and 274 items. Tools were found in all habitation phases but the majority of them belong to the Final Neolithic habitation phase.

The rest of the categories comprise a small part of the assemblage although the quantity of each of category is one of the biggest found in Greek Neolithic settlements. As with the tools, most items of these categories belong to the Final Neolithic habitation layers which were excavated in the biggest part of the settlement. As it was mentioned in chapter 8, the Late Neolithic layers have not been excavated in the same degree as the Final Neolithic ones therefore any comparison between these two phases is uneven and can't be used for the extraction of secure conclusions

Semi and Completely manufactured items	Quantity
Tools	
Sleeves	97
Handles	1
Picks	34
Bevel ended tools	50
Axes	16
Adzes	5
Needles	8
Fragments of perforated tools of undefined function	58
Retouching tools	7
Subtotal	**276**
Fishing / Hunting Equipment and Weapons	
Harpoon heads	11
Harpoons	2
Projectile points	8
Thumb rings	9
Fish hooks	1
Mace heads	1
Subtotal	**32**
Ornaments	
Pendants	24
Rings	4
Subtotal	**28**
Eating and mixing food equipment	**1**
Artifacts of undefined function	**28**
Grand total	**365**

Table 9.4. Categorization of the semi and completely manufactured items

9.5. Chronological and spatial distribution of the artifacts

The excavation process affected highly the number of the collected artifacts and therefore our remarks about their spatial and chronological distribution. The partially excavated trenches in the centre of the settlement and the fully excavated trenches in the periphery is one of the reasons for the unequal distribution of the artifacts in time and space.

The studied assemblage is coming mainly from the area east from the drainage canal that runs diagonally the settlement with a SW to NE direction and only a few items come from the area in its west side that was partially investigated. Since there are any studies concerning the spatial organization of the settlement, it was considered best not engage any spatial analysis of the artifacts.

Concerning the chronological distribution of the artifacts, it was considered best to distribute the assemblage into the broad habitation phases of the settlement, the Late Neolithic and Final Neolithic habitation phases and the upper disturbed FN/EBA layers. The few artifacts that could be ascribed to the controversial Late Neolithic II phase have been united with those from the Late Neolithic I phase as artifacts from one broad Late Neolithic habitation phase.

The majority of the artifacts (n: 390) belongs to the Final Neolithic habitation layers and the rest of them to the Late Neolithic layers and the upper disturbed FN/EBA layer (table 9.5). The semi/completely manufactured items dominate in the Final Neolithic layers wjile in the other artifact categories the proportion between the two main habitation phases is almost 1:2 (blanks/raw material) and almost 1:3 (waste).

	Late Neolithic	Final Neolithic	FN/EBA	
Semi/Completely manufactured	54	302	9	**365**
Waste	22	61	2	**85**
Blanks/Raw material	10	27	1	**38**
Total	**86**	**390**	**12**	**488**

Table 9.5. Chronological distribution of the artifacts

9.6. Analysis of the artifact categories

9.6.1. Semi and completely manufactured items

9.6.1.1. Tools

Sleeves

The biggest tool category in Anarghiri IXb consists of 97 tools. These are tools shaped on basal parts, beam segments or tines that were intermediate parts of composite tools that consisted of three parts: the stone tool, the antler part and the wooden handle. The antler parts were used as the stone tool sockets of composites axes or adzes in order to absorb the shock from the impact during the use and to prevent the break of the wooden handle (Winiger 1981). Their main characteristic is the existence of a socket that was used for the insertion of a stone tool and also the existence (or the absence) of a shaft hole for the wooden handle.

These tools are very well known from the lakeside settlements of Central Europe of the 4th and 3rd mil BC and their thorough study the last 50 years has led to the creation of either simple or very detailed and extensive typologies (Maigrot 2003,2011,2015; Billamboz 1977; Billamboz and Schlichtherle 1982,1999; Suter 1981,1987,2000; Ramseyer 1999; Schwab 1971; Schibler 1987; Voruz 1984, 1987,1989,1997; Winiger 1985).

The presence of this kind of tools in the Neolithic settlements in Greece is not so frequent. Sleeves have been attested in various settlements both in Northern and in Southern Greece but their quantity is rather small (max. 5-10 tools) compared to the quantity unearthed from the Anarghiri IXb settlement.

In Northern Greece, sleeves have been attested in the Neolithic settlement of Stavroupoli (Χατζούδη 2002:616), in Makriyalos (Tsoraki 2008, Vol.II, Pl.4.12), in Dikili Tash (Séfériadès 1992, Pl. 141, Pl.195a,b) and in Sitagroi (Elster 2001,365,Fig.3; 2003). Similar tools have been reported from the lakeside settlement of Dispilio in lake Orestias although their number remains so far unknown since the preliminary report about the bone and antler tools of this settlement doesn't mention their exact quantity (Στρατούλη 2002).

In Thessaly, sleeves have been found in the Late Neolithic layers of Dimini (Stratouli 1998 Taf.35:1; Moundrea-Agrafioti 1981,1987:Fig.1,2,3), in the Late Neolithic and Chalcolithic layers of Pefkakia –Magula (Stratouli 1998, Taf. 41:10, 42:9, 48:8), in the Chalcolithic phase of Pyrgos (Stratouli 1998, Tafel 36:1,6,8) in Argissa (Hanschman and Milojcic 1976) in Pyrassos (Weisshaar 1978) and in the Neolithic levels of the Theopetra Cave (Στρατούλη 2000,326, Fig. 19:1-4). In Central Greece, antler sleeves have been reported from the Late Neolithic layers in settlement in the Cave of Skotini Tharrounion in the island of Evroia

In Southern Greece, a few tools have also been attested in the Neolithic habitation layers of Franchthi Cave (Stroulia 2003). In the islands the Aegean Sea there have been found in the Late Neolithic settlement in the island of Aghios Petros (Moundrea-Agrafioti 1987), in the settlement of Uğurlu in the island of Gökçeada (Turkey)(Paul 2016; Paul and Erdoğu 2017), in the Late Neolithic layers of the settlement in the Cave of Skotini Tharounion in the island of Euboea (Στρατούλη 1993) and in the Cave of Aghios Georghios in the island of Rhodes (Στρατούλη 1987,509-511,Fig.107-108).

In the rest of the Balkans the situation is almost the same. So far only in a few settlements there have found antler sleeves and in most of the cases their number is relatively small and don't exceed the 5-10 artifacts per settlement. In Serbia a few antler sleeves have been found in Divostin in Serbia (Lyneis 1988; Vitezović 2011, 2013, 2017), and in Ušće Kameničkog Potoka (Vitezović 2014:128,Fig.12) while in the Republic of Northern Macedonia similar tools have been found in the Late Neolithic layers of settlement Mogila in Senokos (Temelkoski-Mitkoski 2006; Mitkoski 2017,125,Plate II:21) and in the settlement Trestena Stena (Mitkoski 2011). Antler sleeves have been also reported from various Neolithic and Eneolithic settlements in Romania (Bolomey and Marinescu-Bilcu 2008; Beldiman et al. 2012; Sztancs and Beldiman 2014; Margarit et al. 2009) .

Raw material

The majority of the intermediate tools was shaped on basal parts (**n: 79**). The rest of them were shaped on beam segments (**n: 13**) and on tines (**n: 5**). It seems that this preference for basal parts is not restricted in one habitation phase. The basal part of the antler was used rarely in the Late Neolithic (**n: 4**) but its exploitation rises during the next phase (**n: 74**). The use of beam segments for the manufacture of intermediate tools began also in the Late Neolithic phase (**n: 3**) and it continued until the Final Neolithic habitation phase (**n: 10**). The tines were rarely used. Their use is attested in all phases but in very small quantities (table 9.6, fig.9.1).

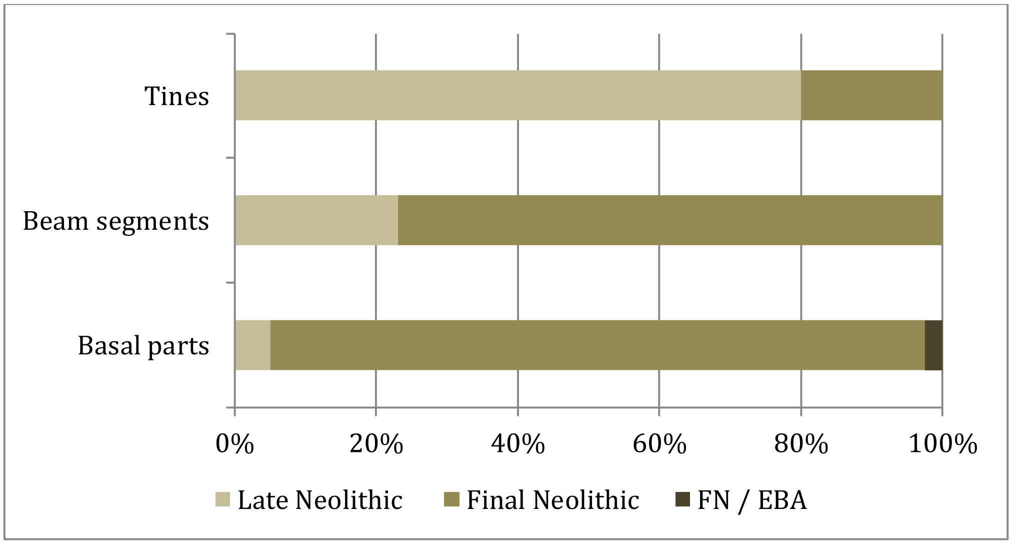


Table 9.6. Chronological distribution of the raw material used for sleeves

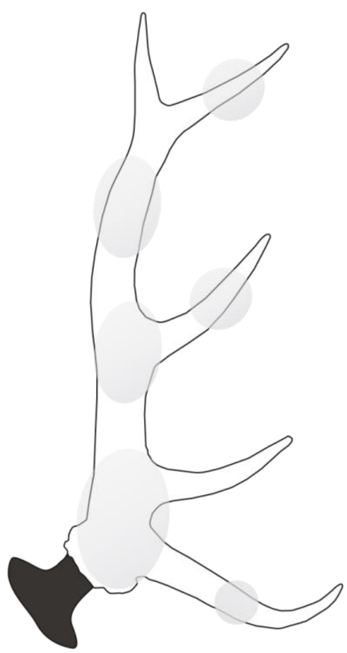


Figure 9.1. Raw material used for the manufacture of sleeves

Typology

Since these tools present a great variability, the typological process was based on the existence or absence of some characteristics alongside with the raw material criterion. All intermediate tools at first were divided according to **a)** the raw material, **b)** the existence of a shaft hole and **c)** the existence of a hafting socket (fig. 9.2).

According to the following, four main types can be distinguished:

1. Type I. Sleeves on basal parts with shaft hole
2. Type II. Slevees on beam segments with shaft hole
3. Type III. Socketed sleeves
4. Type IV. Perforating sleeves

Most of the tools fall diachronically into the first category (table 9.7). The basal part of the antler seemed to be the best choice for a perforated intermediate tool that could be used for heavy tasks. The small quantity of the non-perforated tools – socketed sleeves and perforating sleeves – that were shaped on beam segments and tines could reflect the small need of the inhabitants for small and lightweight tools.

	Chronological periods			
	FN/ EBA	FN	LN	Total
Types	**n**	**n**	**n**	**n**
I-Sleeves on basal parts with shaft hole	2	73	4	79
II-Sleeves on beam segments with shaft hole	0	8	2	10
III-Socketed sleeves	0	2	1	3
IV-Perforating sleeves	0	2	3	5
Total sleeves	2	85	11	**97**

Table 9.7. Chronological distribution of the four main sleeve types

Type I. Sleeves on basal parts with shaft hole

It's the most numerous type as it consists of 79 tools and comprises the 76.63 % of the intermediate tools category. The tools of this type were shaped on basal parts of the antler and they have one shaft hole for the insertion of the wooden handle and one socket for the insertion of a stone tool.

This type is also attested in other lakeside settlements of the 4th and 3rd mil BC in France and in Switzerland (Billamboz 1977; Voruz 1984, 1997; Winiger 1985; Maigrot 2003). In Greece it has been attested in the Neolithic settlement of Dikili-Tash (Sériadès 1992, Pl.141,195), in the Chalcolithic phase of Pefkakia-Magoula in Thessaly (Stratouli 1998a, Taf.41,10), in the cave of Skotini Tharounion in Euboea (Στρατούλη 1993, fig.17, 18.2) and in Sitagroi in Eastern Macedonia (Elster 2001, fig.3).

All of them have been shaped on basal parts of red deer antler. It seems that the small basal part of the roe deer antler wasn't considered strong and compact enough from the manufacturers for their needs and it was not used at all in this kind of tools. Also there seems to be a clear diachronic preference on shed antlers as only three sleeves have been shaped on unshed antler. This choice could have been based in symbolic reasons that are unknown to us now and also in practical reasons. The big number of the shed antler shows that the inhabitants of the settlement knew about the antler cast off and could collect them without having to wait for a successful deer hunt in order to obtain the raw material.

The manufacture sequence of these tools consists of the following steps: **a)** raw material procurement, **b)** removal of the first or the first two tines from the antler, **c)** detachment of the basal part from the rest of the antler through percussion at the desired length of the tool, **d)** optional removal of the coronet and **e**) shaping of the shaft hole and the socket.

The socket hole on the distal part of the tool was shaped mainly through percussion and hollowing. The percussion technique was used for the detachment of the basal part from the rest of the antler and usually it was deployed in the area where the socket was formed. The use of the sawing for the detachment of the basal part and the shaping of the percussion is attested rarely. The final shaping of the socket was achieved through hollowing. The manufacturer removed the inner spongy tissue of the antler with a stone tool (probably a borer or a blade and a borer) and could shape the size and shape of the socket according to the needs. In some cases the outer surface of the socket was leveled through grinding but this treatment is not so frequent and it's attested only in eight (8) cases.

The shaft hole was shaped in an anterior-posterior direction **a)** either between the first tine (T1) and the second tine (T2), **b)** on the first tine base, **c)** on the second tine base or **d)** beyond the second tine. The shaft hole has a round or usually an oval cross section. The manufacture of the shaft hole was achieved through the use of three techniques: the percussion, the drilling and the boring technique which were used mainly in combinations.

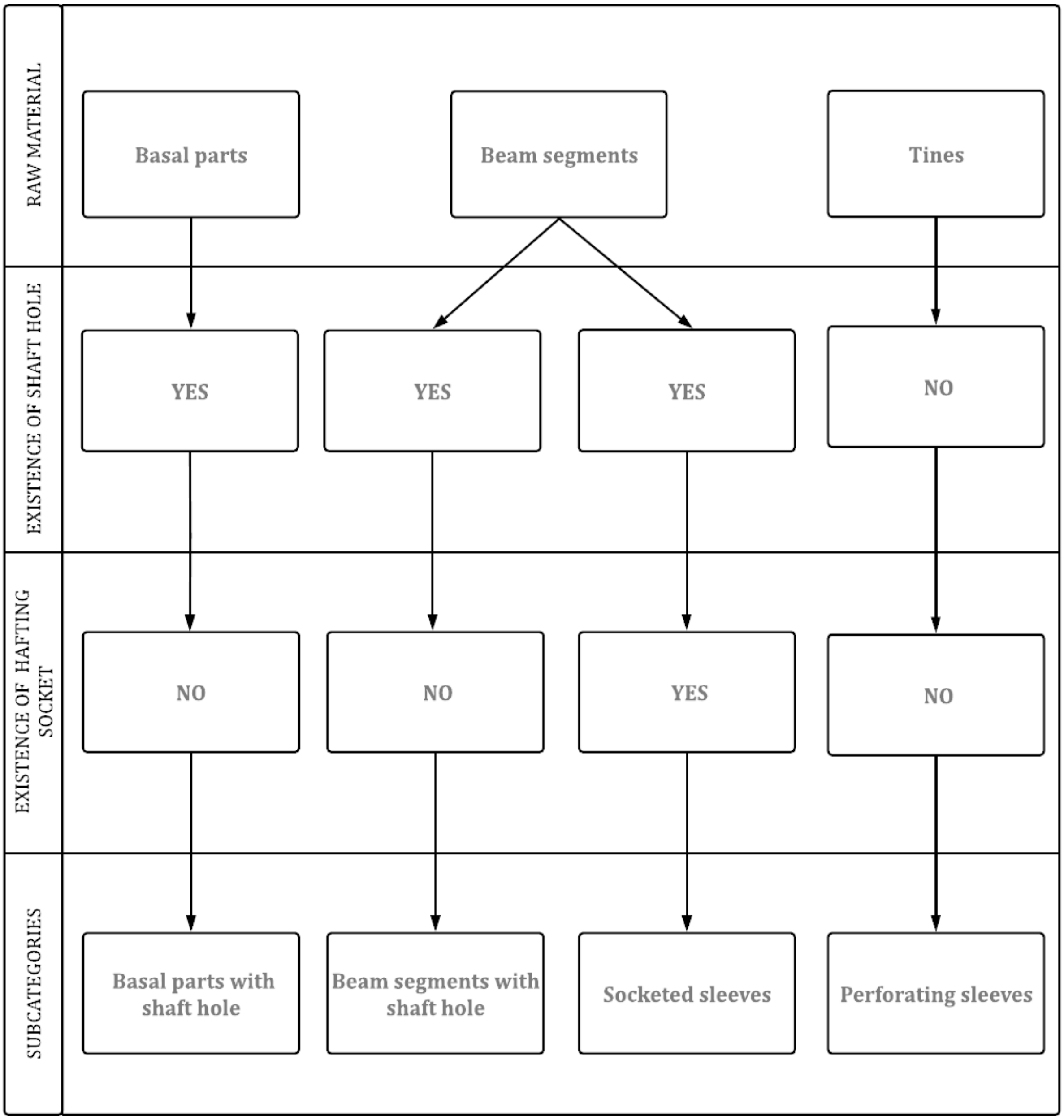


Figure 9.2. Flowchart with the classification criteria and the main categories of the sleeves

In the fifth stage of the manufacture sequence the manufacturer had two choices: **a)** to shape the shaft hole before the shaping of socket or **b)** after the shaping of the socket. The semi-finished items so far showed that the manufacturers preferred to shape at first the shaft hole and then to proceed with the socket shaping.

According to the position of the shaft hole, there have been distinguished four distinct subtypes of this tool (figure 9.3):

Ia. Sleeves on basal parts with a shaft hole shaped between T1 and T2.
Ib. Sleeves on basal parts with a shaft hole shaped on T1 base
Ic. Sleeves on basal parts with a shaft hole shaped on T2 base
Id. Sleeves on basal parts with a shaft hole shaped beyond T2

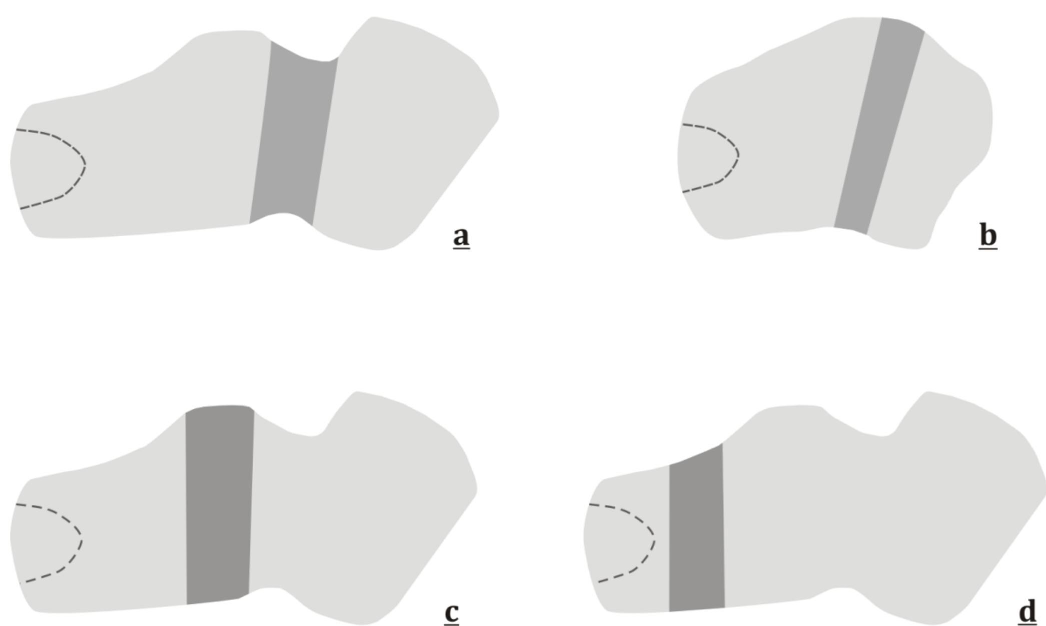


Figure 9.3. Sleeves on basal parts (Type I), a) Subtype Ia, b) Subtype Ib, c) Subtype Ic, d) Subtype Id (Dark grey area: shaft hole, dotted area: socket hole)

The most common practice was to shape the shaft hole close to the base of the antler either in the area between the first and the second tine or in the area of the first tine (table 9.8). Perhaps this choice for the shaft hole position is related with practical reasons that would matter during the use of the tool like the transfer of the energy of the stroke, the absorbement of the impact or the tools damage. It‘s noteworthy that most of these tools are completely manufactured and that only twenty items are semi-finished. Most of the semi-finished items come from the Final Neolithic habitation phase. The majority of them belong to the Ia subtype and the rest of them in the subtypes Ib and Id (tables 9.9, 9.9, 9.10).

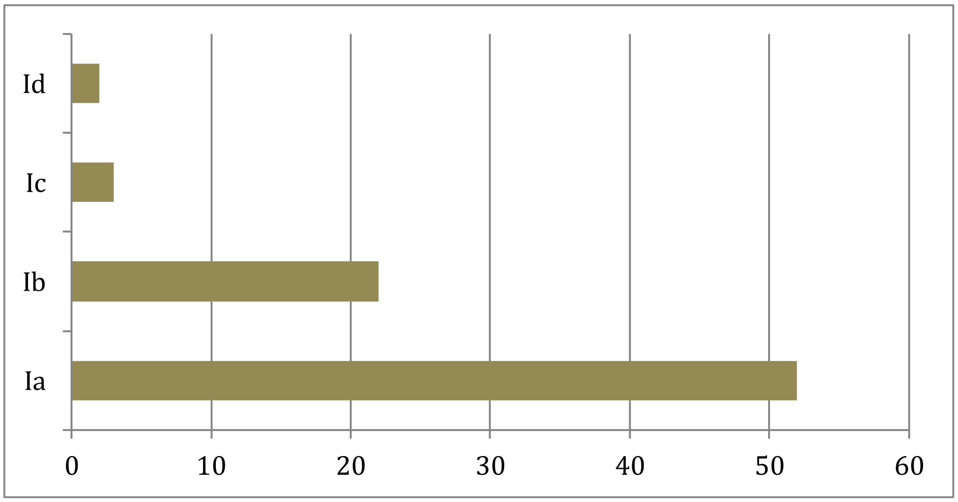


Table 9.8. Type I. Sleeves on basal parts. Subcategories and their quantity

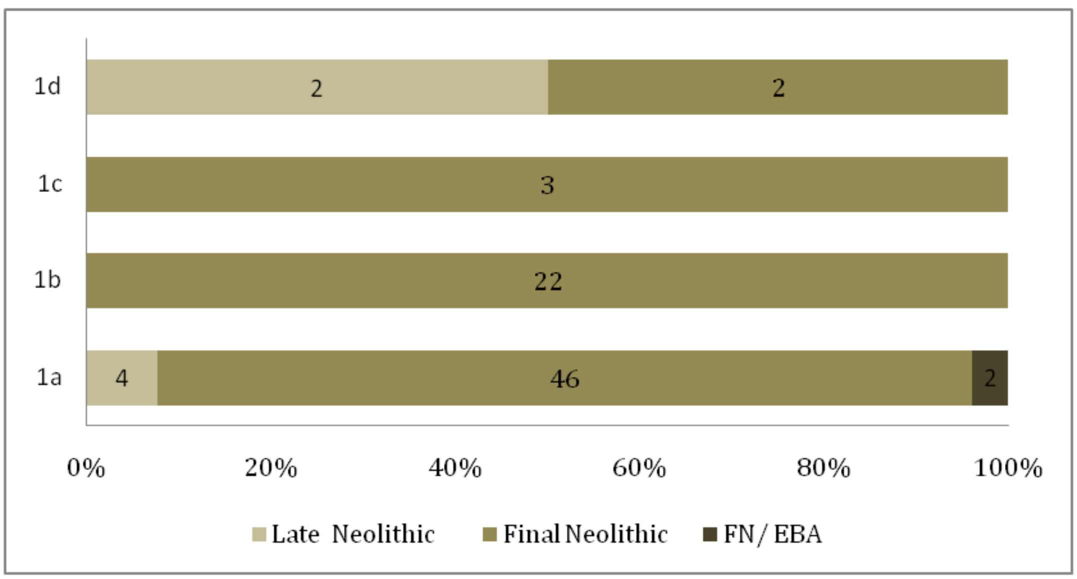


Table 9.9. Chronological distribution of the subcategories of the type I sleeves

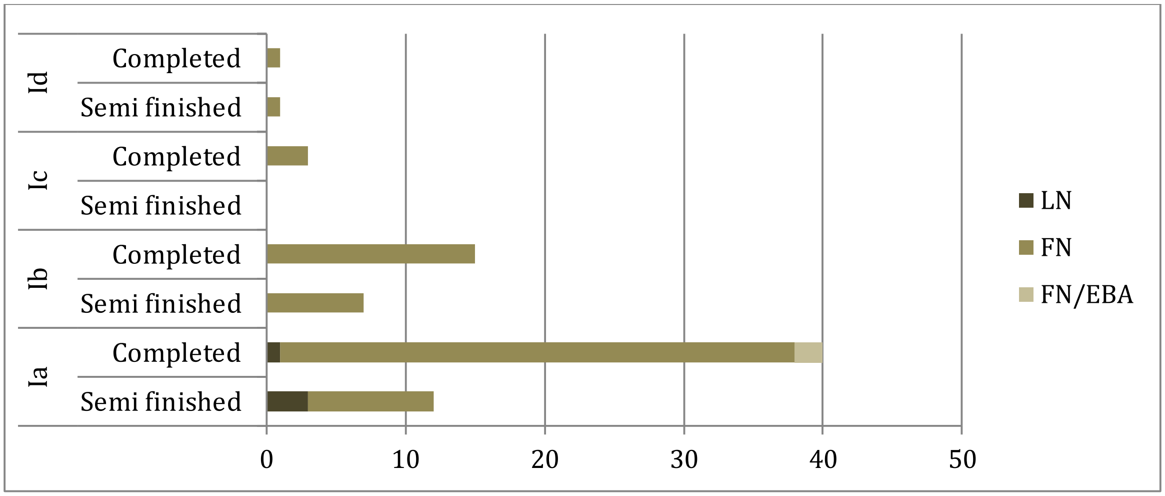


Table 9.10. Sleeve Type I. Chronological distribution and manufacture status of the four subtypes

At least thirty seven tools have use wear traces (change of the natural surface, high polish and small pits) in the burr base. These wear traces don't appear to all subtypes with the same frequency but mainly in the subtype Ia and less on the subtupes Ib and Ic whereas they don't appear in the subtype Id sleeves (table 9.11). These traces appear **a)** in the centre of the base (**n: 3**), **b)** in the marginal areas of the base (**n: 6**) or **c)** they cover the whole surface of the base (**n: 22)** (Fig. 9.4,9.5, table 9.11). The appearance of these traces in this part of the antler means that these tools were also used as hammers as the surface of the base provided a rather big hitting surface. Also, it is unknown if this use coincided with their use as sleeves (sleeves-hammers) or if their use as hammer preceded the one as sleeves.

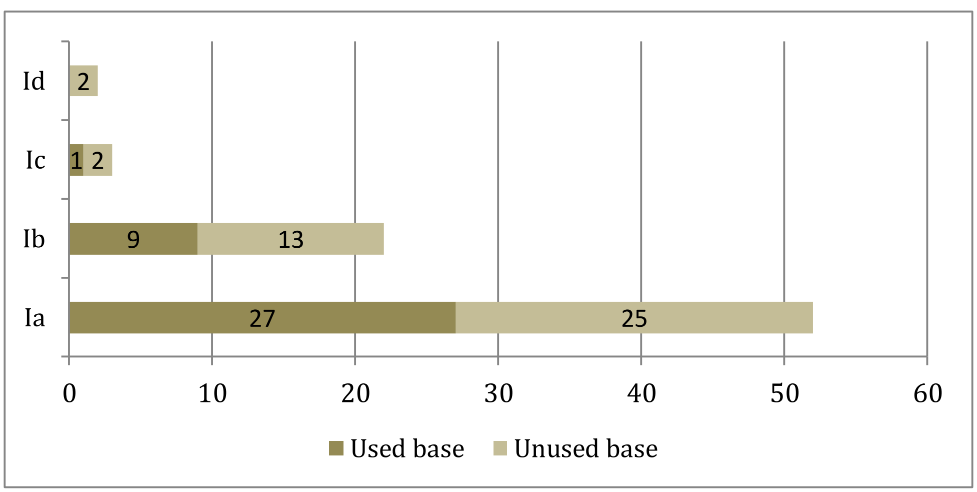


Table 9.11. Percentage of the type I sleeves with used and unused base

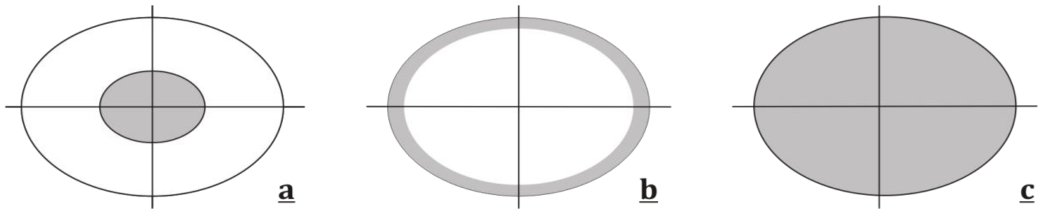


Figure 9.4. Localization of the use wear traces in the burr base, a.central, b) marginal,c) whole base covered (modified after Averbouh and Bodu 2002, fig.5)

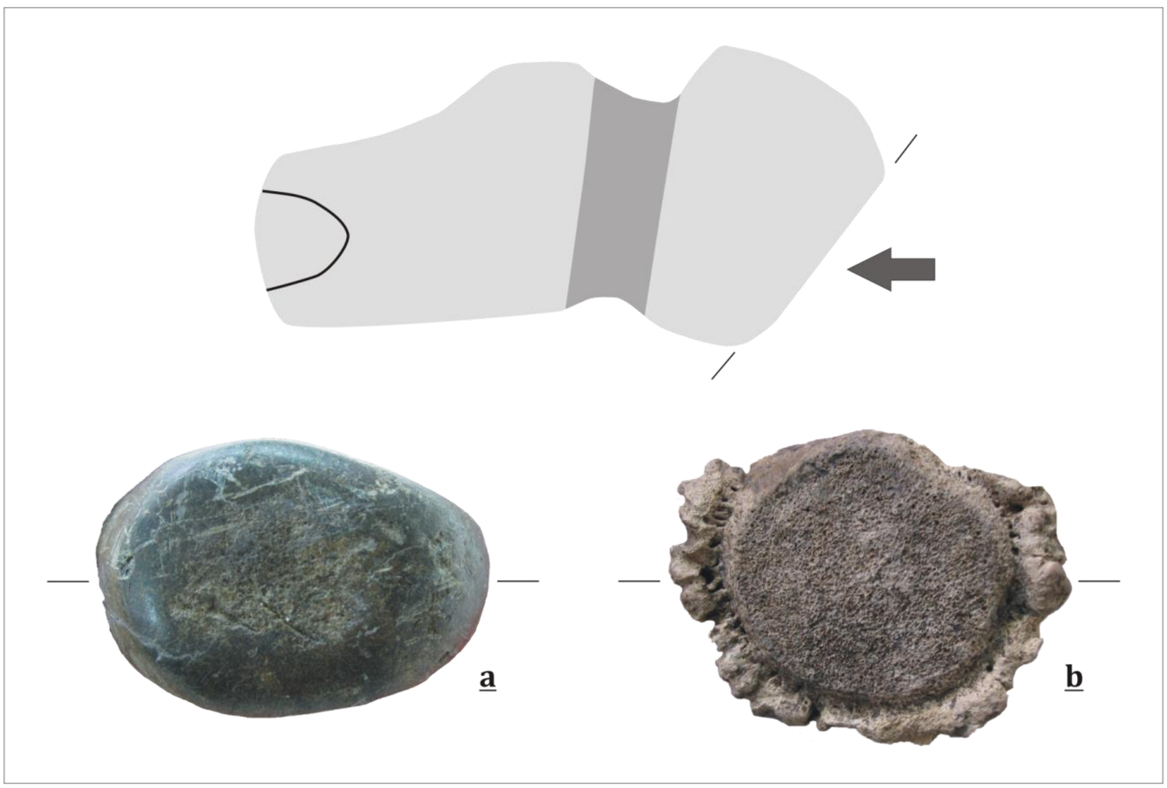


Figure 9.5. Type I sleeves. a, Used burr base, b. Unused burr base

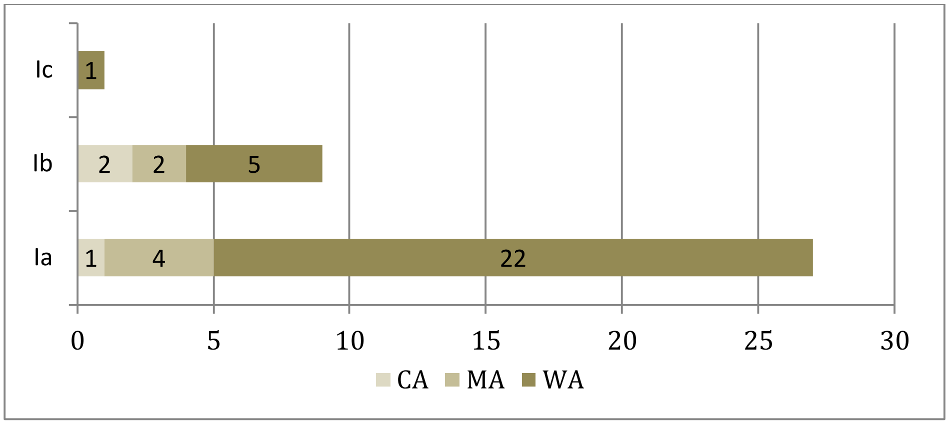


Table 9.12. Sleeve I subtypes used as hammers and localization of use wear traces in their base (CA: central area, MA: marginal area, WA: whole area)

Subtype Ia. Shaft hole shaped between T1 and T2.

Fifty two tools comprise the biggest sleeve subcategory whose main characteristic is the existence of a shaft hole in the area between the first and the second tine (fig 9.6, 9.7, Pl.Ia-d., Pl.II.a,b). This practice was the most common of all four especially in the Final Neolithic habitation where it predates all other practices.

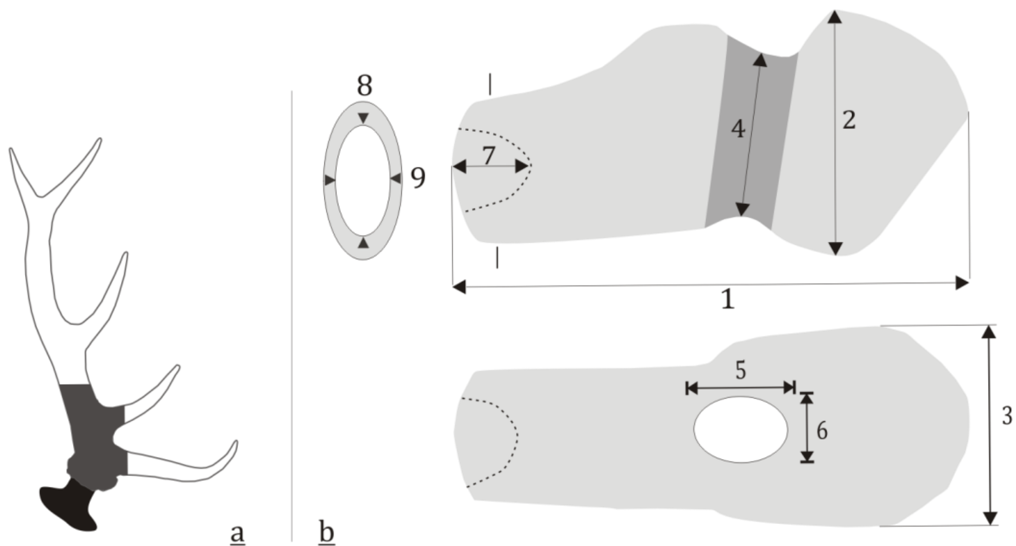
Forty tools are completely manufactured and the rest of them (**n: 12**) are semi-finished items. Their preservation state varies. The majority of them (**n: 28**) are almost fully preserved. Twenty three tools are half preserved and only one tool is preserved partially.

Their use starts during the Late Neolithic habitation phase (**n: 4**) and it continues during the Final Neolithic habitation phase (**n: 46**). Two tools can be attributed to the FN/EBA phase.

Their use during the Late Neolithic habitation phase seems very limited as only four tools have been recovered. All of them were shaped on shed red deer antler. Two of them were shaped on left side antler and two in right side antler. Unlike the next phase, in all tools the coronet was retained and not removed during the manufacturing process. One of them could have been used also as a hammer-sleeve as it bears use wear traces in the whole surface of the base burr.

The majority of them are semi-finished and totally preserved (**n: 3**) and only one tool is completely finished (table 9.13). This tool is half preserved (length 9.0 cm, height 6.0 cm, thickness 5.8 cm, weight 127.8 gr) as it lacks part of the shaft hole and the socket.

The length of the semi-finished and fully preserved tools ranges from 10 cm to 15.1 cm (average length: 12.7 cm), their height ranges from 8.0 cm to 14.0cm (average height: 11 cm) and their thickness varies from 5.6 cm to 7.6 cm (average thickness: 6.56 cm). These tools are quite heavy as their weight ranged from 240.1 gr to 392.9 gr (average weight: 313.43 gr).



1.Length, **2.**Height, **3.**Thickness, **4.**Shaft hole length**, 5.**Shaft hole long diametre (ShLD), **6.**Shaft hole short diametre(ShSD), **7.**Socket depth, **8.**Socket long diametre (SoLD), **9.**Socket short diametre (SoSD)

Figure 9.6. Sleeve subtype Ia. a.Origin of the raw material, b. Metrical analysis

		Preservation status		
		Half/Almost half	Fully	Total
Manufacture status	Completely manufactured	1	0	1
	Semi-finished	0	3	3

Table 9.13. Sleeve subtype Ia, Late Neolithic. Preservation and manufacture status

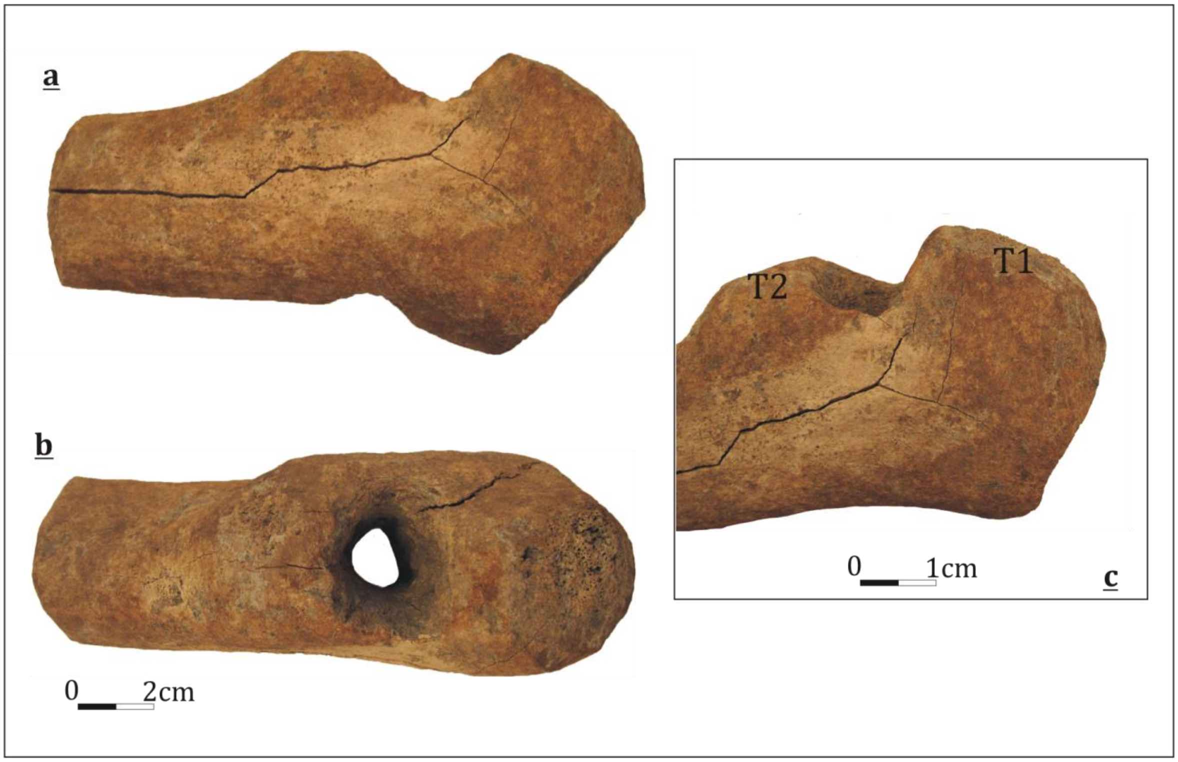


Figure 9.7. Sleeve subtype Ia (A9b.KE071)
a,b. Different views of the tool, c. View of the shaft hole area

These three semi-finished tools can provide us with useful information about the manufacture sequence. After the extraction of the basal part and the removal of the tines, in all three tools the shaft hole was shaped before the socket hole in the area between the first and second tine. In all three cases the manufacturer(s) tried to shape the shaft holes but never finished them. The shaping of the shaft holes was performed through the use of two techniques: the drilling and the percussion. In two cases the manufacturers used only the drilling technique and in two cases the percussion technique was used before the drilling in order to form the rough out shape of the hole, to remove the outer surface of the antler and to prepare the raw material for the drilling. In one case the perforation was nearly completed but the shaft hole was very small and probably non-functional (fig.9.8) and in another case the manufacturer used only the percussion technique and left the shaft hole unfinished as it was not further drilled (fig.9.9). In three cases the perforation of the shaft hole started from one side and only in two cases the perforation was bidirectional. All shaft holes are round shaped and their diametre ranges from 1.5 cm to 2.5 cm (average diametre 1.6 cm). The information about the sockets is rather limited as most of the preserved sockets are semi-finished.

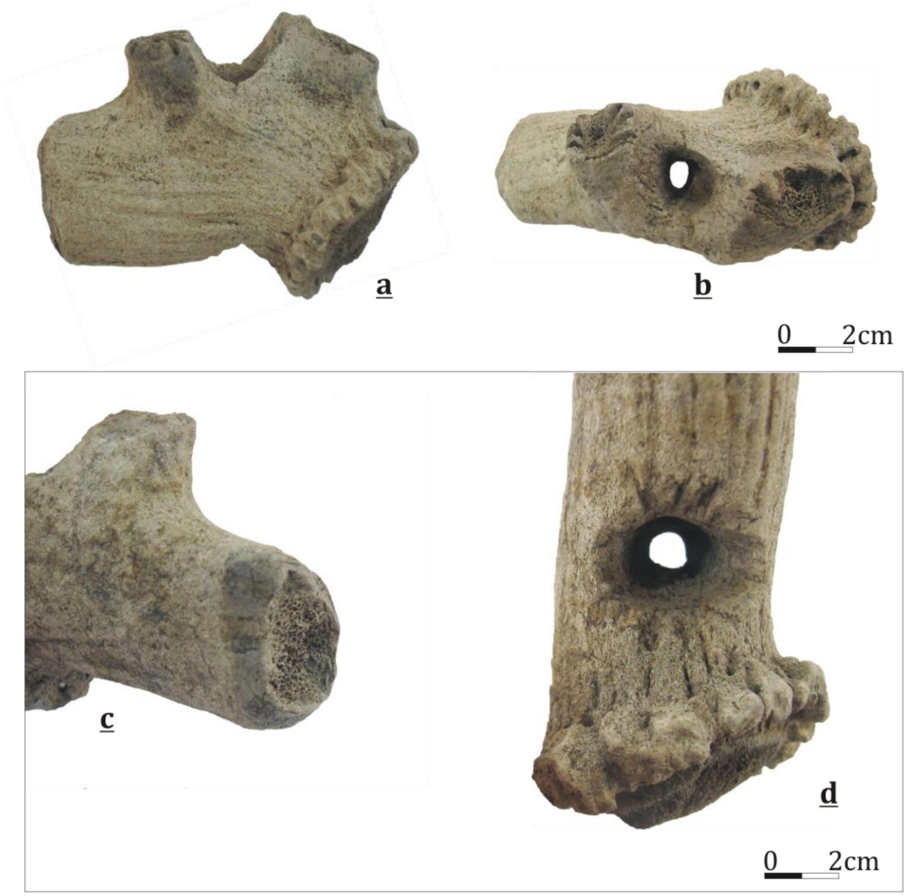


Figure 9.8. Late Neolithic sleeve subtype Ia (A9b.KE139), semi-finished tool.
a,b. Different views of the tool, c. View of the non-shaped socket, d. View of the unfinished shaft hole

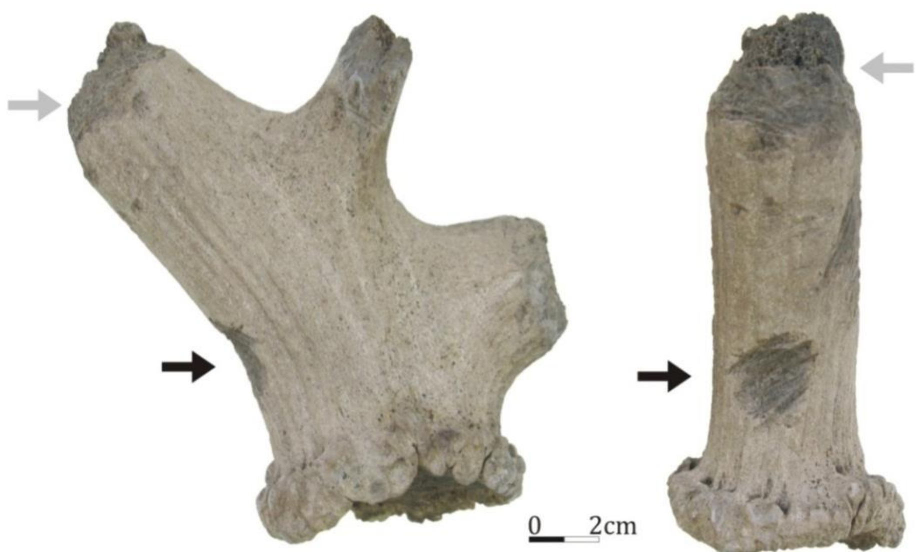


Figure 9.9. Late Neolithic subtype Ia sleeve (A9b.KE251), semi-finished tool.
(Black arrow: shaft hole drilling attempt, grey arrow: detachment attempt percussion traces)

The number of the tools of this subcategory reached its peak during the Final Neolithic as forty six tools can be ascribed to this habitation phase. All of the tools were shaped in shed red deer antler. Twenty four tools were shaped in the left side antler and twenty three in right side antler. In forty cases the outer burr (coronet) was removed maybe for aesthetic rather for practical reasons since its position in the tool could not have incommoded its function. Twenty six of these tools could have also been used as hammers as they have use wear traces in the centre (**n: 1**), in the margins (**n: 4**) and in the whole surface (**n: 21**) of the base burr.

The vast majority of the tools (**n: 37**) are completely manufactured and only nine tools are semi-finished. Twenty two tools are (almost) half preserved, one is preserved partially and the rest of them (**n: 23**) are almost fully preserved. All semi-finished tools are fully preserved (table 9.14). The half preserved tools lack usually the proximal part with the socket and sometimes also part of the shaft hole.

The length of the fully preserved tools ranges from 7.1 cm to 16 cm (average legth 11.3 cm). The height ranges from 4.0 cm to 10.5 cm (average height 7.13 cm) while the thickness ranges from 3.7 cm to 6.5 cm (average thickness 4.99 cm). Their average weight is 256.gr.

		Preservation status			
		Partially	Half/Almost half	Fully	Total
Manufacture status	Completely manufactured	1	22	14	37
	Semi-finished	0	0	9	9

Table 9.14. Sleeve subtype Ia, Final Neolithic. Preservation and manufacture status

The semi-finished tools reveal the manufacturer(s) choices concerning the steps after the first manufacturing steps which are the shaping of the socket and the shaft hole. There have been distinguished two sequences with the second one being the most popular:

- **i.** Shaping attempts of the socket before the perforation of the shaft hole (1 case)
- **ii.** Shaping attempts of the shaft hole before the shaping of the socket (8 cases)

As is also evident from the semi-finished tools from the previous phase, the manufacturer(s) preferred to shape at first the shaft hole and later the socket hole. It is possible that this action was deliberate and that these tools could have been left unfinished with an unshaped socket hole so that this part of the tool could have been shaped later stage when the user of the tool was about to choose the size of the stone tool that would place in the socket according to his/her needs. In this case, the size of the inserted stone tool affected the shaping of the socket hole in terms of size, shape and also the time of the finalization of the manufacture process.

The majority (**n: 35**) of the shaft holes has round cross section (table 9.15, fig.9.10, 9.11, 9.12). In sixteen cases the shaft hole is completely manufactured and is preserved totally so it was possible to measure the dimensions of the holes and to recognize the manufacture techniques. They were shaped through different techniques either drilling (fourteen cases) or through percussion and drilling (two cases). In one case the perforation was attempted from both sides (anterior-posterior) and in the rest of them (**n: 15**) only from one side. Their diametre ranges from 1.4 cm to 2.6 cm (average diametre: 1.85 cm) and their length ranges from 3.95 cm to 8.0 cm (average length: 5.51 cm).

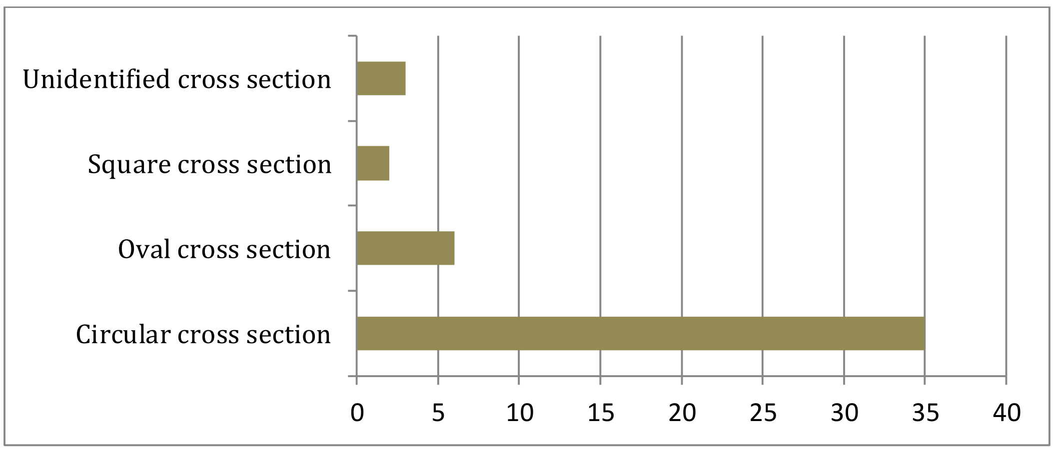


Table 9.15. Sleeve Type Ia (Final Neolithic). Shaft holes cross sections

In the partially preserved shaft holes with round cross section, the perforation was performed through one side (one directional). In those tools the shaft hole diametre ranges from 1.2 cm to 2.45 cm (average diametre: 1.49 cm) and the shaft hole length from 3.45 cm to 9 cm (average length: 4.92 cm). It is noteworthy that the boring technique was used in two semi-finished shaft holes with round cross section (fig.9.10, 9.11).

The shaft holes of the rest of the tools have oval (**n: 6**) or square cross section (**n: 2**) (fig. 9.13) and in three cases it was not possible to identify the shape and the size of the shaft holes. The shaping of the shaft holes with square cross sections was onedirectional (**n: 1**) or bidirectional (**n: 1**).Their average dimensions are 1.7 cm x 1.7 cm and their length ranges from 1.45 cm to 5.0 cm. The shaft holes with oval cross section the shaping was one directional. The short diametre (ShSD) ranges from 1.4 to 2.8 cm while the long diametre (ShLD) ranges from 1.8 cm to 3.5 cm. Their length ranges from 3.5 cm to 7.7 cm (average length 5.37 cm).

Concerning the hafting angle (the angle between the antler tool and the inserted wooden handle), it seems that most of the shaft holes were vertical or almost vertical to the longitudinal axis of the antler tool. The rest of them were drilled diagonally to the antler tool and their small number shows that perhaps this choice was not so practical concerning the tool use.

Most of the sockets (**n: 38**) are completely manufactured. They were shaped by percussion and hollowing. Some sockets were grinded and their outer surface was leveled (fig.9.14b,c). The rest of them bear a few traces of hollowing attempts (**n: 3**) or have not been shaped at all (**n: 5**). The preservation status varies as only ten of them are totally preserved and the rest of them are half/partially preserved and in some cases not preserved at all.

Although it seems that most of them have oval cross section, it was possible to recognize with certainty the shape only in ten of these tools. Eight socket holes have oval cross section (average dimensions 2.76 cm x 2.21 cm) and the remaining have almost round cross section (average diametre 1.5cm).In all these cases the stone tool was placed in the socket in alignment with the longitudinal axis of the tool and the tool was used as an axe.

The two tools that can be attributed to the upper FN/EBA disturbed layers were shaped on left side shed red deer antler and in both cases the coronet was removed. They don't differ technologically from the tools of the previous phase. Both of them are completely manufactured. One of them lacks part of its shaft and its shaft hole while the other is in almost perfect preservation condition. The first one is 15.4 cm in length (thickness 6.5 cm, weight 392 gr), it has a shaft hole with an oval cross section (hole at the posterior side of the tool: LD 2.2 cm, SD 1.4cm) and a round shaped section socket hole (diametre 2.0 cm). The second one is smaller in size (length10.8 cm, thickness 4.7 cm, weight 195 gr), it has a shaft hole with a round cross section (diametre 1.8cm) and a socket with an oval cross section (2.2 cm x 1.7 cm).

Figure 9.10. Final Neolithic subtype Ia sleeve. View of the slightly drilled shaft hole

Figure 9.11. Final Neolithic subtype Ia sleeve (A9b.KE286). Semi-finished tool with slightly drilled shaft hole

Figure 9.12. Final Neolithic subtype Ia sleeve (A9b.KE126)

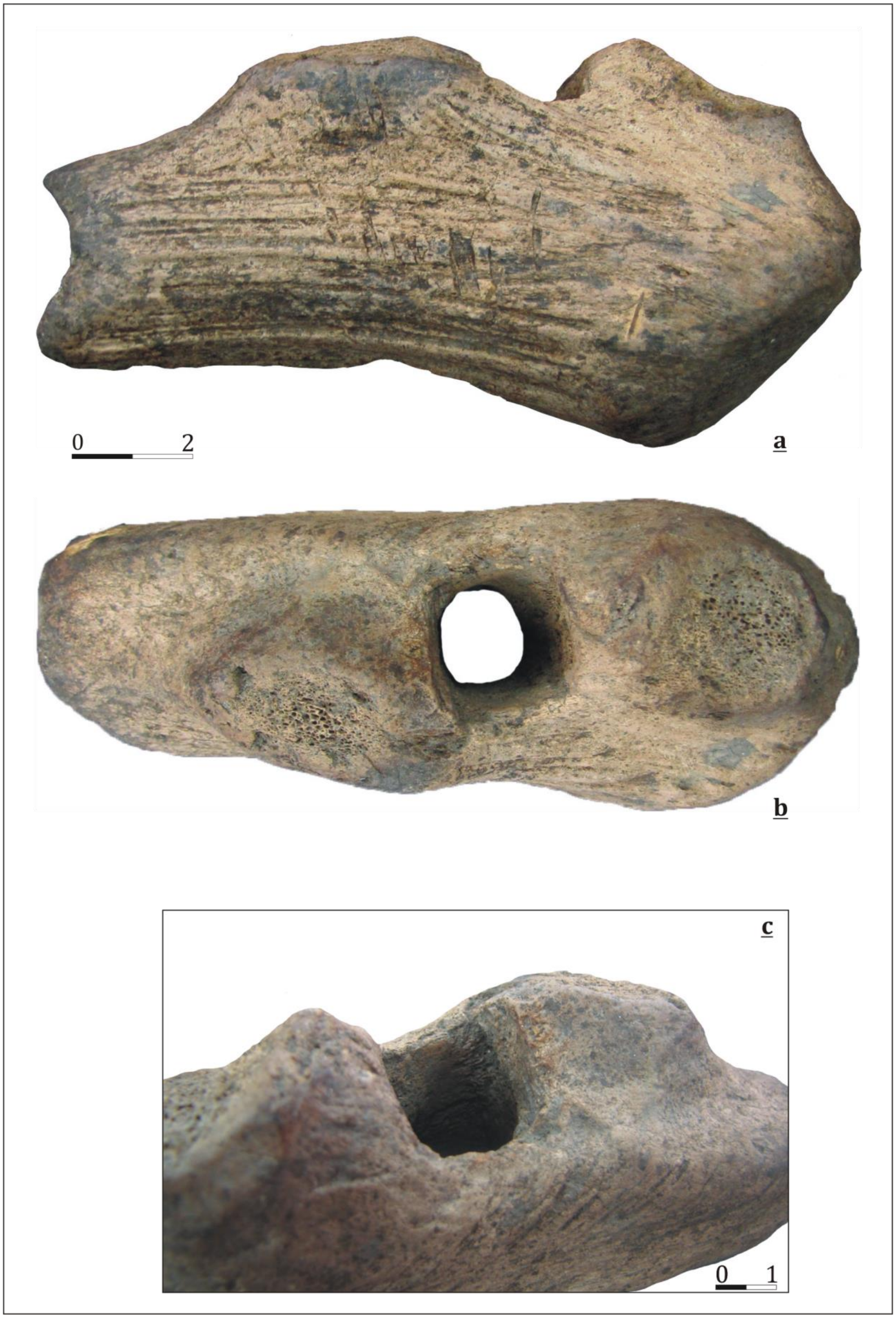


Figure 9.13. Final Neolithic subtype Ia sleeve (A9b.KE146).
a,b.Different views of the tool, c. Detail from the shaft hole

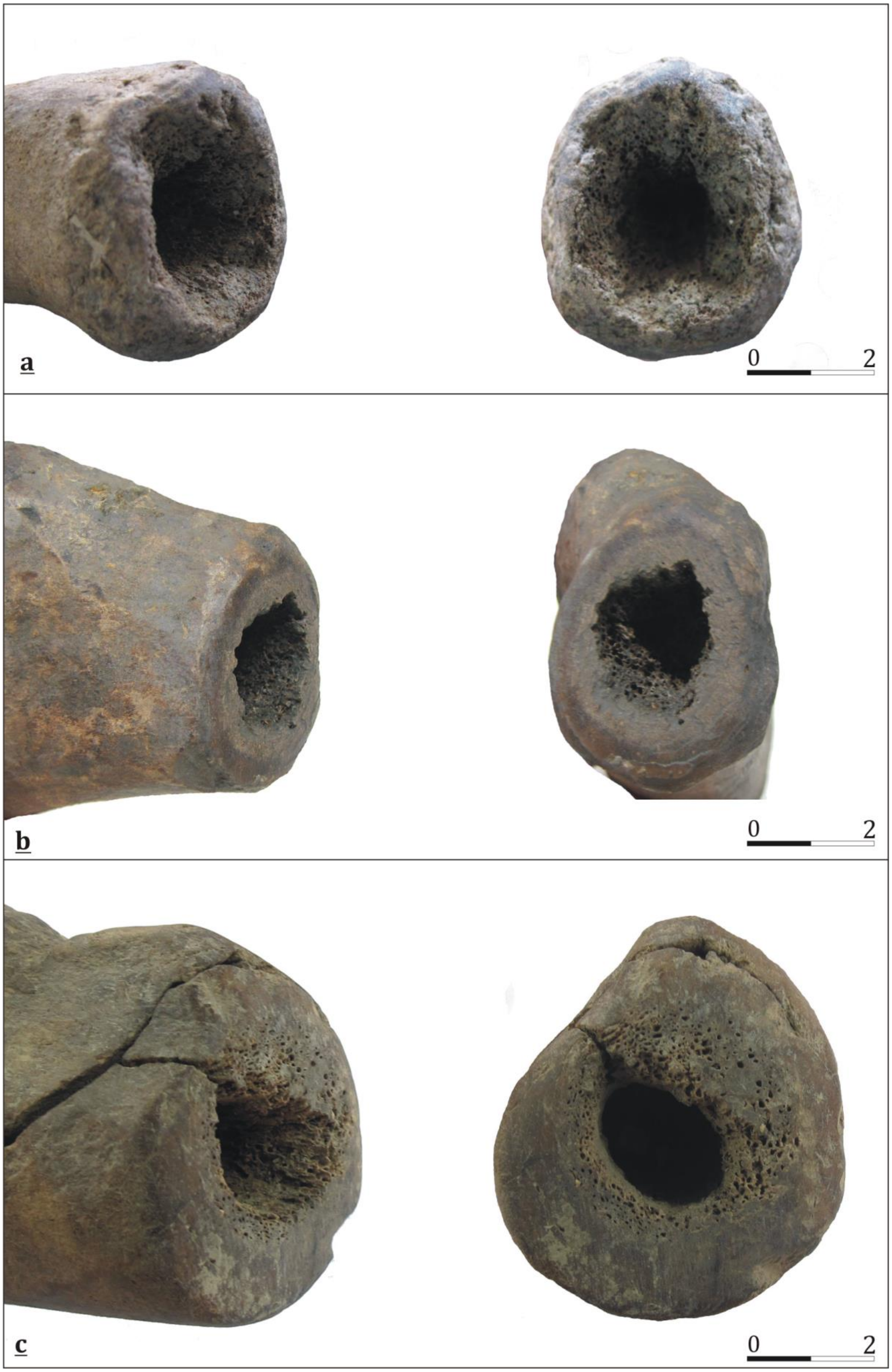
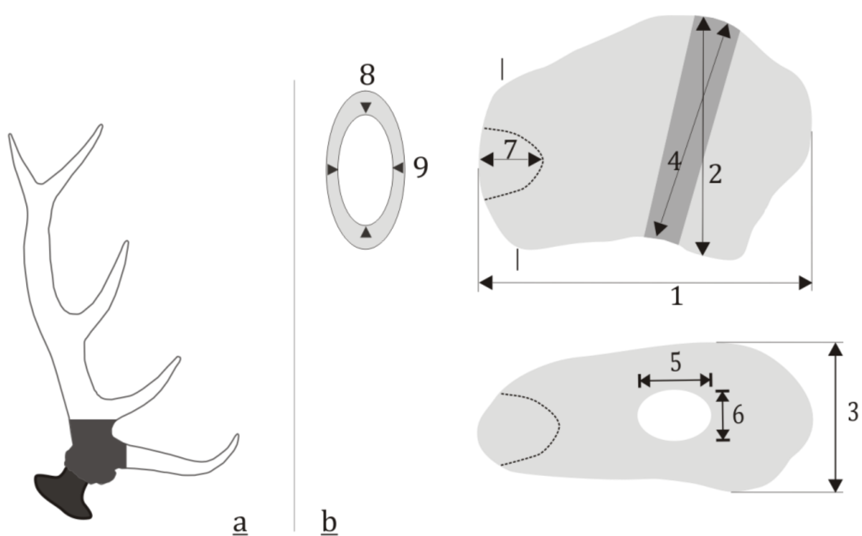


Figure 9.14. Sleeve subtype Ia (Final Neolithic), a-c. Sockets for stone tools

Subtype Ib. Shaft hole shaped on T1 base

Twenty two tools comprise this sleeve subcategory. Its main characteristic is the shaping of the shaft hole in the lowest part of the basal area of the first tine after its detachment (fig.9.15, 9.18, Pl.IIc). The manufacture sequence involved the removal of the first tine usually by percussion and the cutting of the basal part at the desired length usually some centimeters above the area of the first tine through percussion (fig.9.16). The next step was the shaping of the shaft hole on the base of the removed tine that was left in the antler and the hollowing of the socket.



1.Length, **2.**Height, **3.**Thickness, **4.**Shaft hole length,
5.Shaft hole long diametre (ShLD), **6.**Shaft hole short diametre(ShSD),
7.Socket depth, **8.**Socket long diametre (SoLD),**9.**Socket short diametre (SoSD)

Figure 9.15. Sleeve sutype Ib. a.Origin of raw material, b.Metrical analysis of the subtype Ib sleeves

All tools of this category belong to the Final Neolithic habitation phase. Seven tools are semi-finished items (fig.9.16) and fifteen tools are completely manufactured (fig.9.17). Their preservation state varies. The majority of them (**n: 14**) are half or almost half preserved and eight tools are totally preserved (table 9.16). All tools were shaped on shed red deer antler. Most of the tools (**n: 13**) were shaped on right antler, eight tools were shaped on left antler and in one case it was not possible to identify the side. As in the previous subtype, the coronet was removed in most of the tools (19/22 cases). Nine tools could have been used also as hammers as they have use wear traces (high polish, deep grooves and pits) in the central area (n:2), in the marginal area (n:2) or in the whole surface of the base burr (n:5).

Figure 9.16. Subtype Ib sleeve (A9b.KE016). Semi-finished tool shaped on unshed red deer antler a.Different views of the tool, b.View of the undrilled socket, c.Manufacture traces in the base of the tool

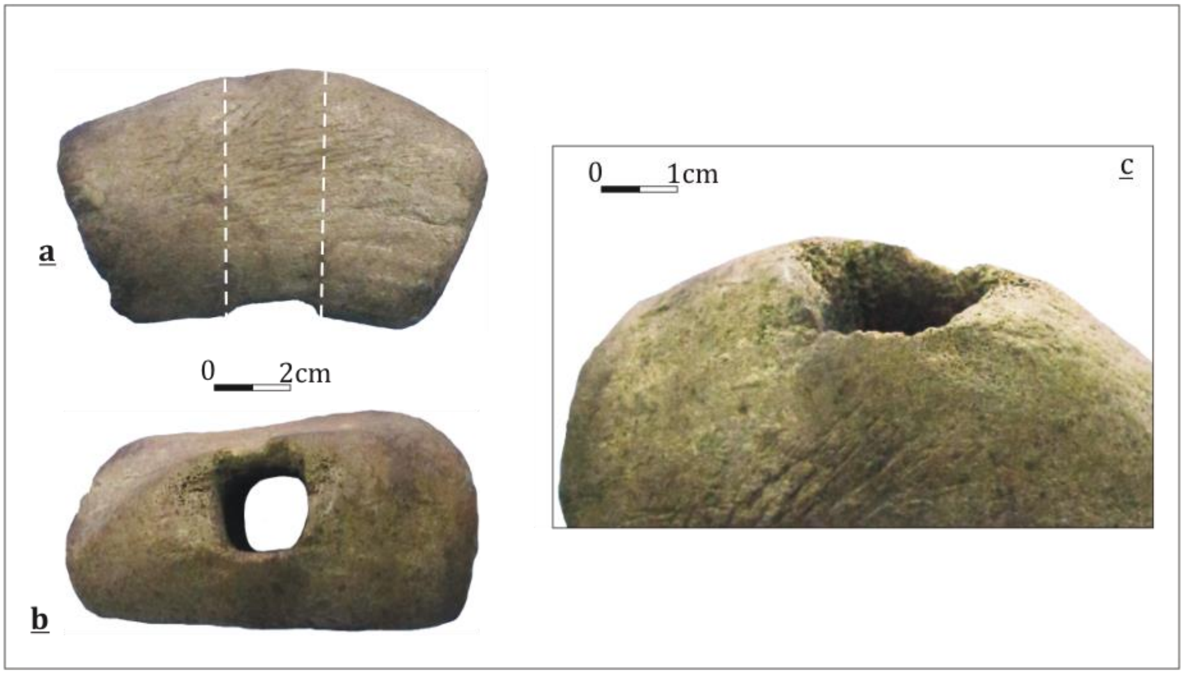


Figure 9.17. Subtype Ib sleeve (A9b.KE272), a-b.Different views of the tool, c. Detail of the shaft hole area

		Preservation status		
		Half/Almost half	Fully	Total
Manufacture status	Completely manufactured	13	2	15
	Semi-finished	1	6	7

Table 9.16. Sleeve subtype Ib, Final Neolithic. Manufacture and preservation status

In eight cases it was possible to measure fully all the dimensions of the tools. The average length is 10.82 cm, the average height is 7.88 cm, the average thickness is 5.46 cm while the average weight of these eight tools is 269.2 gr

As in the other subtypes, the FN semi-finished tools of this phase reveal the same choices concerning the shaft hole and the stone tool socket. Most of the shaft holes (**n: 11**) have a round cross section (table 9.17, 9.18) with an average diametre of 1.8 cm (table 9.18). They were shaped mainly through drilling and in three cases the artisans used the percussion technique in order to remove the outer surface and to prepare the drilling of the hole. The rest of them have oval (**n: 7**) and square (**n: 2**) (average dimensions 2.2 cm 2.2 cm) cross section. One shaft hole was not drilled and in one tool it was not possible to specify the shape of the hole. Most of them were shaped through drilling (**n: 13**), percussion and drilling (**n: 8**) or only through percussion in the case of the semi-finished shaft hole. Almost all of the shaft holes were drilled vertically or almost vertically to the longitudinal axis of the antler tool.

It seems to be a difference between the length of the shaft hole of different cross sections. The average length of the shaft holes of round cross section is 5.21 cm while the average length of the ones with oval and square cross section is 5.66 cm and 7.23 cm respectively. Also, there seems to be a correlation between the shaft hole diametre and the shaft hole length in the tools with a round cross section (table 9.18). The length of most of the shaft hole ranges from 5.0 cm to 9.0 cm and their diametre ranges from 1.2 cm to 2.3cm.

Eight tools preserve fully the distal part with the socket area but only three of them are completely manufactured (oval with average dimensions 2.63 x 1.93 cm and average depth 2.1 cm) (fig.9.19). The shape and the dimensions of the sockets indicate that the stone tool was placed in the socket in alignment with the longitudinal axis so these tools were parts of composite axes The rest of the sockets are half preserved and it was not possible to measure exactly their dimensions.

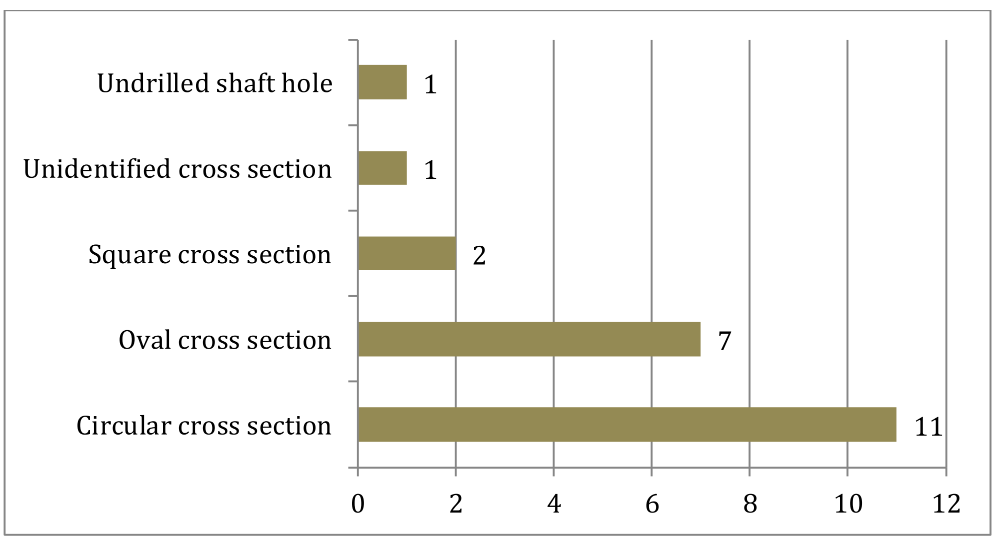


Table 9.17. Sleeve Type Ib (Final Neolithic). Shaft hole cross sections

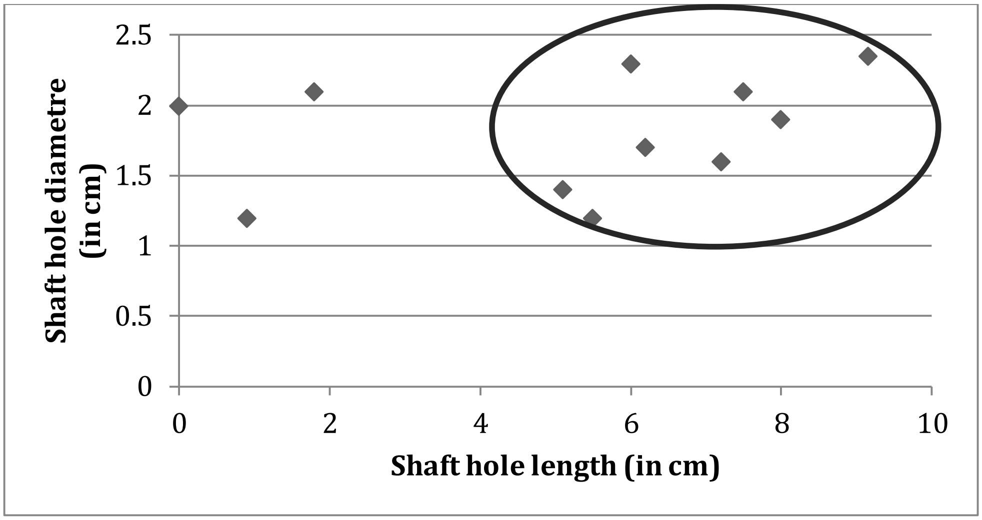


Table 9.18. Sleeve subtype Ib, Final Neolithic.
Length and diametre of the shaft holes with round cross section

Figure 9.18 Subtype Ib sleeve (Final Neolithic). Semi drilled shaft hole of round cross section

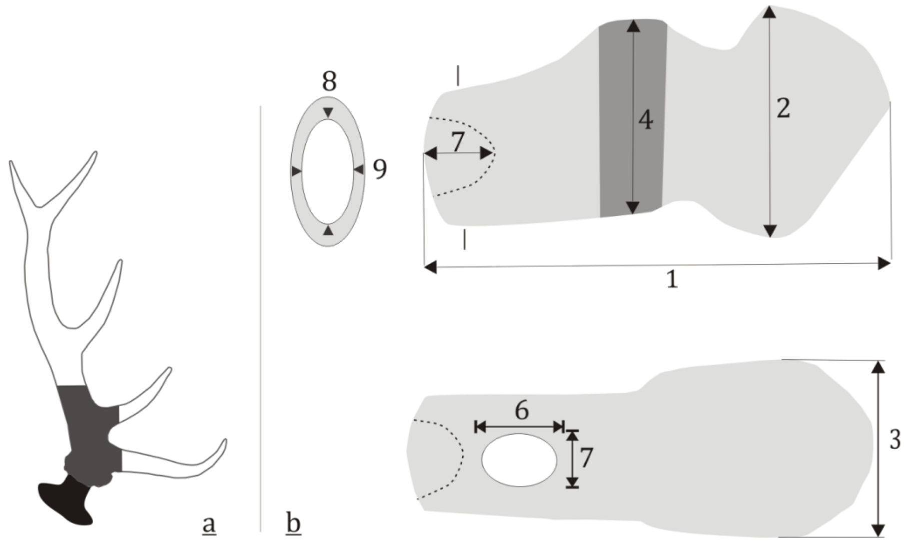
Figure 9.19. Subtype Ib sleeve (Final Neolithic). Percussion traces around the socket hole

Subtype Ic. Sleeves on basal parts with shaft hole shaped on T2 base

This small subcategory consists of three tools that belong to the Final Neolithic habitation phase (fig.9.20, 9.21, Pl.IId) and it seems that this subtype was not so popular amongst the inhabitants of the settlement. Its main characteristic is the shaping of the shaft hole on the base of the second tine after its detachment. The manufacture sequence involved the removal of the first tine usually by percussion and the cutting of the basal part at the desired length usually some centimeters above the area of the first tine through percussion. The next step was the shaping of the shaft hole on the base of the removed tine that was left in the antler and the hollowing of the socket.

All tools were shaped on shed red deer antler (two on left and one on right side antler) and they lack the coronet. They are completely manufactured and their preservation condition varies: one of is fully preserved, one lacks part of the shaft hole and the part of the socket and the third one is half preserved. They are quite lengthy (average length: 14.03cm) and their average weight is 246 gr. One of them bears use wear traces on the burr base and it was probably used also as a hammer.

In two tools the shaft hole has round cross section (2.1 cm in both cases) that was shaped through one directional drilling (fig.9.21, 9.22). The average shaft hole length is 6.0 cm. The sockets have round cross section (diametre 2.0 and 2.1 cm respectively) and they were shaped through hollowing. All shaft holes were drilled vertically to the antlers longitudinal axis.



1.Length, **2.**Height, **3.**Thickness, **4.**Shaft hole length, **5.**Shaft hole long diametre (ShLD), **6.**Shaft hole short diametre(ShSD), **7.**Socket depth, **8.**Socket long diametre (SoLD), **9.**Socket short diametre (SoSD)

Figure 9.20. a.Origin of the raw material, b. Metrical analysis of the subtype Ic sleeves

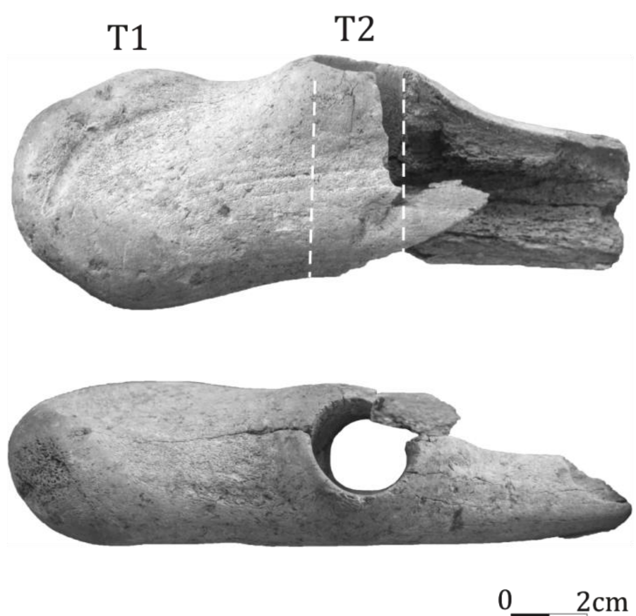
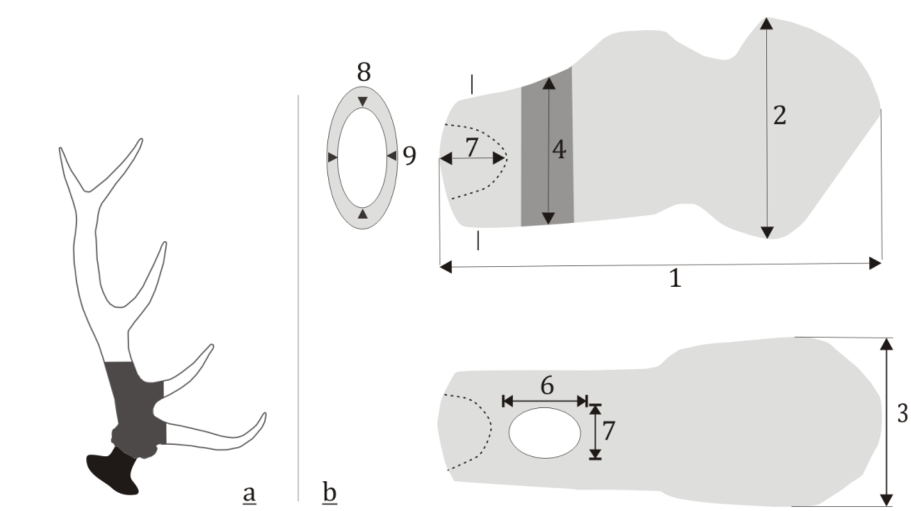


Figure 9.21. Final Neolithic sleeve subtype Ic (A9b.KE46) (the white lines indicate the shaft hole position)

Figure 9.22. Final Neolithic subtype Ic sleeve (A9b.KE268)

Subtype Id. Shaft hole above T2

The two tools of this subcategory were shaped in collected red deer antler (one left and one right antler) and as in the other subtypes the coronet was removed during the manufacturing process. Both of them belong to the Final Neolithic habitation phase and they were found in the northern and in the central part of the settlement. One of them is semi-finished and the other one is a completed tool (fig.9.24).



1.Length, **2.**Height, **3.**Thickness, **4.**Shaft hole length, **5.**Shaft hole long diametre (ShLD), **6.**Shaft hole short diametre(ShSD), **7.**Socket depth, **8.**Socket long diametre (SoLD), **9.**Socket short diametre (SoSD)

Figure 9.23. Sleeve subtype Id, **a.** Origin of the raw material, **b.** Metrical analysis

The main characteristic of these tools is the existence of the shaft hole in the area right above the second tine and close to the socket (fig.9.23, 9.24). The tools of this subcategory are quite lengthy (11.2 cm and 14.0 cm respectively) and heavy (average weight is 237.7 gr).

In one case the shaft hole has round cross section (diametre 2.0 cm) and it was shaped through drilling and in the other tool the artisan tried to shape the hole by percussion. The shaping of the socket was completed only in one tool. Its socket has an almost round cross section (2.2 cm x 2.0cm) and it was shaped by percussion and hollowing.

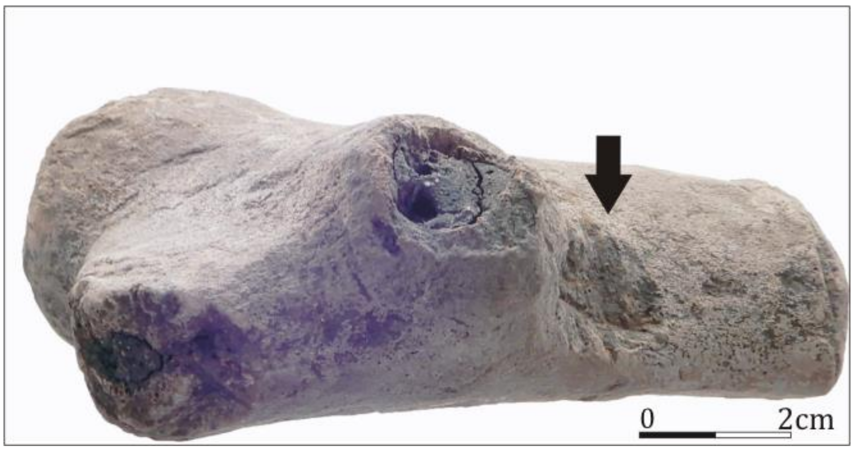
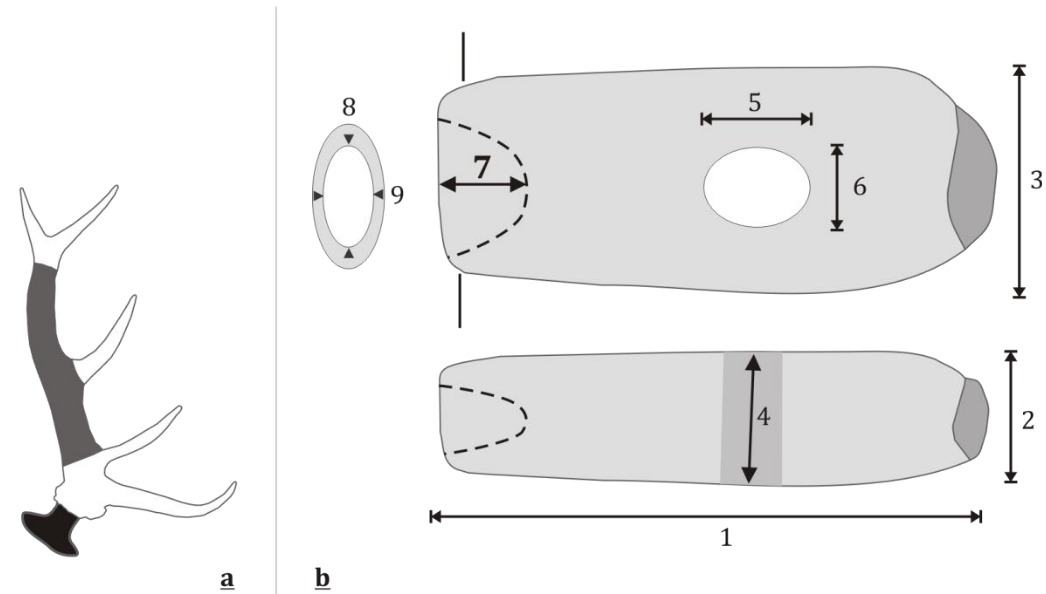


Figure 9.24.Final Neolithic subtype Id sleeve (A9b.KE253).Semi finished tool.
(The arrow indicates the position of the shaft hole shaping attempt)

Type II. Sleeves on beam segments with shaft holes.

The presence of a different kind of indirect hafting method in Anarghiri IXb is indicated by the presence of sleeves shaped on beam segments with a shaft hole. Their main characteristic is the existence of a shaft hole mainly in the middle in their length for the insertion of the wooden handle and a socket in the distal part for the insertion of the stone tool (fig.9.25, fig.9.26).



1.Length, **2.**Height, **3.**Thickness, **4.**Shaft hole length**, 5.**Shaft hole long diametre (ShLD), **6.**Shaft hole short diametre(ShSD), **7.**Socket depth, **8.**Socket long diametre (SoLD), **9.**Socket short diametre (SoSD)

Figure 9.25. Type II sleves. a.Origin of the raw material, b.Metrical analysis

The beam segment was detached from the antler through heavy percussion at the desired length. Later the artisan shaped the shaft hole through drilling or through percussion and drilling. As is evident from the semi manufactured items, the socket was shaped at the final stage of the manufacture sequence through hollowing**.** The proximal part was left unshaped or roughly shaped with traces of percussion or polishing.

So far these tools are rather unknown in Greece. A few items have been found in the Neolithic settlement in the Cave of Limnes in Peloponnese (Στρατούλη 1997, Fig. 107,108), and in the Cave of Skotini Tharounion in the island of Euboea (Στρατούλη 1993, Fig.18.1)

This category is comprised by ten tools. Two tools can be ascribed to the Late Neolithic phase and eight tools belong to the Final Neolithic habitation phase. Most of them were shaped on main beam segments and only one is shaped in upper beam segment. In this tool the shaft hole is shaped on the third tine and the socket is shaped on the beam.

The tools that belong to the LN phase present different manufacture and preservation status. There is one totally preserved semi-finished tool and one completed but partially preserved tool. The semi-finished tool (length 10 cm, weight 108.5gr) has a slightly drilled shaft hole of round cross section (diametre: 1.1cm) and a roughly shaped but not drilled socket. The small dimensions of the fully preserved oval cross sectioned socket (2.5cm x 2.1 cm) indicate the use of a rather small stone tool that was used as an axe to light woodworking tasks. The other tool preserves only part of the probably square sectioned shaft hole and the distal part with the socket. Due to the partial preservation the measurement of the shaft hole dimensions is not possible.

The vast majority of the tools (**n: 9**) of the Final Neolithic habitation phase are completely manufactured and half or partially preserved and only one semi-finished tool is almost totally preserved. Almost all the half/partially preserved tools (average length: 9.4 cm, average thickness: 2.48 cm, average weight: 66.7 gr) lack both part of their socket and their shaft hole. The distal part was fully preserved in one case.

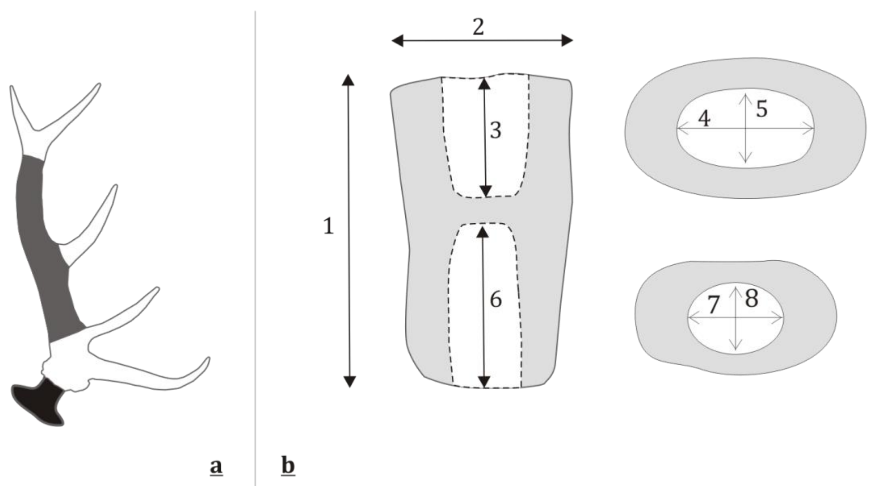
Since the shaft holes are not fully preserved is not possible to measure the exact dimensions of their shaft holes (the diametre or long/short diametre ranges from 1.0 cm to 2.0 cm). Nevertheless, the overall impression is that half of them were round shaped and that the rest of them are probably oval (**n: 2**), rectangular (**n: 1**). In one case it was impossible to determine the shaft hole shape. Most of them were shaped through drilling and only two holes were shaped through the combination of percussion and drilling techniques. The holes were perforated mainly transversally and less diagonally to the longitudinal axis of the tools. The FN semi-finished tool has an unfinished socket. Its almost round shaft hole (diametre 1.7 cm) was shaped through one directional percussion and drilling. The average length of the shaft hole is 3.47 cm (min. 2.5 cm, max.5 cm).

Except from one case the sockets are completely manufactured. Their preservation status varies. Only four tools preserve completely their socket holes, two of them with oval cross section with average hole dimensions 2.3 x 1.65cm and two with almost round cross section with average diametre 1.9 cm. In the rest of them the socket is preserved half or partially. In two cases the socket was probably oval. Although the information derived from the shape and the size of the socket holes in relatively poor, the data so far indicates that the stone tools were inserted in parallel with the longitudinal axis of the sleeve and that the tools were used as axes.

Figure 9.26. Type II sleeve on beam segment with shaft hole (A9b.KE257)

Type III.Socketed sleeves

Three tools comprise the third sleeve category. They are shaped on beam segments and they have two sockets, one mounting socket in which it was inserted the ground stone tool and one hafting hole that was receiving the tenon of the wooden haft (fig. 9.27).



1.Length,
2.Thickness,
3.Mounting socket depth,
4.Mounting socket long diametre (MoLD),
5.Mounting socket short diametre (MoSD),
6.Hafting socket depth,
7.Hafting socket long diametre (HsLD)
8.Hafting socket short diametre (HsSD)

Figure 9.27**.** Socketed sleeves. **a.** Origin of the raw material, **b.** Metrical analysis.

One tool belongs to the Late Neolithic phase and two can be ascribed to the Final Neolithic phase of the settlement**.** Their manufacture sequence involved **a)** the extraction of the raw material from the beam through percussion and **b)** the shaping of the two holes through hollowing and grinding. Since all tools of the studied assemblage are completely manufactured, it is not possible to identify which of the two sockets was shaped first**.**

The LN tool is completely manufactured and totally preserved. Its length is 6.3 cm and it weighs 69 gr. The mounting socket has an oval shaped section (1.6 cm x 1.2 cm) and the hafting socket has a round shaped section (diametre 1.1 cm). Taking into consideration the dimensions of the mounting socket, it must be assumed that the tool that was inserted in the mounting socket must have been rather small.

The tools of the FN phase are completely manufactured and totally preserved. The most remarkable tool is the one that was shaped on a beam junction area segment (fig.9.28) and is one of the fewest examples of sleeves that were found in Greece with the inserted stone tool on it. Its length is 7.9cm (width: 7.27 cm, thickness 5.2 cm) and it weighs 161 gr. It has two holes that were shaped through careful hollowing. In the distal part the socket for the stone tool has an oval cross section (SoLD 4.3 cm x SoSD 2.05 cm) and its depth is 2.8cm (fig.9.28b). The proximal part of the tool has a hafting hole with a round cross section (diametre 2.0 cm, hafting socket depth 2.2 cm) in which it was inserted the wooden handle of the composite tool (fig.9.28c).

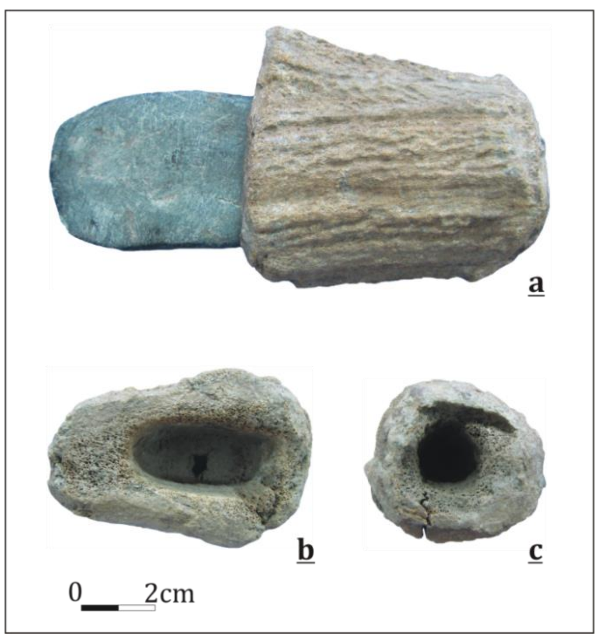


Figure 9.28. a. Socketed sleeve with inserted stone tool (A9b.KE080),
b.View of the socket, c.View of the hafting hole

This sleeve category is very well documented in many (lakeside) neolithic settlements of the 5th and 4th mil BC in the Central Europe. In Switzerland it appears for the first time in the last quarter of the 5th mil BC in the settlement of Egolzwil 3 (Wyss 1994) and its use continues until the end of the 4th mil BC in the area of Zurich and Lake Twann (Furger 1981; Schibler 1987, Abb.193; Gross-Klee and Schibler 1995:163; Zimmerman 2016) and until the first centuries of the 3th mil BC in the area of the lakes Neuchatel , Bienne et Morat (Region de trois lacs) (Furger 1981; Gross 1991; Gross-Klee and Schibler 1995:163; Suter 1981, 2000:Abb.78, Maytain 2010;). In France these tools appear in the area of Clairvaux almost in the middle of the 4th mil. BC in the area of Clairvaux (Pétrequin 2005; Maigrot 2011) and they are also attested in the phases 1-4 of the Chalain 4 settlement that are dated in the beginning of the 3rd mil BC (Maigrot 2003, 33:Fig.17) and in Chalain 3 (Voruz 1997)

In Greece, there have been found only a few socketed sleeves, mainly in Thessally. At least eleven tools have been found in Dimini (Moundrea-Agrafioti 1987, Stratouli 1998a,Taf.35.1), one tool in Theopetra Cave (Στρατούλη 1988, Fig.19.3.1), one from the Chalcolithic phase of Pyrgos (Stratouli 1998a,Taf.36.8) and one item from the Chalcolithic phase of Pefkakia-Magoula (Stratouli 1998a,Taf.42.9).

Type IV.Perforating sleeves

The perforating sleeves comprise a small category that consists only of five tools. Three of them belong to the Late Neolithic and two of them to the Final Neolithic habitation phase.

This type of sleeves has been also attested in other lakeside settlements in France and in Switzerland. In France, its use is rather rare with a few items coming from the Middle Neolithic phase of the Clairvaux VII settlement (Maigrot 2015). On the contrary, in Switzerland the Middle Neolithic, and more particularly the Cortaillod and Pfyn cultures, are characterized by the presences of perforating sleeves (Maytain 2010, Billamboz 1982; Suter 1981, 2000; Gross *et al.* 1987; Maytain 2010; Schibler *et al.* 1997; Wey 2001). So far the quantity of the perforating sleeves found in Neolithic settlements in Greece and in rest of the Balkans is very small as this tool type has been found only in Dimini in Thessaly (Moundrea-Agrafioti 1987:252, Fig.3.5) and in Divostin in Serbia (Lyneis 1988, Pl.IV.d,e).

These sleeves are shaped on tines (mainly whole pieces and in one case a tine segment) that were cut off by percussion and sometimes by sawing and later the proximal part of the antler was hollowed for the creation of the socket where a ground stone tool was inserted (fig.9.29, fig.9.30a). In a few cases the percussion marks derived from the detachment process were smoothed out by grinding perhaps for a better aesthetic result (fig.9.30b). The difference between the previous sleeve categories and this one is the absence of a shaft hole or a hafting socket. The tool was penetrating vertically the longitudinal axis of the wooden handle with the distal part of the tine situated in the posterior side of the wooden handle. The stone tool was placed inside the socket also vertically to the longitudinal axis of the wooden handle and it was used as an axe (fig. 9.31a).

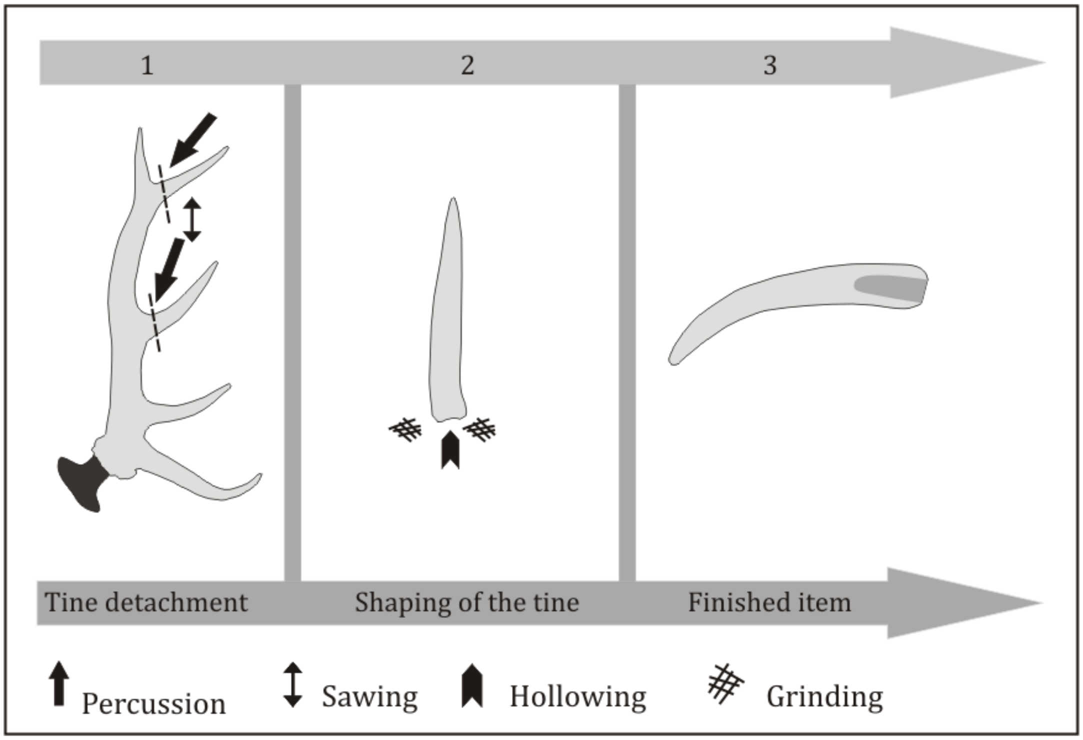


Figure 9.29. Manufacture sequence of the perforating sleeves

The LN tools present different manufacture and preservation status. Two tools are completely manufactured and totally preserved and one is partially preserved and has a slightly drilled socket (fig.9.31b). The average length of the completed tools is 14.2 cm and their average weight is 76 gr. One of them bears marks of transversal cutting around all of its circumference almost in the middle of its length, which could be interpreted as a sign of recycling attempt. The sockets have round or oval shaped section and the diametre is rather small (oval:1.6 cm x 1.25 cm, almost round: 1.3cm x 1.15 cm) while the socket depth is 4.2 cm in both of them.

The two tools that belong to the Final Neolithic are completely manufactured and totally preserved (fig.9.31c). They were shaped on a whole tine (length: 14 cm, weight: 43.4gr) and on a tine segment (length: 6.8 cm, weight: 41.3 gr). Both sockets have oval shaped section (2.7 cm x 1.7 cm and 1.1 cm x 0.7 cm) and their depth is 3.0 cm and 2.3 cm respectively. Taking into account the dimensions of the sockets (2.7 cm x 1.7 and 1.1 cm x 0.7cm respectively) and their depth (3.0 cm and 2.3 cm respectively) it is obvious that the inserted stone tools were rather small and these tools could not have been used in heavy woodworking activities.

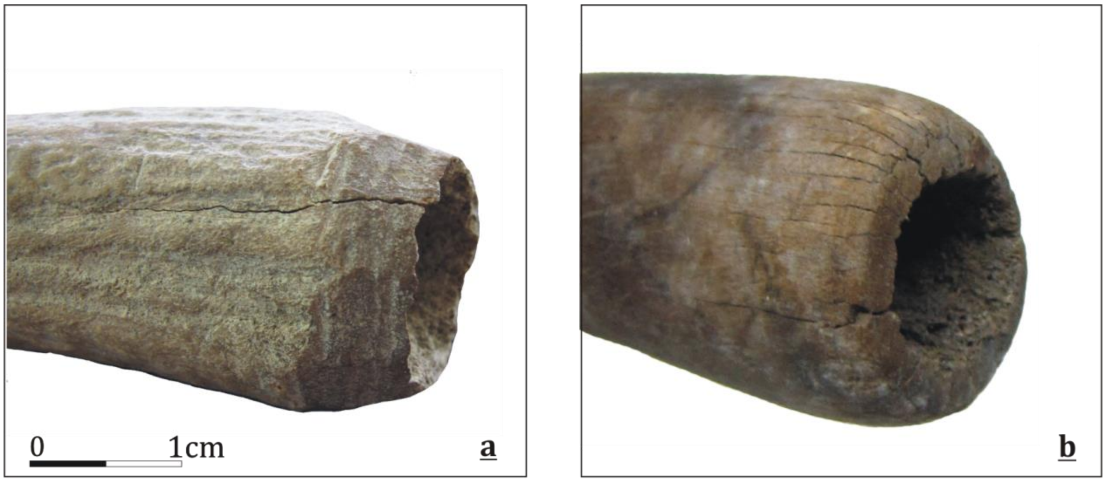


Figure 9.30 a,b. Perforating sleeves. Socket details. a. Late Neolithic, b. Final Neolithic

Figure 9.31. a. Hafting method of the perforating sleeve (after Billamboz 1977; Billamboz and Schlichtherle 1985, Gross-Klee and Schibler 1995), b. Late Neolithic perforating sleeve (A9b.KE150), c. Final Neolithic perforating sleeve (A9b.KE147)

Handles

The assemblage contains one big handle (fig.9.32) (length: 14.5 cm) that belongs to the Final Neolithic phase. It was shaped in the area of the trez junction. The blank was extracted through percussion and probably sawing. The trez tine, which is half preserved, served as the grip of the tool. The beam segment served as the mounting part as in one side of it the manufacturer shaped through hollowing a mounting socket (dimensions: 3.1cm x 2.8 cm) where a cutting edged stone tools could be inserted. Similar item has been found in the late Horgen layers of the lakeside settlement of Twann in Switzerland (Furger 1981, Tafel.19, fig.408).

Figure 9.32. Final Neolithic handle with socket for stone tool (A9b.KE164)

Bevel ended tools

The bevel ended tools comprise the second biggest tool category that consists of fifty artifacts. Bevel ended tools have been found in all habitation phases, from the Late Neolithic to the upper disturbed layers and almost in all excavated trenches and sectors.

Their main characteristic is the existence of a single or double beveled active end that was shaped in the longitudinal axis of the raw material that was usually tines or beam segments. Due to the lack of shaft holes, these tools must have been hand held and they were used directly or indirectly, vertically or diagonally to the worked material. In the case of the antler tine, the active end was shaped only in the distal part of the tine.

Their typology was affected by three factors: **the number of the bevels**, **the position of the bevels** and **the raw material**. The tools were divided into two big categories: the **unifacial bevel ended** tools and the **bifacial** bevel ended tools. The tools of the first category have one beveled end and the tools of the second category two beveled active ends that were shaped on tines or beam segments. The beveled tools present a big typological variety that reflects the adaptability and the inventiveness of the inhabitants of the settlement to combine the raw material and the needed form in order to cover their needs and they can be divided into the following subcategories according to the position of the beveled end and the raw material (table 9.19, fig.9.33):

Category name	Quantity
A. Unifacial bevel ended tools (UB)	
A1.Unifacial bevel ended tools shaped on tines (UBT)	
A1.1. Unifacial internal bevel ended tools on tines (UBTin)	3
A1.2. Unifacial lateral bevel ended tools on tines (UBTlat)	11
A2. Unifacial bevel ended tools shaped on beam segments (UBB)	3
A3. Unifacial bevel ended tools shaped on basal and beam segments (UBBS)	2
B.Bifacial bevel ended tools (BB) on tines	31
TOTAL	**50**

Table 9.19. Categories of the bevel ended tools.

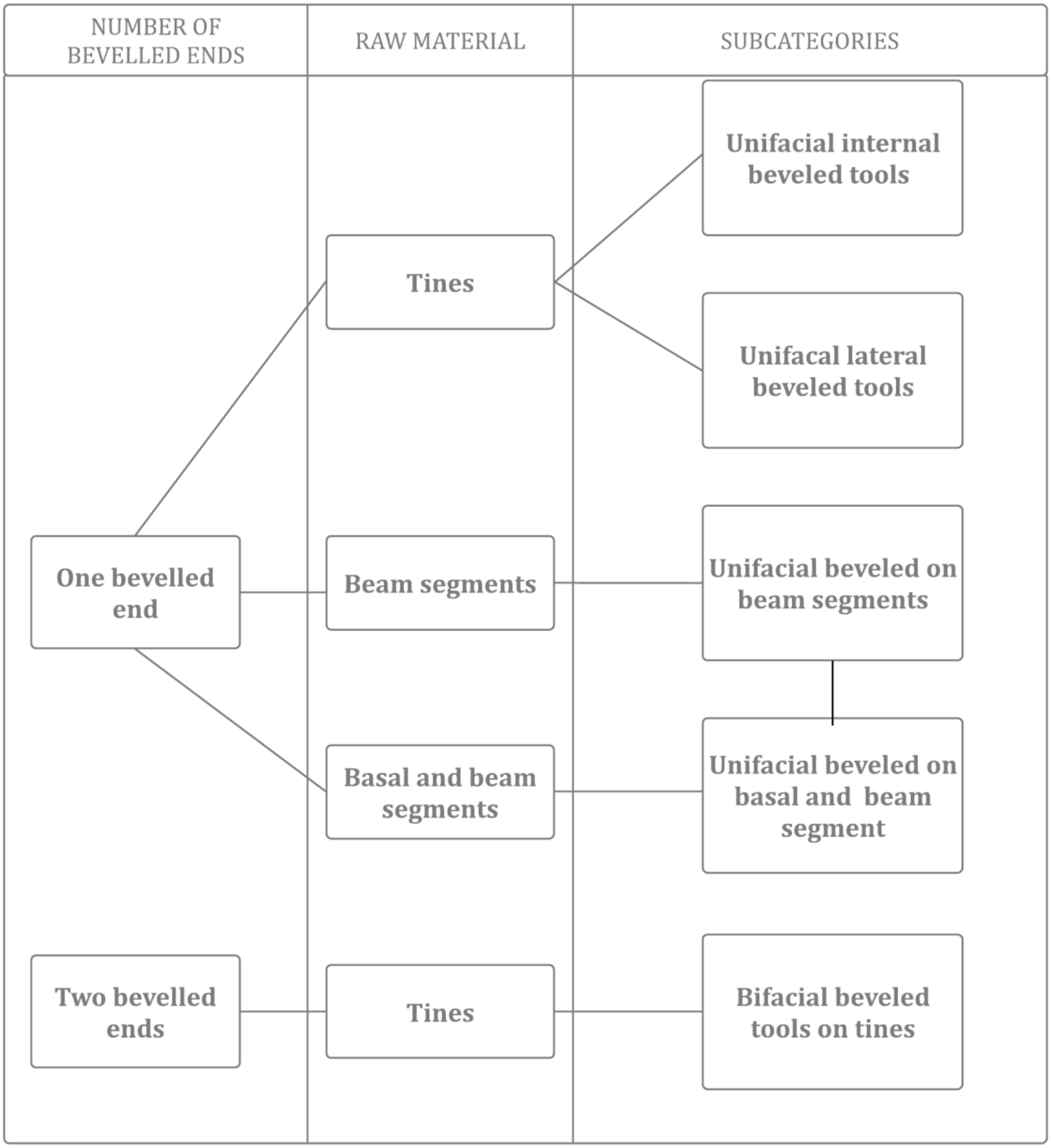


Figure 9.33**.** Relationship between the active ends and the raw material in the formation of the categories

The study of the tools of this category showed some preferences related to the morphology of the active end and the raw material. The use of bevel ended tools starts in Late Neolithic phase (at least five tools belong to the lowest LN I layers) and reaches its peak in the Final Neolithic. Some categories appear slightly in some phases (unifacial tools on basal and beam segments in the Late Neolithic) and all categories appear in the Final Neolithic habitation which is the period with the biggest concentration of bevel ended tools (table 9.20).

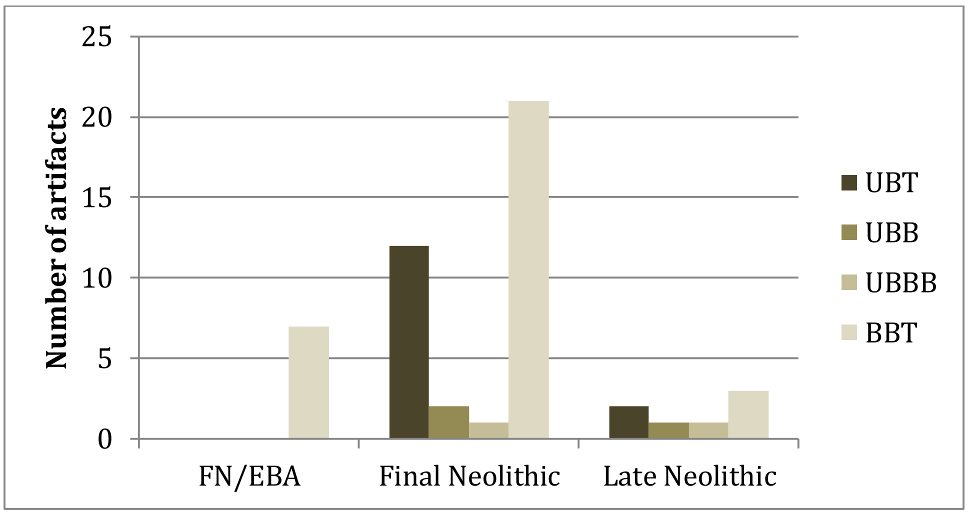


Table 9.20. Chronological distribution of the bevel ended tools. (UBT: Unifacial bevel ended tools shaped on tines, UBB: Unifacial bevel ended tools shaped on beam segments, UBBB: Unifacial bevel ended tools shaped on basal and beam segments, BBT: Bifacial bevel ended tools shaped on tines)

The bifacial beveled active end tools is the biggest category which comprises the 62 % of the beveled tools. They were shaped mainly on tines in contrast to the unifacial beveled tools that were shaped on various antler parts like tines , like beam segments or basal and beam segments.

Almost all of the tools were shaped on red deer antler and less on roe deer antler **(n: 1)** which was used only in the Final Neolithic habitation phase for specific kind of tools (table 9.21). This choice could be based mainly to the morphological and mechanical characteristics of the red deer antler, which could be considered more robust and stiff than the roe deer antler.

Tines dominate in the assemblage on all categories (table 9.22). Although at first the use of tines and beam segments was equal, later the tines were used more than any other element. The red deer tines seemed the perfect raw material for this kind of tools as it would be easier for the manufacturer to detach a tine than to cut off a thick beam segment from the whole antler. Also, the shaping of the active end would be easier in a case of the tines, as the width of the distal part of a tine is much less compared to the width of a thick beam segment that has to be grinded a lot more and more intensively in order to obtain a beveled edge.

		Chronological Periods			
		FN/EBA	Final Neolithic	Late Neolithic	Total
Raw material	Red Deer	3	35	10	**48**
	Roe Deer	0	1	1	**2**

Table 9.21. Chronological distribution of bevel ended tools shaped on red and roe deer antler

		Chronological Periods			
		FN/EBA	Final Neolithic	Late Neolithic	Total
Raw material	Basal and Beam Segments	0	0	0	**0**
	Beam segments	0	2	1	**3**
	Tines	3	33	9	**45**

Table 9.22. Chronological distribution of the raw material on beveled tools shaped on red deer antler

Also, it is noteworthy that most of the tools were completely manufactured and only a few semi items have been found. The fact that the semi-finished items were found inside the settlement indicates that they were manufactured inside the settlement. This suggestion is strengthened by the presence of the manufacturing waste and unworked antler inside the settlement.

A. Unifacial bevel ended tools (UB)

This category consists of twenty tools. There were distinguished three categories according to the used raw material. The first category consists of tools shaped on tines (**n: 14**), the second of tools shaped on beam segment and the third one of tools shaped on basal and beam segments (n: 2). Their chronological distribution shows that while in the Late Neolithic phase there was an almost equal use of all available raw material, later, in the Final Neolithic, the use of tines increased dramatically and it became the dominant raw material (table 9.23).

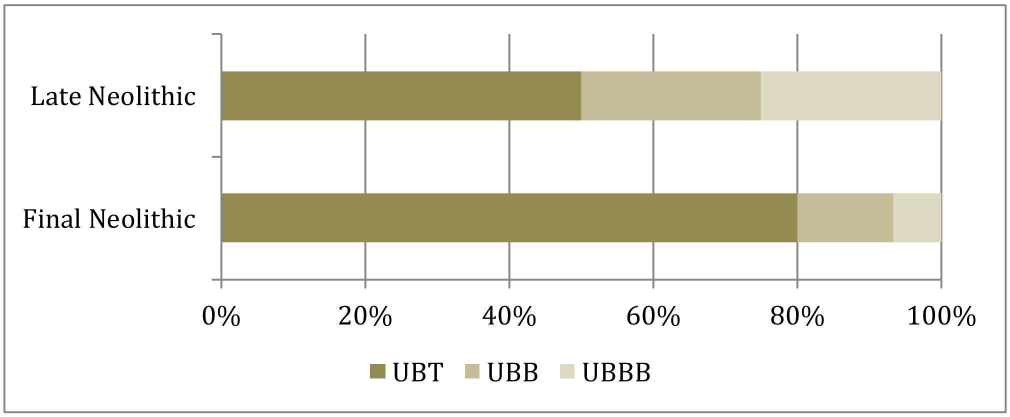


Table 9.23. Chronologicall distribution of the unifacial bevel ended tools (UBT: Unifacial bevel ended tools shaped on tines, UBB: Unifacial bevel ended tools shaped on beam segments, UBBB: Unifacial bevel ended tools shaped on basal and beam segments)

A1.Unifacial bevel ended tools shaped on tines (UBT)

This subcategory consists of 14 tools. Two tools belong to the Late Neolithic habitation phase and twelve tools belong to the Final Neolithic habitation phase (table 9.24).

The tools of this category has been divided into two subcategories according to the position of the beveled end according to previous researches on this kind of tools (Camps-Fabrer and Ramseyer 1998:33-34): the **unifacial internal bevel ended** and the **unifacial lateral bevel ended** tools. In the first subcategory, the beveled end was shaped in the posterior side of the distal part of the tine and in the second subcategory the active end was shaped in one of the lateral sides of the distal part of the tine (fig.9.34a,b; fig.9.35).

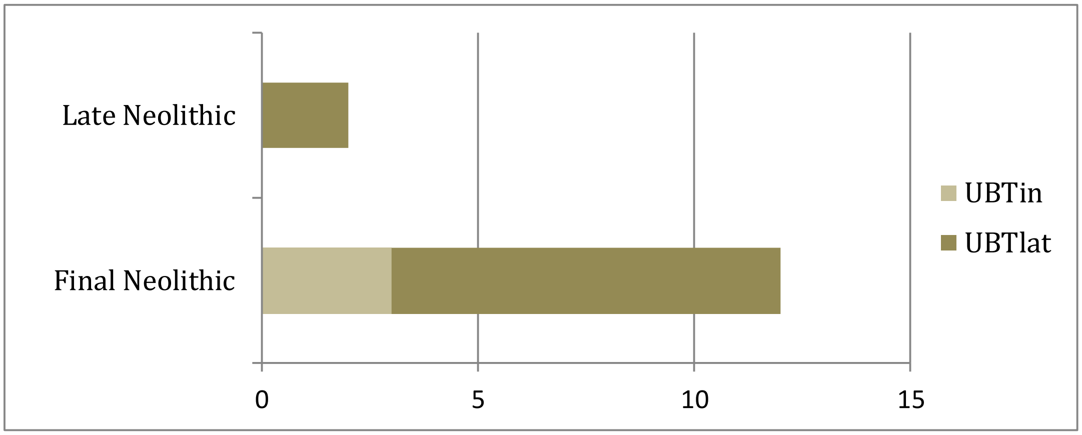


Table 9.24. Unifacial bevel ended tools on tines. Chronological distribution of the two subcategories

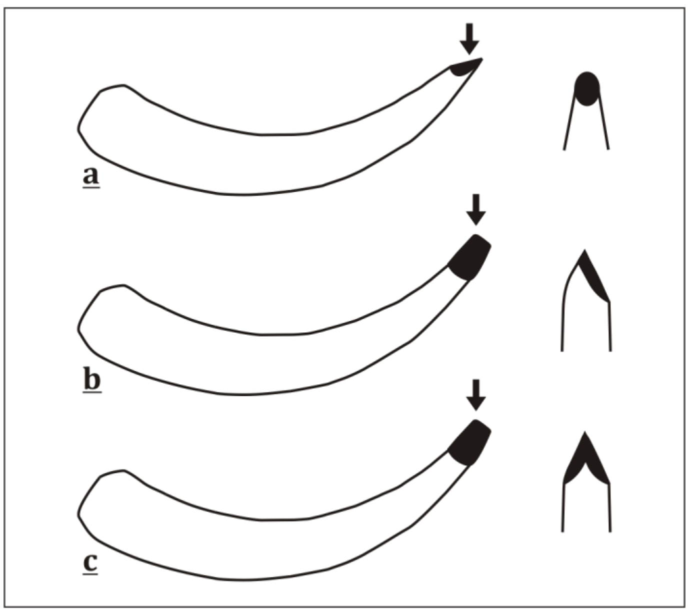


Figure 9.34. Types of beveled tools
a.Unifacial internal beveled tool, b.Unifacial lateral beveled tool, c. Bifacial lateral beveled tool
(After Camps-Fabrer and Ramseyer 1998, fig.2)

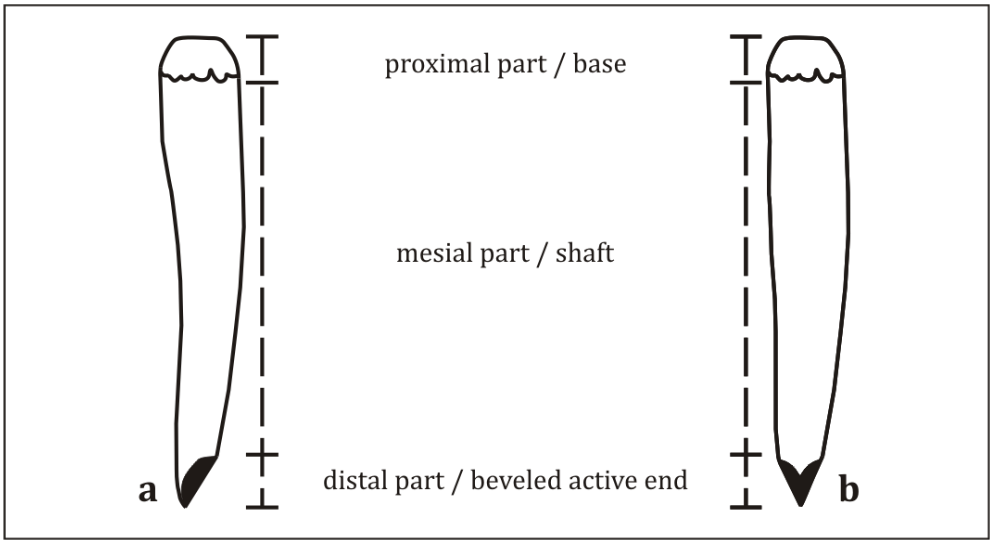


Figure 9.35. Parts of the unifacial (a) and bifacial bevel (b) ended tools on tines

A1.1.Unifacial internal bevel ended tools on tines (UBTin)

Three tools can be ascribed to this category. All of them are completely manufactured and are coming from the Final Neolithic habitation layers. Their preservation condition is very good as, except from one tool that lacks part of the shaft and the basal part of the tine, most of them are almost fully preserved.

Their manufacture sequence involved the detachment of the whole tine from the antler and then the shaping of its distal part into a beveled end (fig.9.36). The detachment was performed carefully by the use of the percussion technique that was deployed in all the circumference of the proximal part of the tine. The shaft of the tool was left unshaped and only the distal part of the tine was shaped, mainly through scraping and/or grinding (fig. 9.36, 9.37).

Their length ranges from 10.8 cm to 20.5 cm (average length: 14.1 cm), their width from 2.3 cm to 3.0 cm (average width: 2.77cm) and their thickness from 2.1 cm to 2.6 cm (average thickness: 2.4cm). Their weight ranges from 38 gr to 150.3 gr (average weight: 87.43 gr).

Camps-Fabrer and Ramseyer (1998:34) suggested that the relationship between the length of the completely preserved items and the length of the beveling should be investigate and they introduced the bevel index by dividing the beveling length with the tool's length.

In these three tools the length of the beveled surface varies from 1.05 cm to 2.0 cm. Although in this case only two tools are completely preserved and the extracted data can't be so secure, it's noteworthy to mention that the bevel index is almost the same for these tools (0.9722 and 0.9755 respectively).

Concerning the use wear traces, all three tools bear heavy polish and discoloration in their active end. The polish exceeds up to 2.0 cm from the tip of the active end and it's very probable that these tools were used in leatherworking.

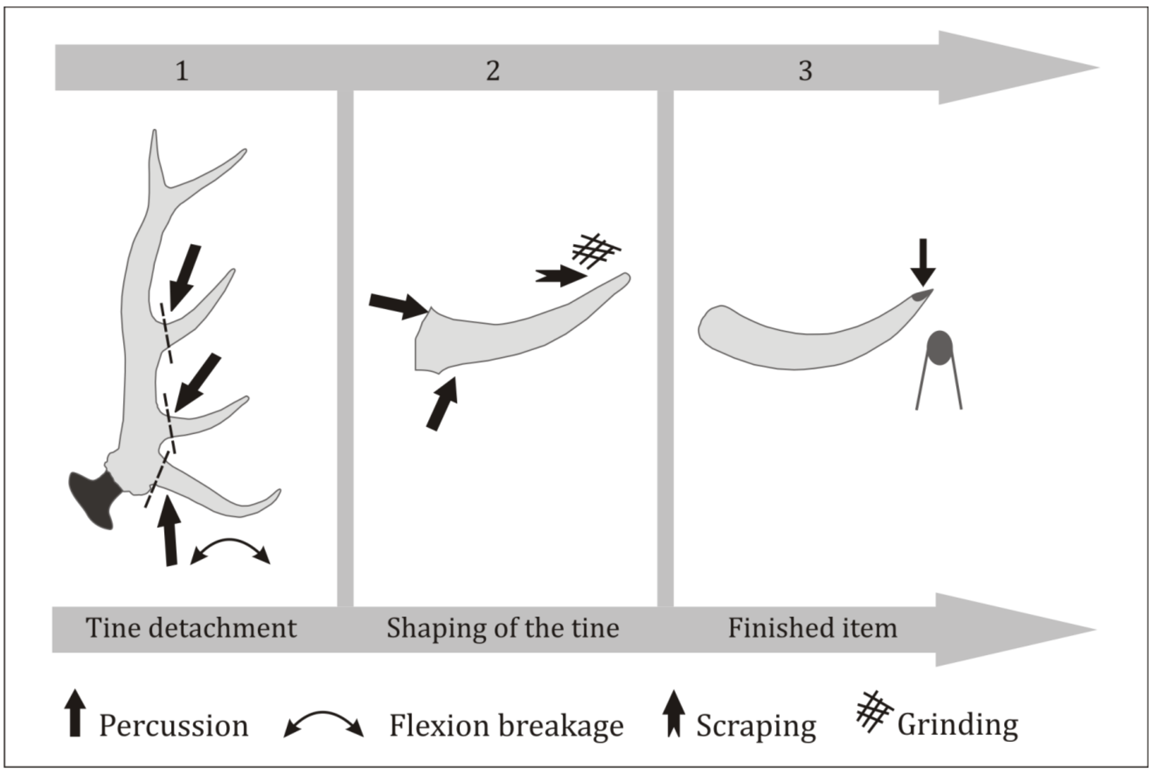


Figure 9.36. Manufacturing sequence of the unifacial internal beveled tools on tines

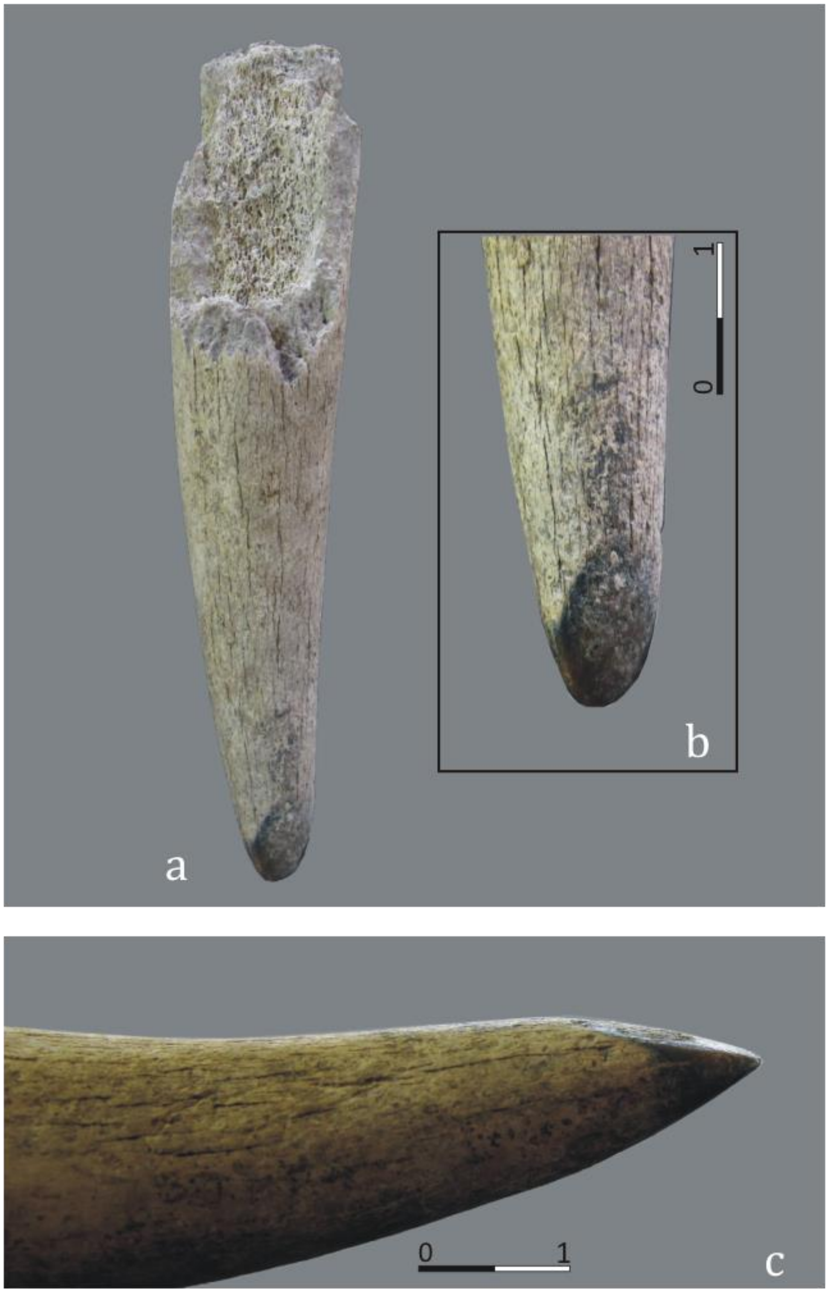


Figure 9.37. a.Unifacial internal beveled tool on tine (A9B.KE057, scale 1:1), b,c.Details of the active end

A1.2. Unifacial lateral beveled tools on tines (UBTlat)

This subcategory consists of eleven tools. The manufacturing sequence differs slightly from the one that was deployed in the previous subcategory. The tine was detached from the antler by percussion and sometimes also with flexion breakage. The proximal part of the tine served as the base of the tool. The mesial part didn't get modified. The active end was shaped at the distal part of the tine but in this case it was shaped in one of the lateral sides through scraping and grinding (fig.9.38, 9.39b,c).

Two of the tools belong to the Late Neolithic phase and the rest of them **(n: 9**) to the Final Neolithic habitation phase. Both LN tools are fully preserved (average length: 10 cm, average width 3.2 cm, average thickness 2.5 cm, average weight 43.5 gr) but only one is completed. In the semi-finished item, the tine has been extracted from the antler by the percussion technique that was applied to their proximal part. The shaft was left unshaped and only the distal part of the tine has manufacture traces. The distal part of the tine was scraped in order a bevel end (length of the bevel: 2.2 cm) to be formed but it was never grinded or shaped further and its surface is rough.

Eight completed and one semi-finished tool belong to the Final Neolithic habitation phase. Two of them are partially preserved while the rest of them are almost totally preserved.

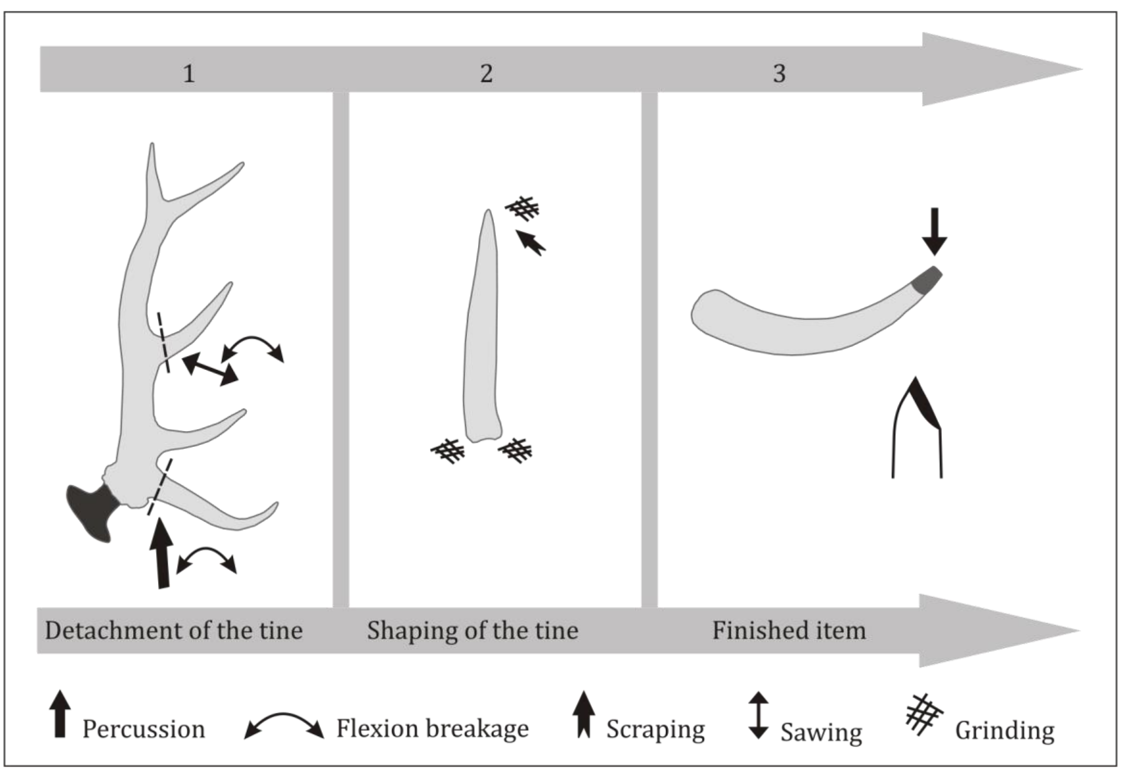


Figure 9.38. Manufacturing sequence of the unifacial lateral beveled tools on tines

The length of the seven fully preserved tools varies from 8.6 cm to 20.6 cm (average length: 15.71 cm), their width varies from 2.2 cm to 5.8 cm (average width: 3.35 cm) and their thickness varies from 2.3 cm to 3.1 cm (average thickness: 2.73 cm). Their weight ranges from 31.6 gr to 123 gr (average weight 79.04 gr).

On most of the tools the beveled end is convex and it was shaped by scraping and axial or cross grinding (fig.9.39b,c). In four cases it was possible to identify the length of the beveled end. It ranges from 2.5 cm to 6.3 cm and its average maximum width is ranges from 1.8 cm to 3.5 cm. As the bevel indices show, there doesn't seem to be any standardization in the ratio between the length of the bevel and the tools length

A variety of use wear traces had been distinguished in the active end of these tools. Two of them bear chipping sometimes alongside with localized polish that extends up to 2.6cm in the beveled area and in one case there are striations accompanied with polish up to 6.3cm.

The macroscopic and low powered microscopic observations alongside with suggestions of other experimental approaches (Beugnier and Maigrot 2005) give strong indications that most of the unifacial internal and lateral beveled tools were used diagonially to their long axis in wood working and leather working.

Figure 9.39. a.Unifacial lateral tool scale (A9B.KE062,scale 1:2), b.Detail of its active end c.Manufacturing traces and chipping on active end

Similar morphologically tools have been found in Neolithic and Bronze Age settlements of Central Europe. There have been reported in Switzerland in the settlement of Hitzkirch-Seemat (Wey 2001:159, Taf. 84), in Twann (Suter 1981; Furger 1981) and in the lakeside settlement of Concise 3 (Maytain 2010). Also, a few items have been reported from the settlement of Chalain 3 in France (Voruz 1997).

A2.Unifacial tools shaped on beam segments (UBB)

Three tools comprise this small subcategory. One belongs to the Late Neolithic habitation phase and two to the subsequent phase. All of them are completely manufactured. As of their preservation conditions, one of them is almost fully preserved and one is half preserved and one is partially preserved.

The completed LN tool (catalogue item KE188) is barely preserved (length: 3.65cm, width 2.6 cm, thickness: 0.8 cm, weight: 7.0 gr) as only part of the active end is preserved. It must have been used a scraper.

Two FN tools have been shaped on beam segments which were extracted by longidutinal division from the beam. Later the beam part was hollowed and the active end was shaped on one of the ends of the beam segment by grinding in a sandstone. The slightly beveled end bears striations parallel to the longitudinal axis of the tools that extend up to 1.0 cm from the end of the bevel alongside with high polish that is superimposed over the manufacturing grinding traces. These tools could have been used as scrapers/polishers.

Similar beveled tools on beam segments have also been reported from other prehistoric settlements in Greece, in the region of Macedonia (Stavroupoli, Sitagroi) and in central Greece (Theopetra Cave). In Stavroupoli the small scale rescue excavation yielded two tools on beam segments with cutting/beveled edges (Χατζούδη 2002:616,624, Fig.4δ). Elster reports two tools shaped on red and roe deer antler beam segments with chisel/bevel ends from the Middle Neolithic/Chalcolithic phases and two similar tools from the Early Bronze phase of the settlement of Sitagroi (Elster 2001:372,Tab.6-7; 2003:38,Table 2.6-2.7, fig.2.9.a.). In Central Greece so far only one beveled tool has been reported. It is shaped on a beam segment and it comes from the Neolithic strata in Theopetra Cave (Στρατούλη 2000:314-315,325: fig.19.2. 3).

Bevel ended tools shaped on beam segments were also found in other Balkan settlements. Tools with beveled polished edges shaped on beam segments have also been found in the Neolithic settlement of Divostin in Serbia (Lyneis 1988:323, Pl. IV, *Vitezović* 2011,fig.102) and in the Cucutenian settlement of Drăguseni in Romania (Bolomey and Marinescu-Bilcu 2000 Fig.61.1,3,4,13; Fig.73.5,7). In Central Europe they have been reported in the Swiss lakeside settlements of Arbon Bleiche 3 (Deschler-Erb et al. 2002:364, Abb. 529. 3-4) and Twann (Suter 1981).

A3.Unifacial tools shaped on basal and beam segments (UBBS)

The use of basal and beam segments for the manufacture of single beveled tools was not so common in the prehistoric settlement on Anarghiri IXb. The two tools (one from the Late Neolithic and the other from the Final Neolithic layers) of this category are shaped on roe deer antler. The LN tool (catalogue item A9b.KE256) was shaped on a small basal and beam segment of an unshed antler (length 9.1 cm). The burr was flattened and the shaft of the tool bears high polish due to manufacture and also probably due to the contact of the hand of the user with the tool. The active end (length 1.5 cm) bears signs of heavy use (worn and damaged end). It was probably used as a chopper. The Final Neolithic tool (catalogue item A9B.KE044) is quite bigger (length 17.0 cm) and it was shaped on shed antler. The shaft doesn't bear any manufacture traces. Its active end was shaped by scratching and cross grinding and is not fully preserved, so it is not possible to determine its exact use.

B. Bifacial beveled tools on tines (BBT)

This subcategory consists of 31 items. The main characteristic of these tools is the existence of two beveled ends that were shaped in the two lateral sides of the distal part of the tine (fig.9.34c, 9.40, 9.41a,b, Pl.IIIa-d). The tine was detached from the antler by percussion (some of the tools still bear traces of failed percussion attempts at their basal part (basal parts of the tool in figure 9.41a,b and fig 9.43a) and then the proximal part of the tine was treated by grinding or by sawing and grinding (fig.9.40; 9.41c). The distal part of the tine was shaped in its lateral sides into a double beveled tool by scraping and grinding (fig.9.40).

As for their chronological distribution, it seems that there is an increase of their use from the Late Neolithic (**n: 7**) to the Final Neolithic (**n: 21**). Also a few items (**n: 3**) can be ascribed to the upper disturbed layer with FN/EBA material.

All seven LN tools are completely manufactured (fig.9.41). Their preservation condition varies as five of them are almost totally preserved (three of them lack a small part of their active end) and the rest of them (**n: 2**) are partially preserved (part of the shaft and part of the active end is missing).

Concerning the dimensions of the almost totally preserved tools, the length ranges from 13.2 cm to 21 cm (average length: 16.3 cm), the width from 2.55 cm to 4 cm (average width: 3.05 cm), the thickness from 2.3 cm to 3.0 cm (average thickness: 2.6 cm) and the weight from 44gr to 170.8gr (average weight: 94.36gr).

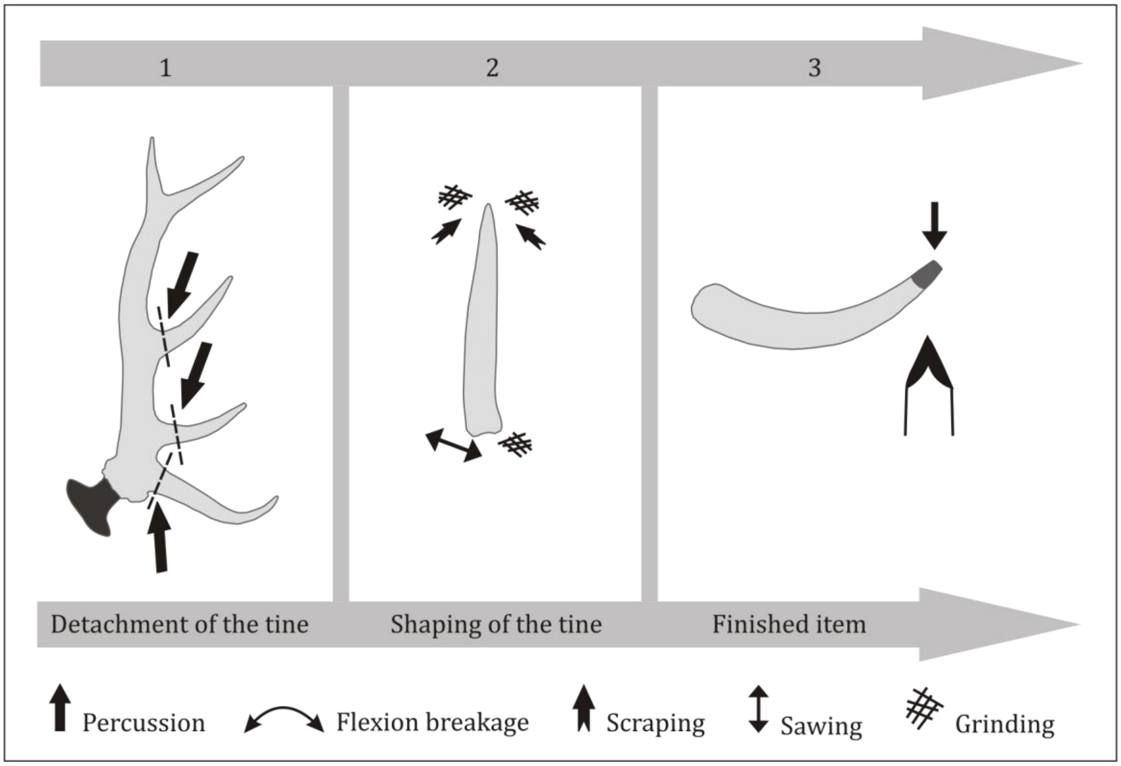


Figure 9.40. Manufacture sequence of the bifacial beveled tools on tines

The tines were detached from the antler through percussion (4 out of 5 cases). Except from one case where grinding was deployed, the shaft was not shaped. The active end was shaped through grinding (four cases) and through scraping and grinding (one case).

The length of the beveled worked surface on the almost fully preserved items varies from 1 cm to 10cm and the average length is 4.68 cm. The active end of the tools bears discoloration (formation of dark areas), chipping and polish that sometimes extends up to 5.0 cm from the edge of the beveled end. Striations that are parallel to the long axis of the tools were also obseved in low microscope analysis and sometimes were also visible macroscopically.

Except from one tool, all the FN tools are completely manufactured. Eight tools are almost totally preserved, while the rest of them are half preserved (**n: 5**) or they (**n: 8**) preserve part of the shaft and the distal part (active end) (fig.9.42, 9.43).

In eight cases it was possible to recognize the techniques for the tine detachment and the later shaping of the basal part. In most of the cases there was a combination of techniques:

1. percussion and fracture (3 cases),
2. percussion, flexion breakage and grinding (3 cases),

3. sawing and grinding (2 cases)

The shaft was treated only in two cases where it was grinded diagonally in order to become thinner. Although in some cases the manufacture traces were covered by the use wear traces, it seems that the main method for the shaping of the active end was the grinding (almost 18 cases). In one case the tool's end was heated after the grinding and in one case the grinding was deployed after the scraping. The active end of the semi-finished tool was shaped only by scraping.

The majority of the tools bear heavy polish in their convex active end. In seven cases the active end bears polish and chipping, in four cases they bear polish alongside with striations parallel to the longitudinal axis of the tool and in seven cases only heavy polish was identified. The polish was observed usually in the first 3 cm of the active end (0.7cm to 3.0cm) and in three cases it extends up to 3.5 cm.

Three tools seem to belong in the FN/EBA upper layer. All of them are completely manufactured and they are shaped on parts of tines and preserve only part of the shaft and/or of the active end (average length: 8.1 cm). Their convex active end was shaped mainly through axial and cross grinding. The active ends bear polish (up to 2.0cm from the edge) and only in one tool the polish is accompanied by chipping. Taking into consideration the morphology of the active end and the use wear traces, it is possible that these tools could have been used vertically in hard materials like wood or diagonally in softer materials like leather (Maigrot 2003, Campana 1989) (fig.9.44)

While tools of similar morphology are absent in the Neolithic settlements of Greece and the Balkans, it seems that they were often used in many European Neolithic lakeside settlements. In France similar tools have been reported from Chalain 3 (Voruz 1997:321, Pl.6,13,16) and from Chalain 4 (Maigrot 2003). They were also often used in Swiss Neolithic settlements: Nidau-BKW, in Twann, Lattringen Riedstation (Furger 1981; Suter 1981, 2002:Abb.77), in Hitzkirch-Seemat (Wey 2001:159, Tafel 84), in Zurich (Schibler 1987) and in Arbon Bleiche 3 (Deschler-Erb et al.2002 Abb.528, 5-6) where they have been considered as chisels (*sprossenmeissel*).

Figure 9.41. a,b.Late Neolithic bifacial beveled tool (A9b.KE061) with visible manufacture traces on the basal part, c. Detail of the active end

Figure 9.42. a.Different views of a Final Neolithic bifacial beveled tool (A9b.KE084) b. Grinded and polished basal part of the tool, c,d. Details of the active end

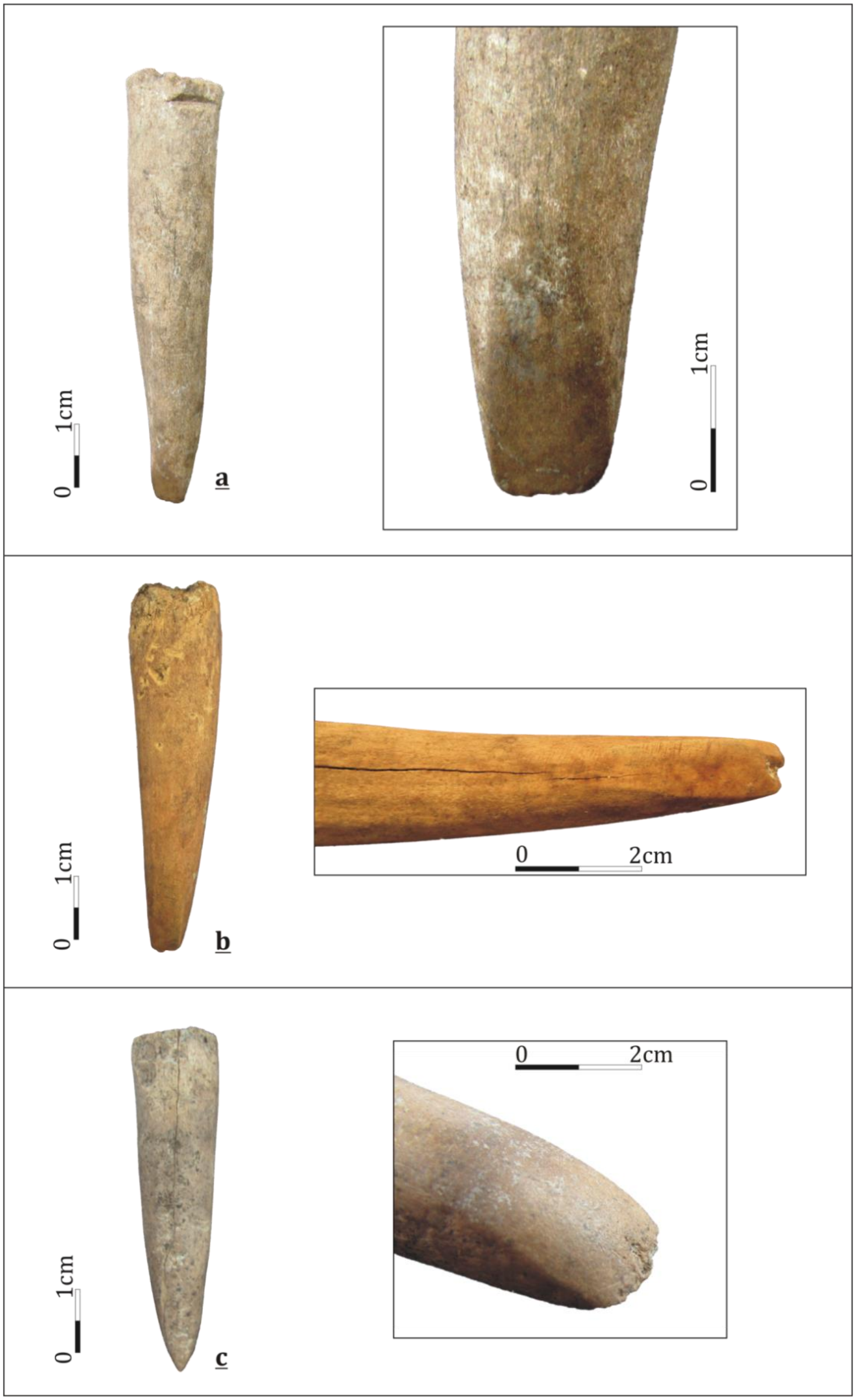


Figure 9.43. a-c.Final Neolithic bifacial bevel ended tools and details of their active end (a. A9b.KE047, b. A9b.KE042, c.A9B.KE058)

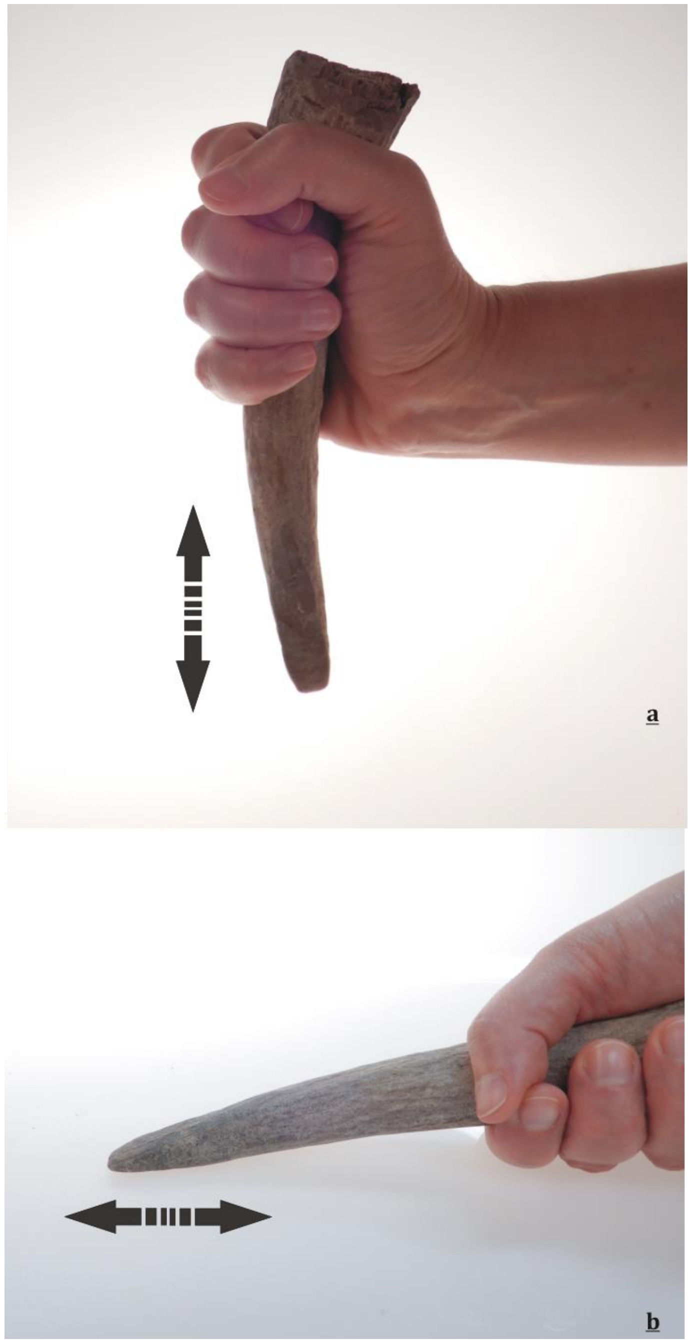


Figure 9.44. Possible tool movements across worked material of the A9b.KE061 tool
a) Vertically to the worked material, b) Diagonially to the worked material

Picks

One distinctive tool category is the one that has been named "picks" due to the morphological characteristics of the items and their similarity to modern-day picks. Their main characteristics are the existence of a shaft hole in the middle of their length for the insertion of the wooden handle and a usually rounded active end. These tools are considered soil digging sticks and/or mining tools (Beldiman et al. 2012).

There have been collected thirty four **(34)** items**.** The majority of them (**n: 20**) are completely manufactured and fourteen items are semi-finished. As for their preservation, nineteen (**19**) tools are preserved intact or almost intact and the rest of them are half or almost half preserved. All of them were shaped on red deer antler. The tines are the most common raw material while the other parts of the antler were also used but with less frequency.

The different types of raw material lead to the categorization of this category into four subcategories: **a)** picks shaped on tines, **b)** picks shaped on basal and beam segments and **c)** picks shaped on beam segment, **d)** picks shaped on crown. The majority of the tools (**n: 28**) of this category belong to the first subcategory and the rest of them are represented by only one tool (table 9.25).

Picks categories	Quantity
Picks shaped on tines	28
Picks shaped on basal segments	3
Picks shaped on beam segments	2
Picks shaped on crown	1

Table 9.25. Subcategories of the picks

Picks shaped on tines

This assemblage consists of twenty eight (**28**) items (Pl.IVa-c, Pl.Va-b). The majority of them **(n: 23)** belong to the Final Neolithic layers, three items belong to the Late Neolithic layers and only two belong to the upper FN/EBA disturbed layers.

Their preservation state varies. Sixteen picks have been found (almost) completely intact and twelve items are half or almost half preserved. Moreover sixteen items are completely manufactured and the rest of the assemblage consists of semi-finished items (table 9.26).

		Manufacture status		
		Completely manufactured	Semi-finished	Total
Preservation status	(Almost) totally preserved	7	9	16
	Half preserved	9	3	12
	Total	**16**	**12**	**28**

Table 9.26 .Manufacture and preservation status of the picks shaped on tine

Their size varies as there were used different kinds of tines (brow, bez and trez tines)[20].The length of all items varies from 4.4 cm to 26 cm. The average length of all items is 11.8 cm.

At least two manufacturing stages have been recognized for the shaping of the picks with a variety of techniques in each stage. Also, as it will be shown below, in each phase there are combinations of these techniques with different outcomes.

The first stage of the manufacture concerned with the detachment of the tines from the main antler beam. Through the study of the proximal part of the whole preserved picks it was possible to recognize that the tine had been detached from the main antler shaft or from a bigger part of the tine by the percussion and flexion breakage techniques. In most of the cases the artisans used both techniques. The percussion technique was used in order to thin the base of the antler tine and the flexion breakage for the detachment of the tine from the beam.

The second stage was related with the shaping of the shaft hole. The shaft hole was shaped mainly by the use of perforating techniques such as bow drilling and boring. These two techniques were the most popular techniques as they were used in most of the cases. In many cases the percussion technique was deployed alongside with the bow drilling technique. It seems that at first the outline of the shaft hole was created through percussion

[20] The metrical analysis of the artifacts was done according to the drawings of the fig. 9.45. The terms used for the localization of the tine sides and the parts of the tines are described in fig. 9.46

and then the artisan was using the bow drilling technique in order to widen the diameter of the shaft hole (fig.9.47)

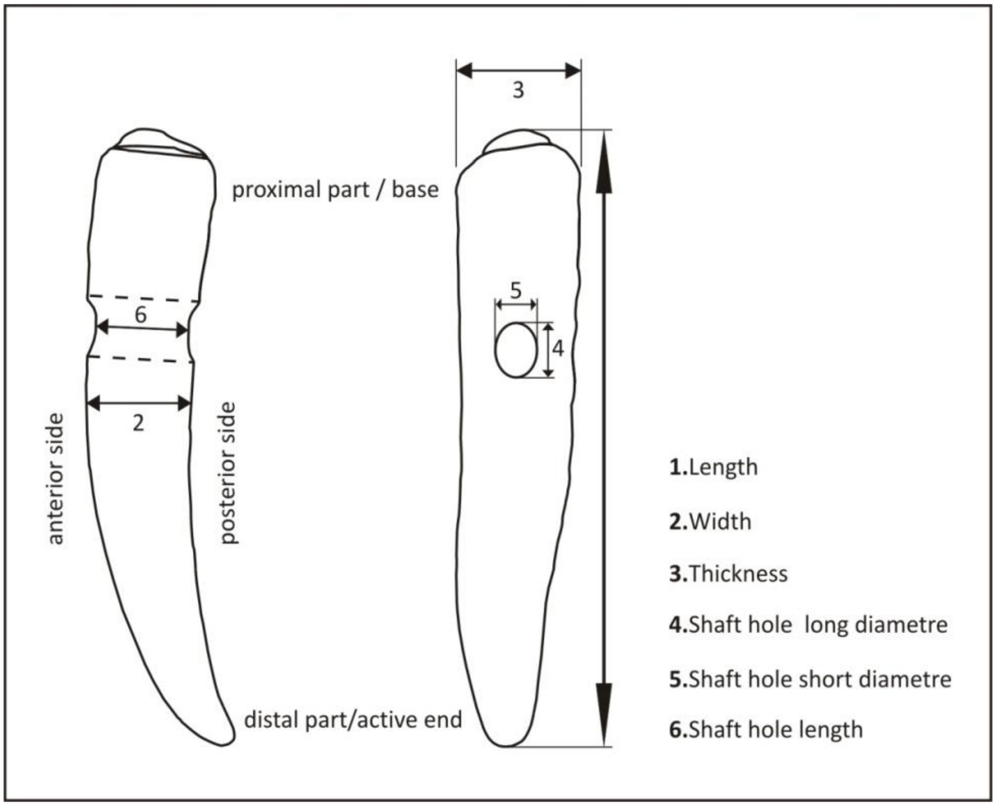


Figure 9.45. Metrical analysis of the picks shaped on tines

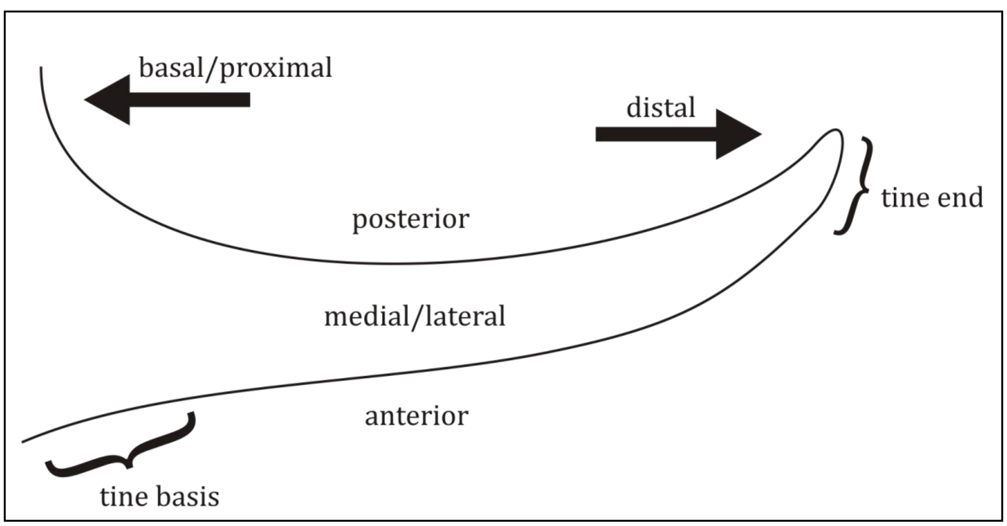


Figure 9.46. Localization of the antler tine (modified after Werning 1983 and Riedel 2013)

In the majority of the tools the shaft hole perforation was performed in both sides (bilateral perforation) as there have been recognized percussion of drilling marks both in anterior and in posterior sides. In all other cases the most common practice was to start the perforation of the shaft hole at the anterior side.

There have been documented three different cross section shapes in the shaft holes. Most of the picks (**n:17**) have shaft holes with round cross section, at least seven have oval cross section and only one tool has a rectangular/trapezoid shaft hole. In the rest of them it was not possible to identify the shaft hole shape.

The small number of the picks that can be attributed to the Late Neolithic phase could indicate the limited use of antler picks but it must be taken into consideration that the central part of the settlement was not excavated thoroughly to the natural soil. Therefore it is very possible that a lot of artifacts from this typological group could have been retrieved from this area.

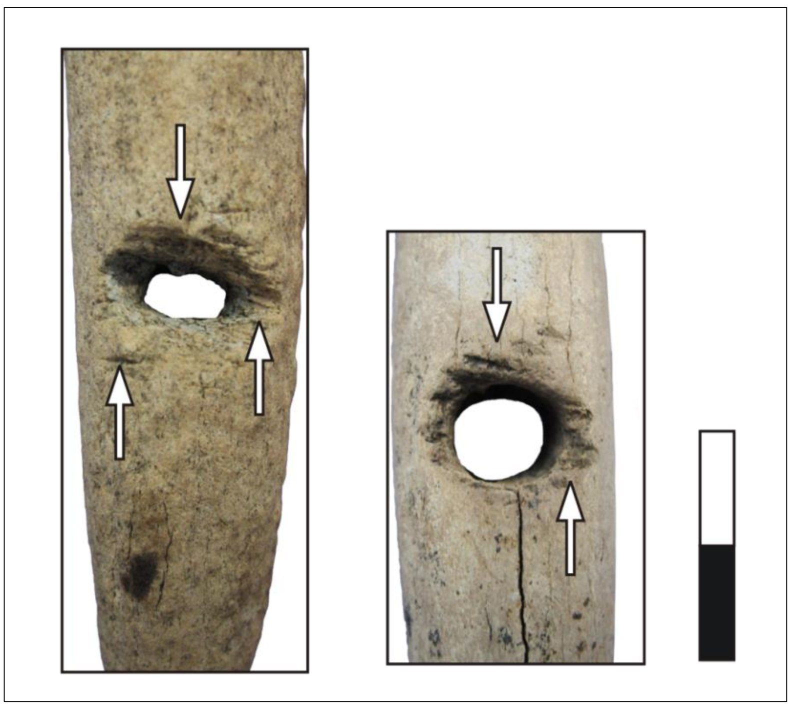


Figure 9.47. Percussion traces around the shaft hole

One fully preserved semi-finished and two completely manufactured picks (one half and one almost totally preserved) belong to this phase (fig.9.48). The average length of the completely manufactured items is 8.35 cm and the length of the semi-finished tool is 14.0 cm. The extraction method of the tine was recognized only in one tools that retains its basal part. The tine was extracted through percussion at first and then by flexion breakage, a combination of techniques that will be used also in the manufacture of picks of the next phase.

Two techniques for the shaping of the shaft hole have been recognized in the completed tools: one shaft hole has been shaped through bow drilling and the other though boring. In both cases the perforation started in the posterior side. One shaft hole has round cross section (diametre: 1.3cm, length: 2.1cm) and the other has an oval cross section (ShLD 1.9 cm x ShSD 0.9cm). In the semi-finished tool there was an attempt to perforate the tine through boring but the shaft hole was never drilled completely and the tool left unfinished. The shaft hole seems to have also round cross section and its diametre is rather small (0.7 cm) (fig.9.49). The small number of picks from this phase don't allow for the recognition of any patterns between the techniques and the shape of the shaft holes.

Only one completed tool bears use wear traces. The heavy polish that extends up to 2.0cm cm in the tool shaft shows that the tool must have been used in agricultural activities (soil digging).

Figure 9.48. Late Neolithic half preserved pick on tine (A9b.KE143)

Figure 9.49. Late Neolithic pick (A9B.KE160). Detail of the semi-finished shaft hole.

The number of the picks rises during the Final Neolithic as twenty three tools can be attributed to this phase. Thirteen items are completely manufactured and ten items could be considered as semi-finished tools due to their incomplete shaft holes.

The preservation state of the completely manufactured items varies. The majority of them (**n: 8**) are half preserved and five are almost totally preserved (fig.9.50). Their length varies from 4.4 cm to 25 cm with an average length of 10.39 cm, while the average length of the totally preserved completely manufactured tools is 15.54 cm.

The majority (**n: 7**) of the semi-finished tools are preserved almost totally. In the remaining three tools, two of them lack big part of the active end and part of the proximal part. Their average preserved length is 11.37 cm.

In thirteen cases it was it possible to determine the process of the tine detachment from the antler. As in Late Neolithic phase, the tine was removed from the beam through the percussion and flexion breakage techniques.

The second stage of manufacture involved the perforation of the shaft hole. The percussion and the bow drilling technique were the most frequently used techniques. In one case, a semi-finished shaft hole bears traces left by the use of the percussion technique. In eight cases, the percussion technique was used in combination with two other techniques: in seven cases it was used before the bow drilling technique in order to make the outline of the shaft hole and in one case it was used before the grinding technique. Eight shaft holes were shaped through bow drilling and four through boring.

Figure 9.50. Final Neolithic pick on tine with half preserved shaft hole (A9B.KE093)

Most of the shaft holes (**n: 13**) have round cross section (fig.9.51, 9.52a). Nine of them are completely manufactured and four of them are half/slightly drilled. The preservation of these shaft holes varies. Five of them are half preserved and the rest are fully preserved (table 9.27).Their diametre varies from 0.4 cm to 1.15 cm (average diametre: 0.81 cm).

The most common techniques for the shaping of the round shaft hole were the bow drilling and boring techniques. In many cases the manufacturer(s) used one of these techniques or a combination of them. In eight cases the shaft holes were shaped through bow drilling that was performed in both sides (one case of unilateral perforation) or in either of the sides seven cases of unilateral perforation). Only one completed tool bears of bilateral perforation performed through bow drilling.

The boring technique was used for the shaping of four shaft holes and in all four cases the manufacturer performed both sides of the tine (bilateral perforation). The use of this technique led to three completely shaped shaft holes and to one half-finished tool. Only in one case there is a combination of techniques. In this case, the completed shaft hole with round cross section was shaped through the combination of percussion and bow drilling technique in both sides (bilateral perforation) (table 9.28).

		Manufacture status		
		Completely manufactured	Semi-finished	Total
Preservation status	Totally preserved	4	4	8
	Half preserved	5	0	5
	Total	9	4	**13**

Table 9.27.Final Neolithic Picks. Shaft holes with round cross section. Manufacture and preservation status.

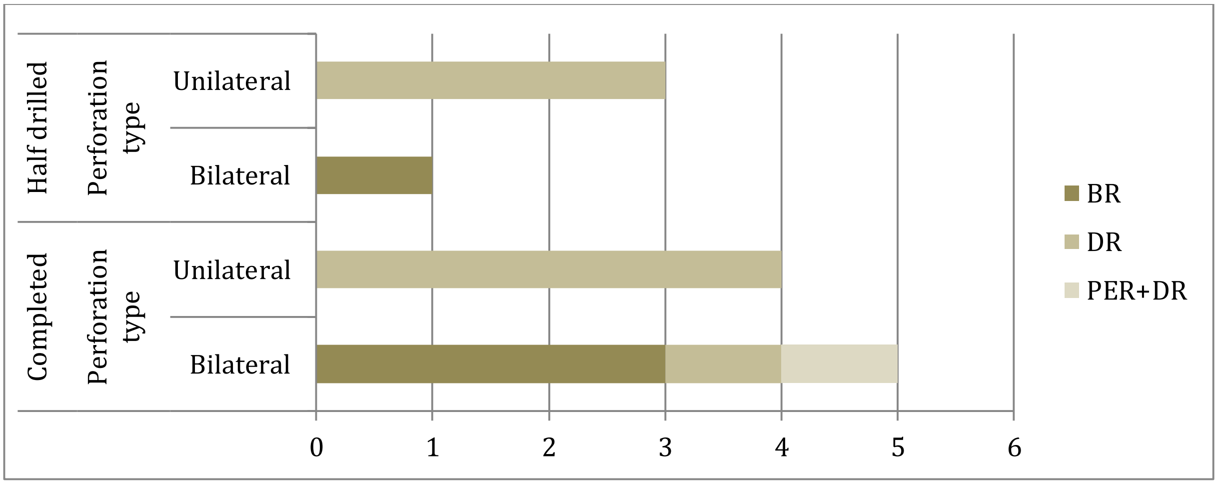


Table 9.28. Final Neolithic picks. Shaft holes with round cross section. Comparison between the different shaping techniques and the perforation type (BR: Boring, BDR: Bow Drilling, PER+DR: Percussion and Drilling)

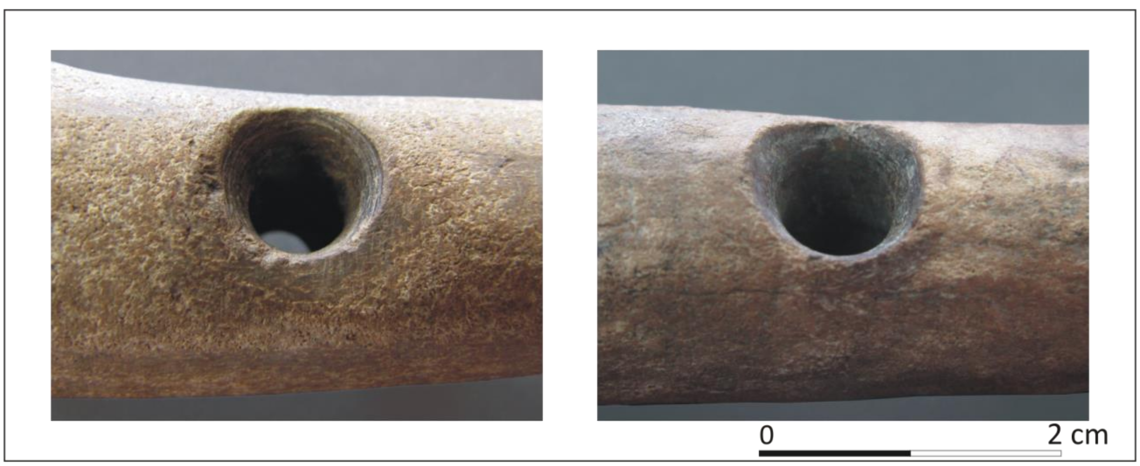


Figure 9.51. Final Neolithic picks. Round shaft holes from completely manufactured picks on tines

The length of their shaft hole ranges between 1.3 cm and 2.0 cm (average length: 1.46cm). There seems to be a connection between the size of the shaft hole and its length as in most of the shaft holes with round cross section the length is 1.7 cm to 2.0 cm and their diametre is from 0.8 cm to 1.2 cm (table 9.29).

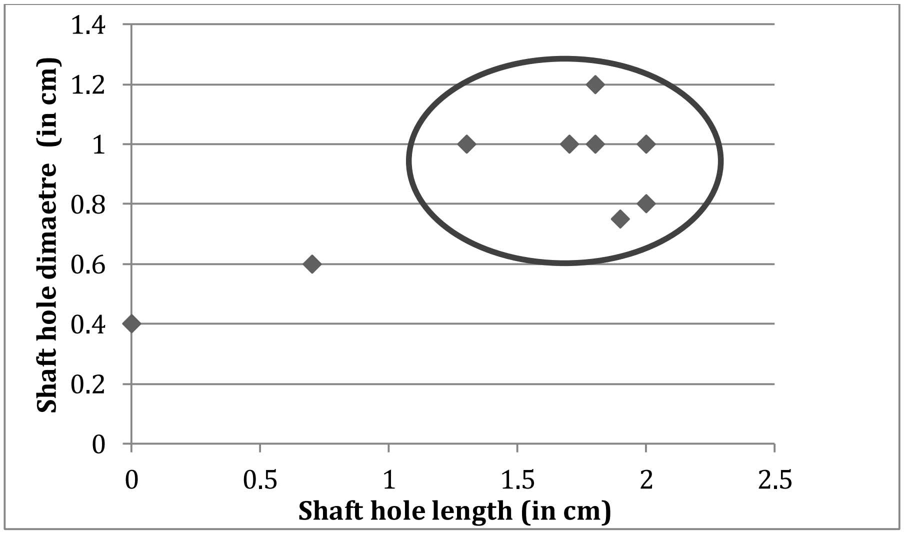


Table 9.29. Picks on tines. Shaft holes with round cross section.
Relationship between the shaft hole diametre and length

Seven tools have shaft holes with oval cross section. Four of them are completely manufactured (two half preserved and two totally preserved) and the remaining three are semi-finished. The long diametre (ShLD) of the totally preserved shaft holes ranges from 1.4 cm to 2.6 cm and the short diametre ranges from 1 cm to 2.3 cm.

A different manufacturing sequence is observed in the shaping of the shaft holes with oval cross section. In six cases the percussion technique was deployed for the rough shaping of the shaft holes outline and then the manufacter(s) used the bow drilling in order to finish the shaping of the holes (fig.9.52b,9.53).In the case of one semi-finished shaft hole, the manufacturer of the tool used only the percussion technique without any further modification of the shaft hole.

In many cases the use wear traces (polish and striations) were visible macroscopically. Both these types of use wear traces are visible at the end of the active ends. The striations run parallel to the vertical axis of the pick and in some cases are visible up to 6.0 cm from the tip of the active end. Sometimes the striations are accompanied by polish that is observable up to 4.0 cm from the tip of the active end to the main shaft of the tool.

Figure 9.52. Final Neolithic picks on tines. a. Semi-finished shaft hole with round cross section (A9b.KE051), b.Slightly shaped finished shaft hole of oval cross section (A9b.KE092)

Figure 9.53. Final Neolithic semi manufactured pick on tine with unfinished oval shaft hole (A9b.KE235)

Two picks, one semi-finished and one completed, can be attributed to the FN/EBA phase (fig.9.54, 9.55). The semi-finished mattock is preserved intact (length: 15.7cm) and has a slightly drilled shaft hole with round cross section (fig.9.55a, 9.56). The completed tool (preserved length: 12.5cm) lacks part of its active end. Its shaft hole was drilled from the anterior side and there are some traces from a slight use of the percussion technique (fig.9.55b). Although a part of the active end of the completely manufactured mattock is missing, it was possible to identify use wear traces in the remaining part of it. High polish and discoloration are observed up to 5.0 cm from the active end to the shaft of the tool.

1st stage	Technique(s)	Extraction of the tine by percussion and/or flexion breakage	
2nd stage Shaft hole shaping	Technique(s)	Percussion and drilling	Boring
	Uni/Bilateral perforation	Unilateral	Unilateral
	Shaft hole shape	Round shaft hole	Round shaft hole
Final Product	Completely/Semi manuafactured	Completely manuafactured	Semi manufactured

Figure 9.54. Manufacture sequence of the picks on tine from the Final Neolithic/Early Bronze Age disturbed layers.

Figure 9.55. Final Neolithic/Early Brone Age picks on tines. a. Semi-finished tool (A9b.KE006), b.Completely manufactured (A9b.KE098)

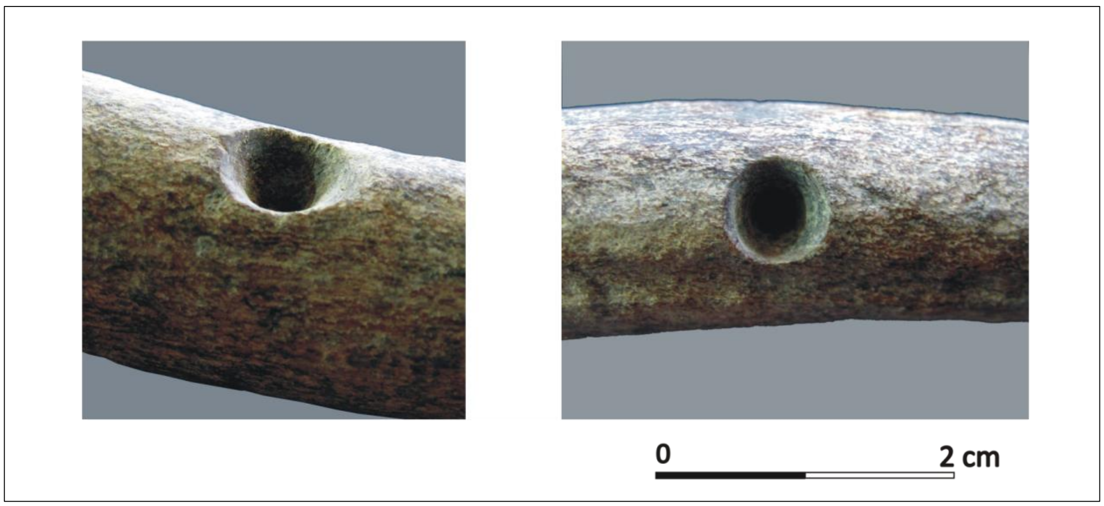


Figure 9.56. Picks on tines from the FN/EBA disturbed layer. Semi-finished shaft holes with round cross section

Overview

The above analysis of this subcategory leads to some remarks concerning the change of the quantity and the manufacture techniques through time. The picks shaped on tine are rather few during the Late Neolithic but they are increasing significantly during the FN phase. In all phases there are attested both completely manufactured and semi-finished item (table 9.30). In Final Neolithic habitation phase the completely manufactured are slightly more compared to the unfinished ones. The number of tools in the other two phases is rather small and the comparison between the two categories can't provide any reliable data taking also into account the partially excavated settlement and that the LN layers have been reached only in a few areas of the settlement.

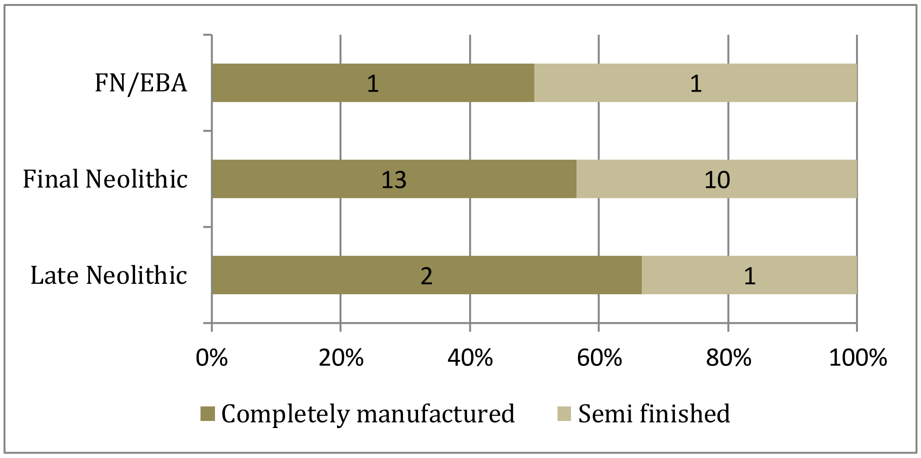


Table 9.30. Picks on tines. Chronological distribution of the completely manufactured and semi-finished tools

The picks on antler tines are rather few in the Greek Neolithic settlements. So far only a few similar tools have been reported, mainly from Neolithic settlements in Central mainland and the Aegean Sea islands. One tool has been reported from the Theopetra Cave settlement (Στρατούλη 2000, fig.19.3.3) and one from the Late Neolithic settlement in Tharounia Cave in Euboea (Στρατούλη 1993, fig.19.1, 19.3). Late Neolithic picks on perforated antler tines have been also reported from Eneolithic settlements from the region of South Moldova (Beldiman et al. 2012, pl.9,17,19).

Picks shaped on basal segments

This subcategory consists of three tools that can attributed to the Final Neolithic habitation phase. All of them are shaped on red deer antler, one on collected antler (Pl.Vc) and two on unshed antler that was obtained through hunting. The item on shed antler (length:15.2cm) is completed has a shaft hole with oval cross section (3.7cm x 3.1 cm) but lacks part of its active end.

The massive and heavy picks on unshed antler present different manufacture and preservation status. The first one (A9b.KE 212) is completed and totally preserved (length: 24.3cm, weight: 386gr) (fig.9.57) with a big shaft hole (4.4cm x 2.5cm) and a fully preserved pointed end. The other one is semi-finished and half preserved as its shaft hole it not drilled and it lacks a big part of its active end (length:19.5cm, weight: 345gr).

Figure 9.57. Final Neolithic pick on basal and beam segment (A9b.KE 212)

The manufacture of these tools must have been a time consuming process as the manufacturing sequence differs a lot from the one used for the manufacture of picks shaped on tines (fig.9.58). At first the artisan(s) had to extract the antler from the skull of the red deer and later to remove the tines and to cut off the antler at the desired length. According to the semi-finished pick, the next stage was related with the shaping of the active end which was achieved through percussion and heavy grinding. The next step was the manufacture of the shaft hole that was drilled transversally to the beam segment in the area of the first tine that was cut off at the previous stage. The perforation was done by percussion and later by bow drilling using a big stone drill bit as the diametre of the preserved shaft hole is quite big (fig. 9.59).

These tools could have been used in agricultural activities but other functions cannot be excluded. Similar items from Chalcolithic settlements in Bulgaria have been considered as close combat weapons (Бояджиев 2014) and perhaps this suggestion can apply to the Anarghigi IXb massive tools.

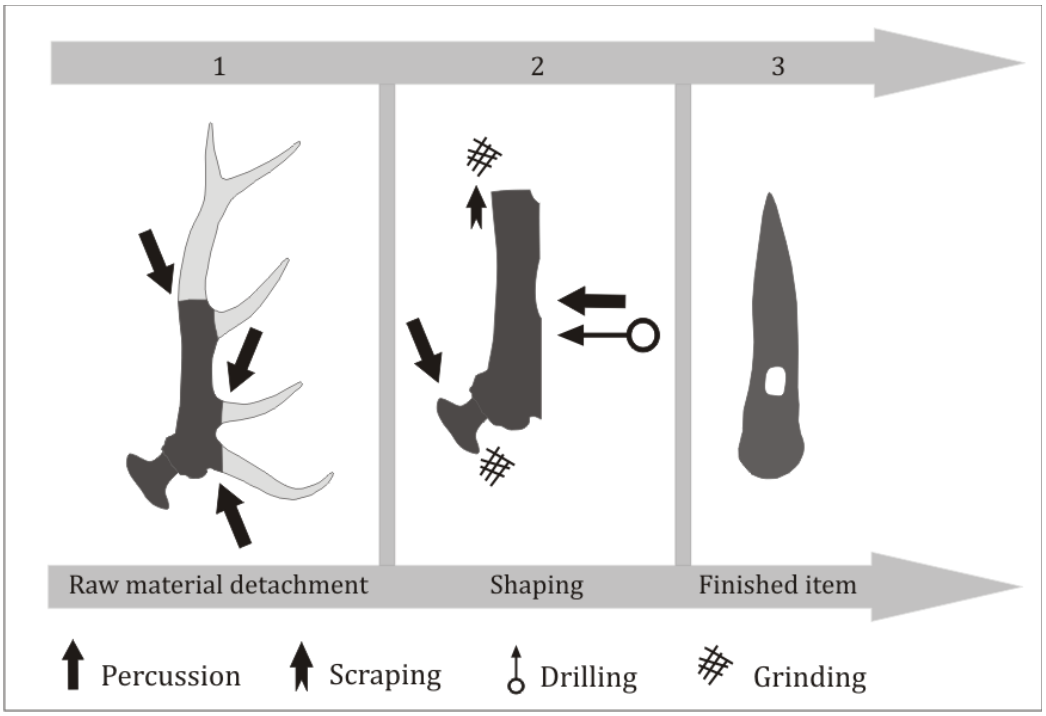


Figure 9.58. Picks on basal and beam segment on unshed antler. Manufacture sequence

Figure 9.59. Pick on basal and beam segment. Detail of the shaft hole.

Picks shaped on beam segments

This subcategory consists of two items, one half preserved completed pick and one semi-finished item. The completed item was shaped on a beam segment that was extracted by the groove and splinter technique and later was grinded in all of its sides in order to obtain a pointed end and flattened sides. It preserves only its distal part and there is no info if it was used handheld or it was a hafted too. The semi-finished tool (catalogue item A9b.KE025) that was shaped on a beam segment (length: 16.7 cm, weight 206 gr) (fig.9.60). The segment was extracted by the rest of the antler by percussion and probably the artisan intended to use the small protruding tine as the active end of the tool. The manufacture of the tool stopped at the second stage of its shaping, the shaft hole shaping. There are percussion traces on both lateral sides through percussion as the manufacturer removed the compact bone in order to shape the outline of the holes (almost round cross section, dimensions: 1.9 cm x 1.75 cm) but he/she quit the manufacture of the tool without any further modification.

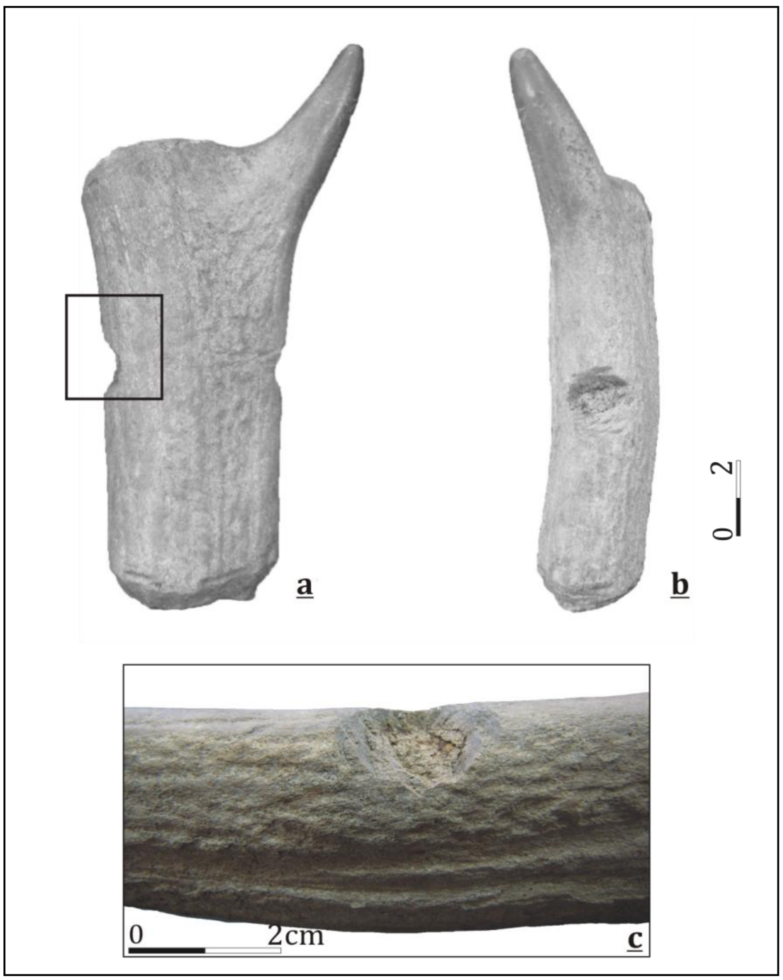


Figure 9.60.Pick on beam segment (A9b.KE025). a,b.Different views of the tool, c.View of the unfinished shaft hole

Picks shaped on crown

A very unique Final Neolithic tool belongs to this category as it is the only tool shaped on red deer antler crown (length: 24.7 cm, weight 297 gr). Its manufacture shows that the manufacturer dedicated a lot of his/her time in order to shape it as almost all of it bears manufacture traces. It was detached by percussion from the rest of the antler and then through percussion and bow drilling the manufacturer shaped a rectangular shaft hole in the basis of the crown (fig.9.61).The manufacturer wanted to change totally the appearance of the raw material as the whole crown bears percussion traces (fig.9.62). The two tines bear also percussion traces on them but they also bear some use wear traces (heavy polish, blunted tips). As this tool is a unique find without any parallels in the Balkans or in Europe, there can be only assumptions about its use. It is possible that a wooden handle was inserted through the shaft hole and that this item was used in agricultural activities.

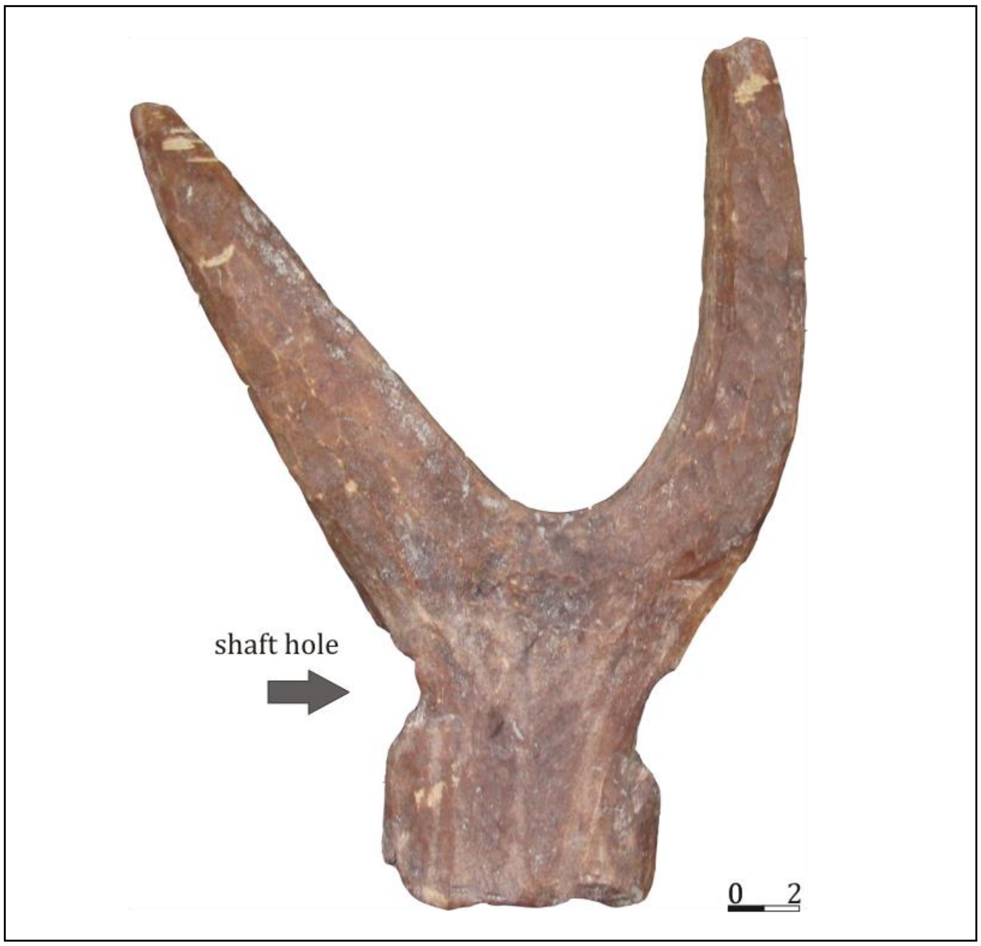


Figure 9.61. Pick shaped on crown (A9b.KE149)

Figure 9.62. Pick shaped on crown (A9b.KE149). a.Detail of the crown tine, b.Detail of the shaft hole

Adzes

This small category consists of five items shaped on big beam segments which have shaft holes that were drilled medio-laterally and the blades are at a right angle to the haft. Two of them belong to the Late Neolithic phase and three in the Final Neolithic phase. So far there haven't been reported such tools from other Greek Neolithic settlements and the only similar items in the Balkans come from Serbia (Vitezović 2017: fig.5).

A big adze (length: 34 cm, weight: 508gr) (fig.9.63) shaped on an upper beam part belongs to the Late Neolithic phase. It was extracted by percussion from the rest of the antler and It is equipped with a shaft hole of round cross section that was drilled close to the base of the crown through percussion and unidirectional bow drilling. Its worn beveled working edge was shaped through oblique scraping and grinding. The other LN adze (length: 11.5 cm, weight 132.5 gr) was shaped on the T-junction area of the beam and third tine. It has a shaft hole with an irregular cross section (1.8 cm x 1.6 cm) but it lacks part of its active end.

Figure 9.63 Late Neolithic adze (A9b.KE 243)

In the Final Neolithic phase belong three adzes. Two of them are completed and are almost fully preserved and the other one is a fully preserved semi-finished item. A completed adze (length: 16.5 cm, weight: 214gr) that comes from the beam segment of the trez tine junction (fig.9.64a). The desired beam portion was removed by percussion and then the manufacturer drilled the shaft hole in the junction area (round cross section, diametre 2.4 cm) and created through scrapping a beveled active end that seems quite worn out and damaged. The other completed tool was shaped on an upper beam segment. Its shaft hole has a round cross section and its diametre is 1.4 cm. One of the crown tines of the antler was used as the active end of the tool.

In the third FN big adze (length: 23.8 cm, weight 363.4 gr) (fig.9.64b) the crown tines were removed through careful percussion by a stone tool with small blade width. The shaft hole has an almost round cross section (3.0 cm x 3.2 cm) and was also drilled in the base of the crown through percussion and bow drilling. The unilateral beveled end (length: 11 cm) was shaped though oblique scraping. The shaft hole inside still bears its manufacture traces and the active end don't bear any use wear traces. This tool seems unused and it can also be considered as a semi-finished item.

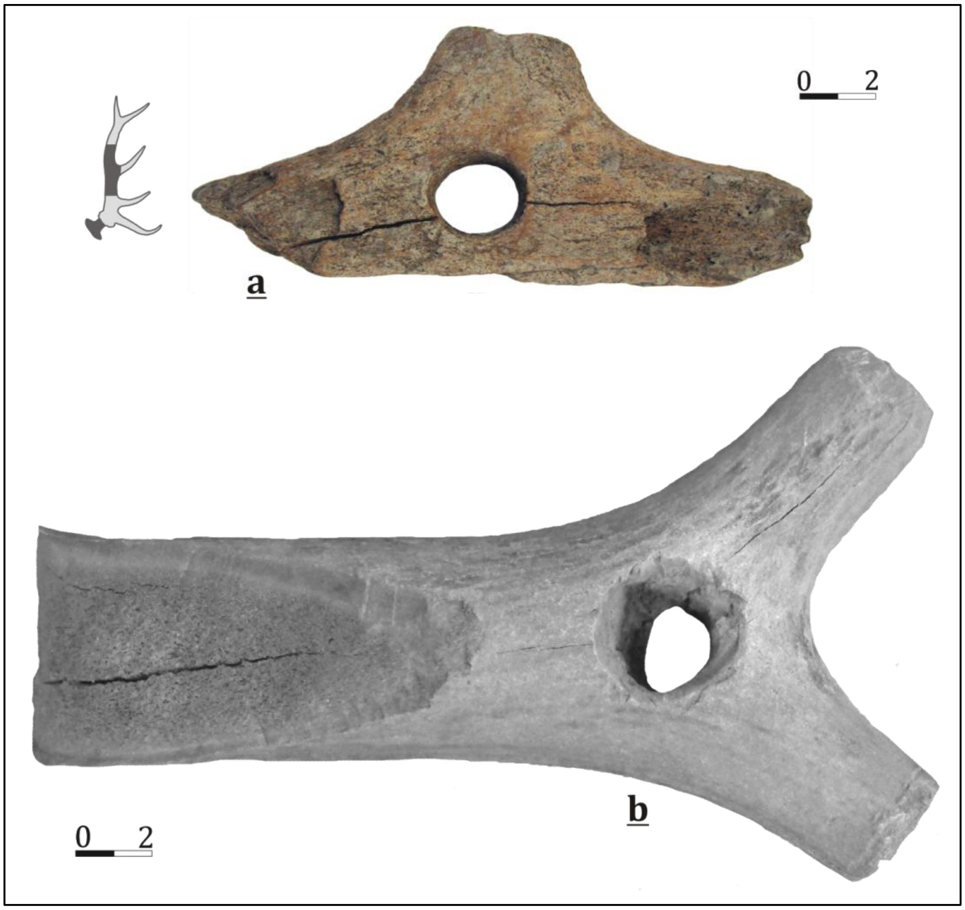


Figure 9.64. Final Neolithic adzes (a: A9b.KE178, b:A9b.KE271)

Axes

The Anarghiri IXb antler axes comprise the biggest recovered antler axe assemblage in Greece. The assemblage comprises of sixteen items that belong to both main habitation phases. Six axes belong to the Late Neolithic layers and ten axes can be ascribed to the Final Neolithic layers. Their categorization was based on the raw material, tines and beam segments. The type A, axes on tines, consists of seven axes and the type B, the beam axes, consists of ten axes that were shaped on beam segments and present a very interesting varied typology. The tines were used mostly in the Final Neolithic phase whereas the number of the beam axes is the same in both phases (table 9.31)

	Late Neolithic	Final Neolithic	Total
Type A	1	5	6
Type B	5	5	10
Total	**6**	**10**	**16**

Table 9.31.Chronological distribution of the axe types

Type A. Axes on tines.

Six axes on perforated tines have been collected. One belongs to the Late Neolithic and five to the Final Neolithic layers. Three of them are completely manufactured and three are semi-finished due to uncompleted active ends or half drilled shaft holes (table 9.32).

		Late Neolithic		Final Neolithic	
		Preservation status			
		Totally preserved	Half preserved	Totally preserved	Half preserved
Manufacture status	Completely maufactured	1	0	1	2
	Semi-finished	0	0	2	0

Table 9.32. Axes shaped one tines. Preservation and manufacture status per habitation phase

The axe that belongs to the Late Neolithic phase is a completely manufactured axe with a double beveled active end (length: 12.8 cm) coming from the northeastern area of the settlement. It has a shaft hole with a round cross section (diametre 1.3cm) near to the basal part of the tine which was shaped through unidirectional bow drilling. Its active end is blunted and very worn out due to heavy use probably to woodcutting tasks.

The axes of the Final Neolithic layers are coming from various areas of the settlement and present a variety in the manufacture and the preservation status. Three of them are completely manufactured but only one is totally preserved (fig.9.65). One axe lacks part of its active end, and the other one lacks part of the shaft hole and its proximal part. In three identifiable cases the shaft hole has round cross section (shaft hole diametre ranges from 1.2 cm to 2.0 cm). In one case the working surface, that was shaped through shaving and grinding, is extended up to 1.2 cm from the edge and it bears discoloration and high polish.

The two semi-finished axes (7.5 cm and 12 cm respectively) were shaped on tines that were extracted by percussion and fracture from the antler. They have slightly shaped shaft holes through percussion (one case) or percussion and boring (one case). In one tool the active end was roughly shaped through scraping.

Figure 9.65. Final Neolithic type A axe shaped on tine (A9b.KE023)

Type B. Beam axes

This subcategory consists of ten axes that were shaped on beam segments. Their manufacture was a time consuming procedure that demanded a lot of effort, physical strength, technical skills and deep knowledge of the physical properties of the antler.

The beam axes comprise a rather interesting typological assemblage. They comprise the biggest part of the assemblage and their morphology show the desire and the ability of the settlements inhabitants to work this hard material and to invest a lot of effort and time in order to create strong and robust tools that could help them in their everyday needs. Their use started in the Late Neolithic (**n: 5**) and the number remains the same in the Final Neolithic phase.

There have been identified four morphologically distinct types which are the results of different manufacture sequences. All these types appear only in this settlement and they could be considered as “local” types since so far they haven’t been found similar items in Greece or in the Balkans. The only antler axe that was found in vicinity comes from the nearby Late/Final Neolithic settlement of Anarghiri IXa but it is totally different from the

Anarghiri IXb axes as it was shaped on the basal part of the antler and has a shaft hole on the areas of bez tine (Arabatzis 2016, fig.9).

The type B1 axe is shaped on a big unsplit beam segment and the active end shaped on the burr, in the type B2 the beam is split in half and the active end is shaped on the burr and in the type B3 the beam is split in half and its base is shaped on the burr. The B4 axe is a handheld axe with a single beveled end. It's rather intriguing that these types don't appear in every phase. The type B1 appears only in the Late Neolithic phase, the type B2 in both phases while the types B3 and B4 only in the Final Neolithic (table 9.33).

Types	Late Neolithic	Final Neolithic	Total
Type B1	3	0	3
Type B2	2	3	5
Type B3	0	1	1
Type B4	0	1	1
Total	**5**	**5**	**10**

Table 9.33. Chronological distribution of the beam axe types

Type B1. Beam axe with active end on burr

In the Late Neolithic all type B1 axes are coming from collected antler. After their acquisition of the raw material, the manufacturer chopped off the antler usually in the middle of the beam segment and kept the part with the basal part. The next manufacturing step was the removal of the tines (first and second) usually by percussion and/or flexion breakage.

After this rough shaping, the manufacturer grinded heavily the base and beam segment medio-laterally in all over its length in order to thin out the volume of the shaft so that these two sides to become flat. Also some grinding was applied to the other sides, mainly in the anterior side in order to smooth out the surface after the detachment of tines. After this process, the cross section in the middle of the axe shaft became rectangular. The usually flat oval in cross section shaft hole was shaped through bow drilling and in some cases through percussion and bow drilling (fig.9.66). The few fully preserved shaft holes show that the perforation was done close to the basis of the tool, in its proximal part and the hafting angle is almost vertical to the longitudinal axis of the raw material.

The basal part of the antler, a very tough and compact part of the antler, was transformed to the active end of the axe. The part of the outer burr (coronet) that was left from the previous grinding process, was then removed and smoothed out and the burr was shaped through percussion and heavy grinding on all sides into a massive axe head with a convex profile.

As most of the axes are fragmented and lack their basal part, it's not possible to identify if this part was shaped or not. This was identifiable only in one case where the axe basis was shaped through grinding and polishing.

The three LN axes of this subtype present different preservation status as all of them are completely manufactured but only one them is totally preserved (artifact (A9B.KE175). Its length is 23 cm and it weighs 184 gr. Its base has an almost round cross section and was shaped through grinding and polish. The shaft hole has a flat oval cross section (2.96 cm x 1.0 cm) and its length is 2.5 cm. It was shaped through percussion and bow drilling from both sides. The shaft bears a lot of grinding traces medio-laterally. A big part of the shaft was leveled medio-laterally through grinding.

The head of the axe (length: 5.0 cm, height: 4.7 cm, thickness: 2.2 cm) has a convex profile and it was shaped through heavy use of the percussion, grinding and polishing technique and it bears traces of contract with hard material (worn/blunted end and pits) Although it bears some traces of contact with other materials, some factors don't make this axe so usable. The small size of the shaft hole (fig.9.67) and therefore of the size of the wooden handle bears some questions about its usability as the thin handle could break easily during use and the user should replace it often with a new one.

Figure 9.66. Final Neolithic type B1 axe (A9b.KE175)

Figure 9.67. Detail of the shaft hole from the A9b.KE175 axe

The other two axes are partially preserved. One axe (catalogue item A9B.KE 052) (fig.9.68) lacks its proximal part and part of the shaft hole (preserved length: 21.2 cm, weight: 176 gr). It has a rectangular cross section in the middle of the shaft and its active end still preserves a small part of the heavy grinded coronet (fig.9.69). The other tool (catalogue item A9B.KE184) preserves only part of the shaft and part of the active end (preserved length: 7.5 cm, weight: 23 gr). The axe had a flat oval cross section in the middle of its shaft and it doesn't preserve its shaft hole. On both axes the active end bears traces of use on hard material like wood

Figure 9.68. Late Neolithic type B beam axe (A9b.KE052)

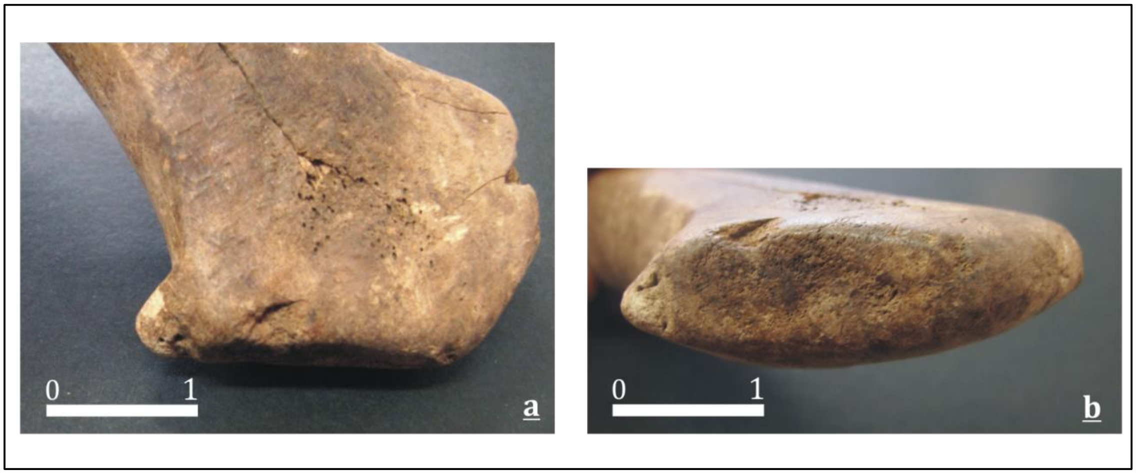


Figure 9.69. Beam axe type B2.
a.Detail of the flattened active edge and the small part of the coronet, b. Close view of antler base/axe edge

Type B2. Split beam axe with active end on burr

The items of the subtype B2 come from collected shed antler (Pl.VI). The manufacturer chopped off the antler in the middle of the beam segment and kept the part with the basal part. The next manufacturing step was the removal of the tines (first and second) usually by percussion and flexion breakage.

In this subtype, the manufacturer didn't grind the raw material but chose to split it in half longitudinally, a very difficult and time consuming procedure that was carried out in detail and with great success through the use of the sawing and splitting techniques. The factors behind this choice could be stylistic or economic. Splitting the raw material in two halves, the manufacturer could have two blanks that could shape according to the needs.

The next manufacture steps are related with the shaping of the shaft hole and the shaping of the base. The few available data provide limited information about the shaft hole and the basal part of the axe. In one case the shaft hole was shaped through percussion and bow drilling close to the basal part of the axe that was left unshaped. The active end was also formed in the basal part of the antler. It has a broad cutting edge and a plano-convex cross section.

The two axes from the Late Neolithic layers are completely manufactured but they are not totally preserved. One of them preserves only its distal part and part of the shaft (without the shaft hole) (preserved length: 15.5 cm) and the other (preserved length: 6.1 cm) only one small part of its distal part (Pl.VIc). Only in one case it was possible to measure the width of the cutting edge (7.7 cm) which preserves small parts of heavy grinded coronet. Both axes were used as their edges bear polish and in some cases chipping.

Figure 9.70. Final Neolithic type B2 beam axe (A9b.KE221)

Three type B2 axes belong to the Final Neolithic phase. All of them are completed but only one is almost totally preserved (fig.9.70). The other two axes lack their basal part along with part of their shaft hole (Pl.VIa,b). All of them share the same characteristics: their mid-shaft and cutting edge cross section is plano-convex and they have broad cutting edges (from 6.7 cm to 9.4 cm). Also, it seems that their shaft hole had oval/flat oval cross section. All of them bear polish, rounding, chipping and pits in their cutting edge.

Type B3.Split beam axe with active end on upper beam

This subcategory is represented only by one item. Its difference from the other split beam axes is in the position of the active end and of the base. In this case, the base was formed in the lower beam area and the active edge in the upper beam part of the raw material. The semi-finished axe (length 23.5 cm, weight 300 gr) from the Final Neolithic phase is totally preserved. The raw material was split in half successfully through sawing. The inner surface of the split beam bears a few grinding traces probably from some smoothing/flattening procedure after the splitting. The shaft hole has a flat oval cross section (3.45 cm x 1.15 cm) and it was shaped through percussion and bow drilling. The formation of the active end was not finished (fig.9.71). It is noteworthy that this axe was found together with a B2 subtype axe. Although it would be tempting to characterize this area as a workshop the available data so far can't provide information for such a hypothesis.

Figure 9.71 .Final Neolithic type B3 beam axe (A9b.KE222)

Type B4. Handheld beam axe on junction

The Final Neolithic tool A9b.KE041 (length 21.0 cm, weight 319 gr) (fig.9.72) is a unique hand held tool whose form reminds the one of the T-axes that were used in many parts of Europe throughout the Neolithic period (Bogucki 2008; Kabaciński et al. 2014; Classon 1983; Elliot 2012,2015; Grygiel and Bogucki 1990; Riedel 2003; Tóth 2012). In this case there are no attempts for shaft hole shaping and the tool bears use wear traces therefore it must be assumed that it was used handheld. The raw material, part of the beam segment and trez junction, was cut out mainly by percussion and flexion breakage from the rest of the beam and the third tine was removed by percussion. The active end was shaped probably by scraping and it's quite damaged and worn.

The antler axes consist part of a toolkit that was used in woodworking, a demanding task that was practiced regularly as it can be inferred by the thousands of the piles and structures that were found during the excavation seasons (Giagkoulis in press). The contrasting quantity between these two categories reflects the preferences of the settlements inhabitants concerning the raw material and the tool types.

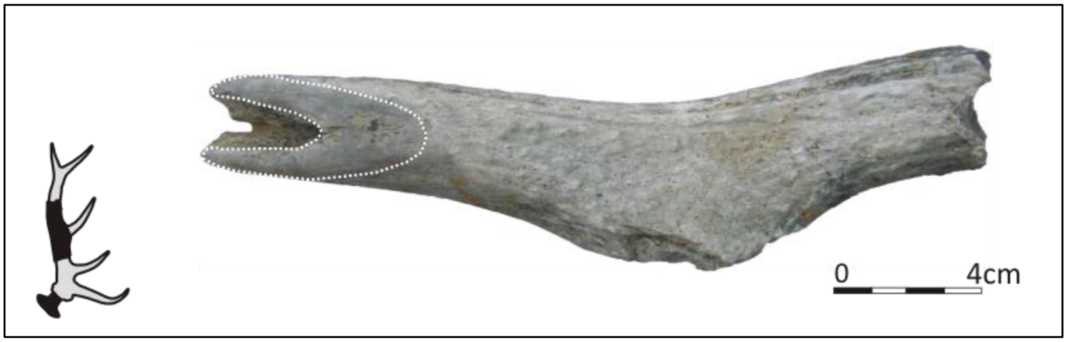


Figure 9.72. Handheld axe Type B4 on junction (the dotted area indicates the worked area) (A9b.KE041)

The small number of the axes and adzes in both phases (regardless the excavation bias in favor of the Final Neolithic layers) and the big number of the sleeves especially during the Final Neolithic (table 9.34) shows that although the manufacturers had the technical knowledge and the abilities to manufacture axes, they chose to invest less time and effort in the shaping of tools of similar use (sleeves) that could be renewed easily the change of the stone blade than to reshape the blunted axe blade.

Although the most obvious use of the axes could be woodcutting, one can't exclude other functions for these items. These massive tools of types B1, B2 and B3 could be also used as weapons in close combat as it has been suggested for other antler axes from some Chalcolithic settlements in Bulgaria (Бояджиев 2014) or could be used as supplementary toolkit in hunting activities.

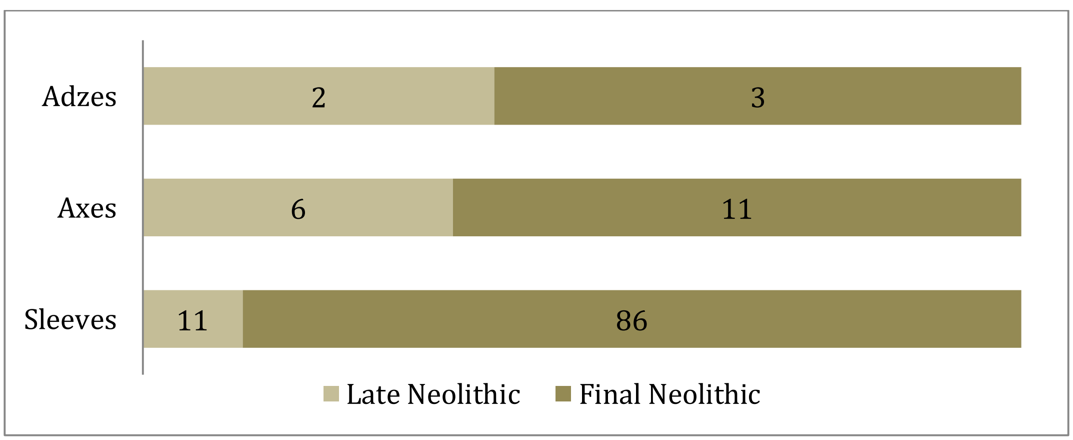


Table 9.34. Chronological distribution of woodworking tools

Needles

Eight antler needles have been collected and all of them belong to the Final Neolithic habitation layers. They were shaped on tines (**n: 6**) and on beam segments (**n: 2**). There have been distinguished two basic types with their subtypes according to the raw material, the morphology of the needle and the number of the thread hole (table 9.35):

Type	Quantity
Type I. Needles on tine segments	6
Type II. Needles on beam segments	2

Table 9.35. Needle types

Type I. Needles on tine segments

Six type I needles have been found. Their main characteristics are the curved silhouette/profile and the existence of a thread hole in the mesial section that can be parallel to the longitudinal axis of the needle (**subtypes IA1 and IA2**) or vertical to the longitudinal axis of the needle (**subtype IB**).

Subtype IA.

The subtype IA1 consists of three items. As it can be inferred from the semi-finished and the fully preserved items, the manufacture sequence involved the selection of thin and long tines and the extraction of the distal curvy segment of them through percussion and/or sawing. Later the manufacturer reduced the volume of the tine by scraping and percussion and later by grinding. This procedure excluded the area in the middle of the tine where the manufacturer left the raw material unshaped but removed the spongy tissue in order to create the thread hole. Then the tine was grinded into a sandstone or it was scraped/shaved in its distal part so that the lateral sides converge into a sharp tip.

The A9b.KE205 needle (fig.9.73) is the best preserved Type IA1 needle. Its total length is 14.4 cm and it width is 1.6 cm. Its base and its mesial part have a plano-convex cross section. The mesial part is thicker than the distal and proximal part and it bears polish in all over is length. The thread hole was created by a borer through one-directional perforation. Its cross section is almost round (0.7 cm x 0.8 cm) and its length is 1.2 cm. It bears polish that was caused by the constant contact with the thread. The tip is worn and blunted and it bears polish both internally and externally.

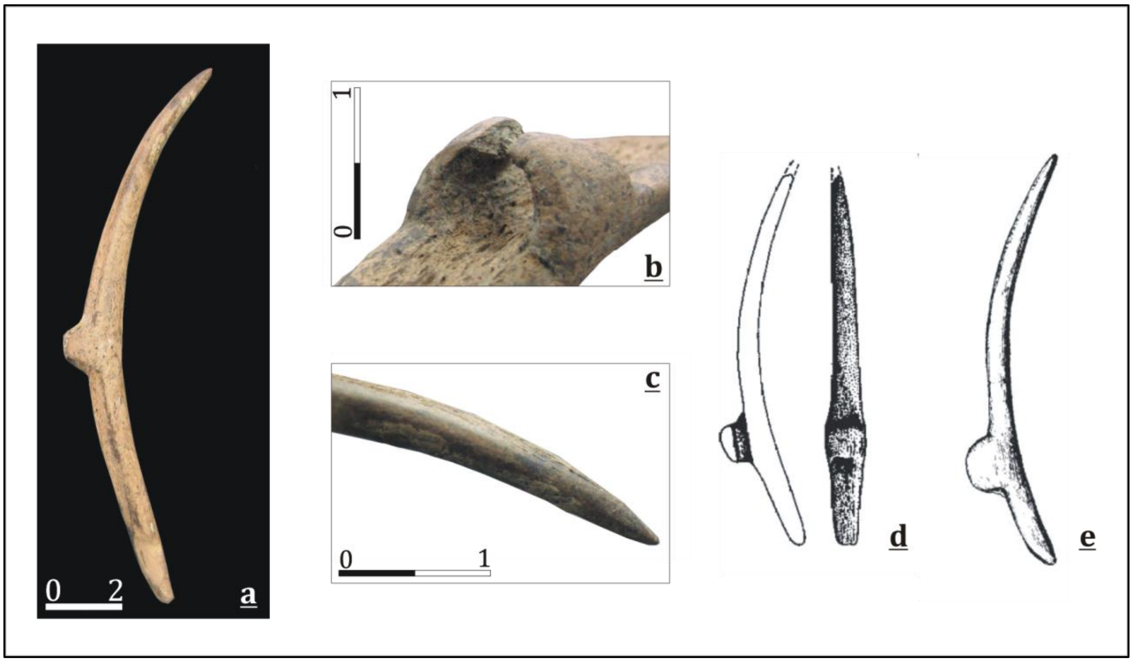


Figure 9.73. a.Needle subtype IA1,b.Close view of the thread hole, c.View of the pointed end, d, Similar needle from Steinhausen – Sennweid,Switzerland (Elbiali 1990), e.Similar needle from Delley - Portalban II,Switzerland (Ramseyer 1987) (items d and e are not in scale)

One fragmented needle (catalogue item A9b.KE083, length: 6.0 cm) lacks part of its distal and proximal end. The thread hole has an almost round cross section (0.75 cm x 0.7 cm) and its length is 2.15 cm. It bears polish inside the thread hole due to the contact with the thread and in its sides near to the tip breakage point and in its external side.

The subtype IA2 consists of two needles, both of semi-finished. In one case the thread hole is semi drilled and in the other case the active end is rather thick and unmodified. Both of them are not totally preserved and they preserved mainly their distal part (average length: 7.8cm) which in this case is not split longitudinally but it retains the natural form of the tine (fig.9.74). The thread hole is parallel to the longitudinal axis of the needle and in both cases the attempts for the thread hole drilling were made through the boring technique. One needle bears a pointed end that was shaped through shaving.

Figure 9.74. Semi-finished subtype IA2 needle (A9b.KE040)

Subtype IB.

This subtype is represented only by one item. Its manufacture sequence doesn't differ from the one of subtype except that the thread hole was shaped vertically to the longitudinal axis of the tool. The needle (catalogue item A9b.KE070) is rather lengthy (13.7 cm) like the other type I needles. It has a more straight profile and only the proximal part is curved outwards. The mesial and the proximal part have plano convex cross sections while the last 2.5 cm of the tip have round cross section. The fragmented thread hole was shaped in the middle of tools length with a borer through one-directional boring. It has a round cross section (0.6 cm x 0.6 cm) and its estimated length is 1.3 cm.

Needles of the subtypes IA and IB have been attested in Neolithic and Bronze Ages settlements of Central and Southern Europe and also in England. The type IA1 needle is known as "Luscherz needle" in Western and Central Switzerland (fig.9.73d,e) and it was used during the first quarter of the 3rd mil BC in settlements around the lakes Neuchatel, Biel, Morat and Zug (Camps-Fabrer and Ramseyer 1990 Fig.2; Elbiali 1990; Gross 1991; Hafner and Suter 2003; Nielsen 1991; Ramseyer 1987, 2004) where they have been interpreted as netweavers (netznadeln) (Gross 1991; Nielsen 1989). These needles have also been found in various Late Neolithic/Chalcolithic and Bronze Age settlements in France, in England, in Italy and also in Spain (Camps-Fabrer and Ramseyer 1990, Fig. 2.).

Type II.Needles on beam segments

This small assemblage consists of two different needle subtypes. The subtype IIa needle was shaped on a beam segment that was extracted through the 'groove and splinter' technique. Later an "eye"/thread hole was drilled (round cross section, diametre 0.8 cm) in the proximal part. The mesial part was shaped through grinding that was also deployed laterally in order to shape the missing pointed end.

The thin and elongated needle of subtype IIb (length: 9.55 cm, width: 1.1 cm thickness: 0.4cm) has two holes instead of one and was shaped in a straight beam segment that was extracted through the "groove and splinter" technique. The blank was thinned through grinding that was also applied for the shaping of two beveled sides that converge to a pointed end. The two holes have round cross section but their size differs (diametre: 0.35cm for the one close to the proximal end and 0.5 cm for the other) and they were shaped through boring. The biggest one bears polish inside its walls probably due to the contact with the thread. The intact active end is rounded and bears high polish in the tip and laterally. Its morphology (low width and thickness, small tip angle) in combination with the use wear and the results of experimental approaches (Campana 1989) show that it is possible that this tool was penetrating soft material and maybe it was used in order to join different pieces of leather.

Fragments of perforated tools of undefined function

This category consists of fifty seven (57) fragments of perforated tools. These tools lack their biggest part, usually from the shaft hole to the tip of the distal part therefore it is rather impossible to define their function. These fragments appear in all phases. The majority of them (**n: 45**) can be ascribed to the Final Neolithic habitation phase and the rest of them in the Late Neolithic. They are shaped on basal segment (**n: 23**), beam segments (**n: 22**) and on tines (**n: 12**). Except from the fragments shaped on tines that are almost equally distributed in the Final and Late Neolithic habitation phases, all other categories are attested mainly in the Final Neolithic phase (table 9.36).

		Chronological period		
		Final Neolithic	Late Neolithic	Total
Raw material	Basal segment	20	3	23
	Beam segment	18	4	22
	Tines	7	5	12
	Total	**45**	**12**	**57**

Table 9.36. Chronological distribution of the perforated tool fragments

Fragments on perforated basal segments

The acquisition mode of the fragments on basal segments presents a rather interesting aspect as the vast majority of them were shaped on unshed antler (fig.9.75). In Late Neolithic in three cases the tools were shaped on shed antler and in one case on unshed antler. In Final Neolithic thirteen tools (**n: 13**) were shaped on unshed antler and only seven (**n: 7**) on collected antler.

In most of the fragments the shaft hole is preserved partially (half or at least some parts of them) and therefore in many cases (if not in the most of them) it is not possible to identify the shaft hole shape or to measure its exact dimensions.

The fragments which belong to the Late Neolithic phase have an average length of these tools is 7.9 cm and their average weight is 72.6 gr. They retain part of the shaft hole which seems to be relatively small and in one case it was possible to identify a shaft hole with round cross section.

In the Final Neolithic, the length of the fragments coming from shed antler have average length 8.01 cm and average weight 105 gr. In five cases the shaft hole is half preserved, in one only part of it and only in case the shaft hole is preserved fully (round cross section, diametre: 1.4cm).

The pieces coming from unshed antler are slightly bigger. They preserve only the basal part of the tool and part of the shaft hole and the rest of the tool is missing. Their preserved length ranges from 6.2 cm to 11.5 cm (average length: 8.16 cm) and their weight ranges from 26.5 gr to 275 gr (average weight: 103.63 gr). In these tools, the manufacturer shaped the pedicle through percussion and grinding into an elongated basal part of round cross section. The shaft holes of these fragments are half/partially preserved. In some cases it was possible to measure the diametre (2.0 to 5.5 cm and round cross section) and it seems that the shaft holes are bigger than those of the fragments of shed antler. Taking into account the size of the fragments and the size of the shaft holes, one could speculate that these fragments belonged to massive tools like the pick A9b.KE212 that was shaped on unshed antler.

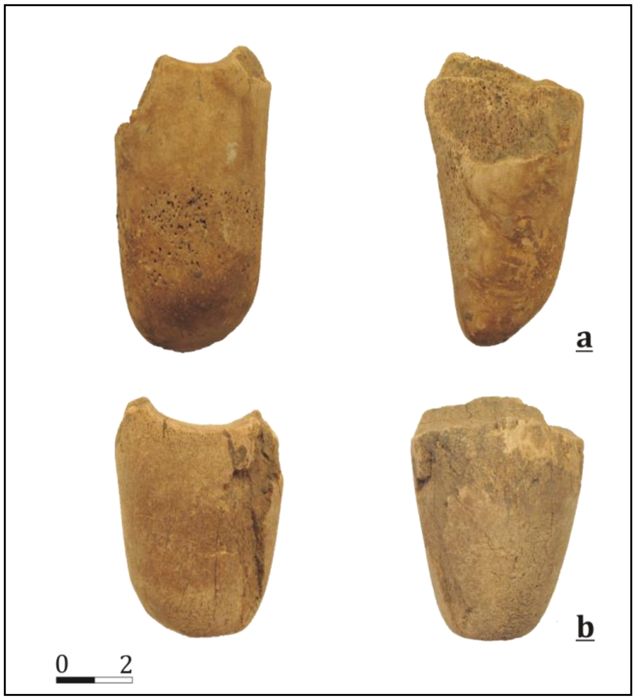


Figure 9.75. Fragments of perforated basal segments of undefined function (a.A9b.KE014, b. A9b.KE111)

Fragments of perforated beam segments

The fragments of perforated tools shaped on beam segments could have been parts of picks, sleeves or axes. The fragments preserve only part of the shaft with the usually partially preserved shaft hole therefore it is not possible to identify their possible function or to reconstruct the manufacture sequence of the tools that they belonged to (fig.9.76)

The four fragments from the Late Neolithic phase preserve only part of the tool shaft and part of the shaft hole. Their length ranges from 5.7 cm to 11.5 cm (average length: 8.25 cm) and their weight ranges from 35.5 gr to 99 gr (average weight: 55.87 gr). In four fragments the shaft holes are half/partially preserved and in one is fully preserved (irregular cross section, 1.8 cm x 1.8 cm). In all cases the few manufacture traces indicate the joint use of the percussion and bow drilling for the shaping of the shaft holes.

In the Final Neolithic the length of the preserved beam segments ranges from 4.2 cm to 15.5 cm (average length: 9.09 cm) and the weight from 7 gr to 272 gr (average weight: 96.1 gr). Ten shaft holes are half preserved and in the rest of them only a small part of them is preserved. Nine shaft holes bear traces of percussion and bow drilling. The rest of them must have been shaped only through bow drilling. In seven cases the shaft hole has probably round cross section, in one oval cross section and in the rest of them it was not possible to identify the cross section shape.

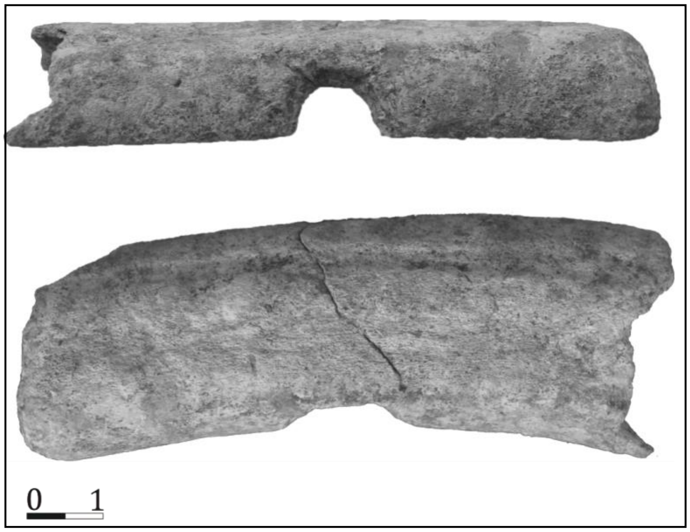


Figure 9. 76. Fragment of perforated beam segment of undefined function (A9b.KE133)

Fragments of perforated tines

The fragments of perforated tools shaped on tines preserve mainly their proximal part and part of the shaft hole and since they lack their active end it is unclear whether they were used as picks or as bevel ended tools. Five fragmented perforated tines belong to the Late Neolithic habitation phase. Four of them probably belong to the earliest habitation phase of the settlement (Late Neolithic I). Their length ranges from 4.8 cm to 12.5 cm (average length: 7.8 cm) and their weight from 7.8 gr to 18.4 gr (average weight: 12.26 gr). In two cases the fragments preserve the basal/proximal part of the. Four shaft holes are half preserved and two are totally preserved. All shaft holes were shaped through bow drilling and their cross section is round (**n: 3**), oval (**n: 1**) and rectangular (**n: 1**). In one case the tool has two shaft holes, a broken/half preserved one and one half drilled (fig.9.77). If those shaft holes weren't drilled at the same time, it can be suggested that after the breakage of the first one, the manufacturer tried to recycle the raw material by bow drilling it and making one more shaft hole that was never finished.

The seven perforated tine fragments of the Final Neolithic phase are slightly bigger. Their length ranges from 5.05 cm to 15.1 cm (average length: 9.0.8 cm) and their weight from 15.9 gr to 96 gr (average weight: 48.23 gr). Some of them preserve traces of the detachment process that was performed usually by percussion and flexion breakage. The shaft hole is half preserved in most of the cases except from one tool that preserves a very small part of it. Four shaft holes seem to have round cross section (approximate diametre ranges from 0.8 t o1.6 cm) and one probably oval cross section. In three tools it was possible to identify the use of percussion and bow drilling for the perforation of the shaft holes while the other shaft holes were shaped probably only through bow drilling.

Figure 9.77. Fragment of perforated tine of undefined function (A9b.KE085)

Retouching tools

Bones and bone fragments have been used as retouching tools since the Middle Pleistocene in Europe (Yeshurun et al.2018). The osseous (bone, antler or teeth) retouching tools were used in order to shape,modify or recycle stone tools .The physical properties of antler made it an ideal raw material for the manufacture of such tools, that were characterized by Chase (Chase 1990) as "tool-making tools".

In the Balkans, antler retouching tools have been documented in Serbia (Russell 1990, Vitezović 2007, 2011a, 2013a, 2013b, 2018), in Bulgaria (Vitezović 2018) and in Romania (Beldiman 2007). In Eastern Europe a great number of retouching tools has been unearthed in the Late Neolithic settlement of Aszód Papi in Hungary (Tóth 2012). Retouchers have been also attested in many Neolithic lakeside settlements in France and in Switzerland: Chalain 3 (Voruz 1989, 1997), Chalain 4 (Maigrot 2003), Clairvaux VII and XIV (Maigrot 2015), Egolzwil 3 (Wyss 1994), Concise 3 (Maytain 2010), Hitzkirch-Seematt (Wey 2001) and Arbon Bleiche 3 (Deschler-Erb et al.2002)

The antler retouching tools are rare in Greece although the use of soft hammer technique has been reported in a lot of Neolithic settlements (Stavroupoli: Σκουρτοπούλου 2004; Mikri Volvi: Δογιάμα 2009; Lete: Κακαβάκης 2012; Sitagroi:Tringham 2003). So far the assemblage of Anarghiri IXb is the only one that contains osseous tools that are relating with the manufacture of chipped stone tools (soft hammers). This is reinforced by the study of the settlements chipped stone tool assemblage as preliminary data from this study showed the existence of chipped stone tools that were manufactured through this method (Papadopoulou pers.com.).

The assemblage consists of seven retouching tools that belong to the Final Neolithic habitation phase of the settlement and they are shaped on tines (**n: 2**), basal segments (**n: 1**) and beam segments (**n: 4**). All of them are completely manufactured but their preservation status varies. Most of them are completely preserved and only one item lacks its distal end.

The tines were detached by percussion and flexion breakage from the antler. One of them was used unmodified with minor shaping in its distal part while the distal part of the other tools was rejuvenated (maybe more than once) through shaving (fig. 9.78, Pl.VIIa). The active end is preserved totally in one case and it is blunt and worn out due to heavy use.

The other tools were shaped on beam segments (Pl.VIIb). In three cases the segments were extracted from the beam by the groove and splinter technique and in one case the tool was shaped on a big segment that extracted from the main beam through percussion and perhaps also with fracture. The distal parts of the tools bear pits or they are blunt and worn. One tool has two working ends. One tip is round and blunt with some grooves and pits and the other one is broken it was probably used as its sides are converging.

The assemblage contains a big hammer that was shaped on the base of red deer shed antler (fig.9.79). The tool was shaped through percussion, which was used in order to remove the tine and the coronet but also to perform a big groove between the burr and the beginning of the beam segment that maybe was used in order to attach the tool with a rope around a belt. The tool was also equipped with a (half preserved) shaft hole that was shaped through bow drilling. Since the tools is half preserved, it is unknown if it was used only as a hammer or if the missing part was ending to a beveled end and the tool was a hammer-axe. Similar tool, without the shaft hole, has been found in the Neolithic settlement of Divostin in Serbia (Vitezović 2013a fig.9).

The low microscope analysis of some of these tools and its comparison with experimental analysis (Maigrot 2003) or macroscopical analysis of other assemblages (David et al.2016) showed that at least two of them were used for retouching by compression while the rest of them by percussion.

Although the number of the retouching tools is limited, there is some interesting data that can be extracted. The choice of the raw material and the used techniques reveal that the manufacturers of these tools were fully aware of the mechanical and physical properties of the antler. They chose red deer antler that as it seems was in abundance in the settlement and not roe deer antler that was not so preferred. Only a small percentage of these tools could be characterized as expedient tools, as the vast majority is result of careful planning and manufacture. Their small number however may indicate that although it was possible to manufacture such tools from osseous material, perhaps the settlements inhabitants chose to use other material that was shaped more easily such as the wood.

Figure 9.78. Final Neolithic retouching tool on tine (A9b.KE029)

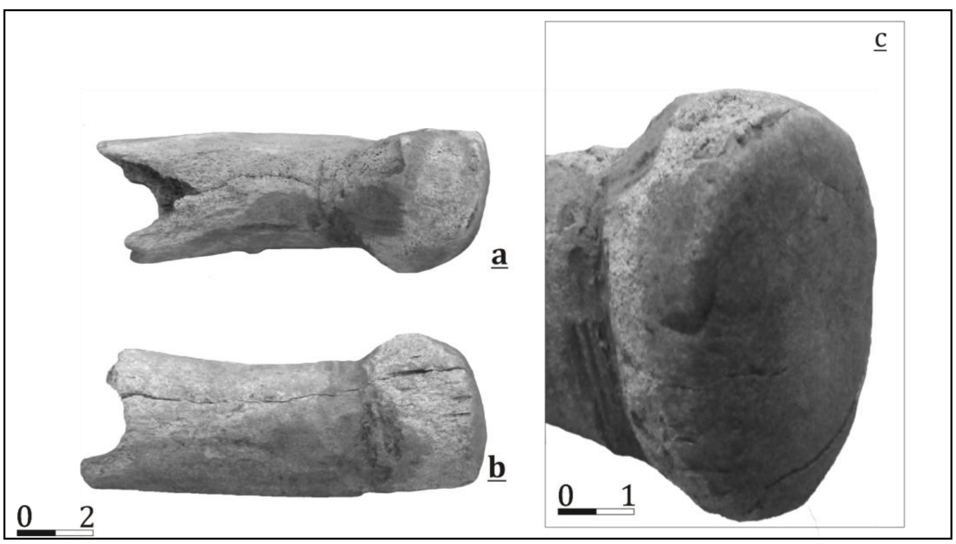


Figure 9.79. Final Neolithic antler hammer (A9b.KE287)

9.6.1.2. Hunting - Fishing equipment and weapons

The hunting and fishing equipment of the settlement give us information about the activities outside of the settlement and in the area of the lakes that surrounded it. The search of bone artifacts in the zooarchaeological material and the number of osseous artifacts from wild animals (Arabatzis 2016b,2017,2018) indicate that the hunting must have played a significant role in the settlements economy like in other Neolithic settlements of the area (Megalo Nisi Galanis: Fowler and Greenfield 2005 Dispilio: Σαμαρτζίδου 2014). The ichtyoarchaeological material has not been studied yet but it is possible that a part of the settlements economy was based on the lakes fish resources just like in the nearby settlement of Dispilio (Θεοδωροπούλου 2008).

The assemblage is rather small in quantity (**n: 28**) (table 9.37) but it is characterized by diversity since it consists of five distinct categories, some of them rather unknown from other Greek Neolithic settlements. The assemblage comprises of harpoons, harpoon heads, thumb rings, fish hooks, projectile points and mace heads. Their function distinction is not so clear as most of them (except the fish hooks and the harpoons) could have been also used in armed conflicts (interpersonal or between groups of different settlements).

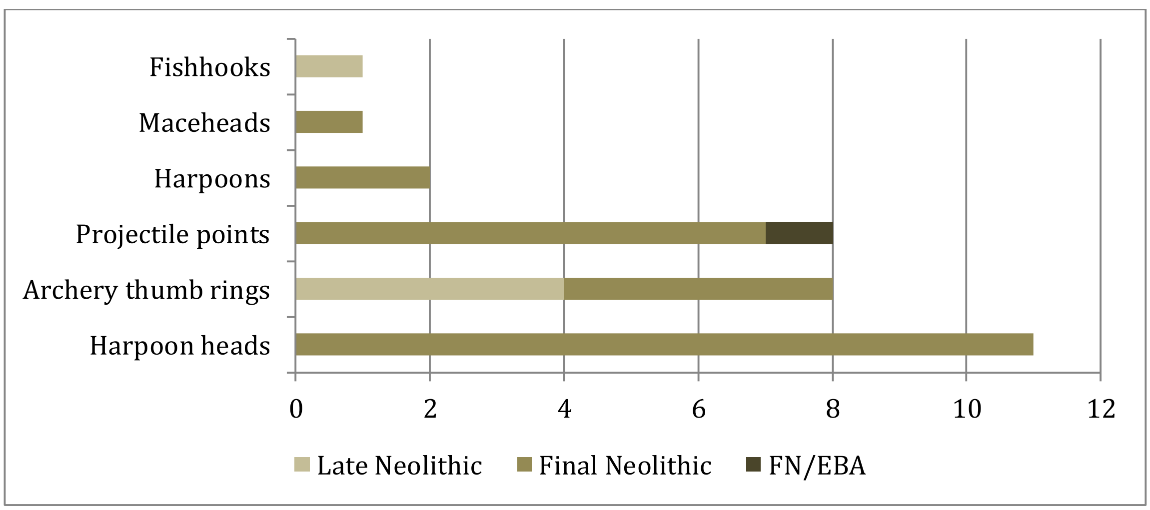


Table 9.37. Chronological distribution of hunting-fishing equipment and weapons

The harpoon heads comprise the biggest category followed by the thumb rings and the projectile points. The remaining categories are not so well represented here (table 9.36). Most of the items are coming from the Final Neolithic phase. The harpoon heads, the harpoons and the mace head are attested only in the Final Neolithic phase while the projectile points are attested mainly in the Final Neolithic phase and only an item belongs to the FN/EBA layer. It’s very interesting that the thumb rings are attested in both of the main habitation phases and that there are no fish hooks in the Final Neolithic phase as the only one comes from the deep layers of the Late Neolithic phase.

Harpoon heads

The eleven collected harpoon heads comprise the biggest antler harpoon assemblage found so far In Greece. The small number of the items indicates that perhaps the majority of the harpoons were made on other material (wood) that wasn't preserved.

All harpoon heads belong to the Final Neolithic phase. They are shaped on tine segments and they have two distinct parts: the distal part, which has a line hole on it and a pointed active end, and the proximal part which is the part that is attached to the wooden shaft of the harpoon (fig.9.80). They are shaped on tine segments and they all belong to the same morphological type that presents some small variations. The harpoon heads present different manufacture and preservation status. Three items are finished and the rest of them are semi-finished. All finished items are half preserved while the semi-finished items lack their proximal part.

There have been distinguished three variations of the harpoon head according to the position of the line hole (type A, B and c) (fig.9.81). At first the manufacturer selected the appropriate tine and he/she extracted the desired part out of it through percussion and/or sawing. The next step was the shaping of the base in the proximal part of the tine segment through percussion that was applied almost in the middle of the blank (fig.9.82a).Then through sawing and grinding the proximal part was split longitudinally and obtained a flat inner surface and a plano-convex cross section. In one case the grinding was not limited to the inner surface of the proximal part but also in its lateral sides (fig.9.82b).

The next steps involved the shaping of the main line hole and the shaping of the active end. In the type A and B harpoon heads the line hole was opened in the anterior part of the tine segment at the end of the distal part through boring. In type A and B harpoon heads the rope was inserted from the main line hole and exited from a nearby hole at the beginning of the proximal part that also served as a mounting socket as the tip of the wooden shaft was inserted in that hole (fig. 9.81, 9.83).

In type B there was also an attempt for drilling a second line in the proximal part of the harpoon head near to the line hole of the distal part (fig. 9.81b) probably in order to secure better the strap between the antler and the wooden shaft. In type C the main line hole was drilled in the proximal part and not in the distal part (fig. 9.81c).

In all types the rope must have been tied in the wooden shaft so that antler harpoon head wouldn't get lost after an unsuccessful throw or in order to pull the harpoon head and the fish out of the water. The active end of the distal part was shaped through shaving and grinding (fig.9.84).

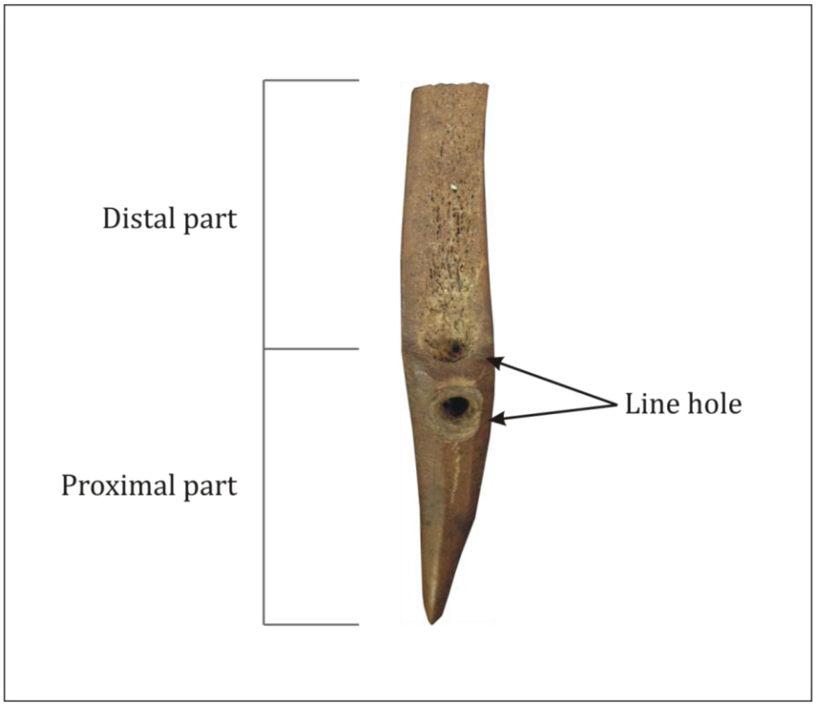


Figure 9.80. Morphology of the harpoon head

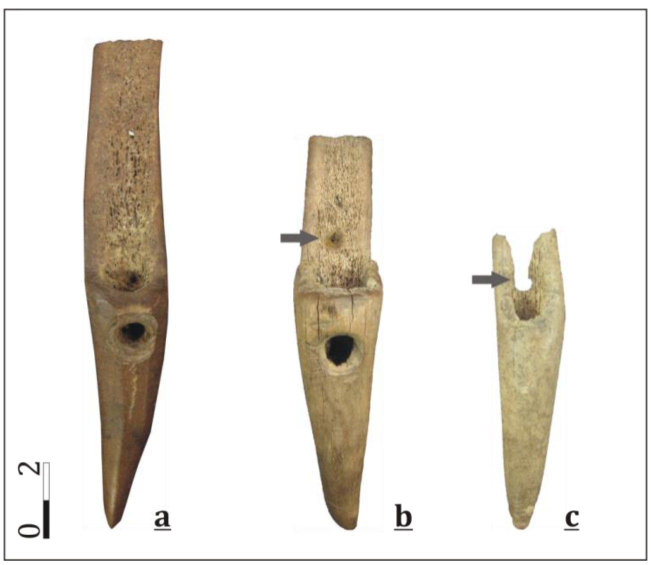


Figure 9.81. Harpoon heads. a. Semi-finished item (Type A), b.Semi-finished item (Type B),
c. Completely manufactured but half preserved (Type C) (arrows indicate the holes in the proximal parts)

Figure 9.82. Harpoon heads. a.Manufacture traces on a semi-finished item, b.Grinding traces in the lateral side of the proximal part.

Figure 9.83. Harpoon head line holes a.Unfinished, b.Completed

Figure 9.84. Distal part of a harpoon head with grinding traces and polish on the tip

The length of the semi-finished items, regardless of the preservation status, ranges from 7.2 cm to 12.3 cm (average length: 9.43 cm). In seven out of eight cases the tip of the distal part is unmodified (fig.9.85) and it retains its natural form and only in one case the tip was shaped through grinding and polishing. The line hole is completed only in three items while in the rest of them is semi-finished or the shaping stopped almost in the beginning of the process. Its diametre ranges from 0.52 to 1.1cm (average diametre: 0.724cm).

Figure 9.85. a,b. Unmodified and unused harpoon head tips

The finished items are half preserved. One of them (length: 3.55 cm, width: 1.5 cm) lacks almost all of its proximal part and at least half of the distal part. The length of the preserved distal part is 2.8 cm and the length of the preserved proximal is 0.75 cm. The line hole has a round cross section and its diametre is 0.52 cm. The high polish in the line hole inner walls indicate that the item was used.

The other harpoon head preserves only the distal part (length: 8.2 cm, width: 1.8cm) which bears grinding traces laterally, around the line hole and close to the active end. The line hole has a round cross section and its diametre is 0.6 cm. The active end is blunted and worn (diametre: 0.6 cm) and it has not been renewed. In one case the active end presents the same use wear traces (blunt ruffled tip) as the harpoon found in Divostin (Lyneis 1988, fig.10.2.a) (fig.9.86). It is noteworthy that some of the ornaments shaped on tines have the same tip morphology and probably they are recycled items, harpoons that were transformed to pendants because they couldn't be used anymore as fishing equipment.

Since only a few items are finished and most of them are half preserved, it is not possible to measure the relationship between the distal and the proximal part of the harpoon head.

Similar harpoon heads have been found in other nearby Neolithic settlements and it seems that this harpoon head type is found so far only in the Western Balkan. This type differs a lot from other tine harpoon head types from the Eastern Balkans and especially those found in Pietrele (Hansen 2013). Although they look almost the same, only the Eastern Balkan harpoon heads can be characterized as toggle harpoons as they have line holes in two opposite sides (anterior/posterior or medial/lateral) and they seem to have a small tang whose role was to force the harm the prey when it penetrated its skin. On the other hand the Western Balkans harpoon heads have a big proximal part that was attached to wooden shaft and couldn't penetrate the preys' skin.

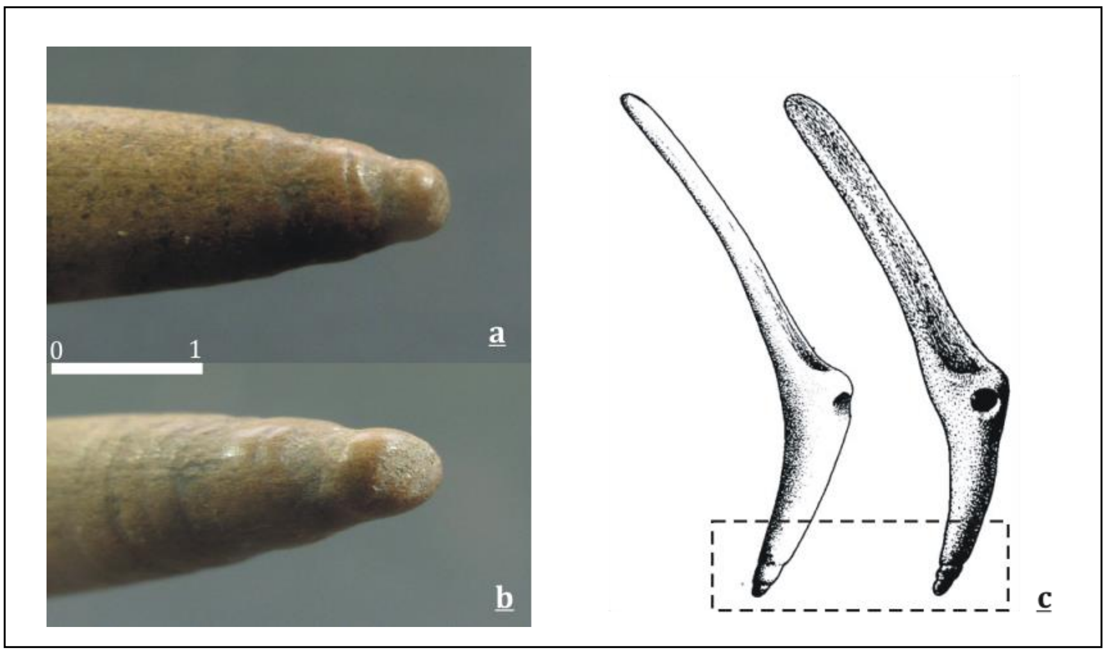


Figure 9.86 a, b. Use wear traces on the tip of the harpoon heads,
c.Harpoon head from Divostin with similar traces on its tip (modified after Lyneis 1988,fig.10.2.a)

Harpoons

The assemblage contains only two harpoons and each one represents a different morphological type (HR1 and HR2). Both of them belong to Final Neolithic habitation phase.

The HR1 type is a unique find from the Four Lakes area and it belongs to the Final Neolithic habitation phase of the settlement. It is partially preserved (length: 9.3 cm, width: 3.75, thickness: 1.2 cm) and it was shaped on a beam segment (fig.9.87). The fragment comes from the basal part of a possible barbed harpoon, has a curved cross section and preserves the line hole that was used for its retrieval after the throw. Harpoons with the same basal cross section and line holes in the basal part have been found in Swiss Neolithic lakeside settlement of the 5th mil BC (Egolzwil 3-Wyss 1994) as well as of the 4th and 3rd mil BC (Montilier/Platzbünden, Delley/Portalban Il, Les Grèves, Auvemier/Les Graviers, La Neuveville /Chavannes-Ramseyer 1995; Schwab 1982)

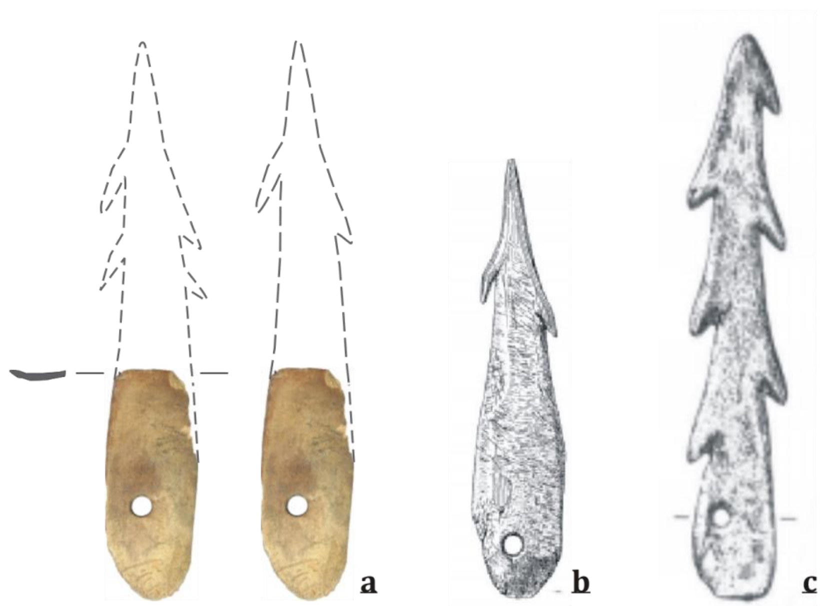


Figure 9.87. a.Possible reconstructions of the antler harpoon, b,c Similar barbed harpoons from Egolzwil 3 and Montilier/Platzbünden (Wyss 1994; Ramseyer 1995)

The type HR2 (fig.9.88) consists of only one item whose morphology is well attested in the Swiss Neolithic settlements but so far is totally unknown in the Neolithic Balkans. It is shaped on a beam segment through sawing and grinding and it is not totally preserved (preserved length: 6.5 cm). It seems to be the distal part of a barbed harpoon that preserves also a small part of the shaft (proximal part). As it seems it had only one barb (length: 3.3cm) which is well preserved and bears high polish in its end (fig.9.89). The curved proximal part is rather thin and has a plano-convex cross section. The distal part is a barb shaped through sawing and grinding with a well preserved point which bears use wear traces (bluntness and small pits).

Figure 9.88. Type HR2 harpoon (A9b.KE323)

Figure 9.89. Close view of the HR2 harpoon barb

Archer thumb rings

The hunting equipment includes nine items that were used in archery hunting and until recently were almost unknown from the Neolithic settlements in Greece. So far archer thumb rings have been found only in the Neolithic settlement of Dispilio (Υφαντίδης 2006, 2018) and in Anarghiri IXb. It seems that it's a local tradition that appears in Northwestern Greece in the Late Neolithic and it continues in the Final Neolithic period. The assemblages of these sites are unique in the area and they are the oldest manifestations of the use of the antler thumb ring archery in the Neolithic Balkans.

The thumb rings were shaped probably on beam and tine segments. At first the manufacturer extracted the desired part through sawing. Then through grinding he/she leveled one of the sides. The final form of the ring along with its hole shaping was the result of a lot of techniques like sawing, bow drilling, grinding and polishing. In some cases the spongy tissue of the antler is still visible under the polishing traces.

The Anarghiri IXB antler thumb rings have a different form that the traditional bone thumb rings or from the Dispilio thumb rings. Their thumb hole is mainly oval and they consist of the following elements: a) the front lip or thumb cover which is the part that protects the thumb, b) the stringrest, which is the angled or curved part between the two lips where the bow string rests before the release of the arrow and c) the back lip (fig.9.90). According to modern traditional archers the front lip is placed in the inner part of the thumb facing towards, to the target and the string is placed in the stringrest between the ring and the thumb (fig.9.91, 9.92).

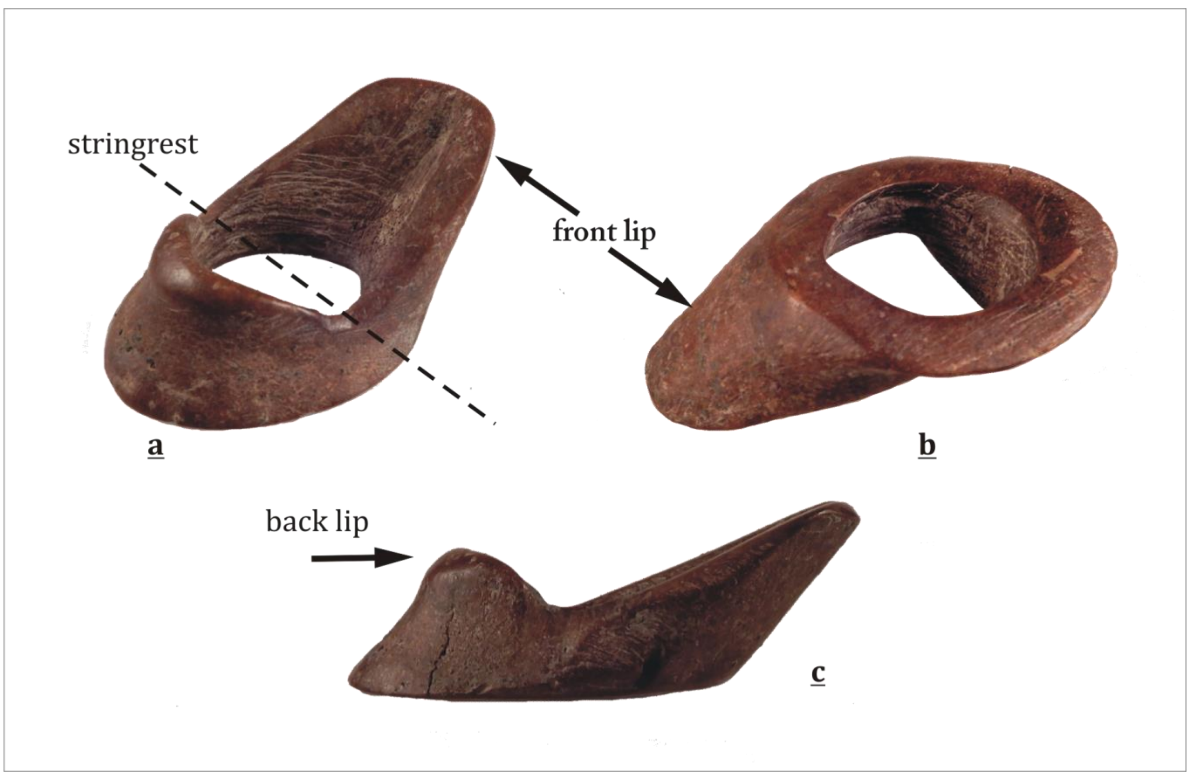


Figure 9.90. Different views of a thumb ring and its major parts

Figure 9.91.Thumb ring technique (Photograph by Martin Groeber. Used under kind permission)

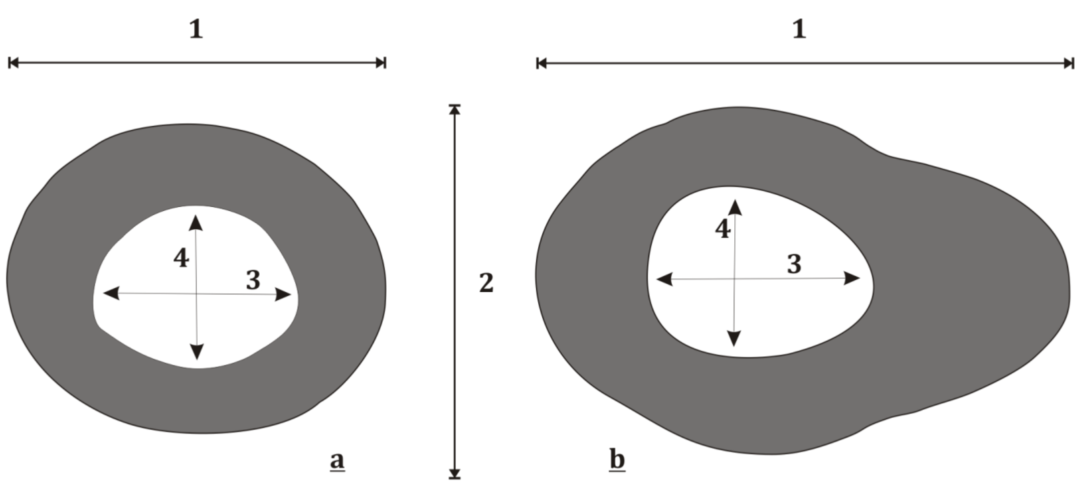
Figure 9.92. Close view of the thumb ring (Photograph by Martin Groeber. Used under kind permission)

Two different thumb ring types have been identified. Their categorization was based in the morphology of the front and back lip. The type I thumb rings are oval shaped with a wide but narrow front lip that is not so extruded. The back lip has usually round or plano-convex cross section (fig.9.93a, fig.9.94). The type II thumb ring has a long protruding front lip which covers if not whole but the biggest part of the thumb and the back lip has big thick walls that enclose big part of the thumb as well (fig.9.93b, 9.95, 9.95, 9.98, 9.99).

The type I rings were found both in Late Neolithic and Final Neolithic habitation layers while the type II rings belong only to the Final Neolithic habitation layers. It seems that the type I was used mostly in the Late Neolithic and later it was substituted by the type II **(table 9.38)** which is more close to the type that is used even nowadays by traditional archers.

	Late Neolithic	Final Neolithic
Type I	4	1
Type II	0	4
Total	**4**	**5**

Table 9.38. Chronological distribution of the thumb ring types



1.Outer long diametre, **2.** Outer short diametre
3.Inner long diametre, **4.**Inner short diametre

Figure 9.93. Metrical analysis of the thumb rings. a Type I, b. Type II

Figure 9.94. Type I thumb ring (A9b.KE280)

The five type I thumb rings are completely manufactured items. Four items belong to the Late Neolithic phase and on in the Final Neolithic phase and there seems to be a size difference between the rings of these periods.

Two LN rings are totally preserved and the other two are half preserved. The two totally preserved have almost the same dimensions (outer LD and SD diametre: 4.25cm x 3.7 cm and 4.8 cm x 4.0 cm respectively) (fig.9.94). All four items have oval shaped thumb holes. The two fully preserved thumb holes are relatively small (inner LD and SD diametre: 3.0 x 2.3 and 2.6 x 2.1 cm respectively) compared to the ones of the Type II thumb rings. The height of the front lip is 1.5cm and 2.1 cm respectively. In all rings the inner walls of the back lip and in two cases the inner walls of the thumb holes have high polish due to the contact with the archers thumb.

The FN thumb ring (catalogue item A9b.KE283) (fig.9.95) is half preserved as it lacks its distal part with the front lip and it is quite bigger than the LN rings (preserved dimensions: 6.0 x 3.9 cm). The stringrest angle is quite acute and the back lip is rather thick (max.thickness:2.6 cm). Given these dimensions it is quite probable that the archers hand was rather big.

Figure 9.95. Type II thumb ring (A9b.KE283)

The four completely manufactured type II thumb rings belong to the Final Neolithic habitation phase. Three of them are totally preserved (fig.9.96) while the fourth one preserves only part of stringrest and the back lip. These are not completely identical as there have been identified some variations in either the form of the thumb cover (front lip) or in the the shape of the back lip. The thumb cover could be oblong or could have a wide base and a narrow curved ending. The outer diametre of the rings ranges from 5.2 cm to 6.4 cm. In two cases the thumb hole has oval cross section (inner LD and SD diametre: 2.6cm x 2.1cm and 3.2cm x 2.7 respectively) and in one case the thumb hole has almost round cross section (2.4cm x 2.2 cm).

In one case in the outer surface of the thumb ring there are still visible the grinding manufacture traces. The contact of the thumb and the ring resulted in the appearance of high polish in the thumb hole walls but also in the front and back lip of the rings (fig.9.97, 9.98).

Figure 9.96. Type II thumb rings

Figure 9.97 Type II thumb ring (A9b.KE276). Manufacture and use wear traces

Figure 9.98 Type II thumb ring (A9b.KE277).Manufacture and use wear traces

Figure 9.99. Type II thumb ring (A9b.KE277)

Fish hooks

The fishing equipment contains only one fish hook perform (fig.9.100) that belongs to the Final Neolithic habitation phase. It is shaped on a beam segment and it was cut out though the groove and splinter technique and it was fashioned through abrasion. It is a one piece fish hook (length: 10.3 cm, width: 5.5 cm) with an almost straight, wide and thin shank (rectangular cross section) that has a rectangular flat head. The small unshaped point (length: 2.45 cm) is almost vertical to the shank and it is rather short compared to the shank. There are not any notches in the lateral sides of the shanks base nor any suspension hole drilling attempts on it so it is not possible to identify the way the hook was going to be attached to the fishing rope. So far it is the only osseous fish hook from this settlement. This image is in contrast with the situation in the settlement of Dispilio where more than forty bone fish hooks have unearthed (Στρατούλη 2008:15) but none of them resembles typologically the Anarghiri IXb antler fish hook.

Figure 9.100. Final Neolithic semi-finished fish hook (A9b.KE019)

Mace heads

One Final Neolithic item shaped on the basal part of a red deer antler could be characterized as a mace head due to its similarity to the stone mace heads (fig.9.101). Similar items have been found in the Neolithic settlement of Montilier/Portalban in Switzerland and they have also been characterized as mace heads (Ramseyer 1985:fig.5.2, 5.3).The basal part was detached by the rest of the antler by percussion. The same technique was used for the detachment of the first tine from the basal part. Traces of the use of this technique are still visible in the body of the tool. The tool bears an almost round shaft hole (1.7 x 1.6 cm, length: 4.7 cm) that was shaped in the middle of medial and lateral sides by percussion and bow drilling. The coronet was removed and the surface that was lying underneath was smoothed out. Except from a few polish traces that could be also result of the finishing of the item, there aren't any other traces that could suggest that this item was used intensively.

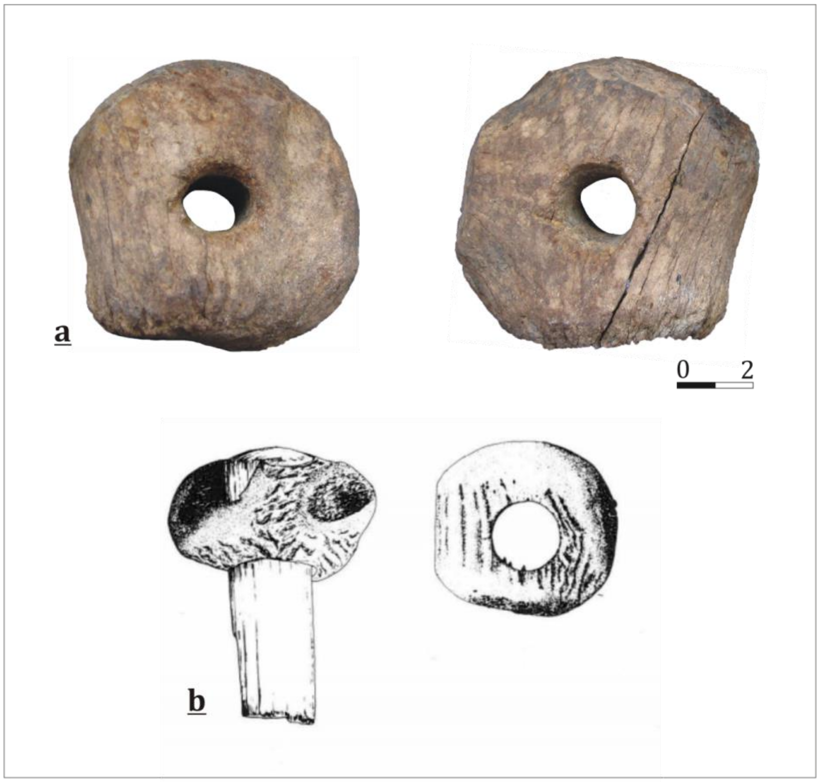


Figure 9.101. a.Final Neolithic mace head (A9B.KE322), b.Macehead from Montilier/Portalban (after Ramseyer 1985, fig.5.4.)

Projectile points

The assemblage contains eight projectile points which could be used as spear points. Seven of them belong to the Final Neolithic phase and one to the FN/EBA disturbed layer. All of them seem to have shaped on red deer antler and mostly on beam segments except from the FN/EBA projectile point that was shaped on tine.

The points that belong to the Final Neolithic phase are divided into five distinct categories based on their overall morphology (fig.9.102, table 9.39).

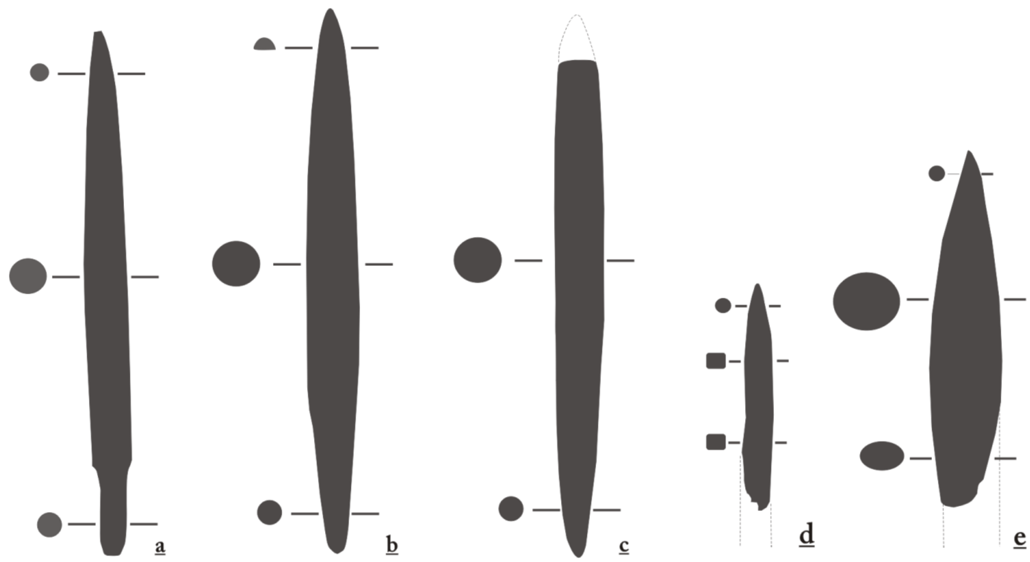


Figure 9.102. Final Neolithic projectile points.a.Type I, b. Type II, c.Type III, d.Type IV, e.Type V

	Final Neolithic	FN/EBA
Type I	1	0
Type II	3	0
Type III	1	0
Type IV	1	0
Type IV	1	0
Type VI	0	1

Table 9.39. Chronological distribution of the projectile point types

The type I consists of one point which is completed and totally preserved (length: 12.2 cm) (fig.9.102a, fig.9.103a,b). It is shaped on the compact part of a beam segment. It has a small distinct tang with round cross section that was inserted into the wooden part of the point (fig. 9.103c). The mesial and the distal part have also round cross sections. The sides of the distal end are sub-parallel and only converge near the tip, which seems to have been resharpened judging from the asymmetrical outline. A similar bone projectile points has been found in the nearby Neolithic settlement Anarghiri IXa (Arabatzis 2016a, fig.11a)

The type II points (**n: 3**) (fig.9.102b, fig.9.104) were also shaped on the compact part that was extracted from a beam segment. As in type I, the blank was probably scraped all around its length and in some cases it was grinded as one projectile point with plano-convex cross section in the mesial and proximal part retains oblique and transversal traces of heavy grinding that was applied.

Figure 9.103. a.Type I projectile point (A9B.KE291), b.Detail of the distal part, c.Detail of the tang

Two projectile points are completed, totally preserved and quite lengthy (average length: 10.0 cm). The difference between this type and the previous one is that in type II the transition from the mesial to the proximal part is smoother. These three points present different cross section in their three main parts. The proximal part could have oval or round cross section, the mesial part could have round or plano-convex cross section and the distal part could have round or plano-convex cross section. In both points the maximum width is close to the proximal part. The sides of this type seem to converge straight from the point of maximum width to the tip. It seems that these points were fixed into a wooden shaft without any extra ligature (fig.9.105a,fig.9.106a).In one case the tip of the point was heated but it is unknown if it was heated during the manufacture process or just before its use in order to increase the preys pain. A similar antler projectile point has been found in the nearby Neolithic settlement Anarghiri IXa (Arabatzis 2016, fig.11b).

The type III consists of one item (length: 9.5cm) (fig.9.102c, fig.9.104b) that is not totally preserved as it lacks its distal part that probably was about to reshaped. The proximal part bears marks that are vertical to the longitudinal axis of point that indicate the method that was used for its hafting (fig. 9.105b, 9.106b). It seems that after its insertion to the wooden shaft, the point was fastened on it with fibres that left their marks in its proximal part.

Figure 9.104. a.Type II projectile point (A9B.KE295), b.Type III projectile point (A9B.KE292)

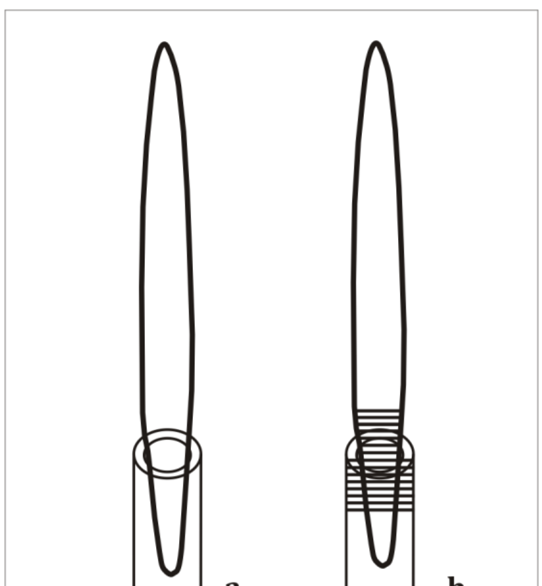


Figure 9.105. Projectile point hafting methods. **a**. Fixing the point into the wooden shaft,
b. Fixing and fastening the point into the wooden shaft (modified after Knecht 2000, fig.12)

Figure 9.106. a. Proximal part of the Type II projectile point, b. Proximal part of the type III projectile point

The fourth type and fifth type consist also of one item. These two rather small points (5.6cm and 6.65 cm respectively) are completed and half preserved. The type IV (catalogue item A9b.KE325) has a mesial part with a rectangular cross section that was shaped through heavy transversal grinding that is converging into an active end with a round cross section. The type V point (catalogue item A9b.KE097) has an oval cross section mesial part. Since the proximal part in both of them is not preserved, it's not possible to identify their hafting method.

The projectile point of the FN/EBA layers (catalogue item A9b.KE315) (fig.9.107a) belongs to the sixth type that differs totally from the previous ones that is already known from the Upper Magdalenian period in Europe (ca.13.500-12.000 BC) (Petillon 2009). This big spearhead (length 14.5cm) was shaped on a tine that was attached to a wooden pointed shaft. The biggest part of the tine was scraped and removed and o nly its distal part was left in order to serve as the penetrating end. The tine was attached to a wooden shaft and was probably fantened with fibers or with a rope in order to be steady. This form is rare in the wider Balkana area as so far there aren't been found any similar items. Bone points with almost similar morphology have been reported from the Arbon Bleiche 3 settlement (Deschler-Erb et al.2002, Abb.70).

The projectile points could have been used in hunting, but we can't exclude the idea that they could have also been used as warfare equipment although until now the excavated settlements of the area don't provide us with evidence of interpersonal violence or more organized conflict between groups or communities.

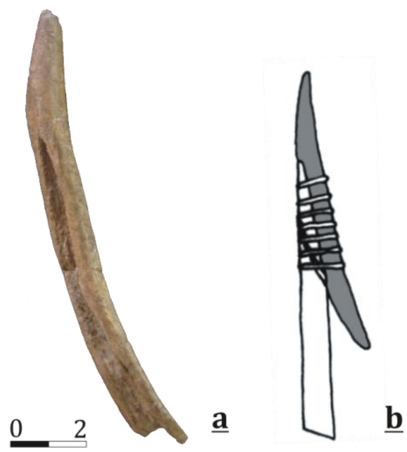


Figure 9.107. a.Projectile point from the FN/EBA layers, b. Possible hafting method (after Petillon 2009, fig.1a)

9.6.1.3. Eating and mixing food equipment

Spoons

The osseous spoons are rare in the Neolithic settlement in Greece (Χατζούδη 2002; Χρηστίδου 1998; Christidou 1999) in contrast with the rest of the Europe and Anatolia where the bone and antler spoons are very well attested (Beldiman 2007; Beldiman and Sztancs 2011; Buitenhuis 2008; Dekker 2014; Erdalkiran 2015; Luik 2011; Makkay 1990; Mărgărit et al. 2016; Nandris 1972; Özdogan 2014, Paul and Erdogu 2017; Sidéra 1998; Tóth 2012; Vitezović, 2011,2016, 2017; Zidarov 2014)

The spoon from Anarghiri IXb is the second antler spoon found so far in Greece as the other one comes from the Neolithic settlement of Arkadikos in Eastern MAcedonia (Χρηστίδου 1998; Christidou 1999). This unique in Western Macedonia spoon is a restored and completely manufactured item that belongs to the Final Neolithic habitation layers of the settlement. It is an elongated piece (18.0 cm) and probably comes from a fallow deer palmate.

It consists of two parts: the bowl and the handle (fig.9.108). The transition from the handle to the bowl is smooth and not so abrupt or distinct like in the bone tools that were found in Serbia and in Anatolia where the distinction between these two parts is very apparent. The rather shallow bowl has an elongated oval shape (10.0 cm x 2.8 cm) and its distal part is slightly curved (fig.9.109). The straight handle (8.0 x 1.7 cm) has a rounded rectangular cross section and a slightly rounded ending.

Figure 9.108. Final Neolithic antler spoon (A9b.KE305)

The blank was extracted through the use of groove and splinter technique. Later the manufacturer removed the spongy issue from the area that was could serve as the bowl part of the spoon and carefully smoothed this inner surface. The handle was created by slight grinding and polish.

The inner side of the bowl bears a lot of manufacture and use wear traces .Grinding traces appear in the transition area from the handle to bowl and only one area of the bowl while the rest of it has high polish. Polish is also observed at the bowl lips especially in the distal part of the bowl.

Figure 9.109. Antler spoon. Detail of the bowl

The lack of antler spoons and bone spoons in the settlement may indicate the use of other raw materials for the shaping of similar items. Clay spoons have already been found in the settlement and perhaps there were used wooden spoons like the one that was found in the nearby Neolithic settlement Limnochori II (Chrysostomou pers.com.).

9.6.1.4. Ornaments

The antler ornaments of the settlement reveal that its inhabitants exploited the antler not only for functional reasons but also for symbolic ones. So far, antler ornaments have been also attested in the lakeside settlements of Dispilio (Υφαντίδης 2006, 2018) and Anarghiri IXa (Arabatzis 2016) that was situated very close to this settlement.

The antler ornaments assemblage of the settlement consists of twenty eight items that are divided into two main types: the pendants, which comprise the biggest part of the assemblage, and the rings. All ornaments are coming from the Final Neolithic layers except from one item that can be ascribed to the upper FN/EBA layers. The pendants have been shaped on tines and on beam segments while the ring have been shaped on tine segments

Pendants

The assemblage contains twenty three pendants. More than half of them have been shaped on beam segments and the rest of them on tines. Most of them are shaped on red deer antler (beam segments and tines) and two items were shaped on roe deer crown. They can be divided into the following types according to their morphology and the raw material. Some of them are represented only by one item that is unique in the area while other types have been also attested in nearby settlements or in the wider area of Western Macedonia.

The type I consists of nine completely manufactured pendants shaped mainly on thin rectangular beam segments that have a suspension hole in one of their endings and are or undecorated (Type Ia, n:4) or decorated (type Ib, n:5) . The raw material for the type I pendants was extracted from the beam by the groove and splinter technique and then was grinded in one of its sides in order to become flat. The perforation of the suspension hole was performed through boring or bow drilling usually in one side of the ornament

The four undecorated Type Ia pendants are completed but only item is totally preserved (fig.9.110a).Their average length, regardless of their preservation status, is 7.17 cm. All suspension holes seem to have round cross section. Three suspension holes are half preserved and only two are totally preserved. These two holes have rather small diametre (0.3 cm and 0.5 cm respectively) and their depth is 0.4cm and 0.7 cm respectively. The half preserved suspension holes have also small diametre (0.50 cm to 1.0cm) and their depth ranges from 0.35 to 0.53cm. In one case the bow drilling was performed from both sides.

The five decorated Type I pendants belong to the Final Neolithic layers. Although all of them are completed items, only one of them is totally preserved (fig.9.110b). It's the biggest type I ornament as its length is 11.3 cm. It has a plano-convex cross section in its mesial and distal part. The suspension hole has a round cross section and its diametre is 0.5 cm. The ornament has incised checkerboard decoration in almost all of its length that was created with the use of thin stone blade (fig.9.111a).The size of the squares is bigger in the proximal part of the pendant and it is reducing towards the distal part.

The rest of the decorated type Ib pendants have diagonial incisions in at least half of their preserved legth (Fig.9.111b). They preserve their proximal (**n: 1**), mesial (**n: 1**), distal part (**n: 1**) or they are almost totally preserved (**n: 1**). The suspension hole is half preserved in two items and in one pendant is not preserved at all. Their average length, regardless of their preservation status, is 7.24cm.

Figure 9.110. a. Undecorated pendant (A9b.KK020), b. Pendant decorated with incisions (A9b.KK001)

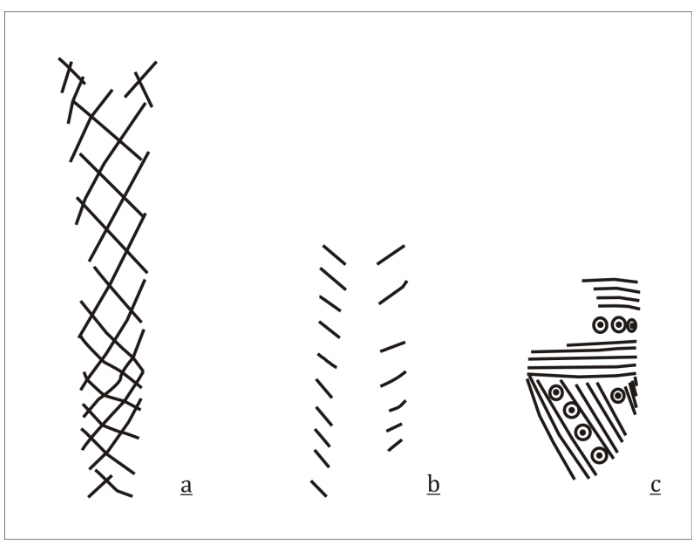


Figure 9.111. a-c. Incised decoration motifs on pendants (not in scale)

Pendants on thin flat beam segments with one shaft hole have also been found in various Swiss Neolithic settlements of the 4th and 3rd mil BC (e.g. Egolzwil 2 Hitzkirch-Seematt, Twann). The majority of them are undecorated and while the others were decorated with dot motif (Gutcher and Suter 1994; Schlenker 1994; Schweichel 2013; Suter 1981; Wey 2001).

The second type consists of two ring shaped pendants that were shaped on beam segments. These items resemble the so called "ring idols" pendants which were shaped on various materials (bone, stone, clay and mainly gold) and they have been found in various Neolithic and Chalcolithic settlements in the Greece and in the Balkans.

In Greece ring shaped idols, shaped on various raw materials, have been found mainly in Thessaly (Theopetra Cave, Pefkakia, Visviki Magoula, Palioskala, Paliomafoules, Dimini, Mandra) and in Macedonia (Anarghiri IXb, Dispilio, Platamonas, Aravissos, Megalo Nisi Galanis, Paliampela, Makriyalos) and less in other regions (Strofila in Andros, Euripides Cave in Salamina, Ftelia in Mykonos) (Alram-Stern and Duraer 2015; Sampson 2002;Televantou 2017; Toufexis 2016; Γραμμένος 1991; Καραμήτρου-Μεντεσίδη 2007a; Κυπαρρίση-Αποστολίκα 2001; Κωτσάκης και Halstead 2004; Μερούσης και Στεφανή 2006; Παππά 1998; Τσούντας 1908; Υφαντίδης 2018; Χρυσοστόμου 2016). In Bulgaria, ring idols have been found as burial offerings in the chalcolithic cemetery of Varna (Todorova 1999; Ivanov and Avramova 2000; Zimmerman 2007) and in Romania in the Cucuteni A settlement of Trusesti in Romania (Dergacev 2002).

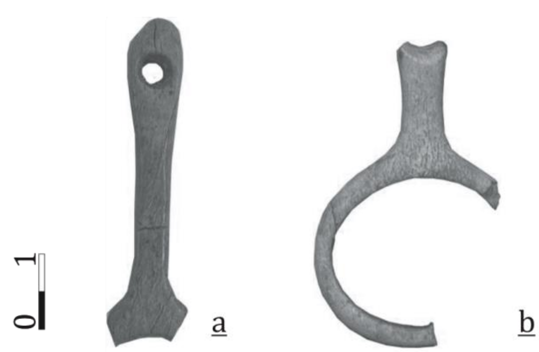


Figure 9.112. Partially preserved antler ring idols (a.A9b.KK023, b.A9b.KK019)

The two Anarghiri IXb antler ring idols (fig.9.112) are partially preserved but it can be inferred that these rings had almost the same morphology as the others that were shaped on other materials. These pendants consist of either two or three parts. The distal part consists of a ring which usually has a round cross section and is being connected to the proximal part, the neck, which is rather thin and oblong. The suspension hole of the pendant was shaped either in the distal end of the neck or in the "head", a protruding part with round cross section on top of the neck. One item (catalogue item A9b.KK023, fig.9.112a) preserves only part of neck with the suspension hole and a small part of the ring. The second item (catalogue item A9b.KK019, fig.9.112b) (height: 3.95cm, width: 2.6cm and thickness: 0.5cm) preserves part of the neck and a big part of the ring which has oval cross section.

The third type of pendants consists of seven items that were shaped on tines. The main characteristic of this type is that the distal part of the tine is decorated with alternating parts of notches and protrusions with round cross sections. The once rounded or pointed tip of the tine was leveled and become a flat surface with round cross section. A closer view of the distal parts and the suspension holes indicates that part of the assemblage consists of recycled harpoon heads. It seems that when the active end of the harpoon head became blunted, its user decided to recycle the raw material and to transform the harpoon head into an ornament. The line hole of the harpoon head was used as the ornaments suspension hole, the blunted tip was transformed into a flat distal part and the once ruffled part of the tine behind the tip, became the base for the gradual transformation of the harpoon head into an ornament with notches and protrusions that could cover the whole length of the distal part of the harpoon head (fig.9.113a-c, fig.9.114a-c, fig.9.116a-f).

The proximal part of the harpoon was cut off so that it won't bother the wearer of the ornament. It is rather interesting that this practice is also attested in the neighboring settlement of Anarghiri III that was inhabited during the 6th and 5th mil BC (fig.9.115) and perhaps it can be related to practical reasons (recycling of material that can't be available at any time or easily obtained) or to symbolic reasons that are unknown to us.

Figure 9.113. a.Harpoon head in the transformation process of becoming an ornament (scale 1:2)(A9B.KK007), b. First stage of the transformation of the blunt tip, c. Broken hole line/suspension hole.

Figure 9.114. a. Harpoon transformed to pendant (A9b.KK008),
b. Detail of the transformed distal part, c. Finished pendant (A9b.KK003)

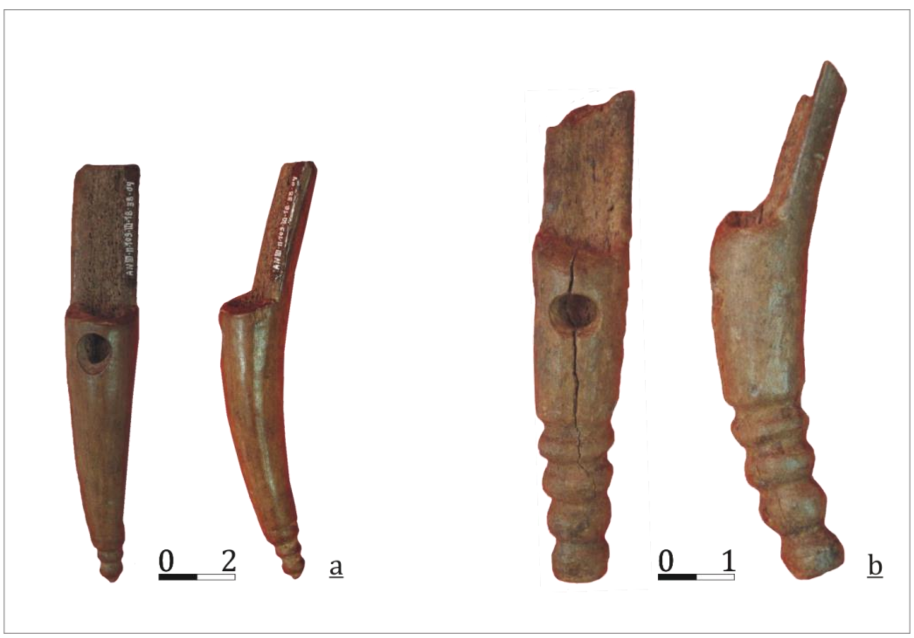


Figure 9.115. Anarghiri III. Pendants from harpoon heads

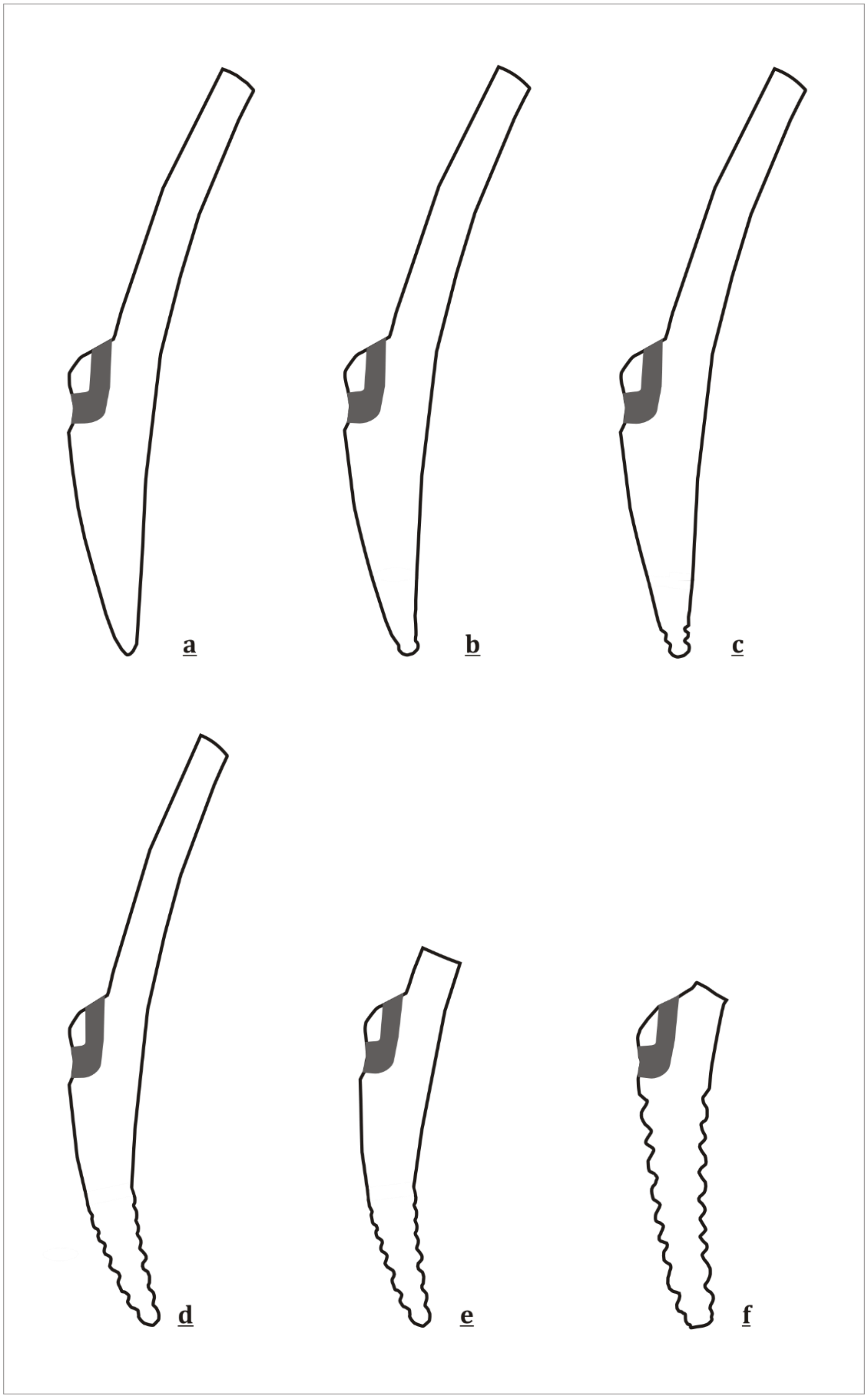


Figure 9.116. a-f. Transformation stages of the harpoon head to pendant (items not in scale)

The fourth type consists of two items. Both of them are shaped on young roe deer crowns and only one is completed. This item (A9b.KK011, length: 8.25cm, fig.9.117a) has a shaft hole shaped on the base of the small crown which was detached by percussion from the rest of the antler. The small crown tines bear high polish and they are rather pointed.

The type V consists of one item (fig.9.117b) that was shaped on a tine segment (length: 10 cm) that was probably detached by percussion from the rest of the antler. The ornament is undecorated but the manufacturer paid attention to the manufacture of the proximal part that was fashioned with abrasion and polishing. The latest technique was applied in the biggest part of the ornament and gave it a polished surface. The shaft hole has round cross section and was drilled from both sides.

The sixth type is represented by a fragment of an ornament (fig.9.117c) that was probably shaped on a tine segment that extracted by groove and splinter techn9.117que and then fashioned by abrasion. The preserved part (length: 3.9 cm) belongs to the proximal part of the ornament which had two small completed suspension holes which are partially preserved. The ornament bears incised decoration in all over its preserved length that can be divided two parts. In the upper part there are two sets of four thin horizontal lines that are interrupted by multiple circle and dot motifs. Right above there are also at least two sets of four thin lines that run diagonially to the longitudinal axis of the pendants that are again interrupted by circle and dot motifs (fig.9.111c).

The type VII consisted of a small size ring with a small protrusion (fig.9.117d) quite similar to the one that belongs in the MN/LN layers of Dispilio (Υφαντίδης 2018, τ.II,150).The diametre of the suspension hole of the Anarghiri IXb item is very small (0.6 cm) therefore this item couldn't be used as a ring as it would be impossible to fit in a finger even in a childs finger therefore it must have been used as a pendant.

Figure 9.117. Pendants. a.Type IV, b.Type V, c.Type VI, d.Type VII (a,b scale 1:2, c,d – scale 1:1)

Rings

The number of the antler rings is rather small (**n: 5**) compared to the nearby settlement of Dispilio where 43 antler rings have been unearthed. The five rings are coming from the Final Neolithic layers. All of them are shaped on tine and they are completely manufactured. Three of them are totally preserved white the other two are partially or half preserved so it's not possible to measure their inner or outer diametre.

The preserved rings present variability in size and shape. One of them has octagonal cross section while the others have almost round cross section. The outer diametre ranges from 1.9cm to 3.5cm**.**

One semi preserved Late Neolithic ring probably was repaired at the final stage of its use. The ring must have been broken sometime during its use and then the user shaped small holes in the fragmented parts in order to join them with a thread that went through the holes. Similar attempts for the reuse of rings have been attested in some stone rings in the late Neolithic layers of Dispilio (Υφαντίδης 2018).

9.6.1.5. Artifacts of undefined function

The assemblage contains twenty eight artifacts which can't be ascribed for sure to any of the above or any other categories. Their preservation (most of them are partially preserved) and their manufacture statues (semi-finished items or partially preserved completed items) doesn't allow for the drawing of definite conclusions so there can be only speculations about their possible use.

Most of them (**n: 25**) belong to Final Neolithic layers and only three items belong to the Late Neolithic phase. All of them are shaped on red deer antler. Eighteen items were shaped on beam segments, eight items on tines and one on basal segment.

In the Late Neolithic belongs a small beam fragment with a hole that could possibly be part of an ornament, a small piece of tine with a hole vertically to its longitudinal axis and a tine tip with a flattened base with round cross section.

Five similar tine tips with flattened base can be attributed to the Final Neolithic layers (fig.9.118). All these tips were extracted by percussion and/or sawing from the rest of the tines and their base was flattened by grinding. The Late Neolithic tine tip differs a lot from the FN ones. Its length is 8.2 cm and the diametre of its base is 2.5cm. It's rather heavy compared to others as it weighs 32.5 gr. The length of the Final Neolithic tine tips ranges from 2.75 cm to 8.2 cm (average length: 4.7cm) and the diametre of the base ranges from 1.2 cm to 2.5 cm (average diametre: 1.6 cm). Their weight ranges from 3.4cm to 8.7 cm. In the FN tine tips there seems to be relationship between the length of the tip and the diametre of its base (table 9.40) but also between the length and the weight of the tip (table 9.41). Since there haven't been found any other items from this part of the tine, we can't be sure if these items were used as in their recovered form or if they are semi-finished items of ornaments like those pendants that were shaped in tine tips in the Swiss lakeside settlements of Arbon Bleiche 3, Twann and Sutz-Lattrigen (Deschler-Erb et al.2002; Suter 1981; Hafner and Suter 2000).

The assemblage that was shaped on beam segments contains fragments of possible polishers, handles of unknown items (spoons?)(fig.9.119a), fragments of thin items with small holes of round cross section (fig.9.119b) that could be weaving tablets or ornaments and fragments of possible ornaments. Moreover, there have been recovered fragments of elongated beam segments of baquette form like those found in French Neolithic lakeside settlements (Maigrot 2003) and fragments of hafted tools with unknown function (fig.9.1119c). The assemblage also contains an item that was shaped on a small antler base. It has a small semi drilled hole and perhaps it's a semi-finished spindle whorl (fig.9.119d).

Figure 9.118. a, b. Tine tips of unknown function with flat base (a. A9b.KE298, b.A9b.KΔ023)

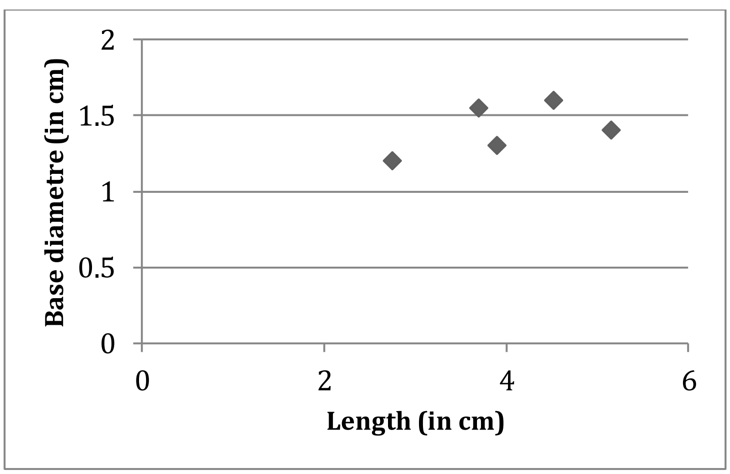


Table 9.40. Tine tips. Relationship between the length and the diametre of the base

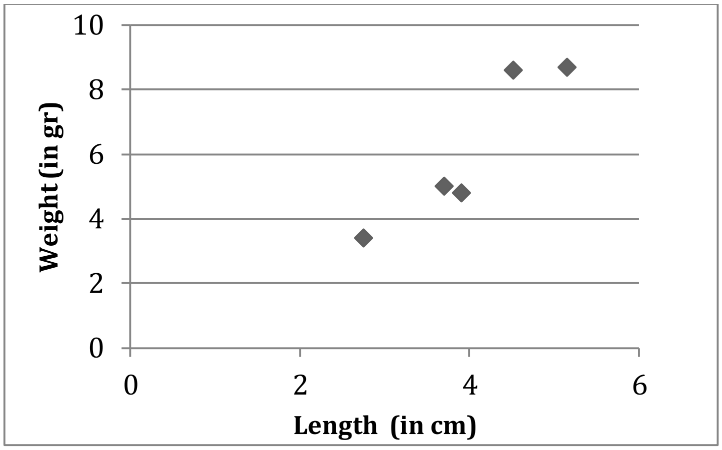


Table 9.41. Tine tips. Length and weight relationship

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Figure 9.119. Fragments of artifacts of undefined function
(a. A9b.KΔ065, b A9b.KΔ016, c. A9B.KE299, d. A9B.KE321)

Two identical, completed but not totally preserved items (fig.9.120), are coming from the Final Neolithic layers and so far they have been only in this settlement. They are shaped on beam T- junction antler and both of them have a hole in the middle (2.5 cm and 2.8 cm respectively) which bears high polish from the manufacture process and probably from its use. These items could have been used as shaft straightners although there is no direct evidence that favors over this opinion.

Figure 9.120. Fragmented item of undefined function (shaft straightner?) (A9b.KE310)

9.6.2. Blanks/Raw material

This category consists of thirty eight antler segments that could have been defined as raw material for the manufacture of various artifacts or they have traces of the preparatory manufacturing stages. It contains items from all antler elements but the most common element of this category is the tine that is followed by the beam and basal segment (table 9.42). The majority of them belong to the Final Neolithic layers and only a few items can be ascribed to the layers of the other habitation phases (table 9.43). The vast majority of them are coming from red deer antler and only one item comes from roe deer antler.

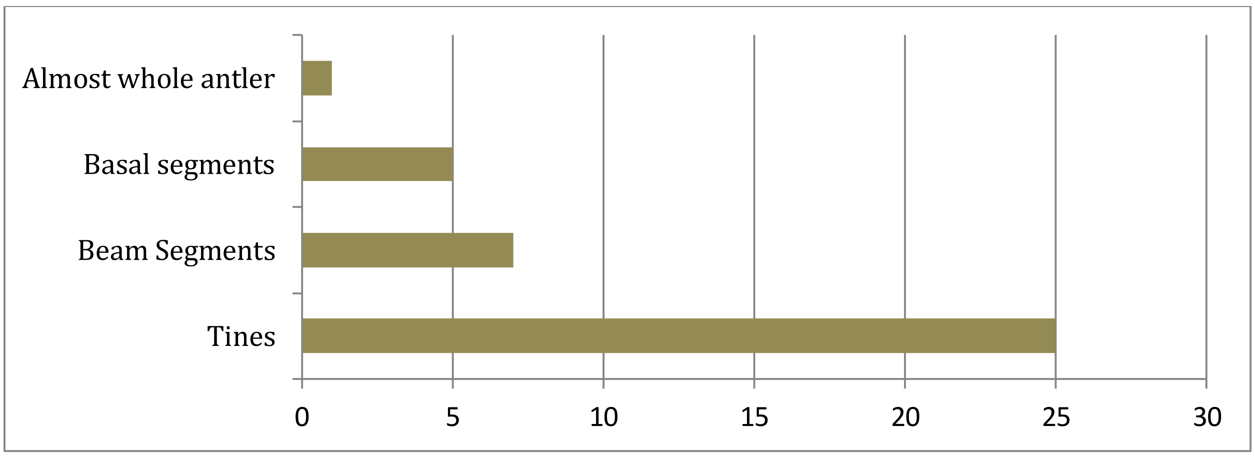

Table 9.42. Raw material of the blanks/raw material

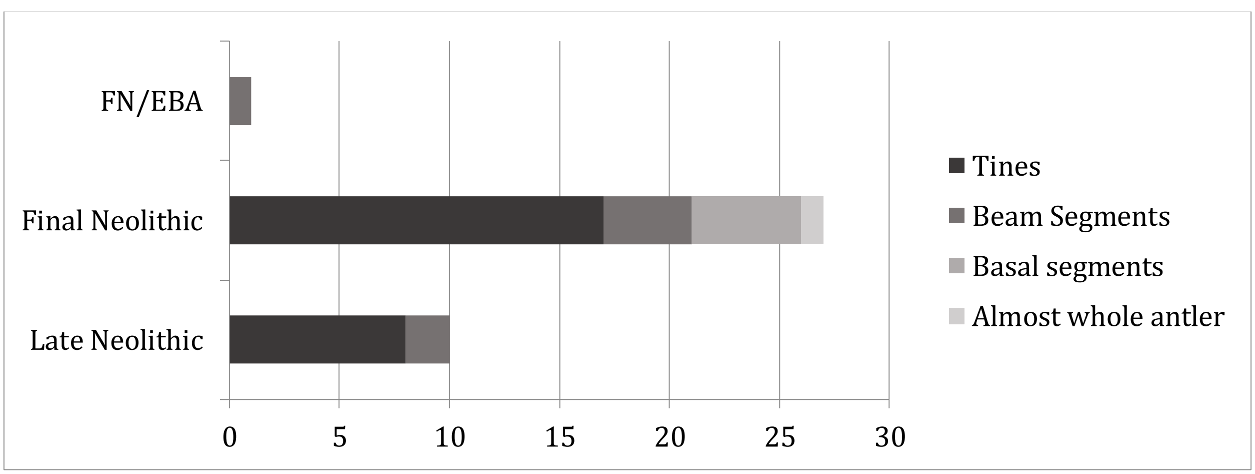

Table 9.43. Blanks/raw material on red deer antler.
Chronological distribution of the blanks per habitation phase

Ten blanks on tines belong to the Late Neolithic phase. Except from one item, the rest of are fully preserved. Their length ranges from 11.2 cm to 38 cm (average length: 19.66 cm). Seven of them were detached from the beam by percussion and/or flexion and in three of them there are also traces of use of the sawing technique.

Most of the blanks of tines (**n: 15**) belong to the Final Neolithic phase. The majority of them are totally preserved. Their length ranges from 4.7cm to 38.0 cm (average length 17.196 cm). They were extracted carefully from the rest of the antler and the majority of them retain traces of the detachment procedure in their proximal parts. The majority of them were detached through percussion and/or flexion breakage (fig.9.121b) and less by combination of other methods such as sawing and flexion breakage (fig.9.121a)

The assemblage contains also one tine which must have been used as raw material for the extraction of rings (fig.9.122).The rings were extracted and shaped from the proximal part of the tine which has bigger diametre compared to the distal part. The use of tines as raw material for the manufacture of rings is not a local innovation as it has also been attested in the phase C (transitional phase from Middle to Late Neolithic) in lakeside settlement of Dispilio (Υφαντίδης 2018).

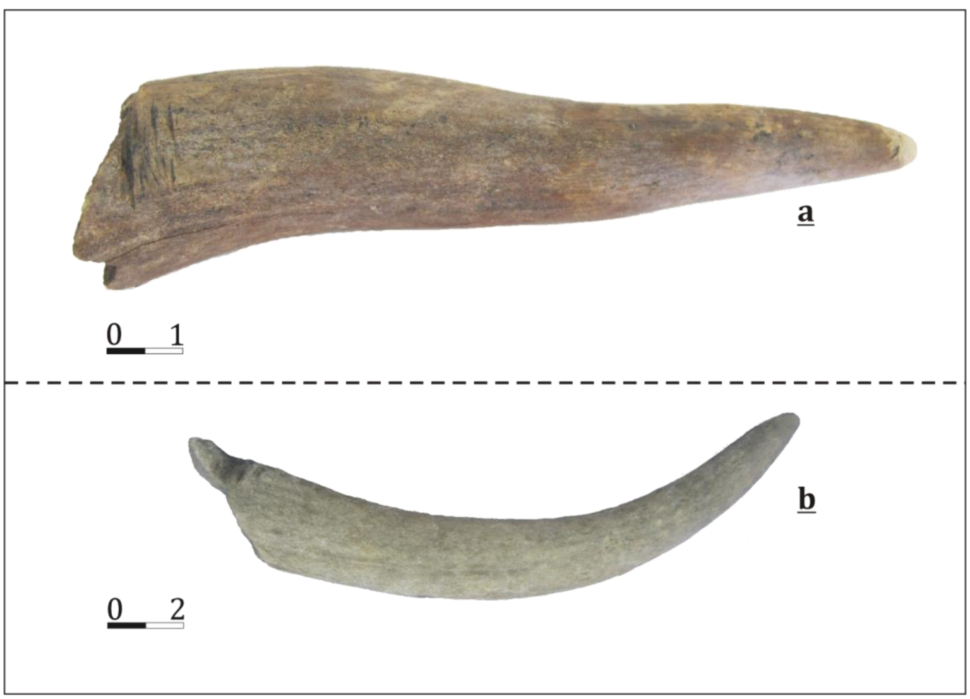

Figure 9.121. Blanks on tines (a. A9b.ΚΔ042, b. A9b.ΚΔ111)

Figure 9.122. a,b.Tine-raw material for the extraction of rings

While the Late Neolithic blanks on beam segments don't provide much information about the manufacture of antler artifacts, the situation changes in the Final Neolithic phase. The Final Neolithic assemblage contains an upper beam segment of a red deer antler which was detached by careful percussion and could have been used as raw material for the extraction of blanks. Beam segments were also used for the extraction of different kind of antler rings. In one case a big upper beam segment was used as raw material for the extraction of thin rings (fig.9.123) which were extracted through the use of sawing technique and in another case a beam segment was transformed into ring blank through percussion.

The five items on basal segments belong to the Final Neolithic layers. Three basal segments (fig.9.124) don't retain any tines as these were either removed carefully or they were cut off more abruptly through the percussion and flexion breakage technique. These three items could be later shaped into sleeves. The remaining two segments retain the first two tines and part of the lower beam which bears traces of the detachment techniques (percussion) (fig.9.125). Both these items could have been used at a later stage for the manufacture of various items.

Figure 9.123. a,b. Raw material for the extraction of rings

Figure 9.124. Blanks on basal segments (a. A9b.KΔ002, b. A9b.KΔ128)

Figure 9.125. Raw material on basal segment (A9b.KΔ089)

9.6.3. Waste

The number of the collected waste items is rather high as the eighty five items represent almost the 17, 41 % of the total studied assemblage. This situation is not unique as the same one can be attested in other prehistoric settlements in Central Europe where the quantity of the waste material is very high and sometimes is more than the completely manufactured items (Deschler-Erb et al. 2002; Kotai 2010; Maigrot 2003; Suter 1981, 2000; Voruz 1997).

This category includes items that they cannot be transformed to finished products either because they were rejected during the manufacturing process or because they are fragments of tools that can't be repaired or recycled. This view of course reflects our own current views and not the ones of the prehistoric inhabitants of the settlement who could use this material for any other task or for the creation of other artifacts.

The existence of the waste inside the settlement indicates that at least some of the manufacturing process was held inside it and that these items weren't rejected totally by the manufacturer or by the owner of the raw material in rubbish pits or in other areas outside of the settlement. This hypothesis is strengthened by the high presence of unworked raw material inside the settlement[1].

The waste material from Anarghiri IXb consists of items from various red deer antler elements. They are shaped on beam segments, T-junctions, crown parts and the rest of them in basal parts and tines (table 9.44). As for their temporal distribution, the majority of the waste can be ascribed to the Final Neolithic where the quantity of these items increases gradually (table 9.45).

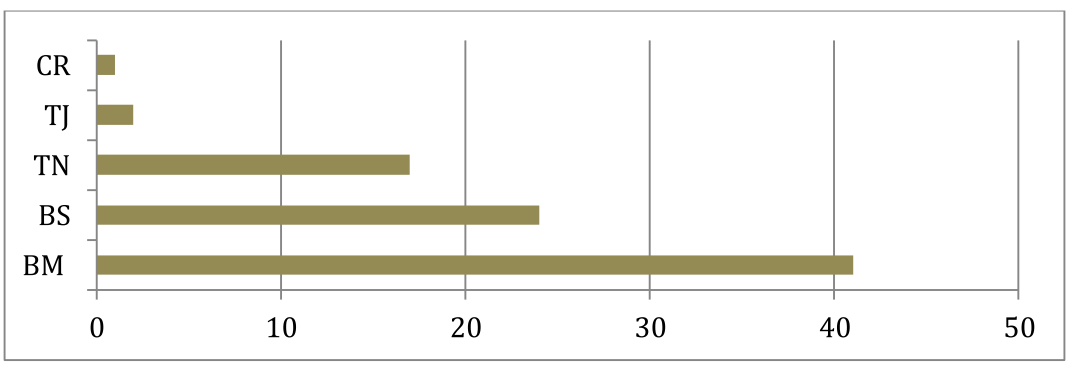

Table 9.44. Waste material per element (BM:beam segments, TN: tines, TJ: T-junction, CR:crown, BS:basal segment). All elements are coming from red deer antler

[1] So far there have been recorded by the author almost 100 kilograms of unworked antler from various areas of the settlement.

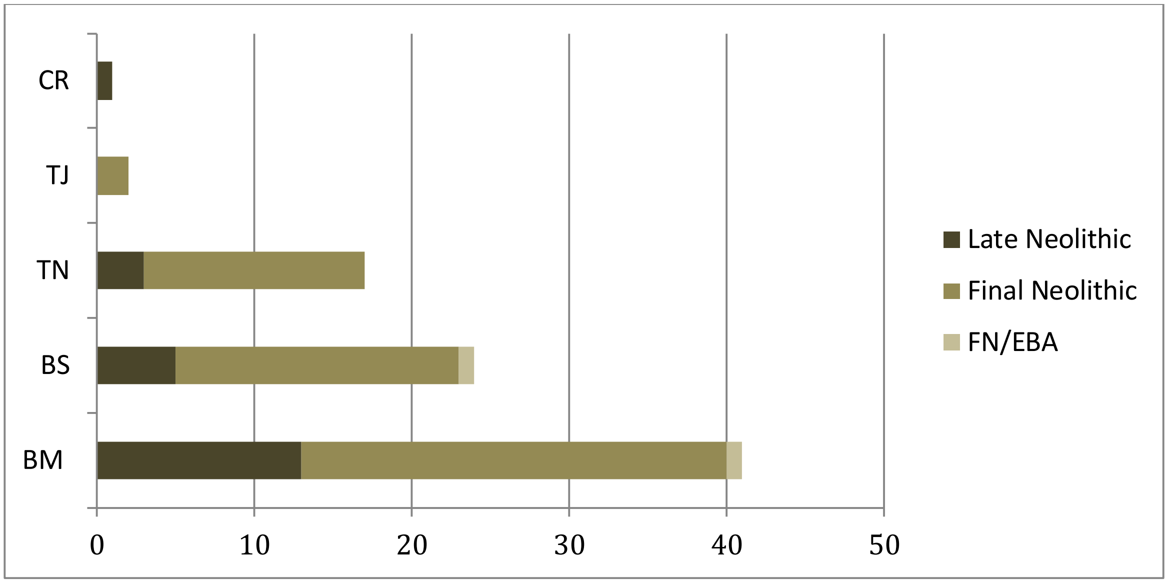

Table 9.45. Red deer antler waste material and its chronological distribution (BM: beam segments, TN: tines, TJ: T-junction, CR: crown, BS: basal segment)

Since the antler working procedure is a reductive process that leaves manufacture traces in the worked material, the waste can give us information about the reduction techniques used in the settlement. A big part of the material, mainly the manufacture debris on basal part, bears manufacture traces of the failed or the successful antler working attempts.

Five waste items on basal part are coming from the Late Neolithic. Four of them are coming from shed and one from unshed antler (Pl.VIII, Pl.IX,). Three of them bear traces of percussion and flexion breakage techniques were used for the detachment of the tines. In one case thermal treatment was used in the base of the tine which facilitated its detachment from the rest of the antler.

In the next phase (Final Neolithic), there are fourteen waste items from shed antler and four from unshed antler. As in the previous phase, most of them bear traces of the techniques that were used for the detachment of the tines. Thirteen items bear traces of percussion and flexion breakage techniques which were used for the detachment of the tines (first and second tine) (fig.9.126, Pl.VIIIa-b). In two cases, the waste retains a big part of the lower beam.

One waste item from basal segment belongs to the upper FN/EBA disturbed layers. It bears traces of the same techniques (percussion and flexion breakage) in the tine area and in its upper/distal part.

Forty one waste items from beam segment have been collected. The majority (**n: 34**) are coming from the upper part of the antler beam (three of them retain the third tine) (Pl.Xb) and the remaining four are coming from the lower part of the beam. Thirteen items can be ascribed to the Late Neolithic habitation phase, twenty seven items to the Final Neolithic and one scrap item belongs to the FN/EBA layers.

The number of the waste items on tines is rather small compared to other elements. Three items are coming from the Late Neolithic and fourteen items are coming from the Final Neolithic phase. Some of them bear percussion traces on their basal parts and the majority of them lack their distal part.

The limited number of the waste on crown (**n: 1**) and T-junction parts (**n: 2**) (Pl.Xa) indicates the limited desire of the manufacturers to exploit these antler parts. This view is also reinforced by the small presence of completed objects from these materials.

Figure 9.126. Final Neolithic waste on basal segment (A9b.ΚΔ033)

Figure 9.127. Waste on basal segments. a.shed antler (A9b.KΔ127), b.unshed antler (A9b.KΔ052)

Chapter 10 - Research results and conclusions

‘A conclusion is the place where you got tired thinking’

Martin H. Fischer

In Charlie Walker, *My Few Wise Words of Wisdom*

10.1. Research results

The analysis of the previous chapter provide us with useful information about the antler exploitation in the 6th and 5th mil BC in the area of Lake Chimaditis in Western Macedonia in Greece concerning the raw material exploitation, the artifacts typology and their use.

As it was stated in previous chapters, the excavation procedure (partially excavated trenches that didn't reach the natural soil in the centre of the settlement) doesn't provide the suitable ground for a constructive comparison between the two main habitation phases of the settlement. Nevertheless, the available data provides interesting information about the antler exploitation in the lakeside settlements in Western Macedonia during the late 6th and 5th mil BC.

10.1.1. Raw material preferences

The vast majority of the assemblage is shaped on red deer antler (98,77 %) whereas roe deer antler and fallow deer antler are slightly attested (1,03 % and 0,2 % respectively). Since the zooarchaeological material has not yet been studied, it is not possible to compare the number of the antler of each deer species with the worked ones. Nevertheless, this great difference in the antler exploitation of these three species could be the result of ecological, practical or symbolic reasons or perhaps a combination of these reasons.

In the case of red deer antler, most of the semi-finished and completed collected items were shaped on tines. The rest of them were shaped on basal segments, on beam segments, on basal and beam segments and on crown parts (table 10.1). The items of roe deer were shaped on crown, on basal and beam segments and in one in an almost whole antler. The only possible item from fallow deer comes from the palmate area of the antler.

In the Late Neolithic layers most of the semi-finished items on red deer are shaped on tines and beam segments and less on basal segments, basal beam segments or crowns. In the next phase the preference over tines is continued but the ratio between this element and the others is almost the same. Also, the quantity of the used crowns and basal and beam segments is almost the same as in the Late Neolithic. Although the quantity ascribed to the upper FN/EBA layers is rather small, the ratio between the various elements is almost similar as to the ones of the previous phases. The tines are the dominant raw material followed by the beam segments and the basal segments (table 10.2).

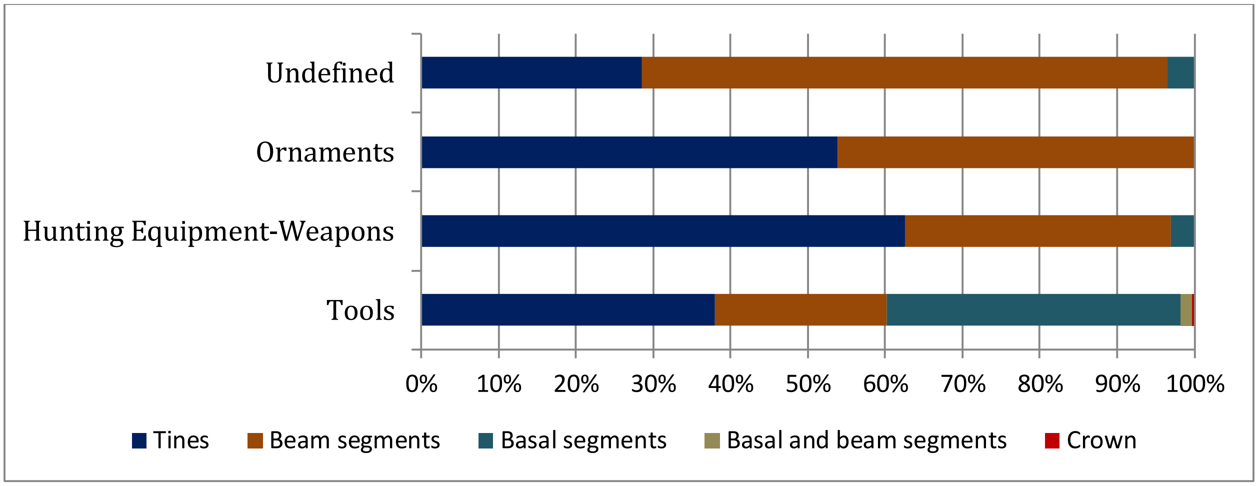

Table 10.1. Semi finished and completed items on red deer antler.
Artifact distribution according to raw material

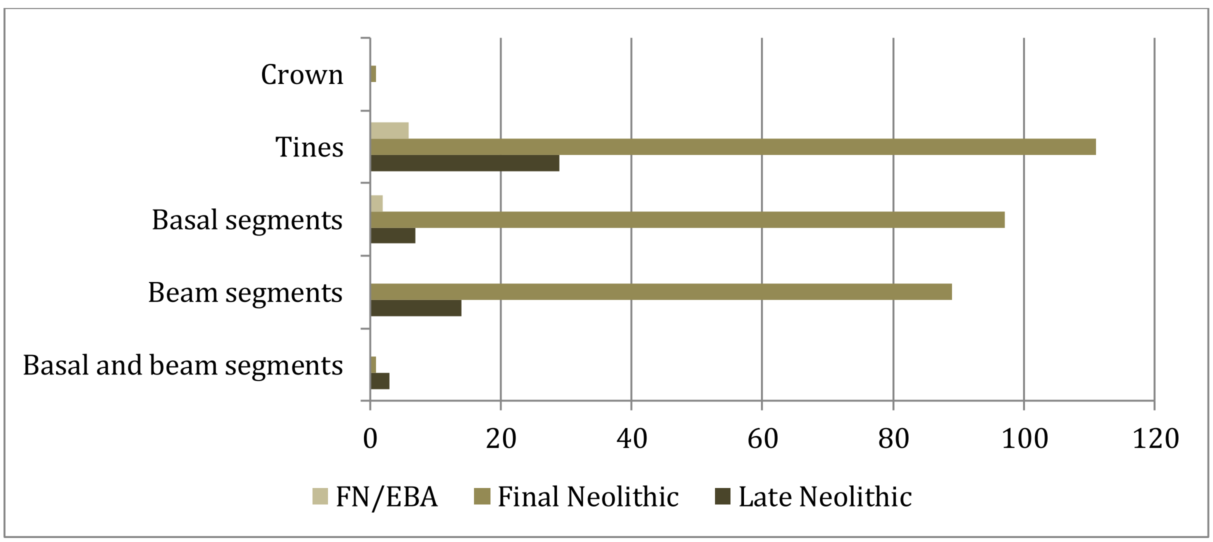

Table 10.2. Semi finished and completed artifacts on red deer.
Chronological distribution according to raw material

The artifacts that were shaped on red deer antler basal segments provide us with useful information about the acquisition mode of the raw material. At least 116 items (blanks, semi/completed items and waste) were shaped on antler that was collected after it was shed and twenty three items were shaped on unshed antler which comes from killed deer. In the Late Neolithic the ratio between unshed and shed items is 1:6.5 while in the Final Neolithic is almost is 1:5 (table 10.3). As the number of the items from shed antler is rather high, it is obvious that the inhabitants of the settlement knew about the deer seasonal antler cast and planned the gathering of this raw material in the settlements vicinity.

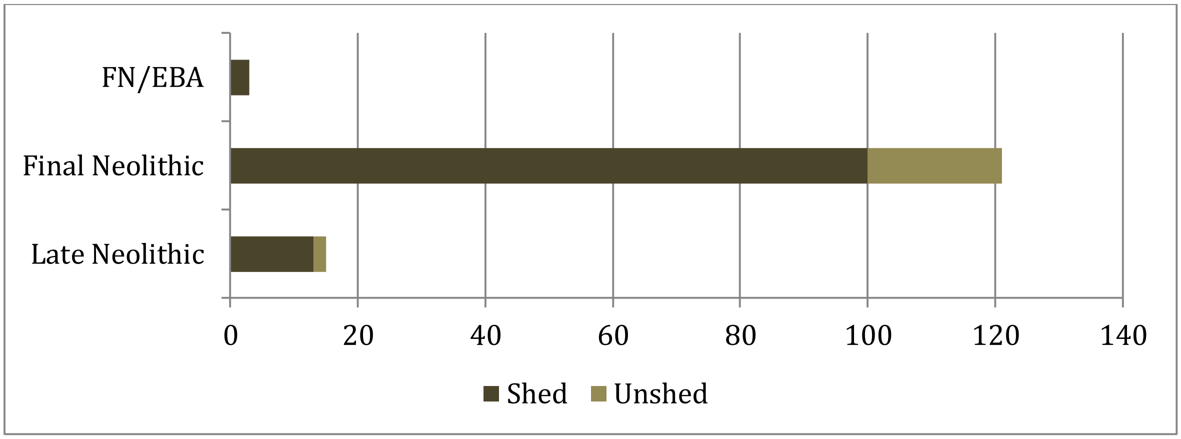

Table 10.3. Chronological distribution of the items on shed and unshed antler

The tines were used mainly for the manufacture of tools and less for the manufacture of ornaments or hunting equipment. In the case of the tools, the tines were exploited mainly for the shaping of handheld tools (bevel ended tools, needles, retouching tools) and less for hafted tools (sleeves, axes, adzes). The tines are the basic raw material for the manufacture of hunting equipment as twenty items were shaped on this material. Moreover, tines were the main raw material for pendants manufacture since most of the ornaments (16/28) were shaped on tines.

The basal segment of the antler was used mainly for the manufacture of tools (sleeves) that were used for tough and demanding activities like woodworking while the items from basal and beam segments are hafted tools (picks and axes) that were used in woodworking and in earth digging.

The beam part of the antler was used in the manufacture of items of various tool categories but mainly for the manufacture of sleeves. Also, it was used for the manufacture of ornaments since almost half of the ornaments (12/28) are shaped on this element.

The small number of artifacts shaped on roe deer antler and fallow deer antler indicates the limited use of this kind of antler. There have been collected only six items shaped on this kind of antlers; one spoon, two bevel ended tools, two pendants and one blank. This limited repertoire, especially the tools one, could indicate the deliberate avoidance of use of roe deer in the manufacture of tools perhards due to the mechanical and physical properties of these antlers (thinner and less robust compared to the red deer antler).

10.1.2. Typologies over time

The three main categories (blanks/raw material, waste and semi/completed items) appear in all three habitation periods. The vast majority of the assemblage (79,92 %) belongs to the Final Neolithic habitation layers and the rest of it mainly to the Late Neolithic habitation layers (17,62 %) and less (2,46 %) to the upper disturbed FN/EBA layers (table 10.4).

A further comparison between the two main habitation periods shows that the 71, 05 % of the blanks, the 82, 74 % of the semi/completed items and the 71,77 % of the waste belongs to the Final Neolithic habitation period while the Late Neolithic habitation period holds the 26,32 % of the blanks, the 14,79 % of the semi/completed items and 25,88 % of the waste (table 10.5).

Chronological period	Percentage
Late Neolithic	17,62 %
Final Neolithic	79,92 %
FN/EBA	2,46 %

Table 10.4. Chronological distribution of the studied material

	Chronological period			
Manufacture state	Late Neolithic	Final Neolithic	FN/EBA	**Total**
Blanks / Raw material	26,32%	71,05	2,63	**100%**
Semi-finished / Completed	14,79%	82,74	2,47	**100%**
Waste	25,88%	71,77	2,35	1**00%**

Table 10.5. Chronological distribution of the artifacts according to their manufacture state

In all phases the majority of the assemblage belongs to the semi-finished/completely manufactured category and less in the other categories. In the Late Neolithic habitation period, the semi-finished/completed artifacts comprise the 62,79 % of the artifacts of this period while in the Final Neolithic this category comprise the 77,44 % of the artifacts. Nearly similar percentages apply for the items of the upper FN/EBA disturbed layers (table 10.6).

The percentage of the other two categories (blanks/raw material and waste) is rather high (11,63 % and 25,58 % respectively) during the Late Neolithic but in the succeeding, Final Neolithic period their percentages are reduced (blanks/raw material: 6,92

%, waste: 15,64 %) (table 10.6) . This change, although it can only be the result of the excavation bias, could also reflect the high technical skills and manufacture standardization that lead to the production of less waste or just the partial cleaning of the waste from the settlement as it has been suggested for other Neolithic settlements of Northern Greece (Arabatzis 2013, Christidou 1994).

		Late Neolithic	Final Neolithic
Manufacture state	Blanks / Raw material	11.63 %	6.92 %
	Semi-finished / Completed	62.79 %	77.44 %
	Waste	25.58 %	15.64 %
	Total	**100%**	**100%**

Table 10.6. Chronological distribution of the three main categories

The high presence of semi-finished, blanks and waste in the settlement indicates that the manufacture of the artifacts or at least a part of it was held inside the settlement. Moreover, according to the results of a preliminary study, unworked antler was also available inside the settlement and it was used according to the needs of the settlements inhabitants[1].

It seems that antler was used mostly for the manufacture of tools and items with practical function and less for items with symbolic function. Most of the semi-finished/completely manufactured items are tools and equipment that could be used in outdoor activities and only a small part of it consists of ornaments or non-utilitarian items

The tools consist the biggest artifact category as 275 tools comprise the 56,35 % of the total assemblage. This category consists of eight distinct tool subcategories that give us indirect evidence about various activities that were taken place inside and outside of the settlement. Only a few tools can be described as ad hoc/expedient tools. The morphology of the majority of the tools indicates that their artisans spent a lot of time and effort for their manufacture. Most of them have been shaped through a manufacturing sequence with at

[1] According to the preliminary study of the unworked antler conducted by the author, more than 50 kgs of antler have been collected during the five excavation seasons

least two or three stages and in each of one the manufacturer had to use at least two techniques.

10.1.3. Craft activities

A great number of tools (**n: 119**) is related with heavy woodworking activities. The sleeves, the axes and the handle consist the 43,43 % of the tool assemblage and 24,39 % of the total studied assemblage. The high percentage of woodworking related tools reveals the intensive wood exploitation which is testified also by the thousands of piles that have been found inside the settlement but also in its periphery (Giagkoulis in press). Most of the woodworking tools belong to the Final Neolithic and the rest of them in the Late Neolithic phase (table 10.7). The manufacture of these tools especially of the axes reveals knowledge of the physical and mechanical properties of certain parts of the tools but also physical and technical skills.

The rest of the tools are related with soil/earthworking activities (1,4 % of the tools), stone tool manufacture (2,55 % of the tools), joining/binding leather or nets (2,55 % of the tools) or with leather working and perhaps bark removing activities (18,25 % of the tools) (table 10.7). Also a big part of the assemblage consists of items whose function cannot be inferred due to their partial preservation.

The study of the chronological distribution of the tool categories provides us with some interesting results. Five out of eight tool categories were present in Late Neolithic and Final Neolithic habitation layers while three of them are appearing for the first time in the Final period habitation layers (table 10.8). The use of the same tool types throughout the habitation periods reveals the existence of the same subsistence needs and of a technological tradition that remained the same throughout the millennia. The appearance of new tool types in the Final Neolithic layers should not be considered as an introduction of new types that reflect different subsistence needs as someone must seriously take into account the whole excavation process that led to the partial excavation of the Late Neolithic habitation layers.

The existence of ornaments reveals the symbolic exploitation of the antler. The assemblage consists of many semi-finished ornaments while the completed ones are far less so it is possible that many of them were shaped inside the settlement or that they were transported inside the settlement if they were shaped outside of it. Since almost all of them belong to the Final Neolithic habitation phase it is not possible to distinguish any special stylistic preferences over time.

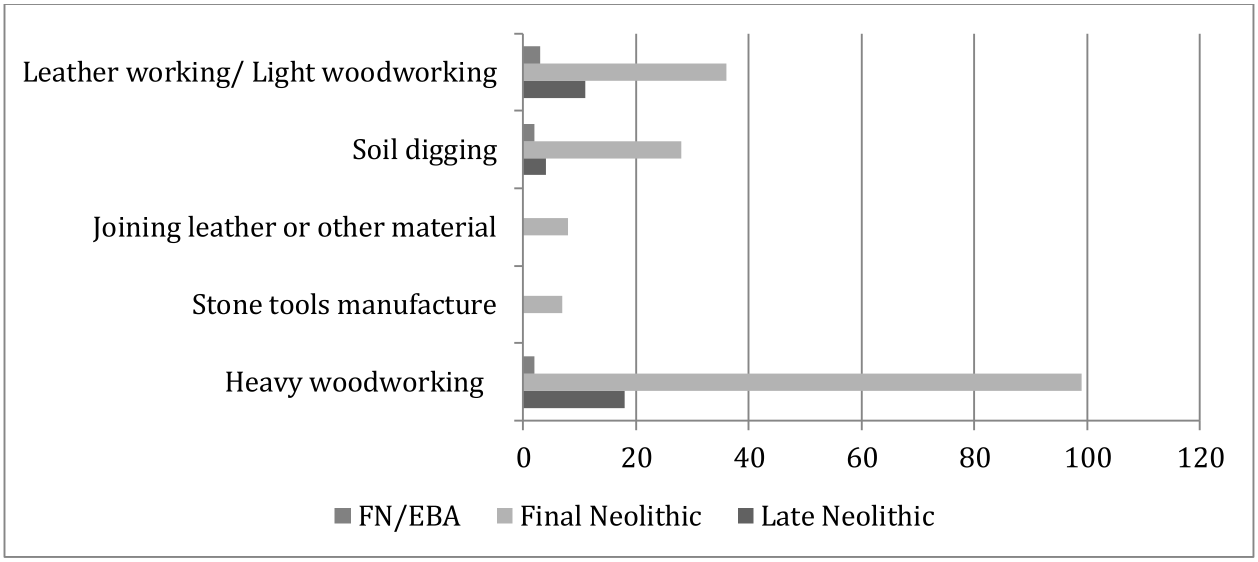

Table 10.7. Chronological distribution of the tools according to their inferred function

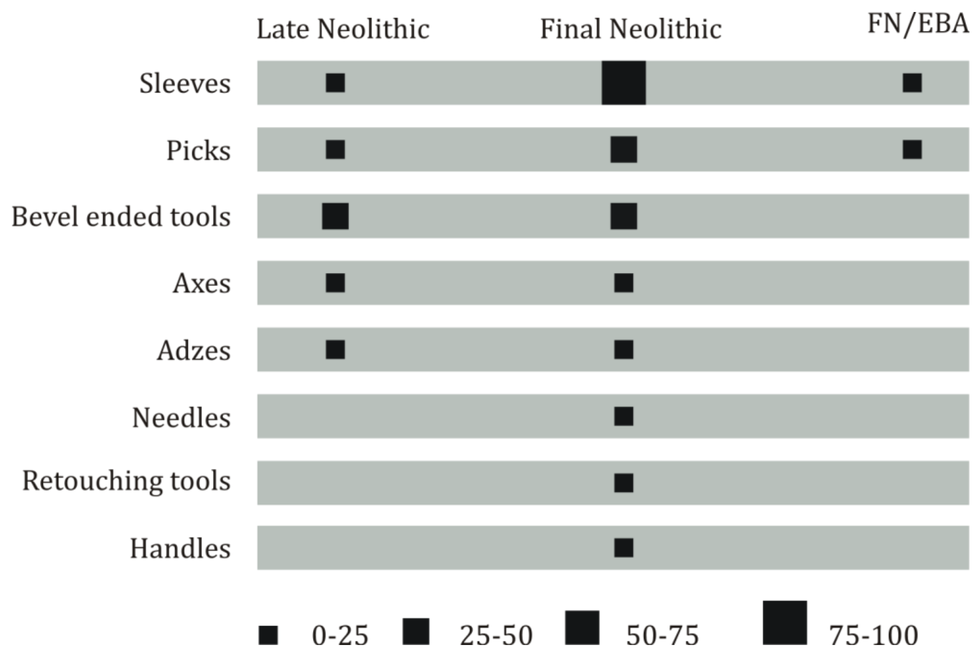

Table 10.8. Chronological distribution of the tool types

Pendants made on antler may have had more than one function except the aesthetic one. These body ornaments could have communicated messages and expressed social identity and prestige within the community. The choice of the raw material and its acquisition mode may have served a symbolic function that could have given some prestige and could have functioned as a trophy to the person that wore this kind of artifacts or the person who killed the game and maybe manufactured the pendants.

One interesting aspect concerning the ornaments is the recycling of the material and the change of use of the items. At least seven pendants (25 % of the ornaments) are coming from harpoons. It seems that their users (or their manufacturers) decided not to discard the non-usable harpoons and to transform them into ornaments. Since this certain raw material is not easily obtained (only after successful hunting or collecting in certain periods of the year), perhaps this action could be based to temporary shortage of raw material or perhaps to symbolic reasons.

The hunting equipment and the weapons are strong indicators about the hunting and fishing activities outside of the settlement. They comprise a toolkit that is characterized by an interesting diversity that is not attested in other Neolithic settlements in Greece since it contains items from at least six different categories: thumb rings, harpoons, harpoon heads and projectile points, mace heads and fish hooks. Except from the thumb rings, all the other categories are attested only in the Final Neolithic habitation phase so it is not possible to distinguish any stylistical variability between the two main habitation phases for the rest of the equipment. As for the thumb rings, the two types present chronological variation since only one of them is attested in both main phases while type II is attested only in the Final Neolithic phase.

10.1.4. The Anarghiri IXb assemblage in the wider region

In this subchapter there will be an attempt to compare the Anarghiri IXb assemblage with others from Northern Greece. Such an attempt is limited due to three interconnecting factors: the small number of LN and FN settlements that could provide comparable material, the small number of publications concerning Neolithic antler industries and finally the small quantity of the so far studied assemblages (table 10.9).

In the region of Western Macedonia, reports about comparable worked antler assemblges and antler working are coming from one dryland settlement and two lakeside settlements (Megalo Nisi Galanis, Dispilio and Anarghiri IXa). The comparison of these assemblages to the one of Anarghiri IXb is not without any problems.

The assemblage from the neighboring lakeside settlement of Anarghiri IXa, contains less than ten antler artifacts, mainly axes and projectile points (Arabatzis 2016). Although these artifact types from Anarghiri IXa resemble to the ones from Anarghiri IXb settlement, the problem lies in their attribution to stratigraphic layers. Due to the lack of data concerning the stratigraphy of the settlement, the osseous artifacts from Anarghiri IXa have been studied diachronically (ibid.) therefore any comparison between this assemblage and the one from Anarghiri IXb could not provide any useful information.

Western Macedonia			
Settlement	**Chronology**	**Quantity**	**Reference**
Anarghiri IXb	LN-FN	488	-
Anarghiri IXa	LN-FN	6	Arabatzis 2016
Dispilio (antler tools)	MN-LN	Not specified	Στρατούλη 2002
Dispilio (antler ornaments)	MN-LN	57	Υφαντίδης 2006, 2017
Megalo Nisi Galanis	LN-FN	15	Christidou 1999

Central Macedonia			
Settlement	**Chronology**	**Quantity**	**Reference**
Thermi	MN-LN	12	Christidou 1999
Stavroupoli	LN	20	Χατζούδη 2002
Nea Nikomideia	EN	1	Stratouli 1998a
Makriyalos	LN	200 (?)	Isaakidou 2003
Servia	MN-LN	5	Stratouli 1998a

Eastern Macedonia			
Settlement	**Chronology**	**Quantity**	**Reference**
Dikili Tash	MN-FN	3	Sériadès 1992
Dikili Tash	MN-FN	35	Christidou 1999
Sitagroi I-III	MN-EBA	90	Christidou 1999
Sitagroi	MN-EBA	161	Elster 2001, 2003
Arkadikos Dramas	FN	19 / 18	Χρηστίδου 1998 / Christidou 1999

Thrace			
Settlement	**Chronology**	**Quantity**	**Reference**
Proskinites	MN-LN	2	Αραμπατζής 2006

Table 10.9. Quantity of antler artifacts from Neolithic settlements from Northern Greece

The brief preliminary report of the bone and antler artifacts from Dispilio (Στρατούλη 2002) is rather interesting but not so useful in this comparison. Stratouli mentions the presence of some tool types similar to those from Anarghiri IXb (fish hooks, bevel ended tools on tines, hafted tools on beam segments or on tines) and of antler manufacture waste but fails to mention the number of artifacts of each category and more importantly didn't attribute them into the habitation phases of the settlement.

The antler ornaments (**n: 57**) of Dispilio were treated in a recent PhD thesis related to the settlement's ornaments (Υφαντίδης 2018). The thesis provides interesting data about the antler exploitation and the personal ornaments manufacture since the assemblage contains (thumb) rings, pendants, belt hooks, beads and pins. Thirty four ornaments are coming from the third phase (Γ) which belongs to the transitional period between the Middle and Late Neolithic, eleven are related to the second phase (B) which belongs to the Late Neolithic I period and the rest of them (**n: 12**) can't be attributed to any habitation phase.

The comparison between the ornaments of Anarghiri IXb and Dispilio is rather impossible since most of the Dispilio material is dated to the Middle/Late Neolithic period while the Anarghiri IXb ornaments belong mainly to Final Neolithic habitation layers. However, the Dispilio assemblage provides useful data about the earliest so far manufacture of antler (thumb) rings. The Middle/Late Neolithic Dispilio (thumb) rings seems to be the earliest so antler rings in Greece and in the Balkans and their typological category is rather different from the FN ones that have been found in Anarghiri IXb.

The Final Neolithic settlement of Megalo Nisi Galanis provides a small worked antler assemblage (Christidou 1999) which was treated more technologically and less typologically. Christidou mentions fifteen worked antler items from the FN phase and according to her study, the Neolithic artisans deployed techniques such as the percussion and sawing on beam segments and on tines that were also used in the Anarghiri IXb settlement.

Except from one case (Stavroupoli Thessalonikis), the studied worked antler assemblages from Central Macedonia don't provide useful information concerning antler use due to their small quantity (Christidou 1997,1999) and the lack of comparable data

The small rescue excavation in the Late Neolithic settlement of Stavroupoli in Thessaloniki unearthed twenty (20) antler artifacts (Χατζούδη 2002). In her small report regarding the antler artifacts, the researcher reports the presence of some categories that existed also in Anarghiri IXb such as pointed tools, chiseld and manufacture waste but there is no mention to the quantity of these items. She also reports some items decorated with incisions and an animal shaped figurine, which is rather unique as so far there haven't been reported similar items from any Neolithic settlement in Greece.

The excavation in the Late Neolithic settlement of Makriyalos unearthed almost 200 antler artifacts (Isaakidou 2003:234). Although the quantity is quite big, the researcher chose not to provide details about the worked antler assemblage therefore any comparison to this material is not possible

In the Eastern part of Macedonia, the biggest comparable assemblages are coming from the settlement of Dikili Tash and Sitagroi. The Sitagroi assemblage was studied by Christidou (Christidou 1999) and Elster (Elster 2001, 2003). Christidou approached the assemblage from a technological point of view while Elster tried to provide a useful typology. Elster mentions 161 artifacts which can be attributed to the various habitation phases of the settlement. According to the excavators (Renfrew and Elster 2003), the first two phases (I and II) belongs to the Middle Neolithic, the third phase (III) in the Chalcolithic and the fourth phase and the fifth (IV) in the Early Bronze Age. They define the second phase as a Middle Neolithic phase although the dates that they provide (5200-4900 BC) could place this phase in the Late Neolithic period (cf table 5.1). Having that in mind, the only comparable material from this settlement comes from the third phase which belongs to the Chalcolithic period, which as has been described in chapter 5 is the equivalent of the Final Neolithic in Northern Greece. Sixty three antler artifacts belong to this phase (Elster 2003). The assemblage contains some tool types that are also attested in the Anarghiri IXb assemblage (chisel ended tools, perforated tines, round ended tools, shaft holed tools) and some worked antler items of unknown function (Elster 2001, 2003).

Antler artifacts have been also reported from the Neolithic settlement of Dikili Tash, which was inhabited from the Early Neolithic to the Early Bronze Age with a hiatus in the 5th mil BC (Darcque et al.2014). The bone and antler artifacts have been studied by Séfériadès (1992) and Christidou (1999) who at that time studied the artifacts from the Middle Neolithic (Dikili Tash I) and Chalcolithic layers (Dikili Tash II). Séfériadès provided a comprehensive and comparable typology and he reported only three antler tools from the Chalcolithic/Final Neolithic phase (Dikili Tash II); two sleeves shaped on basal and beam segment and one pick (Séfériadès 1992:109). On the other hand, Christidou, through a detailed technological analysis, gave useful insights about the manufacture of the artifacts and mentioned thirty five antler artifacts (Christidou 1999:212) from the Dikili Tash II phase. Seven were shaped on beam segment, 12 on tines and 16 on undetermined element. The biggest part of the assemblage consists of waste and undefined items. It also contains six blanks shaped on tines. Antler was cut mainly transversally and there are also traces of sawing and percussion in many of the antler segments.

As it is obvious from the above brief presentation of worked antler assemblages from other Neolithic settlements from Northern Greece, the Anarghiri IXb worked antler assemblage is the biggest so far LN and FN studied assemblage. Moreover, while the worked antler industry of Anarghiri IXb is characterized by typological diversity, the assemblages of the above aforementioned settlements are characterized by limited antler exploitation. This is reflected mainly both in the tool and ornaments typologies. In most of the settlements, the tool repertoire contains only chisel/bevel ended tools, a few picks and in a few cases a small number of intermediate tools. On the other hand, the Anarghiri IXb assemblage contains eight tool categories and most of the tools are intermediate tools whose presence reveals extensive woodworking activity mainly in the Final Neolithic habitation phases.In the case of the ornaments, except from the Dispilio assemblage and a few decorated items from the settlement of Stavroupoli in Thessaloniki, in the rest of the settlements there haven't been any found any ornaments so in this case it is also impossible to compare the assemblage to others.

10.2. Conclusion

Concluding, through a thorough analysis of the assemblage, it was possible to identify the raw material preferences and to establish a typology concerning the antler artifacts of the settlement from the end of the 6th mil BC to the end of the 5th mil BC.

The worked antler assemblage of Anarghiri IXb is characterized by the dominance of artifacts shaped on red deer antler. Roe deer and fallow deer antler were used rarely and the reasons behind this preference could be related to the availability of the raw material and to its mechanical and physical properties although we can exclude any cultural preferences over red deer antler.

The assemblage is characterized by typological diversity that is not encountered in any other Neolithic settlement in Greece. Some of the typological groups can be found in other more or less contemporary settlements in Greece and in the Balkans but the Anarghiri IXb assemblage is so far the most diversified worked antler assemblage in in Greece and in the Balkans.

It seems that the antler working was adjusted to the needs (practical and symbolic) of inhabitants of the settlement. Tools comprise the majority of the collected artifacts and the toolkit contains tools related to woodworking activities, leatherworking activities (joining or scraping), agricultural activities and in the manufacture of stone tools. In both habitation phases (Late and Final Neolithic) the expedient tools are rather few and most of the tools were shaped after a series of carefully planned steps with a wide array of techniques that were deployed by skillful artisans.

At the same time, the typological scheme contains fishing and hunting equipment which indicates the exploitation of terrestrial and marine resources and ornaments revealing at the same time the non-functional exploitation of the raw material but a symbolic one. Antler must have been a special prized and valued raw material since some of the ornaments are recycled items. The harpoons were not thrown away but they were transformed into pendant revealing a symbolic connection between the raw material and the manufacturer/user of the harpoon and at the same time revealing a change in the use of the item, from practical to symbolic one.

The typological repertoire of the settlement, especially the toolkit, contains a few typological groups that with some, more or less contemporary, Neolithic sites in Greece but also in the rest of the Balkans where there have been found some similar types, such as harpoons, chisels and hammers.

The big quantity of blanks and waste indicate that the raw material was transported and processed into artifacts in site. Antler procurement could be a by-product of the deer carcass acquisition or result of a well-planned strategy of collecting shed antler after their cast in spring.

10.3. Future research strategies

There are a number of potential ways to develop this research in order to to advance our understanding concerning the antler technology of the prehistoric lakeside settlement Anarghiri IXB and the rest of the prehistoric lakeside settlements of the Four Lakes Region.

Although this study tried to present the manufacturing techniques and the use wear traces of the tools, there was no attempt for an experimental approach of this numerous artifact category. Future experimental approach of the assemblage and the comparison between the experimental and archaeological tools could enrich our knowledge about the deployed techniques and give us useful insight about the biographies of the antler artifacts.

The study of the spatial organization of the settlement which requires further investigation, could provide valuable data. The spatial distribution of the artifacts in combination with their chronological distribution could help us to define the antler working areas or the waste discard areas of the settlement throughout the settlements' habitation phases.

Since this settlement forms part of a cluster of lakeside settlements of the wider area that could include Lake Orestias and the settlement of Dispilio, one of the future research works would be the study and analysis of the antler assemblages of these settlements. Through this regional analysis it would be possible to create a comparable typological scheme of the antler artifacts of the wetland sites of Western Macedonia.

References

Adams, A.W.1982. Migration. In: Thomas, J.W. and Toweill, D.E (eds.), *Elk of North America: Ecology and Management.* Stackpole Books: Harrisburg, PA: 301- 321

Adams, W.Y.2010. Classification and typology,Encyclopedia of Archaeology, Vol.I,https://www.eolss.net/sample-chapters/C04/E6-21-01-05.pdf Last accessed : 09/08/2016

Adams, W.Y. and Adams, E.W.1991. *Archaeological typology and practical reality: a dialectical approach to artifact classification and sorting,* Cambridge: Cambridge University Press.

Aimar, A., Cilli,C.,Giacobini, G. and Malerba, G.1998. Scanning Electron Microscopy and Bone Surface Modification: A Contribution to the Study of Anthropic Actions on Animal Hard Tissues from Archeological Sites. In: Guarino, A . (ed.), *Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin*, Rome and Paris: CNR and CNRS: 1437-1443

Alram-Stern, E. and Dousougli-Zachos, A. (eds.) 2015.*Die Deutschen Ausgrabungen 1941 auf der Visviki-Magula/Velestino. Die Neolithischen Befunde und Funde*, Beiträge zur Ur-und Frühgeschichtlichen Archäologie des Mittelmeer-Kulturaaumes, Band 36, Dr. Rudollf Habelt Gmbh, Bonn.

Alram-Stern, E. and Durauer, C.2015.Die statuette,In:*Die Deutschen Ausgrabungen 1941 auf der Visviki-Magula/Velestino. Die Neolithischen Befunde und Funde*, Beiträge zur Ur-und Frühgeschichtlichen Archäologie des Mittelmeer-Kulturaaumes, Band 36, Dr. Rudollf Habelt Gmbh, Bonn: 439-443

Altamirano, G.M.2013. Bronze Age Bone and Antler Working: the Osseous Assemblage from Motilla del Azuer (Daimiel, Ciudad Real, Spain), Revista de Prehistoria de Andalucía 4:173-185

Andreou, S., M. Fotiadis and K. Kotsakis.2001. The Neolithic and Bronze Age of Northern Greece. In: Cullen, T. (ed.), *Aegean Prehistory, A review*, Boston, Archaeological Institute of America: 259-327

Appadurai, A. (ed.).1988.*The social life of things.Commodities in cultural perspective*, University of Pennsylvania

Arabatzis, C. 2013.The bone tools from the Neolithic settlement of Proskinites. In Lang, F. (ed.)*, The Sound of Bones, Proceedings of the 8th Meeting of the ICAZ Worked Bone Research Group in Salzburg 2011*, Austria, ARCHAEOPlus, p.33-39

Arabatzis, C. 2016a.Bone industry from the prehistoric settlement Anarghiroi IXa, Greece', In: Vitezovic, S. (ed.), *Close to the bone: current studies in bone technologies. Proceedings of the 10th Meeting of the ICAZ Worked Bone Research Group,* Institute of Archaeology, Belgrade, p.19-27

Arabatzis, C. 2016b. Preliminary *data about the bone, teeth and antler artifacts from the prehistoric wetland settlements of Amindeon, Western Macedonia, Greece'*. Paper presented on 15.05.2016 in the NEENAWA International Scientific Meeting 'Prehistoric Wetlands and Lakes: bringing forward dendrochronology in archaeology' 11/05-17/05/2016, Ohrid

Arabatzis, C. 2017. *'Worked bone from the prehistoric lakeside settlements of Amindeon, Western Macedonia, Greece: first data from the settlement Anarghiri IXb'*. Paper presented on 13.12.2017 in the "Neolithic in Macedonia III" archaeological meeting, Skopje, F.Y.R.O.M.

Arabatzis, C. 2018. *'Bone and Antler Exploitation in the Prehistoric Lakeside Settlements of Western Macedonia, Greece: First data from the settlement Anarghiri IXb'*. Paper presented in the workshop 'Southeast European and Swiss Network in Wetland Archaeology', 02.05.18-04.05.2018, Institute of Archaeological Sciences, University of Bern, Switzerland

Aslanis, I. 1989. Das Neolithikum und das Chalkolithikum im Nordgriechische Raum, In: *Teil Karanovo und das Balkan-Neolithikum. Gesammelte Beiträge zum Internationalen Kolloquium in Salzburg, 20-22 Oktober 1988,* Institut für Klassische Archäologie der Universität Salzburg: 65-81

Aslanis, I. 1997. Die Dimini-Keramik in Westmakedonien, Griechenland Zeugnis kultureller Ausstrahlung, Spuren von Handelsbeziehungen oder Ergebnis einer Kolonisation?" in *Chronos: Beiträge zur prähistorischen Archäologie zwischen Nord- und Südosteuropa: Festschrift für Bernhard Hänsel*, Espelkamp: Verlag Marie Leidorf GmbH: 83-89

Aslanis, I. 2004. Das späte Neolithikum und das beginnende Chalkolithikum in Westmakedonien, Griechenland. Ihre stratigraphische Abfolge. In: *Zwischen Karpaten und Ägäis: Neolithikum und ältere Bronzezeit: Gedenkschrift für Viera Němejcová-Pavúková*, Rahden/Westf: Verlag Marie Leidorf: 39-46

Audouze, F. 2002.Leroi-Gourhan, a Philosopher of Technique and Evolution, *Journal of Archaeological Research*, Vol. 10(4): 277-306

Averbouh, A. 2000.Technologie de la matiere osseuse travaillee et implications palethnologiques (These de doctorat). Universite de Paris I

Averbouh, A. 2001.Methodological Specifics of the Techno-Economic Analysis of Worked Bone and Antler: Mental Refitting and Methods of Application. in: Choyke, A. M. amd Bartosiewicz, L. (eds.): *Crafting Bone: Skeletal Technologies through Time and Space,* Proceedings of the 2nd meeting of the (ICAZ) Worked Bone Research Group Budapest, 31 August – 5 September 1999, British Archaeological Reports International Series 937: 111-121

Averbouh, A. and Bodu, P., 2002. Fiche percuteur sur partie basilaire de bois de cervide. In: Patou-Mathis, M. (Ed.), *Fiche typologique de l'industrie osseuse prehistorique, Cahier X, compresseurs, percuteurs, retouchoirs…Os a impression et eraillures*. Commission de nomenclature sur l'industrie de l'os prehistorique, Paris: 117 -131

Averbouh A. and Pétillon, J.M. 2011.Identification of "debitage by fracturation" on reindeer antler: case study of the Badegoulian levels at the Cuzoul de Vers (Lot, France). In: Justyna, B. and Kufel-Diakowska, B. (eds.), *Written in Bones. Studies on technological and social contexts of past faunal skeletal remains*, Uniwersytet Wrocławki, Instytut Archeologii, Wroclaw: 41-51

Bačkalov, A.1979.*Predmeti od kosti i roga u preneolitu i neolitu Srbije,* Archaeologia Iugoslavica. Fontes archaeologiae Iugoslaviae, t.2 , Beograd

Bailey, D.W.2000.*Balkan Prehistory. Exclusion, incorporation and identity*. Routledge

Barge, H. 1982. Les parures du Néolithique ancien au début de l'Age des Métaux en Languedoc, Éd. du CNRS

Baumann, M. and Maury, S.2013. Ideas no longer written in antler, *Journal of Archaeological Science* 40:601-614

Beldiman, C. 2005. Paleotechnology of antler working in the Mesolithic of the Iron Gates, Romania. In: Luik, H., Choyke, A., Batey, C., Lougas, L. (eds.), *From Hooves to Horns, from Mollusc to Mammoth. Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present*, Proceedings of the 4th Meeting of the ICAZ Worked Bone Research Group at Tallinn, 26th-31st of August 2003. Tallinn, Book Printers, Muinasaja teadus 15, Talinn: 33-46

Beldiman, C.2007. *Industria materiilor dure animale în preistoria României. Resurse naturale, comunităţi umane şi tehnologie din paleoliticul superior până în neoliticul timpuriu.*Asociaţia Română de Arheologie, Studii de Preistorie, Supplementum 2, Ed. Pro Universitaria, Bucureşti,

Beldiman C. and Sztancs, D.-M., 2011. Technology of skeletal materials of the Starcevo-Cris Culture in Romania. In S. A.Luca, C. Suciu (eds.), *The First Neolithic Sites in Central/ South-*

East European Transect, vol II: Early Neolithic (Starcevo-Cris) Sites on the Territory of Romania. British Archaeological Reports IS 2188., Archaeopress,O xford: 57–70

Beldiman, C, Bărbat, I.-A. and Sztancs, D.-M. 2012. Bone and antler artefacts dated from Early Neolithic discovered recently in South-Western Transylvania, Romania, *Annales d'Université Valahia Targoviste, Section d'Archeologie et d'Histoire*, Tome XIV, Numéro 1:43-57

Beugnier, V. and Maigrot, Y. 2005. La fonction des outillages en matières dures animales et en silex au Néolithique final. Le cas des sites littoraux des lacs de Chalain et Clairvaux (IIIème millénaire av.J.-C., Jura, France). *Bulletin de la Société Préhistorique Française* 102 (2):335-344

Biewener, A.A. and Bertram, J.E.A 1991. Efficiency and optimization in the design of skeletal support systems. In: Blake, R.W.(ed.), *Efficiency and Economy in Animal Physiology,* Cambridge: Cambridge University Press: 65-82

Billamboz, A. 1977. L'industrie en bois de cerf de Franche Comté au Néolithique et au début de l'Age du Bronze, *Gallia préhistoire*, 20(1): 91–176

Billamboz, A. 1982. *L'industrie en bois de cervidés de la station littorale d'Auvernier-Port (Suisse NE). Essai d'étude synoptique*. Thèse de doctorat, Université de Franche Comté.

Billamboz, A. and Schlichtherle, H. 1982. La mise à profit de la ramure dans l'industrie sur bois de cervidés d'Auvernier-Port et d'Auvernier-Brise- Lames (NE, Suisse).In: Camps-Fabrer, H.(ed), *Industrie de l'os néolithique et de l'Age des Métaux (2)*, Paris: CNRS: 60–76

Billamboz, A. and Schlichtherle, H.1983.Neolithische hirschgeweih-Zwischenfutter in Südwestdeutschland. Ein Beitrag zur techno- morphologischen Entwicklung des Beils in der Zone nördlich der Alpen, Sonderdruck aus Festschrift für Günter Smolla, *Materialien zur Vor- und Frühgeschichte von Hessen* 8, Manuskript 1983 eingereicht: 41–64

Binford, L. R. 1962. Archaeology as anthropology, *American Antiquity,* 28(2): 217-225

Bintliff, J. 1976. The Plain of Western Macedonia and the Neolithic Site of Nea Nikomedeia, *Prooccedings of the Prehistoric Society* 42: 241-262

Bleed, P.2001.Trees or Chains, Links or Branches: Conceptual Alternatives for Consideration of Stone Tool Production and Other Sequential Activities, *Journal of Archaeological Method and Theory* 8(1): 101–127

Bloedow, E.F.1991. The 'aceramic' Neolithic phase in Greece reconsidered, *Mediterranean Archaeology*, Vol. 4: 1-43

Bloedow, E.F.1992/1993. The date of the earliest phase at Argissa Magoula in Thessaly and other Neolithic sites in Greee, *Mediterranean Archaeology,* Vol. 5/6: 49-57

Bloom, P. 1996. Intention, history, and artifact concepts, *Cognition* 60: 1–29

Bloom, P. 1998. Theories of artifact categorization. *Cognition* 66:87–93

Витезовић, С. 2012. Коштани пројектили са локалитета Старчево-Град.*Гласник Српског археолошког друштва* 28:233-246

Bogucki, P. 2008. The Danubian-Baltic Borderland: Northern Poland in the fifth millennium BC, In: Fokkens,J., Coles,B.J, Van Gjin,A., Kleijne, J.P., Ponjee, H.-H and C.-G. Slappender, (eds.*), Between Foraging and Farming, An extended broad spectrum of papers presented to Leendert Louwe Koojimans*, Analecta Praehistorica Leidensia 40: 6-65

Бояджиев, К. 2014. *Въоръжение През Халколита В Българските Земи*. Българска академия на науките НациоНалеН археологически иНститут с музей.

Bouchud, J. 1966. Essai *sur le Renne et la climatologie du Paléolithique moyen et supérieur*. Imprimerie Magne, Périgueux.

Bouchud, J. 1974. L'origine anatomique des matériaux osseux utilisés dans les industries préhistoriques. In: Camps-Fabrer, H. (ed.), *Premier colloque international sur l'industrie de l'os dans la préhistoire*. Abbaye de Sénanque (Vaucluse). Éditions de l'Université de Provence, Paris:257-267.

Bubenik, A. 1966. *Das Geweih- Entwicklung, Aufbau und Ausformung der Geweihe und Gehörne und ihre Bedeutung für das Wild und für die Jagd*, Hamburg, Berlin

Bubenik, G. A. 2006. Seasonal regulation of deer reproduction as related to the antler cycle - a review. *Veterinaski arhiv* 76 (Suppl.):275-285

Buitenhuis, H. 2008. Ilipinar: The faunal remains from the late Neolithic and early Chalcolithic levels. In: *Archaeozoology of the Near East VIII. Actes des huitièmes Rencontres internationales d'Archéozoologie de l'Asie du Sud-Ouest et des régions adjacentes*. Lyon : Maison de l'Orient et de la Méditerranée Jean Pouilloux (Travaux de la Maison de l'Orient et de la Méditerranée, 49): 299-322

Campana, D.V.1989. *Natufian and Protoneolithic bone tools: the manufacture and use of bone implements in the Zagros and the Levant*. Oxford, England, B.A.R.

Camps-Fabrer, H. 1966. *Matière et art mobilier dans la préhistoire nord-africaine et saharienne*, Paris: Mémoires du Centre de recherches anthropologiques préhistoriques et ethnographiques.

Camps-Fabrer, H. (ed.). 1977. *Méthodologie appliquée à l'industrie de l'os préhistorique*. Premier colloque international sur l'industrie de l'os dans la Préhistoire. Paris, Éditions du C.N.R.S.

Camps-Fabrer, H. (ed.).1979. *L'Industrie en Os et Bois de Cervide durant le Neolithique et l'Age des Metaux*. Editons CNRS: Paris

Camps-Fabrer, H. (ed.) 1992. *Fiches typologiques de l'industrie osseuse préhistorique, Cahier V, Batons percés, Baguettes*, Aix-en-Provence: éd. de l'Université de Provence.

Camps-Fabrer, H. and Ramseyer, D. 1998. Objet biseauté non perforé pris sur extrémité d'andouiller de cerf. In: Camps-Fabrer, H., Cattelain,P., Choi, S.-Y., David, E., Pascual-Benito, J.-L., Provenzano, N., and D.Ramseryer (eds.), *Fiches typologiques de l'industrie osseuse préhistorique, cahier VIII:Biseaux et tranchants,* Aix-en-Provence: éd. de l'Université de Provence: 31-42

Camps-Fabrer, H., Ramseyer, D, and Stordeur,D.(eds.)1990.*Fiches typologiques de l'industrie osseuse préhistorique, cahier III: Poincons, pointes, aiguilles, poignards*, Aix-en-Provence: éd. de l'Université de Provence.

Casson, S. 1918-19. Macedonia: notes. *Annual of the British School at Athens* 23: 60–63

Casson, S. 1919-21. Excavations in Macedonia, *Annual of the British School at Athens* 24:1–33

Casson, S. 1923/24-1924/25.Excavations in Macedonia-II, Annual of the British School at Athens, 26:1-29

Casson, S. 1926. *Macedonia, Thrace, and Illyria - Macedonia, Thrace, and Illyria: Their Relations to Greece from the Earliest Times down to the Time of Philip, Son of Amyntas*.Oxford University Press

Catellain, P. (ed.) 1988. Fiches typologiques de I'industrie prehistorique Cahier II. Propulseurs. Aix-en-Provence, éd. de l'Université de Provence

Cegielski, M., Calkosinski I., Dziegiel P., Gebarowski T., Podhorska-Okolow M., Skalik R. and Zabel M. 2006. Search for Stem Cells in the Growing Antler Stag (*Cervus elaphus*) *Bulletin of the Veterinary Institute of Pulawy,* 50: 247-251

Chapman, D. 1975. Antlers-bones of contention, *Mammal Review* 5:121–172

Chen, P.Y., Lin, A.Y.M., Lin, Y.-S., Seki, Y., Stokes, A.G., Peyras. J., Olevsky, E.A., Meyers, M.A. and McKittrick, J. 2008. Structure and mechanical properties of selected biological materials, *Journal of the Mechanical Behavior of Biomedical Materials* I: 208-226

Chilton, E.1999. Material meanings and meaningful materials: an introduction. In: Chilton, E. (ed.), *Material Meanings: critical approaches to the interpretation of material culture*. Salt Lake City: University of Utah Press: 1–6

Choyke, A. M. 2000. Bronze Age antler and bone manufacturing at Arslantepe (Anatolia). In: Mashkour, M., Choyke, A. M. and Buitenhuis, H. (eds.), *Archaeozoology of the Near East IVA*. ARC Publication 32, Groningen: 170-183.

Choyke, A.M. 2005. Bronze Age bone and antler working at the Jászdózsa–Kápolnahalom tell. In: H. Luik, A.M. Choyke, C.E. Batey and L. Lõugas (eds.), *From Hooves to Horns, from Mollusc to Mammoth: Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present*, Tallinn: Teaduste Akadeemia Kirjastus: 129-156

Choyke, A.M.2011.L'industrie osseuse de Godedzor. In: Chataigner, C.(ed.) *Godedzor, Chalcolithique récent, sud-ouest Arménie.* Rapport de MAE 2011:86-98

Choyke A.M. and Daroczi-Szabo M. 2010. The Complete and Usable Tool: Some Life Histories of Prehistoric Bone Tools in Hungary. In: Legrand, A., and Sidera, I. (eds.), *Ancient and Modern Bone Artefacts from America to Russia. Cultural, technological and functional signature*. BAR IS 2136.Archaeopress, Oxford: 235–248

Christidou, R. 1997. Dimitra. Bone Working. In: Γραμμένος Δ. (επιμ.), *Νεολιθική Μακεδονία*, Υπουργείο Πολιτισμού, Ταμείο Αρχαιολογικών Πόρων, Αθήνα:128-199

Christidou, R. 1999. Outils *en os néolithiques du Nord de la Grèce: etude technologique*. Thèse de doctorat.Universitè de Paris X.

Christidou, R. 2001. Study of Bone Tools at Three Late/Final Neolithic Sites from Northern Greece, In: Choyke, A.M. and L.Bartosiewicz, (eds.), *Crafting Bone: Skeletal Technologies through Time and Space*, Proceedings of the 2nd meeting of the (ICAZ) Worked Bone Research Group Budapest, 31 August – 5 September, British Archaeological Repors, Oxford: 41-47

Christidou, R. 2005. Aspects of bone exploitation in the Neolithic sites of Eastern Macedonia, Greece. In: Luik, H., Choyke, A.M.**,**Batey C.,Lougas, L. (eds.): *From Hooves to Horns, from Mollusc to Mammoth – Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present,* Proceedings of the 4th Meeting of the ICAZ Worked Bone Research Group at Tallinn, 26th–31st of August 2003, Muinasaja teadus 15, Tallinn: 91-104

Christidou, R. and Legrand.A.2005. Hide working and bone tools: experimentation design and applications, In: Luik, H., Choyke, A., Batey, C. and Lougas, L. (eds.), *From Hooves to Horns, from Mollusc to Mammoth: Manufacture and Use of Bone Artefacts fro Prehistoric Times to the*

Present. Muinasaja Teadus No 15. Tallinn (Estonia), Archaeological Department of the Institute of History & Chair of Archaeology of the University of Tartu: 385-396

Chrysostomou, P., Jagoulis, T. and A. Mäder. 2015. The „Culture of Four Lakes“. Prehistoric lakeside settlements (6th - 2nd mill. BC) in the Amindeon Basin, Western Macedonia, Greece, *Archäologie Schweiz* 38.3: 24 – 32

Chrysostomou, P. and Giagkoulis.T. 2016. Land und Seeufersiedlungen der "Kultur der Vier Seen", Griechenland. Neue archäologische Einblicke in den prähistorischen Siedlungen im Amindeon-Becken, *Plattform* 23/24: 4-9

Clark, J.G.D. and Thompson, M.W. 1953. The Groove and Splinter Technique of Working Reindeer and Red Deer Antler in Upper Paleolithic and Early Mesolithic Europe. *Archivo De Prehistoria Levantina* 4:57- 65

Classon, A. 1983. Spoolde: Worked and Unworked Antlers and Bone from Spoolde, De Gaste, The Ijsselmeerpolders and Adjacent Areas, *Palaeohistoria* 25:77–128

Cornwall, I.W.1968. *Bones for the Archaeologist*. Phoenix house, London.

Clutton-Brock, J.1984. Excavations at Grimes Graves, Norfolk, 1972-1976. Fascicule 1: Neolithic Antler picks from Grimes Graves, Norfolk, and Durrington Walls, Wiltshire: a Biometrical Analysis. The Trustees of the British Museum, London. Cornwall, I.W., 1968. Bones for the Archaeologist. Phoenix house, London

Crigel, M-H, Balligand, M., Heinen, E. 2001.Les bois de cerf: revue de littérature scientifique. *Annales de Médecine Vétérinaire* 145:25–38

Crilly, N. 2010. The roles that artefacts play: technical, social and aesthetic functions. *Design Studies*, 31(4):311–344

Crilly, N., Moultrie, J. and Clarkson, P.J.2004. Seeing things: consumer response to the visual domain in product design. *Design Studies,* 25 (6):547-577

Currey, J.D.1970. *Animal Skeletons*. Studies in Biology 22, London

Currey, J.D., 1979. Mechanical properties of bone tissues with greatly differing functions, *Journal of Biomechanics* 12:313-319

Currey, J.D. 2002. *Bones: Structure and Mechanics.* Princeton: Princeton University Press.

Currey, J.D., Landete-Castillejos, T., Estevez, J., Ceacero, F., Olguin, A., Garcia, A. and Gallego, L. 2009. The mechanical properties of red deer antler bone when used in fighting, *Journal of Experimental Biololgy* 212:3985-3993

Clutton-Brock, T.H.1974 .Why do animals live in groups? *New Scientist* 63 (905):72-74

Clutton-Brock, T.H.,Guinness, F.E. and S.D.,Albon1982. Red deer: behavior and ecology of two sexes, Chicago, University of Chicago Press

Clutton-Brock, J.1984. *Excavations at Grimes Graves, Norfolk 1972-1976. Fascicule 1: Neolithic Antler Picks from Grimes Graves, Norfolk, and Durrington Walls, Wiltshire: A Biometrical Analysis*.

d'Errico, F. 1991. Étude technologique à base expérimentale des entailles sur matière dure animale. Implications pour l'identification de systèmes de rotation. In:Perlès,C.(ed.), *La préhistoire et l'ethnologie: 25 ans d'études technologiques en préhistoire, bilan et perspectives*. Actes des XIe Rencontres Internationales d'Archéologie et d'Histoire d'Antibes, Antibes, 18-20 Octobre 1990, Juan-les-Pins (France): Éditions APDCA: 83-97

d'Errico, F. 1993. Identification des traces de manipulation, suspension, polissage sur l'art mobilier en os, bois de cervidé, ivoire. In: Anderson, P.C., Beyries, S., Otte, M., and H.Plisson (eds.), *Traces et fonctions: les gestes retrouvés*, Actes du colloque international de Liège, décembre 1990, vol. 1, ed. P. C. Anderson, S. Beyries, M. Otte and H. ERAUL No 50. Liège (Belgium): Études et Recherches archéologiques de l'Université de Liège: 177-188

d'Errico, F. 1996. Image Analysis and 3-D Optical Surface Profiling of Upper Palaeolithic Mobiliary Art, *Microscopy and Analysis* vol. 39:27-29

Danilkin, A.1996.*Behavioural Ecology of Siberian and European Roe Deer*. London: Chapman & Hall.

Darcque, P., Koukouli-Chryssantaki, H., Malamidou, D., Tsirtsoni, Z., Lespez, L, and Vallé**e Germain, C.2014**.The impact *of Environmental Changes on the Neolithic Settlement of Dikili Tash (Northern Greece),* In:Touchais,G., Laffineur,R., and Rougemont, F.(eds.), *Physis, L' environnement naturel et la relation Homme-Milieu dans le monde* égéen *protohistorique*, Actes de la 14e Rencontre égéenne internationale, Paris, Institut National d'Histoire de l'Art (INHA), 11-14 décembre 2012, Aegaeum 37:425-430

David, E. 1999. *L'industrie en matières dures animals du Mésolithique ancient et moyen en Europe du Nord. Contribution de l'analyse technologique à la definition du Maglemosien.* Doctoral, Université Nanterre-Paris X, Paris.

David, E. 2003. The contribution of the Technological Study of Bone and Antler Industry for the definintion of the Early Maglemose Culture. In: Larsson,L., Kindgern,H., Knuttson,K., Loeffler,D. and A., Akerlund(eds.), *Mesolithic on the Move: papers presented at the Sixth International Conference on the Mesolithic in Europe, Stockholm 2000*, Oxford: Oxbow. 486–493

David, E. 2004. Fiche transformation des matières dures d'origine animale dans le Mésolithique ancien d'Europe du Nord. In:Ramseyer,D.(ed.),*Fiches typologiques de l'industrie osseuse préhistorique: Cahier XI - Matières et Techniques,* Paris: Société Préhistorique Française:113-149

David, E. 2007. Technology on Bone and Antler Industries: A Relevant Methodology for Characterizing Early Post-Glacial Societies (9th-8th Millennium BC). In: Gates St- Pierre, C. and C.W. Walker(eds.), Bones As Tools:Current Methods and Interpretations in Worked Bone Studies. BAR International Series 1622. British Archaeological Reports, Oxford, pp.35-50

Dauvois, M. 1977. Industrie osseuse préhistorique et expérimentation. In: H. Camps-Fabrer (ed.): *Méthodologie appliquée à l'industrie de l'os préhistorique.* Premier colloque international sur l'industrie de l'os dans la Préhistoire. Université de Provence: 73-83

Davis, S., 1987. *The Archaeology of Animals*. Yale University Press, London.

Dawkins, R., Hawes, C. and Bosanquet. R. 1904. Excavations at Palaikastro. IV. *The Annual of the British School at Athens* 11:258-308

Dekker, K. 2014. *What Tools Can Tell the Bone Tools of Barcın Höyük*, Free University of Amsterdam (Unpublished MA Thesis). Amsterdam

Dellantonio, S., Mulatti, C. and Job, R. 2013. Artifact and Tool Categorization, *Review of Philosophy and Psychology* 4:407-418

Delporte, H., Hahn, J., Mons, L., Pinion, G. and D.De Sonneville-Bordes(eds.)1988.*Fiches typologiques de I'industrie prehistorique. Cahier I. Sagaies*. Aix-en-Provence, éd. de l'Université de Provence

Démoulé, J-P., Gallis K., Knoll H., Schneider G. 1991. Transition entre les cultures néolithiques de Sesklo et de Dimini: Recherches minéralogiques, chimiques et technologiques sur les céramiques et les argiles, *Bulletin de Correspondance Hellénique*, Volume 115(1): 1-64

Démoulé, J.-P. and Perles, C. 1993.The Greek Neolithic: a new review, *Journal of World Prehistory* 7(4): 355-416

Démoulé, J.P. 1993. Néolithique et Chalcolithique de Macédoine: Un état des questions, *Αρχαία Μακεδονία* V, *Ανακοινώσεις κατά το 5ο Διεθνές Συμπόσιο, Θεσσαλονίκη, 10-15 Οκτωβρίου 1989,* 1, Θεσσαλονίκη, ΙΜΧΑ 240:373-389

Démoulé, J-P. 1994. Problèmes chrono-culturels du Néolithique de Grèce du Nord, In J.-C. Decourt, B. Helly, and K. Gallis (eds.), *La Thessalie. Quinze années de recherches archéologiques, 1975-1990: Bilans et perspectives*, Athens: 79-90

Dergacev, V. 2002. Die aeneolithischen und bronzezeitlichen Metallfunde aus Moldavien, *Praehistorische Bronze-funde* XX 9

Deschler-Erb, S., Marti-Grädel, E. and Schibler, J.2002. Die Knochen-, Zahn- und Geweihartefakte. In: de Capitani, A., Deschler-Erb, S. Leuzinger, U., Marti-Grädel,E., and Schibler, J. (eds.), *Die jungsteinzeitliche Seeufersiedlung Arbon Bleiche 3: Funde.* Archäologie im Thurgau 11:277-366

Djindjian,F. 2000. Artefact Analysis (https://publikationen.unituebingen.de/xmlui/bitstream/handle/10900/61178/07_Djindjian_CAA_2000.pdf?sequence=2) Last accessed: 16/08/16

Dipert, R. 1993. *Artifacts, art works, and agency.* Temple University Press.

Dobres, M.-A. 1999. Technology's links and chaines: the processual unfolding of technique and technician, In: Dobres, M.-A. and Hoffman, C.R.(eds.), *The Social Dynamics of Technology: Practice, Politics, and World Views*, Washington, DC, Smithsonian:124-146

Dobres, M.-A.2000. *Technology and Social Agency. Outlining a Practice Framework for Archaeology*. Oxford: Blackwell Publishers.

Dobres, M.-A. 2010. Archaeologies of technology, *Cambridge Journal of Economics* Vol. 34(1): 103-114

Douka, K., Efstratiou, N., Hald, M., Henrkiksen, P.S. and Karetsou, A. 2017. Dating Knossos and the arrival of the earliest Neolithic in the southern Aegean, *Antiquity* 91 (356): 304-321

Dragomir, I.T.1983. *Eneoliticul din sud-estul României.* Bucureşti

Dumitrescu,Vl.1982.The prehistory of Romania : from the earliest times to the 1000 B.C.In:Boardman, J., Edwards, I.E.S., N. G. L. Hammond and E. Sollberger (eds.) *The Cambridge Ancient History,Vol.3, Part 1:. The prehistory of the Balkans; and the Middle East and the Aegean world, Tenth to Eighth centuries B.C*, 2nd edition, Revised and Enlarged edition,Cambridge University Press:1-62

Efstratiou, N., Karetsou, A. and Ntinou, M. (eds.) 2013. *The Neolithic Settlement of Knossos in Crete.New Evidence for the Early Occupation of Crete and the Aegean Islands*. Prehistory Monographs 42. Instap Academic Press

Elliott, B. J. 2012. *Antlerworking Practices in Mesolithic Britain*. PhD Thesis. University of York

Elliott, B.J.2015. Facing the Chop: Redefining British Antler Mattocks to Consider Larger-Scale Maritime Networks in the Early Fifth Millennium Cal BC, *European Journal of Archaeology* 18(2): 222-244

Elster, E. 2001. Middle Neolithic to Early Bronze Age Bone Tools from Sitagroi, Greece. In : Choyke A.M., Bartosiewicz, L.(eds.) *Crafting Bone: Skeletal Technologies Through Time and Space*, Proceedings of the 2nd Meeting of the (ICAZ), Worked Bone Research Group, Budapest, 31 August-5 September 1999:355-369

Elster, E. 2003. Bone Tools and Other Artifacts. In: Elster, E. and Renfrew, C. (eds.), *Prehistoric Sitagroi: Excavations in Northeast Greece, 1968-1970, vol. 2: The Final Report*, Monumenta Archaeologica 20, Los Angeles: University of California: 31-53

Elster, E. and Renfrew C. (eds.) 2003. *Prehistoric Sitagroi: Excavations in Northeast Greece, 1968 – 1970, vol. 2: The Final Report*, Monumenta Archaeologica 20, Los Angeles: University of California

Ellul, J. 1980. *The technological system,* Continuum, London

Erdalkiran, M. 2015. Barcın Höyük 2013 Yılı Kemik Aletlerinin Ön Raporu, 30. *Arkeometri Sonuçları Toplantısı* 30:115-128

Evans, J.D.1964*.* Excavations in the Neolithic settlement of *Knossos*, 1957–1960, Part I. *British School at Athens* 59: 132–240

Evans, J.D.1971. Neolithic Knossos; The Growth of a Settlement. *Proceedings of the Prehistoric Society* 37, part 2:95-118

Facorellis,Y., Sofronidou, M. and Hourmouzadis, G. 2014. Radiocarbon dating of the Neolithic Lakeside settlement of Dispilio, Kastoria, Northern Greece,*Radiocarbon*, Vol 56(2): 511–528

Jacobsen, T.1969. Excavations at Porto Cheli and vicinity, preliminary report, II: The Franchthi Cave 1967-1968, *Hesperia* 38:343-381

Flerov, K.K. 1952. Fauna of the USSR, Mammals. Vol. 1. Musk Deer and Deer. Academy of Sciences of the USSR, Moscow. English translation, Office of Technical Services, U.S. Dept. of Commerce, Washington

Ford, J.A and Steward, J.H. 1954. On the Concept of Types, *American Anthropologist, New Series*, Vol. 56(1): 42-57

Fotiadis, M., Hondroyanni-Metoki A., Kalogirou A. and Ziota Chr. 2000. Megalo Nisi Galanis (Kitrini Limni Basin) and the Later Neolithic of Northwestern Greece, In: St. Hiller, V.

Nicolov(eds.),KARANOVO, Beiträge zum Neolithikum in Südosteuropa, τόμ. III, Vienna: 217-228.

Fowler, K.D. and Greenfield, H.J. 2005. *The secondary products revolution in Macedonia: The zooarchaeological remains from Megalo Nisi Galanis, A Late-Neolithic-Early Bronze Age site in Greek Macedonia.* BAR International Series 1414

Foxon, A.D.1991. *Bone, antler, tooth and horn technology and utilisation in prehistoric Scotland.* PhD thesis.University of Glasgow

Gaul, J.H. 1948. *The Eneolithic Period in Bulgaria*. Cambridge

Geist, V. 1998. *Deer of the World: Their evolution, behaviour and ecology*. Mechaniesburg, USA:Stackpole.

Giagkoulis, T. in press. On the Edge: The Pile-field of the Lakeside Settlement Anarghiri IXb (Amindeon, Western Macedonia, Greece) and the Non-Residential Wooden Structures on the Periphery of the Prehistoric Occupation,In:Dolbunova, E., Hafner, A., Mazurkevich A. and E. Pranckenaite E. (Eds.), *Settling watery landscapes in Europe: archaeology of pile-settlements of Neolithic-Bronze Age* (European Association of Archaeologists, EAA Conference Vilnius 2016)

Gimbutas M. 1974. Achilleion: A Neolithic Mound in Thessaly; Preliminary Report on 1973 and 1974 Excavations, *Journal of Field Archaeology* 1(3/4):277–302

Gnecco, C. and Langebaek, C. (eds.) 2014. *Against Typological Tyranny in Archaeology: A South American Perspective*, Springer

Goss R.J. and Powell R.S. 1985. Induction of deer antlers by transplanted periosteum, 1. Graft Size and Shape, *Journal of Experimental Zoology* 235: 359-373

Gould, J.L. 2009. Animal artifacts. In: Margolis, E. and Laurence,S.(eds.), *Creations of the mind. Theories of artifacts and their representation*, Oxford: Oxford University Press: 249–266

Goutas, N. 2009. Réflexions sur une innovation technique gravettienne importante: le double rainurage longitudinal, *Bulletin de la société Préhistorique française* 106:437-56

Gross-Klee, E. and Schibler, J.1995. Fäll- und Behaubeile / Haches et herminettes. In: *Die Schweiz vom Paläolithikum bis zum frühen Mittelalter. SPM II: Neolithikum*. Verlag Schweiz. Ges. f. Ur- und Frühgeschichte, Basel: 159-168

Grygiel, R and Bogucki, P. 1990. Neolithic manufacture of antler axes at Brzesc Kujawski, Poland, *Archaeomaterials* 4(1): 67-76

Habel, R.E. (ed.) 1994.*Nomina anatomica veterinaria*, World Association of Veterinary Anatomists, Antwerp, 4th edition

Hansson, S. O. 2006. Defining technical function. *Studies in History and Philosophy of Science,* 37 (1):19-22

Hall, R. 1981. *The mammals of North America, Vol. II*, John Wiley & Sons. II. New York

Hall, B.K. 2015. Bones and Cartilage. *Developmental and Evolutionary Skeletal Biology*, Second edition, Elsevier,Academic Press,

Hanschman, E. and Milojcic, Vl. 1976. *Argissa Magoula in Thessalien, III: die fruhe unde beginnende mittlere Bronzezeit*, Bonn

Harris, M. 1964. *The Nature of Cultural Things*.New York:Randon House

Harris, M. 1968. *The Rise of Anthropological Theory*. Crowell: New York

Hayden, B.1984. Are Emic Types Relevant to Archaeology?, Ethnohistory, Vol. 31(2): 79-92

Heurtley, W.A. 1932. Excavations at Servia in Western Macedonia, *The Antiquaries Journal* XII: 227-238

Heurtley, W.A. 1939. *Prehistoric Macedonia: an archaeological reconnaissance of Greek Macedonia (west of Struma) in the Neolithic, Bronze, and Early Iron Ages*. Cambridge: Cambridge University Press.

Hill, J.N. and Evans, R.K. 1972. A model for classification and typology. In: Clarke, D.L. (ed.), *Models in Archaeology*, Methuen, London: 231-27

Hilpinen, R. 2011. "Artifact", *The Stanford Encyclopedia of Philosophy* (Winter 2011 Edition) Edward N. Zalta (ed.), https://plato.stanford.edu/archives/win2011/entries/artifact)Last accessed: 09/08/2016

Hollenback, K.L. and Schiffer, M.B. 2014. Technology and Material Life.In: Beaudry, M.C. and Hicks, D(eds.),*The Oxford Handbook of Material Culture Studies*, Oxford Handbooks: 313-331

Höglinger, P.1997. Neolithisches Bein- und Geweihgerät, In: Hiller,St. and Nikolov, V. (eds.), *Karanovo – Die Ausgrabungen im Südsektor 1984 – 1992*, Osterreichisch-Bulgarische Ausgrabungen und Forschungen in Karanovo Bd I.1, Text, Horn/Wien 1977:157-196

Hurcombe, L. 2014. *Archaeological Artefacts as Material Culture*, Routledge

Isaakidou, V.2003. Worked and utilized bone and antler: practical and cultural rationales for the selection of raw materials, In: Kotjabopoulou, E., Hamilakis, Y., Halstead, P., Gamble,C. and Elefanti, P. (eds.), *Zooarchaeology in Greece*, London: British School at Athens: 233-238

Ivanov, I. and Avramova, M. 2000. *Varna Necropolis. The Dawn of European Civilization* (Sofia)

Jin, J.J.H. 2010. *Zooarchaeological and taphonomic analysis of the faunal assemblage from Tangzizou, Southwestern China*, PhD Thesis, The Pennsylvania State University, The Graduate School,College of the Liberal Arts

Jin, J.J.H. and Shipman, P.2010. Documenting Natural Wear on Antlers: A First Step in Identifying Use-Wear on Purported Antler Tools, *Quaternary International* 211:91-102

Kabaciński, K., Sobkowiak-Tabaka, S., David, E., Osypińska, M., Terberger, T., Winiarska-Kabacińska, M. 2014. The chronology of T-shaped axes in the Polish Lowland.In: *Sprawozdania Archeologiczne*, Instytut Archeologii i Etnologii Polskiej Akademii Nauk, Archaeological Reports 66: 29-57

Karamitrou-Mentesidi, G., Efstratiou, N. Kozlowski, J.K., Kaczanowska, M., Maniatis, Y., Curci, A., Michalopoulou, S., Papathanasiou, A. and S.M. Valamoti 2013. New evidence on the beginning of farming in Greece: the Early Neolithic settlement of Mavropigi in western Macedonia (Greece), *Antiquity* 87(336).
Available at: http://antiquity.ac.uk/projgall/mentessidi336/ Last accessed 17/06/2016

Karamitrou-Mentessidi, G., Efstratiou, N., Kaczanowska, M., Kozlowski, J.K. 2015.Early Neolithic Settlement of Mavropigi in Western Greek Macedonia, *Eurasian Prehistory* 12 *(1–2):* 47–116

Kelemen, D. and Carey, S.2009.The essence of artifacts: Developing the design stance, In:Margolis, E. and Laurence, S.(eds.),*Creations of the mind. Theories of artifacts and their representation*, Oxford: Oxford University Press: 212–230.

Kelly, R.R. and Thomas, D.H. 2017. *Archaeology*, Cengage Learning, 7th Edition

Kierdorf, U. and Kierdorf, H.2002. Pedicle and first antler formation in deer: Anatomical, histological, and developmental aspects, *European Journal of Wildlife Research* 48:22-34

Kokkinidou, D. and Trantalidou, K. 1991. Neolithic and Bronze Age settlement in western Macedonia. *Annual of the British School at Athens* 86:93–106

Korkuti, M. 1995.*Neolithikum und Chalkolithikum in Albanien*. Mainz am Rhein: Internationale Interakademische Kommission fur die Erforschung der Vorgeschichte des Balkans, Monographieren 4

Kotai, S. 2010. Die Knochenartefakte, die Geweihartefakte. In: Eberli, U.(ed.), *Die horgenzeitliche Siedlung PfaeffikonBurg,* Monogr. KA Zurich 40/1 (Zurich/Egg 2010): 161–191

Kotsakis, K. 2001. Mesolithic to Neolithic in Greece.Continuity, discontinuity or change of course, *Documenta Praehistorica* 28:63-73

Kotsakis, K. 2002. «Book Review of Catherine Perlès, The Early Neolithic in Greece." *European Journal of Archaeology* 5(3): 373-377

Kotsakis, K. 2003. From the Neolithic Side: the Mesolithic / Neolithic Interface, In: Perles, C. and Galanidou, N.(eds.), *The Greek Mesolithic,* London, British School at Athens Vol.10:217-221

Kotsakis, K., Papanthimou-Papaefthimiou, A., Piliali-Papasteriou, A., Savopoulou,T., Maniatis, Y. and Kromer, B. 1989. Carbon 14 Dates from Mandalon, W-Macedonia. In: Maniatis,Y.(ed.) *Archaeometry. Proceedings of the 25th International Symposium,* Oxford, Blackwell Publishing. pp. 679-685

Kotsos, S. and D. Urem-Kotsou, 2006. Filling in the Neolithic landscape of central Macedonia, Greece. In: Tasic, N. and Grozdanov, C. (eds.) *Homage to Milutin Garasanin*, Belgrade: Serbian Academy of Science and Arts, Macedonian Academy of Sciences and Arts: 193-207

Lang, F. 2005. Knochen- und Geweihartefakte, In: SHiller, St. and Nikolov, V. (eds.), *Karanovo – Die Ausgrabungen im Nordsüd-Schnitt 1993-1999, österreichisch-bulgarische Ausgrabungen und Forschungen in Karanovo* Bd IV.1,Text, Wien: 263-340

Langvatn,R. and Albon, S.D.1986. Geographic clines in body-weight of Norwegian red deer - A novel explanation of Bergmann rule, *Holarctic ecology*, 9:285-293

Legrand, A. and Sidéra, I. 2004. Les outils en matières osseuses. Exemple des sites de Khirokitia (Chypre) et de Drama (Bulgarie), *Dossiers d'Archéologie* 290:52-55

Lemoine, G.M. 1994. Use Wear on Bone and Antler Tools From the Mackenzie Delta, Northwest Territories. American Antiquity 59:316-334.

Lemoine, G.M. 1997. *Use Wear Analysis on Bone and Antler Tools of the Mackenzie Inuit*. BAR International Series 679, Oxford.

Leroi-Gourhan, A. 1964. *Le geste et la parole*, 2 vols, Paris: Albin Michel

Leroy-Prost, C.1977. L'industrie osseuse néolithique de la grotte de Kitsos (Attique, Grèce).Eléments de morphologie anatomique et descriptive, *Bulletin de la Société préhistorique française* 74(6):179-184

Linnæus, C, 1758. *Systema naturæ per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis.* Tomus I

Linnell, J., Duncan, P. and Andersen, R.1998. The European roe deer: a portrait of a successful species. In: R. Andersen, P. Duncan and J. Linnell, (eds.), *The European roe deer: the biology of success,* Scandinavian University Press, Oslo11–22

Loe, L.E., Bonenfant, C., Mysterud, A., Gaillard, J. M., Langvatn, R., Klein, F., Calenge, C., Ergon, T., Pettorelli, N., and Stenseth, N.C. 2005. Climate predictability and breeding phenology in red deer: timing and synchrony of rutting and calving in Norway and France, *Journal of Animal Ecology* 74:579-588

Losonsky, M. 1990. The Nature of Artifacts, *Philosophy* 65 (251): 81-88

Lovari, S., Herrero, J., Masseti, M., Ambarli, H., Lorenzini, R. and Giannatos, G. 2016. *Capreolus capreolus. The IUCN Red List of Threatened Species 2016. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T42395A22161386.en*
Last accessed 09/10/2016

Lovari, S., Herrero. J., Conroy, J., Maran, T., Giannatos, G., Stubbe, M., Aulagnier, S., Jdeidi, T., Masseti, M., Nader, I., de Smet, K. and Cuzin, F. 2008. *Cervus elaphus. The IUCN Red List of Threatened Species 2008*.
http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T41785A10541893.en Last accessed 09/10/2016

Luik, H. 2011. Material, technology and meaning:antler artefacts and antler working on the eastern shore of the Baltic sea in the Late Bronze Age, *Estonian Journal of Archaeology* 15(1): 32–55

Lyneis, M.M. 1988. Antler and Bone Artifacts from Divostin. In: McPherron, A and Srejovic, D. (eds.), *Divostin and the Neolithic of Central Serbia*, Ethnology Monographs 10, Pittsburgh:301-319

Macdonald, D.W. and Barrett, P.2001. *Mammals of Europe*. Princeton University Press, Princeton, New Jersey

MacGregor, A. 1985. *Bone, Antler, Ivory & Horn: The Technology of Skeletal Materials Since the Roman Period.* University of Toronto Press, Toronto.

McGeehan-Liritzis, V.1996. *The role and development of metallurgy in the Late Neolithic and Early Bronze Age in Greece*, Studies in Mediterraneanarchaeology and literature 122, Jonsered, Sweden : P. Aströms förlag

Maigrot, Y.2003.*Étude technologique et fonctionnelle de l'outillage en matières dures animales, la station 4 de Chalain (Néolithique final, Jura, France*), Thèse de doctorat, Université Paris 1, Paris.

Maigrot, Y. 2005. Ivory, Bone and Antler Tools Production Systems at Chalain 4 (Jura, France), Late Neolithic Site, 3rd Millennium, In : Luik, H., Choyke,M.A., Batey, C.E. and Lougas,L (eds.), *From Hooves to Horns, from Mollusc to Mammoth, Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present*, 4th Meeting of the Worked Bone Research Group, Tallinn, 2003, Talinn, Ajaloo Instituut Tartu Ülikool (Muinasaja teadus 15): 113-126

Macgregor, A. and Currey, J.D. 1983. Mechanical Properties as conditioning factors in the bone and antler industry of the 3rd to the 13th century AD, *Journal of Archaeological Science* 10:71-77

Makkay, J. 1990. Knochen-, Geweih-und Eberzahngegenstände der frühneolithischen Körös-Kultur, *Communicationes Archæologicæ Hungariæ* 1990:23-58

Marinelli, M. 1995. The Bone Artefacts of Ilıpınar. In: Roodenberg, J. (ed), *The Ilıpınar Excavations. Vol. 1, Five seasons of fieldwork in NW Anatolia, 1987–91*, Leiden: Nederlands Instituut voor het Nabije Oosten: 121-143

Mărgărit, **M., Popovici, D.N. and Vlad, F.2009**. L'exploitation du bois dans l'habitat énéolithique de Borduani-Popin*, Annales d'Université Valahia Târgovite, Section d'Archéologie et d'Histoire*, Tome XI, Numero 1: 53 – 67

Mărgărit, **M., Popovici, D.N. and Vlad, F.2010**. L'utilisation du harpon dans la culture Gumelnita. Etude de cas: l'habitat de Bordusani-Popina (dep. de Ialomita), *Cercetari Arheologice* XVII:35–54

Mărgărit, M., Ştefan, C.E. and Dumitrascu, V. 2016. The exploitation of animal resources in Şoimuş-La Avicola (*Ferma 2*) settlement (Romania), *Documenta Praehistorica* XLIII: 363-397

Marinescu-Bîlcu, S. and Bolomey, A.2000. The Bone and and antler industy In: Marinescu-Bîlcu,S. and Bolomey,A.(eds.), *Draguseni, a Cucuteni Community*, Archaeologia Romanica II, Editura Enciclopedica,Wasmuth Verlag:63-89

Maublanc, M.L., Bideau E. and Vincent J.P.1987. Flexibilité de l'organisation sociale du chevreuil en fonction des characteristiques de l'environnement*, Revue d' Ecologie (Terre Vie)* 42: 109-133

McCullough, D.R. 1969. The Tule Elk: Its history, behavior, and ecology, *University of California Publications in Zoology* 88:1-209

Maytain, S. 2010. Le bois de cerf: Approaches typologique, technologique et spatial, In: Winiger, A., Bullinger, J., Burri,E., Chauviere, F-X., Maytain, S.(eds.)*, Le mobilier organique et lithique du Néolithique moyen.La station lacustre de Concise 3*, Cahiers d' Archeologie Romande 119:51-89

Miller,H.M-L.2000.*Archaeological Approaches to Technology*, Elsevier

Milojčić, **V. 1950/51.** Zur Chronologie Der jungeren Steinzeit Griechenlands, *Jahrbuch des Deutschen Archaologischen Instituts*, 1950-1:1-50

Milojčić, V. 1956a. Bericht über die Ausgrabungen auf der Gremnos-Magula bei Larisa 1956, *Archäologischer Anzeiger 1956*: 141–183

Milojčić, V. 1956b. Die erste präkeramische bäuerliche Siedlung der Jungsteinzeit in Europa, *Germania* 34: 208–210

Milojčić, V. 1959. Ergebnisse der Deutschen Ausgrabungen in Thessalien, *Jahrbuch des Römisch-Germanischen Zentralmuseums* 6:1-56

Milojčić, V. 1960. Präkeramisches Neolithikum auf der Balkanhalbinsel, *Germania* 38:320–340

Milojčić, V. 1973. Zur Frage eines präkeramischen Neolithikums in Mitteleuropa, In: *Actes du VIII congres international des sciences préhistoriques et Protohistoriques,* Belgrad: Union Internationale de Sciences Préhistoriques et Protohistoriques. vol. 2: 248–52

Milojcic, V., Boessneck, J., and Hopf, M. 1962 .*Die deutschen Ausgrabungen auf der Argissa-Magula in Thessalien I: Das präkermische Neolithikum sowie die Tier- und Pflanzenreste*. Beitrâge zur Ur- und Fruhgeschichtlichen Achfiologie des Mittelmeer Kulturraumes fiir das Institut fiir U-und Frahgeschichte der Universitaet Heidelberg, BAM 2, Bonn

Mitchell, B., Staines, B.W. and Welch, D.1977. *Ecology of Red Deer A research review relevant to their management in Scotland*. Natural Environment Research Council, Institute of Terrestrial Ecology, Banchory , Cambridge

Mitkoski, A. 2011. The site of Trestena Stena at the village of Manastir, Marlovo, *Macedoniae Acta Archaeologica* 20, Skopje: 125-170

Mitkoski, A. 2017. The Late Neolithic Period in Pelagonia and Mariovo in the Prilep Region in Stojanova Kanzurova, E.(ed.) *Dragisa Zdravkovski In Memoriam. Cultural Manifestations during the Neolithic Period on the Territory of the Republic of Macedonia and Neighboring Regions*, Archaeological Museum of Macedonia, Skopje:119-160

Morintz, S. and Roman, P. 1968. Aspekte des Ausgangs des Aneolithikums und der bergangstufe zur Bronzezeit im Raum der Niederdonau, *Dacia* N.S. XII: 45-128

Moundrea-Agrafioti, H.A. 1981. *La Thessalie du Sud-Est au Neolithique. Outillage lithique et oseeux.* Thèse de doctorat. Universitè de Paris X

Moundrea-Agrafioti, H.A.1987. Problemes d'emmanchement dans le Neolithique grec: Les gaines et manches en bois de cervide, In: Stordeur, D. (ed.), *La main et l'outil: Manches et emmanchements pre'-historiques*, Lyon: 247-256

Moundrea-Agrafioti, H.A.2011. The Mesolithic and Neolithic Bone Implements,In: Sampson, A.(ed.),*The Cyclops Cave on the island of Youra, Greece. Mesolithic and Neolithic networks in the Northern Aegean Basin*, vol 2, INSTAP Monograph Series, pp.3-52

Muir, P. 1985. *Studies of the Growth and Compositional Development of Antlers in Red Deer,* University of Canterbury, Canterbury.

Mylonas, G.E. 1929. *Excavations at Olynthos. Part I. The Neolithic settlement.* Oxford: Oxford University Press.

Mylonas G.E. 1941. The site of Akropotamos and the Neolithic period in Macedonia, *American Journal of Archaeology* 44: 557-576

Nandris, J. 1972. Bos primigenius and the bone spoon, *Bulletin of the Institute of Archaeology* 10: 63-82.

Nowak, R.M. 1991. *Walker's mammals of the world*, The Johns Hopins University Press. Baltimore, Maryland, EUA

Olsen, S.L. 1984. *Analytical Approaches to the Manufacture and Use of Bone Artifacts in Prehistory.* Unpublished Ph.D. Dissertation, Institute of Archaeology, University of London.

Olsen, S.L. 2007. Bone Artifacts and their Importance to Archaeology. In: Gates St-Pierre,C. and Walker, C.W(eds.*), Bones As Tools: Current Methods and Interpretations in Worked Bone Studies*, BAR International Series 1622. British Archaeological Reports, Oxford:175-182

Özdoğan, M. 2014. A new look at the Introduction of the Neolithic way of life in Southeastern Europa. Changing Paradigms of the Expansion of the Neolithic Way of Life, *Documenta Praehistorica* XLI: 33-49.

Page, F.J.T. 1971. *Guide to British Deer*, Oxford: Blackwell Scientific Publications, Second Edition

Papadopoulou, S. 2018. Preliminary remarks on the chipped stone industry from the lakeside settlement Anarghiri IXb, Western Macedonia, Greece.In: Fidanoski, L and Naumov, G. (eds.) *Neolithic in Macedonia III*, Proceedings of the Archaeological Conference held in the Archaeological Museum of Skopje, Macedonia: 67-82

Patou, M. (ed.). 1986. *Artefacts 3, Outillage peu élaboré en os et en bois de cervidés II,* Treignes, CEDARC

Patou-Mathis, M. (ed.) 2002. *Industrie de l'os préhistorique. Cahier X. Compresseurs, percuteur, retouchoirs. Os à impressions et éraillures*. (Editions Société Préhistorique Française, Paris,

Paul, J.W. 2016.*The prehistoric worked bone and antler assemblage at Uğurlu, Gökçeada: a local and regional perspective.* Unpublished Ph.D. thesis. School of Historical and Philosophical Studies Faculty of Arts, The University of Melbourne

Paul, J.W. and Erdoğu, B. 2017. An examination of the worked bone and antler ssemblage at Ugurlu (Gökçeada, Turkey), Documenta Praehistorica XLIV: 368-385

Peltier, A. 1986. Étude expérimentale des surfaces osseuses façonnées et utilisées, *Bulletin de la Société Préhistorique Française* 83(1): 5-7

Perlès, C. 2001. *The Early Neolithic in Greece: The First Farming Communities in Europe*, Cambridge.

Petillon, J-M. 2009. What are these barbs for? Preliminary study on the function of the Upper Magdalenian barbed weapon tips.In: Jean-Marc Petillon,J-M., Dias-Meirinho,M-H., Cattelain,P., Honneger,M., Normand, C., Valdeyron, N. (eds.), *Projectile Weapon Elements from the Upper Paleolithic to the Neolithic* (Proceedings of session C83, XVth world congress, UISPP, Lisbon, 4-9 September 2006) : 66-97

Phelps, W.W. 1975. *The Neolithic Pottery Sequences in Southern Greece*. Unpublished dissertation, University of London

Phelps, W.W. 2004. *The Neolithic pottery sequence in southern Greece*. BAR IS 259. Archaeopress. Oxford.

Pétrequin, P. 2005. Habitats lacustres néolithiques et perception du temps, In: *La perception du temps en Préhistoire*, 129e congrès du CTHS, Besançon, 19–24 avril 2004, *Bulletin de la Société Préhistorique Française*, 102(4): 789–802

Perlès, C. 2001. *The Early Neolithic in Greece: the first farming communities in Europe*. Cambridge: Cambridge University Press.

Pyke, G. and Yiouni, P.1996. The Excavation and the Ceramic Assemblage.In: Wardle,K.(ed.) *Nea Nikomedeia I: The Excavation of an Early Neolithic Village in Northern Greece,1961-1964.Directed by R.J. Rodden*, British School at Athens Suppl. 25, London

Picavet, P.P. and Balligand, M.2016. Organic and mechanical properties of Cervidae antlers: a review, *Veterinary Research Communications* 40:141–147

Pikula J., Koubek, P., Kratovchil,Z. and Kux, Z.1985. Age composition of roe deer population in Czechoslovakia. *Acta Scientiarum Naturalium,* Brno, 19: 1-46

Price, J. S., Allen, S., Faucheux, C., Althnaian, T. and Mount, J. G.2005. Deer antlers: a zoological curiosity or the key to understanding organ regeneration in mammals?, *Journal of Anatomy* 207: 603–618

Rajaram, A. and Ramanathan, N. 1982.Tensile properties of antler bone, *Calcified Tissue International* 34:301–305

Read, D.W. 1974. Some Comments on Typologies in Archaeology and an Outline of Methodology. *American Antiquity* 39(2):216-242

Read, D.W. 2013. *Artifact Classification: A Conceptual and Methodological Approach*, Routledge

Reingruber, A. 2005. The Argissa Magoula and the beginning of the Neolithic in Thessaly, In: Lichter, C. (ed.) 2005, *How did farming reach Europe? Anatolian-European relations from the second half of the 7th through the first half of the 6th millennium cal BC,* BYZAS 2, İstanbul, Ege Yayınları: 155-171

Reingruber, A. 2008. *Die Argissa-Magula. Das frühe und das beginnende Mittlere Neolithikum im Lichte Transägäischer Beziehungen, Beiträge zur Ur- und Frühgeschichtlichen Archäologie des Mittelmeer-Kulturraumes, Band 35*, Bonn, Verlag Dr. Rudolf Habelt.

Reingruber, A. 2015. Preceramic, Aceramic or Early Ceramic? The radiocarbon dated beginning of the Neolithic in the Aegean, *Documenta Praehistorica* 42:147-158

Reingruber, A. and Thissen, L. 2005. 14C database for the Aegean Catchment (Eastern Greece, Southern Balkans and Western Turkey) 10.000 - 5500 cal BC, In: Lichter, C. (ed.), How Did farming Reach Europe? Anatolian-European relations from the second half of the 7th through the first half of the 6th millennium cal. B.C., Proceedings of the International Workshop Istanbul, 20-22 May 2004, Byzas 2:295-327

Reingruber, A. and Thissen, L. 2009. Depending in 14C Data: Chronological frameworks in the Neolithic and Chalcolithic of Southeastern Europe, *Radiocarbon* Vol.51(2): 751–770

Reingruber, A., Toufexis, G., Kyparissi, N., Anetakis, M., Maniatis, Y. and Facorellis, Y. 2017. Neolithic Thessaly: radiocarbon dated periods and phases. Documenta Praehistorica 44:34-53.

Reitz, E.J. and Wing, E.S., 2008. *Zooarchaeology,* Cambridge University Press,Cambridge, 2nd edition

Renfew, C. 1972. *The emergence of civilization. The Cyclades and the Aegean in the third millennium* B.C. Methuen. London.

Ridley, C. and Ρωμιοπούλου, K. 1972. Prehistoric Settlement of Servia (West Macedonia): Excavations 1971, *Αρχαιολογικά Ανάλεκτα Εξ* Αθηνών 5:27-34.

Ridley C. and Wardle K. A. 1979. Rescue excavations at Servia 1971-1973: A preliminary report, *British School at Athens* 74: 185-230

Ridley, C., Wardle, K.A. and Mould, C.A. (eds.).2000 *Servia I: Anglo-Hellenic Rescue Excavations 1971–73, Directed by Katerina Rhomiopoulou and Cressida Ridley*. BSA Supplementary Volume 32. Athens

Riedel, K. 2003. *Materialorientierte und funktionelle Untersuchungen von Hirschgeweihgeraten aus dem Leinetal bei Koldingen/Gleidingen, Lkr Hannover*, DVM Thesis, School of Veterinary Medicine, Hannover

Riedel, K., Pohlmeyer, K., and von Rautenfeld,D.B. 2004. An examination of Stone Age/Bronze Age adzes and axes of red deer (Cervus elaphus L.) antler from the Leine Valley, near Hannover, *European Journal of Wildlife Research* 50:197–206

Rigaud, A. 2001. Les bâtons percés: décors énigmatiques et fonction possible, *Gallia Préhistoire* 43:101-151

Rodden, R.J. 1962. Excavations at the Early Neolithic site at Nea Nikomedeia, Greek Macedonia (1961 season). Proceedings of the Prehistoric Society 11: 267-288.

Rodden, R.J. 1964 .Recent discoveries from Prehistoric Macedonia: an interim report, *Balkan Studies*, 5(1):110-124

Rodden, R. J. 1965. An Early Neolithic village in Greece, *Scientific American* 212(3): 82-92.

Roozenburg, N.F. M. and Eekels, J.1995. *Product Design: Fundamentals and Methods.* Chichester, UK: John Wiley and Sons

Russell, N. 1990. The bone tools. In: Tringham, R. and Krstic,D.(eds.) *Selevac: A Neolithic Village in Yugoslavia. Los Angeles* UCLA Institute of Archaeology Press: 521-548

Sampson, A. 2002. *The Neolithic settlement at Ftelia, Mykonos*. University of the Aegean, Department of Meditteranean studies

Savchenko, S.2010. Experiments on Manufacturing Techniques of Mesolithic and Early Neolithic Slotted Bone Projectile Points From Eastern Urals. In: Legrand-Pineau, A., I. Sidéra, N. Buc, E.David and V. Scheinsohn (eds.), *Ancient and Modern Bone Artefacts from America to Russia: Cultural, technological and functional signature*, BAR International Series 2136. British Archaeological Reports, Oxford: 141-148

Schachermeyr, F. 1955. *Die ältesten Kulturen Griechenlands*. Stuttgart: W.Kohlhammer

Sherratt, A.G. 1981 .The Eneolithic Period in Bulgaria in its European Context. Ancient Bulgaria; papers presented to the International Symposium on the Ancient History and Archaeology of Bulgaria, University of Nottingham: 188-98

Schibler, J. 1981 .Typologische Untersuchungen der cortaillodzeitlichen Knochenartefakte. Die neolithischen Ufersiedlungen von Twann 17, Bern 1981.

Schibler, J. 1987. Die Knochenartefakte. In: Gross, E., Bleyer, E., Hardmeyer, B. und Haussener, H. (eds.) *Zürich "Mozartstraße". Neolithische und bronzezeitliche Ufersiedlungen 1*. Berichte der Zürcher Denkmalpflege. Monographien4, Zürich: 167-176

Schibler, J. 1997. Knochen-und Geweihartefakte. In: Schibler, J., Hüster-Plogmann, H., Jacomet, S. (eds.) *Ökonomie und Ökologie neolithischer und bronzezeitlicher Ufersiedlungen am Zürichsee*. Bd. A: Text. Monographien der Kantonsarchäologie Zürich 20, Zürich-Egg 1997: 122-219

Schibler, J. 2001a Red deer antler: exploitation and raw material management in Neolithic lake dwelling sites from Zürich, Switzerland. In: Buitenhuis, H. and Prummel, W. (eds.), *Animals and Man in the Past*. Essays in Honour of Dr. A.T. Clason, Emeritus Professor of archaeozoology Rijksuniversiteit Groningen, the Netherlands. ARC-Publicatie 41, Groningen: 82-94.

Schibler, J. 2001b .Experimental production of neolithic bone and antler tools. In:Choyke, A.M., Bartosiewicz, L. (eds.), *Crafting Bone: Skeletal Technologies through Time and Space*, Proceedings of the 2nd Meeting of the (ICAZ) Worked Bone Research Group Budapest, 31

August – 5 September 1999, British Archaeological Reports International Series 937. Archaeopress, Oxford: 49-60

Schibler, J. 2013. Bone and Antler Artefacts in Wetland Sites. In: Menotti, F. and Sullivan, A. (eds.), *The Oxford Handbook of Wetland Archaeology*, Oxford: 339-355

Schibler, J., Marti-Grädel, E., Deschler-Erb, S., Doppler, T. 2010. Hafted Points and their Functional Interpretation on the Basis of their Horizontal Distribution at the Neolithic Site of Arbon Bleiche 3 (3384 – 3370 BC), Switzerland. In: Legrand-Pineau, A., Sidéra, I., Buc, N., David, E., and Scheinsohn, V.(eds.), *Ancient and Modern Bone Artefacts from America to Russia. Cultural, technological and functional signature*, British Archaeological Reports International Series 2136, Oxford: 249-254

Searle, J. R. 1995. *The construction of social reality.* London, UK: Allen Lane.

Sedman, A.J.1993. *Mechanical failure of bone and antler:the accumulation of damage*, PhD Thesis, Departmentof Biology, University of York

Séfériadès, M. 1992. L'outillage: III. L'os et le bois de cervidé. In: Treuil, R. (ed.), *Dikili Tash, village préhistorique de Macédoine orientale, I. Fouilles de Jean Deshayes (1961-1975),* vol. 1, *Bulletin de Correspondance Hellénique* Supplément XXIV, Athènes: 99-119

Schiffer, M.B. 1992. *Technological perspectives on behavioural change.* Tucson,AZ: University of Arizona Press.

Schiffer, M.B. 2014*. The Archaeology of Science: Studying the Creation of Useful Knowledge* (Manuals in Archaeological Method, Theory and Technique), Springer, 2nd Edition

Schiffer, M. B. and Skibo, J.1987. Theory and experiment in the study of technological change. *Current Anthropology*, 28(4): 595–622

Schwab, H. 1971 .*Jungsteinzeitliche Fundstellen im Kanton Freiburg*, Basel: Schriften zur Ur- und Frühgeschichte der Schweiz, 16

Sellet, F. 1993. Chaine Opératoire; the Concept and its applications, *Lithic Technology* 18:106-12

Semenov, S.A. 1964. *Prehistoric Technology: an Experimental Study of the Oldest Tools and Artefacts from Traces of Manufacture and Wear*, London, Cory, Adams & Mackay,

Sempere, A., Sokolov, V. and Danilkin, A. 1996. Capreolus capreolus, *Mammalian Species*. American Society of Mammalogists: 1-7

Shanks, M. 1998. The role of artifact in interpretive archaeology, *Fennoscandia Archaeologica* XV: 15-30

Shott, M.J .2003 .Chaîne Opératoire and Reduction Sequence, *Lithic Technology* 28(2): 95-105.

Sidéra, I. 1993. *Les assemblages osseux en bassins parisien et rhénan du VIe au IVe millénaire BC. Histoire, techno-économie et culture*. Paris, Thèse de Doctorat de l'Université Paris-1

Sidéra, I.1998. Nouveaux éléments d'origine proche-orientale dans le Néolithique ancien balkanique.Analyse de l'industrie osseuse.In: Otte,M.(ed.), *Préhistoire d'Anatolie. Genèse de deux mondes.* Actes du Colloque international, Liège, 28 Avril – 3 Mai 1997. ERAUL, 85:215–239

Sidéra, I. 2005. Technical Data, Typological Data: A Comparison. In:Luik,H., Choyke, A.M., Batey, C., and L.Lougas(eds.*), From Hooves to Horns, from Mollusc to Mammoth-Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present*. 81- Tallin, Estonia: 81-90

Sidéra, I and Legrand, A.2006. Tracéologie fonctionnelle des matières osseuses: une méthode, *Bulletin de la Société Préhistorique* Française 103(2): 291–304

Solberg, E.J., Strand, O., Veiberg, V., Andersen, R., Heim, M., Rolandsen, C. M., Langvatn, R., Holmstrøm, F., Solem, M. I., Eriksen, R., Astrup, R., and Ueno, M. 2012. Moose, red deer and reindeer - Results from the monitoring program for wild cervids, 1991-2011. *NINA Report*, 885:1-156

Stone, L.M. 1970. *Formal classification and the analysis of historic artifacts*', *Historical Archaeology* 4: 90-102

Stordeur, D. 1983. Quelques remarques pour attirer l'attention sur l'intérêt d'une recherche commune entre tracéologues du silex et technologues de l'os. In: Cauvin, M.-C.(ed.), *Table ronde international,Traces d'utilisation sur les outils néolithiques du Proche Orient*, Travaux de la Maison de l'Orient No 5. Paris: CNRS: 231-240

Stordeur, D. 1986. Recherches technologiques appliquées au matériau osseux. *Bulletin de la Société préhistorique française*; vol. 83(3): 7

Stordeur, D. 1989. Des technologies nouvelles au service de la technologie? L'exemple des outils d'os préhistoriques *Notes et monographies techniques;* No 25: 127-150

Stratouli, G. 1998a .Knochenartefakte aus dem Neolithikum und Chalkolithikum Nordgriechenlands, BAM, Bonn

Stratouli, G. 1998b . Bone Artefacts from Makri. In: Efstratiou, N. Fumanal, M.P., Ferrer, C., Urem- Kotsos, D., Curci, A., Tagliacozzo, A., Stratouli,G., Valamoti,S.M. Ntinou,M., Badal,E., M. Madella, M., Skourtopoulou, K., Excavations at the Neolithic Settlement of Makri, Thrace, Greece (1988-1996) - A preliminary report, Saguntum (Plav) 31: 36-40

Stratouli, G., Triantaphyllou, S., Bekiaris, T. and Katsikaridis, N. 2010. Manipulation of death: a burial area at the Neolithic settlement of Avgi, NW Greece. *Documenta Praehistorica* 37:95–104

Stroulia, A. 2003. Ground stone celts from Franchthi Cave. A close look. *Hesperia* 72(1): 1-30

Straus, L.G. 1981. *On the habitat and diet of Cervus elaphus*. Munibe 33: 175-182

Stubbe, C. 1999. *Capreolus capreolus*. In: A. J. Mitchell-Jones, G. Amori, W. Bogdanowicz, B. Kryštufek,P. J. H. Reijnders, F. Spitzenberger, M. Stubbe, J. B. M. Thissen, V. Vohralík and J. Zima (eds.), *The Atlas of European Mammals*, Academic Press, London:400-401

Suter, P.J. 1981. Die Hirschgeweihartefakte der Cortaillod-Schichten, Die neolithischen Ufersiedlungen von Twann, Band 15, Bern

Suter, P. J. and Hafner, A. 2000. 3400. Die Entwicklung der Bauerngesellschaften im 4. Jahrtausend v. Chr. am Bielersee aufgrund der Rettungsgrabungen von Nidau und Sutz-Lattringen. Ufersiedlungen am Bielersee 6, Bern

Sztancs, D.-M., Luca, S.-A. and CBeldiman, C. 2010. The database of prehistoric bone and antler industry from Transylvania, Romania: some remarks about the Miercurea Sibiului – "Petriş " site, *Annales d'Université* „Valahia" Târgovişte, Section d'Archéologie et d'Histoire, Tome XII, Numéro 2:39-55

Sztancs, D.-M., Beldiman, C. and Bărbat, I.-A. 2013. Bone and antler artefacts dated from Starcevo-Cris culture in Transylvania: Recent discoveries and microscopic analyses, *Arheo vest I*, In Memoriam Liviu M*ă*ruia, Interdisciplinaritate în Arheologie şi Istorie, JATEPress Kiadó, Szeged:773-790

Sztancs, D.-M. and Beldiman, C. 2014. The Ariuşd (Erősd) - Cucuteni culture: Osseous materials artefacts. In: C. Preoteasa and C.-D. Nicola (eds.), *L'Impact Anthropique sur l'Enivronnement durant le Néo-Énéolithique du sud-est de l'Europe* . Piatra- Neamţ

Tejero, J.M., Christensen, M. and Bodu, P. 2013. Red deer antler technology and early modern humans in southeast Europe: An experimental study, *Journal of Archaeological Science 39(*2):332-346

Televantou, C.A. 2017 .Figurines from Strofilas, Andros.In:Marthari,M., Renfrew,C., and Boyd, M.J, (eds.), *Early Cycladic Sculpture in Context*, Oxbow Books, Oxford:39-52

Temelkoski, D and Mitkoski, A. 2006. The prehistoric settlement Mogila Senokos, *Macedoniae Acta Archaeologica* 17:55-75

Thomasson, A.L. 2009. Artifacts and human concepts. In: Margolis,E, and Laurence, S.(eds.) *Creations of the mind. Theories of artifacts and their representation*, Oxford: Oxford University Press :52-73

Todorova, H. 1978. *The Eneolithic in Bulgaria*, BAR 49

Todorova, H.1995. The Neolithic, Eneolithic and Transitional Period in Bulgarian Prehistory. In: D. W. Bailey, D.W., Panayotov, I. and Alexandrov, S. (eds.), *Prehistoric Bulgaria*. Monographs in World Archaeology 22:79–98

Todorova, H. 1999. Die Anfänge der Metallurgie an der westlichen Schwarzmeerküste.In: Hauptmann, A., Pernicka, E., Rehren, T. and Yalçin, Ü. (eds.), *The Beginnings of Metallurgy, Proceedings of the International Conference 'The Beginnings of Metallurgy,* Bochum 1995 (Bochum, Der Anschnitt Beiheft 9): 237–46

Toufexis, G. 2016. Palioskala: A Late Neolithic, Final Neolithic and Early Bronze Age settlement in the Eastern Thessalian plain, Central Greece. In: Tsirtsoni, Z.(ed.), The Human Faceof Radiocardon:Reassessing Chronology in Prehistoric Greece and Bulgaria, 5000-3000 BC, Maison de l'Orient et de la Méditerranée Jean Pouilloux, Lyon, (Travaux de la Maison de l'Orient 69):361-380

Tóth, Z. 2012. Bone, antler, and tusk tools of the Early Neolithic Körös culture. In: Anders, A. and Siklósi, Z. (eds.): *The First Neolithic Sites in Central/South-East European Transect*, Volume III. The Körös Culture in Eastern Hungary, British Archaeological Reports International Series 2334, 171-178

Tsoraki, C. 2008. *Neolithic society in Northern Greece: the evidence of ground stone artefacts*, Ph.D. Thesis, University of Sheffield

The Deer Initiative 2008a. Species Ecology: Red Deer (available on-line: *http://www.thedeerinitiative.co.uk/uploads/guides/168.pdf*, Last accessed:13/04/2015)

The Deer Initiative 2008b. Species Ecology: Roe Deer (available on-line: *http://www.thedeerinitiative.co.uk/uploads/guides/169.pdf* Last accessed:13/04/2015)

Tomkins, P. 2007 .Neolithic: Strata IX–VIII, VII–VIB, VIA–V, IV, IIIB, IIIA, IIB, IIA and IC Groups. In: N.Momigliano (ed.), *Knossos Pottery Handbook: Neolithic and Bronze Age (Minoan),* British School at Athens: 9–48

Tomkins, P. 2008. Time, Space and the Reinvention of the Cretan Neolithic.In:Isaakidou,V. and P.Tomkins(eds.), *Escaping the Labyrinth: The Cretan Neolithic in Context*, Sheffield Studies in Aegean Archaeology 8:21-48

Tomkins, P. 2009. Domesticity by default.Ritual, ritualization and cave-use in the Neolithic Aegean, *Oxford Journal of Archaeology* 28(2): 125-153

Tóth, Z. 2012. Bone, antler and tusk tools of the Early Neolithic Körös culture. In:Anders, A., Siklósi, Zs. (eds.), *Central/SouthEast European Transect, volume III: The Körös Culture in Eastern Hungary*, BAR International Series 2334, Oxford: 171-178

Trantalidou, K., E. Belegrinou and Andreasen, N.H. 2011. Pastoral societies in the Southern Balkan Peninsula. The evidence from caves occupied during the Neolithic and Chalcolithic Era.In: *Proceedings of the International conference*: *The phenomena of cultural borders and border cultures across the passage of time*, *Anodos* 10: 295–320

Trantalidou, K. and Andersen, N.H. 2015. Pastoralists' equipment at the Piges Koromilias cave, a livestock shelter in the Haliakmon river drainage system, *Aegean Archaeology* 11 (2011):35-60.

Tringham, R.E. 2003. Flaked Stone. In: Elster E. S. and Renfrew C. (eds.), *Prehistoric Sitagroi: Excavations in Northeast Greece, 1968–1970. Volume 2: The Final Report*, Cotsen Institute of Archaeology, University of California, Los Angeles: 81–126

Vitelli, K.D. 1993. *Franchthi Neolithic Pottery.* Excavations at Franchthi Cave, Greece, Fascicle 8, Vol. 1. Indiana University Press, Bloomington, IN

Vitezović, S. 2007. *Koštana industrija u neolitu srednjeg Pomoravlja*. Magistarska teza, Filozofski fakultet, Univerzitet u Beogradu.

Vitezović, S. 2011a. *Koštana industrija u starijem i srednjem neolitu centralnog Balkana.* Nepublikovana Doktorska disertacija. Beograd: Filozofski fakultet, Univerzitet u Beogradu

Vitezović, S. 2011b. The Neolithic Bone Industry from Drenovac, Serbia. in: Baron, J. and Kufel-Diakowska, B. (eds.), *Written in Bones. Studies on technological and social contexts of past faunal skeletal remains*, Uniwersytet Wrocławki, Instytut Archeologii, Wroclaw: 117-135

Vitezović, S. 2012. Osseous Projectiles from the site Starcevo-Grad, *Journal of the Serbian Archaeological Society* 28: 233-246

Vitezović, S. 2013a. Bone Industry from Starčevo-Grad: Technology and Typology. in: Lang, F.(ed.),*The Sound of Bones.* Proceedings of the 8th Meeting of the ICAZ Worked Bone Research Group in Salzburg 2011, Archaeo Plus. Schriften zur Archäologie und Archäometrie der Paris Lodron-Universität Salzburg 5:263-276

Vitezović, S. 2013b. Bone manufacturing in the Neolithic: the problems of reconstructing the chaîne opératoire and identifying workshops. – Archeometriai Műhely / Archaeometry Workshop 2013 /X /3:201-208

Vitezović, S. 2013c. Osseous Raw Materials in Vinča Culture. In: Choyke, A.M. and O'Connor, S. (eds.), *From These Bare Bones: Raw Materials and the Study of Worked Osseous Objects*, Oxbow, Oxford: 59-72

Vitezović, S. 2013d. Retouching Tools from Osseous Raw Materials in the Starčevo Culture, *Haemus Journal* 2:31-42

Vitezović, S. 2013e. Vincanska koštana industrija sa Divostina, *Zb. Nar. muzeja XXI-1*:109-127

Vitezović, S. 2014a. Antlers as raw material in the Starcevo culture. In: Vitezović, S. and Antonović, D. (eds.*), Archaeotechnology: Studying Technology from Prehistory to the Middle Ages*, Srpsko arheolo sko dru stvo, Beograd: 151-176.

Vitezović, S. (ed.) 2016. *Close to the bone: current studies in bone technologies*, Beograd

Vitezović, S. 2017. Antler exploitation and management in the Vinca culture: An overview of evidence from Serbia, *Quaternary International* 450 :209-223

Vitezović, S. 2018. Retouching tools from the Post-Palaeolithic period in Southeast Europe, In: Hutson, J.M., García-Moren, A., Noack, E.S, Turner, E, Villaluenga, A., Gaudzinski-Windheuser, S., (eds.), *Retouching the Palaeolithic: Becoming Human and the Origins of Bone Tool Technology,* Conference at Schloss Herrenhausen in Hannover, Germany, 21.- 23. October 2015, RGZM-Tagungen, Band 35:1-19

Vitezović, S. and Bulatović, J. 2013. Managing raw materials in Vinca culture: a case study of osseous raw materials from Vitkovo, *Documenta. Prehistorica* 40: 279-289

Voruz, J-L. 1984. *Outillage osseux et dynamisme industriel dans le Néolithique Jurassien*, Cahiers d'archéologie romande, 29, Lausanne: Bibliothèque Historique Vaudoise.

Voruz, J-l. 1987. *Typologie analytique d'industries osseusses néolithiques. l'industrie en os et bois de cervidé durant le Néolithique et l'age des metaux* II. paris. C.N.R.S.: 77-105

Voruz, J-L. 1989. L'outillage en os et en bois de cerf, in P. Pétrequin (ed.), *Les sites littoraux néolithiques de Clairvaux-les-Lacs (Jura), t. II Le Néolithique moyen*, Paris, Éd. MSH (Archéologie et culture matérielle): 313-341

Voruz, J-L. 1997. L'outillage en os et en bois de cerf de Chalain 3, In Petrequin,J.-C.(ed.), *Les sites littoraux néolithiques de Clairvaux-les-lacs et de Chalain (Jura) III. Chalain Station 3, 3200-2900,* Paris, Maison des Sciences de l'Homme: 467-510

Walter, H. and Felten, F. 1981. *Alt-Aegina Vol. III, 1. Die vorgeschichtliche Stadt*. Befestigungen. Häuser. Funde, Mainz

Wescott, D. 1999. *Primitive Technology: A Book of Earth Skills*. Gibbs Smith.

Whittaker, J.C., Caulkins, D. and Kam, K.A. 1998. Evaluating Consistency in Typology and Classification, *Journal of Archaeological Method and Theory*, Vol. 5(2): 129- 164

Wace, A.J.B. and Thompson, W.B. 1912. Prehistoric Thessaly, Cambridge

Walvius, M.R. 1961. A discussion of the size of recent red deer (Cervus elaphus L.) compared with prehistoric specimens, *Beaufortia* 9: 75-82.

Wardle, K. 2014. The contribution of the British School at Athens and its members to a century of prehistoric research in Macedonia στο Ευαγγελία Στεφανή,Ευ.,Μερούσης. Ν. και Α. Δημουλά (επ.), *1912-2012. Εκατό χρόνια έρευνας στην προϊστορική Μακεδονία.* Πρακτικά διεθνούς συνεδρίου, Αρχαιολογικό Μουσείο Θεσσαλονίκης, 22-24 Νοεμβρίου 2012,Θεσσαλονίκη,σ.45-56

Wardle K.A. και Βλαχοδημητροπούλου Β. 2000. Ανασκαφή Σερβίων Κοζάνης 1971-73: Αποτελέσματα, *Το Αρχαιολογικό Έργο στη Μακεδονία και* Θράκη 12 (1998):543-556

Weinberg, S.S. 1947.Aegean Chronology: Neolithic Period and Early Bronze Age, *American Journal of Archaeology* LI:165-82

Weinberg, D.R. 1970. The Stone Age in the Aegean.In: Edwards, I, Gadd, C., and Hammond, N. (eds.), *The Cambridge Ancient History*,Cambridge: Cambridge University Press: 557-618

Weisshaar, H.J. 1978. Kupferzeitliche Funder von der Pyrassos-Magula, *Archaeologisches Korrespondezblatt* 8: 181-196

Wey, O. 2001. *Die* Cortaillod-*Kultur in der Zentralschweiz: Studien an Hand der Keramik und des Hirschgeweihmaterials,* Archäologische Schriften Luzern

Wijnen, M. 1982. *The Early Neolithic I Settlement at Sesklo: An Early Farming Community in Thessaly, Greece,* Leiden: Analecta Praehistorica Leidensia.

Whitehead, G. 1964. *The deer of Great Britain and Ireland an account of their history, status and distribution*. London: Routledge & K. Paul.

Wilkie N.C. 1993. The Grevena Project, Αρχαία Μακεδονία V, Πέμπτο διεθνές συμπόσιο, Θεσσαλονίκη, IMXA: 1747–55

Wilkie, N.C. 1999. Some aspects of the prehistoric occupation of Grevena", *Αρχαία Μακεδονία. Έκτο διεθνές συμπόσιο*, τομ. 2, Θεσσαλονίκη, ΙΜΧΑ:1345-1357

Wilkie, N. C. and Savina, M.E. 1992. *Notes, lists and maps of the archaeological sites recorded during a surface survey of the nomos of Grevena, Greece. Northfield, Minnesota*: Notes on archaeological sites of the Nomos of Grevena.

Wilkie, N. C. and Savina, M.E. 1997. The earliest farmers in Macedonia, *Antiquity* 71: 201-207

Wilkie, N. C., J. Rosser, M. E. Savina and R. B. Doyle 1990.The Grevena Project, 1988-1989, *American Journal of Archaeology* 94(2): 309-309.

Wilson, D.E. and Reeder, D.M. (eds.). 2005. Mammal Species of the World. A Taxonomic and Geographic Reference, Third edition**,** Johns Hopkins University Press, Baltimore

Wilson, D.E. and Mittermeier, R.A. 2011. *Handbook of the mammals of the world. Vol. 2. Hoofed mammals*. Lynx Edicions, Barcelona, Spain

Winiger, J.1985. *Das Neolithikum der Schweiz*, Basel: Unveraederte Neueflage 16

Wislocki, G.B. and Waldo, C.M. 1953. Further observations on the istological changes associated with the shedding of the antlers of the white-tailed deer (Odocoileus virginianus borealis), *Anatomical Record 117*:353-375.

Wyss, R. 1994. *Steinzeitliche Bauern auf der Suche nach neuen Lebensformen. Egolzwil 3 und die Egolzwiler Kultur. Band 1: Die Funde.* Archaeologische Forschungen, Zürich

Yeshurun, R., Tejero, J.-M., Barzilai, O., Hershkovitz, I., Marder, O. 2018. Upper Palaeolithic Bone retouchers from Manot Cave (Israel): A preliminary analysis of a (yet) rare phenomenon in the Levant, In: Hutson,J.M., García-Moren,A., Noack, E.S, Turner, E, Villaluenga, A., Gaudzinski-Windheuser, S., (eds.), Retouching the Palaeolithic: Becoming Human and the Origins of Bone Tool Technology, Conference at Schloss Herrenhausen in Hannover, Germany, 21.- 23. October 2015, RGZM-Tagungen, Band 35: 287-296

Zidarov, P.2005. Bone artefacts, *Acta archaeologica* 76(1), Supplementa 6:124-131

Zidarov, P. 2014. Knochen-und Geweihgeräte: Traditionen und Praktiken im Alltag der Einwohner von Ovčarovo-Gorata. In Krauss R. (ed.), *Ovcarovo-Gorata. Eine frühneolithische Siedlung in Nordostbulgarien*. Habelt Verlag, Bonn: 250-270

Zimmerman, T.2007. Anatolia and the Balkans, once again-ring-shaped idols from Western Asian and a critical reassessment of some 'Early Bronze Age' items from Ikiztepe, Turkey, *Oxford Journal of Archaeology* 26(1): 25–33

Zioupos, P., Currey, J.D. and Sedman, A.J 1994. An examination of the micromechanics of failure of bone and antler by acoustic emission tests and laser scanning confocal microscopy, *Medical Engineering and Physics* 16:203–12

Ακαμάτη, Μ. και Βελένη, Π.1987.*Νομός Φλώρινας.Απο τα προϊστορικά στα ρωμαϊκά χρόνια*. Αθήνα, Υπουργείο Πολιτισμού

Αραμπατζής, Χ. 2006. *Τα οστέινα εργαλεία από τους Προσκυνητές Ροδόπης*, Αδημοσίευτη μεταπτυχιακή εργασία, Τμήμα Ιστορίας και Αρχαιολογίας, Φιλοσοφική Σχολή, Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης

Ασλάνης, Ι. 1992. *Η προϊστορία της Μακεδονίας: η Νεολιθική εποχή*. Athens: N.P. Goulandris Foundation.

Ασλάνης, Ι. 1993. Η χαλκολιθική περίοδος στο βορειοελλαδικό χώρο. Προβλήματα αναγνώρισης και διάρκειας,Στο: Αρχαία Μακεδονία V: ανακοινώσεις κατά το Πέμπτο Διεθνές Συμπόσιο, Θεσσαλονίκη, 10 - 15 Οκτωβρίου 1989. Στη μνήμη Μανόλη Ανδρόνικου, vol. 1. Ι.Μ.Χ.Α., Θεσσαλονίκη:133-145

Ασλάνης, Ι. 2003 .Η 'αφανής' χαλκολιθική εποχή στην Ελλάδα: μια άλλη μεθοδολογική προσέγγιση Στο: *Η προϊστορική έρευνα στην Ελλάδα και οι προοπτικές της: Θεωρητικοί και μεθοδολογικοί προβληματισμοί: Πρακτικά διεθνούς συμποσίου στη μνήμη του Δ. Ρ. Θεοχάρη*: Θεσσαλονίκη - Καστοριά, 26 - 28 Νοεμβρίου 1998. University Studio Press, Θεσσαλονίκη: 37-46

Ασλάνης, Ι.2010. Η κατοίκηση στην Ελλάδα κατά την 5η και 4η χιλιετία π.Χ. Στο: Παπαδημητρίου, Ν.(επιμ.), *Η Ελλάδα στο ευρύτερο πλαίσιο των Βαλκανίων κατά την 5η και 4η χιλιετία π.Χ.*, Athens: Museum of Cycladic Art – N.P. Goulandris Foundation: 38–53

Γαλλής, Κ. 1992. Άτλας Προϊστορικών Οικισμών της Ανατολικής Θεσσαλικής Πεδιάδας, Λάρισα

Γαλλής, Κ. 1996. Ο νεολιθικός κόσμος, Στο: Γ. Παπαθανασόπουλος (επιμ.), *Νεολιθικός Πολιτισμός στην Ελλάδα*, Αθήνα: Ίδρυμα Ν.Π. Γουλανδρή:23-37

Γιαννακοπούλου, Κ.2009.*Τα οστέινα εργαλεία και τα μικροαντικείμενα της Νεολιθικης Περιόδου από τη Φτελιά Μυκόνου και το σπήλαιο Σαρακηνού Βοιωτίας*, Αδημοσίευτη διδακτορική διατριβή, Τμήμα Μεσογειακών Σπουδών, Σχολή Ανθρωπιστικών Σπουδών, Πανεπιστήμιο Αιγαίου

Γραμμένος, Δ.Β. 1991. Νεολιθικές Έρευνες στην Κεντρική και Ανατολική Μακεδονία, Βιβλιοθήκη της εν Αθήναις Αρχαιολογικής Εταιρείας 117

Δογιάμα, Τ.-Ε.2009. *Μικρή Βόλβη:Ένας οικισμός της Αρχαιότερης Νεολιθικής μέσα από το πρίσμα της λιθοτεχνίας του*, Αδημοσίευτη μεταπτυχιακή εργασία,Τμήμα Ιστορίας και Αρχαιολογίας, Φιλοσοφική Σχολή, Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης

Θεοδωροπούλου, Τ. 2008. Ο άνθρωπος και η λίμνη: Ψαράδες και ψαρέματα στο Προϊστορικό Δισπηλιό, *Ανάσκαμμα* 2:25-45

Θεοχάρης, Δ.Ρ. 1958. Ανασκαφαί και Έρευναι εν Τρίκκη, *Πρακτικά* της εν Αθήναις *Αρχαιολογικής Εταιρείας* 1958: 68-73

Θεοχάρης, Δ.Ρ. 1967. *Η αυγή της Θεσσαλικής Προϊστορίας*, Βόλος (Φιλάρχαιος Εταιρεία Βόλου)

Θεοχάρης, Δ.Ρ. 1973a. Ανασκαφαί εν Σέσκλω, *Πρακτικά* της εν Αθήναις *Αρχαιολογικής Εταιρείας* 1973:22-25

Θεοχάρης, Δ.Ρ. 1973b. *Νεολιθική Ελλάς*, Αθήνα

Ζάχος, Κ. 2010. Η μεταλλουργία στην Ελλάδα και στη ΝΑ Ευρώπη κατά την 5η και 4η χιλιετία π.Χ. Στο: Παπαδημητρίου,Ν. (επιμ.), *Η Ελλάδα στο ευρύτερο πλαίσιο των Βαλκανίων κατά την 5η και 4η χιλιετία π.Χ.*, Athens: Museum of Cycladic Art – N.P. Goulandris Foundation:76-91

Ζιώτα, Χ. 2001. Κίτρινη Λίμνη. *Αρχαιολογικόν Δελτίον* 51 (1996): 536–40

Ζιώτα,Χ. 2007. *Ταφικές πρακτικές και κοινωνίες της εποχής του Χαλκού στη Δυτική Μακεδονία: τα νεκροταφεία στην κοιλάδα και στις Γούλες Κοζάνης*, Αδημοσίευτη διδακτορική διατριβή, Τμήμα Ιστορίας και Αρχαιολογίας, Φιλοσοφική Σχολή, Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης

Ζιώτα, Χ. 2009. Ο νεολιθικός οικισμός «Κλείτος 1» και τα νεότερα δεδομένα για την προϊστορική έρευνα, *Το Αρχαιολογικό Έργο στην Ανω Μακεδονία* 1: 211-230

Ζιώτα, Χ. 2014a. Η ανασκαφή στο Κλείτος Κοζάνης το 2010, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 24(2010): 53-62

Ζιώτα, Χ. 2014b. Ο οικισμός Κλείτος Ι στο ευρύτερο φυσικό και ανθρωπογενές περιβάλλον της Νεότερης Νεολιθικής περιόδου. Στο: Ε. Στεφανή, Ν. Μερούσης και Α. Δημουλά (επιμ.), *Εκατό Χρόνια Έρευνας στην Προϊστορική Μακεδονία, 1912- 2012, Πρακτικά Διεθνούς Συνεδρίου, Θεσσαλονίκη, 22-24 Νοεμβρίου 2012*, Αρχαιολογικό Μουσείο Θεσσαλονίκης:323-336

Ζιώτα, Χ. και Μοσχάκης, Κ. 1999.Από την Αρχαιολογική έρευνα στην αρχαία Εορδαία. Η ανασκαφή στο Φιλώτα Φλώρινας, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 11(1997): 43-56

Ζιώτα, Χ., και Χονδρογιάννη-Μετόκη, Α. 1997. Αλιάκμων 1993: προϊστορική έρευνα, *Το αρχαιολογικο Έργο στη Μακεδονία και Θράκη* 7 (1993): 33–42

Ζιώτα, Χ., Χονδρογιάννη-Μετόκη, Α. και Μαγγουρέτσιου,Ε. 2013. Η αρχαιολογική έρευνα στον Κλείτο Κοζάνης το 2009, *Το αρχαιολογικο Έργο στη Μακεδονία και Θράκη* 23 (2009): 37– 52.

Ζιώτα, Χ., Καλογήρου, Α., Φωτιάδης, Μ και Χονδρογιάννη, **Α. 1993**. Κίτρινη Λίμνη: τέσσερα χρόνια έρευνας, *Το αρχαιολογικο Έργο στη Μακεδονία και Θράκη* 4 (1990): 93–104

Κακαβάκης, Ο. 2012. *Οι λιθοτεχνίες πελεκημένου λίθου της νεολιθικής εποχής στην ανατολική και κεντρική Μακεδονία: παράγοντες και συνθήκες διαφοροποίησης*, Αδημοσίευτη διδακτορική διατριβή, Τμήμα Ιστορίας και Αρχαιολογίας. Τομέας Αρχαιολογίας και Ιστορίας της Τέχνης, Φιλοσοφική Σχολή, Εθνικό και Καποδιστριακό Πανεπιστήμιο Αθηνών

Καραμήτρου-Μεντεσίδη Γ. 1995. Γούλες, Αρχαιολογικόν Δελτίον 44 (1989), Χρονικά Β΄2, σ. 366

Καραμήτρου-Μεντεσίδη Γ. 1987. Προϊστορικοί οικισμοί Κίτρινης Λίμνης Κοζάνης, *Αμητός*: *Τιμητικός_τόμος_για_τον_Μ._Ανδρόνικο*, Θεσσαλονίκη:391-416

Καραμήτρου-Μεντεσίδη, Γ. 2000. Ξηρολίμνη Κοζάνης 1998, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 1(1998):465-480

Καραμήτρου-Μεντεσίδη, Γ. 2001. Νομός Κοζάνης 1999: Ανασκαφές εν Οδοίς και Παροδίως, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 13:337-368

Καραμήτρου-Μεντεσίδη, Γ. 2002. Νομός Κοζάνης 2000: Ανασκαφές εν Οδοίς και Παροδίως, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 14: 607-640

Καραμήτρου-Μεντεσίδη,Γ.2007a. Μαυροπηγή 2005: Λιγνιτωρυχεία και αρχαιότητες, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 19 (2005): 511-539

Καραμήτρου-Μεντεσίδη,Γ.2007b. Νομός Γρεβενών (Κνιδή, Πριόνια) 2005,*Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 19 (2005): 541-561

Καραμήτρου-Μεντεσίδη, Γ. 2014. Περί Προϊστορικών Θέσεων στη Δυτική Μακεδονία: Νομοί Κοζάνης και Γρεβενών. Στο: Ε. Στεφανή, Ν. Μερούσης και Α. Δημουλά (επιμ.), *Εκατό Χρόνια Έρευνας στην Προϊστορική Μακεδονία, 1912- 2012, Πρακτικά Διεθνούς Συνεδρίου, Θεσσαλονίκη, 22-24 Νοεμβρίου 2012*, Αρχαιολογικό Μουσείο Θεσσαλονίκης: 233-250

Καραμήτρου-Μεντεσίδη, Γ, Λόκανα, Χ. και Κ. Αναγνωστοπούλου.2014.Δύο θέσεις της αρχαιότερης και μέσης νεολιθικής στην Ποντοκώμη και Μαυροπηγή Εορδαίας,*Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 24 (2010): 39-52

Κεραμόπουλος, Α.1937. Μακεδονικά εγχωρίου κατασκευής λίθινα εργαλεία, *Αρχαιολογική Εφημερίς*, μέρος Α΄: 367-73

Κεραμόπουλος, Α.1938. *΄Ερευναι εν τη Δυτική Μακεδονία*. Πρακτικά της εν Αθήναις Αρχαιολογικής Εταιρείας 1938: 53-66

Κεραμόπουλος, Α.1940. Ανασκαφή εν Καστοριά. Πρακτικά της εν Αθήναις Αρχαιολογικής Εταιρείας: 22-23

Κοτταρίδη, Α. 2002. Απο τη νεκροπολη των Αιγών στο νεολιθικό οικισμό των Πιερίων , Το *Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 14:527-535

Κυπαρρίση-Αποστολίκα, Ν.2001. *Τα Προϊστορικά κοσμήματα της Θεσσαλίας,* Ταμείο Αρχαιολογικών Πόρων και Απαλλοτριώσεων, Αθήνα

Κωτσάκης,Κ. και Halstead,P.2004. Ανασκαφή στα Νεολιθικά Παλιάμπελα Κολινδρού, Το Αρχαιολογικό Έργο στη Μακεδονία και Θράκη 16(2002):407-416

Μανιάτης, Γ. 2014. Χρονολόγηση με Άνθρακα-14 των Μεγάλων Πολιτισμικών Αλλαγών στην Προϊστορική Μακεδονία: Πρόσφατες Εξελίξεις. Στο: Ε. Στεφανή, Ν. Μερούσης και Α. Δημουλά (επιμ.), *Εκατό Χρόνια Έρευνας στην Προϊστορική Μακεδονία, 1912-2012, Πρακτικά Διεθνούς Συνεδρίου, Θεσσαλονίκη, 22-24 Νοεμβρίου 2012,* Αρχαιολογικό Μουσείο Θεσσαλονίκης, σελ.205-220

Μανιάτης, Γ, Κωτσάκης, Κ., και P.Halstead. 2015. Παλιάμπελα Κολινδρού. Νέες χρονολογίες της αρχαιότερης νεολιθικής στη Μακεδονία, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 25 (2011):149-156

Μοσχάκης, Κ. 1998. Φιλώτας Φλώρινας.Δυο χρόνια Ανασκαφής (συνοπτική εκθεση των πρώτων αποτελεσμάτων*), Εταιρία: Περιοδική Έκδοση Γραμμάτων και Τεχνών Φλώρινας* 30:19-32

Μυλωνάς.Γ.Ε. 1928. *Η Νεολιθική Εποχή εν Ελλάδι*.Βιβλιοθηκη της εν Αθηναις Αρχαιολογικής Εταιρείας 24 (ανατύπωση του 1976)

Ντίνου, Μ. 2002. Η παλαιοβλάστηση γύρω από τον οικισμό και η χρήση της. Στο: Χουρμουζιάδης, Γ.(εκδ.), *Δισπηλιό: 7500 χρόνια μετά*, Thessaloniki: University Studio Press:317–30

Ντίνου, Μ. 2008. Η εφαρμογή της ανθρακολογίας στο νεολιθικό οικισμό της Αυγής. http://www.neolithicavgi.gr/?page_id=116&langswitch_lang=el
Last accessed : 12/10/2016

Ντίνου, Μ. 2010. Παλαιοπεριβάλλον και ανθρώπινες δραστηριότητες: η ανθρακολογία στο λιμναίο οικισμό στο Δισπηλιό Καστοριάς, *Ανασκαμμα* 3:45–60.

Παπαδάκου, Τ., Ούρεμ-Κώτσου, Ντ., και Κωτσάκης, Κ. 2015. Κεραμική της αρχαιότερης νεολιθικής από τα Παλιάμπελα Κολινδρού, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 25 (2011):157-162

Παππά, Μ. 1998. Λήμματα καταλόγου αρ.72-73, 101-104. Στο:Δημακοπούλου, Κ.(επιμ.), *Κοσμήματα της Ελληνικής Προϊστορίας: Ο Νεολιθικός Θησαυρός*, Ταμείο Αρχαιολογιών Πόρων και Απαλλοτριώσεων 67:74-75

Ρωμιοπούλου, Κ. 2014. Οι αρχές της προϊστορικής έρευνας στη Μακεδονία Στο Ευ. Στεφανή, Ευ.,Μερούσης. Ν. και Δημουλά, Α.(επ.), *1912-2012. Εκατό χρόνια έρευνας στην προϊστορική Μακεδονία.* Πρακτικά διεθνούς συνεδρίου, Αρχαιολογικό Μουσείο Θεσσαλονίκης, 22-24 Νοεμβρίου 2012,Θεσσαλονίκη:31-36

Σαμαρτζίδου, Ε. 2014. *Η παλαιοπανίδα στους λιμναίους οικισμούς της νεολιθικής Ευρώπης: η περίπτωση του Δισπηλιού Καστοριάς*. Αδημοσίευτη Διδακτορική Διατριβή, Τμήμα Ιστορίας και Αρχαιολογίας, Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης

Σάμψων, Α 1993. *Σκοτεινή Θαρρουνιών. Το σπήλαιο, ο οικισμός και το νεροταφείο*, Τμήμα Παλαιοντολογίας-Σπηλαιολόγιας, ΕΚΠΑ, Αθήνα

Σκουρτοπούλου, Κ. 2004.Η λιθοτεχνία αποκρουσμένου λίθο στον οικισμό της Σταυρούπολης. Στο:Γραμμένος, Δ.Β. και Κώτσος, Σ. (επιμ.*), Σωστικές Ανασκαφές στο Νεολιθικό Οικισμό Σταυρούπολης Θεσσαλονίκης , Μέρος ΙΙ (1998-2003),* Δημοσιεύματα του Αρχαιολογικού Ινστιτούτου Βόρειας Ελλάδας Αρ. 6.Θεσσαλονίκη:361-476

Σταυριδόπουλος, Γ. και Τ. Σιάνος. 2009. Ο λίθινος περίβολος του Δισπηλιού, *Ανάσκαμμα* 4:143-52

Στρατούλη, Γ. 2002. Τα εργαλεία από λειασμένο λίθο, οστό και κέρατο. Στο:Χουρμουζιάδης, Γ. (επιμ.), Δισπηλιό, 7500 χρόνια Μετά. Θεσσαλονίκη: University Studio Press: 155-174

Στρατούλη, Γ. 2004. Νεολιθική Αυγή Καστοριάς: ένα χωριό πριν από 7500 χρόνια, *Archaeology and Arts* 91: 110–16

Στρατούλη, Γ. 2006. Νεολιθική Αυγή Καστοριάς 2003–2004: τα πρώτα βήματα ενός ερευνητικού προγράμματος, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 18 (2004): 661– 668

Στρατούλη, Γ. 2010. Νεολιθικός Οικισμός Αυγής Καστοριάς 2006–2007: χωρο-οργανωτικές πρακτικές 6ης και 5ης χιλιετίας, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη 21* (2007): 7– 14

Στρατούλη, Γ. 2011. Αυγή: ο νεολιθικός οικισμός: πρώτες ανασκαφικές έρευνες, Αρχαιολογικόν Δελτίον 57: 436–39

Στρατούλη, Γ.2013. Νέες ανασκαφικές έρευνες στη Νεολιθική Μακεδονία (μέρος Δ’): Νεολιθικός οικισμός Αυγής Καστορίας: μία αγροτική κοινωνία της 6ης και 5ης χιλιετίας σε μετάβαση. *Archaeology & Arts* (http://www.archaiologia.gr/blog/2013/10/07/νέες-ανασκαφικές-έρευνες-στη-νεολιθι-4/) Last accessed: 04/05/2016

Στρατούλη, Γ. και Μπεκιάρης, Τ. 2010. Αυγή Καστοριάς: στοιχεία της βιογραφίας του νεολιθικού οικισμού, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 22 (2008): 1–10

Στρατούλη, Γ., Κατσικαρίδης, Ν., Μπεκιάρης,Τ., Τζεβελεκίδη, Β. 2014. Ενσωματώνοντας το παρελθόν, προσδιορίζοντας το παρόν, νοηματοδοτώντας το μέλλον: αναγνώριση και ερμηνεία των πρακτικών δομημένης (εν)απόθεσης στο νεολιθικό οικισμό Αυγής Καστοριάς στη Βόρεια Ελλάδα. Μακεδονία Στο Ευ. Στεφανή,Ευ.,Μερούσης. Ν. και Α. Δημουλά (επ.), *1912-2012. Εκατό χρόνια έρευνας στην προϊστορική Μακεδονία.* Πρακτικά διεθνούς συνεδρίου, Αρχαιολογικό Μουσείο Θεσσαλονίκης, 22-24 Νοεμβρίου 2012,Θεσσαλονίκη:349-358

Τουφεξής, Γ. 1998. Ανασκαφή στο Νεολιθικό Οικισμό Κρεμαστός του Ν. Γρεβενών, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 8:17-26

Τρανταλίδου Κ. 1989 .Προϊστορικοί οικισμοί στις λεκάνες της Φλώρινας και του Αμυνταίου (Δυτική Μακεδονία), *Αρχαία Μακεδονία* V, τόμος 3:1593-1622

Τρανταλίδου, Κ., Καρκάνας, Π., Μπελεγρίνου, Ε. και Χατζηθεοδώρου, Θ. 2007. Σπήλαιο σε μια Σημαντική δίοδο Της δυτικής Μακεδονίας, Στο φαράγγι Λιβαδοποτάμου. Πρώτη Παρουσίαση, *Το Αρχαιολογικό Έργο στη Μακεδονία και Θράκη* 19 (2005): 579-594

Τσούγγαρης, Χ.1999.Ανασκαφικές έρευνες στον Νομό Καστοριάς το 1997, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 11 (1997): 19–30

Τσούγγαρης, Χ. 2006. Νομός Καστοριάς: Κρεπενή Μαυροχωρίου, *Αρχαιολογικό Δελτίον* 54 : 644–645

Τσούγγαρης,, Χ. Σαλονίδης, Τ. , Δούμα,Α. και Σαρηγιαννίδου, Χ. 2004. Κολοκυνθού: ένας παραποτάμιος νεολιθικός οικισμός του Ν. Καστοριάς, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 16 (2002): 625–40

Τσούντας, Χ. 1908.Αι Προϊστορικαί Ακροπόλεις Διμηνίου και Σέσκλου, Βιβλιοθήκη της εν Αθήναιας Αρχαιολογικής Εταιρείας 14

Υφαντίδης, Φ.2006. *Τα Κοσμήματα του Νεολιθικού Οικισμού Δισπηλιού Καστοριάς: Παραγωγή & Χρήση μίας 'Αισθητικής Εργαλειοθήκης.* Μεταπτυχιακή εργασία, Τμήμα Ιστορίας & Αρχαιολογίας, Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης

Υφαντίδης, Φ.2018. *Πρακτικές προσωπικής κόσμησης στη Νεολιθική Ελλάδα*, Αδημοσίευτη διδακτορική διατριβή, Τμήμα Ιστορίας & Αρχαιολογίας, Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης

Φακορέλλης, Γ. και Γ. Μανιάτης. 2002. Αποτελέσματα χρονολόγησης δειγμάτων με τη μέθοδο του C-14. Στο: Χουρμουζιάδης, Γ. (επιμ.), *Δισπηλιό 7500 χρόνια μετά*, Θεσσαλονίκη: University Press: 289-294

Φωτιάδης, Μ.1988. Κίτρινη Λίμνη Νομού Κοζάνης 1987: προϊστορική έρευνα, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 1 (1987): 51–62

Φωτιάδης, Μ. 1991.Προϊστορική έρευνα στην Κίτρινη Λίμνη Ν. Κοζάνης, 1988: μία σύντομη έκθεση, Το Αρχαιολογικό Έργο στη Μακεδονία και Θράκη 2 (1988): 41–54

Φωτιάδης, Μ. και Α. Χονδρογιάννη-Μετόκη, 1997. Κίτρινη Λίμνη: διαχρονική σύνοψη, ραδιοχρονολογήσεις, και η ανασκαφή του 1993. *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 7 (1993): 19–31

Χατζούδη, Α. 2001. *Οστέινα* εργαλεία και *αντικείμενα* από την *Τούμπα* Θεσσαλονίκης. Αδημοσίευτη μεταπτυχιακή εργασία/ Τμήμα Ιστορίας και Αρχαιολογίας, Φιλοσοφική Σχολή, Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης

Χατζούδη, Α. 2002. Προκαταρκτική μελέτη των οστέινων αντικειμένων.Στο:Γραμμένος, Δ.Β. και Σ.Κώτσος (εκδ.), Σωστικές ανασκαφές στο νεολιθικό οικισμό Σταυρούπολης Θεσσαλονίκης, Δημοσιεύματα του Αρχαιολογικού Ινστιτούτου Βόρειας Ελλάδας 2, Θεσσαλονίκη: 609-626

Χονδρογιάννη-Μετόκη Α. 1993. Από την έρευνα στην παραποτάμια-παραλίμνια περιοχή του Αλιάκμονα, *Το Αρχαιολογικό Έργο στη Μακεδονία και Θράκ*η 4 (1990):105–120

Χονδρογιάννη-Μετόκη, Α. 1995. Αλιάκμων 1992, Προϊστορική Ανασκαφή στα Κρανίδια, *Το Αρχαιολογικό Έργο στη Μακεδονία και Θράκ*η 6(1992): 35-43

Χονδρογιάννη-Μετόκη, Α. 1999. Από την προϊστορική έρευνα στην κοιλάδα του μέσου ρου του Αλιάκμονα, *Αρχαία Μακεδονία*, VI, τόμος 1: 241-258

Χονδρογιάννη-Μετόκη, Α. 2001. Εγνατία οδός, ανασκαφή στην προϊστορική θέση «Τούμπα Κρεμαστής-Κοιλάδας», Νομού Κοζάνης, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 13 (1999): 399–414

Χονδρογιάννη-Μετόκη, Α. 2004. Αλιάκμων 2000-2002. Σωστική Ανασκαφή σε δύο Οικισμούς της Αρχαιότερης και Μέσης Νεολιθικής Περιόδου, *Το Αρχαιολογικό Έργο στη Μακεδονία και στη Θράκη* 16(2002): 557- 570

Χονδρογιάννη-Μετόκη, Α. 2009a. Αλιάκμων 1985-2005: Η αρχαιολογική έρευνα στην περιοχή της τεχνητής λίμνης Πολυφύτου (κοιλάδα μέσου ρου του Αλιάκμονα), αποτελέσματα και προοπτικές, *Το Αρχαιολογικό Εργο στη Μακεδονία και Θράκη* 20 χρόνια, Επετειακός Τόμος: 449-462

Χονδρογιάννη-Μετόκη, Α. 2009b. *Μη οικιστικές χρήσεις χώρου στους νεολιθικούς οικισμούς. Το παράδειγμα της Τούμπας Κρεμαστής Κοιλάδας*, Αδημοσίευτη Διδακτορική Διατριβή, Τμήμα Ιστορίας και Αρχαιολογίας, Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης.

Χονδρογιάννη-Μετόκη Α. 2010. Κλείτος 2009. Η ανασκαφή στα ανατολικά όρια του οικισμού της Νεότερης Νεολιθικής και στον οικισμό της Τελικής Νεολιθικής, Το αρχαιολογικό Έργο στην Άνω Μακεδονία 1: 231-244

Χονδρογιάννη-Μετόκη, Α. 2012a. Η αρχαιολογική έρευνα στην κοιλάδα του μέσου ρου του Αλιάμονα, μέρος Α'. Η περιοχή: Φυσικό και ανθρωπογενές περιβάλλον. *Archaeology & Arts* (web-journal: http://www.archaiologia.gr/blog/2012/05/07/η-αρχαιολογική-έρευνα-στην-κοιλάδα-το/). Last accessed: 15-05-2016

Χονδρογιάννη-Μετόκη, Α. 2012b. Η αρχαιολογική έρευνα στην κοιλάδα του μέσου ρου του Αλιάμονα, μέρος Β'. Η επιφανειακή έρευνα: Προϊστορική και ιστορική τοπογραφία. *Archaeology & Arts* (web-journal: http://www.archaiologia.gr/blog/2012/05/21/η-αρχαιολογική-έρευνα-στην-κοιλάδα-το-2/) Last accessed: 15-05-2016

Χονδρογιάννη-Μετόκη, Α. 2012c. Η αρχαιολογική έρευνα στην κοιλάδα του μέσου ρου του Αλιάμονα, μέρος Γ'. Η κατοίκηση: τα δεδομένα από τις ανασκαφές των οικισμών. *Archaeology & Arts* (web-journal: http://www.archaiologia.gr/blog/2012/06/04/η-αρχαιολογική- έρευνα-στην-κοιλάδα-το-3/) Last accessed: 15-05-2016

Χονδρογιάννη-Μετόκη, Α. 2012d. Η αρχαιολογική έρευνα στην κοιλάδα του μέσου ρου του Αλιάμονα, μέρος Δ'. Η κατοίκηση: τα δεδομένα από τις ανασκαφές των οικισμών. *Archaeology & Arts* (web-journal: http://www.archaiologia.gr/blog/2012/06/18/ η-αρχαιολογική-έρευνα-στην-κοιλάδα-το-4/). Last accessed: 15-05-2016

Χονδρογιάννη-Μετόκη, Α. 2014. Αρχιτεκτονικές μορφές της Προϊστορίας στην κοιλάδα του μέσου ρου του Αλιάκμονα στο Μακεδονία Στο Ευ. Στεφανή, Ευ., Μερούσης. Ν. και Α. Δημουλά (επ.), *1912-2012. Εκατό χρόνια έρευνας στην προϊστορική Μακεδονία.* Πρακτικά διεθνούς συνεδρίου, Αρχαιολογικό Μουσείο Θεσσαλονίκης, 22-24 Νοεμβρίου 2012,Θεσσαλονίκη: 337-348

Χρηστίδου, Ρ. 1992. Οστέινα αντικείμενα : Η επεξεργασία των οστών.Στο: Γραμμένος Δ.Β.,. Παππά, Μ., Ούρεμ-Κώτσου, Ν., Σκουρτοπούλου, Κ., Γιαννούλη,Ε., Μαραγκού, Χ., Βαλαμώτη, Σ., Συρίδης, Γ., Μαρκή, Ε., Χρηστίδου, Ρ., «Ανασκαφή νεολιθικού οικισμού Θέρμης Β και βυζαντινής εγκατάστασης παρά τον προϊστορικό οικισμό Θέρμη Α. Ανασκαφική περίοδος 1989», Μακεδονικά ΚΗ : 474-492

Χρηστίδου, Ρ. 1998. Επεξεργασμένα κέρατα απο τον Αρκαδικό Δράμας και το Ντικιλί-Τας στο *Η Δράμα και η περιοχή της. Ιστορία και πολιτισμός.Β' Επιστημονική Συνάντηση*, Δράμα 18-22 Μαϊου 1994:115-127.

Χρυσοστόμου, Π. και Χρυσοστόμου, Παν. 1993. Νεολιθικές έρευνες στην περιοχή των Γιαννιτσών, *Το Αρχαιολογικό Έργο στη Μακεδονία και Θράκη* 4, 1990 : 169-186

Χρυσοστόμου, Παν. 1997a. Ο νεολιθικός οικισμός Γιαννιτσών Β'. Νέα ανασκαφικά δεδομένα (1992-1993), *Το Αρχαιολογικό Έργο στη Μακεδονία και Θράκη* 7(1993): 135-146. Θεσσαλονίκη: ΥΠΠΟ- ΤΑΠ.

Χρυσοστόμου, Παν. 1997b. Η νεολιθική κατοίκηση στη βόρεια παράκτια ζώνη του άλλοτε Θερμαϊκού κόλπου (Επαρχία Γιαννιτσών), *Το Αρχαιολογικό Έργο στη Μακεδονία και Θράκη* 10 (1996): 159- 172

Χρυσοστόμου, Παν. 2000. Η *νεολιθική ειδωλοπλαστική της επαρχίας Γιαννιτσών*. Αδημοσίευτη διδακτορική διατριβή. Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης.

Χρυσοστόμου, Παν. 2003. Νέα στοιχεία από τη νεολιθική έρευνα στην επαρχία Γιαννιτσών. Μια άγνωστη μορφή προϊστορικής γραφής, *Το Αρχαιολογικό Έργο στη Μακεδονία και Θράκη* 15: 489-500

Χρυσοστόμου, Παν. 1998. Τούμπα Αρμενοχωρίου. Στο:Λιλιμπάκη-Ακαμάτη,Μ.(επιμ.) *Μνείας Χάριν.Τόμος στη μνήμη Μαίρης Σιγανίδου,* Θεσσαλονίκη,ΥΠΠΟΑ:335-353

Χρυσοστόμου, Παν.2016. *Ένας αρχαιολογικός πολιτισμός χάνεται,* https://www.zougla.gr/politismos/article/enas-arxeologikos-politismos-xanete Last accessed :19/05/2016

Χρυσοστόμου, Παν., Γιαγκούλης, Τ., Νάιδου, Ε.(in press). Εντος ορίων: όψεις του οικιστικού χώρου στους προϊστορικούς οικισμούς Ανάργυροι ΙΧα και Ανάργυροι ΧΙ στην περιοχή Αμυνταίου Φλώρινας, Το αρχαιολογικο Έργο στη Μακεδονία και Θράκη 2012

Χρυσοστόμου, Π., Ι. Ασλάνης Α. Χρυσοστόμου, Α. 2007. *Αγριοσυκιά. Ένας οικισμός των προϊστορικών και κλασικών χρόνων*. Βέροια: Ινστιτούτο Ελληνικής και Ρωμαϊκής Αρχαιότητας. Ε.Ι.Ε.

Plates

Plate I. Sleeves on basal segments, a. A9b.KE202, b.A9b.KE088, c. A9b.KE190, d. A9b.KE223

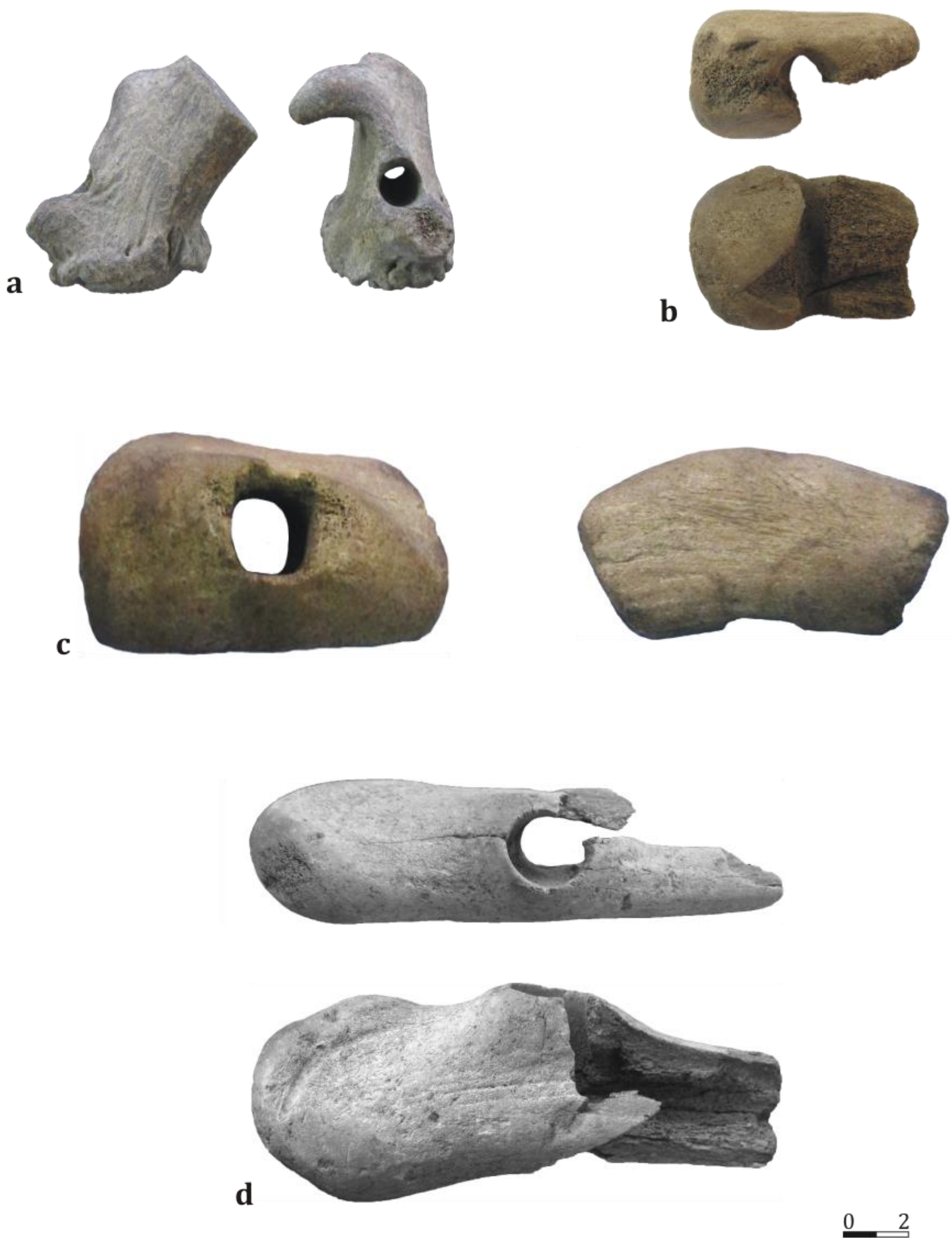

Plate II. Sleeves on basal segments, a. A9b.KE096, b. A9b.KE223, c. A9b.KE272, d. A9b.KE46

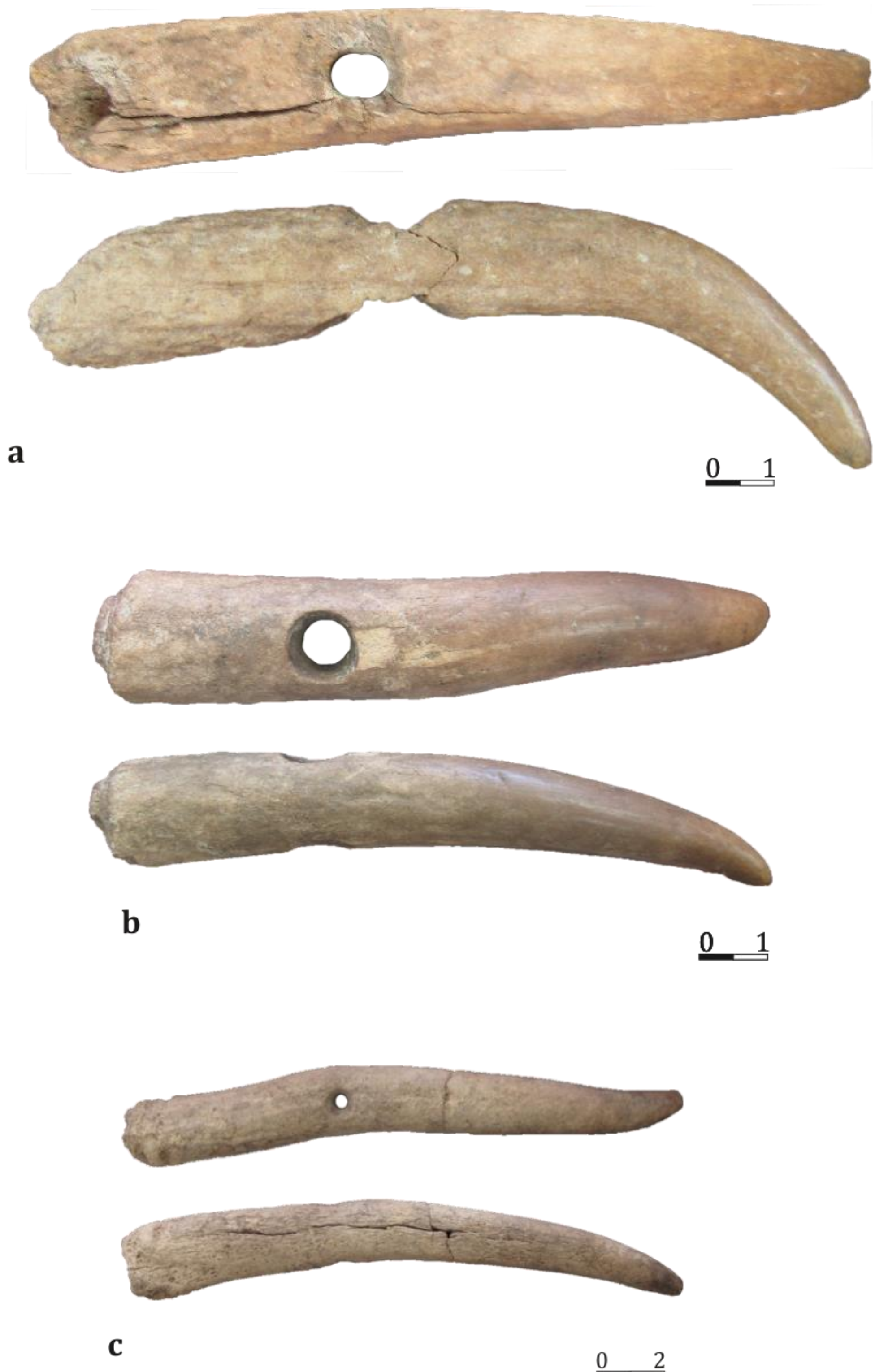

Plate III. Picks on tines, a. A9b.KE094, b. A9b.KE008, c. A9b.KE00

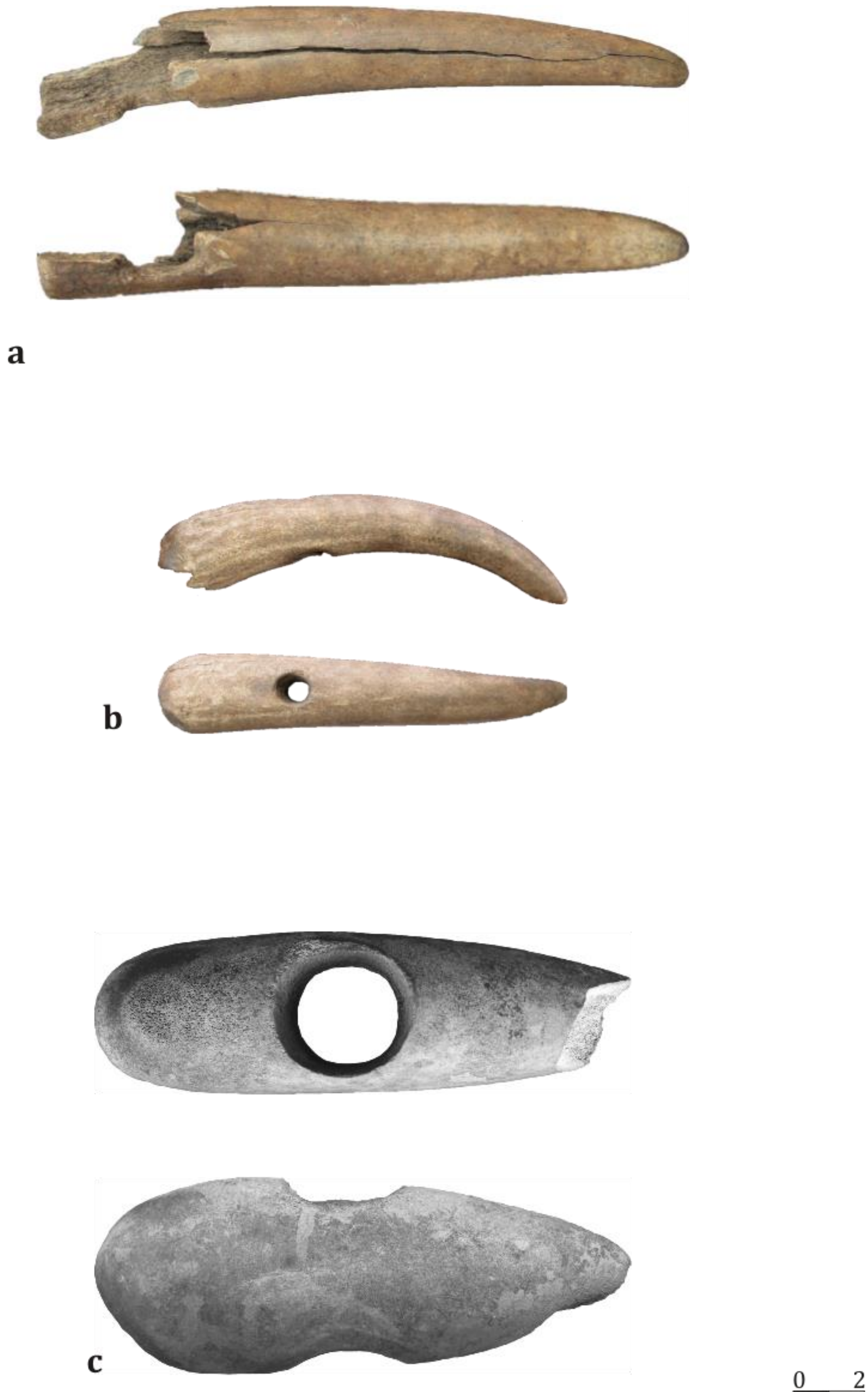

Plate IV. Picks on tines, a. A9b.KE093, b. A9b.KE171, Pick on basal segment c. A9b.KE264

Plate V. Bifacial bevel ended tools on tines, a. A9b.KE050, b. A9b.KE074, c. A9b.KE058, d. A9b.KE123, e. A9b.KE151 (a-d in 1:2, e in 1:1)

Plate VI. Axes, a. A9B.KE046, b. A9b.KE079, c. A9b.KE138

Plate VII. Retouching tools, a.A9b.KE029, b. A9B.KE134

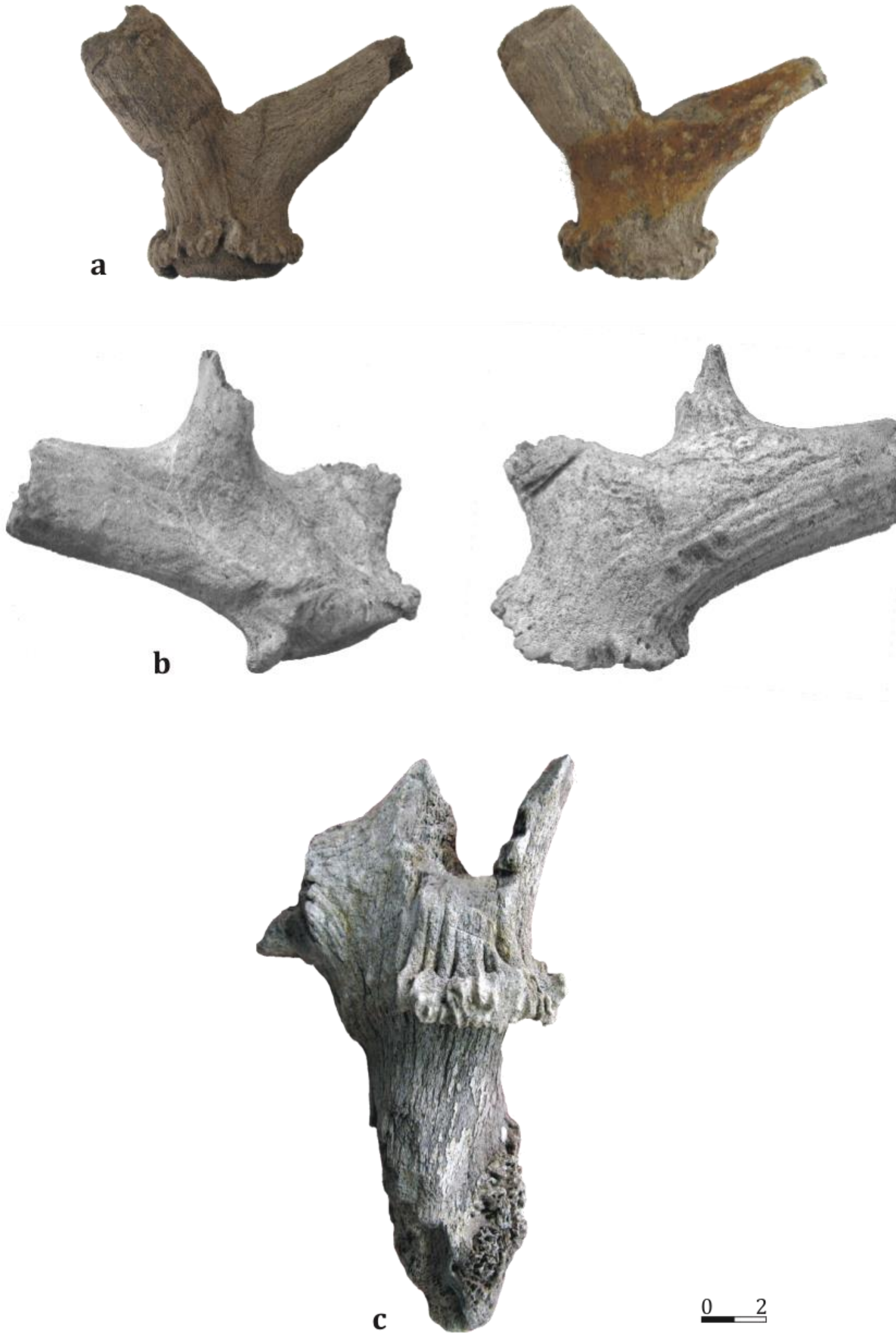

Plate VIII. Waste on basal segments, a.A9b.KΔ007, b. A9b.KΔ033, c. A9b.KΔ052

Plate IX. Waste on basal segments, a.A9b.KΔ081, b. A9b.KΔ088

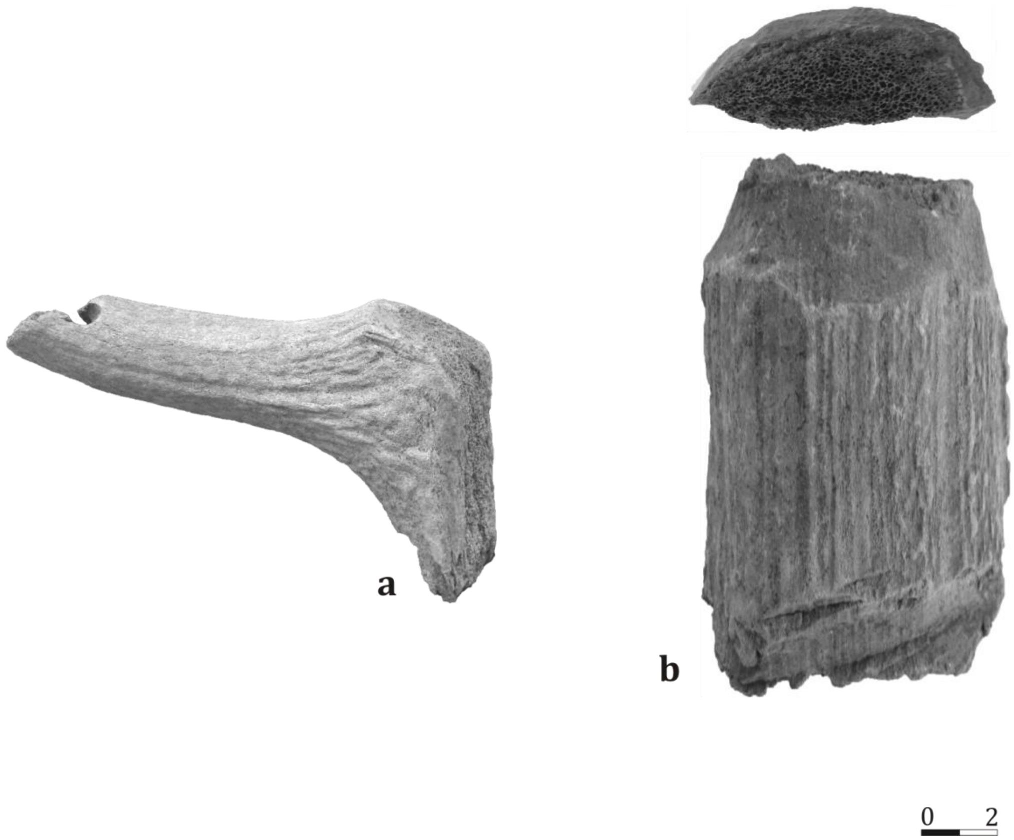

Plate X. Waste on tine and beam segments, a.A9b.KΔ102, b. A9b.KΔ063

ANNEX – CATALOGUE OF THE ARTIFACTS

Sleeves

Sleeves on basal parts with shaft hole

Catalogue number	Period	Species	Shed / unshed basal part	Manufacture state	Preservation State	Subtype	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE144	Late Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	9	6	5.8	127.8
A9B.KE122	Late Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	13	14	7.6	307.3
A9B.KE139	Late Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	10	8	5.6	240.1
A9B.KE251	Late Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	15.1	11	6.5	392.9
A9B.KE015	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	7.3	5.5	3.3	49.1
A9B.KE021	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	12.2	8.1	4.3	195.8
A9B.KE024	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	7.3	5	3.8	118.3
A9B.KE033	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	7.6	5.4	1.5	42.7
A9B.KE065	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	8.9	8	4.2	174
A9B.KE066	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	7.9	4.5	4.7	87
A9B.KE297	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	7.7	5	3.4	73
A9B.KE095	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	6.8	4.8	3.2	65
A9B.KE100	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	11.7	11	5.1	222.5
A9B.KE105	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	9.1	7.7	2.5	108
A9B.KE128	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	9.3	4.8	5.2	112.4
A9B.KE131	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	6.2	5.5	2.3	82.5
A9B.KE153	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	10.5	9.7	4.5	234.5
A9B.KE163	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	6.6	4.6	4.4	100
A9B.KE180	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	9	3	1.7	34.5
A9B.KE183	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	7.9	5.6	6	169
A9B.KE193	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	9	5.9	3.1	99.3
A9B.KE195	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	12	10.8	4	134
A9B.KE203	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	6.2	6.2	3.5	90
A9B.KE224	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	10	7.2	2	138
A9B.KE227	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	6.4	4.7	3.8	55
A9B.KE232	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ia	9	10	5.5	217
A9B.KE286	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	12.5	6	5.3	195.5
A9B.KE020	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	9	7.7	4.2	162.8
A9b.KE031	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	10	9	5.5	261.6
A9B.KE035	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	11.5	8.8	5.2	270.9
A9B.KE055	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	9.5	6.5	3	151.5
A9B.KE071	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	16	7	5.9	430
A9B.KE086	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	7.7	5.3	3.7	96.2
A9B.KE088	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	11.5	4	6	298.1
A9B.KE096	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	7.35	7.2	5.1	128.1
A9B.KE106	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	10.5	9.6	5.1	257
A9B.KE115	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	15.4	8.7	6.2	300
A9B.KE126	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	13	6.5	4.7	240.4
A9B.KE146	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	13.7	9.1	5	337.2

Sleeves

Sleeves on basal parts with shaft hole

Catalogue number	Period	Species	Shed / unshed basal part	Manufacture state	Preservation State	Subtype	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE168	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	9.8	6.6	4.3	211
A9B.KE197	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	12.7	10.5	5	365.3
A9B.KE198	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	9.5	6.2	3.6	142
A9B.KE202	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	15	6.5	4.5	339.6
A9B.KE220	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	12	8.5	6.5	370.7
A9B.KE223	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	7.1	5.1	3.8	81.1
A9B.KE236	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	10.5	7	4.3	255
A9B.KE237	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ia	8.6	7.5	5.3	178
A9B.KE253	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	11.8	7	3.6	293
A9B.KE273	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ia	15.6	5.3	5.8	331
A9B.KE091	Final Neolithic	Red deer	Shed	Completely manufactured	Partially preserved	Ia	7.4	8	4.1	115.3
A9B.KE260	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ib	7.8	9	5.2	95
A9B.KE018	Final Neolithic	Red deer	Shed	Semi finished	Half preserved	Ib	13	6.8	4.6	176.5
A9B.KE034	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	9.5	11.5	6	218.8
A9B.KE048	Final Neolithic	Red deer	Unshed	Completely manufactured	Half preserved	Ib	8.1	7.7	4.8	169
A9B.KE075	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	8.2	7.2	6.2	156.7
A9B.KE077	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	10.3	4.5	2	67.5
A9B.KE113	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	7.2	7	5.5	130
A9B.KE114	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	8.1	6.8	3.6	141.7
A9B.KE129	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	6.2	4	4	79.1
A9B.KE135	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	8	7.2	4.7	179
A9B.KE209	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	12.5	5.3	4.5	128.1
A9B.KE249	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	11.2	9.45	6.4	289
A9B.KE265	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	10.6	7.2	6	250.1
A9B.KE016	Final Neolithic	Red deer	Unshed	Semi finished	Fully preserved	Ib	16	7.5	5.3	535
A9B.KE102	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ib	7.2	6.2	3.9	107
A9B.KE120	Final Neolithic	Red deer	Unshed	Semi finished	Fully preserved	Ib	13	7	5	213.6
A9B.KE208	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ib	10.7	9.5	5.9	338
A9B.KE262	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ib	8.3	8.3	5.1	258
A9B.KE272	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ib	11.5	7	6	145
A9B.KE014	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	7.4	9.3	4.4	115.2
A9B.KE124	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ib	6.9	5.3	4.4	91.7
A9B.KE266	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Ib	12.1	8.6	7.3	362
A9B.KE046	Final Neolithic	Red deer	Shed	Completely manufactured	- Almost whole	Ic	16.4	6.8	4.5	320
A9B.KE268	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Ic	14.2	9	4.8	340
A9B.KE037	Final Neolithic	Red deer	Shed	Completely manufactured	Half preserved	Ic	10.6	5	2.6	78
A9B.KE028	Final Neolithic	Red deer	Shed	Completely manufactured	Fully preserved	Id	14	4.9	10.8	271.4
A9B.KE142	Final Neolithic	Red deer	Shed	Semi finished	Fully preserved	Id	11.2	7.7	4.3	204
A9B.KE076	FN/EBA	Red deer	Shed	Completely manufactured	Fully preserved	Ia	15	11	6.5	392
A9B.KE190	FN/EBA	Red deer	Shed	Completely manufactured	Fully preserved	Ia	10.8	8.4	4.7	195

Sleeves

Slevees on beam segments with shaft hole

Catalogue Number	Period	Species	Element	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE165	Final Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	7	3.1	1.3	17.3
A9B.KE257	Final Neolithic	Red deer	Beam segment	Semi finished	Almost fully preserved	17	6.2	3	149.5
A9B.KE108	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	6	5.1	4	83
A9B.KE169	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	10.3	3.5	3.3	92.6
A9B.KE172	Late Neolthic	Red deer	Beam segment	Completely manufactured	Half preserved	7.8	3.8	3.1	68.3
A9B.KE179	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	10	3.5	2.3	66
A9B.KE207	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	6.2	2.2	0.6	13.1
A9B.KE214	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	7.7	3.7	0.8	27
A9B.KE054	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	11	7.7	4.6	85
A9B.KE027	Late Neolthic	Red deer	Beam segment	Semi finished	Fully preserved	10	3.8	3.1	108.5

Perforating sleeves

Catalogue Number	Period	Species	Element	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE293	Late Neolthic	Red deer	Tine	Semi finished	Almost fully preserved	7.4	2.25	2	25.5
A9B.KE101	Final Neolithic	Red deer	Tine	Completely manufactured	Fully preserved	6.8	3.2	2.4	41.3
A9B.KE147	Final Neolithic	Red deer	Tine	Completely manufactured	Fully preserved	14	2.3	1.7	43.4
A9B.KE150	Late Neolthic	Red deer	Tine	Completely manufactured	Fully preserved	15	3.45	2.6	107.1
A9B.KE258	Late Neolthic	Red deer	Tine	Completely manufactured	Fully preserved	13.4	2.1	1.8	45

Socketed Sleeves

Catalogue Number	Period	Species	Element	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE080	Final Neolithic	Red deer	Beam segment	Completely manufactured	Fully preserved	7.9	7.27	5.2	161
A9B.KE216	Late Neolthic	Red deer	Beam segment	Completely manufactured	Fully preserved	6.34	4.2	3	69
A9B.KE239	Final Neolithic	Red deer	Beam segment	Completely manufactured	Fully preserved	12	5.5	4	157

Bevel ended tools

Unifacial bevel ended tools

Catalogue ID	Period	Species	Element	Subtype	Manufacture state	Preservation state	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE030	Final Neolithic	Red Deer	Tine	UBTin	Completely manufactured	Almost fully preserved	11	2.6	3	74.3
A9B.KE057	Final Neolithic	Red Deer	Tine	UBTin	Completely manufactured	Almost fully preserved	10.8	2.1	2.3	38
A9B.KE087	Final Neolithic	Red Deer	Tine	UBTin	Completely manufactured	Almost fully preserved	20.5	2.5	3	150.3
A9B.KE161	Late Neolthic	Red Deer	Tine	UBTlat	Semi finished	Fully preserved	11	2.5	2.7	43
A9B.KE176	Late Neolthic	Red Deer	Tine	UBTlat	Completely manufactured	Fully preserved	8.9	2.5	3.7	44
A9B.KE060	Final Neolithic	Red Deer	Tine	UBTlat	Completely manufactured	Almost fully preserved	8.6	2.3	2.2	31.6
A9B.KE062	Final Neolithic	Red Deer	Tine	UBTlat	Completely manufactured	Almost fully preserved	13.85	3.1	3	61
A9B.KE107	Final Neolithic	Red Deer	Tine	UBTlat	Completely manufactured	Almost fully preserved	15	2.5	3.2	84.2
A9B.KE127	Final Neolithic	Red Deer	Tine	UBTlat	Completely manufactured	Almost fully preserved	20.6	3	3.45	123
A9B.KE157	Final Neolithic	Red Deer	Tine	UBTlat	Completely manufactured	Partially preserved	4.3	1.9	1.9	9.3
A9B.KE166	Final Neolithic	Red Deer	Tine	UBTlat	Semi finished	Almost fully preserved	19.3	2.7	5.8	106.2
A9B.KE167	Final Neolithic	Red Deer	Tine	UBTlat	Completely manufactured	Almost fully preserved	14.4	2.4	3.1	55.5
A9B.KE204	Final Neolithic	Red Deer	Tine	UBTlat	Completely manufactured	Partially preserved	5	1.5	2	13.5
A9B.KE267	Final Neolithic	Red Deer	Tine	UBTlat	Completely manufactured	Almost fully preserved	18.2	3.1	2.7	91.8
A9B.KE188	Late Neolthic	Red Deer	Beam segment	UBB	Completely manufactured	Partially preserved	3.65	0.8	2.6	7
A9B.KE081	Final Neolithic	Red Deer	Beam segment	UBB	Completely manufactured	Almost fully preserved	12	1.7	3.5	57
A9B.KE231	Final Neolithic	Red Deer	Beam segment	UBB	Completely manufactured	Half preserved	7.2	1.6	3	27
A9B.KE044	Final Neolithic	Roe Deer	Basal and beam segment	UBBS	Completely manufactured	Almost fully preserved	17	2.2	2.7	96.8
A9B.KE256	Late Neolithic	Roe Deer	Basal and beam segment	UBBS	Completely manufactured	Fully preserved	9.1	1.5	2	40.1

Picks

Catalogue number	Period	Species	Element	Manufacture state	Preservation state	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE158	Late Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	7.4	2.2	1	12.7
A9B.KE160	Late Neolithic	Red deer	Tine	Semi finished	Fully preserved	14	2.8	1.8	62.3
A9B.KE275	Late Neolithic	Red deer	Tine	Semi finished	Almost fully preserved	6.1	3.1	2.4	29
A9B.KE143	Late Neolithic	Red deer	Tine	Semi finished	Fully preserved	10.6	2.1	2.1	33.7
A9B.KE285	Final Neolithic	Red deer	Tine	Completely manufactured	Half preserved	13	2.7	2.2	66.1
A9B.KE002?	Final Neolithic	Red deer	Tine	Completely manufactured	Half preserved	9.1	1.85	1.9	31.6
A9B.KE003	Final Neolithic	Red deer	Tine	Semi finished	Fully preserved	16.5	1.65	1.8	47.1
A9B.KE007	Final Neolithic	Red deer	Tine	Semi finished	Almost fully preserved	7.3	1.5	1.3	10
A9B.KE008	Final Neolithic	Red deer	Tine	Completely manufactured	Half preserved	10.1	1.9	2	33.4
A9B.KE009	Final Neolithic	Red deer	Tine	Semi finished	Half preserved	4.4	1.97	1.7	11
A9B.KE011	Final Neolithic	Red deer	Tine	Completely manufactured	Fully preserved	5.3	1.8	2.5	130
A9B.KE025	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	16.7	6	3	206
A9B.KE038V	Final Neolithic	Red deer	Tine	Semi finished	Half preserved	16.5	3	2.7	94.6
A9B.KE049	Final Neolithic	Red deer	Tine	Completely manufactured	Almost fully preserved	5.1	1	1	5.4
A9B.KE051	Final Neolithic	Red deer	Tine	Completely manufactured	Fully preserved	7	1.8	2.1	24.3
A9B.KE067	Final Neolithic	Red deer	Tine	Completely manufactured	Almost fully preserved	25	2.5	2.2	176.5
A9B.KE082	Final Neolithic	Red deer	Tine	Completely manufactured	Half preserved	5.4	1.6	1.7	14.3
A9B.KE092	Final Neolithic	Red deer	Tine	Semi finished	Fully preserved	16	3	3	98
A9B.KE093	Final Neolithic	Red deer	Tine	Completely manufactured	Half preserved	18.5	2.5	3.2	99.7
A9B.KE094	Final Neolithic	Red deer	Tine	Completely manufactured	Fully preserved	12.5	2.1	2.3	50.2
A9B.KE112	Final Neolithic	Red deer	Tine	- Completely manufacture	Half preserved	11	2.8	2.5	23
A9B.KE136	Final Neolithic	Red deer	Tine	Semi finished	Half preserved	10.3	1.75	1.2	15.5
A9B.KE149	Final Neolithic	Red deer	Crown	Semi finished	Fully preserved	24.7	6.2	3.1	297
A9B.KE010	Final Neolithic	Red deer	Beam segment	Completely manufactured	Fully preserved	22	7	6	345
A9B.KE171	Final Neolithic	Red deer	Tine	Semi finished	Almost fully preserved	11.6	2.3	2.5	51
A9B.KE194	Final Neolithic	Red deer	Tine	Completely manufactured	Fully preserved	11.4	2.9	3.1	99.4
A9B.KE212	Final Neolithic	Red deer	Basal and beam segment	Completely manufactured	- More than half	24.3	4.8	5.5	386
A9B.KE225	Final Neolithic	Red deer	Tine	Semi finished	- More than half	5.9	1.6	2	24.5
A9B.KE226	Final Neolithic	Red deer	Tine	Semi finished	Fully preserved	11.1	2	1.4	12.2
A9B.KE235	Final Neolithic	Red deer	Tine	Completely manufactured	More than half preserved	12.7	2	1.95	56
A9B.KE264	Final Neolithic	Red deer	Basal segment	Semi finished	Fully preserved	15.2	5.7	4.4	275
A9B.KE274	Final Neolithic	Red deer	Tine	Completely manufactured	Almost fully preserved	26	4.7	3.5	179
A9B.KE006	FN/EBA	Red deer	Tine	Completely manufactured	Half preserved	15.7	2.1	3	61.5
A9B.KE098	FN/EBA	Red deer	Tine	Completely manufactured	Fully preserved	12.5	1.8	3	30

Axes

Catalogue number	Period	Species	Element	Type	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE248	Late Neolithic	Red deer	Tine	A	Semi finished	Fully preserved	12.8	2.8	2.2	89.4
A9B.KE004	Final Neolithic	Red deer	Tine	A	Completely manufactured	Half preserved	7.1	2.1	2	26.3
A9B.KE023	Final Neolithic	Red deer	Tine	A	Completely manufactured	Fully preserved	17.8	3.5	2.7	124
A9B.KE043	Final Neolithic	Red deer	Tine	A	Semi finished	Fully preserved	7.5	22	1.5	21
A9B.KE156	Final Neolithic	Red deer	Tine	A	Completely manufactured	Half preserved	10	2.7	2.4	45
A9B.KE219	Final Neolithic	Red deer	Tine	A	Semi finished	Fully preserved	12	2	3	13.6
A9B.KE052	Late Neolithic	Red deer	Basal and beam segment	B1	Completely manufactured	Almost half preserved	21.2	6.45	3	176
A9B.KE175	Late Neolithic	Red deer	Basal and beam segment	B1	Completely manufactured	Fully preserved	23	4.7	2.9	184
A9B.KE184	Late Neolithic	Red deer	Basal and beam segment	B1	Completely manufactured	Partially preserved	7.5	1.5	1.3	23.1
A9B.KE138	Late Neolithic	Red deer	Beam segment	B2	Completely manufactured	Partially preserved	6.1	4.4	1.7	44
A9B.KE270	Late Neolithic	Red deer	Beam segment	B2	Semi finished	Half preserved	15.5	7.7	1.6	99.2
A9B.KE046	Final Neolithic	Red deer	Beam segment	B2	Completely manufactured	Half preserved	17.8	7.2	2	183
A9B.KE079	Final Neolithic	Red deer	Beam segment	B2	Completely manufactured	Almost half preserved	21	6.7	1.4	161
A9B.KE221	Final Neolithic	Red deer	Beam segment	B2	Completely manufactured	Fully preserved	22.2	9.4	4.7	241
A9B.KE222	Final Neolithic	Red deer	Beam segment	B3	Semi finished	Fully preserved	23.5	6.7	3.25	300
A9B.KE290	Final Neolithic	Red deer	Beam segment	B4	Completely manufactured	Almost fully preserved	21.1	6	4	319

Adzes

Catalogue number	Period	Species	Element	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE288	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Fully preserved	18.5	4.8	3.2	124
A9B.KE178	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Fully preserved	16.5	7.3	3.3	214
A9B.KE271	Final Neolithic	Red Deer	Beam segment	Semi finished	Fully preserved	23.8	6.2	3.5	363.4
A9B.KE307	Late Neolthic	Red Deer	Beam segment	Completely manufactured	Almost fully preserved	11.5	8.6	3.6	132.5
A9B.KE243	Late Neolthic	Red Deer	Beam segment	Completely manufacture	Fully preserved	34	12	4.1	508

Fragments of perforated tools of undefined function

Catalogue number	Period	Species	Element	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE259	Late Neolithic	Red deer	Tine	Semi finished	Fully preserved	12	3.6	3.3	124.3
A9B.KE110	Late Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	9.4	3.2	3.5	69
A9B.KE119	Late Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	6.4	10	3.7	99
A9B.KE140	Late Neolithic	Red deer	Tine	Completely manufactured	Partially preserved	4.8	2.2	1	8
A9B.KE159	Late Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	11.5	4.4	1	35.5
A9B.KE162	Late Neolithic	Red deer	Tine	Completely manufactured	Half preserved	7.3	2.5	1.2	18.4
A9B.KE173	Late Neolithic	Red deer	Tine	Completely manufactured	Half preserved	12.5	3	3.5	87
A9B.KE215	Late Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	5.7	2.6	2.1	20
A9B.KE228	Late Neolithic	Red deer	Tine	Completely manufactured	Half preserved	8.4	2.1	1.2	18.4
A9B.KE255	Late Neolithic	Red deer	Tine	Completely manufactured	Half preserved	6	2	1	7.8
A9B.KE116	Late Neolithic	Red deer	Basal segment	Completely manufactured	Partially preserved	8.7	5.4	4.3	100
A9B.KE145	Late Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	6.25	5.85	4	64.5
A9B.KE247	Late Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	8.5	4	1.5	53.5
A9B.KE005	Final Neolithic	Red deer	Tine	Completely manufactured	Half preserved	8.8	2.5	4.1	59
A9B.KE014	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	7.2	4.1	3.2	56.7
A9B.KE013	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	7.9	3.8	4.2	81
A9b.KE017	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	6.5	4	2.5	27.1
A9B.KE022	Final Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	10.3	5.5	4.1	142
A9B.KE026	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	11	6.1	4.2	116
A9B.KE031	Final Neolithic	Red deer	Beam segment	Completely manufactured	Fully preserved	10	7.1	3	93.6
A9B.KE036	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	7	4	4	80
A9B.KE039	Final Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	6	2.5	0.8	27
A9B.KE056	Final Neolithic	Red deer	beam segment	Completely manufactured	Half preserved	7.5	3.6	2.5	52
A9B.KE059	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	6.9	2.3	2.6	25.7
A9B.KE063	Final Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	10.6	3.4	2.8	48.7
A9B.KE064	Final Neolithic	Red deer	Tine	Completely manufactured	Half preserved	15.1	3.1	2	50.4
A9B.KE069	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	6.4	2.8	2.2	26.5
A9B.KE073	Final Neolithic	Red deer	Tine	Completely manufactured	Half preserved	9.4	3.2	3	96

Fragments of perforated tools of undefined function

Catalogue number	Period	Species	Element	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE085	Final Neolithic	Red deer	Tine	Completely manufactured	Half preserved	10	2.4	3	76
A9B.KE090	Final Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	4.5	2.75	1.2	11.4
A9B.KE111	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	6.3	4.6	4.6	101.5
A9B.KE117	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	8.3	5.2	2.1	36.3
A9B.KE118	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	6.2	3.7	3.45	44
A9B.KE121	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	6.6	5.5	5	124.2
A9B.KE125	Final Neolithic	Red deer	Tine	Semi finished	Half preserved	6.8	1.2	0.8	8
A9B.KE130	Final Neolithic	Red deer	Beam segment	Semi finished	Fully preserved	15.5	7.1	3.4	189
A9b.KE132	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	10.1	3.1	2.8	87
A9B.KE133	Final Neolithic	Red deer	Tine	Completely manufactured	Half preserved	8.7	3.3	1.7	32.3
A9B.KE137	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	7.5	6.9	3.3	70.8
A9B.KE141	Final Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	15	7.7	2.7	125
A9B.KE152	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	7.5	4.7	2.5	63
A9B.KE177	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	8.5	5.5	2	42.5
A9B.KE199	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	8.1	5.7	3.1	119
A9B.KE200	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	12.3	9.8	4	255
A9B.KE206	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	14.8	14.6	47	272
A9B.KE210	Final Neolithic	Red deer	Beam segment	Completely manufactured	Half preserved	8.3	3.4	2.6	41.5
A9B.KE213	Final Neolithic	Red deer	basal segment	Completely manufactured	Half preserved	9.5	4.2	4.2	126.5
A9B.KE217	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	7.7	6.2	5.7	188
A9B.KE229	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	9.6	5.4	4.3	152.6
A9B.KE233	Final Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	6.2	2.5	1.7	12.7
A9B.KE238	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	7.4	5	2.8	80
A9B.KE240	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	11.4	7.3	5.2	275
A9B.KE241	Final Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	4.2	2.4	1.1	10
A9B.KE244	Final Neolithic	Red deer	Tine	Completely manufactured	Partially preserved	5.05	2.55	1.5	15.9
A9B.KE245	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	11.5	4.7	4.4	138
A9B.KE246	Final Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	4.2	2.3	1.1	7

Fragments of perforated tools of undefined function

Catalogue number	Period	Species	Element	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE252	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	9.3	8.4	6.5	198.5
A9B.KE254	Final Neolithic	Red deer	Beam segment	Completely manufactured	Partially preserved	8.1	4.2	2.3	48.4

Retouching tools

Catalogue number	Period	Species	Element	Manufacture state	Preservation state	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE012	Final Neolithic	Red deer	Beam segment	Completely manufactured	Fully preserved	16.4	2.6	2.6	102
A9B.KE029	Final Neolithic	Red deer	Tine	Completely manufactured	Half preserved	16.3	2.6	2.2	66
A9B.KE104	Final Neolithic	Red deer	Tine	Completely manufactured	Fully preserved	8.75	2.4	1.8	25.5
A9B.KE134	Final Neolithic	Red deer	Beam segment	Completely manufactured	Fully preserved	12	2.1	1.4	38
A9B.KE170	Final Neolithic	Red deer	Beam segment	Completely manufactured	Fully preserved	14	3.25	1.8	29.5
A9B.KE189	Final Neolithic	Red deer	Beam segment	Completely manufactured	Fully preserved	14.8	1.5	1.1	29.3
A9B.KE287	Final Neolithic	Red deer	Basal segment	Completely manufactured	Half preserved	10.8	6.5	4.4	135

Needles

Catalogue number	Period	Species	Element	Type	Manufacture State	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE083	Final Neolithic	Red deer	Tine	IA1	Completely manufactured	Half preserved	6	1.5	1.7	10.5
A9B.KE205	Final Neolithic	Red deer	Tine	IA1	Completely manufactured	Fully preserved	14.4	1.6	1.6	19.2
A9B.KE269	Final Neolithic	Red deer	Tine	IA1	Semi finished	Fully preserved	18.5	1.6	1.8	31.2
A9B.KE040	Final Neolithic	Red deer	Tine	IA2	Semi finished	Almost fully preserved	8.3	1.55	1.75	16
A9B.KE201	Final Neolithic	Red deer	Tine	IA2	Completely manufactured	Fully preserved	7.3	1.5	1.7	46.5
A9B.KE070	Final Neolithic	Red deer	Beam segment	IB	Completely manufactured	Almost fully preserved	13.7	1.5	1.4	16.1
A9B.KE182	Final Neolithic	Red deer	Beam segment	IIA	Completely manufactured	Almost fully preserved	8	1.4	0.6	8.4
A9B.KE078	Final Neolithic	Red deer	beam segment	IIB	Completely manufactured	Fully preserved	9.55	1.1	0.4	5.2

Harpoon heads

Catalogue number	Period	Species	Element	Type	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE041	Final Neolithic	Red Deer	Tine	-	Completely manufactured	Half preserved	3.55	1.5	1.5	7
A9B.KE042	Final Neolithic	Red Deer	Tine	-	Semi finished	Half preserved	7.2	1.6	1.1	11.7
A9B.KE001	Final Neolithic	Red Deer	Tine	-	Completely manufactured	Half preserved	8.2	1.8	2.1	25.5
A9B.KE300	Final Neolithic	Red Deer	Tine	-	Semi finished	Fully preserved	12.3	2.1	2.1	34
A9B.KE309	Final Neolithic	Red Deer	Tine	-	Semi finished	Half preserved	9.3	2	2	23.6
A9B.KE311	Final Neolithic	Red Deer	Tine	-	Semi finished	Half preserved	7.4	2	2.2	18
A9B.KE316	Final Neolithic	Red Deer	Tine	-	Semi finished	Fully preserved	12.3	2.1	1.3	34
A9B.KE317	Final Neolithic	Red Deer	Tine	-	Semi finished	Fully preserved	11	1.5	1.3	14.5
A9B.KE318	Final Neolithic	Red Deer	Tine	-	Semi finished	Fully preserved	10.5	2.1	2	26.1
A9B.KE320	Final Neolithic	Red Deer	Tine	-	Completely manufactured	Half preserved	8	1.5	1.7	14.3
A9B.KE332	Final Neolithic	Red Deer	Tine	-	Semi finished	Half preserved	7.5	1.7	1.4	21.7

Harpoons

Catalogue number	Period	Species	Element	Type	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE294	Final Neolithic	Red Deer	Beam segment	HR1	Completely manufactured	Half preserved	9.3	3.75	1.2	33.5
A9B.KE323	Final Neolithic	Red Deer	Beam segment	HR2	Completely manufactured	Fully preserved	6.5	2.45	1.1	12

Maceheads

Catalogue number	Period	Species	Element	Type	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE322	Final Neolithic	Red deer	Basal segment	-	Completely manufactured	Fully preserved	7.7	7.6	5.2	138.9

Thumb rings

Catalogue number	Period	Species	Element	Type	Manufacture state	Preservation State	Outer long diametre (cm)	Outer short diametre (cm)	Weight (gr)
A9B.KE279	Late Neolithic	Red deer	Tine	I	Completely manufactured	Fully preserved	4.25	3.7	17.2
A9B.KE280	Late Neolithic	Red deer	Tine	I	Completely manufactured	Fully preserved	4.8	4	18
A9B.KE281	Late Neolithic	Red deer	Tine	I	Completely manufactured	Half preserved	5	3.5	17.4
A9B.KE282	Late Neolithic	Red deer	Tine	I	Completely manufactured	Half preserved	3.5	2.2	9.5
A9B.KE276	Final Neolithic	Red deer	Tine	II	Completely manufactured	Fully preserved	6.25	3.35	18.4
AA9B.KE277	Final Neolithic	Red deer	Tine	II	Completely manufactured	Fully preserved	6.4	4	27.2
A9B.KE278	Final Neolithic	Red deer	Tine	II	Completely manufactured	Fully preserved	6.2	4.2	22.4
A9B.KE283	Final Neolithic	Red deer	Beam segment	I	Completely manufactured	Half preserved	6	3.9	18.3
A9B.KE284	Final Neolithic	Red deer	Tine	II	Completely manufactured	Half preserved	5.2	2.6	15

Projectile points

Catalogue Number	Period	Species	Element	Type	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE291	Final Neolithic	Red deer	Beam segment	I	Completely manufactured	Fully preserved	12.2	1	0.85	11.4
A9B.KE319	Final Neolithic	Red deer	Beam segment	II	Completely manufactured	Fully preserved	10.7	1.1	1	10.7
A9B.KE295	Final Neolithic	Red deer	Beam segment	II	Completely manufactured	Fully preserved	10.7	1.15	0.95	14.1
A9B.KE303	Final Neolithic	Red deer	Beam segment	II	Completely manufactured	Fully preserved	9.3	1	0.9	7.1
A9B.KE292	Final Neolithic	Red deer	Beam segment	III	Completely manufactured	Almost fully preserved	9.5	1.1	0.9	10.9
A9B.KE325	Final Neolithic	Red deer	Beam segment	IV	Completely manufactured	Half preserved	5.6	0.7	0.6	3.7
A9B.KE097	Final Neolithic	Red deer	Beam segment	V	Completely manufactured	Half preserved	6.65	1.35	1.1	10
A9B.KE315	FN/EBA	Red deer	Tine	VI	Completely manufactured	Fully preserved	14.5	2	1	25.2

Fish hooks

Catalogue Number	Period	Species	Element	Type	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE019	Final Neolithic	Red deer	Beam segment	-	Semi finished	Fully preserved	10.3	0.5	5.5	25

Ornaments

Pendants

Catalogue number	Period	Type	Species	Element	Manufacture state	Preservation State	Height (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9b.KK002	Final Neolithic	Ia	Red Deer	Beam segment	Completely manufactured	Half preserved	6.6	1.48	0.53	6.6
A9b.KK006	Final Neolithic	Ia	Red Deer	Beam segment	Completely manufactured	Almost fully preserved	8.55	1.1	0.5	6
A9b.KK014	Final Neolithic	Ia	Red Deer	Beam segment	Completely manufactured	Half preserved	5	1.2	0.4	4.6
A9b.KK020	Final Neolithic	Ia	Red Deer	Beam segment	Completely manufactured	Fully preserved	8	1.6	0.7	12.1
A9b.KK001	Final Neolithic	Ib	Red Deer	Beam segment	Completely manufactured	Fully preserved	11.3	1.85	1.05	15.1
A9b.KK009	Final Neolithic	Ib	Red Deer	Beam segment	Completely manufactured	Half preserved	6.6	1.7	1	8.4
A9b.KK017	Final Neolithic	Ib	Red Deer	Beam segment	Completely manufactured	Half preserved	5	1.7	1	76.8
A9b.KK021	Final Neolithic	Ib	Red Deer	Beam segment	Completely manufactured	Half preserved	6.4	1.5	0.8	8.9
A9b.KK027	Final Neolithic	Ib	Red Deer	Beam segment	Completely manufactured	Almost fully preserved	6.9	1.3	0.3	7.5
A9b.KK019	Final Neolithic	II	Red Deer	Beam segment	Completely manufactured	Almost fully preserved	3.95	2.6	0.5	1.8
A9b.KK023	Final Neolithic	II	Red Deer	Beam segment	Completely manufactured	Half preserved	4.35	1.1	0.45	1.9
A9b.KK003	Final Neolithic	III	Red Deer	Tine	Completely manufactured	Fully preserved	5.1	1.3	1.2	4.8
A9b.KK007	Final Neolithic	III	Red Deer	Tine	Semi finished	Almost fully preserved	9.8	1.4	1.5	13.6
A9b.KK008	Final Neolithic	III	Red Deer	Tine	Semi finished	Fully preserved	11.2	1.7	2	28
A9b.KK010	Final Neolithic	III	Red Deer	Tine	Semi finished	- Almost whole	7.3	1.6	1.7	11.4
A9b.KK015	Final Neolithic	III	Red Deer	Tine	Semi finished	Fully preserved	11.8	1.5	1.33	15.2
A9b.KK018	Final Neolithic	III	Red Deer	Tine	Semi finished	Almost fully preserved	6	1.7	1.76	12.3
A9b.KK028	Final Neolithic	III	Red Deer	Tine	Completely manufactured	Half preserved	8.1	1.2	1.3	8.1
A9b.KK013	Final Neolithic	IV	Red Deer	Crown	Semi finished	Almost fully preserved	6.1	2.2	1.3	17.3
A9b.KK022	Final Neolithic	V	Red Deer	Tine	Completely manufactured	Fully preserved	10	1.1	1.1	9
A9b.KK025	Final Neolithic	VI	Red Deer	Tine	Completely manufactured	More than half preserved	3.9	2	1.1	6
A9b.KK005	Final Neolithic	VII	Red Deer	Beam segment	Completely manufactured	Fully preserved	2.08	1.46	0.6	1.8
A9b.KK011	FN/EBA	IV	Red Deer	Crown	Completely manufactured	Fully preserved	8.25	5.45	0.9	13.8

Rings

Catalogue Number	Period	Type	Species	Element	Manufacture state	Preservation State	Outer diametre	Inner diametre	Weight
A9b.KK012	Final Neolithic	-	Red deer	Tine	Completely manufactured	Fully preserved	3.2	2.41	7.8
A9b.KK016	Final Neolithic	-	Red deer	Tine	Completely manufactured	Fully preserved	1.95	1.2	1.6
A9b.KK024	Final Neolithic	-	Red deer	Tine	Completely manufactured	Fully preserved	2.8	2.5	0.8
A9b.KK026	Final Neolithic	-	Red deer	Tine	Completely manufactured	Almost half preserved	1.6 (estimated)	1.2 (estimated)	0.9
A9b.KK004	Late Neolithic	-	Red deer	Tine	Completely manufactured	Half preserved	2.7 (estimated)	2.5 (estimated)	1.9

Eating and mixing food equipment

Spoons

Catalogue Number	Phase	Species	Element	Manufacture state	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9B.KE305	Final Neolithic	Fallow deer	Palmate	Completely manufactured	Fully preserved	18	0.7	2.8	17.7

Artifacts of undefined function

Catalogue Number	Period	Species	Element	Manufacture state	Preservation State	Length (cm)	Thickness (cm)	Width (cm)	Weight (gr)
A9B.KE308	Late Neolthic	Red Deer	Beam segment	Completely manufactured	Half preserved	6.3	3.1	0.5	6.7
A9B.KE329	Late Neolthic	Red Deer	Tine	Completely manufactured	Fully preserved	3.45	2.75	3	20.6
A9B.KE331	Late Neolthic	Red Deer	Tine (tip)	Semi finished (?)	Fully preserved	8.2	1.4	2.5	32.5
A9b.KΔ023	Final Neolithic	Red Deer	Tine (tip)	Semi finished (?)	Fully preserved	2.75	1.2	1.2	3.4
A9B.KE045	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved	6.6	0.5	1.7	9.1
A9b.KΔ016	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Partially preserved	4	1.1	3	7.8
A9B.KE296	Final Neolithic	Red Deer	Tine	Completely manufactured	Half preserved	4.15	1.15	2.15	7.3
A9B.KE289	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved	7.5	2.4	1.1	10.4
A9B.KE298	Final Neolithic	Red Deer	Tine (tip)	Semi finished (?)	Fully preserved	4.52	1.5	1.6	8.6
A9B.KE299	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved(?)	13.4	0.7	2.4	24.3
A9B.KE301	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved(?)	10.5	0.7	2	20
A9B.KE302	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved(?)	7.7	1.1	2.7	23
A9B.KE304	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved(?)	5.2	1.7	0.4	7.9
A9B.KE306	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved(?)	12.5	1.5	2.5	32.3
A9b.KΔ065	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved	4.7	0.6	2.35	7.3
A9b.KΔ067	Final Neolithic	Red Deer	Beam segment	Semi finished	Fully preserved	12.3	1.8	0.9	20.8
A9B.KE181	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved	8.4	0.55	1.5	11.5
A9B.KE310	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved	5.25	5.25	5.4	91.2
A9B.KE312	Final Neolithic	Red Deer	Tine (tip)	Semi finished (?)	Fully preserved	5.15	1.4	1.4	8.7
A9B.KE313	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved	6.6	4.8	6.2	100.9
A9B.KE314	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved	5.2	1.2	3.8	64.4
A9b.KΔ079	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Fully preserved	4.25	0.8	2	7.2
A9B.KE321	Final Neolithic	Red Deer	Basal segment	Semi finished	Fully preserved	3.5	3.7	4.8	6.8
A9B.KE324	Final Neolithic	Red Deer	Tine (tip)	Semi finished (?)	Fully preserved	3.9	1.3	1.3	4.8
A9B.KE326	Final Neolithic	Red Deer	Beam segment	- Completely manufacture	Half preserved	4	1.05	2.3	8.5
A9B.KE327	Final Neolithic	Red Deer	Tine (tip)	Semi finished	Fully preserved	3.7	1.55	1.55	5
A9B.KE328	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved	5	0.7	2.5	7.5
A9B.KE330	Final Neolithic	Red Deer	Beam segment	Completely manufactured	Half preserved	5.6	0.7	1.8	3.5

Blanks

Catalogue number	Period	Species	Element	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9b.KΔ042	Late Neolithic	Red Deer	Tine	Fully preserved	11.5	2.5	2.7	37
A9b.KΔ043	Late Neolithic	Red Deer	Tine	Fully preserved	14.6	2.7	2.5	74.4
A9b.KΔ101	Late Neolithic	Red Deer	Beam segment	Fully preserved	7.65	3.5	3	81
A9b.KΔ057	Late Neolithic	Red Deer	Tine	Fully preserved	17	4.5	2.5	73
A9b.KΔ125	Late Neolithic	Red Deer	Beam segment	Fully preserved	9.3	3.1	2.65	73
A9b.KΔ069	Late Neolithic	Red Deer	Tine	Fully preserved	25	3.8	1.7	197
A9b.KΔ080	Late Neolithic	Red Deer	Tine	Fully preserved	38	4	3	324
A9b.KΔ083	Late Neolithic	Red Deer	Tine	Fully preserved	12	2.3	2	50
A9b.KΔ105	Late Neolithic	Red Deer	Tine	Fully preserved	28.5	4.1	3.5	205
A9b.KΔ114	Late Neolithic	Red Deer	Tine	Fully preserved	16.5	3	2.4	73
A9b.KΔ012	Final Neolithic	Red Deer	Tine	Fully preserved	25.7	5.5	2.8	195
A9b.KΔ001	Final Neolithic	Roe Deer	Basal and beam segment	Fully preserved	18.5	3	1.8	71
A9b.KΔ002	Final Neolithic	Red Deer	Basal segment	Fully preserved	10.3	7.6	4.5	239
A9b.KΔ003	Final Neolithic	Red Deer	Beam segment	Fully preserved	37	22	3.1	560
A9b.KΔ014	Final Neolithic	Red Deer	Tine	Half preserved	5.2	1.2	1.2	6.2
A9b.KΔ013	Final Neolithic	Red Deer	Tine	Fully preserved	18	2	1.7	82.3
A9b.KΔ005	Final Neolithic	Red Deer	Basal segment	Fully preserved	10.2	7.6	4	213.5
A9b.KΔ015	Final Neolithic	Red Deer	Tine	Fully preserved	21	3.7	2.15	116.8
A9b.KΔ017	Final Neolithic	Red Deer	Tine	Fully preserved	30	4.6	3.1	219
A9b.KΔ018	Final Neolithic	Red Deer	Basal segment	Fully preserved	23	15.5	6	345
A9b.KΔ021	Final Neolithic	Red Deer	Tine	Fully preserved	13.8	3	2.7	86.2
A9b.KΔ026	Final Neolithic	Red Deer	Tine	Fully preserved	8	1.9	1.95	18
A9b.KΔ028	Final Neolithic	Red Deer	Tine	Fully preserved	13.2	5.4	1.9	86.4
A9b.KΔ097	Final Neolithic	Red Deer	Beam segment	Fully preserved	19.5	5.5	3.5	165
A9B.KE109	Final Neolithic	Red Deer	Tine	Fully preserved	27	4.5	3	221
A9b.KΔ048	Final Neolithic	Red Deer	Beam segment	Fully preserved	3	4.5	3.5	37
A9b.KΔ055	Final Neolithic	Red Deer	Tine	Fully preserved	5.8	1.4	1.3	8.1
A9b.KΔ128	Final Neolithic	Red Deer	Basal segment	Fully preserved	10.3	5.2	3.1	103
A9b.KΔ064	Final Neolithic	Red Deer	Tine	Fully preserved	4.7	1.6	1.6	11.5
A9b.KΔ078	Final Neolithic	Red Deer	Tine	Fully preserved	14.5	2.65	2.3	63.3
A9b.KΔ086	Final Neolithic	Red Deer	Tine	Fully preserved	19	3.5	2.5	140
A9b.KΔ089	Final Neolithic	Red Deer	Basal segment	Fully preserved	25.5	12	37.4	480
A9b.KΔ090	Final Neolithic	Red Deer	Beam segment	Fully preserved	4	5.4	4.5	69
A9b.KΔ111	Final Neolithic	Red Deer	Tine	Fully preserved	16.2	2.1	1.7	66

Blanks

Catalogue number	Period	Species	Element	Preservation State	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9b.KΔ113	Final Neolithic	Red Deer	Tine	Fully preserved	16.5	2.2	2.2	71
A9b.KΔ115	Final Neolithic	Red Deer	Tine	Fully preserved	18.5	4.2	2.7	121
A9b.KΔ120	Final Neolithic	Red Deer	Tine	Fully preserved	9.6	2.5	2.5	62.8
A9b.KΔ099	FN/EBA	Red Deer	Beam segment	Fully preserved	2.35	2.45	2.6	15.1

Waste

Catalogue number	Period	Species	Element	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9b.KΔ019	Late Neolithic	Red Deer	Beam segment	12.5	8.5	4.1	228
A9b.KΔ024	Late Neolithic	Red Deer	Beam segment	12.2	3.5	3	128
A9b.KΔ031	Late Neolithic	Red Deer	Beam segment	10.5	6.2	4.6	200
A9b.KΔ034	Late Neolithic	Red Deer	Beam segment	9.6	2.5	0.55	27
A9b.KΔ039	Late Neolithic	Red Deer	Basal segment	17.8	5	1.8	156
A9b.KΔ045	Late Neolithic	Red Deer	Basal segment	9.5	9	6.9	200
A9b.KΔ047	Late Neolithic	Red Deer	Beam segment	8.1	3.6	2.6	42.5
A9b.KΔ051	Late Neolithic	Red Deer	Beam segment	5	3.1	2.8	33.3
A9b.KΔ124	Late Neolithic	Red Deer	Beam segment	17	6	4	321
A9b.KΔ052	Late Neolithic	Red Deer	Basal segment	18	10	6.3	389
A9b.KΔ059	Late Neolithic	Red Deer	Beam segment	10.3	6.1	4.2	164.1
A9b.KΔ060	Late Neolithic	Red Deer	Beam segment	22.5	9	3	185
A9b.KΔ102	Late Neolithic	Red Deer	Beam segment	13.1	8.1	3.5	214
A9b.KΔ063	Late Neolithic	Red Deer	Beam segment	14.4	8.2	7.5	62.5
A9b.KΔ084	Late Neolithic	Red Deer	Beam segment	30	8	4.1	431
A9b.KΔ108	Late Neolithic	Red Deer	Tine	10	2.35	2.35	42
A9b.KΔ109	Late Neolithic	Red Deer	Basal segment	13.7	7.6	2.4	62
A9b.KΔ118	Late Neolithic	Red Deer	Tine	6.6	1.5	1.3	20
A9b.KΔ123	Late Neolithic	Red Deer	Tine	11.2	2.5	3	61.9
A9b.KΔ100	Late Neolithic	Red Deer	Basal segment	17.5	9.6	7.3	360
A9b.KΔ050	Late Neolithic	Red Deer	Crown	13	15	35	205
A9b.KΔ053	Late Neolithic	Red Deer	Beam segment	8.6	4	2.7	62.5
A9b.KΔ041	Final Neolithic	Red Deer	Tine	6.1	2.5	1.3	15.2
A9b.KΔ098	Final Neolithic	Red Deer	Tine	9.7	2.25	1.75	65

Waste

Catalogue number	Period	Species	Element	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9b.KΔ127	Final Neolithic	Red Deer	Basal segment	12.1	9.2	5.8	322
A9b.KΔ004	Final Neolithic	Red Deer	Tine	19	4.5	3.2	182
A9b.KΔ006	Final Neolithic	Red Deer	Beam segment	9	6	3.6	76
A9b.KΔ007	Final Neolithic	Red Deer	Basal segment	10.4	8.6	2.6	107.4
A9b.KΔ008	Final Neolithic	Red Deer	Tine	9.5	2	2	23
A9b.KΔ009	Final Neolithic	Red Deer	Tine	17	3.1	3.5	124.5
A9b.KΔ010	Final Neolithic	Red Deer	Beam segment	4.15	5	4.55	61
A9b.KΔ011	Final Neolithic	Red Deer	Beam segment	28	13	3.6	405
A9b.KΔ022	Final Neolithic	Red Deer	Beam segment	7.5	5.3	4.1	102.1
A9b.KΔ020	Final Neolithic	Red Deer	Beam segment	22	4.45	4.2	322.5
A9b.KΔ121	Final Neolithic	Red Deer	Tine	14.4	3.5	3.5	104
A9b.KΔ025	Final Neolithic	Red Deer	Tine	9.1	3.3	2.5	27.5
A9b.KΔ027	Final Neolithic	Red Deer	Tine	10.6	2.6	1.7	25.3
A9b.KΔ029	Final Neolithic	Red Deer	Beam segment	4.8	2.45	2.1	21
A9b.KΔ030	Final Neolithic	Red Deer	Basal segment	9	9.2	3.8	154.5
A9b.KΔ032	Final Neolithic	Red Deer	Basal segment	10.4	5.6	3.1	120
A9b.KΔ033	Final Neolithic	Red Deer	Basal segment	10.6	13.3	6.1	214
A9b.KΔ035	Final Neolithic	Red Deer	Beam segment	9.1	3.7	3.2	105
A9b.KΔ036	Final Neolithic	Red Deer	Beam segment	11	2.6	2.5	36.1
A9b.KΔ037	Final Neolithic	Red Deer	Beam segment	17	8.1	4.3	196
A9b.KΔ038	Final Neolithic	Red Deer	Basal segment	7.9	10.6	7	276.5
A9b.KΔ122	Final Neolithic	Red Deer	Beam segment	7.9	3.8	2.6	38.5
A9b.KΔ044	Final Neolithic	Red Deer	Basal segment	64	8	5.5	149
A9b.KΔ046	Final Neolithic	Red Deer	Beam segment	11.3	3.45	2.2	77.6

Waste

Catalogue number	Period	Species	Element	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9b.KΔ049	Final Neolithic	Red Deer	Basal segment	9	6	6.6	213
A9b.KΔ054	Final Neolithic	Red Deer	Beam segment	11	3.7	1.3	64
A9b.KΔ056	Final Neolithic	Red Deer	Beam segment	19.1	5.9	3.5	210
A9b.KΔ062	Final Neolithic	Red Deer	Tine	16	3.9	3	173
A9b.KΔ104	Final Neolithic	Red Deer	Beam segment	8.5	3.5	2.7	58
A9b.KΔ066	Final Neolithic	Red Deer	Beam segment	21.5	4.3	4.3	328
A9b.KΔ068	Final Neolithic	Red Deer	Beam segment	19	6	3.6	36
A9b.KΔ070	Final Neolithic	Red Deer	Basal segment	8	7	3.8	118
A9b.KΔ071	Final Neolithic	Red Deer	Basal segment	13	5	2.8	112.3
A9b.KΔ072	Final Neolithic	Red Deer	Beam segment	13	8.3	5.1	249
A9b.KΔ073	Final Neolithic	Red Deer	Basal segment	9.5	11	4.9	312.4
A9b.KΔ074	Final Neolithic	Red Deer	Basal segment	7.5	5.2	3.7	74.7
A9b.KΔ126⍰	Final Neolithic	Red Deer	Basal segment	4	5	4.5	57.6
A9b.KΔ075	Final Neolithic	Red Deer	Beam segment	14.6	7.6	3.5	124
A9b.KΔ076	Final Neolithic	Red Deer	Beam segment	17.5	7.5	4	65
A9b.KΔ077	Final Neolithic	Red Deer	Beam segment	7.2	6	4.6	103
A9b.KΔ081	Final Neolithic	Red Deer	Basal segment	23	25	5.3	921.2
A9b.KΔ082	Final Neolithic	Red Deer	Beam segment	9.8	6	4.6	161
A9b.KΔ085	Final Neolithic	Red Deer	Beam segment	4.4	3.3	1.2	31.8
A9b.KΔ087	Final Neolithic	Red Deer	Beam segment	24	6	3.7	200
A9b.KΔ088	Final Neolithic	Red Deer	Basal segment	7.1	8.5	5.7	117
A9b.KΔ091	Final Neolithic	Red Deer	Tine	16.5	3.8	2.9	183.3
A9b.KΔ092	Final Neolithic	Red Deer	Tine	9.5	3.7	3	71
A9b.KΔ093	Final Neolithic	Red Deer	Tine	9.5	2.5	2	36.7

Waste

Catalogue number	Period	Species	Element	Length (cm)	Width (cm)	Thickness (cm)	Weight (gr)
A9b.ΚΔ094	Final Neolithic	Red Deer	Beam segment	11.7	4.4	1.6	61
A9b.ΚΔ095	Final Neolithic	Red Deer	Basal segment	5.6	5.3	3.3	51
A9b.ΚΔ096	Final Neolithic	Red Deer	Beam segment	18	8.75	3	236
A9b.ΚΔ103	Final Neolithic	Red Deer	Beam segment	26.7	6.3	4.4	473
A9b.ΚΔ107	Final Neolithic	Red Deer	Beam segment	18.1	3.6	3.6	200
A9b.ΚΔ106	Final Neolithic	Red Deer	Tine	12.3	2.95	2.3	78
A9b.ΚΔ117	Final Neolithic	Red Deer	Basal segment	6	6.7	6.7	167.5
A9b.ΚΔ110	Final Neolithic	Red Deer	Beam segment	8.6	3.1	1.25	31
A9b.ΚΔ112	Final Neolithic	Red Deer	Beam segment	7.3	5.5	2	63.5
A9b.ΚΔ116	Final Neolithic	Red Deer	Tine	14	3.35	3.2	126.4
A9b.ΚΔ119	Final Neolithic	Red Deer	Basal segment	21.3	8	4.5	605
A9b.ΚΔ040	FN/EBA	Red Deer	Beam segment	16	4.6	4.1	155
A9b.ΚΔ061	FN/EBA	Red Deer	Basal segment	11	8	2.7	200