

Hunter-Gatherers' Tool-Kit

Hunter-Gatherers' Tool-Kit:

A Functional Perspective

Edited by

Juan F. Gibaja, Joao Marreiros,
Niccolò Mazzucco and Ignacio Clemente

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PART I:

EUROPE

CHAPTER ONE

APPEARANCE AND FUNCTION OF HARPOONS IN NORTHEASTERN ITALY

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Abstract

The chapter discusses the appearance of osseous harpoons in northern Italy. At present, in Italy, the earliest harpoons come from the eastern Alpine region and in particular from the Adige Valley, the southern Dolomites and the Julian Alps. Typologically, specimens from these areas are defined as bilateral harpoons with straight barbs and basal bilateral gorge and bevelled bases. On the basis of the radiocarbon dates available for the archaeological layers containing the harpoons, it seems that lateral-barbs technology was introduced in the eastern Alpine region during the Sauveterrian, in the 9th millennium cal BC.

Only in the Adige Valley have a total of 15 entire and fragmentary harpoons been found in the Late Sauveterrian and Castelnovian levels of the sites of Romagnano Loc III, Riparo Pradestel, Riparo Gaban and Doss de la Forca. One entire specimen comes from the burial of Mondeval de Sora in the southern Dolomites whereas another two fragments were recovered at the sites of Riparo Biarzo and Cladrecis in the Julian Alps. Such harpoons underwent a technological and functional analysis, the results of are discussed in relation to experimental data as well as evidence from contemporaneous stone projectile technologies. In the chapter, we explore whether the introduction of standardized hunting toolkits, such as that represented by lateral barbed osseous projectiles, might have been related to changes in environmental conditions and how cultural transmission

processes might have spread the use of this curated technology across a wide region. The evidence we collected seems to indicate that such an innovation spread locally at the end of the Early Mesolithic. Other chronologically earlier specimens have been found in the adjacent Balkan Peninsula and southern France.

Keywords: Osseous harpoons; Eastern Alpine region; Lateral-barbs technology; Projectile technology; Hunting and fishing toolkit; Technological and use-wear analysis; Mesolithic.

1. Introduction

Organic projectile points represent a key component of Upper Palaeolithic and Mesolithic hunting equipment. After they appeared in Europe by 40,000 years ago, a number of technological transformations are documented with regard to their morphology, hafting, predatory strategies and systems of propulsion (Pétillon 2008). The introduction of lateral barbs on osseous projectiles undoubtedly denotes one of the major technological innovations in the evolution of prehistoric hunting techniques, which happened for the first time in Africa ca. 90,000 years ago. Although the exact function of prehistoric barbed points is still debated, it was noticed that the application of lateral barbs to osseous points involved a variation in hunting techniques as the barbs were primarily conceived for hampering the extraction of the point from the body of the animal (Julien 1982; Pétillon 2008).

The presence of lateral-barbs technology in Europe is defined by a geographical and chronological discontinuity since its very first appearance at the end of the Gravettian, ca. 22,000 years ago (Pétillon 2008). Harpoons with one or two rows of lateral barbs characterize the Upper Magdalenian tradition, ca. 16,500 - 15,500 cal BC, on the northern and eastern coasts of Spain to central Germany (Pétillon 2008). These tools disappear from the north of France and the Iberian Mediterranean at the end of the Magdalenian, in the south of the region at the end of the Azilian and at the end of the Ahrensbourgian in the north of Germany (Rozoy 1978). In some areas of Western Europe, for instance in Belgium, harpoons reappear in a later phase of the Mesolithic characterized by typical notched blades and bladelets (Montbani type) as well as trapezes (Rozoy 1978). Yet, in Italy, harpoons are unknown until the Mesolithic. At the face of current data, no osseous harpoons or barbed points characterize hunting strategies of the Late Maximum Glacial (LGM) and Tardiglacial Epigravettian groups in Italy. Harpoons are documented only from an

advanced phase of the Early Mesolithic (Dalmeri et al. 2001). An exception to this pattern is a unilateral harpoon found in the northern Adriatic region in Epigravettian layer B/g at the site of Šandalja II in Istria (Karavanić 2013). In addition, several unilateral barbed points were found at the Epipalaeolithic site of Badanj in Herzegovina (Kujundžić 1990; Whallon 1989, 1999), and two in Epigravettian levels of the site of Vlakno on the island of Dugi Otok in Dalmatia (<https://archaeologynewsnet.work.blogspot.com/2017/11/15000-year-old-venus-figure-discovered.html> accessed on April 2019).

To barbed points from Badanj have been AMS-dated, and that their chronological attribution to the Epigravettian period.

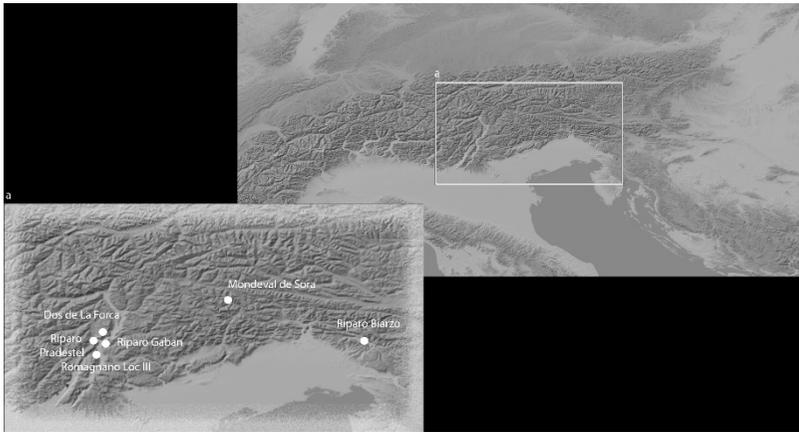


Figure 1: Map with the location of the eastern Alpine sites where harpoons have been recovered.

In this chapter, we focus on the appearance of harpoons in northern Italy. Such an innovation seems to have spread locally at the end of the Early Mesolithic since no other chronologically earlier specimens have been found in either of the two peninsulas. We present technological and functional characteristics of harpoons and discuss them in comparison to contemporaneous traits of stone projectile technologies as well as in relation to experimental data. We explore whether the introduction of this innovation in weaponry, i.e. standardized hunting toolkits, might have been related to changes in environmental conditions and how cultural transmission processes might have spread the use of this curated technology across a wide region.

2. Human adaptations at the onset of the Holocene in the Alps

Favourable environmental conditions for human inhabitation of the Alps were established after the Last Glacial Maximum (between 25,000 and 18,000 cal BP) (Ravazzi 2003). After the onset of the Bolling-Allerod and late Holocene warming, different environments and biomass started to characterize the region. Forests, Alpine prairies, rivers and lakes became important locations for temporary as well as seasonal exploitation by Mesolithic foragers (Dalmeri et al. 2001; Dalmeri and Grimaldi 2002).

During the Preboreal (ca. 11,500-9300 years cal BP) (Ravazzi 2003) the raising of the temperature by ca. 4-6 degrees C determined the rise of approximatively 800 metres of the forest limit (Tinner and Vescovi 2005). Forests of *Quercus*, *Tilia*, *Ulmus*, *Fraxinus* and *Acer* are documented at the south of the Garda Lake whereas *Pinus*, *Larix* and *Betula* are present in the mountainous parts of the region (Drescher-Schneider 2009). The extent of the glaciers during the Boreal (ca. 9000 - 7500 years cal BP) was similar to today (Ravazzi 2003; Tinner and Vescovi 2005).

In the Adige Valley, human occupation became more intense from the start of the Preboreal. In particular, rock shelters between 210 and 250 m a.s.l. were occupied until the beginning of the Atlantic (ca. 8200 - 5600 years cal BP) (Ravazzi 2003) and numerous sites distributed between the Alpine watershed and the northern fringe of the Prealps document the exploitation of high altitudes – from ca. 1900 to 2300 m a.s.l. (Dalmeri et al. 2001). In the Dolomites, large erratic or landslide masses were often used as shelters and places for burials (Bagolini and Dalmeri 1987, 1994). Areas surrounding glacial lakes were also exploited in the Lagorai Chain as well as high altitude mountain passes, crests and saddles (Dalmeri and Lanzinger 1989, 1994). Early Mesolithic occupations are also documented in Friuli, in the Isarco and Natisone Valleys (Bressan and Guerreschi 1982; Guerreschi 1996). The economy was based on ibex and later on red deer hunting but also on fishing, collecting fresh water shells and mussels, turtles and small game hunting (Dalmeri and Lanzinger 1989, 1994; Guerreschi 1996).

The onset of the Atlantic is characterized by a number of transformations, which occurred in the climate and involved readjustments of settlement strategies, predatory strategies and the composition of hunting equipment. Pollen series indicate a warmer and moister climate with the expansion of the forest at higher altitudes than today and the reduction of the Alpine prairie. In the Venetian Prealps, *Picea* and *Corylus* become common at 1400 m a.s.l. whereas *Abies* and *Fagus* are diffused at mid altitudes

(Drescher-Schneider 2009). The expansion of the limit of the vegetation caused the migration of ibex to high altitudes and the predominance of cervids in lowlands and at mid-altitudes. The Atlantic, is considered a period of climatic optimum and the limit of the Alpine prairie was 300 m higher than today. In this period, the exploitation of lowlands and aquatic resources increased with the decline in ibex hunting. This situation indicates that higher altitude hunting declined from the beginning of the 6th millennium cal BC. A drastic change is also documented in knapped stone technology: the dimensions of blades increased, and trapezes and osseous harpoons were introduced as the main components of hunting equipment. New shelters were occupied in the lowlands and mountain settlements began to be slowly abandoned. In the faunal assemblage, red and roe deer predominate over ibex and chamois, which became rare (Bagolini 1980a, b; Dalmeri et al. 2001).

So far, it is still not clear whether the occupation of the multi-stratified shelters in the Adige Valley was co-terminus during the Early and Late Mesolithic. Some of these sites are characterized by long stratigraphic sequences testifying to uninterrupted occupations (Riparo Gaban, Romagnano Loc III) whereas others (Riparo Pradestel and Riparo Soman) were utilized discontinuously in the Boreal and Atlantic periods. In the Natisone Valley in Friuli, a long stratigraphic sequence ranging from the final Epigravettian, to the Mesolithic and the Neolithic periods has been documented at Riparo Biarzo (Guerreschi 1996).

On the basis of site distributions and knapped stone tool morphometric characteristics, rock shelters in the Adige Valley have been considered as winter locations whereas sites located between 1800 and 2000 m a.s.l. might have been preferred during the summer season. However, the Mesolithic catchment area in the eastern Alpine region likely included a wider territory, from the southern Alps to the Adriatic Sea and from the Triest Karst to the western side of the Po Plain (Grimaldi 2005), where evidence of Mesolithic frequentation was recently discovered (Fontana et al. 2009). Here, the presence of big rivers, marshy areas, lagoons and the Adriatic coast might have favoured the formation of stable settlements where local groups would gather in wider regional groupings during the winters.

The presence of marine gastropods used as personal adornments (e.g. *Columbella rustica*, *Cyclope neritea*, etc.) in the lowlands and high-altitude sites would confirm the existence of long-distance strategies of mobility and exchange (Cristiani 2009, 2012). According to this interpretation of the Mesolithic mobility strategy in the eastern Alpine region, sites in the Adige Valley represented semi-permanent camps where

local groups performed activities such as butchering or hide processing, supported by the presence of numerous limb extremities in the Early Mesolithic levels of Riparo Pradestel, Vatte di Zambana, Romagnano Loc III and Riparo Gaban (Kozłowski and Dalmeri 2000). This evidence suggests the introduction of both animal meat and skins at these sites (Boscato and Sala 1980). Following this model, the dispersal of small groups of hunters to high altitudes happened between summers and autumns, based on faunal remains at the high-altitude sites of Mondeval de Sora and Plan de Frea IV (Alessio et al. 1983; Alciati et al. 1994; Angelucci et al. 1995, 2002). Children's deciduous teeth recovered at high-altitude locations such as Plan de Frea, Lago delle Buse (Dalmeri and Lanzinger 1989, 1994) and Colbricon 1 (Bagolini and Dalmeri 1987) suggest the movement of the entire group to the mountain locations.

Environmental and archaeological data presented so far highlight the key role of the Eastern Alpine region, and its variety of gated ecozones (forests, prairies, rivers and lakes) for Holocene forager populations on a temporary as well as seasonal basis (Dalmeri et al. 2001; Dalmeri and Grimaldi 2002).

3. Methods

By analysing Mesolithic osseous harpoons from the Eastern Alpine region, we aim at reconstructing the sequence of gestures related to their production and use. Morphological definitions of the harpoons are based on the Committee of Nomenclature of Prehistoric Bone Industry (Averbouh et al. 1995: *Fiche typologique*, Cahier VII). Osseous specimens were directly analysed without the use of resin replicas. Animal species and anatomical provenance of the blanks were recorded in order to identify specific criteria of raw material selection. Metrical information of harpoons included length, width and thickness, invasiveness and symmetry of the distal and proximal parts (e.g. of the pointed ends and the bases of the harpoons) together with the sections of distal, mesial and proximal parts. Manufacturing techniques and use-wear traces were recorded with regard to their development, location and distribution on the tools.

Techno-functional traces were identified using a stereoscope Leica MZ12.5 (magnification range from 10x to 100x). Their interpretation was based on (1) the results of experimental activities (reproduction of harpoons by using different techniques such as longitudinal engraving, direct and indirect percussion, scraping and abrasion); and (2) criteria defined in the literature (for the technological interpretations: Newcomer

1974; d'Errico et al. 1984; Campana 1989; Averbouh and Provenzano 1999; David 2004; 2005; for the study of the use-wear traces: Maigrot 1997; Christidou 1999; Christidou and Legrand 2005; Legrand 2007; for the study of impact traces: Pétillon 2006, 2008; Pétillon et al. 2011).

4. Provenance and characteristics of the harpoons from the eastern Alpine region

The earliest harpoons in southern Europe come from the eastern Alpine region and in particular from the Adige Valley, the southern Dolomites and the Julian Alps. So far, no harpoon found in the region has been dated directly. Their chrono-cultural attribution has been based on the material culture found in association with the harpoons, by dating charcoal preserved in the layers that barbed technology was recovered in and, in one case, by dating the humans remains associated with a harpoon.

In the Adige Valley, a total of 15 entire and fragmentary harpoons were found in the Late Sauveterrian and Castelnovian levels of the sites of Romagnano Loc III (n=4), Riparo Pradestel (n=5), Riparo Gaban (n=4) and Doss de la Forca (n=2) (Fig. 2; 3). At Riparo Gaban, a barbed point is also documented. One entire specimen comes from the burial of Mondeval de Sora in the southern Dolomites whereas another two fragments were recovered at the sites of Riparo Biarzo and Cladrecis in the Julian Alps. Harpoons from the eastern Alpine region of Italy were all made on antler with one exception on bone.

As indicated by the radiocarbon dates available for the archaeological layers containing the harpoons, lateral-barbs technology was introduced in the eastern Alpine region at the end of the 9th millennium cal BC, during the Sauveterrian (Broglio 2016). Typologically, specimens from the Eastern Alpine region are defined as “bilateral harpoons with straight barbs and basal bilateral gorge” (Averbouh et al. 1995), and bevelled bases.

Site	Early/Middle Sauveterrian (ca. 8500- 6550 cal BC)	Final Sauveterrian (ca. 6550-6200 cal BC)	Castelnovian (ca. 6200- 5500 cal BC)	Total
Romagnano Loc III	3		1	4
Riparo Pradestel		5		5
Dos de la Forca			2	2
Riparo Gaban			4	4
Mondeval de Sora			1	1
Riparo Biarzo			1	1
Cladrecis			1	1
Total	3	5	11	18

Table 1: Frequencies of harpoons in the eastern Alpine region.

Romagnano Loc III

The site of Romagnano Loc III (210 m a.s.l.) is located ca. 12 km south of the city of Trento. It yielded a stratigraphic column of ca. 6 m documenting inhabitation from the Early Mesolithic to the Iron Age (Alessio et al. 1983). Early Mesolithic Sauveterrian industry is documented in layers AF-AE to AC2-AC1 whereas Late Mesolithic finds were found in layers AB2-AB1. Several radiocarbon dates on charcoal are available for the site (Table 2). One entire harpoon and three harpoon bases on antler come from the middle Sauveterrian layers AC5 and AC4 of Romagnano Loc III (Figs. 2.2; 3.1-4).

Riparo Pradestel

The site of Pradestel (225 m a.s.l.) is situated at ca. 20 m from the actual level of the Adige River in the locality of Ischia Podetti (Trento). The stratigraphic sequence of ca. 5 m documents the occupation of the site from the Early Mesolithic to the Early Neolithic (Dalmeri et al. 2008). Four radiocarbon dates are available for the Mesolithic period (see Table 2). The harpoons from Riparo Pradestel come from the final Sauveterrian layers G3-G2-G1 and F3. The ensemble is fragmentary, and composed of two distal parts with lateral barbs, one single barb and two fragmentary bases (Fig. 3.9-13).

Site	Layer	Date – uncal BP	Calibrated age BC (95.4%)	Calibrated age BP	Material
<i>Romagnano Loc III</i>	AC5	9090±90 BP	8564-7980	10513-9929	Charcoal
	AC4	8740±90 BP	8201-7592	10150-9541	Charcoal
<i>Riparo Pradestel</i>	F3-G1-G2-G3	(H-H2 Final Sauveterrian) 8200±50 BP	7352-7065	9301-9014	Charcoal
	D	6870±50 BP	5878-5661	7827-7610	Charcoal
<i>Gaban</i>	E5-E6-E7	6968±41 BP	5978-5745	7927-7694	Charcoal
<i>Mondeval de Sora</i>	Burial	7425±55	6429-6119	8378-8068	Human bone

Table 2: Chronological framework of the archaeological harpoons from the Eastern Alpine region.

Riparo Gaban

Gaban rock shelter (270 m a.s.l.) is situated about 3 km north of Trento, in a dominant position on the eastern side of the Adige River. The site was occupied from the Early Mesolithic throughout the Neolithic and Middle Bronze Age. B. Bagolini conducted the first archaeological excavations from 1971 to 1979. Successively, S. Kozłowski and G. Dalmeri continued fieldwork from 1982–1984, focusing only on Mesolithic levels. The Late Mesolithic (Castelnovian) was found in spits 1 to 6 of layer E (Bagolini excavations) and layer FA (Kozłowski and Dalmeri excavations). The lower layers, FB and FC, are representative of the Early Mesolithic occupations (Sauveterrian). All published conventional radiocarbon dates from Riparo Gaban were made on charcoal. Four bases of harpoons were recovered from layers E5 (2), E6 (1) and E7 (1) (Fig. 3.5-7). This tool shares morpho-technological similarities with Early Mesolithic notched points found in southern Germany (see below for regional technomorphological and typological comparisons).

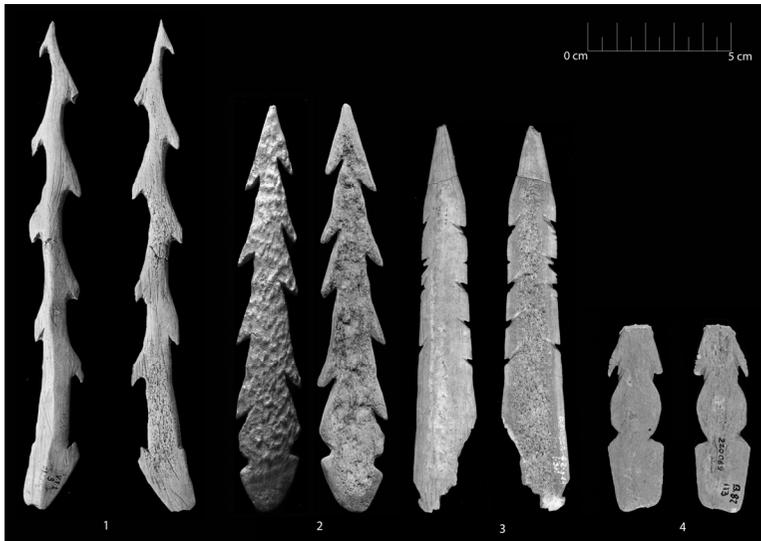


Figure 2: Entire harpoons from the eastern Alpine region. 1) Mondeval de Sora; 2) Romagnano Loc III; 3) Dos de la Forca; 4) Riparo Biarzo.

Dos de la Forca

The site is located at 225 m a.s.l. in the proximity of a huge erratic mass in the locality of Ischia Alta, along the left side of the Noce river. The stratigraphic sequence documents a brief Late Mesolithic, and Early Neolithic occupations. After being abandoned, the site was used as a burial place in the Eneolithic. Two harpoon specimens, one almost whole and one fragmented, were recovered in the Late Mesolithic layers (Figs. 2.3; 3.8). Although used, the functional attributes of the more complete specimen, and particularly its barbs, are only roughly shaped, suggesting this was an unfinished roughout.

Mondeval de Sora

The burial of Mondeval de Sora is sited in San Vito di Cadore (Belluno) at 2150 m a.s.l., underneath a huge dolomite erratic boulder (Fontana 2006) (Fig. 1). The skeleton, which was directly dated to the Castelnovian period (OxA-7468: 7425 ± 55 BP), belongs to a ca. 40-year-old robust male who was 167 cm tall (Fontana 2006). The body was buried in an extended supine position with a north-south orientation and with the feet leaning

against a big rock. Blocks of tuff and marl collected around the site were covering the lower part of the body. The burial of Mondeval de Sora is unique for the unusual geographic position and for the rich repertoire of 61 grave goods which accompanied the deceased. Amongst them, one entire 187 mm-long harpoon with a triangular-flat section was recovered along the left side of the body (Fontana 2006) (Fig. 2.1).

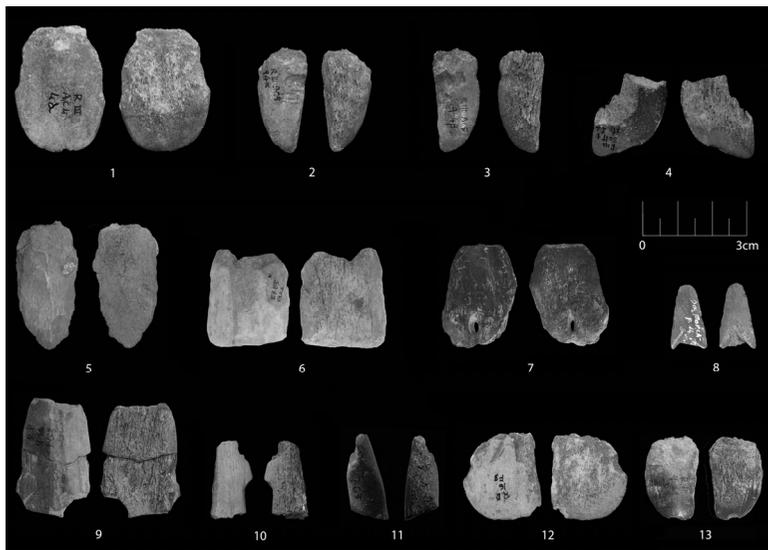


Figure 3: Fragments of harpoons from the Alpine region. 1- 4: Fragmentary harpoon bases from Romagnano Loc III; 5-7: Fragmentary harpoon bases from Riparo Gaban; 8: Harpoon distal part from Dos de la Forca; 9-11: Harpoon distal barbs from Riparo Pradestel; 12, 13: Harpoon basis from Riparo Pradestel.

Riparo Biarzo

The rock shelter of Biarzo, found at 160 m a.s.l. is located on an alluvial terrace on the left bank of the Natisone River in the Julian Prealps (Fig. 1). The site was excavated from 1982 to 1984 by F. Bressan and A. Guerreschi and has yielded a stratigraphic column ca. 1.5 m thick, which revealed occupations from the late Epigravettian to the Bronze Age. A Late Mesolithic occupation with the presence of trapezes (Castelnovian phase) was recovered in layer 3A. In the upper part of this layer, a few *Impressed Ware* potsherds were also found. The presence of pottery fragments in this layer is interpreted as a Neolithic disturbance on the

basis of geoarchaeological observations, which report the erosion of the upper part of layer 3A, where materials from Late Neolithic and Bronze Age layers (2 and 1) were found. Pollen data and microfaunal remains are also more characteristic of the end of the Boreal (Guerreschi 1996) and the climate was still not humid and warm as would be expected had layer 3A formed during the Atlantic. The only date on charcoal available for layer 3A is 5600 ± 300 BP (R1S51) which calibrates to 5210-3906 cal BC at 95% confidence (Guerreschi 1996). This date has a very large standard deviation and cannot be taken as reliable. Layer 3 yielded an almost entire harpoon made on antler (Fig. 2.4).

Cladrecis

Cladrecis Cave is located on the slopes of Brischis Mountain, close to the town of Prepotto in eastern Friuli. The deposit is characterized by a series of occupations ranging from the Mesolithic to the Neolithic through to the Middle Ages. One harpoon on antler comparable to the specimen from Mondeval de Sora was found in association with a Castelnovian lithic industry (Montagnari Kokelj 1994).

5. Harpoon technology and function in the Northeastern Alps

Mesolithic groups who created and used harpoons in the eastern Alpine region share a common tradition of gestures and know-how. The *chaîne opératoire* for producing harpoons involved different phases: (1) selection of raw material; (2) extraction of regular blanks; (3) creation of the barbs; (4) production of gorges and bevel bases; and (5) regularization of the surfaces. Usually, antler compact tissue was preferred as raw material with the exception of two specimens from Riparo Gaban, which were carried out on red deer metatarsal bones (Fig. 3.5, 7). Antler and bone blanks were extracted from the main beams/diaphysis through longitudinal grooving. This technique is widely documented in the Eastern Alpine region since the Tardiglacial (Cristiani 2008; Gurioli 2008; Cilli 2002). Surfaces were regularized by scraping (Fig. 4 b) often after lateral barbs were created by oblique deep incision and transversal lateral sawing (Figs. 4 a-c; 5.3 c; 6.1 a, b; 6.2 a, b). The first phase of such a series of operations can be observed on the harpoon from Dos de la Forca where the invasiveness of the lateral barbs is just outlined (Figs. 2.3; 6.2 a, b). Sawing was also used to create the lateral barbs of the harpoon of Mondeval de Sora (Figs. 2.1; 6.1 a, b). The latter harpoon is also notable for the sinuous outline of its

body, which has been obtained experimentally after prolonged lateral planing with a flint edge. Proximal gorges were also created by lateral chiselling (Fig. 5.1*a*; 5.2 *d, e*) as well as sawing (Fig. 6.2 *c*). Chiselling or planing was sometimes applied on the upper surfaces in order to create a gorge (Figs. 5.1 *a*; 7.1 *a-c*; 7.2 *d*) whereas both the upper and lower surfaces of the harpoons were regularized using flint scraping.

All the archaeological harpoons, entire or fragmented and including the one recovered from the burial of Mondeval de Sora, show traces of prolonged use. Their surfaces are well rounded and lateral barbs are often missing (e.g. Riparo Pradestel, Mondeval de Sora) (Fig. 2) or characterized by bending fractures produced while extracting the harpoon from the animal. Rounding, compression marks, macro-scars, modification of the outline of the bases (Fig. 5 *a, b*) and longitudinal fractures on harpoons indicate their proximal extremities were possibly fixed to the shaft with a line (similar to ethnographic detachable head harpoons: Rudenko 1961; Boas 1888; Rozoy 1968; Owen 2005; but see discussion in Pétillon 2008). Strings were possibly coiled upon the gorges as rounding and compression marks were also identified around their surfaces (Figs. 5.1 *a, b*; 7.2 *d*). Jagged fractures are also located at the level of the gorges, the most fragile part of the tool (Pétillon 2000). Invasive longitudinal fractures are also a characteristic along the length of the bases (Fig. 3.2-4, 12).

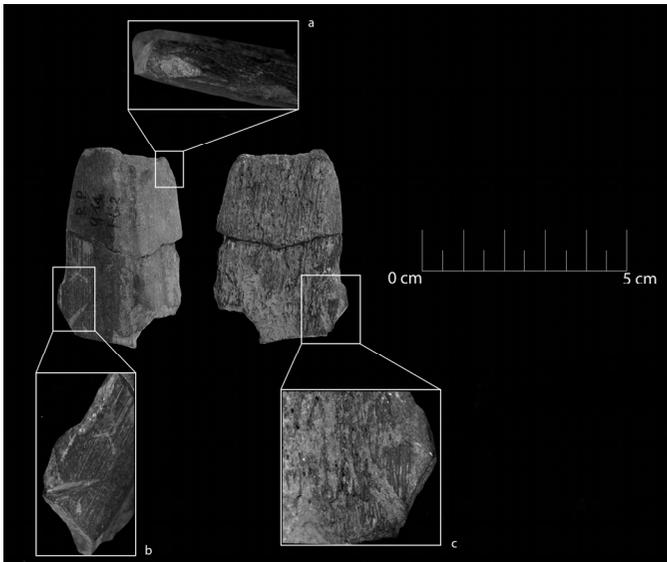


Figure 4: Incision and transversal sawing traces produced while creating barbs on a harpoon fragment from Riparo Pradestel.

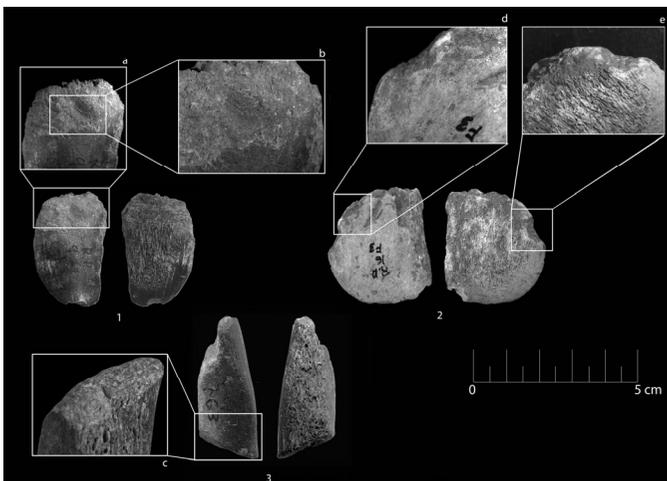


Figure 5: Close-up of techno-functional traces on fragmentary harpoons from Riparo Pradestel. 1a, b: Chiselling marks left while creating the basal gorge. Note the rounded surfaces produced through use; 2d, e: Chiselling marks left while creating the basal gorge. Rounded surfaces produced through use; 3c: Use-fracture at the bottom of a harpoon barb.

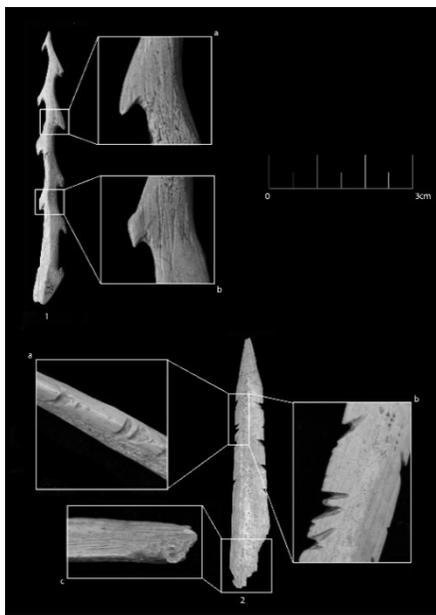


Figure 6: Close-up on the technological and functional analysis from harpoons of Mondeval de Sora (1) and Dos de la Forca (2). 1a, b: Sawing marks produced for cutting the lateral barbs; 2a, b: Sawing marks produced for cutting the lateral barbs; 2c: Sawing marks produced for creating the lateral gorge. The change of colour in the gorge is associated with the period use.

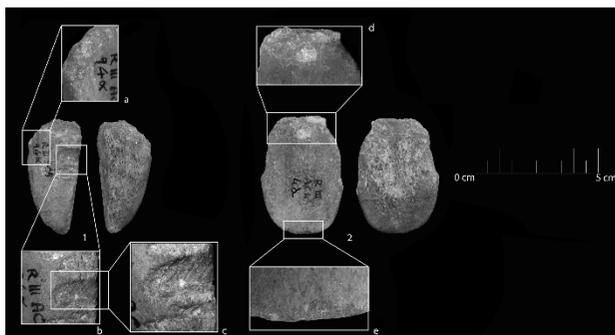


Figure 7: Close-up of techno-functional traces on fragmentary bases of harpoons from Romagnano Loc III. 1a: Chiselling marks left while creating the lateral gorge. Note the rounded surfaces produced through use; 1b, c: Planning striations produced while creating the basal gorge; 2d: Chiselling marks left while creating the basal gorge. Note the rounded surfaces produced through use; 2e: Well-developed compression marks and colour change due to the insertion of the base in a shaft.

6. Discussion

The chronological and geographical distribution of harpoons in Europe indicates that barbed weapons represented a widely diffused hunting technology in northern and Western Europe from ca. 16,000 years ago. Yet, barbed equipment became part of Italian foragers' toolkit only by the mid-9th millennium cal BC.

A total of 18 projectile tools with lateral barbs and basal gorges were recovered at 7 Mesolithic sites in the Eastern Alpine region (Adige Valley, Dolomites, Julian Alps, Istria and the northern Adriatic region), in association with the Sauveterrian and Castelnovian techno-cultural complexes. In the adjacent region of Switzerland, harpoons with lateral barbs and basal gorges appear at the site of Birmatten-Basisgrotte, in levels attributed to the Boreal-Early Atlantic and Early Atlantic transition, and in association with the Tardenosian lithic industries (David 2000).

The same phenomenon is reported in the northern Adriatic region and the central Balkans where harpoons are found in unspecified Mesolithic layers of the sites of Šandalja III (Istria) (Karavanić 2013) and Ljubljanska riverbed (Slovenia) (Turk 2004). At Vruća Cave and Odmu (Montenegro) as well as at Vlasac (Serbia) harpoons are found in association with lithic industries in which trapezes are present, dating to a later phase of the Mesolithic and the earliest phase of the Neolithic (Cristiani and Borić 2016; Borić et al. 2019). With the exception of two specimens from Istria and Slovenia, harpoons from the Balkans show peculiar technological features. Namely, there is the presence of holes in their proximal parts, hinting at the existence of a different technological tradition in the southern Adriatic region and the central Balkans for the production and use of organic detachable head harpoons. Observed traces on these perforations indicate that mechanical bow drills were used for producing the proximal holes in this regional context (Cristiani and Borić 2016). This difference is further supported by other strands of evidence, such as the technological gestures involved in microlithic production, osseous morpho-technological characteristics, ornamental traditions and similar.

The late acceptance of harpoon technology among the Holocene hunters in Italy opens up questions regarding the function, the nature and the timing of such technical innovations in the Eastern Alpine region. In particular the following are pertinent for our discussion: (1) Is the introduction of harpoons related to changes in climate and environmental conditions, predatory strategies and mobility patterns?; and (2) Can we consider harpoons to be a chronological marker of specific cultural adaptations in southern Europe?

Environmental and archaeozoological data may encourage a hypothesis that the introduction of harpoons in the list of standardized hunting toolkits of Mesolithic foragers of the Eastern Alpine region might have represented a new predatory strategy that was related to their inhabiting of landscapes rich in aquatic resources, such as those characterizing the beginning of the Holocene. Pollen sequences available for the Alpine region indicate a series of transformations in the climate that took place already in the Preboreal and, later, in the Boreal, with possible consequences in settlement and subsistence strategies, material culture and symbolic behaviours (Ravazzi 2003; Tinner and Vescovi 2005; Drescher-Schneider 2009). In particular, the expansion of the forest at higher altitudes than today determined the reduction of the Alpine prairie, the abandonment of many high-altitude locations and the increase of lowlands exploitation. Changing climate is also reflected in the composition of the faunal assemblage and, consequently, in the hunting strategies which now reveal the predominance of red and roe deer over ibex and chamois and also the increased use of aquatic resources (fish, turtle, beaver as well as aquatic birds). New predatory strategies are accompanied by the introduction of different types of microliths (notably trapezes) for composite projectile tools and osseous harpoons in forager toolkits (Bagolini 1980a, b; Dalmeri et al. 2001).

Detachable-head harpoons were most often used in fishing or aquatic hunting based on ethnographic data (Rudenko 1961; Rozoy 1978). In the Alpine region, evidence of fishing (both riverine and lacustrine) is dated back to the Tardiglacial period as documented by faunal remains at the sites of Riparo Tagliente, Riparo Dalmeri, La Cogola, and Riparo Biarzo (Albertini and Tagliacozzo 2004, Romandini and Bertolini 2010) and is recently confirmed by isotopic analysis of a burial from Riparo Tagliente (Veneto), where the $\delta^{15}\text{N}$ value of 13 ‰ and the $\delta^{13}\text{C}$ value of -18,4 ‰ were reported, suggesting a moderate to high intake of protein that likely came from riverine fish (Gazzoni 2011). An increase in fish remains shows an intensification in the exploitation of aquatic resources in the Adige Valley during the Boreal. Numerous ichthyic remains were found at Riparo Pradestel (Albertini comm. pers. 2009), Riparo Biarzo (Rowley-Conwy 1996) and Galgenbuhel/Dos de la Forca (Bazzanella et al. 2007). A systematic analysis of the ichtiofauna from the latter site allowed the identification of the remains of pike (*Esox lucius*), and Cyprinidae, such as rudd (*Scardinius erythrophthalmus*) and roach (*Rutilus erythrophthalmus*). Specialized fishing of pike (*Esox Lucius*) is documented in the most recent phases of occupation at this site (Bazzanella and Wierer 2001; Bazzanella et al. 2001; Wierer and Boscato 2006). Pike's vertebrae as well as those of

other freshwater fish species were also used as ornaments during the Mesolithic in the eastern Alpine region (Dalmeri et al. 2001).

In central parts of Switzerland, a close correlation between harpoons and fishing practices is confirmed during the Late Mesolithic at the site of Abri of Liesbergmühle VI where numerous antler and bone harpoons were found in association with a high density of fish remains (ca. 20% of the whole faunal assemblage) (Nielsen 2009 b). Also, at the site of Scholts 7 (Nielsen 2009a, b) in the former lake Wauwil, one similar antler bone harpoon was found. Techno-morphological features of Late Mesolithic Swiss harpoons are analogous to the assemblage from the Adige Valley and the Julian Alps. Additionally, bones of pike were also found in association with an entire harpoon at the Maglemosian site of Kunda in Estonia (Cleyet-Merle 1990: 110).

Cyprinidae and pike represent the most hunted species amongst Mesolithic communities in central and eastern Alpine areas. Pike live in rivers and lakes, i.e. in slow waters with vegetation. This species is present in water courses and lakes from lowlands to mid-altitudes and from big lakes and small ponds to big and small rivers. It can reach 1.3 m in length and exceed 20 kg in weight. During the spawning period, pike preferably move to shallow and clean water courses, rich in vegetation. The presence of pike in archaeological faunal assemblages suggests highly selective fishing. As this species is a predator at the top of the food chain, its frequency in the ecosystem is much lower than prey fish (e.g. Cyprinids). The marked selectivity could be favoured by the relative ease of catching the pike with some fishing techniques or at certain times (e.g. during the warm season or in early spring, during spawning periods).

Today, this species is generally caught by identifying the den or hunting territory: submerged logs, reeds, grasslands, areas with water lily can all be places where the pike awaits its lurking prey. Pike have probably been caught with tools that allowed individual fishing, which is also favoured by the habit of *Esox lucius* of halting in shallow waters during the hot season. A bow and arrow or harpoon, often mentioned among the potential tools for catching pike, are commonly documented in the European Mesolithic (Bazzanella et al. 2007).

Besides fish, ethnographic accounts testify that detachable-head harpoons were often used for hunting beavers and otters amongst North American traditional societies (Giffen [1930] 1975; Russell 1977; Owen 2005). Accordingly, the possibility that Alpine harpoons might have been part of more complex predatory strategies related to lacustrine and riverine environments cannot be excluded. Furthermore, evidence for the use of harpoon heads in hunting aquatic animals such as beavers is known during

the Mesolithic in central Russia where a beaver skull was found with the first barb of a harpoon still embedded in it (Zhilin 2004).

In the Eastern Alpine region, beaver and otter remains are numerous in Early and Late Mesolithic faunal assemblages of the Adige Valley and sometimes their bones were associated with evidence of dismemberment traces (Clark 2000: 91). This opulence in aquatic species certainly required a variability in predatory tactics, and possibly the introduction of specific tools in the repertoire of hunting equipment during the Early Holocene. Such rich environments for variegated hunting strategies have also been documented in the interalpine area, shaped by the large valleys of the Rhone and Rhine Rivers and in particular at the site of the Collombey--Vionnaz Plain (390 m a.s.l.). Here a mixed economy is attested, with fishing and hunting practiced in forests and swamps (Crotti and Pignat 1983, 1985).

A. Broglio argued how these harpoons became diffused to the Southern Alps (e.g. the sites of Romagnano Loc III, Dos de la Forca and Riparo Biarzo), thus revealing contacts between different sides of the Southern Alps. The extent of evidence from Switzerland with striking morpho-technological similarities between the harpoons found in this area and the Southern Alps would extend such connections to more northern parts of the Alpine mountain chain, as already suggested by other strands of evidence (i.e. flint acquisition) (Crotti and Pignat 1993).

Mesolithic fishing and aquatic hunting certainly involved a complex series of tactics and the use of a variety of different components of the equipment, which were likely produced on perishable materials (e.g. traps, nets, lures). The recovery of 18 harpoons from the Alpine region reveals that the use of such tools was certainly an important part of predatory strategies and adaptive technology amongst Mesolithic communities inhabiting this region, with abundance of freshwater courses as well as lakes. Unquestionably, the presence of an antler harpoon in the repertoire of burial goods from Mondeval de Sora confirms the role of fishing and/or aquatic mammal hunting as a valuable subsistence strategy within the Mesolithic groups of the Alpine region while also unveiling the significance of such projectile weaponry in the construction of a Mesolithic hunter's identity.

7. Conclusions

Harpoons from the mid-9th millennium cal BC contexts of the Eastern Alpine region represent the first evidence of osseous barbed technology in Italy. Although no specimen has directly been dated in the eastern Alpine

region, the harpoons have all been recovered in layers attributed to the Sauveterrian and the Castelnovian cultural taxonomic units.

The use-wear analysis of harpoons from the Adige Valley, Southern Dolomites and Julian Alps testifies that functional traces are very developed on all of the examined tools. Functional modifications on harpoons have been discussed against environmental and archaeozoological records, eventually supporting an interpretation of the analysed artefacts as detachable-head harpoons, possibly used in fish and aquatic mammal hunting.

As a specific predatory weapon related to the inhabitation of Alpine landscapes, Mesolithic harpoons certainly represented a key technological innovation for a successful adaption to mountainous landscapes rich in freshwater resources, which characterized the Alpine region from the beginning of the Holocene. Due to their functional versatility, the barbed weaponry became an important part of the Mesolithic hunter's toolkit. The role of harpoons in defining the personal identity of fully equipped Holocene Alpine hunters is suggested by funerary data from Mondeval de Sora.

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