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Neolithisation of the Lower Danube as reflected by the osseous industry
Case study: Măgura "Buduiasca" settlement (Romania)

La Néolithisation du Bas-Danube à travers l'industrie osseuse
Étude de cas : l'habitat de Măgura « Buduiasca » (Roumanie)

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Abstract: The first farmers originating from the Near East arrived in Europe and encountered hunter-gatherer communities with different subsistence patterns. Alongside other evidence, the contacts between the two different economies are reflected by the osseous industry. For the Lower Danube Early Neolithic the presence of several elements related to Mesolithic traditions such us harpoons, perforated deer canines and teeth scrapers, can be noted. New elements appear, both technologically (bipartition through abrasion, segmentation with abrasive fibre and perforation by wear technique), and typologically (spoons, rings or bones with scraping marks, flattened astragalus) entirely related to the Neolithic. Another typical element covering the sequence from Early Neolithic to the beginning of Chalcolithic is the poor exploitation of deer antlers and boar canines, compared with the bones from domestic species. In the Middle Neolithic a continuity with the Early Neolithic, both at typological and technological levels, can be observed. However, among the defining elements for the neolithization process, we notice that pointed tools obtained by bipartition through abrasion no longer appear. The previous typological categories are maintained and belt elements and hairpins are new. Within the various cultural phases, this study discusses the composition of the osseous industries, looking for specific innovations or the continuation of certain typological and technological categories. We tried to identify the timing of their emergence and abandonment, to establish if their appearance was triggered by cultural reasons or technological constraints. The multi-period site at Măgura "Buduiasca" was used as a case study.
Keywords: Neolithization, Lower Danube, osseous industry, cultural traditions and innovations, typological and technological categories.

Résumé : En arrivant en Europe, les premiers agriculteurs originaires du Proche-Orient ont rencontré des communautés de chasseurs-cueilleurs vivant selon divers modes de subsistance. Les contacts entre ces différentes économies se reflètent entre autres dans l'industrie osseuse. Dans cette étude, nous discutons de la composition des industries osseuses de ces différentes phases culturelles en recherchant des innovations spécifiques ou, à l'inverse, la persistance de certaines catégories typologiques et technologiques. Nous avons tenté d'identifier la chronologie d'apparition et d'abandon des innovations pour déterminer si elle est liée à des raisons culturelles ou à des contraintes technologiques.
Le cas d'étude est le site de Măgura « Buduiasca » (sud de la Roumanie).
Le niveau Starčevo-Criș I présente plusieurs éléments qui peuvent être reliés aux traditions mésolithiques (harpons, canines de cerf utilisées comme éléments de parure, racloirs sur dent, etc.). Mais de nouveaux éléments apparaissent également, sur le plan tant technique (tels que l'emploi de procédés de perforation par forage rotatif ou l'usage de l'abrasion dans les procédés de bipartition et de segmentation) que typologique (nouvelles catégories d'objets : cuillères, anneaux ou os avec traces de raclage, astragales abrasés), spécificités qui renvoient totalement au Néolithique. Un autre élément connu au Néolithique ancien et au début du Chalcolithique est la diminution de l'exploitation des bois de cerf et des canines de sanglier au profit des os d'espèces domestiques. L'étude de l'ensemble

du corpus archéologique a conduit à identifier des procédés de détachement par débitage transversal associé au schéma de transformation par segmentation, et par débitage longitudinal associé aux schémas de transformation par extraction et par partition (bipartition, quadripartition ou partition multiple). À ceux-ci s'ajoute un schéma de transformation par façonnage direct, identifié dans le cas des astragales travaillés et des os à bords concaves et à facettes de raclage striées. Les techniques en jeu dans le débitage transversal sont le sciage et la percussion. Le sciage a été effectué aussi bien avec des tranchants en silex qu'à l'aide de fibres abrasives (sciage à la ficelle). Longitudinalement, pour les procédés de partition, il s'agit de techniques d'abrasion, de raclage, de percussion, de rainurage, une combinaison de rainurage et de sciage/rainurage et, enfin, de percussion pour les partitions multiples. Pour la mise en forme, ce sont des techniques de raclage et d'abrasion qui ont été utilisées.
Dans le niveau Starčevo-Criș III (au Néolithique ancien), nous n'observons pas d'innovations typologiques ou technologiques. Les schémas de transformation des matières premières sont les mêmes, mais nous observons une diminution de certaines variantes techniques et du nombre de catégories typologiques, dans le sens où les éléments de la tradition mésolithique susmentionnés disparaissent.
Dans le niveau Dudești (au Néolithique moyen), on observe une continuité avec le Néolithique ancien, au niveau tant typologique que technologique. Cependant, parmi les éléments déterminants du processus de néolithisation, on note l'absence d'outils pointus obtenus par bipartition et par abrasion. Sur le plan typologique, les catégories précédentes se retrouvent, à côté de nouveautés telles que des éléments de ceinture et des épingles à cheveux. La présence du schéma de transformation par segmentation transversale, faisant intervenir les mêmes techniques que le schéma par partition longitudinale, est confirmée. Pour la mise en forme des pièces, les procédés restent identiques.
Enfin, dans le niveau de Vădastra, ce sont principalement les ébauches et les déchets de débitage qui fournissent des informations. Certaines des catégories typologiques apparues dans la culture de Dudești disparaissent, en particulier les éléments de ceinture et les épingles à cheveux, qui restent ainsi caractéristiques du Néolithique moyen. En revanche, d'autres éléments spécifiques au Néolithique ancien et moyen survivent, tels que : 1. la proportion écrasante d'os dans l'assemblage, au détriment du bois de cervidé (alors que ces pourcentages s'équilibreront dans les étapes culturelles ultérieures) ; 2. la faible représentation de la catégorie typologique des outils biseautés en os, qui atteignent des chiffres comparables à ceux des outils pointus du Chalcolithique tardif (par exemple dans la culture de Gumelnița) ; 3. l'utilisation des mêmes schémas de transformation ou procédés pour modifier la surface et le volume, mais surtout le maintien de certains procédés tels que la segmentation de l'os avec une fibre abrasive ou la perforation par carottage, qui disparaissent au Chalcolithique tardif. Il faut cependant considérer que l'ensemble archéologique de Vădastra reste restreint et que, très probablement, une partie des données techniques et typologiques spécifiques à cette culture n'ont pas pu y être identifiées.
Mots-clés : néolithisation, Bas-Danube, industrie osseuse, tradition culturelle, innovation culturelle, catégorie typologique, catégorie technologique.

INTRODUCTION

The Pleistocene/Holocene transition in the Lower Danube was marked by an economy based on hunting and gathering reflected in the osseous industry by the selection of blanks deriving exclusively from wild animal bones. Variations across the different chronological phases in the ratio of species or types of raw materials conditioned by the variations of the faunal remains could be identified. The osseous industries identified at different sites from the Danube Gorges were characterised by the significant number of tools made of *Cervus elaphus* antler, *Sus* sp. tusk and the long bones of large mammals. The typology consists of adzes, hoes, mattocks, picks, all antler made. The bone industry comprised various types of awls and spear points, bevelled tools and spatulas, while from *Sus* sp. tusk scrapers especially were made (e.g. Mărgărit et al., 2023).

The first farmers originating from the Near East arrived in Europe and encountered hunter-gatherer communities with different subsistence patterns. Alongside other evidence, the contacts between the two different economies are reflected by the osseous industry. The new arrivals came with their Neolithic package reflected by pointed tools made from tibias and metapodials of ruminants, elaborated bone hooks, bone buckles and rings, tubes made from bird bones and spoons (e.g. Sidéra, 1998, 2011 and 2012; Vitezović, 2016 and 2023; Mărgărit et al., 2018a) which saw changes in the selection of raw materials, of the typology and technology but without the complete disappearance of Mesolithic elements.

The oldest Neolithic assemblages of the north of the Lower Danube belong to the Starčevo–Criș-Körös culture. In present-day Romanian this is dated between 6200–5300 cal BC although some of the dates fall outside this range. For a more detailed analysis of the innovation and tradition of the osseous industries in the Neolithic, the settlement of Măgura "Buduiasca" was chosen as a case study. It is a multi-period site, with habitation that started around 6100–6000 cal BC in the Early Neolithic and ended around 5000 cal BC in the Early Chalcolithic.

1. ARCHAEOLOGICAL BACKGROUND

Măgura "Buduiasca" settlement is located in southern Romania, on the lower terrace of the Teleorman river within the south-east part of Măgura village (Teleorman County). The settlement was discovered in 2001 and excavated during 2001–2008. The site measures approx. 850×350 m on the east-west and north-south axes, with a surface area of almost 30 ha. In the exca-

vated area of the site, which sums to 400 m^2, the archaeological levels have varying consistency. Evidences from stratigraphy and pottery typology enabled identification of a temporal relationship between the different Neolithic levels. A series of 32 ^{14}C dates suggests the following Neolithic occupation sequence and chronology: Starčevo-Criș I – c. 6000–5900 cal BC, Starčevo-Criș III – c. 5800–5700 cal BC, Dudești – c. 5500–5300 cal BC and Vădastra – c. 5200–5000 cal BC (e.g. Mirea, 2005 and 2011; Walker and Bogaard, 2011; Thissen, 2012 and 2013; Balasse et al., 2013; Bălășescu, 2014; Evin et al., 2015). During the excavations, features belonging to the entire sequence of the Neolithic were discovered. After the analysis of their structure, inventory and the association between the different categories of materials, the features were interpreted as dwellings, pits, waste areas and ritual depositions. The inventory of the assemblages generally consists of ceramic fragments, animal bones, shells, stones, bone and flint tools, anthropomorphic and zoomorphic figurines, and adornments (Mirea, 2005).

2. ARCHAEOLOGICAL ASSEMBLAGE

2.1. Starčevo-Criș I level

For Starčevo-Criș I, the number of artefacts made of bones (found in various stages of processing) is prominent: 91% by the total of 184 pieces. The amount of the other raw materials is insignificant: only 5% (N = 12) were made of tooth and 4% (N = 7) of deer antler. *Bos taurus* and *Ovis aries/Capra hircus* bones were used in similar percentage and the predominate species. The main exploitation of bones deriving from domestic species was as blanks recovered from culinary remains and adapted by shape to different uses. Sporadically, bones from hunted taxa were also used (*Bos primigenius, Cervus elaphus*, birds; Mărgărit et al., 2014). It is difficult to establish if the deer antlers used as raw material were collected as fallen antlers or came from hunted animals because the basal areas used as proof of this fact are totally missing. Also present are perforated teeth, including a *Cervus elaphus* canine, and scrapers produced from *Sus* sp. canines.

The main typological category is pointed tools (N = 41), most of them made on flat blanks. We used the term "flat blank" to define blanks with an artificial morphology obtained through the longitudinal debitage of the bone applying various procedures. A varied range of techniques was used to obtain the blanks with the most interesting being bipartition by abrasion (fig. 1a), a Neolithic innovation. Another debitage technique consists in the bipartition or quadri-partition of the bone by double grooving. The shaping of the end was achieved by scraping or abrasion applied at the distal end. A third option consists of the fracturing of the bone by percussion (fig. 1b), the result being irregular splinters. An abrasion (fig. 1c) or scraping (fig. 1d) was applied to the irregular surfaces of the debitage edges for the finish of the artifacts. The active end was crafted by distally abrading on both sides.

The spatulas (N = 25; fig. 1e) have a great degree of uniformity in terms of raw material (large mammal ribs predominate) and manufacturing technique. Spatulas processed on a flat blank (the main type) exhibit a technological chain comprising, first, mainly bipartition by percussion (fig. 1g) and less often by scraping, followed by shaping by abrasion (fig. 1f; Mărgărit and Mirea, 2024). In the case of the few spatulas processed by preserving the volume of the blanks the working effort was minimal, with the shaping of the active end by percussion, and adjusted by abrasion.

Bevelled tools (N = 6) were made on a flat blank by the combination of grooving and percussion or by successive partitions in percussion. The surface was prepared by abrasion applied to different areas.

Spoons (N = 4; fig. 1h) were made of metapodes or ribs of large mammals, which required wide blanks. The flat blanks seem to have been obtained by a longitudinal bipartition method, achieved by grooving. The specific concavity of the bowl of the spoon was obtained by a longitudinal scraping (fig. 1i). The handle, with a circular section, was shaped by a scraping applied around the entire circumference and, in a few cases, decorated (fig. 1j).

Needles (N = 3) were crafted on flat blanks by bipartition using double grooving or quadri-partition grooving technique. The surface of the items was regularized by abrasion. At the edge of the proximal end, a bifacial rotation perforation was performed. The convergent arrangement of the edges at the distal level was achieved by a longitudinal scraping.

A *Sus scrofa* metatarsus and a *Ovis aries* radius were transformed into handles by removing the epiphysis through a segmentation procedure by sawing with a flint tool. One *Bos taurus* astragalus and two *Ovis/Capra* astragali were transformed by the abrasion of one and of two sides respectively. The only bone with scraping marks is a fragment of a large mammal metapodial. It shows a rectilinear facet with typical striations of a scraping technique which thinned the bone wall and probably caused the transversal breakage.

Four rings were made on flat blanks (fig. 1k) from the diaphysis wall of mammal bones. Toward the middle of the blank area, a perforation with a conical shape was carried out (fig. 1m). The surface of the pieces was rigorously abraded (fig. 1l). Also, two rings preserving the volume (fig. 1n) of the blank were identified. The blank was obtained by sawing with a flint tool or an abrasive fibre. The segmentation edges were abraded (fig. 1o) and the medullary canal was widened by transversal scraping (fig. 1p).

Seven tools made from *Sus scrofa* teeth had the function of scrapers (fig. 1r). One of them was crafted by bipartition by grooving, and another one by longitudinal bipartition by percussion. Abrasion was used to adjust the debitage edges. They have one or two concavities with visible scraping marks (fig. 1s). Among these tools, one

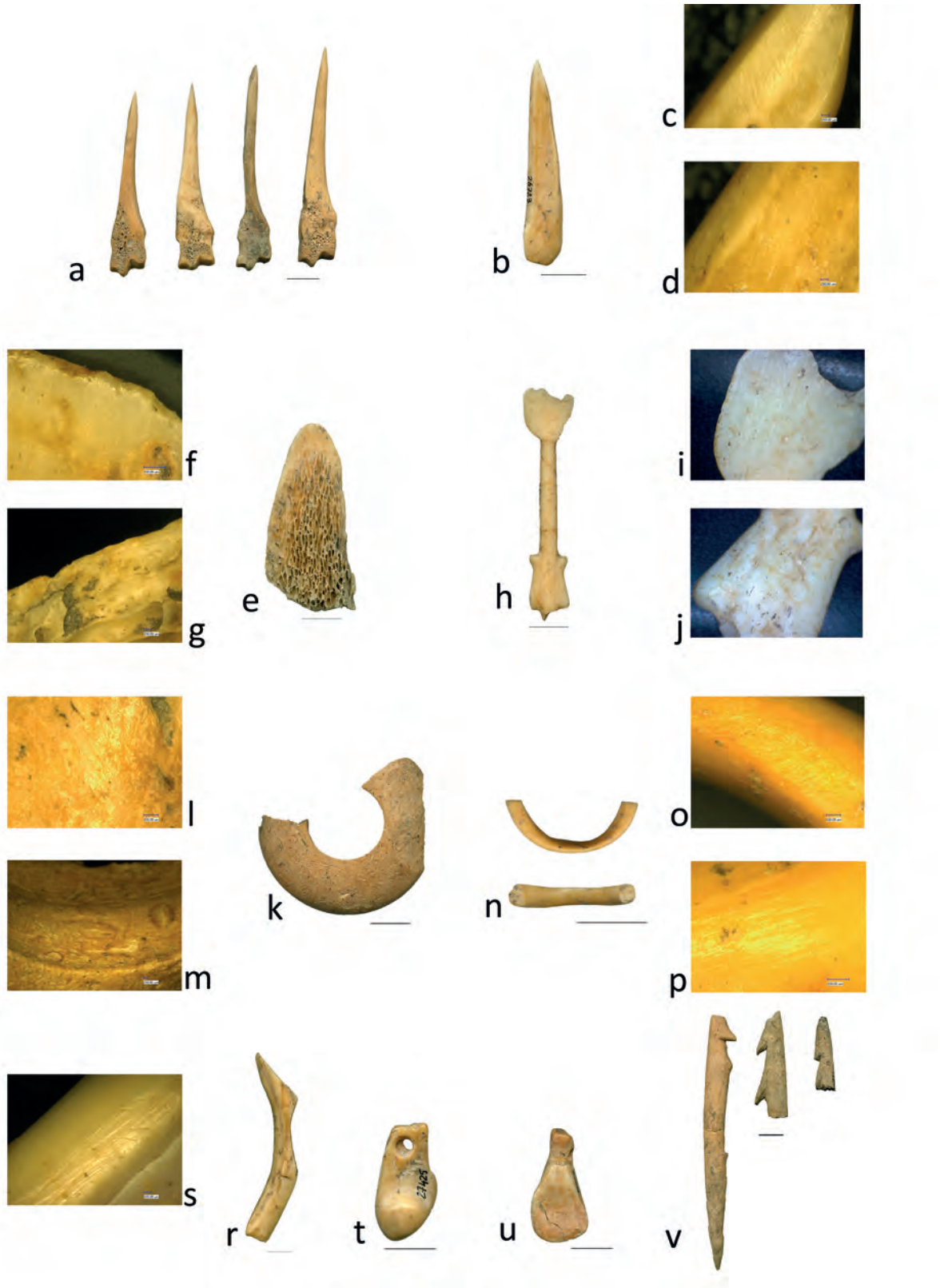

Fig. 1 – Typological categories found in Starčevo-Criș I level: a, b. Bone pointed tools (scale = 1 cm); c, l, o. Abrasion marks (c - 50×; l, o - 100×); d, i, p, s. Scraping marks (d - 50×; l - 10×; p - 150×; s - 50×); e. Bone spatula; f. Distal end detail (150×); g. Percussion marks (50×); h. Bone spoon; j. Proximal end detail (10×); k, n. Bone rings; m. Perforation detail (30×); r. Tooth scraper; t. Perforated *Cervus elaphus* canine; u. Perforated *Bos* sp. incisor; v. antler harpoons.

***Fig. 1** – Catégories typologiques trouvées dans le niveau Starčevo-Criș I : a, b. outils pointus en os (échelle = 1 cm) ; c, l, o. stigmates d'abrasion (c - 50× ; l, o - 100×) ; d, i, p, s. stigmates de raclage (d - 50× ; i - 10× ; p - 150× ; s - 50×) ; e. spatule en os ; f. détail de l'extrémité distale (150×) ; g. stigmates de percussion (50×) ; h. cuillère en os ; j. détail de l'extrémité proximale (10×) ; k, n. anneaux en os ; m. détail de perforation (30×) ; r. racloir à dent ; t. canine perforée de* Cervus elaphus *; u. incisive perforée de* Bos *sp. ; t. harpons en bois de cervidé.*

of them has a typical shape of a bevelled end, but some studies prove that it was also used as a scraper (Mărgărit and Boroneanț, 2019). The distal end was crafted by a transversal scraping on the lower side. A *Cervus elaphus* canine (fig. 1t), a *Bos* sp. incisor (fig. 1u) and two perforated fragments of *Sus scrofa* canines were adornments.

Three antler barbed harpoons fragments (fig. 1v) were discovered from this habitation level. They were made on flat blanks but the debitage procedures could not be identified. The first of them, with the distal part broken, shows surface preparation by scraping, shaping by sawing of the barbed detachment and of a small protuberance in the proximal end. The other two are a mesial fragment and a distal fragment with the same preparation type of the surface by longitudinal scraping and the detachment of the two barbs by bifacial sawing. Two bevelled tools were made on flat blanks. At the distal end, an abrasion was applied to create the active end. One antler pointed tool was made on a flat blank but the bipartition procedure could not be identified because the debitage edges were highly abraded. The pointed end was also crafted by abrasion.

2.2. Starčevo-Criș III level

For Starčevo-Criș III the number of artefacts is lower (N = 44 items). Our analysis attempts the identification of any differences compared to the previous chronological sequence. Animal bones predominated, with 89% (N = 39), with the *Bos taurus* bones in first place. Some of the bones (*Cervus elaphus* and *Capreolus capreolus*) and probably the teeth (N = 3) come from hunted species.

The typological categories are the same with those from the previous level, except the prevalence: first spoons (N = 10; fig. 2a-c), followed by pointed tools (N = 5; fig. 2d-f) and spatulas (N = 4). Rings (N = 2) on flat blanks or blanks in volume, needles (N = 1) or bevelled tools (N = 2) also occurred.

The technological chain of raw materials crafting is identical to those identified in the previous level and no typological or technological innovation is recorded. On the other hand, no pointed tools processed by direct shaping (abrasion) bipartition were identified.

2.3. Dudești level

The osseous industry (N = 233) from the Dudești level (Mărgărit et al., 2016) is characterised by high transformation of the bone without any preservation of the morphological elements that would allow the identification of animal species. Consequently, we have a wide category of indeterminates, especially of the *Bos*/*Cervus elaphus* species. Thus, it is impossible to establish a realistic picture of the exploited species. Of the determinable species, first place is *Bos taurus* (32 pieces), followed by *Ovis aries*/*Capra hircus* (31 pieces). The same preponderance of bones from domestic species as for the Starčevo-Criș levels was noticed. *Sus scrofa* canines (N = 10), *Cervus elaphus* and *Capreolus capreolus* antlers (N = 9) were also used in a small proportion. It is difficult to find out how many of these pieces come from fallen antlers and how many from antlers cut from the skull of hunted animals, given the preponderance of the tines of antler branches.

The typology is varied, same as the typological range encountered in the Starčevo-Criș levels, with few additional innovations. Pointed tools are the most important category (N = 42 specimens). With one exception, they were processed on flat blanks obtained by quadripartition or bipartition in percussion, by a combination of grooving and percussion (fig. 2g-i) or by scraping (for ribs; fig. 2j-l). The active ends were shaped by bilateral abrasion, bilateral scraping or a combination of the two techniques, distally applied.

20 spatulas were processed on flat blanks (fig. 2m-o) and six on blanks in volume, using the ribs of large mammals. In the case of the flat blanks, a bipartition method by percussion was applied continuing with a shaping procedure by abrasion or longitudinal scraping. To create the active end, an abrasion was applied. For the tools made by preserving the volume of the blanks, the active end was created through an oblique breakage after the debitage edge was shaped by abrasion.

Spoons (N = 15; fig. 2p-s) are the third category, crafted following the same technological chain of transformation as the pieces from the previous levels.

Four rings were made on flat blanks. Because they are in the final stage of processing, marks of the debitage operation can be identified. The presence of two preforms indicates a combination between the sawing segmentation and longitudinal bipartition methods. The central perforation has a circular morphology, being obtained by unifacial rotation. One of these pieces of particular note is a burnt black ring fragment provided with an anthropomorphic decorative element (fig. 3a-c). Eight rings preserving the anatomical volume of the bone diaphysis were identified in the Dudești level. A segmentation by sawing procedure was applied to both ends. Moreover, one of the pieces has a decoration composed of two parallel grooves with a U-shaped profile, along the entire circumference (fig. 3d-f).

The *Ovis aries/Capra hircus* astragali (N = 12) were abraded (fig. 3g-i) on variable sides. Three of them have a perforation performed by rotation. Two *Bos taurus* astragali have an abrasion of the dorsal side, in different degrees of intensity.

Six scraped bones (fig. 3j-l) are represented by various blanks (humerus, metacarpus, metatarsus, metapodials) belonging to large mammals (*Bos taurus/Bos primigenius* and *Cervus elaphus*). Technologically, the presence of a rectilinear area, clearly delimited, created by a deep scraping can be observed. The depth of the processed areas is variable, ranging from flat to concave sides that reach the medullary canal and caused bone breakage.

Three of the pieces are considered belt elements (fig. 3m-o). They have a rectangular proximal part with a V-shaped extremity and a circular distal end broken. The artefacts were made on flat blanks, it was not possible to identify the debitage procedure because the debitage

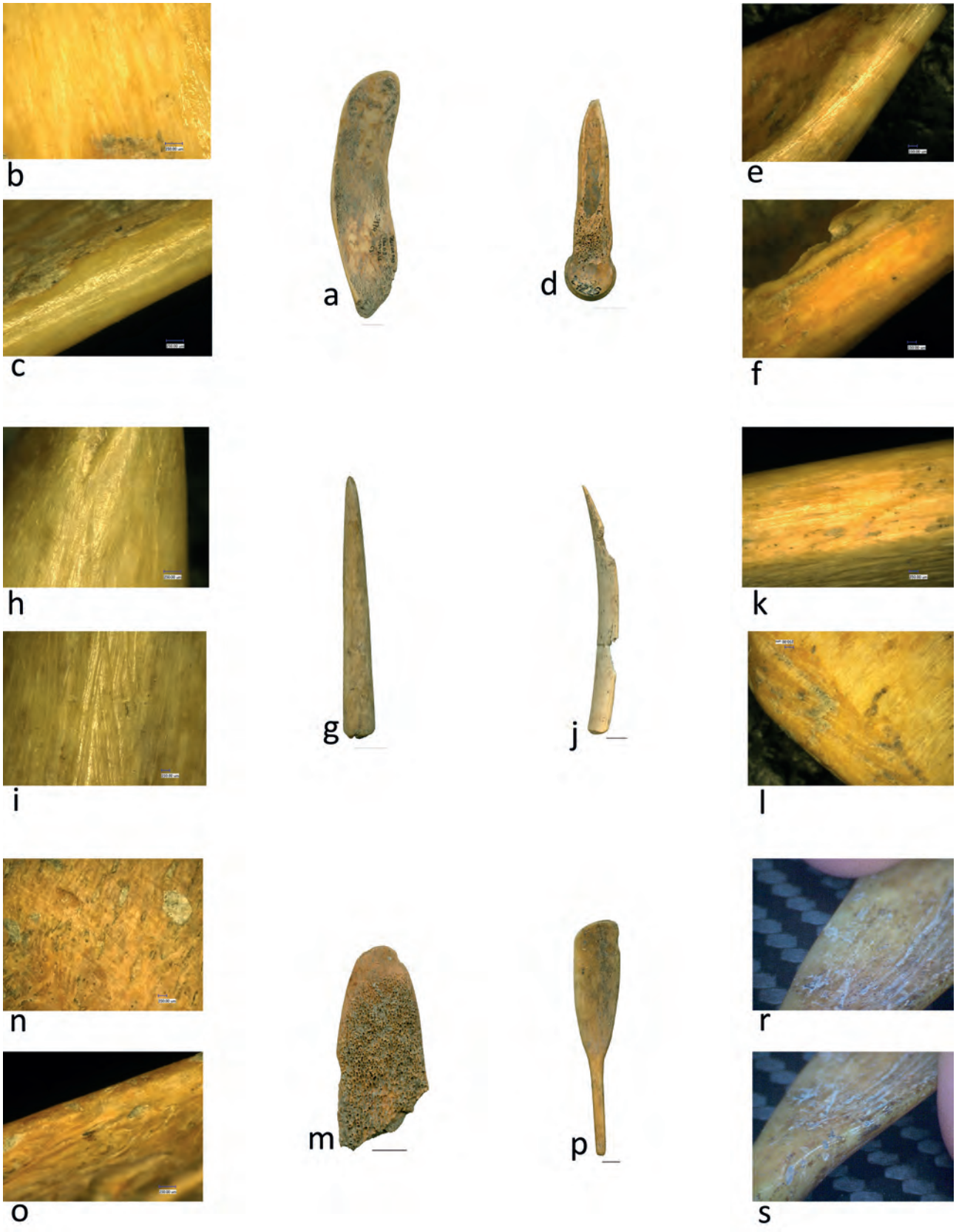

Fig. 2 – Typological categories found in Starčevo-Criș III (a, d) and Dudești (g, j, m, p) levels: a, p. Bone spoons (scale = 1cm); b, e, i, k, r-s. Scraping marks (b - 100×; e, i, k - 50×; r-s - 10×); c, h, n-o. Abrasion marks (n - 50×; c, h, o - 100×); d, g, j. Bone pointed tools; f. Grooving marks (50×); l. Sawing marks (50×); m. Bone spatula.

Fig. 2. *– Catégories typologiques trouvées dans les niveaux Starčevo-Criș III (a, d) et Dudești (g, j, m, p) : a, p. cuillères en os (échelle = 1 cm) ; b, e, i, k, r-s. stigmates de raclage (b - 100× ; e, i, k - 50× ; r-s - 10×) ; c, h, n-o. stigmates d'abrasion (n - 50× ; c, h, o - 100×) ; d, g, j. outils pointus en os ; f. stigmates de rainurage (50×) ; l. stigmates de sciage (50×) ; m. spatule en os.*

edges were highly abraded. At the distal end, a perforation with a cylindrical shape was made using the *carottage* technique.

Bevelled tools are represented by two pieces, crafted in two different procedures. A flat blank, successively partition (until it represented less than one quarter of the diameter of the bone) was used for the first tool. The entire surface of the piece was adjusted by abrasion. The second tool was crafted using a tibia of *Bos* sp. (fig. 3p-r). To create the active end, a diffuse direct percussion was applied. Only the distal end was shaped.

Two tubular beads (fig. 3s-u) were obtained by a sawing segmentation technique, applied at both ends, with the abrasion of the segmentation edges.

Two needles (fig. 3x-z) are other tools types, processed on flat blanks, one obtained by the rib bipartition in diffuse percussion, and the other one by successive partitions in percussion. The perforation was achieved by unifacial (for one) and bifacial rotation (for the other). The active end was finished using longitudinal scraping, extended on variable areas on the body of both pieces.

Hairpins (N = 2) can be attributed to adornments. A bone splinter has on the upper part a bilobed decoration consisting of two grooves around the entire circumference. This pattern was created by a deep sawing. The second hairpin is special because of the finesse of the realization and the elaborate decoration (fig. 3v).

Sus scrofa canines are the only type of worked teeth used for obtaining six scrapers (fig. 4a-c). The blanks belong to the flat type obtained by bipartition in percussion of the tooth, or by grooving and indirect percussion combination. The shaping operation is different for these pieces: scraping applied to the debitage edges only at the distal part or complete scraping of the lower side followed by abrasion. Towards the distal end, one of the edges representing the functional area of the tool has a concave shape obtained by a deep scraping.

The deer antler artefacts are either indeterminable in terms of functionality (being broken) or they are in different processing stages. However, methods of longitudinal debitage by percussion or segmentation by sawing or percussion are identifiable. For shaping techniques scraping was mostly used and more rarely abrasion. Three pieces were perforated by rotation.

2.4. Vădastra level

For Vădastra the assemblage is reduced comprised of only 54 bone artefacts (Mărgărit et al., 2018b) but it is extremely important because it is the only one belonging to this culture analysed to date. Of the artefacts made of bone (83%, N = 45), two domestic species predominate (*Bos taurus* and *Ovis aries/Capra hircus*), and a small number of skeletal elements were selected as blanks. Exceptionally, wild animal bones (*Cervus elaphus* tibia) are used. Of the deer antlers (N = 5), the basal area of the branch is completely missing, therefore the sources of procurement cannot not be established. A tooth (N = 1) belongs to a hunted boar (*Sus scrofa*).

A significant decrease of the typological diversity compared to previous chronological stages is recorded. The most important typological category is represented by pointed tools (N = 16) crafted by sheep/goat metapodes and large mammal ribs (fig. 4d-f). All pieces were made on flat blanks obtained by two longitudinal debitage methods: bipartition and quadri-partition. A first variant of bipartition was by applying a double grooving. Another variant, used for the ribs, was by applying a longitudinal scraping on both sides. When reaching the spongy tissue, the splitting of the two half-ribs was achieved by an indirect percussion. For ribs the bipartition was also achieved by percussion, the division of the blanks being achieved by the same indirect percussion procedure. Quadri-partition was applied for the medium-sized mammalian diaphysis, to which the debitage procedure involved a combination of grooving and indirect percussion. The debitage edges were regularized by abrasion applied to various areas. The active end was achieved by a longitudinal scraping applied at the distal level.

A second typological category is represented by *Bos taurus* and *Ovis aries/Capra hircus* processed astragali—abraded and perforated (N = 5). Three astragali were abraded on various sides and two of them were perforated. Other two astragali were only perforated.

Diaphysis of medium-sized mammalians bones (N = 3) were used to craft rings (fig. 4g-i) on volume blanks using a segmentation by sawing at both ends. The segmentation edge was abraded and the upper side was finely shaped. The medullary canal was widened by scraping along the circumference.

Three spatulas were made from *Bos taurus* ribs. The bone was longitudinally split by percussion. The debitage edges were regularized by a longitudinal scraping. The crafting of the active end was achieved by a transversal abrasion applied at the distal end.

On a *Bos taurus* metatarsus (fig. 4j-l), a longitudinal scraping was applied on three sides resulting in a concave surface, very well delimited, and to thinning of the bone at the medial side follow by breakage.

Regarding the deer antler, one of the pieces is a pressure flaker (fig. 4m-o) from a tine obtained by segmentation in percussion. Another typological category is represented by bevelled tools (N = 2). First is an antler tine preserving the anatomical volume. The segmentation was carried out by percussion. The distal end was processed by shaping two converging oblique sides. The second bevelled tool was made from an antler beam (fig. 4p-s). The blank is flat obtained by longitudinal bipartition with abrasion of the debitage edges. The active end was also created by abrasion applied unifacially.

3. DISCUSSION

The presence of several elements related to Mesolithic traditions in the Starčevo-Criș I level osseous industry, draws attention. First, deer antler harpoons occur at

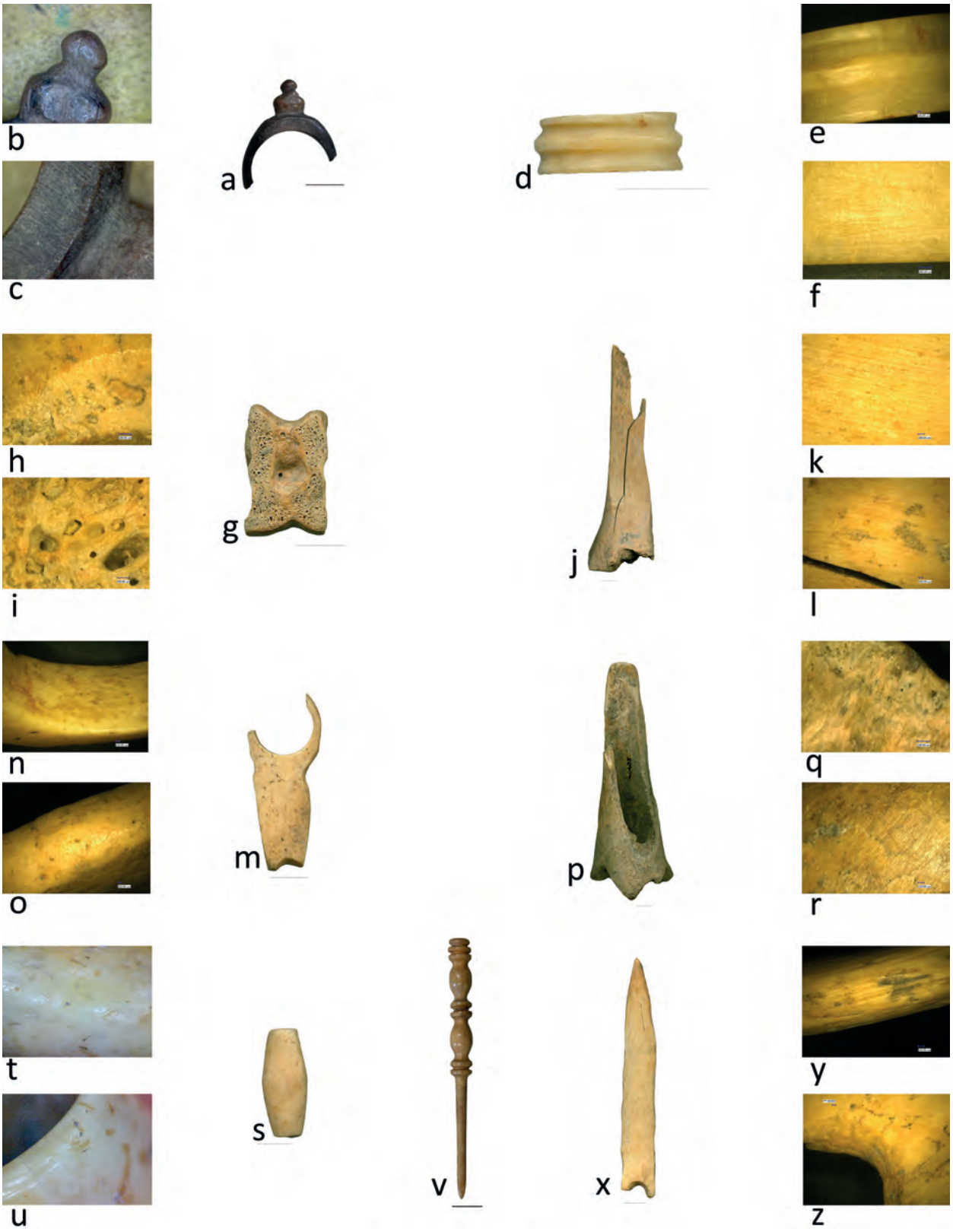

Fig. 3 – Typological categories found in Dudești level: a, d. Bone rings (scale =1 cm); b-c, e. Decorative details (b-c - 10×; e - 50×); f, k-l, y. Scraping marks (f - 100×, k, y - 50×; l - 30×); g. Flattened astragalus; h-i, o, r, t-u. Abrasion marks (h-i - 100×; o - 30×; r - 50×; t-u - 10×); j. Bone with scraping marks; m. Bone belt element; n, z. Perforation details (n, z - 30×); p. Bone bevelled tool; q. distal end detail (100×); s. Bone bead; v. Bone hairpin; x. Bone needle.

***Fig. 3** – Catégories typologiques trouvées dans le niveau Dudești : a, d. anneaux osseux (échelle = 1 cm) ; b-c, e. détails de décoration (b-c - 10× ; e - 50×) ; f, k-l, y. stigmates de raclage (f - 100×, k, y - 50× ; l - 30×) ; g. astragale aplati ; h-i, o, r, t-u. stigmates d'abrasion (h-i - 100× ; o - 30× ; r - 50× ; t-u - 10×) ; j. os avec des marques de raclage ; m. élément de ceinture osseuse ; n, z. détails de perforation (n, z - 30×) ; p. outil biseauté en os ; q. détail de l'extrémité distale (100×) ; s. perle en os ; v. épingle à cheveux en os ; x. aiguille en os.*

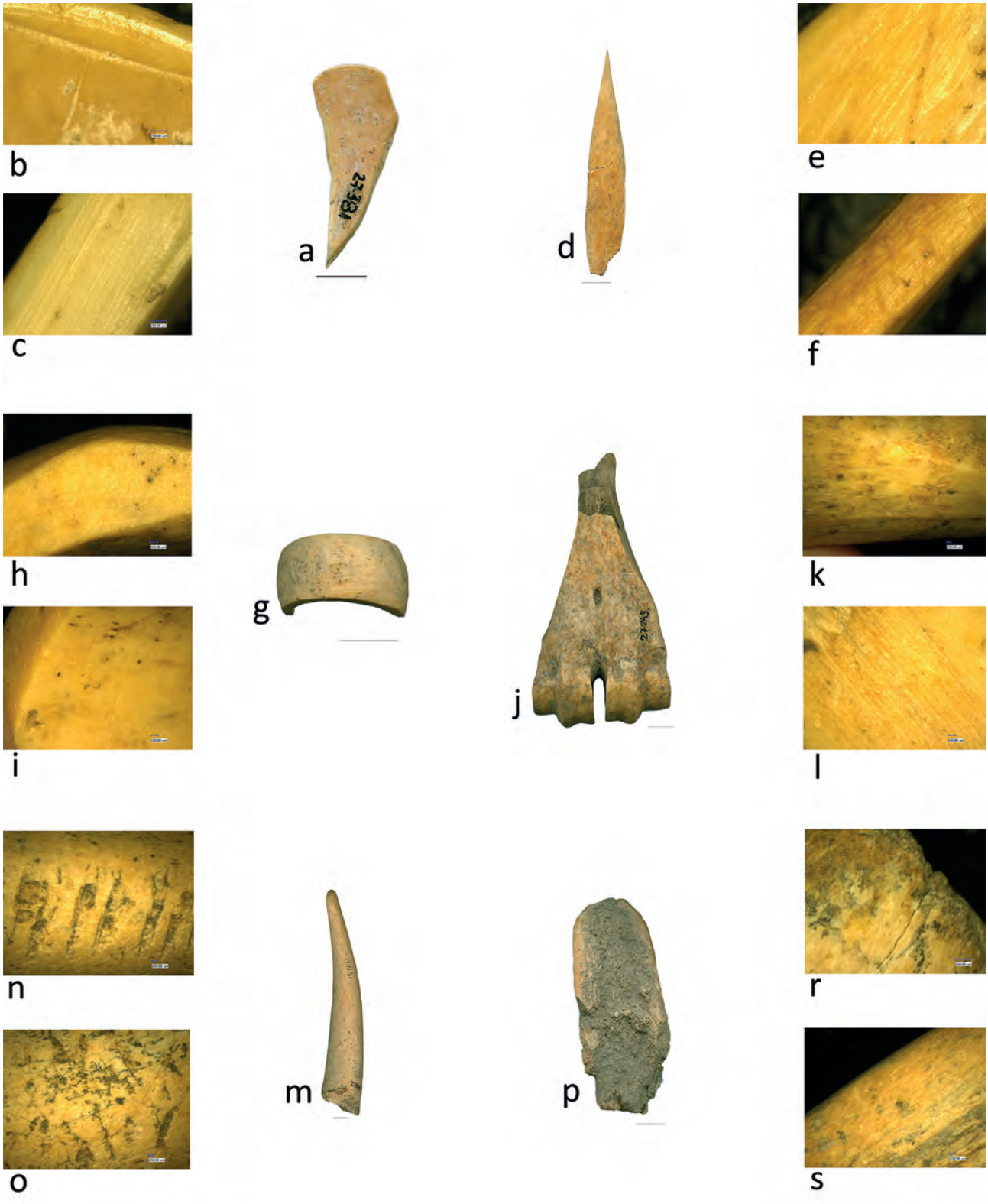

Fig. 4 – Typological categories found in Dudești (a) and Vădastra levels (d, g, j, m, p): a. Tooth scraper (scale = 1 cm); b. Sawing marks (50×); c, e-f, i, k-l. Scraping marks (c, e-f - 50×; i, l - 30×; k - 20×); d. Bone pointed tools; g. Bone ring; h, s. Abrasion marks (h - 30×; s - 20×); j. Bone with scraping marks; m. Antler pressure flaker; n-o. Cutting marks (n-o - 20×); p. Antler bevelled tool; r. Distal end detail (50×).

***Fig. 4** – Catégories typologiques trouvées dans les niveaux Dudești (a) et Vădastra (d, g, j, m, p) : a. racloir à dents (échelle = 1 cm) ; b. stigmates de sciage (50×) ; c, e-f, i, k-l. stigmates de raclage (c, e-f - 50× ; i, l - 30× ; k - 20×) ; d. outils pointus en os ; g. anneau en os ; h, s. stigmates d'abrasion (h - 30× ; s - 20×) ; j. os avec marques de raclage ; m. compresseur en bois de cervidé ; n-o. stigmates de coupe (n-o - 20×) ; p. outil biseauté en bois de cervidé ; r. détail de l'extrémité distale (50×).*

Măgura "Buduiasca" only in this level. The same occurrence is recorded for the deer canines used as pendants, which are not present in the next chronological stages. Finally, the scrapers from the *Sus scrofa* canine prove a Mesolithic tradition. This category of artefacts continues to appear in the next Neolithic sequences but in a reduced percentage. Consequently, we can conclude that some Mesolithic traditions are still maintained at this level and they disappear during the neolithization process. Instead, new elements appear, both technologically (manufacture-by-wear techniques: bipartition through abrasion, segmentation with abrasive fibre and perforation by wear technique), and typologically (new categories: spoons, rings or bones with scraping traces, abraded astragalus) that are entirely Neolithic. Another specific element from the Early Neolithic to the beginning of Chalcolithic is the poor use of cervid antlers and boar canines as raw material in exchange of the bones of domestic species.

The study of this assemblage led to the identification of different working procedures: the detachment by transversal debitage including the segmentation and the longitudinal debitage with different variants: transformation by extraction (fig. 5m-o), by bipartition, by quadripartition and by successive partitions. A scheme of transformation by direct shaping, identified for the astragals and for bones with scraping marks, can be added. Transversal debitage was done by direct sawing and percussion. The sawing was made both with flint tools (fig. 5g-j) and abrasive fibres (fig. 5k-l). As techniques for longitudinal bipartition abrasion (fig. 5a-c), scraping, percussion, double grooving (fig. 5d-f) and grooving combined with sawing/grooving and percussion were used while for successive partition percussion was used. As methods of surface adjustment scraping and abrasion were both used. To modify the volume a perforation by rotation or by *carottage* (fig. 5p-r) was initiated. A tool with a hollow inside (perhaps a reed) was used, resulting a cylindrical debris (fig. 5s-u; Mărgărit et al., 2018a).

In the Starčevo-Criș III level no typological or technological innovations are recorded. The operational schemes of the raw materials are the same, but a decrease of the variants through the disappearance of the bipartition by abrasion technique is noticed. The artefact typology also decreases, with the disappearance of those of Mesolithic tradition (e.g. deer antler harpoons or perforated deer canines).

In the Dudești level a continuity with the Starčevo-Criș I in terms of typology and technology is observed. However, among the defining elements for the neolithization process, pointed tools processed by bipartition through abrasion no longer appear in this phase, confirming what was also recorded for the Starčevo-Criș III level. The archaeological evidence clearly proves the disappearance of the pointed tools at the end of the Starčevo-Criș I phase, and at least for the studied area, as a distinctive marker for the Early Neolithic. The previous typological categories are maintained, but new ones appear: belt elements and hairpins. Debitage by segmentation is confirmed as well. For the longitudinal debitage, the processing schemes include bipartition, quadri-partition and successive partitions. Additionally, a scheme of transformation by direct shaping is also confirmed. While not direct proof, some fragments of pieces suggest the possibility that the extraction method was the technology used. Transversal debitage was done both by direct percussion and by sawing with a flint tool and with abrasive fibre. For the longitudinal debitage by bipartition procedures, percussion, double grooving and the combination of grooving and percussion were used. Percussion was also used for the successive partitions procedure. The techniques used for the surface adjustment and the changing of volume were the same as the previous levels. Sawing (for a hairpin decoration and ring decoration with anthropomorphic ornament) and grooving (for ring decoration) are sporadically used to modify the volume of the bone.

In the Vădastra level useful information is mainly provided by the blanks and the debitage waste. Some of the artefact categories occurring in the Dudești culture are no longer present: the belt elements and hairpins, therefore they can be connected with the Middle Neolithic. Instead, other elements typical for the Early and Middle Neolithic continue to survive, such as:

4. the overwhelming proportion of the bones in the assemblage relative to the antlers percentages that will be balanced in subsequent cultural stages;
5. the weak representation of the typological category of bone bevelled tools compared to those of the pointed tools known in the Late Chalcolithic (e.g. Gumelnița culture);
6. the use of exactly same procedures, such as the bone segmentation with an abrasive fibre or perforation by *carottage*, but no longer used in the Late Chalcolithic.

However, we point out the fact that the Vădastra assemblage is restricted and, most likely, a series of technological and typological data specific to this culture could not be identified.

Gathering the data from the cultural levels defined at the Măgura "Buduiasca", we are able to say that the osseous industry can contribute to a better understanding of the neolithization process, especially if we be able to identify how the appearance/abandonment of certain typological/technological elements can become indicators for certain cultural stages. The persistence of certain Mesolithic traditions in the Starčevo-Criș I level suggests a gradual technological and cultural continuity. These elements, which diminish in frequency and complexity in subsequent phases, likely reflect a transitional phase where Mesolithic practices persisted alongside the emergence of Neolithic innovations. The disappearance of these Mesolithic elements during the neolithization process could be attributed to environmental shifts that favoured the domestication and consumption of domestic species, as evidenced by the increased use of bones from such animals. Culturally, this transition might also reflect the changing of symbolic or functional preferences, leading to the gradual abandonment of traditional hunting-based tools.

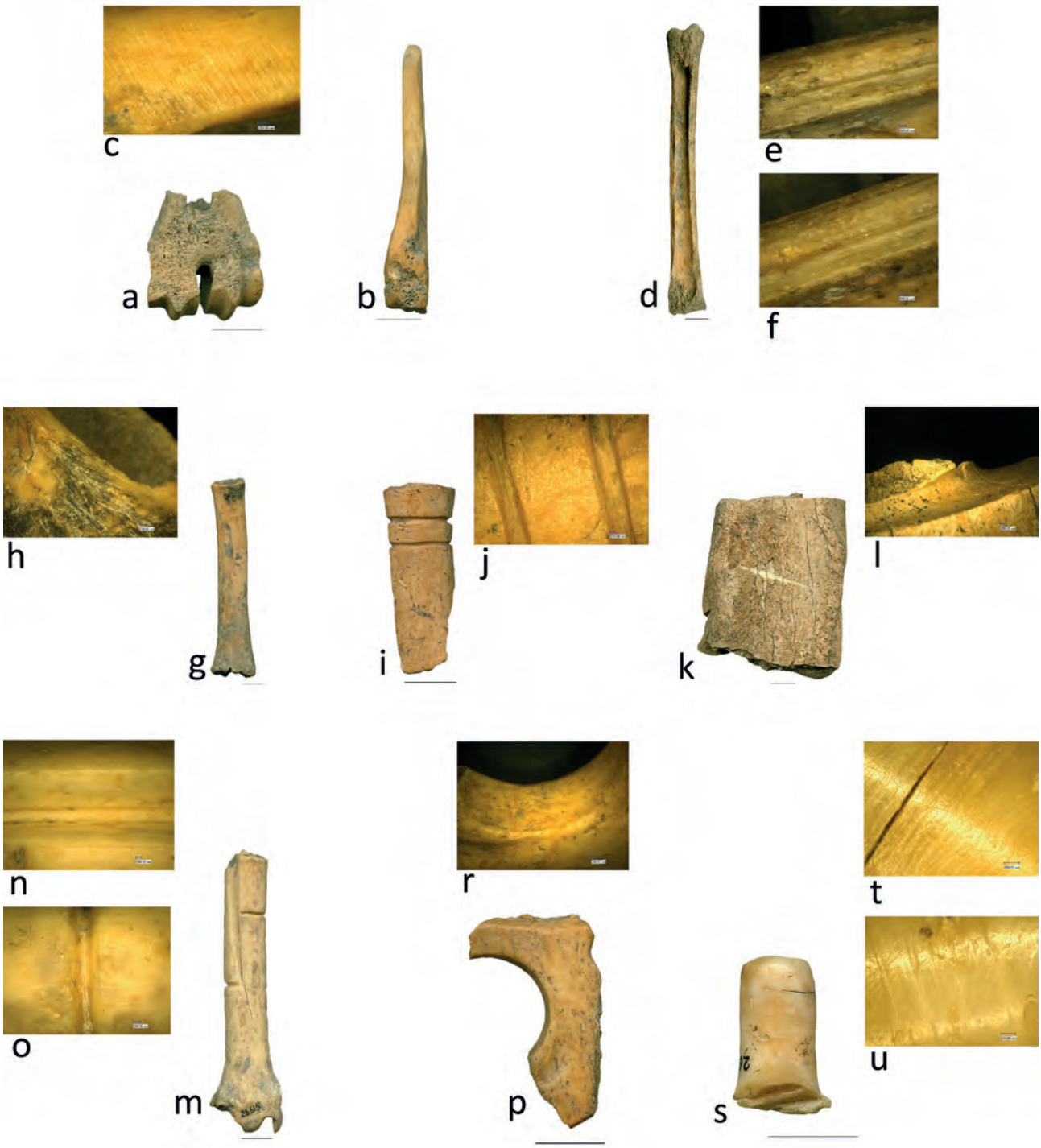

Fig. 5 – The main debitage methods identified at Măgura "Buduiasca": a-b. Bipartition by abrasion (scale = 1 cm); c. Abrasion marks (50×); d. Bipartition by double grooving: e-f, n. grooving marks (e-f - 50×; n - 30×); g, i. Segmentation by sawing with a flint tool; h, j, l, o. Sawing marks (h - 50×; j - 30×; l - 20×; o - 30×); k. Segmentation with vegetable fibre; m. Debitage method by extraction; p. Perforation by core drilling; r. Perforation detail (20×); s. Waste from core drilling; t-u. Traces of rotation by core drilling (t-u - 100×).
***Fig. 5** – Les principales méthodes de débitage identifiées dans le gisement de Măgura « Buduiasca » : a-b. bipartition par abrasion (échelle = 1 cm) ; c. stigmates d'abrasion (50×) ; d. bipartition par double rainurage ; e-f, n. stigmates de rainurage (e-f - 50× ; n - 30×) ; g, i. segmentation par sciage avec une pièce en silex ; h, j, l, o. stigmates de sciage (h - 50× ; j - 30× ; l - 20× ; o - 30×) ; k. segmentation avec fibre végétale ; m. méthode de débitage par extraction ; p. perforation par carottage ; r. détail de perforation (20×) ; s. déchet de carottage ; t-u. stigmates de rotation par carottage (t-u - 100×).*

Although it is a brief review of the evolution of the osseous industries in the analysed geographic area, it highlights innovations influenced by a multitude of factors. One possible hypothesis for the disappearance of certain elements throughout the evolutionary phases of the Neolithic relates to environmental shifts that rendered previous types obsolete or less functional. For instance, changes in climate or available resources might have influenced the loss of specific technical traits, favouring adaptations better suited to new conditions. Similarly, cultural factors, such as shifts in social organization, belief systems, or technological preferences, could have driven the decline of certain typological features while fostering others. For example, the development of new tools for different purposes or the adoption of different aesthetic standards may have facilitated the emergence of innovations. Additionally, the emergence of new elements could also be explained through the diffusion of ideas and technologies across regions, facilitated by trade, migration, or interactions among neighbouring groups. This process might have introduced novel features or hybridized the existing ones, leading to a complex pattern of persistence and innovation. Conversely, some elements persisted despite the changes because they held a significant functional or symbolic value within specific communities, which warrants further investigation into the socio-cultural context.

In conclusion, a multidisciplinary approach integrating environmental data, cultural analysis, and chronological modelling could deepen our understanding of the mechanisms driving these transformations. Future research might focus on developing detailed frameworks to test these hypotheses and further elucidate the complex interplay of factors influencing the evolution of these types over time.

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