Bioarcheological Indicators Related to Human–Environmental Interactions in a Roman–Byzantine Settlement in Southeast Romania: Ibida Fortress

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Abstract
The Roman–Byzantine fortress of (L)Ibida (Slava Rusă, Tulcea County, Romania) has preserved archeozoological and archeobotanical remains (i.e., phytoliths) that allowed an evaluation of the human–environmental interactions in that period. Bringing together bioarcheological data, this study contributes to understand the subsistence economy during a period of sociopolitical changes in the region. The stratigraphical sequences and the preliminary observations made on the archeological materials (ceramics, metal artifacts, coins) indicate a relative chronology beginning with the second to third centuries AD and lasting until the sixth century AD. Phytolith analysis highlights the clear domination of the grasses (Poaceae) and indicates the presence of cereals within the fortress. In the surroundings of the fortress, it appears to have existed an open environment. Although modest, the percentage of the SPHEREID phytoliths suggests the presence of woody dicots, indicating the fact that the wooded surfaces existed near the fortress. The archeozoological data confirm the fact that the fortress was placed in an open environment, where people bred especially cattle (Bos taurus) and sheep/goat flocks (Ovis aries/Capra hircus), and they hunted species such as hare (Lepus europaeus); also, the forest existed nearby, as indicate the remains of hunted species, among which we found the red deer (Cervus elaphus) and the wild boar (Sus scrofa).

Keywords
animal remains, phytoliths, subsistence economy, Roman–Byzantine period, Romania

Introduction
In the last years, the interdisciplinary approach in the knowledge of human past has become more and more important, due to the development of new concepts, methods, and techniques in the investigation of history. Thus, the use together, in complementarity, of historical documentation, archeological, and bioarcheological analyses, provides a richer understanding of complex historical events. If recording of history is dependent on the viewpoint of the recorder and may not accurately reflect the importance of events on the population itself, the bioarcheological techniques are more objective examining material remains from consumed animals (archeozoology) and plants (archeobotany). The bioarcheological data constitute a rich and original source of information not only on the history of paleoeconomy but also on biodiversity/environment and its interaction with human societies.

The present study focuses on an archeological site that has been the subject of a rescue excavation in 2014, inside the (L)Ibida Roman–Byzantine fortress (Tulcea County, Romania). The purpose of this article is to reconstruct the human–environment interactions in the Ibida Fortress area using two types of bioarcheological indicators: phytoliths (microscopic silica structures found in some plant tissues and persisting after plant decay) for the paleovegetation and animal skeletal remains for the paleofauna. This fortification has benefited of archeozoological studies before, made for different other points of research to the fourth to sixth centuries AD (Stanc, 2004, 2009), but this is the first time that the bioarcheological research involves also archeobotany (i.e., phytoliths analysis). Phytoliths may provide important data for paleoenvironmental reconstruction (Rovner, 1971) and

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they can be successfully used in paleoecology and archeology (Piperno, 1988, 1989). The results obtained from this research are important because the existing information concerning the paleoenvironment exploitation of this period’s sites is incomplete. We have to mention that this study represents, for the Roman–Byzantine fortress of (L)Ibida, the first attempt to integrate the archeozoological and archeobotanical data for a well-specified archeological context. Thus, it becomes possible to highlight aspects of the people’s lives in this fortress, by discussing aspects concerning the environment, plant cultivation for subsistence, animal husbandry, hunting, fishing, and so forth.

The integration of archeobotanical and archeozoological data is not new for the archeological sites of Romania. There have been this type of studies, but mostly for the Neolithic and Chalcolithic sites (Bejenaru et al., 2014, 2016, 2018; Danu et al., 2016). This work aims to strengthen the concept of an ethnobiological approach to archeological data (Nagaoka & Wolverton, 2016).

**Study Area**

(L)Ibida is situated in the northwestern part of Slava Rusă (Tulcea County, southeastern Romania) on the valley of Slava River (Figure 1).

The area is included, geologically speaking, in the central part of the Babadag Plateau, formed by sinking two parts of the North-Dobrogean Orogen, during the superior meso-cretaceous and superior Badenian. There are present some typical elements of the superior Cretaceous period, arranged as follows: Cenomanian (gritty chalks and limestone), Turonian (calcareous sandstones, yellow and white gritty chalks, as well as silicified chalks), Coniacian (marble limestone). The newest formations are the ones of Pleistocene, represented by loessoid deposits; they are spread, mainly, in the east and west of the village (Petrescu et al., 2012). Petrescu and collaborators (2012) have mapped the following types of soil in this area: gleic melanic faeoziom, typical luvisols, argic chernozems also typical subrendzinic faeozioms, calcareous rendzines, and lithosols.
The territory between the Danube and the Black Sea, on which the Ibida Fortress is located, was gradually integrated in the Roman Empire, over the course of the first century AD. The archeological discoveries demonstrate intense economic and cultural relations between the Roman settlement on the valley of Slava River and the rest of the province, as well as with the Eastern Roman world. Due to the strategic importance of the Slava River valley, an important defensive system was developed here (i.e., Ibida Fortress), culminating in the Roman–Byzantine period. The fortress had periods of not only peace and prosperity but also critical moments such as the attacks of the Goths (four century AD), Kutrigurs (mid-sixth century AD), and Avars and Slavs (late sixth and early seventh centuries AD; Suceveanu & Barnea, 1991).

Archeological Context

The Roman–Byzantine fortress of (L)Ibida–Slava Rusă (LMI code: TL-I-s-A-05926; RAN code: 161277.01.01) occupies a surface of 24 ha with the shape of an irregular polygon. The enclosure wall is about 2,000 m long and surrounded by 24 towers. To the main fortress was added a supplementary fortification, placed on Harada Hill. This annex has a surface of 3.5 ha and a small fort, placed in the highest spot of the area. Slava River crosses the fortress from west to east, dividing it in two almost equal areas. Currently, 70% of (L)Ibida’s surface is overlaid by the village Slava Rusă.

The fortress was identified by Vasile Pârvan (1912) as being the same with polis Ibida, mentioned by Procopius of Caesarea among the fortifications rebuilt by Emperor Justinian I (Mihăiescu et al., 1970), name corrected afterward by Andrei Aricescu—based on a mention made by Teophylact Simocatta (Mihăiescu, 1985), in which the fortress appears as Libidinon polin—in Libida, Libidum, or Libidina (Aricescu, 1971; Doruțiu-Boilă, 1979; Madgearu, 1999).

Systematic archeological excavations were initiated in 2001 on multiple sectors, both inside and outside of the fortress. In the following years, the excavations were doubled by geophysical, archeozoological, paleoanthropological, and architectural studies (Iacob et al., 2015).

The researched area (point Andrusca property) that is being referred to in this study (25 m²) is situated toward the common interior of the fortress and the nearby fortification, placed on the Harada Hill. It was divided in two rectangles: Surface A, measuring 3.30 m on the direction North–South and 4.40 m on the East–West side, and Surface B, with the dimensions 1.50 × 7.10 m, in the same directions.

In Surface A, the research was done until the archeological sterile soil, at the maximum depth of 3.70 m, where appeared the base of a foundation that belonged to a large-sized edifice, made of stones glued with mortar. The edifice, certainly a public building, was partially investigated in 2008 (Iacob et al., 2009; Paraschiv & Mocanu, 2010). The building was signaled on a height of 3 m (including the foundations); on the surface studied by our team in 2014, we discovered only an exterior corner of it (the northwestern one). The edifice was abandoned sometime in the fifth century AD; the debris was leveled and appears in the northern profile at a depth of 1.10 to 1.20 m. In the current excavation, it was impossible to determine the thickness of the walls; but it is known since the 2008 campaign that the thickest wall measured 1.05 m.

Based on the stratigraphical sequence (Figure 2) and the preliminary observations made on the archeological
materials (ceramics, metal artifacts, coins), it was possible to date seven contexts (from bottom to top): the first layer of second to third centuries AD (level with tegulae, built before the building), the next two layers of fourth century (construction level with mortar and pebbles debris corresponding to the building and level with tegulae, bricks, and mortar), the fourth layer—the end of fourth or the fifth century (level with stone debris falling on the habitation level), the fifth and sixth layers of fifth century (level with stone debris and level with mortar), the seventh layer of sixth century AD (yellow soil).

**Material and Method**

The material analyzed in this study is represented by animal skeletal remains, collected during the rescue excavations developed inside the Roman–Byzantine fortress of (L)Ibida in 2014, toward the common interior of the fortress and the annex fortification from Harada Hill, and sediment samples collected from Section A, to extract the phytoliths.

**Archeozoology**

The faunal remains that represent the studied sample (from the site *Andrusca property*) come only from contexts dated to the fourth to sixth centuries AD (all levels, excepting the level with tegulae built before the building. The last mentioned did not contain archeozoological material). Most of the animal skeletal remains are assumed to be waste of food, presenting a high degree of fragmentation, many anthropic signs (cutting traces, burned areas), and also marks left by dogs (some of the bones were chewed upon). We have to mention that the animal remains were only collected “by hand,” with no sieving of the sediment, a fact that could cause the small fragments to be lost and causing the undervaluation of the small specimens (fish, mammals, even birds).

The archeozoological analysis was conducted in the Faculty of Biology, Alexandru Ioan Cuza University of Iași, respecting the specific methodology, which consisted, mainly, in anatomical, taxonomical, and taphonomical identification; and recording and quantification of the data (Reitz & Wing, 2008; Udrescu et al., 1999).

Even if the size of the archeozoological sample is rather small (i.e., 956 faunal remains), its corroboration with the archeobotanical data and with specific archeological context allows for a particular case study about the use of plants and animals, and also for a diachronic perspective in a next study concerning the Ibida Fortress.

**Archeobotany**

For phytoliths analysis, seven samples were collected from Section A, from the eastern area, more precisely from the construction level with mortar and pebbles debris corresponding the building and from the level with tegulae, bricks, and mortar (Figure 2). Both layers are dated to fourth century AD.

Phytoliths extraction was carried out in Laboratory of Bioarchaeology from Alexandru Ioan Cuza University of Iași, starting from a sample of sediment of between 1 and 3 g. For chemical preparation, we used the standard protocol of the laboratory: clays deflocculation with distilled water under magnetic stirring; 200 μm tumbling for coarse particles removal; centrifugation 2,000 t. min⁻¹ for clays elimination; decarbonation with concentrated hydrochloric acid (33%) by heat and using the ultrasonic bath; organic matter oxidation under hot and ultrasonic action—KOH (10%), nitric acid (30%), hydrogen peroxide (30%); phytoliths densimetric separation with sodium polytungstate (with d = 2.35). Then, the rinsed and dry extract was poured into ethanol, after which few drops were fixed on a microscopic slide using immersion oil. The utilized nomenclature is according to International Code for Phytolith Nomenclature 2.0 (International Committee on Phytolith Taxonomy [ICPT], 2019). All the samples were observed at the optical transmission microscope (×400). Statistically speaking, for each sample, we identified a sufficient number of phytoliths (above 281), to obtain a valid result.

**Results**

**Archeozoology**

The archeozoological sample contains 956 remains belonging to fishes (33 remains) and mammals (923 remains). The identification up to the species level was possible for 594 mammal remains (Table 1); from these, 91.92% represent domestic mammals and 8.08% wild mammals.  

**Fish.** The fish remains are from *Acipenser* sp. (sturgeon)—two fragments, *Cyprinus carpio* (carp)—15 fragments, *Silurus glanis* (cat fish)—six fragments, *Esox lucius* (luce)—one fragment, for nine fragments, no identification could be made up to species level.

**Domestic mammals.** Seven domestic mammal species were identified: *Bos taurus* (cattle), *Ovis aries* (sheep), *Capra hircus* (goat), *Sus domesticus* (pig), *Equus caballus* (horse), *Equus asinus* (donkey), and *Canis familiaris* (dog). In terms of the number of identified specimens (NISP), cattle have the highest frequency (41.9%), followed by sheep/goat (25.9%), and then pig (18.5%). The other three species have lower percentages of NISP: horse—3.37%, donkey—1.01%, and dog—1.18%. Considering the estimated minimum number of individuals (MNI), the pig is placed in the first position (23.6%) and it is followed by cattle (21%) and then sheep/goat (15.7%). The donkey remains come from two mature specimens. The seven dog remains come from two mature specimens. Based on the 20 analyzed horse remains, we were
able to estimate only two specimens, one immature and one mature (Table 1).

**Wild mammals.** Six species of wild mammals were identified: *Cervus elaphus* (red deer), *Sus scrofa* (wild boar), *Capreolus capreolus* (roe deer), *Lepus europaeus* (hare), *Bos primigenius* (aurochs), and *Vulpes vulpes* (fox). The highest percentages, regarding the NISP, are split between red deer (4.7%) and wild boar (1.5%; Table 1).

The 28 red deer remains come from three individuals; on the red deer antler fragments there are traces of processing; two pieces come from antlers gathered by the inhabitants of the settlement. Based on the four skeleton remains of roe deer, two individuals were estimated. The nine boar remains come from a male specimen. Based on the analyzed remains, one specimen was also estimated for each of the following species: aurochs, hare, fox.

**Archeobotany**

The analyzed sediments were very rich in phytoliths and highlighted homogeneous spectra (Figure 3). In the seven samples that we analyzed, we identified 12 morphotypes: **Rondel**, **Bilobate**, **Acute bulbus**, **Spheroid**, **Bulliform flabellate**, **Elongate entire**, **Elongate sinuate**, **Crenate**, **Saddle**, **Cross**, **Elongate dendritic**, **Tracheary**. Articulated phytoliths, also known as silica skeleton, were also found.

Most of identified morphotypes are assigned to grasses. The diversity of the recorded phytoliths suggests the presence of several subfamilies from the Poaceae family.

The **Rondel** type is the most common in all the samples, varying from 61% to 77% (Figure 3). These forms are associated with the subfamily of Pooidae (Mulholland, 1989; Pearsall & Piperno, 1993), plants with C3 metabolism, which are growing in temperate environment, to whom belong most cereals. **Rondel**-type phytoliths can also be identified in other plants such as those from the Arundinoideae subfamily (Barboni & Bremond, 2009).

In six of the seven samples, we identified the **Bilobate** morphotype (Figure 3). This one is produced by the Panicoideae, plants adapted to a warmer climate, often with C4 metabolism, and intertropical spread, with the exception of the wild millet (*Setaria* sp.) and the cultivated millet (*Panicum* sp.). The recorded percentage of this phytolith type was low: no more than 2%. The existence of the Panicoideae subfamily is also suggested by the presence in two samples (Andr 3 and Andr 5) of the **Cross** phytoliths.

The **Spheroid** morphotype, considered to be a characteristic of the dicotyledonous plants (Albert et al., 1999; Alexandre et al., 1997; Bozarth, 1992; Delhon et al., 2003), was observed in all the samples, in percentages that can vary from 0.65 to 3.85 (Figure 3). It is a known fact that dicotyledonous plants do not produce many phytoliths compared with the herbs from the Poaceae family. Research (Albert & Weiner, 2001) shows that the herbs produce 20 times more phytoliths than the wooden dicotyledonous and 16 times more than the herbal dicotyledonous. Therefore, the relatively low percentage of the **Spheroid** morphotype can be considered significant and a forest indicator (Stromberg, 2004). In all samples (except for the Andr 2 sample), the

**Table 1.** Quantification of Faunal Remains.

| Species                  | NISP | %    | MNI | %    |
|--------------------------|------|------|-----|------|
| *Bos taurus* (cattle)    | 249  | 41.92| 8   | 21.05|
| *Ovis aries/Capra hircus* (sheep/goat) | 154  | 25.93| 6   | 15.79|
| *Sus domesticus* (pig)   | 110  | 18.52| 9   | 23.68|
| *Equus caballus* (horse) | 20   | 3.37 | 2   | 5.26 |
| *Equus asinus* (donkey)  | 6    | 1.01 | 2   | 5.26 |
| *Canis familiaris* (dog) | 7    | 1.18 | 2   | 5.26 |
| Domestic mammals         | 546  | 91.92| 29  | 76.32|
| *Cervus elaphus* (red deer) | 28   | 4.71 | 3   | 7.89 |
| *Sus scrofa* (wild boar) | 9    | 1.52 | 1   | 2.63 |
| *Capreolus capreolus* (roe deer) | 4    | 0.67 | 2   | 5.26 |
| *Lepus europaeus* (hare) | 5    | 0.84 | 1   | 2.63 |
| *Bos primigenius* (aurochs) | 1    | 0.17 | 1   | 2.63 |
| *Vulpes vulpes* (fox)    | 1    | 0.17 | 1   | 2.63 |
| Wild mammals             | 48   | 8.08 | 9   | 23.68|
| Total identified mammals | 594  | 100  | 38  | 100  |
| Not identified mammals   | 329  |      |     |      |
| Total mammals            | 923  |      |     |      |
| Fish                     | 33   |      |     |      |
| Total sample             | 956  |      |     |      |

Note. NISP = number of identified specimens; MNI = minimum number of individuals.
Spheroid phytoliths are even better represented than the Bilobate type (Figure 3).

Often attributed to dicotyledonous (Stromberg, 2004), the Trachearphytoliths can be produced by a wide range of plants (ICPT, 2019).

The Bulliform flabellate morphotype can be produced in large quantities in both stems and leaves (Ball et al., 2016). Its presence in all samples is poor (maximum 2.7%).

The Elongate entir morphotype is characteristic for the grasses but cannot be attributed to a certain subfamily (Twiss et al., 1969), and in the (L)Ibida samples, they record relatively high values, reaching almost 17% (Figure 3).

Elongate sinuate are poorly represented in all the samples (no more than 1.65%), with the exception of the Andr 6 sample where no such phytoliths were recorded (Figure 3). This morphotype is very common in Pooidae, being a good indicator for this subfamily (Barboni et al., 2007).

In two samples (Andr 2 and Andr 4), the presence of the Crenate morphotype, the morphotype attributed to the Pooidae subfamily, was also recorded (Figure 3).

In two other samples (Andr 1 and Andr 7), the presence of the Saddle morphotype, which is produced in large quantities by representatives of the subfamily of Chloridoideae, is attested (Figure 3).

Elongate dendritic phytoliths that precipitate in grass inflorescences (Ball et al., 2001) are used in archeology to trace the use of cereals (Novello & Barboni, 2015). Large quantities found in archeological context are interpreted as an accumulation of these plants (Novello & Barboni, 2015). Elongate dendritic are present in all analyzed samples, achieving percentages between 10.32 and 16.34 (Figure 3), suggesting the presence of cereals and, therefore, of cereal crops.

**Discussion**

Although there are differences between plant and faunal data in terms of preservation, recovery, and representation, many studies have demonstrated the importance of using the integration of these two data sets when studying human past and paleoenvironment. Qualitative and quantitative integration were used to reconstruct the local environment and to discern selective use of different resources (Bartosiewicz et al., 2010), to describe food processing activities (Moore et al., 2010), to better understand the daily diet of a certain population (Tóth et al., 2010).

For (L)Ibida site, we had no opportunity to quantitatively integrate data on plant and faunal remains to create a single body of information because of the small size of samples. Our analysis is based on qualitative data. However, both animal and plant remains allow us to gain a more holistic insight into subsistence strategies and human–environmental interactions at Ibida Fortress.

No significant differences were detected between the phytolith spectra of the two layers. There are small variations between these, but it would be imprudent to attribute them to changes in the landscape or to a predominant use of a certain category of plants. Phytolith assemblages clearly show the dominance of the grass. An open environment seems to have characterized the area of Ibida in the Roman–Byzantine period. The proportion of Rondel-type phytoliths demonstrates the overwhelming presence of the Pooidae subfamily, in which we can find species such as wheat (*Triticum* sp.), barley (*Hordeum vulgare*), oat (*Avena sativa*), and rye (*Secale cereale*). The percentages of Elongate dendritic phytoliths support the hypothesis of the existence of cereals in the (L)Ibida site. The accumulation of this type of phytoliths in the cultural layer of the site as well as the presence of...
the silica skeleton elements suggest the processing and use of cereals by the community of (L)Ilbida during the Roman–Byzantine period. Also, taxa belonging to Panicoideae subfamily (e.g., Setaria sp., Panicum sp., Sorghum sp.) existed in the composition of the vegetation from the fortress area. Seeds of plants such as Setaria sp. and Panicum sp. could have been used as food (probably as porridge) and the stems of these plants for fuel. Setaria and Sorghum may have been also good fodder for animals.

The phytolith samples from the cultural layers of (L)Ilbida site show that the woody dicotyledonous plants were also present in the Roman–Byzantine landscape of the fortress. Spheroïd-type phytoliths attest the presence of woody essences in the site. These data suggest that not too far from the fortress area, there were trees and shrubs that the (L)Ilbida community could have brought to the site for various uses (e.g., fuel, construction).

Archeozoological results show the importance of animal husbandry in the local economy, especially large and small horned animals (i.e., cattle and sheep/goat, respectively, with a total of 42.15% NISP from all samples), which implies the existence of open spaces for grazing around the fortress. To these domestic species of open spaces, the horse and the donkey are also added. The open environment is indicated too by the presence of wild mammals, such as the hare, even aurochs, roe deer, the last two being species living on the boundary between forest and open field. The frequency of pig remains, which is also significant (11.50% NISP of the total sample), and correlated with the frequency of the forest wild mammal remains (i.e., red deer and wild boar, with a total of 3.87% NISP from all samples) is an indicator for the presence of a forest not far from the fortress. The exploitation of a third medium—aquatic type is indicated by the fish remains (3.45% NISP of the total sample), which could have come partly from the watercourse that passed through the fortress. Perhaps, fishing was also practiced in the nearby lagoon complex, much more extended—even a gulf in antiquity; in this regard, we mention that from the identified species, carp, catfish, and sturgeon can live in both freshwater and salty water from the canals that communicate with Black Sea. However, we consider that the fish frequency is underestimated, considering the method of collecting remains, without sieving the sediment. Previous archeozoological studies indicate higher frequencies of fish for the same period, but in different other sites of the fortress—9% (Stanc, 2004) or even 79% (Stanc, 2009); it would be also an unequal distribution of the deposited household waste within the fortress.

Taxonomic composition in this sample may be also an indicator of socioeconomic status. We notice some differences from the previously studied samples of Ilbida Fortress (Stanc, 2004, 2009), that is, a higher frequency here of pig and red deer. Faunal assemblages from many of European high-status medieval sites contain a high proportion of pig and deer (Ashby, 2002).

**Conclusion**

This study brings together archeozoological and archaeobotanical data regarding a specific site (i.e., Andrusca property) in (L)Ilbida Fortress (Southeast Romania), dated to the Roman–Byzantine period. Bioarcheological results highlight the fact that between second to third centuries AD and the sixth century AD, the fortress was in an open space, dominated by grasses, as proven by phytolith analysis.

Inhabitants of (L)Ilbida Fortress were relying on a subsistence economy mainly based on plant cultivation, animal husbandry, hunting, and fishing. The archeozoological study confirms the hypothesis of the open field exploitation by the evaluation of the skeletal remains from big horned animals—cattle (B. taurus) and small horned animals—sheep/goat (O. aries/C. hircus), from horse (E. caballus) and donkey (E. asinus), but also from a wild species—hare (L. europaeus). The forest was not far from the fortress, a fact that is suggested by the percentage of Spheroïd-type phytoliths, and also by the presence of wild mammal remains from species of forest biotope, such as red deer (C. elaphus) and wild boar (S. scrofa). We have to mention too the wild species living between forest and open field—roe deer (C. capreolus) and aurochs (B. primigenius). Regarding the existence of cereals in the fortress, this aspect is very plausible given the percentages of Elongate Dendritic phytoliths. Also, the presence of the silica skeleton elements indicates the cereal processing by the Roman–Byzantine community from (L)Ilbida.

The community also used aquatic resources from both the nearby lagoon complex and the Slava River crossing the fortress, because three of four identified fish species (i.e., carp, catfish, and sturgeon) can live in both fresh and salty water.

The size of the building, the diversity of the pottery, and the composition of the archeozoological assemblage suggest an upper class consumer profile.

**Declaration of Conflicting Interests**

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