


# Middle-to-Late Pleistocene malacofauna from the archeopaleontological site of Oued Sarrat (Tajerouine area, NW Tunisia)

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**Abstract** The malacofauna collected from the archeopaleontological site in Oued Sarrat (Tajerouine area, NW Tunisia) is the first reference from the Middle and Late Pleistocene stratigraphic series in Tunisia. These malacologic assemblages are abundant but little diversified; they are considered as continental, lakeside, and fluvial ecosystem forms. They are associated with bones of small and large vertebrates and lithic artifacts. The dominant species of gastropods are *Cerņuella virgata* (Da Costa, 1778), *Xerosecta cespitum* (Draparnaud, 1801), and *Sphincterochila baetica* (Rossmässler, 1854) which are typical of the Mediterranean regions. The abundance of these pulmonate terrestrial gastropods indicates a post-mortem transport of shells by floods and fluvial channels. The only bivalve, *Unio ravoisieri* (Deshayes, 1847), still common in the rivers of northern Tunisia, characterizes a typical lakeside environment, with relatively low energy. Considering the recently discovered associated vertebrate remains, their occurrence corroborates the onset of a paleoenvironment landscape with swamps, or even a shallow freshwater paleolake with close forests. Hence, this environment also inhabited by a diversity of large mammal species and other abundant microvertebrates and invertebrates was a

support for human survival within these northern African latitudes.

**Keywords** Malacofauna · Middle-Late Pleistocene · Paleoenvironment · Acheulian · Oued Sarrat · NW Tunisia

## Introduction

A few and disparate thematic works have dealt with the Pleistocene deposits of Tunisia. In O. Sarrat (Tajerouine area), the first invertebrate collection was produced by the North American paleontologist Pr. Robertson during the 1970s. These were assigned to Neogene. To our knowledge, no systematic excavation with stratigraphic sampling and rigorous marking was undertaken. During the year 2008, a megavertebrate remain of a previously unknown skull was gathered by an amateur non paleontologist; this imposed the necessity to check and evaluate the value and potential scientific contribution of the site paleontological content. Soon after, a Tunisian-Spanish project implying pluridisciplinary specialists has been established. The first investigations in this archeopaleontological site has revealed promising small- and large-vertebrate data, with a special interest to the species *Bos primigenius*, where the worldwide earliest representative of this bovid species has been reported by our team together with lithic artifacts of the Acheulian technocomplex (Martínez-Navarro et al. 2014). The chronology of this site was also established on paleomagnetism and biochronological data from microvertebrates (Martínez-Navarro et al. 2014; Mtimet et al. 2014). In continuation of these works, the present paper aims to describe the first Quaternary continental mollusks documented in northwestern Tunisia. Associated with the archeopaleontological remains, these also serve to

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characterize and reconstruct the Middle and Late Pleistocene paleoenvironments of the Oued Sarrat basin.

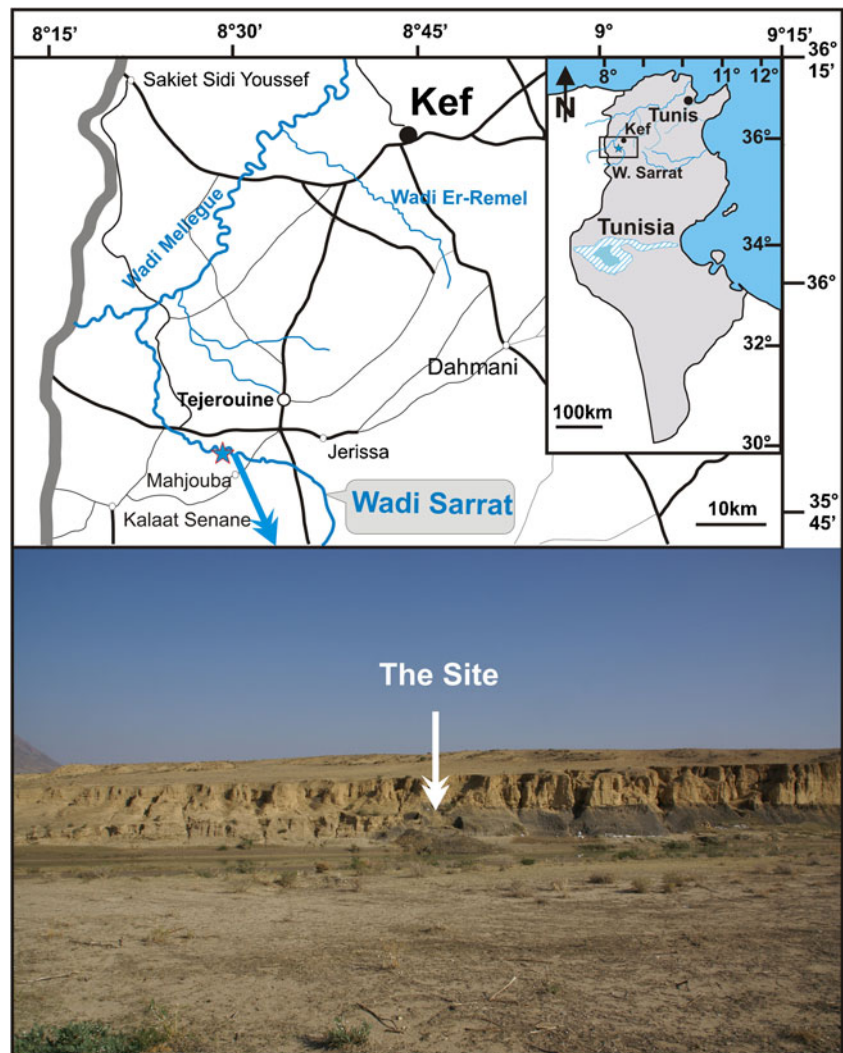
### The Oued Sarrat bearing—site location

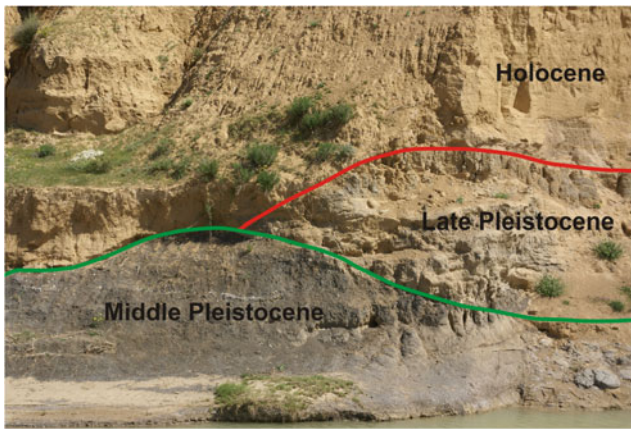
Close to the Algerian border, the Oued Sarrat area of north-western Tunisia is located about 10 km to the southwest of Tazerouine city and 1 km to the north of the Mahjouba village. This river is a tributary of O. Mellegue that belongs to the 2188-km<sup>2</sup> O. Sarrat basin at 700 m above the sea level. The geomorphological context consists of an intermediate zone between the central and the northern Atlas of Tunisia, dominated by folded structures interspersed with rift basins corresponding to the kalaa el Khasba and Rouhia depressions (Buroillet and Sainfeld 1956). The Middle and Late Pleistocene stratigraphic series crop out on both sides of Oued Sarrat (Fig. 1).

### Lithological succession and accompanying paleontological content

The Pleistocene stratigraphic series of Oued Sarrat (OS) are represented by three levels (Fig. 2). At the base, a compact layer of gray-black marl exceeds 4 m in thickness. This layer revealed a rich and a very diverse vertebrate fauna (Martínez-Navarro et al. 2014; Mtimet et al. 2014): a mostly complete skull with both horn cores of *B. primigenius* together with other remains of *Canis* sp. (jackal size), two perissodactyls (*Cerathotherium simum* and *Equus* sp. small-middle size), four artiodactyls (*Suidae* indet., *Hippopotamus* sp., and *Gazella* sp.), one insectivora (*Crocidura* sp.), six rodents (*Mus* aff. *spretus*, *Mus* cf. *hamidae*, *Paraethomys* cf. *rbiae*, *Praomys* sp., *Meriones* sp., and *Eliomys* sp.), some bone fragments of a small freshwater fish (*Cyprinidae* indet.), two anurans [*Discoglossus pictus* (*Alytidae*) and *Bufo bufo* (*Bufo* sp.)], one terrapin (*Emys* sp. or *Mauremys* sp.), three squamates [an indeterminate small lacertid or scincid lizard, *Natrix maura*

**Fig. 1** *Top*: Geographic location of the study area. *Bottom*: panoramic of the site with the systematic excavation in the center





**Fig. 2** The unconformity between the Middle and Late Pleistocene and between the Late Pleistocene and Holocene (Martínez-Navarro et al. 2014)

(Natricidae), and an indeterminate colubrid snake], and one small-sized bird (indet. Passeriforms).

In association with this fauna, some lithic tools, corresponding to the Acheulian technocomplex, have been gathered after a systematic excavation within this stratigraphic level. These marls also yielded very rich invertebrate assemblages from the OS1 and OS2 samples, mainly gastropod and bivalve mollusks. This level is dated as Lowermost Middle Pleistocene (~0.7 Ma) using fossil rodent association and magnetostratigraphy (Martínez-Navarro et al. 2014; Mtimet et al. 2014).

Underlined by an erosive discontinuity, another 2-m-thick clayey level, less compact and light gray in color (OS3), was dated as Late Pleistocene. This level is also rich in vertebrate fauna (*Panthera cf. leo*, Elephantidae indet., *Gazella* sp., indet. Suidae) and invertebrates (bivalves, gastropods) (Martínez-Navarro et al. 2014; Amri 2011, 2014; Mtimet et al. 2014; Bejaoui 2014).

Both marly levels are topped by a yellow to brownish sandy level, exceeding 4 m in thickness (OS4) where Holocene gastropods were collected (Martínez-Navarro et al. 2014).

## Materials and methodology

The fieldwork was carried out during two periods, in 2011 and in 2013. A systematic methodological excavation of 30 m<sup>2</sup> was undertaken in the area where was discovered *B. primigenius*. This grid area from the investigated site underwent a systematic excavation with a wise marking. This required the establishment of a Cartesian system of metric squares with detailed mapping of the recovered materials. On individual sheets for each of the squares were mentioned useful informations (direction, dip, spatial coordinates *x*, *y*, and *z*, all with a photography of the interesting fossil remains). The cleared sediment samples (which may reach the volume of 30 m<sup>3</sup>) were sieved through 2- and 5-mm meshes, and the

paleontological content was carefully dried in situ. A preliminary sorting of the residues depended on their size and nature. For the malacological fauna, the number of shell specimens per sediment volume is noted. All gathered specimens were observed under a binocular microscope.

The minimum numbers of individuals (MNI) for molluscan remains are calculated by counting the frequency of a restricted number of nonrepetitive elements (NREs), the spire of gastropods and hinge of bivalves. Species identification and paleoecological interpretation were based on the reference works of Germain (1930); Favre (1927); Sparks (1961); Lozek (1964); Puisségur (1976); Kerney and Cameron (1979); Kerney et al. (1983, 1999); Rousseau (1990); Fechter and Falkner (1990); Limoldin-Lazouet (1997); Limoldin-Lazouet and Antoine (2001) and Limoldin-Lazouet et al. (2002).

## Systematic paleontology of the malacofauna

The malacofauna is not very diversified; only seven species belonging to four families and six genera were identified. They include six terrestrial gastropods and a single aquatic bivalve (freshwater mussel) (Figs. 3 and 4). All the collected specimens are hosted in the laboratory of Stratigraphic Paleontology of the Earth Science Department of the Faculty of Bizerte in Tunisia.

**Family:** Helicidae Rafinesque, 1815

**Genus:** *Helix* Linnaeus, 1758

**Species:** *Helix melanostoma* (Draparnaud, 1801)  
Fig. 4(1 and 2)

**Synonymy**

*Helicigona melanostoma* Coutagne (1882 and 1892)

*Helix melanostoma* Ziano and Stévanovitch (1992)

*Helix melanostoma* Aubry (2003)

**Material**

The MNI varies between 21 (Middle Pleistocene) and 98 (Late Pleistocene).

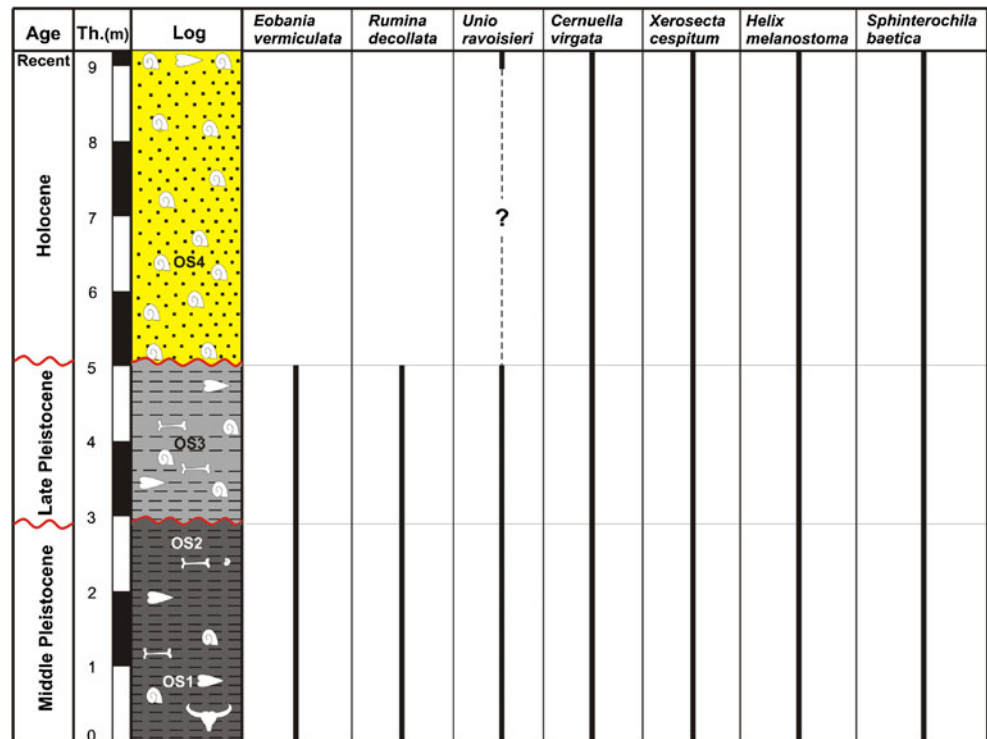
**Description**

A beige shell, highly globular potbellied, rough-looking and showing more marked striations on the last whorl. The spiral side is very convex with a slightly high spire, consisting of fast-growing four whorls. The last whorl is very large and convex; the sutures are deep and slightly oblique. Low apex, fairly at the same level as the last whorl. The umbilical face is convex with a very small umbilicus. The aperture is rounded to angular towards the summit with a labial edge slightly thickened. The columellar edge is curved, flattened, and robust. The original purple pigmentation can be fossilized in some individuals. *H. melanostoma* is collected in the Middle and Late Pleistocene with a notable abundance at the base of the series.

**Dimensions:** height 30 to 50 mm, width 25–40 mm, and aperture 20 to 30 mm.

**Geographical distribution and paleoecology**

**Fig. 3** Vertical distribution of mollusk species found in the Oued Sarrat stratigraphic series



*H. melanostoma* is a common species in western and southern Mediterranean countries. It is recorded in Morocco, Algeria, Libya, Egypt, south of France, and Spain. It lives in the plains, fields, and farmlands with a preference for humid microhabitats. It is quite abundant in northern Tunisia (Magnin 1991b).

**Family:** Sphincterochilidae Zilch, 1960

**Genus:** *Sphincterochila* Ancey, 1887

**Species:** *Sphincterochila baetica* (Rossmässler, 1854)

Fig. 4(3 and 4)

**Synonymy**

*Helix baetica* Rossmassler 1854

**Material**

Forty-seven individuals were collected from the Middle Pleistocene marls and 110 individuals from the Late Pleistocene level.

**Description**

Robust and smooth, beige to reddish shell, slightly tapered and typically convex with a blunt apex. The spire consists of five to six whorls, with a relatively fast growth and shallow sutures. The final whorl is rounded and well developed. The umbilicus is covered; the aperture is round, crescent-shaped with a thick labial edge, blunt, and slightly reflected outward.

**Dimensions:** height 16 to 22 mm, width 12 to 18 mm, and aperture 5 to 11 mm.

**Geographical distribution and paleoecology**

*S. baetica* is known at the southeast of Spain (Andalucía, Almería, Murcia), at the north of Morocco, and at the north-west of Algeria.

This species is found in arid to semi-desert environments, living on the hills of steppe vegetation, both on the coast and inland. It prefers the desert mountains and rocky areas (Magnin 1988a; Abbas et al. 2011).

**Genus:** *Eobania* Hesse, 1913

**Species:** *Eobania vermiculata* (Müller, 1774)

Fig. 4(5 and 6)

**Synonymy**

*Helix vermiculata* O.F. Müller, 1774

*Helix concolor* De Cristofori & Jan. 1832

*Helix linusae* Calcara, 1846

**Material**

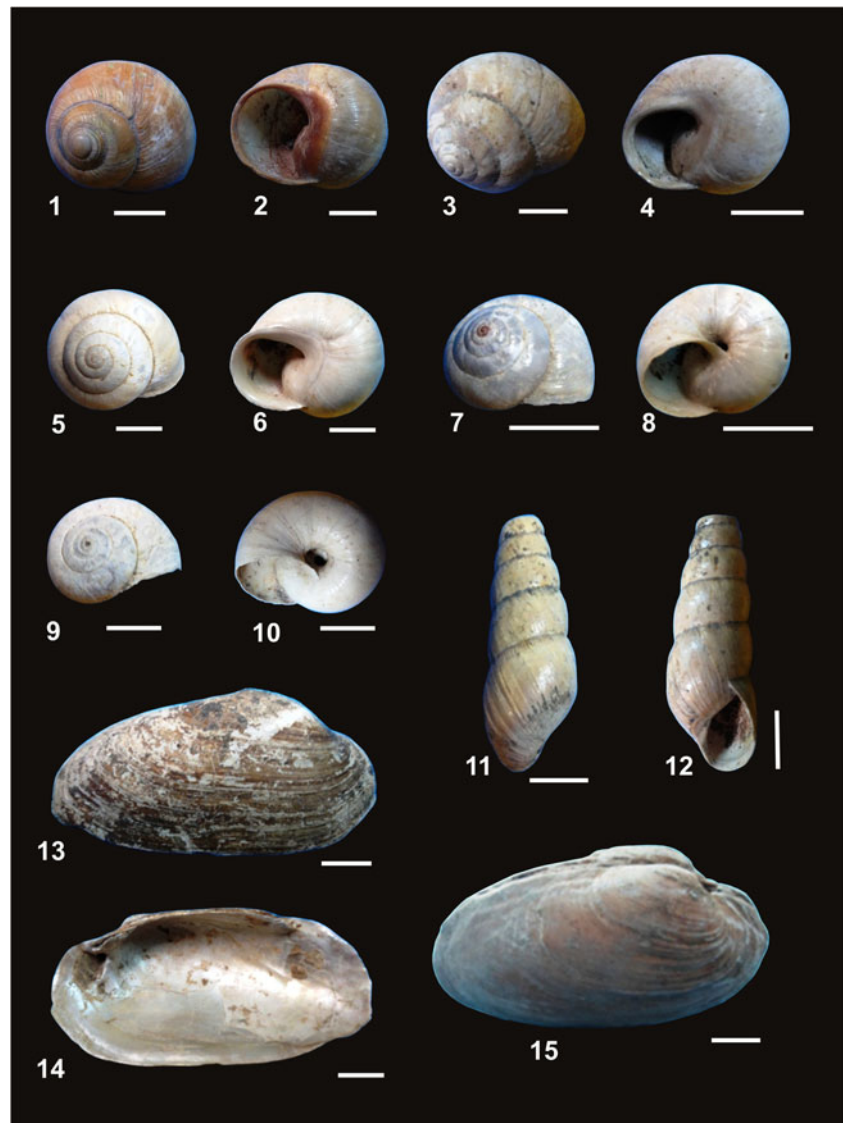
Seventy-nine individuals (22 from the Middle Pleistocene marls and 57 from the Late Pleistocene).

**Description**

Beige to whitish shell, fat, slightly convex on the spiral side and almost flattened on the aperture. The spire consists of five slightly convex whorls in which the first three have a faster growth and shallow sutures. The last whorl lowers sharply at the aperture which is flattened and very stretched. The labrum is blunt, little reflected, and completely overlapping the umbilicus. The columellar edge is elongated and widened.

**Dimensions:** width 22 to 30 mm, height 14 to 27 mm, and aperture from 7 to 11 mm.

**Fig. 4** 1 and 2 *Helix melanostoma* (Draparnaud, 1801); 3 and 4 *Sphincterochila baetica* (Rossmassler, 1854); 5 and 6 *Eobania vermiculata* (Müller, 1774); 7 and 8 *Cerņuella virgata* (Da Costa, 1778); 9 and 10 *Xerosecta cespitum* (Draparnaud, 1801); 11 and 12 *Rumina decollata* (Linnaeus, 1758); 13 and 14 *Unio ravoisieri* (Deshayes, 1847); and 15 *Unio ravoisieri* fossilized in the sediment of the Middle Pleistocene with welded valves. Scale bar = 10 mm



#### Geographical distribution and paleoecology

Typically Mediterranean (Morocco, Algeria, Tunisia, Spain, France, Italy, and Greece), *E. vermiculata* prefers calcareous rocks and dry locations. It is a thermophilic species, abundant in the shrub and brushy areas. It often protects itself against solar radiation hiding under vegetation or under stones. To aestivate, it settles on the trunk or branches of shrubs.

**Family:** Hygromiidae Tryon, 1866

**Genus:** *Cerņuella*, Schlüter, 1838

**Species:** *Cerņuella virgata* (Da Costa, 1778)

Fig. 4(7 and 8)

#### Synonymy

*Helix aglameta* J. Mabile, 1882

*Helix lutulenta* Locard, 1899

*Helix augustiniana* Bourguignat, 1880

*Helix balteata* Pollonera, 1892

#### Material

The MNI is respectively 1372 and 1844 (Fig. 5).

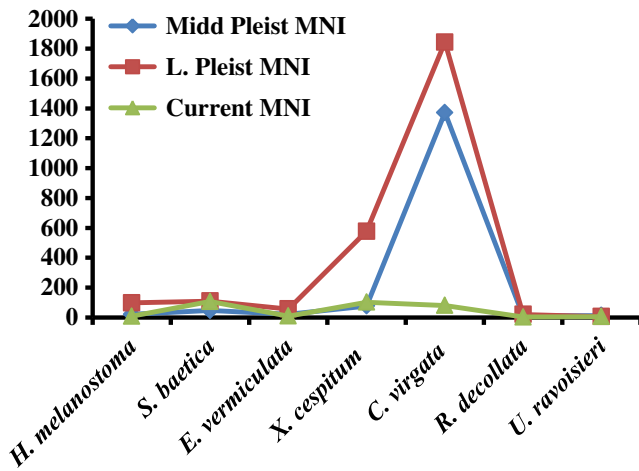
#### Description

Whitish gray shell, globular to relatively depressed form with tight longitudinal and well-marked striations. High spire formed by five to six convex whorls, the outer being large and rounded. The aperture is often circular, rarely oval, with a labial and flared edge. The columellar edge is curved and reflected on the deep and narrow umbilicus.

**Dimensions:** width 5 to 9 mm, height 3 to 6 mm, and aperture 3 to 7 mm.

#### Geographical distribution and paleoecology

Known from dry habitats, in sandy dunes and on calcareous substrates, linked to herbal plants, roadsides, cultivated fields, and railways. It is widespread in coastal regions of the Mediterranean Sea [Morocco, Algeria (Damerdjı 1990), Tunisia] and in the central and western European coasts from



**Fig. 5** Representation of the minimum number of individuals (MNI) of species of mollusks of the Oued Sarrat site in the Middle Pleistocene, Late Pleistocene, and present

Netherlands to Spain including the British Isles (Kerney et al. 1999; Manganelli et al. 1995; Gittenberger 1993).

**Species:** *Xerosecta cespitum* (Draparnaud, 1801)

Fig. 4(9 and 10)

#### Synonymy

*Helix cespitum* Draparnaud, 1801

#### Material

The minimum number of individuals equals to 77 in the Middle Pleistocene marls. In the Late Pleistocene, the MNI becomes more important and it reaches 577 individuals (Fig. 5).

#### Description

Whitish gray thin shell, slightly globular and flattened with a low spire and tight and well-marked longitudinal striations. The spire is formed by five to six not very convex whorls and with quite marked sutures. The last whorl is large and rounded or slightly keeled. The aperture is nearly round to slightly stretched with a sharp edge and a flared lip. The columellar edge is curved and reflected on the deep umbilicus, leaving an apparent part of the inner winding of the penultimate whorl.

**Dimensions:** width 8 to 25 mm, height 6 to 19 mm, and opening 5 to 10 mm.

*X. cespitum* is represented by minimum numbers of individuals equal to 77 and 577, respectively.

#### Geographical distribution and paleoecology

*X. cespitum* is frequent in wastelands, margins of roads, and arable fields and on rock rubble with grasses; it occurs but not commonly in mountains. This species is known from the western part of the Mediterranean basin, in Spain, Italy, Sardinia, Corsica and southern France, Belgium, in North Africa, and Morocco to Tunisia (Gargominy 2011).

**Family:** Subulinidae P. Fischer & Crosse, 1877

**Genus:** *Rumina* Risso, 1826

**Species:** *Rumina decollata* (Linnaeus, 1758)

Fig. 4(11 and 12)

#### Synonymy

*Helix decollata* Linnaeus, 1758;

*Bulimus decollatus* var. *truncata* Mousson 1854

*Rumina decollata* var. *saharica* Pallary 1901

#### Material

This species is represented by minimum numbers of individuals equal to 10 and 20, respectively.

#### Description

Elongated brownish beige shell with a spire consisting of four to six whorls, slightly convex. The last whorl larger than the others with more or less deep sutures. The apex, when observed (in very young specimen), is widely truncated. The test is more or less solid and ornamented of irregular slanting and longitudinal striations. The aperture is inclined and oval and the peristome is generally straight. The columella is fairly straight, sometimes slightly curved and truncated at the base. The umbilicus is completely covered.

**Dimensions:** height 45 mm, diameter 14 mm, and aperture 6 to 11 mm.

#### Geographical distribution and paleoecology

*R. decollata* is typical of several regions from northern and southern of the Mediterranean Sea. It occurs in dry areas but prefers humid microhabitats under rocks, grasses, and shrubs and at slopes, edge ditches, and past gardens (Issel 1914; Carr 2002).

**Family:** Unionidae Rafinesque, 1820

**Genus:** *Unio* Philipsson, 1788

**Species:** *Unio ravoisieri* (Deshayes, 1847)

Fig. 4(13 and 15)

#### Synonymy

*Unio ravoisieri* var. *issericus*, Kobelt, 1884

*Unio zenaticus* Letourneux & Bourguignat, 1887

*Unio seurati* Kobelt-Van Damme, 1984

#### Material

The minimum number of individuals varies between 13 and 6.

#### Description

Elongated whitish, equivalve and inequilateral shell with a prominent apex (umbo) and finely striated, characterized by isolated and few tubercles. The upper edge is rectilinear whereas the lower edge is generally arched with a sinuous depression. The posterior U-shaped edge is descending and narrow. The impressions of the anterior muscles are clearly separated; whereas, the posterior ones are not very marked with a lacking pallial sinus. On the left valve, the two lateral teeth are lamellar, often curved and sculpted. Both cardinal teeth are separated by a shallow dimple.

**Dimensions:** The length can exceed 100 mm. Average length 92, average height 46.5, average convexity 31 mm. The height/length ratio ( $L/H$ ) varies between 1.8 and 2.1.

#### Geographical distribution and paleoecology

In the Maghreb, this species colonizes not only the rivers of the northern Atlassic mountains (Khalloufi and Boumaïza

2005, 2007) but also the coastal rivers of the Atlantic and the Iberian Peninsula (Ghamizi 1998).

*U. ravoisieri* is known to colonize permanent and temporary water flows, with fast or slow current. It adapts at low to slightly high salinity (between 1 and 4 psu). It is currently found in association with fish of the *Cyprinidae* family (Khalloufi et al. 2011). This is confirmed in Oued Sarrat (Mtimet, thesis in progress).

### Quantitative analysis and malacofauna distribution

As shown in Fig. 3, the gathered malacofauna species from O. Sarrat span the Middle and Late Pleistocene. Higher, *E. vermiculata*, *R. decollata*, and *U. ravoisieri* reach the Holocene levels but are no longer documented above, while *H. melanostoma*, *S. baetica*, *X. cespitum*, and *C. virgata* are well known in present-day biotopes. Rare specimens of *U. ravoisieri* were found in sediments of a tributary of Oued Sarrat. This freshwater species is Holocene in age. A standardized quantitative study of Middle and Late Pleistocene mollusks is shown in Fig. 5.

In the Middle Pleistocene sediments, a clear spectrum dominance of *C. virgata* (1372 specimens, 88 %) and *X. cespitum* (77 individuals, 5 %) is easily noted. The unique bivalve species *Unio ravoisieri* is represented by only 13 specimens.

In the Late Pleistocene levels, *H. melanostoma*, *S. baetica*, *E. vermiculata*, *C. virgata*, *X. cespitum*, and *R. decollata* dominate. Within this assemblage, *C. virgata* (1844 individuals, 68 %), *X. cespitum* (577 individuals, 21 %), and *S. baetica* (110 individuals, 4 %) are highly represented. Compared to the Middle Pleistocene, *S. baetica* and mainly *H. melanostoma* become abundant but still less represented than the other Late Pleistocene accompanying species. The remaining components of the spectrum are scarce with 6 to 57 individuals. The bivalve species *U. ravoisieri* becomes notably scarce (6 individuals).

From this quantitative overview, in the Middle and Late Pleistocene, *Cernuella* and *Xerosecta* genera dominate the malacofauna spectrum in western Tunisia.

*S. baetica*, still scarce in Middle Pleistocene, became a little more abundant in Late Pleistocene. The species *C. virgata*, *X. cespitum*, and *S. baetica* that dominate the assemblage since the Middle Pleistocene characterize Mediterranean, hot and dry environments with rainy periods. These are xerothermic species known to live in dry and arid environments and bind strongly to herbaceous plants. The relative abundance of gastropods in the Middle and Late Pleistocene may indicate a phase of maximum development of vegetation in the region. Both species, *H. melanostoma* and *E. vermiculata*, are lowly represented; they would have had some difficulties to colonize natural habitat. Their low occurrence may be interpreted as due to human predation. Nevertheless, our available data are not sufficient enough to discuss this hypothesis considering

that such an activity is recorded for only upper Pleistocene times. In fact, these two species are closely related to human activities and anthropized environments (Magnin 1988b).

The abundance of pulmonate terrestrial gastropods corroborate the onset of lacustrine and/or continental with a possible post-mortem transport of gastropod shells by floods and fluvial channels. Some authors consider the Mediterranean climate is characterized by a hot dry summer with main rainfalls during autumn (e.g., Daget 1980). This would have taken an often stormy character, inducing a certain fragility of soil and vegetation cover (Collective 1984; Quézel and Médail 2003a, b).

The unique bivalve species *U. ravoisieri*, although very rare in Oued Sarrat, may characterize an openly subaquatic environment (freshwater), typically lakeside, with a relatively low energy or a landscape covered by a shallow paleolake, or over permanent or temporary waterway. The presence of welded valves of *U. ravoisieri* can be considered as witness of no transportation but an in situ fossilization (Fig. 4(15)).

### Conclusion

The mollusk assemblages of Oued Sarrat are first documented from a series of Middle-Late Pleistocene in NW Tunisia. This recently discovered site, rich in lithic and fossil material (vertebrates and invertebrates), fills a gap in our knowledge concerning the Middle and Late Pleistocene mollusk associations in Tunisia. Our assemblages include shells from both terrestrial and lacustrine and fluvial ecosystems indicating that, during Middle to Late Pleistocene times, the site of Oued Sarrat would have shown a landscape covered with swamp and forest or even a paleolake of shallow freshwater. In continuation of our previous work conclusions, this lake was powered by channels and, certainly, around the lake, there inhabited abundant different large mammal species, together with other small vertebrates and invertebrates that were consumed for human survival.

The present-work preliminary data gathered from this archeopaleontological site foreshadow the fact that the Oued Sarrat of NW Tunisia is still far from delivering all of its prehistorical secrets. Further researches may focus on linking the occurrence of these malacofauna with the human onset indexes as recently interpreted by Mtimet et al. 2014.

Some taxonomic attributions of Pleistocene mollusks are still a matter of debate among specialists. Future fieldwork would allow a wiser taxonomic revision based on more representative mollusk collections in central and southern Tunisia as well as from other Maghrebian countries. Paleobiological analyses of taxa morphological variations and stratigraphic distributions can be useful for wider paleobiogeographic interpretations aiming prehistorical and ecological reconstructions.

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