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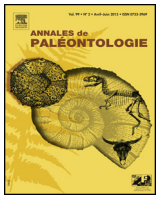

Original article

Systematics and taphonomy of Pliocene Gastropoda (Mollusca) from the Dahra Mountains, NW Algeria

Étude systématique et taphonomique des gastéropodes (Mollusque) pliocènes dans les Monts du Dahra, NO Algérie

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ABSTRACT

Palaeontological investigation of the Pliocene Tahria and Slama formations in the Lower Chelif Basin (NW Algeria) led us to collect significant gastropod assemblages for taxonomic and taphonomic purposes. There is presently a very complete inventory list of Pliocene gastropods from Algeria, with 16 species from the Zanclean Tahria Formation and 54 species from the Piacenzian Slama Formation, some of which are recorded for the first time from the Pliocene of the Mediterranean. The northwestern Algeria gastropods represent a shallow-water, fully marine fauna, sandy substrate, and show a typical Upper Pliocene Mediterranean assemblage. The gastropod shells show significant taphonomic alteration; most specimens are abraded and decalcified to a variable degree. Fragmentation was mainly a result of mechanical and biological processes. Bioerosion traces are uncommon, but when they are present, they are predominantly those of predatory gastropods (*Oichnus simplex* and *Oichnus paraboloides*), polychaete activity (*Maeandropolydora* isp.), and acrothoracican barnacle borings (*Rogerella* isp.). Integration of taphonomical, palaeoecological, and sedimentological characteristics of the gastropod-bearing beds suggests sedimentological concentrations originated from discontinuous processes of winnowing and bypassing sediments, most likely due to storm action in the shoreface depositional environment.

Mots clés :
Pliocène
Méditerranée
Algérie
Gastéropodes
Taxonomie
Taphonomie

RÉSUMÉ

L'étude paléontologique des formations de Tahria et de Slama dans la série du Pliocène supérieur du bassin du Bas Chélif (NO Algérie) nous a permis de recueillir d'importants assemblages de gastéropodes à des fins taxonomiques et taphonomiques. Il existe actuellement un inventaire très complet des gastéropodes pliocènes d'Algérie, avec 16 espèces dans la Formation de Tharia (Zancléen) et 54 espèces dans la Formation de Slama (Piacenzien), dont certaines sont enregistrées pour la première fois dans le Pliocène de la Méditerranée. Les gastéropodes du nord-ouest de l'Algérie représentent une faune d'eau peu profonde, entièrement marine, d'un substrat sableux, et montrent un assemblage typique du Pliocène supérieur de la Méditerranée. Les coquilles de gastéropodes présentent une altération taphonomique significative. De nombreux spécimens sont abrasés et décalcifiés à un degré variable. La fragmentation résulte essentiellement de mécanismes mécaniques et biologiques. Le phénomène de bioérosion est rare, mais quand il existe, il s'agit principalement des traces de gastéropodes prédateurs (*Oichnus simplex* et *Oichnus paraboloides*), de polychètes (*Maeandropolydora* isp.) et des perforations de balanes acrothoraciques (*Rogerella* isp.). L'intégration des caractéristiques taphonomiques, paléoécologiques et

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sédimentologiques des couches livrant les gastéropodes suggère que les assemblages fossiles sont des concentrations sédimentologiques dues aux processus de vannage et de contournement des sédiments, très probablement sous l'effet de l'action des tempêtes dans un environnement d'avant-plage.

1. Introduction

Neogene outcrops are widely dispersed throughout Algeria and well exposed over wide areas stretching across the Tell Atlas mountain ranges. In the Lower Chelif Basin (northwestern Algeria), these rocks have been mapped and studied since the end of the 19th century (e.g., Bleicher, 1875; Pomel, 1892; Brives, 1897). These investigations led to the first stratigraphic and palaeontological indices. Subsequent studies (e.g., Anderson, 1936; Dalloni, 1952; Perrodon, 1957; Gourinard, 1958; Delteil, 1974; Fenet, 1975; Guardia, 1975; Rouchy, 1982; Thomas, 1985; Neurdin-Trescartes, 1992; Belkebir et al., 1996, 2008; Meghraoui, 1988; BessediK et al., 2002; Atif et al., 2008; Belhadji et al., 2008; Mansour et al., 2008; Derder et al., 2013; Osman et al., 2021; Atik et al., 2024) refined the stratigraphic framework and examined the palaeogeographic and tectonic history of the Lower Chelif Basin.

Before the 21st century, the Lower Chelif's Pliocene series was little known, and its fauna was reported only in a few works (e.g., Perrodon, 1957). However, at the beginning of the 21st century, several studies dealt with the fauna, environmental assessment, and sedimentology of the Pliocene series: foraminifera (Atif et al., 2008; Mansour, 2004; Mazzola, 1971), dinoflagellates and calcareous nannofossils (Mansouri et al., 2008; Tchouar, 2013; Mansouri, 2021), bivalves (Satour, 2012, 2015; Satour et al., 2014; Benyoucef et al., 2021), ichnofossils (Bendella et al., 2021), and scaphopods (Benyoucef et al., 2022). The Pliocene gastropod assemblages from Algeria are still poorly known compared to the coeval faunas of the other *Mediterranean basins* (e.g., Granada, Almeria-Nijar and the Sorbas in southern Spain; Siena-Radicofani and Crotone in Italy); therefore, here we present a systematic taxonomic description of the gastropod shells collected from the Pliocene of the Lower Chelif Basin. The taphonomic processes of the gastropod shells are also discussed in the present work.

2. Geological background

The NNW-SSE to NW-SE Africa-Eurasia convergence is the main cause of the active tectonic zone that marks the North African region (Serpelloni et al., 2007). This convergence is accommodated over a wide deformation zone called the Tellian Atlas. This latter is characterised by E-W to NE-SW-oriented folds and thrust belts. It is made up of an "internal zone" with a thrust stack of Palaeozoic metamorphic complexes and Mesozoic calcareous and flysch, and an "external zone" (or Maghrebides) with rocks ranging from Mesozoic to Tertiary. The "external zone" is characterized by a series of intra-mountain Neogene basins, including the Constantine, Hodna, Soummam, Tizi-Ouzou, Mitidja, Medea, and Chelif basins. These basins are extended in an east-west direction and surrounded by the Tellian Atlas mountain belts, which serve as a substratum for their sedimentary covers (Perrodon, 1957; Thomas, 1985; Meghraoui, 1988). The Chelif Basin is located in the northwest of Algeria (Fig. 1A), wedged between the meridional and septentrional Tellian Atlas mountain belts (Fig. 1B). It shows evidence of Alpine tectonics, still active today (Meghraoui, 1988; Derder et al., 2013; Leprêtre et al., 2018). It forms a wide depression of over 450 km in length, fringing the Mediterranean basin, originating from the last stages of the Alpine Orogen and filled with Mio-Plio-Quaternary deposits (Perrodon, 1957). It is the largest (60 to 80 km wide) and the most subsident of the sublittoral basins (Perrodon, 1957; Thomas, 1985). The dimensions of the basin and the complexity of its hydrographic network have led several authors to divide it into three sub-basins: the Lower-, Middle-, and Upper-Chelif (e.g., Issaadi et al., 2021).

The study area is located on the northern side of the intramountain Lower Chelif Basin. The latter is bordered to the north by the northern Tellian Atlas, including the Oranian coastal mountain range. To the south, it is limited by the southern Tellian Atlas, which is represented by the Tessala Mountains, Ouled Ali Mountains, Beni Chougrane Mountains, and Ouarsenis Range (Fig. 1B). It constitutes one of the Neogene "post-thrust" basins located in northern Algeria, resulting from the distention that affected this area during the Lower-Middle Miocene (Thomas, 1985; Neurdin-Trescartes, 1992; Atif et al., 2008; Osman et al., 2021; Atik et al., 2024).

Stratigraphically, the "post-nappes" Lower Chelif Basin is filled by a Mio-Plio-Quaternary pile overlaying in diastrophic unconformity an ante-Neogene basement made of thrust sheets including allochthonous Cretaceous to Oligocene series (Anderson, 1936; Perrodon, 1957; Delteil, 1974). The complete Neogene sedimentary succession ranges from the Burdigalian to the Pliocene and can be subdivided into two main cycles, i.e., the Miocene and Pliocene sedimentary cycles. (1) The Miocene cycle is in turn subdivided into two phases: an early Miocene (Burdigalian) phase, transgressive and discontinuous on the Cretaceous substratum, consisting of conglomerates, sandstones, and dark marls commonly called "marnes bleues" ('blue marls'); and a late Miocene phase marked by a new transgression, followed by regression (Messinian salinity crisis). (2) The Pliocene cycle (or megasequence III of Neurdin-Trescartes, 1992) was deposited during the last compressional episode, coincident with the inversion of the border faults of the Chelif Basin and the formation of subthrust structural closures in the under thrust foreland. It starts with an abrupt marine transgression in the Upper Miocene series and terminates with the Upper Pliocene regression (Perrodon, 1957; Atif et al., 2008; Osman et al., 2021; Atik et al., 2024). Similar to the Zanclean "Trubi" facies of Italian authors (Tahria Formation of Anderson, 1936), the latest Messinian to Piacenzian sediments covering the Messinian gypsum beds in the centre of the Lower Chelif Basin (Sidi Brahim area) are characterised at their base by a reworking of these gypsum beds as conglomerates of gypsum blocks, the deposition of yellow sandy marlstones and grey marlstones, and finally of white marlstones (Atif et al., 2008). The Piacenzian strata are separated into the marine Slama Formation and the continental Hamri Formation (Anderson, 1936). The Slama Formation (Fig. 1C) is characterised by three sandstone packages ('grès astiens' of Perrodon, 1957) intercalated with grey to yellow sandy marlstones yielding benthic macro- and microfauna. Good outcrops are over the southwest flanks of the Dahra Mountains. The Quaternary deposits are made up of continental siliciclastic formations and are predominant in the wide plains.

The succession investigated belongs to the uppermost part of the Tahria Formation and to the Slama Formation, of the latest Zanclean-Piacenzian age (Mazzola, 1971; Tchouar, 2013; Osman et al., 2021; Atik et al., 2024), outcropping in the telegraph Sidi

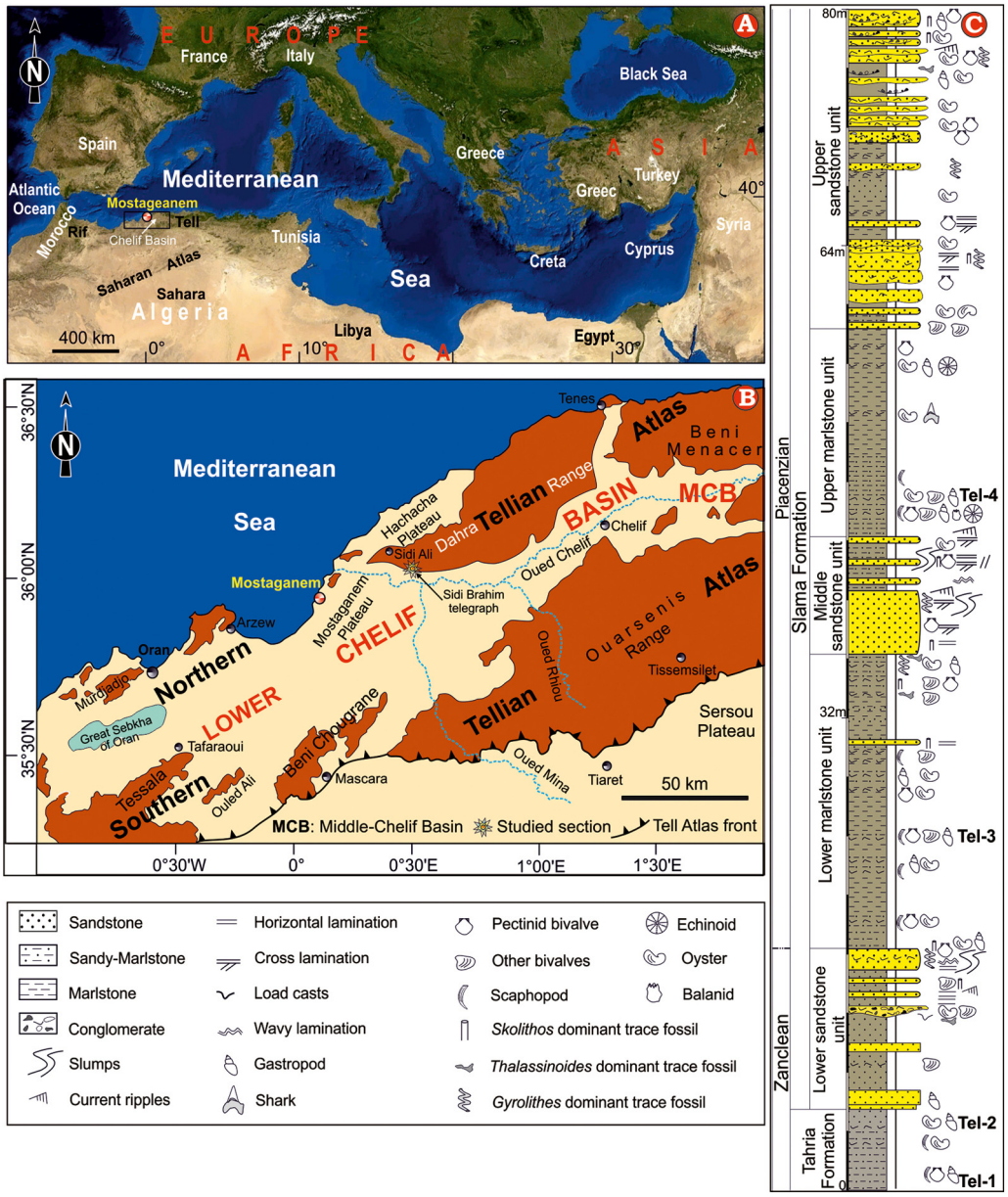

Fig. 1. Location and stratigraphy of the studied area. **A**. Location of the studied section within the Mediterranean Basin. **B**. Position of the studied section within northwestern Algeria. **C**. Measured lithostratigraphic section of the Pliocene in Sidi Brahim telegraph locality (Lower Chelif Basin) showing the position of the gastropod-bearing beds. *Localisation de la zone étudiée.* **A**. *Localisation de la coupe étudiée dans le bassin méditerranéen.* **B**. *Position de la coupe étudiée dans le nord-ouest algérien.* **C**. *Colonne lithostratigraphique de la succession pliocène dans le télégraphe de Sidi Brahim (Bassin du Bas Chelif) montrant la position des niveaux à gastéropodes.*

Brahim section (UMTS coordinates 35°59′41.33″N, 0°28′52.87″E). It is located some 40 kilometres east of Mostaganem city on the southwestern flanks of the Dahra Mountains and is bounded by Djebel Touares in the north, the arterial road CW 07 and Oued Chelif in the south, the agglomerations of Djebabra and Tehaimia in the east, and Chaâbat el Habria in the west (Figs. 1B and 2).

3. Material and methods

This study is based on newly collected gastropod material derived from the Sidi Brahim telegraph section belonging to the Lower Chelif Basin, on the southwestern edge of the Dahra Mountains, 20 kilometres from Sidi Ali town. Age estimates were obtained from analyses (foraminifera, dinoflagellates and calcareous nannofossils) on sediment samples from this section performed by Mazzola (1971), Tchouar (2013), Osman et al. (2021) and Atik et al. (2024). The fossiliferous marine Pliocene strata of the Lower Chelif Basin are characterised by an abundant macrobenthic fauna (e.g., bivalves, gastropods and tusk shells).

In total, 273 gastropod specimens were collected by surface sampling from four beds during two field expeditions in 2020. In addition, the material included approximately 4 kg of sediment samples collected along the richest bed (shell bed Tel-4). In the laboratory, the samples were wet-sieved (mesh sizes 0.5 mm, 1 mm, and 2 mm) in the Geomatics, Ecology and Environment Laboratory (Mustapha Stambouli University, Algeria) in order to sort fossils from matrix using a Euromex Dzet Optika ST-40-2L binocular loupe. Gastropod fossils were photographed in the Naturalis Biodiversity Center (Netherlands) on a Zeiss discovery V20, software Zeiss Zen V3.8, measured, and classified to genus and species level whenever possible. Gastropods were described according to morphological features, such as size and ornamentation.

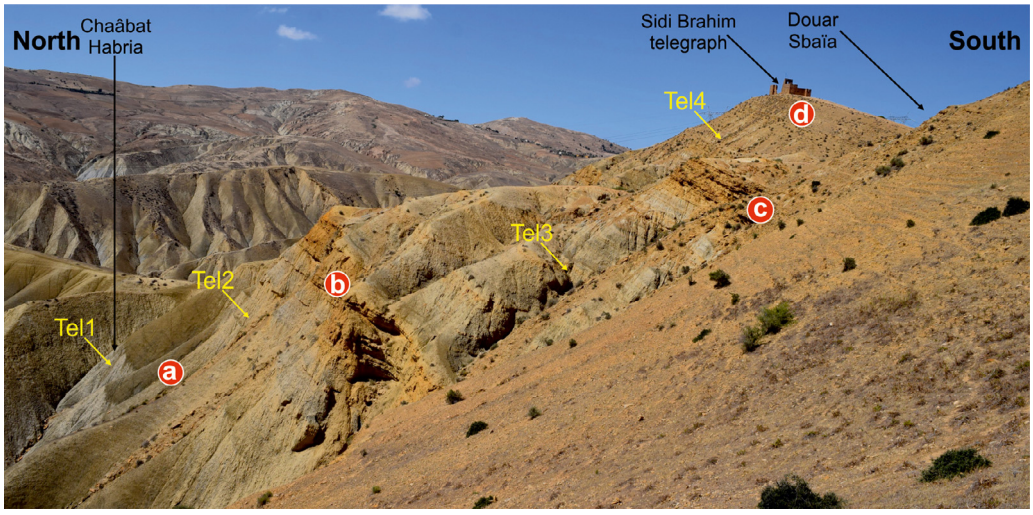

Fig. 2. Panoramic view of the telegraph Sidi Brahim section showing the upper part of the Tahria Formation (a) the Slama Formation (b, lower sandstone unit; c, middle sandstone unit; d, upper sandstone unit), and the sampling locations.
Vue panoramique de la coupe du télégraphe de Sidi Brahim présentant la partie supérieure de la Formation de Tahria (a), la Formation de Slama (b, unité des grès inférieurs ; c, unité des grès médians ; d, unité des grès supérieurs) et la position des échantillons.

The figured specimens are housed in the Natural History Museum Vienna, Austria (prefix NHMW 2024/0165). Additional materials are deposited in the palaeontological collections of the Geomatics, Ecology, and Environment Laboratory of the Mustapha Stambouli University, Algeria, under the acronym *LGEE-SB*.

4. Description of the studied section

The studied succession is easily recognised as horizontal or gently dipping resistant sandstone beds separated by greyish sandy marlstone. It covers the uppermost part of the Tahria Formation and most of the Slama Formation (Figs. 1C and 2). The upper Tahria Formation consists of greyish marlstone, which gradually pass upward to sandy marlstones, including gastropods (shell beds Tel-1 and Tel-2), scaphopods, cirripeds, oysters, and pectinids. The Slama Formation (60 to 75 m) is subdivided into five main informal lithostratigraphic units (Figs. 1C and 2).

4.1. Lower sandstone unit

This lithostratigraphic unit (10 m-thick) directly overlies the yellowish bioclastic sandy marlstones (5 m), which marks the transition between the uppermost part of the Tahria Formation and the lower part of the Slama Formation. It is an alternation of yellowish sandy marlstone and bioturbated, fine- to medium-grained sandstone beds ranging from 0.10 to 0.90 m in thickness, with interbedded thin shelly layers containing disarticulated pectinid and ostreid bivalves, gastropod fragments, and scaphopods. The marlstone intervals between the sandstone yield benthic foraminifera, coralline algae, bryozoan fragments, echinoid spines, and barnacle shells. Planar parallel laminations, low-angle cross-beddings, and current ripples can be observed in the bioturbated sandstone beds. Bioturbation consists of *Ophiomorpha* cf. *annulata* (Książkiewicz, 1977) and *Thalassinoides horizontalis* Myrow, 1995, *T. suevicus* (Rieth, 1932), *Skolithos linearis* Haldeman, 1840, *Gyrolites* isp., and *Palaeophycus* isp. (for more detail, see Bendella et al., 2021 and Benyoucef et al., 2021).

The sandy marlstone strata intercalated between the sandstones also contain foraminifera, dinoflagellate organic cysts, and nannofossils that were used by Mazzola (1971), Tchouar (2013), Osman et al. (2021), and Atik et al. (2024) to assign this unit to the Zanclean (Lower Pliocene).

4.2. Lower marlstone unit

This unit (22 m-thick) consists of greyish biodetrital marlstone intercalated with fine-grained sandstone and marly sandstone beds ranging from 0.10 to 0.30 m in thickness. Shell concentrations occur in the marlstone facies. They are rich in fragmented and abraded ostreid (*Ostrea edulis* Linnaeus, 1758), venerid, and pectinid valves, gastropods and scaphopod shells (shell bed Tel-3). Simple vertical and horizontal burrows [*Skolithos linearis* Haldeman, 1840 and *Thalassinoides paradoxicus* (Woodward, 1830)] are the most common bioturbation structures.

The basal part of the lower marlstone unit yielded foraminifera (Mazzola, 1971) and dinoflagellate cyst and nannoplankton assemblage (Tchouar, 2013; Osman et al., 2021; Atik et al., 2024) of Piacenzian (Upper Pliocene).

4.3. Middle sandstone unit

This unit (7 m) consists mainly of fine- to medium-grained, bioturbated sandstone and thin sandy marlstone strata. The interface of the sandstone beds commonly displays planar and parallel laminations, trough-cross stratifications, angular and tangential cross-bedding, and fluid escape structures. The most common trace fossils are the vertical simple burrows *Skolithos linearis* Haldeman, 1840 and *Conichnus conicus* Männil, 1966, and the chamber-shaped *Macanopsis* (for more detail, see Bendella et al., 2021).

4.4. Upper marlstone unit

This unit (13 m-thick) consists mainly of sandy marlstone interbeded with thin intercalations of fine-grained sandstone (0.25–0.30 m-thick) and shelly concentrations (0.20–0.40 m-thick). Sedimentary structures within the sandstone beds include parallel laminations, low-angle cross-bedding, mud-draped foresets, and internal erosional surfaces. Traces fossils are represented by *Arenicolites* isp., *Gyrolithes polonicus* Fedonkin, 1981, *Gyrolithe variabilis* Mayoral and Muñiz, 1995, *Macaronichnus segregatis* Clifton and Thompson, 1978, and *Skolithos linearis* (for more detail, see Bendella et al., 2021). The lower part of the upper marlstone unit is intercalated with a very poorly sorted coquina-rudstone (shell bed Tel-4) resting on an irregular erosion surface. This concentration can be traced over a continuous lateral distance of several hundred metres.

It contains abundant disarticulated bivalves and gastropods (Tel-4) and less abundant scaphopods, small solitary corals, bryozoans, calcareous algae, and barnacles. A significant proportion of shells is broken and abraded. The matrix of the coquina is predominantly composed of moderately sorted, sand-size skeletal bioclasts (fragments of bivalves, gastropods, echinoids, bryozoans, ostracods, as well as benthic foraminifers).

4.5. Upper sandstone unit

This unit (20 m) is made of an alternation of gravelly sandstone, bioturbated shelly sandstone, and shelly pebbly sandstone. Shells are dominated by pectinids, oysters, and gastropod moulds (*Cochlis* sp.). Bioturbation consists of *Ophiomorpha nodosa* Lundgren, 1891, *Ophiomorpha* cf. *irregulaire* Frey et al., 1978, *Thalassinoides horizontalis*, *Gyrolithes polonicus* Fedonkin, 1981 and *Skolithos* isp. The topmost part of the section shows a sandstone level rich in perforated shells (e.g., borings of the ichnogenra *Oichnus*, *Entobia*, and *Meandropolydora*) of *Ostrea edulis*.

5. Taphonomic features of the gastropod assemblages

The shell concentrations yielding gastropods show a mixture of both whole shells and unidentified fragments of varying sizes. They form beds with a thickness of less than 50 cm. They show evidence of significant taphonomic alteration such as fragmentation (Fig. 3A–F), abrasion, disarticulation, decalcification, and bioerosion (Fig. 3G–L).

5.1. Fragmentation

Fragmentation of shells is one of the most frequent types of taphonomic modifications. It plays a significant role in a variety of modern and fossil marine benthic ecosystems. It is potentially derived from numerous physical and biological factors, including predation (Zuschin et al., 2003), and can be related to high-energy settings such as beaches and tidal channels (Parsons and Brett, 1991).

Given that the palaeoenvironment has been influenced by strong currents (Benyoucef et al., 2021), physical agents are thought to be among the factors influencing the fragmentation of shells in the study area. An important part of shell fragmentation is also due to predation.

5.2. Abrasion

Abrasion of shells is another significant taphonomic process, probably related to shell degradation (Kotzian and Simões, 2006). It is associated with physical transport and biological mechanisms. It is possible when the predator uses its shell to abrade the shelled prey (Glaub et al., 2007). The examined gastropods exhibit signs of mechanical abrasion in the form of mottling on the shell surface and smooth facets without ornamentation in some areas of the shell.

5.3. Disarticulation of bivalve shells

According to Allen (1992), bivalve shells can be sensitive markers of rapid, episodic sediment accumulation. An organism's fragility, environmental energy, temperature, oxygen content, and residence time on the seafloor all affect how quickly its skeleton breaks down after death (Brett, 2003). A reliable measure of the relative exposure time or energy of the depositional environment is the degree of disarticulation. For the investigated shell concentrations bearing gastropods, about 95% of the accompanying bivalve shells are disarticulated (Benyoucef et al., 2021).

5.4. Bioerosion

In the present study, endolithic trace fossils were documented from some gastropod specimens and were attributed to either endobionts (e.g., sponges) or predators (e.g., naticid gastropods). We were able to recognise the following bioerosion *ichnotaxa*:

Maeandropolydora isp. Voigt, 1965 (Fig. 3G–I)

This trace occurs as long, U-shaped pouch-extending, sometimes branched, shallow, and sinuous grooves. Pouches tend to run parallel to a tendency for a symmetrical mode of growth.

Maeandropolydora is found in many different calcareous hard substrates, including mollusc shells. It is produced by polychaete annelids belonging to different families, mostly of the family Spionidae (Bromley and d'Alessandro, 1983; Farinati and Zavala, 2002).

Rogerella Saint-Seine, 1956 (Fig. 3J)

In addition to having an extended distal portion and an elliptical contour, *Rogerella* sp. can also occasionally have a round or conical proximal portion.

Rogerella has been described in many carbonate substrates (shells and hardgrounds) from the Upper Ordovician to recent (Taylor and Wilson, 2003). Today, it is produced by acrothoracican barnacles, most of which do not have an external skeleton (e.g., Chan et al., 2021); thus, they bore in calcareous hard substrates and form dwelling traces (domichnia; Wisshak et al., 2019; Mikuláš et al., 2022).

Oichnus simplex Bromley, 1981 (Fig. 3K)

This trace exhibits smooth, vertical, isolated circular to subcircular holes with an axis more or less perpendicular to the substrate surface; the diameters of these holes range from 1.2 to 1.5 mm.

Oichnus paraboloides Bromley, 1981 (Fig. 3L)

This trace is an elliptical boring that presents an abrupt change in diameter, comprising a narrow diameter boring in the center (internally) of a larger diameter boring (externally). The margins of the boring are curved.

The borings assigned to *Oichnus* are in fact interpreted as predation traces, produced mostly by naticid or muricid gastropods (Bromley, 1981).

6. Taxonomic inventory of gastropods

In this study, 62 species of gastropods (Figs. 4–8) are reported and illustrated. Five species are determined to a generic level due to poor preservation.

Bittium reticulatum (Da Costa, 1778)

Fig. 4A

*1778 *Strombiformis reticulatum* Da Costa, p. 117, pl. 8, fig. 13.

2004 *Bittium reticulatum* (Da Costa, 1778) – Landau et al., p. 12, pl. 2, figs. 4–5 (*cum syn.*).

Material: Maximum height 3.3 mm, width 1.2 mm. Tel-4: NHMW 2024/0165/0042 (1 specimen), *LGEE-SB* (42 specimens and fragments), Slama Formation, Piacenzian.

Discussion: For discussion, see Landau et al. (2004, p. 12).

Distribution: Lower Pliocene to present-day. Iberian Atlantic coast southwards to Canary Islands and Mediterranean (Landau et al., 2004, p. 12). Miocene records so far checked are misidentifications (BL personal data).

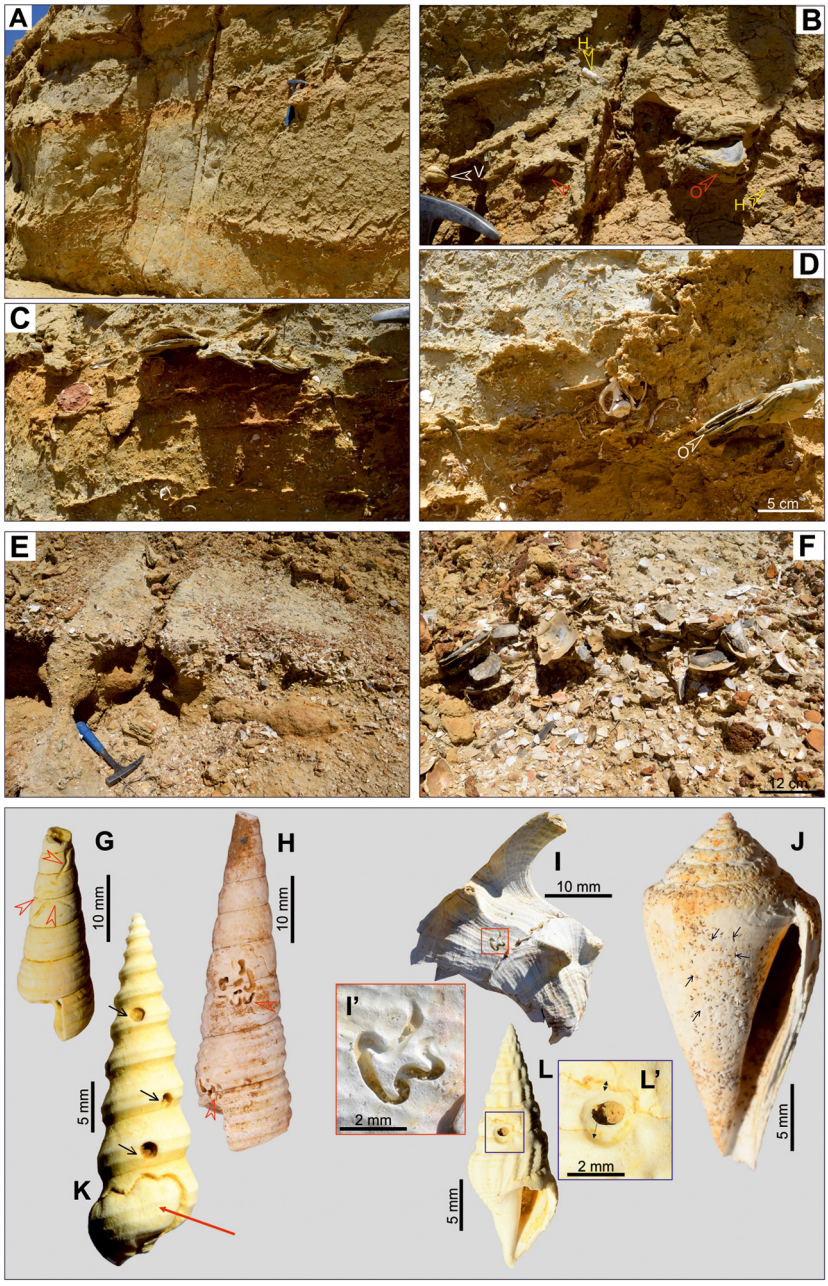

Fig. 3. Outcrop pictures of the Slama Formation and traces of boring organisms in gastropod fauna. **A–D**. Channelised shelly thin layers interbedded in sandy marlstone, showing erosive base, broken and size-graded bivalve and gastropod shells (lower sandstone unit; H, *Helminthia vermicularis* (Brocchi); O, *Ostrea edulis* Linnaeus, V, *Venus nux* (Gmelin, 1791)). **E–F**. Bivalve-dominated unstructured coquina layer interbeded within the lowermost part of the upper marlstone unit. Note the high concentration of shells. **G–H**. Polychaete trace *Maeandropolydora* Voigt, 1965 on gastropods (*Helminthia vermicularis*). I. Fragment of *Bolinus brandaris torularius* (Lamarck, 1822) with Polychaete trace *Maeandropolydora* Voigt, 1965. **J**. Acrothoracican barnacle traces *Rogerella* Saint-Seine, 1956 on *Varioconus striatulus* (Brocchi, 1814). **K**. *Mesalia cochleata* (Brocchi, 1814) showing predator gastropod drill hole *Oichnus simplex* Bromley, 1981 (black arrows). Note that the last whorl of the gastropod specimen had damage (red arrow) due to a crab predation making irregular breakage of the shell. **L**. *Crassispira leonardiana* Ceregato and Della Bella, 2004 with *Oichnus paraboloides* Bromley, 1981 trace.
Photos de terrain présentant la Formation de Slama et les traces de bioérosion sur les coquilles de gastéropodes. **A–D**. *Concentrations coquillières minces intercalées dans des marnes sableuses, présentant une base érosive, des coquilles de bivalves et de gastéropodes cassées (unité des grès inférieurs ; H,* Helminthia vermicularis *(Brocchi) ; O,* Ostrea edulis *Linnaeus, V,* Venus nux *(Gmelin, 1791)).* **E–F**. *Couche coquillière riche en bivalves intercalée dans la partie basale de l'unité des marnes supérieures. Notons la haute concentration des coquilles.* **G–H**. *Traces de* Maeandropolydora *Voigt, 1965 sur des gastéropodes (*Helminthia vermicularis*).* **I**. *Fragment de* Bolinus brandaris torularius *(Lamarck, 1822) présenant des traces de* Maeandropolydora *Voigt, 1965.* **J**. *Traces de* Rogerella *Saint-Seine, 1956 sur* Varioconus striatulus *(Brocchi, 1814).* **K**. Mesalia cochleata *(Brocchi, 1814) présentant des traces d'*Oichnus simplex *Bromley, 1981 (flèches). Notez que le dernier verticille du spécimen de gastéropode a été endommagé (flèche rouge) par la prédation d'un crabe qui a provoqué une rupture irrégulière de la coquille.* **L**. Crassispira leonardiana *Ceregato et Della Bella, 2004 avec* Oichnus paraboloides *Bromley, 1981*.

Helminthia triplicata (Brocchi, 1814)
Fig. 4B

*1814 *Turbo triplicatus* Brocchi, p. 368, pl. 4, fig. 14.

2021 *Helminthia triplicata* (Brocchi, 1814) – Dominici and Forli, p. 16, pl. 1, figs. 10–14 (*cum syn.*).

Material: Maximum height 45.7 mm, width 13.5 mm. Tel-1: (3 incomplete specimens), Tahria Formation, Zanclean. Tel-4: NHMW 2024/0165/0007 (1 specimen), *LGEE-SB* (28 specimens and fragments), Slama Formation, Piacenzian.

Discussion: *Turbo triplicatus* Brocchi, 1814 is attributed to the genus *Helminthia* Handmann, 1882, based on the order of appearance of the spiral cords and the presence of fine spiral threads covering the primary cords (see genus-level diagnosis in Landau et al., 2013, p. 63). Dominici and Forli (2021) discussed the

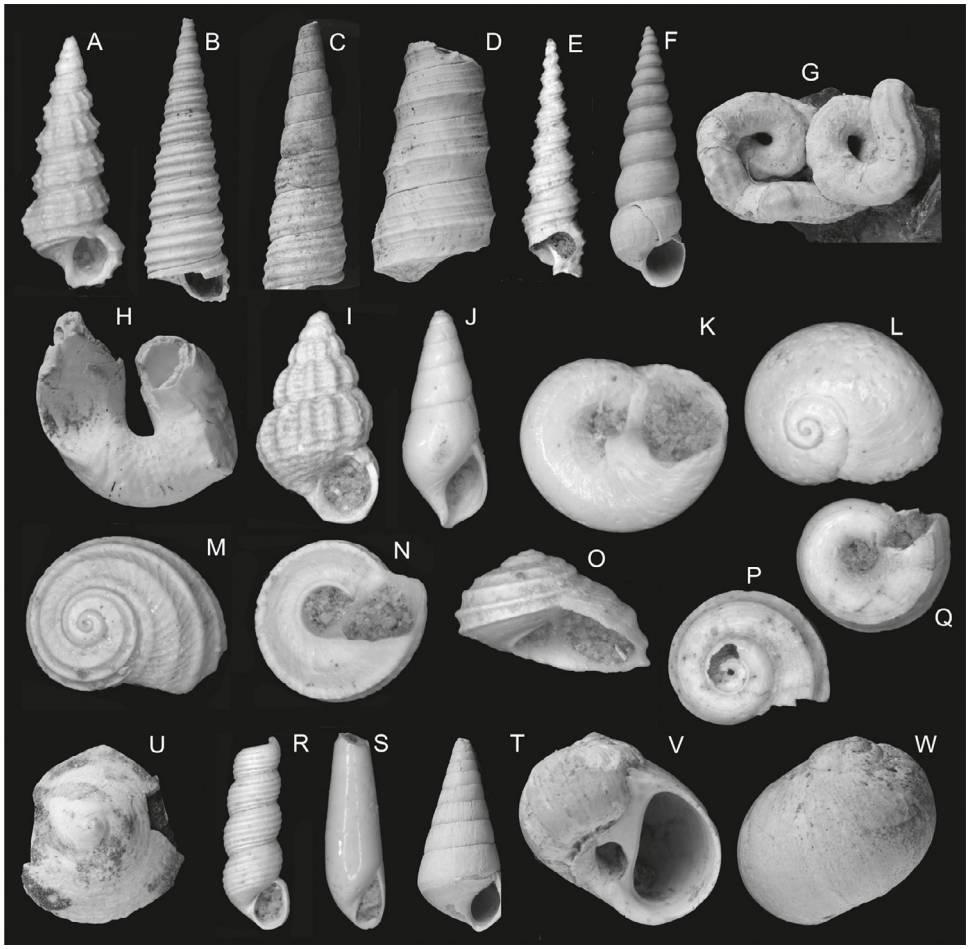

Fig. 4. Gastropod taxa from the Pliocene of the Lower Chelif Basin. **A**. *Bittium reticulatum* (Da Costa, 1778) (height 3.3 mm, width 1.2 mm, NHMW 2024/0165/0042). **B**. *Helminthia triplicata* (Brocchi, 1814) (height 45.7 mm, width 13.5 mm, NHMW 2024/0165/0007). **C**. *Helminthia vermicularis* (Brocchi, 1814) (height 34.3 mm, width 10.2 mm, NHMW 2024/0165/0008). **D**. *Oligodia spirata* (Brocchi, 1814) (height 38.6 mm, width 12.8 mm, NHMW 2024/0165/0009). **E**. *Turritellinella tricarinata* (Brocchi, 1814) (size 6.7 mm × 1.7 mm, NHMW 2024/0165/0056). **F**. *Mesalia cochleata* (Brocchi, 1814) (height 24.4 mm, width 7.0 mm, NHMW 2024/0165/0010). **G**. *Petaloconchus intortus* (Lamarck, 1818) (size 8.0 mm × 8.0 mm, NHMW 2024/0165/001). **H**. *Thylacodes arenarius* (Linnaeus, 1758) (size 21.6 mm × 10.2 mm, NHMW 2024/0165/0012). **I**. *Alvania* cf. *lanciae* (Calcara, 1845) (height 3.2 mm, width 1.8 mm, NHMW 2024/0165/0054). **J**. *Rhombostoma carmelae* (Brugnone, 1873) (height 3.8 mm, width 1.5 mm, NHMW 2024/0165/0034). **K–L**. *Teinostoma minutum* (Conti, 1864) (size 1.3 mm × 1.1 mm, NHMW 2024/0165/0055). **M–O**. *Tornus pedemontanus* Pavia, 1980 (size 2.4 mm × 1.2 mm, NHMW 2024/0165/0035). **P–Q**. *Circulus striatus* (Philippi, 1836) (size 2.0 mm × 1.7 mm NHMW 2024/0165/0036). **R**. *Aclis* sp. (height 3.3 mm, width 1.1 mm, NHMW 2024/0165/0043). **S**. *Eulima* sp. (height 3.7 mm, width 1.1 mm, NHMW 2024/0165/0044). **T**. *Niso eburnea* Risso, 1826–1827 (height 14.7 mm, width 6.7 mm, NHMW 2024/0165/0013). **U**. *Calyptraea chinensis* (Linnaeus, 1758) (height 7.6 mm, width 17.1 mm, NHMW 2024/0165/0014). **V–W**. *Natica virguloides* Sacco, 1890 (height 20.2, width 23.4 mm, NHMW 2024/0165/0058).

Gastéropodes pliocènes du Bassin du Bas Chelif. **A**. Bittium reticulatum *(Da Costa, 1778)* (height *3,3 mm*, width *1,2 mm, NHMW 2024/0165/0042)*. **B**. Helminthia triplicata *(Brocchi, 1814)* (height *45,7 mm*, width *13,5 mm, NHMW 2024/0165/0007)*. **C**. Helminthia vermicularis *(Brocchi, 1814)* (height *34,3 mm*, width *10,2 mm, NHMW 2024/0165/0008)*. **D**. Oligodia spirata *(Brocchi, 1814)* (height *38,6 mm*, width *12,8 mm, NHMW 2024/0165/0009)*. **E**. Turritellinella tricarinata *(Brocchi, 1814)* (size *6,7 mm × 1,7 mm, NHMW 2024/0165/0056)*. **F**. Mesalia cochleata *(Brocchi, 1814)* (height *24,4 mm*, width *7,0 mm, NHMW 2024/0165/0010)*. **G**. Petaloconchus intortus *(Lamarck, 1818)* (size *8,0 mm × 8,0 mm, NHMW 2024/0165/001)*. **H**. Thylacodes arenarius *(Linnaeus, 1758)* (size *21,6 mm × 10,2 mm, NHMW 2024/0165/0012)*. **I**. Alvania *cf.* lanciae *(Calcara, 1845)* (height *3,2 mm*, width *1,8 mm, NHMW 2024/0165/0054)*. **J**. Rhombostoma carmelae *(Brugnone, 1873)* (height *3,8 mm*, width *1,5 mm, NHMW 2024/0165/0034)*. **K–L**. Teinostoma minutum *(Conti, 1864)* (size *1,3 mm × 1,1 mm, NHMW 2024/0165/0055)*. **M–O**. Tornus pedemontanus *Pavia, 1980* (size *2,4 mm × 1,2 mm, NHMW 2024/0165/0035)*. **P–Q**. Circulus striatus *(Philippi, 1836)* (size *2,0 mm × 1,7 mm NHMW 2024/0165/0036)*. **R**. Aclis *sp.* (height *3,3 mm*, width *1,1 mm, NHMW 2024/0165/0043)*. **S**. Eulima *sp.* (height *3,7 mm*, width *1,1 mm, NHMW 2024/0165/0044)*. **T**. Niso eburnea *Risso, 1826–1827* (height *14,7 mm*, width *6,7 mm, NHMW 2024/0165/0013)*. **U**. Calyptraea chinensis *(Linnaeus, 1758)* (height *7,6 mm*, width *17,1 mm, NHMW 2024/0165/0014)*. **V–W**. Natica virguloides *Sacco, 1890* (height *20,2*, width *23,4 mm, NHMW 2024/0165/0058)*.

relationship between *H. vermicularis* and *H. triplicata* Brocchi, 1814, both allegedly collected from the same outcrops at San Miniato, in northern Tuscany, Italy. *Helminthia vermicularis* was said to differ from *H. triplicata* in having four cords instead of three, the abapical being lightly smaller than the others, but clearly detached from the suture. Those authors concluded that the two forms did not occur together and could represent distinct chronospecies: *H. triplicata* occurring in the middle Miocene Paratethys and Proto-Mediterranean Piedmont (Italy), and into the Zanclean of the Rhone Valley (France) and southern Tuscany (Italy). *Helminthia vermicularis* appeared at the Zanclean-Piacenzian boundary and disappeared at the end of the Pliocene. However, it seems that both forms coexisted in the Pliocene of Algeria.

Distribution: Lower and Middle Miocene Paratethys and Proto-Mediterranean. Upper Miocene to Lower Pliocene Mediterranean (Dominici and Forli, 2021), Upper Pliocene (this paper).

Helminthia vermicularis (Brocchi, 1814)

Fig. 4C

*1814 *Turbo vermicularis* Brocchi, p. 372, pl. 6, fig. 13.

2010 *Helminthia vermicularis* (Brocchi, 1814) – Dominici and Forli, p. 64, pl. 5, fig. 15 (*cum syn.*).

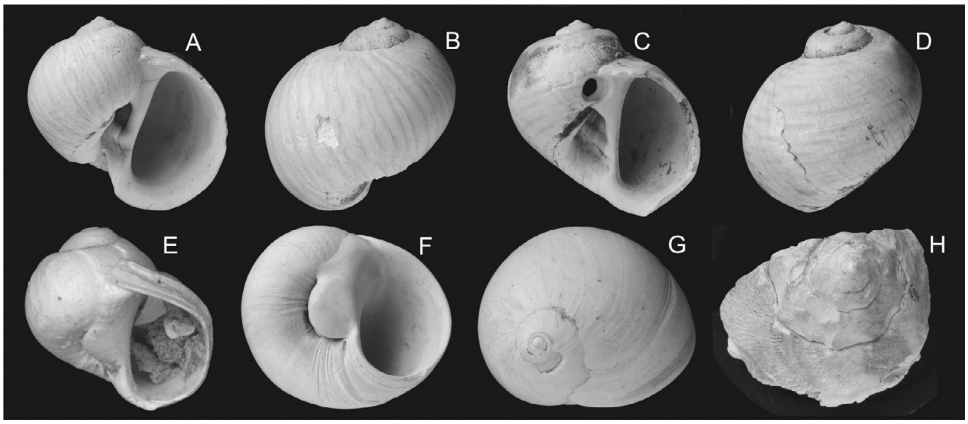

Fig. 5. Gastropod taxa from the Lower Chelif Basin. **A–B**. *Cochlis propinqua* (Pecchioli, 1864) (height 17.1 mm, width 19.3 mm, NHMW 2024/0165/0060). **C–D**. *Cochlis raropunctata* (Sasso, 1827) (height 23.2 mm, width 23.0 mm, NHMW 2024/0165/0059). **E**. *Tectonatica tectula* (Sacco, 1890) (height 4.4 mm, width 4.5 mm, NHMW 2024/0165/0041). **F–G**. *Neverita olla* (de Serres, 1829) (height 19.3 mm, width 24.4, NHMW 2024/0165/0015). **H**. *Aspidophoreas infundibulum* (Brocchi, 1814) (height 21.5 mm, width 24.3 mm, NHMW 2024/0165/0061).
Gastéropodes pliocènes du Bassin du Bas Chelif. **A–B**. Cochlis propinqua *(Pecchioli, 1864)* (height *17,1 mm,* width *19,3 mm, NHMW 2024/0165/0060).* **C–D**. Cochlis raropunctata *(Sasso, 1827)* (height *23,2 mm,* width *23,0 mm, NHMW 2024/0165/0059).* **E**. Tectonatica tectula *(Sacco, 1890)* (height *4,4 mm,* width *4,5 mm, NHMW 2024/0165/0041).* **F–G**. Neverita olla *(de Serres, 1829)* (height *19,3 mm,* width *24,4, NHMW 2024/0165/0015).* **H**. Aspidophoreas infundibulum *(Brocchi, 1814)* (height *21,5 mm,* width *24,3 mm, NHMW 2024/0165/0061).*

Material: Height 34.3 mm, width 10.2 mm. Tel-2: *LGEE-SB* (1 incomplete specimen), Tahria Formation, Zanclean. Tel-4: NHMW 2024/0165/0008 (1 incomplete specimen), *LGEE-SB* (1 incomplete specimen), Slama Formation, Piacenzian.

Discussion: One specimen from Algeria clearly has four low spiral cords and is typical of the *vermicularis* form. See discussion above under *H. triplicata* (Brocchi, 1814).

Distribution: According to Dominici and Forli (2021), this species appears at the Zanclean-Piacenzian boundary and disappeared at the end of the Pliocene (Dominici and Forli, 2021).

Oligodia spirata (Brocchi, 1814)
Fig. 4D
*1814 *Turbo spiratus* Brocchi, p. 369, pl. 6, fig. 19.
2016 *Oligodia spirata* (Brocchi, 1814) – Van Dingenen et al., p. 120, pl. 3, fig. 8 (*cum syn.*).

Material: Maximum height 38.6 mm, width 12.8 mm. Tel-3: NHMW 2024/0165/0009 (1 incomplete specimen), *LGEE-SB* (4 incomplete specimens), Slama Formation, Piacenzian. Lower Chelif Basin: *LGEE-SB* (7 incomplete fragments).

Discussion: The Algerian specimens are of the *spirata* morphotype with a strongly developed cord B, giving an angular whorl profile, and the secondary cords are always much weaker. For discussion, see Van Dingenen et al. (2016, p. 120).

Distribution: Middle Miocene to Pliocene Eastern Atlantic Frontage from France southwards into Mediterranean, where it disappears after the Lower Pleistocene (Van Dingenen et al., 2016).

Turritellinella tricarinata (Brocchi, 1814)
Fig. 4E
*1814 *Turbo tricarinatus* Brocchi, p. 374, pl. 6, fig. 21.
2004 *Turritella tricarinata* (Brocchi, 1814) – Landau et al., p. 19, pl. 2, fig. 13, pl. 3, fig. 9 (*cum syn.*).

Material: Size 6.7 mm × 1.7 mm (incomplete). Tel-2: NHMW 2024/0165/0056 (1 juvenile specimen), *LGEE-SB* (12 fragments), Tahria Formation, Zanclean.

Discussion: For discussion, see Landau et al. (2004, p. 20).

Distribution: Widespread along the Eastern Atlantic Frontage and Mediterranean during the Lower Pliocene to the present day. Today northeastern Atlantic to North Africa and into the Mediterranean (Landau et al., 2004). Paratethyan Miocene records are not for this species (Harzhauser and Landau, 2019).

Mesalia cochleata (Brocchi, 1814)
Fig. 4F
*1814 *Turbo cochleatus* Brocchi, p. 373, pl. 6, fig. 17.
2013 *Mesalia cochleata* (Brocchi, 1814) – Landau et al., p. 64, pl. 5, figs. 12–14, pl. 55, fig. 9 (*cum syn.*).

Material: Maximum height 24.4 mm, width 7.0 mm. Tel-2: *LGEE-SB* (1 specimen), Tahria Formation, Zanclean. Tel-4: NHMW 2024/0165/0010 (1 specimen), Slama Formation, Piacenzian.

Discussion: The genus *Mesalia* Gray, 1847 is characterised by its rounded aperture and sinuous outer lip. For full discussion, see Landau et al. (2013, p. 64).

Distribution: Lower Miocene to Pliocene eastern Atlantic Frontage and Proto-/Mediterranean (Landau et al., 2013).

Petaloconchus intortus (Lamarck, 1818)
Fig. 4G
*1818 *Serpula intortus* Lamarck, p. 365.
2016 *Petaloconchus intortus* (Lamarck, 1818) – Van Dingenen et al., p. 155, pl. 13, fig. 7 (*cum syn.*).

Material: Size 8.0 mm × 8.0 mm. Tel-2: NHMW 2024/0165/0011 (1 specimen), *LGEE-SB* (1 specimen), Tahria Formation, Zanclean.

Discussion: Replaced today by *Petaloconchus glomeratus* (Linnaeus, 1758) that differs in details of the protoconch. For discussion, see Van Dingenen et al. (2016, p. 155).

Distribution: Widespread in the European Lower Miocene to Pleistocene (Van Dingenen et al., 2016).

Thylacodes arenarius (Linnaeus, 1758)
Fig. 4H
*1758 *Serpula arenaria* Linnaeus, p. 1266.
2013 *Tylacodes* [*sic*] *arenarius* (Linnaeus, 1758) – Landau et al., p. 65, pl. 5, fig. 16 (*cum syn.*).

Material: Size 21.6 mm × 10.2 mm. Tel-2: NHMW 2024/0165/0012 (1 incomplete specimen), *LGEE-SB* (1 incomplete specimen), Tahria Formation, Zanclean.

Discussion: The Algerian material is relatively worn but retains the pustulose surface sculpture typical for the species. For

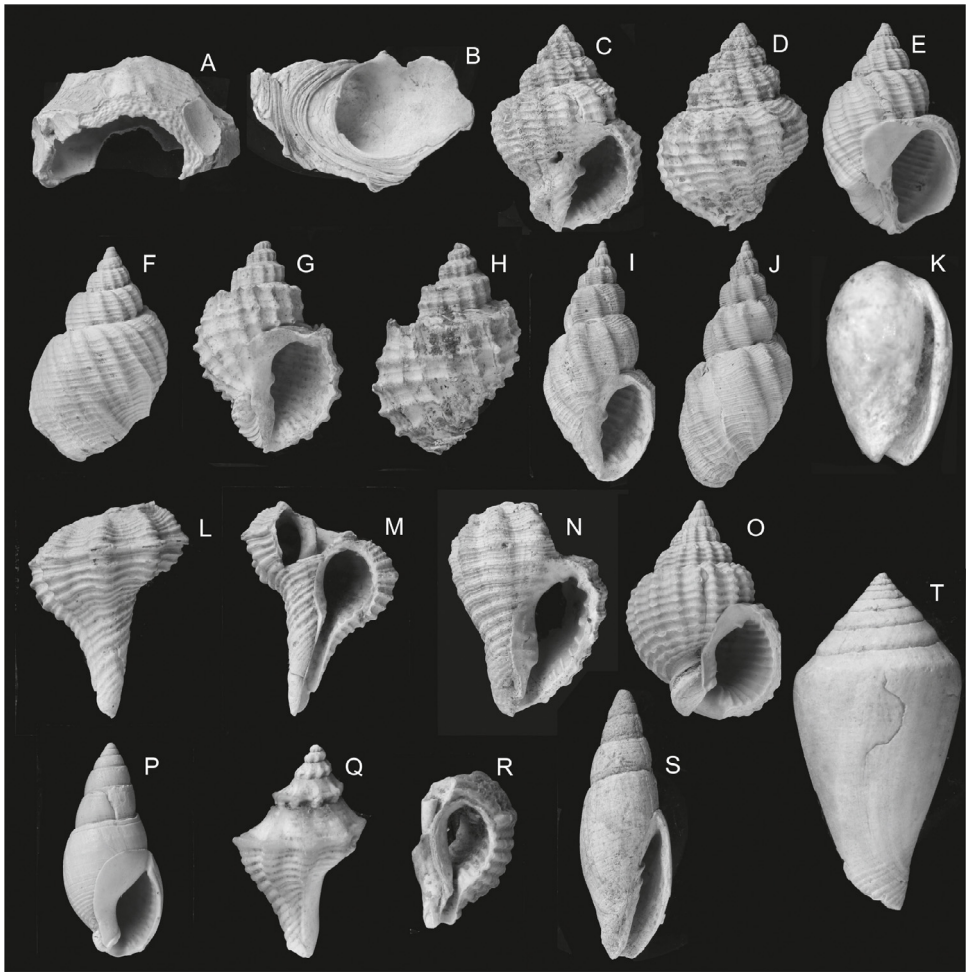

Fig. 6. Gastropod taxa from the Lower Chelif Basin. **A–B**. *Xenophora crispa* (König, 1825) (length 25 mm, NHMW 2024/0165/0057). **C–D**. *Bivetiella cancellata* (Linné, 1767) (height 22.1 mm, width 14.8 mm, NHMW 2024/0165/0016). **E–F**. *Contortia italica* (D'Ancona, 1872) (height 18.5 mm, width 11.7 mm, NHMW 2024/0165/0017). **G–H**. *Solatia hirta* (Brocchi, 1814) (height 22.3 mm, width 14.5 mm, NHMW 2024/0165/0018). **I–J**. *Sveltia varicosa* (Brocchi, 1814) (height 32.3 mm, width 13.6 mm, NHMW 2024/0165/0019). **K**. *Gibberula epigrus* (Reeve, 1864–1865) (height 5.5 mm, width 3.4 mm, NHMW 2024/0165/0040). **L–M**. *Pseudofusus rostratus* (Olivi, 1792) (height 15.7 mm, width 11.3 mm, NHMW 2024/0165/0020). **N**. *Aplus nilus* (De Gregorio, 1884) (height 15.6 mm, width 11.3 mm, NHMW 2024/0165/0021). **O**. *Tritia clathrata* (Born, 1778) (height 17.0 mm, width 11.1 mm, NHMW 2024/0165/0022). **P**. *Tritia semistriata* (Brocchi, 1814) (height 15.2 mm, width 6.9 mm, NHMW 2024/0165/0023). **Q–R**. *Heteropurpura polymorpha* (Brocchi, 1814) (height 15.5 mm, width 8.8 mm, NHMW 2024/0165/0024). **S**. *Episcomitra* cf. *dignota* (Bellardi, 1887a, 1887b) (height 32.2 mm, width 10.8 mm, NHMW 2024/0165/0025). **T**. *Varioconus striatulus* (Brocchi, 1814).
Gastéropodes pliocènes du Bassin du Bas Chelif. **A–B**. Xenophora crispa *(König, 1825)* (length *25 mm, NHMW 2024/0165/0057).* **C–D**. Bivetiella cancellata *(Linné, 1767)* (height *22,1 mm,* width *14,8 mm, NHMW 2024/0165/0016).* **E–F**. Contortia italica *(D'Ancona, 1872)* (height *18,5 mm,* width *11,7 mm, NHMW 2024/0165/0017).* **G–H**. Solatia hirta *(Brocchi, 1814)* (height *22,3 mm,* width *14,5 mm, NHMW 2024/0165/0018).* **I–J**. Sveltia varicosa *(Brocchi, 1814)* (height *32,3 mm,* width *13,6 mm, NHMW 2024/0165/0019).* **K**. Gibberula epigrus *(Reeve, 1864–1865)* (height *5,5 mm,* width *3,4 mm, NHMW 2024/0165/0040).* **L–M**. Pseudofusus rostratus *(Olivi, 1792)* (height *15,7 mm,* width *11,3 mm, NHMW 2024/0165/0020).* **N**. Aplus nilus *(De Gregorio, 1884)* (height *15,6 mm,* width *11,3 mm, NHMW 2024/0165/0021).* **O**. Tritia clathrata *(Born, 1778)* (height *17,0 mm,* width *11,1 mm, NHMW 2024/0165/0022).* **P**. Tritia semistriata *(Brocchi, 1814)* (height *15,2 mm,* width *6,9 mm, NHMW 2024/0165/0023).* **Q–R**. Heteropurpura polymorpha *(Brocchi, 1814)* (height *15,5 mm,* width *8,8 mm, NHMW 2024/0165/0024).* **S**. Episcomitra *cf.* dignota *(Bellardi, 1887a, 1887b)* (height *32,2 mm,* width *10,8 mm, NHMW 2024/0165/0025).* **T**. Varioconus striatulus *(Brocchi, 1814).*

discussion, see Landau et al. (2013, p. 65) and Van Dingenen et al. (2016, p. 156).

Distribution: Widespread in the European Lower Miocene to Pleistocene. Today northeastern Atlantic, Iberian Peninsula, Morocco, into the Mediterranean (Van Dingenen et al., 2016).

Alvania* cf. *lanciae (Calcara, 1845)
Fig. 4I
cf. *1835 *Rissoa lanciae* Calcara, p. 29, pl. 4, fig. 12.
cf. 2006 *Alvania lanciae* (Calcara, 1845) – Chirli, p. 24, pl. 11, figs 1-12 (*cum syn.*).

Material: Height 3.2 mm, width 1.8 mm. Tel-4: NHMW 2024/0165/0054 (1 specimen), Slama Formation, Piacenzian.

Discussion: The single Algerian specimen is very close to the Pliocene shells illustrated by Chirli (2006, pl. 11, figs. 1–12) as *Alvania lanciae* (Calcara, 1845). Unfortunately, the protoconch is not preserved, and the surface is somewhat abraded, making identification provisional.

Distribution: Lower Pliocene to present-day Mediterranean (Chirli, 2006, p. 25).

Rhombostoma carmelae (Brugnone, 1873)
Fig. 4J
*1873 *Eulima Carmelae* Brugnone, p. 7, fig. 6.
2022 *Rhombostoma carmelae* (Brugnone, 1873) – Landau and Mulder, p. 165, figs. 17a, b (*cum syn.*).

Material: Height 3.8 mm, width 1.5 mm. Tel-4: NHMW 2024/0165/0034 (1 specimen), Slama Formation, Piacenzian.

Discussion: *Rhombostoma imperforatum* (Sacco, 1892) differs in having more convex whorls, a deeper suture, a less expanded outer

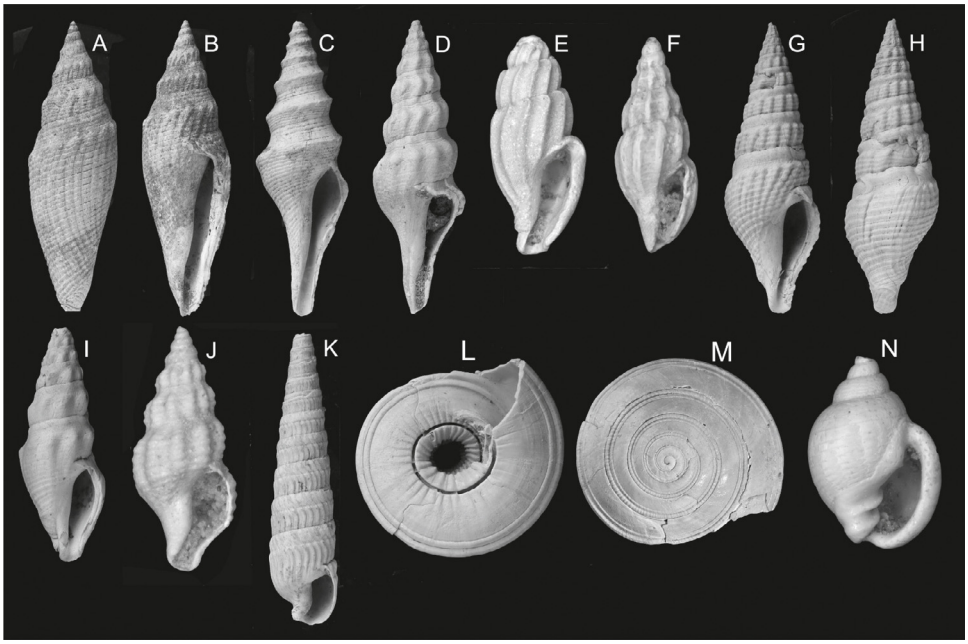

Fig. 7. Gastropod taxa from the Lower Chelif Basin. **A–B**. *Genota bonnanii* Bellardi, 1877 (height 36.7 mm, width 10.8 mm, NHMW 2024/0165/0027). **C**. *Fusiturris dimidiata* (Brocchi, 1814) (height 33.0 mm, width 10.3 mm. Tel-4: NHMW 2024/0165/0028). **D**. *Fusiturris intermedia* (Bronn, 1831) (height 29.6 mm, width 8.8 mm, NHMW 2024/0165/0029). **E**. *Agathotoma angusta* (Bellardi, 1847) (height 5.2 mm, width 2.2 mm, NHMW 2024/0165/0037). **F**. *Mangelia* sp. (height 4.9 mm, width 1.9 mm, NHMW 2024/0165/0038). **G–H**. *Crassispira leonardiana* Ceregato and Della Bella, 2004 (height 27.4 mm, width 8.6 mm, NHMW 2024/0165/0030). **I**. *Crassispira velerinensis* Vera-Peláez, 2002 (height 21.7 mm, width 7.2 mm, NHMW 2024/0165/0031). **J**. *Cyrillia linearis* (Montagu, 1803) (height 3.7 mm, width 1.5 mm, NHMW 2024/0165/0039). **K**. *Terebra postneglecta* Sacco, 1891 (height 26.2 mm, width 6.2 mm, NHMW 2024/0165/0032). **L–M**. *Simplexollata simplex* (Bronn, 1831) (height 10.5 mm, maximum diameter 21.4 mm, NHMW 2024/0165/0033). **N**. *Ringicula auriculata* (Ménard de la Groye, 1811) (height 4.1 mm, diameter 3.2 mm, NHMW 2024/0165/0001).
Gastéropodes pliocènes du Bassin du Bas Chelif. **A–B**. Genota bonnanii *Bellardi, 1877* (height *36,7 mm,* width *10,8 mm, NHMW 2024/0165/0027).* **C**. Fusiturris dimidiata *(Brocchi, 1814)* (height *33,0 mm,* width *10,3 mm. Tel-4 : NHMW 2024/0165/0028).* **D**. Fusiturris intermedia *(Bronn, 1831)* (height *29,6 mm,* width *8,8 mm, NHMW 2024/0165/0029).* **E**. Agathotoma angusta *(Bellardi, 1847)* (height *5,2 mm,* width *2,2 mm, NHMW 2024/0165/0037).* **F**. Mangelia *sp.* (height *4,9 mm,* width *1,9 mm, NHMW 2024/0165/0038).* **G–H**. Crassispira leonardiana *Ceregato et Della Bella, 2004* (height *27,4 mm,* width *8,6 mm, NHMW 2024/0165/0030).* **I**. Crassispira velerinensis *Vera-Peláez, 2002* (height *21,7 mm,* width *7,2 mm, NHMW 2024/0165/0031).* **J**. Cyrillia linearis *(Montagu, 1803)* (height *3,7 mm,* width *1,5 mm, NHMW 2024/0165/0039).* **K**. Terebra postneglecta *Sacco, 1891* (height *26,2 mm,* width *6,2 mm, NHMW 2024/0165/0032).* **L–M**. Simplexollata simplex *(Bronn, 1831)* (height *10,5 mm,* maximum diameter *21,4 mm, NHMW 2024/0165/0033).* **N**. Ringicula auriculata *(Ménard de la Groye, 1811)* (height *4,1 mm,* diameter *3,2 mm, NHMW 2024/0165/0001).*

lip, slightly less excavated columella, and most obviously spiral sculpture developed along the entire teleoconch, although in some specimens it can subobsolete. In *R. carmelae*, sculpture is reduced to a few cords over the base. For further discussion, see Landau and Mulder (2022, p. 166).

Distribution: Upper Miocene to Upper Pliocene Proto-/Mediterranean. Lower Pliocene adjacent Atlantic Guadalquivir Basin, Spain (Landau and Mulder, 2022).

Teinostoma minutum (Conti, 1864)
Fig. 4K–L
*1980 *Tornus minutus* Conti, p. 31, 50.
2006 *Teinostoma minutus* [*sic*] (Conti, 1864) – Chirli, p. 56, pl. 25, figs. 1–7 (*cum syn.*).

Material: Size 1.3 mm × 1.1 mm. Tel-2: NHMW 2024/0165/0055 (1 specimen), *LGEE-SB* (1 specimen), Tahria Formation, Zanclean.

Discussion: For discussion, see Chirli (2006, p. 56).

Distribution: Lower Pliocene to Lower Pleistocene Mediterranean (Chirli, 2006), and adjacent Atlantic Lower Pliocene (Landau et al., 2011).

Tornus pedemontanus Pavia, 1980
Fig. 4M-O
*1980 *Tornus pedemontanus* Pavia, p. 212, pl. 2, figs. 9–10.
2018 *Tornus pedemontanus* Pavia, 1980 – Landau et al., p. 303, pl. 130, fig. 1 (*cum syn.*).

Material: Size 2.4 mm × 1.2 mm. Tel-4: NHMW 2024/0165/0035 (1 specimen), *LGEE-SB* (3 specimens), Slama Formation, Piacenzian.

Discussion: *Tornus pedemontanus primitivus* Moroni and Ruggieri, 1985 described from the Upper Miocene of Italy differs in being smaller, in having a slightly narrower umbilicus, which is bordered by a weaker carina, and in lacking a mid-basal carina. Landau et al. (2018, p. 303) noted that, in contrast to the Mediterranean of Italy, in the Atlantic of NW France, *T. pedemontanus* occurred in the Upper Miocene and *T. pedemontanus primitivus* in the Lower Pliocene. The Algerian specimens are more like typical *T. pedemontanus*, but the mid-basal carina is weaker than usual and completely absent in some specimens. We consider them to fit within the variability of *T. pedemontanus*.

Distribution: Upper Miocene to Lower Pliocene Atlantic, Upper and Lower Pliocene Mediterranean (Landau et al., 2011, 2018).

Circulus striatus (Philippi, 1836)
Fig. 4P–Q
*1836 *Valvata striata* Philippi, p. 137, pl. 9, fig. 3.
2018 *Circulus striatus* (Philippi, 1836) – Landau et al., p. 307, pl. 134, figs. 1–2 (*cum syn.*).

Material: Size 2.0 mm × 1.7 mm. Tel-4: NHMW 2024/0165/0036 (1 specimen), Slama Formation, Piacenzian.

Discussion: The single Algerian specimen is of the strongly tricarinate form. For discussion, see Landau et al. (2018, p. 307).

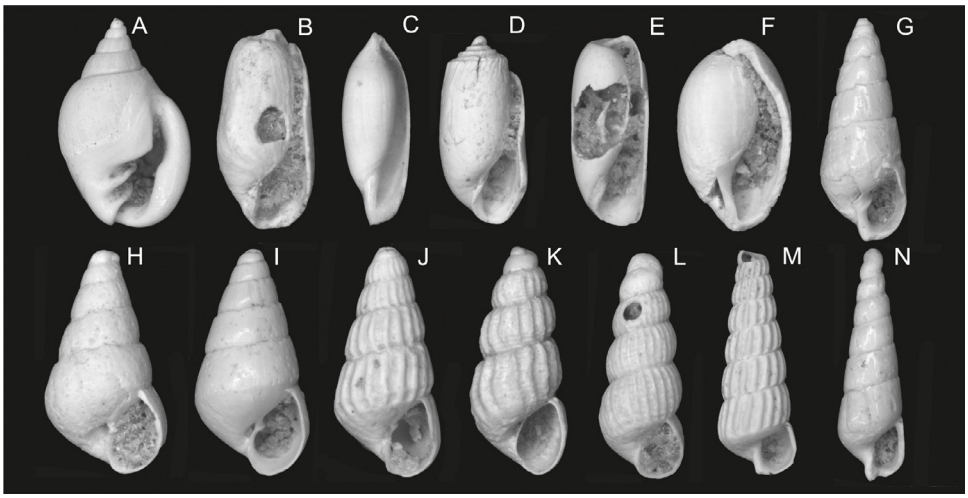

Fig. 8. Gastropod taxa from the Lower Chelif Basin. **A**. *Ringicula buccinea* (Brocchi, 1814) (height 5.9 mm, diameter 4.2 mm, NHMW 2024/0165/0002). **B**. *Retusa umbilicata* (Montagu, 1803) (height 1.9 mm, diameter 0.9 mm, NHMW 2024/0165/0045). **C**. *Volvulella acuminata* (Bruguière, 1789–1792) (height 1.8 mm, diameter 0.6 mm, NHMW 2024/0165/0003). **D**. *Acteocina knockeri* (E.A. Smith, 1872) (height 3.0 mm, diameter 1.4 mm, NHMW 2024/0165/0004). **E**. *Cylichna cylindracea* (Pennant, 1777) (height 2.8 mm, diameter 1.1 mm, NHMW 2024/0165/0005). **F**. *Roxania utriculus* (Brocchi, 1814) (height 2.3 mm, diameter 1.4 mm. Tel-4: NHMW 2024/0165/0006). **G**. *Macrodostomia subangulatina* (Sacco, 1892) (height 4.5 mm, diameter 1.7 mm, NHMW 2024/0165/0047). **H**. *Odostomia acuta* Jeffreys, 1848 (height 2.1 mm, diameter 1.1 mm, NHMW 2024/0165/0048). **I**. *Odostomia conoastensis* (Sacco, 1892) (Height 3.0 mm, diameter 1.5 mm. Tel-4: NHMW 2024/0165/0049). **J**. *Parthenina interstincta* (J. Adams, 1797) (height 1.8 mm, diameter 0.8 mm, NHMW 2024/0165/0050). **K**. *Pyrgulina stefanisi* (Jeffreys, 1862–1869) (height 2.9 mm, diameter 1.2 mm, NHMW 2024/0165/0051). **L**. *Pyrgiscus jaapmulderi* Landau and Micali, 2021 (height 1.9 mm, diameter 0.7 mm, NHMW 2024/0165/0052). **M**. *Chemnitzia lactea* (Linnaeus, 1758) (height 4.4 mm, diameter 1.5 mm, NHMW 2024/0165/0046). **N**. *Eulimella acicula* (Philippi, 1836) (height 2.8 mm, diameter 0.8 mm, NHMW 2024/0165/0053).
Gastéropodes pliocènes du Bassin du Bas Chelif. **A**. Ringicula buccinea *(Brocchi, 1814)* (height *5,9 mm*, diameter *4,2 mm, NHMW 2024/0165/0002).* **B**. Retusa umbilicata *(Montagu, 1803)* (height *1,9 mm*, diameter *0,9 mm, NHMW 2024/0165/0045).* **C**. Volvulella acuminata *(Bruguière, 1789–1792)* (height *1,8 mm*, diameter *0,6 mm, NHMW 2024/0165/0003).* **D**. Acteocina knockeri *(E.A. Smith, 1872)* (height *3,0 mm*, diameter *1,4 mm, NHMW 2024/0165/0004).* **E**. Cylichna cylindracea *(Pennant, 1777)* (height *2,8 mm*, diameter *1,1 mm, NHMW 2024/0165/0005).* **F**. Roxania utriculus *(Brocchi, 1814)* (height *2,3 mm*, diameter *1,4 mm. Tel-4 : NHMW 2024/0165/0006).* **G**. Macrodostomia subangulatina *(Sacco, 1892)* (height *4,5 mm*, diameter *1,7 mm, NHMW 2024/0165/0047).* **H**. Odostomia acuta *Jeffreys, 1848* (height *2,1 mm*, diameter *1,1 mm, NHMW 2024/0165/0048).* **I**. Odostomia conoastensis *(Sacco, 1892)* (height *3,0 mm*, diameter *1,5 mm. Tel-4 : NHMW 2024/0165/0049).* **J**. Parthenina interstincta *(J. Adams, 1797)* (height *1,8 mm*, diameter *0,8 mm, NHMW 2024/0165/0050).* **K**. Pyrgulina stefanisi *(Jeffreys, 1862–1869)* (height *2,9 mm*, diameter *1,2 mm, NHMW 2024/0165/0051).* **L**. Pyrgiscus jaapmulderi *Landau and Micali, 2021* (height *1,9 mm*, diameter *0,7 mm, NHMW 2024/0165/0052).* **M**. Chemnitzia lactea *(Linnaeus, 1758)* (height *4,4 mm*, diameter *1,5 mm, NHMW 2024/0165/0046).* **N**. Eulimella acicula *(Philippi, 1836)* (height *2,8 mm*, diameter *0,8 mm, NHMW 2024/0165/0053).*

Distribution: Widely distributed along the Eastern Atlantic Frontage and Mediterranean from the Upper Miocene to present times (Landau et al., 2018).

Aclis sp.
Fig. 4R
Material: Height 3.3 mm, width 1.1 mm (incomplete). Tel-4: NHMW 2024/0165/0043 (1 specimen), Slama Formation, Piacenzian.

Eulima sp.
Fig. 4S
Material: Height 3.7 mm, width 1.1 mm (incomplete). Te-l4: NHMW 2024/0165/0044 (1 specimen), Slama Formation, Piacenzian.
Discussion: Incomplete specimen missing apex that is undoubtedly ascribed to the genus *Eulima*.

Niso eburnea Risso, 1826–1827
Fig. 4T
*1826 *Niso eburnea* Risso, p. 219, pl. 7, fig. 98.
2016 *Niso eburnea* Risso, 1826–1827 – Pacaud, p. 59, pl. 1, figs. 1–5 (*cum syn.*).
Material: Height 14.7 mm, width 6.7 mm. Tel-2: NHMW 2024/0165/0013 (1 specimen), Tahria Formation, Zanclean.
Discussion: Uncertainty over the validity of this species was resolved by Pacaud (2016) with the rediscovery of the type specimen and gave a detailed chresonymy for that species.

Distribution: Lower and Upper Pliocene Mediterranean (Pacaud, 2016). Miocene records need to be confirmed.

Calyptraea chinensis (Linnaeus, 1758)
Fig. 4U
*1758 *Patella chinensis* Linnaeus, p. 1257.
2023 *Calyptraea chinensis* (Linnaeus, 1758) – Sachetti et al., p. 51, pl. 3, fig. F (*cum syn.*).
Material: Height 7.6 mm, width 17.1 mm. Tel-4: NHMW 2024/0165/0014 (1 Incomplete specimen), Slama Formation, Piacenzian.
Discussion: This species is extremely variable in both sculpture and profile, although it is possible that it represents a species complex rather than a single taxon (B. Landau pers. obs.). The Algerian specimen is rather low in profile and has a smooth rather than squamous surface.
Distribution: Extremely widely distributed in Europe from the Lower Miocene to present day, where it occurs along the Northeastern Atlantic Frontage from the British Isles south to Zaire and into the Mediterranean and Black Seas (Sacchetti et al., 2023).

Natica virguloides Sacco, 1890
Fig. 4V-W
*1890 Natica (Tectonatica) tectula Sacco, p. 30.
2005 *Natica virguloides* Sacco, 1890 – Pedriali and Robba, p. 137, pl. 6, figs. 11–15, pl. 7, fig. 9, 20, pl. 8., fig. 41, pl. 9, figs. 29–30, pl. 10, fig. 32, P (*cum syn.*).
Material: Height 20.2 mm, width 23.4 mm. Tel-4: NHMW 2024/0165/0058 (1 specimen), Slama Formation, Piacenzian.

Discussion: For discussion, see Pedriali and Robba (2005, p. 139).

Distribution: Lower and Upper Pliocene Mediterranean (Pedriali and Robba, 2005), adjacent Atlantic Lower Pliocene (Landau et al., 2011).

Cochlis propinqua (Pecchioli, 1864)
Fig. 5A–B
*1864 *Natica propinqua* Pecchioli, p. 521, pl. 5, figs. 25, 26.
2005 *Cochlis propinqua* (Pecchioli, 1864) – Pedriali and Robba, p. 149, pl. 2, figs. 14–18, pl. 7, fig. 6, pl. 8, figs. 14–15, pl. 9, fig. 9, pl. 10, figs. 10–12, E–F (*cum syn.*).

Material: Height 17.1 mm, width 19.3 mm. Tel-4: NHMW 2024/0165/0060 (1 specimen), Slama Formation, Piacenzian.

Discussion: Characterised by its paucispiral protoconch of 1.25 whorls, inflated last whorl with subsutural area somewhat flattened but poorly delimited, relatively thin funicle, and, above all, a colour pattern of narrow collabral stripes. For full discussion, see Pedriali and Robba (2005, p. 139).

Distribution: Lower and Upper Pliocene Mediterranean (Pedriali and Robba, 2005).

Cochlis raropunctata (Sasso, 1827)
Fig. 5C–D
*1827 *Natica raro-punctata* Sasso, p. 477.
2005 *Cochlis raropunctata* (Sasso, 1827) – Pedriali and Robba, p. 155, pl. 3, figs. 10–20, pl. 4, figs. 1–6, 10, pl. 7, figs. 8–9, pl. 8, figs. 19–25, pl. 9, figs. 14–19, pl. 10, figs. 17–21, 23–24, I–K (*cum syn.*).

Material: Height 23.2 mm, width 23.0 mm. Tel-4: NHMW 2024/0165/0059 (1 specimen), *LGEE-SB* (4 specimens), Slama Formation, Piacenzian.

Discussion: The Algerian specimens are smaller than usual for the species. The protoconch is not perfectly preserved but can be seen to be paucispiral, about 1.25 whorls with a relatively large nucleus; the last whorl is globose, slightly depressed in the subsutural area, and has an expanded aperture; the funicle is narrow, and the umbilicus is mostly open. Colour pattern in the Algerian specimens consists of interrupted spiral lines, an unusual pattern for the species also reported by Pedriali and Robba (2005, p. 157). For full discussion, see Pedriali and Robba (2005, p. 158).

Distribution: Upper Miocene to Upper Pliocene Mediterranean (Pedriali and Robba, 2005), adjacent Atlantic Lower Pliocene (Landau et al., 2011), north to Upper Pliocene of central-west Portugal (Silva, 2001).

Tectonatica tectula (Sacco, 1890)
Fig. 5E
*1890 Natica (Tectonatica) tectula Sacco, p. 33.
2008 *Tectonatica tectula* (Sacco, 1890) – Pedriali and Robba, p. 110, pl. 2, figs. 7–9, 19–20, pl. 3, figs. 9, 22–23 (*cum syn.*).

Material: Height 4.4 mm, width 4.5 mm. Tel-4: NHMW 2024/0165/0041 (1 specimen), Slama Formation, Piacenzian.

Discussion: The protoconch is not preserved and the surface is abraded. However, the very large umbilical callus completely closing the umbilicus suggests *Tectonatica tectula* (Sacco, 1890). The groove seen around the callus is due to the shell surface being decorticated. For full discussion, see Pedriali and Robba (2008, p. 111).

Distribution: Miocene North Sea Basin and Proto-Mediterranean. Pliocene Mediterranean and adjacent Atlantic. Pleistocene records require confirmation (Pedriali and Robba, 2008; Landau et al., 2011).

Neverita olla (de Serres, 1829)
Fig. 5F–G
*1829 *Natica olla* de Serres, p. 102, pl. 1, figs. 1–2.
2010 *Neverita olla* (de Serres, 1829) – Pedriali and Robba, p. 404, pl. 2, figs. 5–9, pl. 3, figs. 14–15, pl. 4, fig. 17 (*cum syn.*).

Material: Height 19.3 mm, width 24.4 mm. Tel-2: *LGEE-SB* (1 specimen), Tahria Formation, Zanclean. Tel-4: NHMW 2024/0165/0015 (1 specimen), *LGEE-SB* (13 specimens), Slama Formation, Piacenzian.

Discussion: *Neverita olla* (de Serres, 1829) differs from the extant Mediterranean *N. josephinia* Risso, 1826–1827 most importantly in having a multispiral protoconch, whereas *N. josephinia* has a paucispiral protoconch. For full discussion, see Pedriali and Robba (2010, p. 410).

Distribution: Widespread in the Miocene and Pliocene of Europe. Pedriali and Robba (2010) reported its first occurrence in the Lower Oligocene of Piedmont, making it an unusually long-lived species. Replaced in the Pleistocene by *N. josephinia* (Pedriali and Robba, 2010).

Aspidophoreas infundibulum (Brocchi, 1814)
Fig. 5H
*1814 *Trochus infundibulum* Brocchi, p. 352, pl. 5, fig. 17.
2004 *Xenophora infundibulum* (Brocchi, 1814) – Landau et al., p. 84, pl. 19, fig. 2 (*cum syn.*).

Material: Height 21.5 mm, width 24.3 mm (incomplete). Tel-2: NHMW 2024/0165/0061 (1 apical fragment), Tahria Formation, Zanclean.

Discussion: The Algerian specimen consists of an apical fragment. The very broad apical angle and relatively smooth surface bearing very fine opisthocline spirals suggest the fragment represents *Aspidophoreas infundibulum* (Brocchi, 1814). For full discussion, see Landau et al. (2004, p. 85).

Distribution: Middle Miocene of the Loire Basin (needs confirmation), Upper Miocene southern Portugal, Lower and Upper Pliocene Mediterranean (Landau et al., 2004).

Xenophora crispa (König, 1825)
Fig. 6A-B
*1825 *Trochus crispus* König, p. 3, pl. 5, fig. 58.
2004 *Xenophora crispa* (König, 1825) – Landau et al., p. 83, pl. 19, fig. 1 (*cum syn.*).

Material: Length 25 mm (incomplete). Tel-4: NHMW 2024/0165/0057 (2 last whorl fragments), Slama Formation, Piacenzian.

Discussion: For discussion, see Landau et al. (2004, p. 84).

Distribution: Lower Pliocene to present-day Mediterranean and Iberian Atlantic coast. Today central and western Mediterranean and Atlantic coasts of West Africa (Landau et al., 2004, p. 84).

Bivetiella cancellata (Linné, 1767)
Fig. 6C–D
*1767 *Voluta cancellata* Linné, p. 1191.
2011 *Bivetiella cancellata* (Linné, 1767) – Brunetti et al., p. 88, figs. 1C–G, 2A–C (*cum syn.*).

Material: Maximum height 22.1 mm, width 14.8 mm. Tel-4: NHMW 2024/0165/0016 (1 specimen), *LGEE-SB* (1 specimen), Slama Formation, Piacenzian.

Discussion: For discussion, see Brunetti et al. (2011, p. 91).

Distribution: Lower and Upper Pliocene Eastern Atlantic Frontage from central Portugal southwards into the entire Mediterranean. Today Mediterranean southwards to entire West Africa (Brunetti et al., 2011).

Contortia italica (D'Ancona, 1872)
Fig. 6E-F
*1872 *Contortia italica* D'Ancona, p. 112, pl. 12, figs. 5–6.
2008 *Contortia italica* (D'Ancona, 1872) – Brunetti et al., p. 58, figs. 5A–H, 9B (*cum syn.*).
Material: Maximum height 18.5 mm, width 11.7 mm. Tel-2: *LGEE-SB* (1 specimen), Tahria Formation, Zanclean. Tel-4: NHMW 2024/0165/0017 (1 specimen), *LGEE-SB* (2 specimens), Slama Formation, Piacenzian.
Discussion: Brunetti et al. (2008) recognised two species in the Italian Pliocene, *C. italica* and *C. strictoturrita* (Sacco, 1894). The specimens at hand from Algeria are small and have a regular spiral sculpture of alternating cords characteristic of *C. italica*.
Distribution: Lower and Upper Pliocene western and central Mediterranean (Brunetti *et al*., 2008).

Solatia hirta (Brocchi, 1814)
Fig. 6G–H
*1814 *Voluta hirta* Brocchi, p. 315, pl. 4, fig. 1.
2011 *Solatia hirta* (Brocchi, 1814) – Brunetti et al., p. 103, figs. 10A–E, 11A–I, 12A–F, 13E–L (*cum syn.*).
Material: Height 22.3 mm, width 14.5 mm. Tel-4: NHMW 2024/0165/0018 (1 specimen), Slama Formation, Piacenzian.
Discussion: *Solatia hirta* (Brocchi, 1814) probably represents a species complex rather than a single taxon (Brunetti et al., 2011). However, the Algerian specimen lacks its protoconch, which makes further determination impossible.
Distribution: Lower and Upper Pliocene Mediterranean and adjacent Atlantic, disappearing from the Mediterranean at the end of the Lower Pleistocene (Landau et al., 2006; Brunetti et al., 2011). Today the genus occurs along West Africa, from Morocco to the Ivory Coast (Verhecken, 2007).

Sveltia varicosa (Brocchi, 1814)
Fig. 6I–J
*1814 *Voluta varricosa* Brocchi, p. 311, pl. 3, fig. 8.
2011 *Sveltia varicosa* (Brocchi, 1814) – Brunetti et al., p. 92, figs. 3A–G, 4A–E (*cum syn.*).
Material: Maximum height 32.3 mm, width 13.6 mm. Tel-4: NHMW 2024/0165/0019 (1 specimen), *LGEE-SB* (6 specimens), Slama Formation, Piacenzian.
Discussion: Characteristic Mediterranean Pliocene species. For discussion and comparison with congeners, see Brunetti et al. (2011) and Landau and Silva (2022).
Distribution: At least three *Sveltia* Jousseaume, 1887 species occurred in the Pliocene Iberian and Atlantic Mediterranean. *Sveltia sofiae* Landau and Silva, 2021, so far known only from the Upper Pliocene Atlantic Mondego Basin (central Portugal), *S. confusa* Brunetti, 2016 from Pliocene assemblages on either side of the Strait of Gibraltar, Spain and extending northwards in the Atlantic to the Ligerian Gulf of NW France, and *S. varicosa* abundant and widely distributed in the Pliocene Mediterranean, but absent in the westernmost Alboran Sea, becoming rarer and disappearing at the end of the Lower Pleistocene. Today, the genus is represented in the eastern Atlantic by a single species, *Sveltia lyrata* (Brocchi, 1814), occurring from Cape Blanc, Mauritania, south (Landau and Silva, 2022).

Gibberula epigrus (Reeve, 1864–1865)
Fig. 6K
*1865 *Marginella epigrus* Reeve, pl. 26, fig. 151.
2011 *Gibberula epigrus* (Reeve, 1864–1865) – Silva et al., p. 1060, figs. 6/7–9 (*cum syn.*).
Material: Height 5.5 mm, width 3.4 mm. Tel-4: NHMW 2024/0165/0040 (1 specimen), Slama Formation, Piacenzian.
Discussion: For discussion, see Silva et al. (2011, p. 1061).
Distribution: Upper Miocene and Pliocene Atlantic Iberian coast south of Mondego Basin, central-west Portugal. Today Atlantic coast of Morocco and western Mediterranean, Alboran Sea (Silva et al., 2011). This is the first Mediterranean fossil record.

Pseudofusus rostratus (Olivi, 1792)
Fig. 6L–M
*1792 *Murex rostratus* Olivi, p. 153.
2024 *Pseudofusus rostratus* (Olivi, 1792) – Landau and Harzhauser, p. x, pl. x, figs. 1–3 (*cum syn.*).
Material: Height 15.7 mm, width 11.3 mm (incomplete). Tel-4: NHMW 2024/0165/0020 (fragment consisting of last half whorl), Slama Formation, Piacenzian.
Discussion: The Algerian specimen consists of the last half whorl but shows the characteristic shoulder carina, small aperture, and straight siphonal canal typical for the species. For full discussion, see Landau and Harzhauser (2024).
Distribution: Lower and Upper Pliocene Mediterranean, where it disappears at the end of the Lower Pleistocene (Landau and Harzhauser, 2024).

Aplus nilus (De Gregorio, 1884)
Fig. 6N
*1884 *Murex* (*Aplus*) *plicatus* f. *nilus* De Gregorio, p. 281.
2014 *Aplus nilus* (De Gregorio, 1884) – Brunetti and Della Bella, p. 5, figs. 2B–G, 3A–D (*cum syn.*).
Material: Height 15.6 mm, width 11.3 mm (incomplete). Tel-4: NHMW 2024/0165/0021 (fragment consisting of last whorl), Slama Formation, Piacenzian.
Discussion: This fragment probably represents *Aplus nilus* (De Gregorio, 1884). The last whorl sculpture of low, rounded cords overrun by finer spiral threads is the same as that illustrated by Brunetti and Della Bella (2014, fig. 3D). For full discussion, see Brunetti and Della Bella (2014).
Distribution: Lower and Upper Pliocene Mediterranean (Brunetti and Della Bella, 2014).

Tritia clathrata (Born, 1778)
Fig. 6O
*1778 *Buccinum clathratum* Born, p. 255.
2009 *Nassarius clathratus* (Born, 1778) – Landau et al., p. 6, pl. 1, figs. 1–4, pl. 14, fig. 1 (*cum syn.*).
Material: Maximum height 17.0 mm, width 11.1 mm. Tel-2: *LGEE-SB* (2 specimens), Tahria Formation, Zanclean. Tel-4: NHMW 2024/0165/0022 (1 specimen), *LGEE-SB* (2 specimens), Slama Formation, Piacenzian.
Discussion: The Algerian specimens seem to represent a dwarf form of this *Tritia clathrata* (Born, 1778). They have the typical multispiral protoconch for the species well preserved. This separates it from *Tritia iberoclathrata* (Landau et al., 2009) from the Upper Pliocene Estepona Basin assemblage that has a similar teleoconch but a paucispiral protoconch.
Distribution: Middle Miocene Aquitaine Basin of France. Pliocene Eastern Atlantic Frontage from Central West Portugal into Mediterranean, where it disappears at the end of the Lower Pleistocene (Landau et al., 2009).

Tritia semistriata (Brocchi, 1814)
Fig. 6P
*1814 *Buccinum semistriatum* Brocchi, p. 651, pl. 15, fig. 15.

2009 *Nassarius semistriatus* (Brocchi, 1814) – Landau et al., p. 12, pl. 2, figs. 8–12, pl. 15, fig. 3 (*cum syn.*).

Material: Height 15.2 mm, width 6.9 mm. Tel-4: NHMW 2024/0165/0023 (1 specimen), LGEE-SB (2 specimens), Slama Formation, Piacenzian.

Discussion: For discussion, see Landau et al. (2009, p. 13).

Distribution: Upper Miocene and Pliocene Iberian Atlantic coast and Mediterranean, from where it disappears at the end of the Lower Pleistocene (Landau et al., 2009).

Heteropurpura polymorpha (Brocchi, 1814)

Fig. 6Q–R

*1814 *Murex polymorphus* Brocchi, p. 415, pl. 7, figs. 6–8.

2007 *Heteropurpura polymorpha* (Brocchi, 1814) – Landau et al., p. 28, text-fig. 7, pl. 7, figs 6–8 (*cum syn.*).

Material: Height 15.5 mm, width 8.8 mm (incomplete). Tel-4: NHMW 2024/0165/0024 (1 juvenile incomplete specimen + 1 apertural fragment).

Discussion: For discussion, see Landau et al. (2007, p. 29).

Distribution: Lower and Upper Pliocene Iberian Atlantic coast and Mediterranean (Landau et al., 2007).

Episcomitra* cf. *dignota (Bellardi, 1887a, 1887b)

Fig. 6S

cf. 1887a *Mitra dignota* Bellardi, p. 77.

cf. 1887b *Mitra dignota* Bellardi, pl. 4, fig. 20.

cf. 2002 *Cancilla* (*Ziba*) *dignota* (Bellardi, 1887a, 1887b) – Chirli, p. 48, pl. 23, figs. 9–12, pl. 24, figs. 1–3.

Material: Height 32.2 mm, width 10.8 mm. Tel-4: NHMW 2024/0165/0025 (1 specimen), LGEE-SB (9 specimens), Slama Formation, Piacenzian.

Discussion: Similar to *E. dignota* (Bellardi, 1887a, 1887b), but larger.

Distribution: Upper Pliocene, Mediterranean coast of Algeria (this paper).

Varioconus striatulus (Brocchi, 1814)

Fig. 6T

*1814 *Conus striatulus* Brocchi, p. 294, pl. 3, fig. 4.

1997 *Conus* (*Cheyconus*) *striatulus* (Brocchi, 1814) – Chirli, p. 10, pl. 3, figs. 2–7 (*cum syn.*).

Material: Height 20.0 mm, width 9.4 mm. Tel-2: LGEE-SB (2 specimens), Tahria Formation, Zanclean. Tel-4: NHMW 2024/0165/0026 (1 specimen), LGEE-SB (2 specimens), Slama Formation, Piacenzian.

Discussion: For discussion, see Davoli (2003) and Psarras et al. (2021).

Distribution: Upper Miocene to Upper Pleistocene Proto-/Mediterranean (Landau et al., 2007), Lower and Upper Pliocene Iberian Atlantic coasts (Silva, 2001; Landau et al., 2011).

Genota bonnanii Bellardi, 1877

Fig. 7A–B

*1877 *Genota Bonnanii* Bellardi, p. 87, pl. 3, fig. 8.

2022 *Genota bonnanii* Bellardi, 1877 – Landau et al., p. 118, pl. 11, figs. 1–4 (*cum syn.*).

Material: Maximum height 36.7 mm, width 10.8 mm. Tel-4: NHMW 2024/0165/0027 (1 specimen), LGEE-SB (1 specimen), Slama Formation, Piacenzian.

Discussion: For full discussion, see Landau and Harzhauser (2022, p. 119).

Distribution: Lower and Upper Pliocene Mediterranean (Landau and Harzhauser, 2022), and adjacent Atlantic Lower Pliocene (Landau et al., 2011).

Fusiturris dimidiata (Brocchi, 1814)

Fig. 7C

*1814 *Murex dimidiatus* Brocchi, p. 431, pl. 8 fig. 18.

1997 *Turricola dimidiata* (Brocchi, 1814) – Chirli, p. 19, pl. 8, figs. 1–2 (*cum syn.*).

Material: Maximum height 33.0 mm, width 10.3 mm. Tel-4: NHMW 2024/0165/0028 (1 specimen), LGEE-SB (4 specimens), Slama Formation, Piacenzian.

Discussion: Both *Fusiturris intermedia* (Bronn, 1831) and *F. dimidiata* (Brocchi, 1814) are widespread in the Mediterranean Pliocene and adjacent Atlantic. *Fusiturris dimidiata* differs in having a well-defined subsutural ramp delimited by a sharper carina; the tubercles are horizontally elongated and restricted to the carina and do not continue as ribs to the suture as they do in *F. intermedia*; the anal sinus is placed on the lower portion of the subsutural ramp in *F. intermedia* rather than at the carina; and the siphonal canal is slightly longer in *F. dimidiata* (Landau and Harzhauser, 2023a).

Distribution: Middle Miocene to Pliocene Proto-/Mediterranean (Chirli, 1997), Lower Pliocene Guadalquivir Basin, southern Spain (Landau et al., 2011).

Fusiturris intermedia (Bronn, 1831)

Fig. 7D

*1831 Pleurotoma intermedia Bronn, p. 45.

2023a *Fusiturris intermedia* (Bronn, 1831) – Landau and Harzhauser, p. 19, pl. 8, figs. 1–2 (*cum syn.*).

Material: Maximum height 29.6 mm, width 8.8 mm. Tel-4: NHMW 2024/0165/0029 (1 specimen), LGEE-SB (4 specimens), Slama Formation, Piacenzian.

Discussion: Both *Fusiturris intermedia* (Bronn, 1831) and *F. dimidiata* (Brocchi, 1814) are widespread in the Mediterranean Pliocene and adjacent Atlantic. *Fusiturris dimidiata* differs in having a well-defined subsutural ramp delimited by a sharper carina; the tubercles are horizontally elongated and restricted to the carina and do not continue as ribs to the suture as they do in *F. intermedia*; the anal sinus is placed on the lower portion of the subsutural ramp in *F. intermedia* rather than at the carina; and the siphonal canal is slightly longer in *F. dimidiata* (Landau and Harzhauser, 2023a).

Distribution: Middle Miocene Paratethys and Proto-Mediterranean, Upper Miocene to Upper Pliocene Atlantic Iberian coast and Proto-/Mediterranean. *Fusiturris intermedia* disappears from the Mediterranean at the end of the Lower Pleistocene (Landau and Harzhauser, 2022).

Agathotoma angusta (Bellardi, 1847)

Fig. 7E

*1847 *Raphitoma angusta* Jan (*Pleurotoma*) Bellardi, p. 103, pl. 4, fig. 25.

2023a *Agathotoma angusta* (Bellardi, 1847) – Landau et al., p. 48, pl. 1, figs. 1–4 (*cum syn.*).

Material: Height 5.2 mm, width 2.2 mm. Tel-4: NHMW 2024/0165/0037 (1 specimen), Slama Formation, Piacenzian.

Discussion: Juvenile specimen with the protoconch missing and the outer lip not fully thickened. For discussion, see Landau et al. (2023a, p. 48).

Distribution: Lower Miocene to Lower Pleistocene Proto-/Mediterranean and adjacent Atlantic Upper Miocene (Landau et al., 2023a).

Mangelia sp.

Fig. 7F

Material: Height 4.9 mm, width 1.9 mm. Tel-4: NHMW 2024/0165/0038 (1 specimen), Slama Formation, Piacenzian.

Discussion: The shell surface is too worn to allow further determination.

Crassispira leonardiana Ceregato and Della Bella, 2004
Fig. 7G–H
*2004 *Crassispira leonardiana* Ceregato and Della Bella in Scarponi and Della Bella, p. 50, figs. 63–66, 77.
2022 *Crassispira leonardiana* Ceregato and Della Bella, 2003 [*sic*] – Landau and Harzhauser, p. 142, pl. 26, figs. 1–4 (*cum syn.*).
Material: Maximum height 27.4 mm, width 8.6 mm. Tel-2: LGEE-SB (5 specimens), Tahria Formation, Zanclean. Tel-4: NHMW 2024/0165/0030 (1 specimen), LGEE-SB (49 specimens), Slama Formation, Piacenzian.
Discussion: Although not perfectly preserved, the protoconch is multispiral and pointed, the subsutural ramp is smooth, and there are four spiral cords below the shoulder on the penultimate whorl. These characters agree with *Crassispira leonardiana* Ceregato and Della Bella, 2004, which is the only *Crassispira* species in the Italian or Spanish Pliocene with a multispiral protoconch (see Landau and Harzhauser, 2022; Scarponi and Della Bella, 2004a,b). The Italian-type material has widely spaced ribs on the last whorl. Landau and Harzhauser (2022, pl. 26, fig. 4) figured a specimen from the Upper Pliocene of Estepona in which the ribs weakened and became close-set on the last whorl. The Algerian specimens are mostly of this type. As the protoconch is the same, we prefer to consider them *C. leonardiana*, although it is possible that they represent a further *Crassispira* species with a multispiral protoconch. This and *Cochlis* are the predominant gastropods in the Algerian assemblage.
Distribution: Lower and Upper Pliocene western and central Mediterranean (Landau and Harzhauser, 2022).

Crassispira velerinensis Vera-Peláez, 2002
Fig. 7I
*2002 *Crassispira velerinensis* Vera-Peláez, p. 201, pl. 3, figs. R, S.
2022 *Crassispira velerinensis* Vera-Peláez, 2002 – Landau and Harzhauser, p. 146, pl. 29, figs. 1–3.
Material: Maximum height 21.7 mm, width 7.2 mm. Tel-4: NHMW 2024/0165/0031 (1 specimen), LGEE-SB (2 specimens), Slama Formation, Piacenzian.
Discussion: Unfortunately, the protoconch is not preserved in the Algerian material, but the small size, ribs forming tubercles at the shoulder, very weak spiral sculpture, and short siphonal canal correspond to *Crassispira velerinensis* Vera-Peláez, 2002. This is the first record outside the Upper Pliocene Alboran Sea. For discussion, see Landau and Harzhauser (2022, p. 146).
Distribution: Upper Pliocene western Mediterranean (Landau and Harzhauser, 2022).

Cyrillia linearis (Montagu, 1803)
Fig. 7J
*1803 *Murex linearis* Montagu, p. 261, pl. 9, fig. 4.
2022 *Cyrillia linearis* (Montagu, 1803) – Landau et al., p. 170, pl. 10, figs. 1–3 (*cum syn.*).
Material: Maximum height 3.7 mm, width 1.5 mm. Tel-4: NHMW 2024/0165/0039 (1 specimen), Slama Formation, Piacenzian.
Discussion: For discussion, see Landau et al. (2022, p. 171).
Distribution: Upper Miocene to present-day Eastern Atlantic Frontage southwards to Canary Islands and Mediterranean (Landau et al., 2022).

Terebra postneglecta Sacco, 1891
Fig. 7K
*1891 *Terebrum postneglectum* Sacco, p. 29, pl. 1, fig. 66.
2023b *Terebrum postneglectum* Sacco, 1891 – Landau et al., p. 327, pl. 2, figs. 4–5 (*cum syn.*).
Material: Maximum height 26.2 mm, width 6.2 mm. Tel-4: NHMW 2024/0165/0032 (1 specimen), LGEE-SB (16 specimens), Slama Formation, Piacenzian.
Discussion: For discussion, see Landau and Harzhauser (2023b, p. 327).
Distribution: Upper Miocene to Upper Pliocene Mediterranean and Lower Pliocene Guadalquivir Basin, southern Spain (Landau and Harzhauser, 2023b).

Simplexollata simplex (Bronn, 1831)
Fig. 7L–M
*1831 *Solarium simplex* Bronn, p. 63.
2023b *Simplexollata simplex* (Bronn, 1831) – Landau et al., p. 354, pl. 12, figs. 1–2, pl. 13, fig. 12 (*cum syn.*).
Material: Height 10.5 mm, maximum diameter 21.4 mm. Tel-2: NHMW 2024/0165/0033 (1 specimen), Tahria Formation, Zanclean.
Discussion: For full discussion, see Harzhauser and Landau (2023) and Landau et al. (2023b).
Distribution: Widely distributed in the Miocene eastern Atlantic Frontage, North Sea Basin, Paratethys, and Proto-Mediterranean. In the Pliocene in the Atlantic south of central Portugal and the entire Mediterranean, and last occurs in the most eastern Mediterranean Lower Pleistocene (Landau et al., 2023b).

Ringicula auriculata (Ménard de la Groye, 1811)
Fig. 7N
*1811 *Marginella auriculata* Ménard de la Groye, p. 332.
2023b *Ringicula auriculata* (Ménard de la Groye, 1811) – Landau et al., p. 371, pl. 25, figs. 1–2 (*cum syn.*).
Material: Maximum height 4.1 mm, diameter 3.2 mm. Tel-4: NHMW 2024/0165/0001 (1 specimen), LGEE-SB (8 specimens), Slama Formation, Piacenzian.
Discussion: For full discussion, see Landau et al. (2023b, p. 373).
Distribution: Widely distributed from the Lower Pliocene in the Atlantic coast of Iberia and Mediterranean to present-day Atlantic from the Bay of Biscay southwards to the Cape Verde Archipelago and entire Mediterranean (Landau et al., 2023b, p. 373).

Ringicula buccinea (Brocchi, 1814)
Fig. 8A
*1814 *Voluta buccinea* Brocchi, p. 319, pl. 4, fig. 9.
2023b *Ringicula buccinea* (Brocchi, 1814) – Landau et al., p. 373, pl. 26, figs. 1–4 (*cum syn.*).
Material: Maximum height 5.9 mm, diameter 4.2 mm. Tel-4: NHMW 2024/0165/0002 (1 specimen), LGEE-SB (4 specimens), Slama Formation, Piacenzian.
Discussion: For full discussion, see Landau et al. (2023b, p. 375).
Distribution: Widely distributed in the Lower and Upper Pliocene in the North Sea Basin, Eastern Atlantic Frontage, and Mediterranean. European Miocene records do not represent this species (Landau et al., 2023b, p. 375).

Retusa umbilicata (Montagu, 1803)
Fig. 8B
*1803 *Bulla umbilicata* Montagu, p. 222, pl. 7, fig. 4.
2023b *Retusa umbilicata* (Montagu, 1803) – Landau et al., p. 385, pl. 35, figs. 1–2 (*cum syn.*).
Material: Height 1.9 mm, diameter 0.9 mm. Tel-4: NHMW 2024/0165/0045 (1 specimen), Slama Formation, Piacenzian.
Discussion: For full discussion, see Landau et al. (2023b, p. 386).
Distribution: Widely distributed in Europe from the Lower Miocene to present-day, where it is found from the northeastern

Atlantic southwards to West Africa and the entire Mediterranean (Landau et al., 2023b, p. 386).

Volvulella acuminata (Bruguière, 1789–1792)
Fig. 8C
*1792 *Bulla acuminata* Bruguière, p. 376.
2023b *Volvulella acuminata* (Bruguière, 1789–1792) – Landau et al., p. 386, pl. 36, figs. 1–3 (*cum syn.*).
Material: Height 1.8 mm, diameter 0.6 mm. Tel-4: NHMW 2024/0165/0003 (1 specimen), Slama Formation, Piacenzian.
Discussion: For full discussion, see Landau et al. (2023b, p. 387).
Distribution: Widely distributed in Europe from the Lower Miocene to present-day, where it is found from the northeastern Atlantic southwards to Angola and the entire Mediterranean (Landau et al., 2023b, p. 387).

Acteocina knockeri (E.A. Smith, 1872)
Fig. 8D
*1872 *Tornatina knockeri* E.A. Smith, p. 738, pl. 75, fig. 30.
2023b *Acteocina knockeri* (E.A. Smith, 1872) – Landau et al., p. 388, pl. 38, figs. 1–3 (*cum syn.*).
Material: Maximum height 3.0 mm, diameter 1.4 mm. Tel-4: NHMW 2024/0165/0004 (1 specimen), LGEE-SB (7 specimens), Slama Formation, Piacenzian.
Discussion: For full discussion, see Landau et al. (2023b, p. 389).
Distribution: Lower Pliocene Mediterranean and adjacent Atlantic. Today western Mediterranean and southwards form northwest Africa to Angola (Landau et al., 2023b, p. 389).

Cylichna cylindracea (Pennant, 1777)
Fig. 8E
*1777 *Bulla cylindracea* Pennant, p. 100, pl. 75, figs. 5, 6.
2023b *Cylichna cylindracea* (Pennant, 1777) – Landau et al., p. 391, pl. 41, figs. 1–3 (*cum syn.*).
Material: Height 2.8 mm, diameter 1.1 mm. Tel-4: NHMW 2024/0165/0005 (1 specimen incomplete), Slama Formation, Piacenzian.
Discussion: For full discussion, see Landau et al. (2023b, p. 391).
Distribution: Widely distributed in Europe from the Upper Miocene to present-day, where it is found from the northeastern Atlantic to the Cape Verde Archipelago and the entire Mediterranean (Landau et al., 2023b, p. 393).

Roxania utriculus (Brocchi, 1814)
Fig. 8F
*1814 *Bulla utriculus* Brocchi, p. 633.
2023b *Roxania utriculus* (Brocchi, 1814) – Landau et al., p. 406, pl. 55, figs. 1–2 (*cum syn.*).
Material: Height 2.3 mm, diameter 1.4 mm. Tel-4: NHMW 2024/0165/0006 (1 specimen incomplete), Slama Formation, Piacenzian.
Discussion: For full discussion, see Landau et al. (2023b, p. 407).
Distribution: Widely distributed in Europe from the Lower Miocene to present-day, where it is found from the northeastern Atlantic southwards to the Canaries and into the entire Mediterranean (Landau et al., 2023b, p. 407).

Macrodostomia subangulatina (Sacco, 1892)
Fig. 8G
*1892 *Odontostomia* (*Macrodostomia*) *submichaelis* var. *subangulatina* Sacco, p. 44, pl. 1, fig. 95.
2021 *Macrodostomia subangulatina* (Sacco, 1892) – Landau and Micali, p. 223, pl. 21, figs. 1–2.
Material: Height 4.5 mm, diameter 1.7 mm. Tel-4: NHMW 2024/0165/0047 (1 specimen), Slama Formation, Piacenzian.
Discussion: We cannot be entirely certain of the determination, as the protoconch is not preserved, but the tall and narrow regularly conical spire, weakly angled periphery, and convex base agree with *Macrodostomia subangulatina* (Sacco, 1892). For full discussion, see Landau and Micali (2021, p. 223).
Distribution: Upper Pliocene Mediterranean (Landau and Micali, 2021, p. 223).

Odostomia acuta Jeffreys, 1848
Fig. 8H
*1848 *Odostomia acuta* Jeffreys, p. 338.
2021 *Odostomia acuta* Jeffreys, 1848 – Landau and Micali, p. 232, pl. 31, figs. 1–2 (*cum syn.*).
Material: Height 2.1 mm, diameter 1.1 mm. Tel-4: NHMW 2024/0165/0048 (1 specimen), Slama Formation, Piacenzian.
Discussion: For discussion, see Landau and Micali (2021, p. 233).
Distribution: Widely distributed along the European Atlantic Frontage and Mediterranean from the Upper Miocene to present-day, where it is found from the northeastern Atlantic southwards to Angola and into the entire Mediterranean (Landau and Micali, 2021, p. 233).

Odostomia conoastensis (Sacco, 1892)
Fig. 8I
*1892 *Odontostomia* (*Turritodostomia*) *turrita* var. *conoastensis* Sacco, p. 42, pl. 1, fig. 90.
2021 *Odostomia conoastensis* (Sacco, 1892) – Landau and Micali, p. 234, pl. 33, fig. 1 (*cum syn.*).
Material: Height 3.0 mm, diameter 1.5 mm. Tel-4: NHMW 2024/0165/0049 (1 specimen), LGEE-SB (7 specimens), Slama Formation, Piacenzian.
Discussion: The lack of denticles within the outer lip place this species in *Odostomia* rather than *Megastomia*, and the relatively tall conical spire, small type C protoconch, and subobsoletely angled last whorl suggest *O. conoastensis* (Sacco, 1892). For full discussion, see Landau and Micali (2021, p. 234).
Distribution: Upper Miocene Atlantic of southwestern Spain, Lower and Upper Pliocene Mediterranean (Landau and Micali, 2021, p. 224).

Parthenina interstincta (J. Adams, 1797)
Fig. 8J
*1797 *Turbo interstinctus* J. Adams, p. 66, pl. 13, figs. 23, 24.
2021 *Parthenina interstincta* (J. Adams, 1797) – Landau and Micali, p. 265, pl. 69, figs. 1–2 (*cum syn.*).
Material: Height 1.8 mm, diameter 0.8 mm. Tel-4: NHMW 2024/0165/0050 (1 specimen), LGEE-SB (1 specimens), Slama Formation, Piacenzian.
Discussion: For full discussion, see Landau and Micali (2021, p. 266).
Distribution: Widely distributed in the European Middle Miocene to present-day Atlantic and Proto-Mediterranean, today found from the northeastern Atlantic, North Sea, southwards to Cape Verde Islands, and into the entire Mediterranean (Landau and Micali, 2021, p. 266).

Pyrgulina stefanisi (Jeffreys, 1862–1869)
Fig. 8K
*1869 *Rissoa Stefanisi* Jeffreys, p. 208.
2021 *Pyrgulina stefanisi* (Jeffreys, 1862–1869) – Landau and Micali, p. 275, pl. 82, figs. 1–2 (*cum syn.*).

Material: Height 2.9 mm, diameter 1.2 mm. Tel-4: NHMW 2024/0165/0051 (1 specimen), LGEE-SB (5 specimens), Slama Formation, Piacenzian.

Discussion: For full discussion, see Landau and Micali (2021, p. 276).

Distribution: Lower Pliocene to present-day Mediterranean and adjacent Atlantic. Today Mediterranean southwards to Ghana (Landau and Micali, 2021, p. 277).

Pyrgiscus jaapmulderi Landau and Micali, 2021

Fig. 8L

*2021 *Pyrgiscus jaapmulderi* Landau and Micali, p. 304, pl. 111, fig. 1 (*cum syn.*).

Material: Height 1.9 mm, diameter 0.7 mm. Tel-4: NHMW 2024/0165/0052 (1 specimen), Slama Formation, Piacenzian.

Discussion: The Algerian specimen represents *Pyrgiscus jaapmulderi* Landau and Micali, 2021 characterised by its rather squat profile, teleoconch of only 4–5 strongly convex whorls, and the single row of grooves placed mid-base. For full discussion, see Landau and Micali (2021, p. 305).

Distribution: Upper Pliocene western Mediterranean (Landau and Micali, 2021, p. 306).

Chemnitzia lactea (Linnaeus, 1758)

Fig. 8M

*1758 *Turbo lacteus* Linnaeus, p. 765.

2021 *Chemnitzia lactea* (Linnaeus, 1758) – Landau and Micali, p. 289, pl. 94, figs. 1–2 (*cum syn.*).

Material: Height 4.4 mm, diameter 1.5 mm (incomplete). Tel-4: NHMW 2024/0165/0046 (1 specimen incomplete), Slama Formation, Piacenzian.

Discussion: For full discussion, see Landau and Micali (2021, p. 289).

Distribution: Widely distributed in Europe from the Upper Miocene to present-day, where it is found from the northeastern Atlantic, North Sea, southwards to Canaries and into the entire Mediterranean (Landau and Micali, 2021, p. 290).

Eulimella acicula (Philippi, 1836)

Fig. 8N

*1836 *Melania acicula* Philippi, p. 135, pl. 9, fig. 6.

2021 *Eulimella acicula* (Philippi, 1836) – Landau and Micali, p. 349, pl. 161, figs. 1–3 (*cum syn.*).

Material: Height 2.8 mm, diameter 0.8 mm (incomplete). Tel-4: NHMW 2024/0165/0053 (1 specimen), Slama Formation, Piacenzian.

Discussion: For full discussion, see Landau and Micali (2021, p. 349).

Distribution: Widely distributed in Europe from the Lower Miocene to present-day, where it is found from the northeastern Atlantic, North Sea, southwards to Senegal and Guinea-Bissau, and into the entire Mediterranean (Landau and Micali, 2021, p. 350).

7. Discussion

A total of 62 gastropod species were identified, with five species left in open nomenclature. The vast majority of the specimens examined come from two levels in the section (Fig. 1C), the transition zone (Tel-2) considered to be the uppermost part of the Tahria Formation, Zanclean, Lower Pliocene, and the upper marls (Tel-4) of the Slama Formation, Piacenzian, Upper Pliocene. The preservation at both levels is similar. The shells are relatively well preserved, although often fragmentary, and the surface is decalcified or decorticated. This is especially true of the preservation of specimens from Tel-2. The protoconch is sometimes preserved in specimens from Tel-4, although the surface is almost invariably abraded.

7.1. Tahria Formation, Zanclean, Lower Pliocene (Tel2)

Relatively few gastropods were collected from level Tel-2. 14 species were identified, of which Turritellid genera predominate. *Cochlis* sp., *Clavatula* (s.l.) sp., and?*Angustifusus* sp. were also present, but all too poorly preserved to include in the systematic section.

The assemblage suggests shallow-water, fully marine conditions prevailed and sandy substrate. During the Zanclean, the Mediterranean was fully tropical (Monegatti and Raffi, 2001; Silva et al., 2006; *inter alia*) and part of the Mediterranean Plio-Pleistocene Molluscan Unit 1 (MPPMU1), former MPMU1 (Mediterranean Pliocene Molluscan Unit 1) as defined by Monegatti and Raffi (2001) for the Mediterranean (Silva et al., 2010). However, the Tel-2 assemblage does not contain any gastropods suggesting fully tropical conditions in the Mediterranean (see Landau et al., 2011, p. 50, table 1). Therefore, the dating of the Tahria Formation cannot be supported by its gastropod content.

7.2. Slama Formation, Piacenzian, Upper Pliocene (Tel4)

The largest number of specimens by far were collected from level Tel-4. 53 species were identified. Turritellids and *Cochlis* sp. predominate, although the total number of *Cochlis* specimens found was considerably higher than that registered here, as most specimens were too abraded to identify to species level. Despite Tel-4 being the most speciose assemblage, it is still a depauperate fauna compared to other Mediterranean and Iberian Atlantic Pliocene assemblages. However, although collecting was intensive, it was only carried out on two occasions. Therefore, this number is likely to be an underestimate of the true diversity.

Of the total 56 taxa identified to species level, 48 were found in Tel-4. Of these, only 18 (38%) are still extant. As for the Tel-2 assemblage, these species represent a shallow-water, fully marine fauna. There are no species associated with rocky deposits nor seagrass communities. The substrate was likely to be sandy. As with Tel-2, there are no tropical elements to the assemblage. As Tel-4 is more speciose, this finding is more likely to be significant. There are no strombids, which are marker species for tropical water, and only one terebrid and one conid, of which greater diversity is found in tropical faunas (Monegatti and Raffi, 2001; Silva et al., 2006). Moreover, none of the gastropods suggesting fully tropical conditions in the Mediterranean by Landau et al. (2011, p. 50, table 1) are found.

Based on foraminifera Mazzola (1971) and dinoflagellates and calcareous nannofossils (Tchouar, 2013; Osman et al., 2021; Atik et al., 2024), Tel-4 is Piacenzian Upper Pliocene in age. Ecostratigraphically, the Lower Piacenzian is part of the tropical MPPMU1 which continued until the major cooling event at about 3.0 Ma (mid-Piacenzian). This was superseded by MPPMU2, which was subtropical. Still warm enough to sustain some molluscs with tropical affinity, but not *Strombus* (s.l) and a small number of Terebridae and Conidae (Silva et al., 2010; Landau et al., 2011). Based on the gastropods, the assemblage in Tel-4 fits within MPPMU2. The upper limit of MPPMU2 is marked by the disappearance of all tropical elements from the Mediterranean assemblages as a result of a minor cooling event that occurred at 2.7 Ma (Monegatti and Raffi, 2007).

8. Conclusions

The Upper Pliocene siliciclastic succession exposed at the southwestern flank of the Dahra Mountains (NW Algeria) is made up of the uppermost Tahria Formation and the Slama Formation. It is rich in shallow marine molluscan fossils, dominated by diverse bivalves,

gastropods, and scaphopods. Gastropods were collected with the purpose of their first comprehensive inventory list for the Pliocene of Algeria and further taphonomic analysis. We then recorded 62 gastropods within such a scope, some of which are described here for the first time in the Mediterranean (e.g., *Gibberula epigrus*) or outside the Alboran Sea (e.g., *Crassispira velerinensis*).

Gastropods collected from both the Tahria and Slama formations are typical for the Mediterranean Pliocene and suggest a fully marine environment with sand substrate. Both assemblages are relatively depauperated compared to other coeval Mediterranean assemblages. Dating of the Tahria Formation to Zanclean Lower Pliocene is not supported by the gastropod assemblage alone. Gastropods found in the Slama Formation are typical for the Mediterranean during subtropical unit MPPMU2. No species endemic to the assemblages were found.

The gastropod assemblages display significant taphonomic alteration, such as fragmentation and abrasion, while bioerosion structures are scarce, except for a few traces produced by predatory gastropods (*Oichnus simplex* and *Oichnus paraboloides*), polychaete activity (*Maeandropolydora* isp.), and acrothoracican barnacle borings (*Rogerella* isp.). Because the Upper Pliocene marine bottom was made of unconsolidated sediments, shells provided the only hard substrate available for colonisation by endoskeletozoans.

Disclosure of interest

The authors declare that they have no competing interest.

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