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Gastropoda, Tergomya and Paragastropoda (Mollusca) from the Lower Ordovician Fezouata Formation, Morocco

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ABSTRACT

Gastropoda, Tergomya, and Paragastropoda (GTP) are a small but recognizable part of the collective Fezouata biota from the Lower Ordovician (Tremadocian–Floian) Fezouata Formation in Morocco. GTP range through the sequence but become more abundant and diverse in the stratigraphically higher and shallower marine parts of the succession. About 200 rock samples in existing collections have GTP but usually each slab contains several specimens so the number of individual is many times higher. A total of seven species are recognized of which four were known earlier. Gastropods are represented by the planispiral bellerophontoid *Sinuites* sp., recognized for the first time in the Tremadocian part of the succession, and the anisostrophic, nearly planispiral *Lesueurilla prima* (Barrande in Perner). Tergomyans are most abundant, dominated by the genus *Carcassonnella* with *Carcassonnella courtessolei* Horný and Peel, *Carcassonnella vizcainoi* Horný and Peel, and *Carcassonnella* sp. The latter encompass several specimens from different localities and stratigraphical levels, and may represent one of the named species or new varieties. *Carcassonnella* is for the first time recorded in the Tremadocian part of the succession. A second tergomyan is *Thoralispira laevis* (Thoral), while paragastropoda are represented by *Pelecyogyra fezouataensis* Ebbestad and Lefebvre. In the peri-Gondwana area *Carcassonnella*, *Thoralispira*, and *Lesueurilla* are considered signature taxa, and the Fezouata GTP compare closely with those of Montagne Noire, France, both in composition and distribution. The Bohemian fauna is slightly younger (Floian–Darriwilian) with different species, except for *Lesueurilla prima*. The latter may have a wider distribution, being tentatively recognized in the Lower Ordovician of Argentina and Spain.

1. Introduction

Molluscs of the classes Gastropoda, Tergomya, and Paragastropoda (GTP) are a recognizable part of the collective Fezouata biota from the Lower Ordovician of Morocco, albeit not among the elusive, exceptionally preserved non-biomineralized or lightly sclerotised elements (Van Roy et al., 2010; Martin et al., in press). Commonly the GTP are found as regular internal or external moulds, sometimes with traces of their external shell preserved, sometimes in aggregations on bedding planes or in nodules, sometimes as part of unsorted bioclastic accumulations. The diversity of these mollusc groups is comparatively low in Fezouata biota terms, especially in the older and deeper parts of succession, but they are a noticable component of the assemblage and represent an important part of the fauna in a peri-Gondwana setting. The Tremadocian and Floian generic GTP diversity in peri-Gondwana areas is generally low with less than 10 genera recognized. Compared to similar faunas of the Czech Republic, France, Spain, and Argentina, the Moroccan assemblage is on a generic level the second richest of these, only slightly surpassed by that of the combined Ibero-Armorica terranes (Horný, 1997b; Ebbestad et al., 2013). The fauna in these areas is as well relatively similar suggesting biogeographical proximity, which is supported by other faunal evidence (see chapters in Harper and Servais, 2013). This is remarkable and important as genera of Tremadocian and Floian GTP globally otherwise display a large high endemicity (Ebbestad et al., 2013).

The present paper presents new material from the Fezouata Formation and expands on the extensive review and taxonomic descriptions of Moroccan Ordovician GTP by Horný (1997b). Stratigraphical ranges are constrained and the GTP assemblage is discussed in an ecological, biostratigraphical, and biogeographical context.

2. Geological setting and material

In the Zagora area of Central Morocco (Fig. 1) the Lower Ordovician succession (Tremadocian–Floian) is about 900 m thick (Martin et al., in press; Gutiérrez-Marco and Martin, 2016–in this issue; Vaucher et al., 2016–in this issue). The Fezouata Shale Formation is in the Zagora area unconformably overlying Cambrian strata. Together with the Zini Sandstone Formation (latest Floian) and the Darriwilian Tachilla Shale Formation, these three units form the Outer Feijas Group (Destombes

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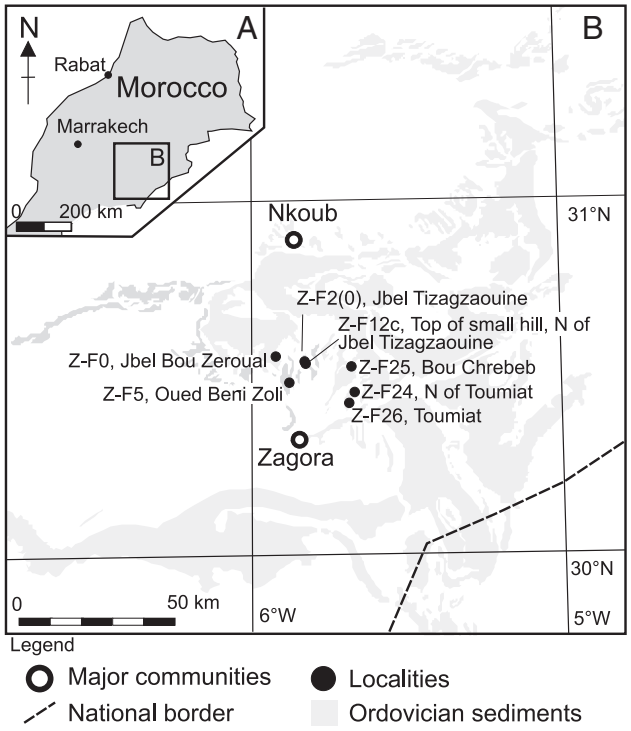

Fig. 1. A. Morocco with an inset (B) of the Zagora area. B. Ordovician outcrops in the Zagora area and vicinities with the localities discussed herein. Modified from Kröger and Lefebvre (2012) and Ebbestad and Lefebvre (2015).

et al., 1985). Outside the Zagora area local occurrence of a glauconitic and ferruginous horizon makes it possible to subdivide the Fezouata Formation into a lower and upper member (Destombes et al., 1985; Martin et al., in press). Graptolites confirm the *Araneograptus murrayi* (Stage Slice Tr3) for the oldest GTP fauna, comprising part of the Lower Fezouata Member, while the upper part is included in the Floian (Stage Slices Fl1–Fl3) (Fig. 2) (Martin et al., in press; Gutiérrez-Marco and Martin, 2016–in this issue). Stage Slices follow Bergström et al. (2009).

GTP in the present study come from eight localities of the Fezouata Formation from the Zagora area (Table 1, Fig. 1). About 210 samples with GTP are presently registered in existing collections at the Cadi-Ayyad University, Marrakesh, Morocco (AA), Lyon 1 University, Villeurbanne, France (FSL), Muséum d'Histoire Naturelle, Marseille, France (MHNM), Muséum d'Histoire Naturelle, Nantes, France (MHNN), Muséum d'Histoire Naturelle, Toulouse, France (MHNT), and the Musée des Confluences, Lyon, France (ML), and the collections are still growing. Each sample usually contains two or more specimens or sometimes numerous specimens in clusters or assemblages, so the total number of specimens exceeds 210 by far. Several GTP are usually found at each locality (Table 1), but mostly the assemblage of GTP on any particular surface will be monospecific (usually *Carcassonnella*) or with a single specimen of another GTP taxon associated. Other associated faunal elements vary, but are nearly always subordinate if there is a GTP assemblage on the surface. The deeper facies in the *A. murrayi* Biozone generally have low diversity assemblages, although locality Z-F5 in this zone is an exception (Kröger and Lefebvre, 2012; Ebbestad and Lefebvre, 2015) and has a high diversity assemblage. The stratigraphical higher localities all have high diversity assemblages.

Horný (1997b) described Ordovician GTP from Morocco based on extensive material collected earlier by Jacques Destombes (France) from a number of localities from the Tarfaya Province in the SW to the wider Zagora area and the Tafilalt Province in the northeast (Horný, 1997b, fig. 1 and locality descriptions; Gutiérrez-Marco et al., 2003, text and appendix). Horný (1997b) described specimens of gastropods and tergomyans from 11 localities of the Upper Fezouata Member. No

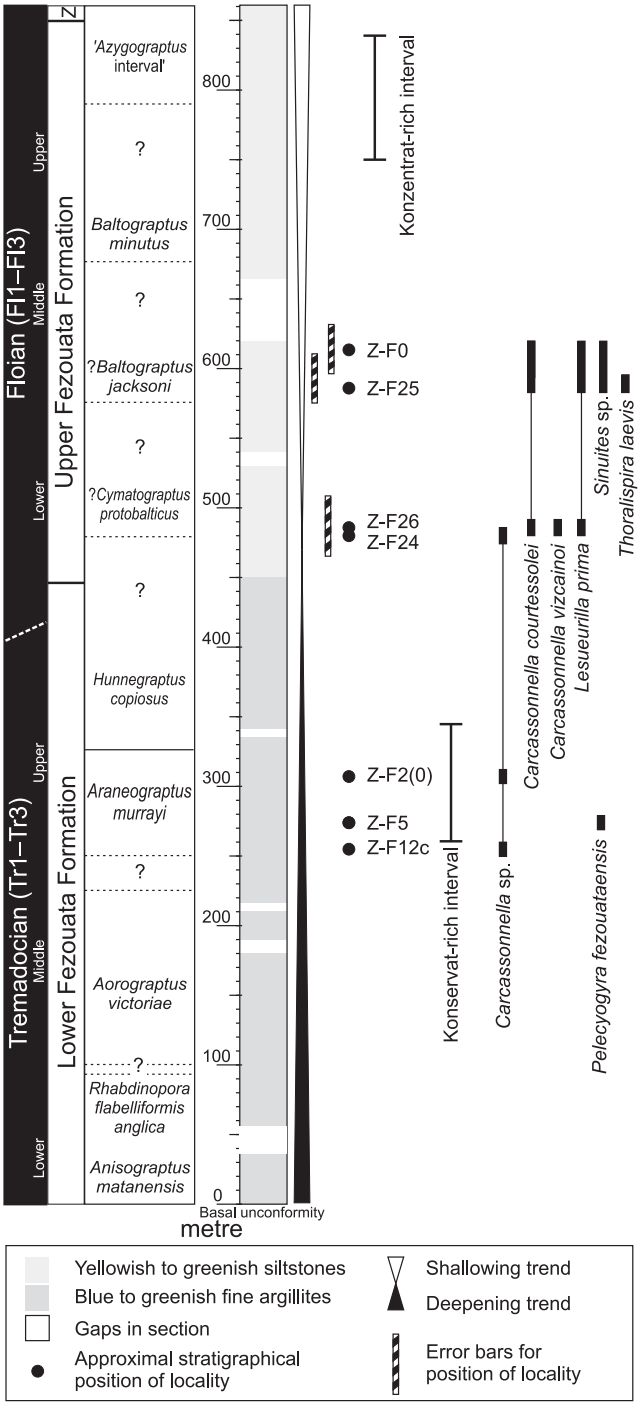

Fig. 2. Composite log of the Fezouata Formation, with the distribution of localities and taxa discussed in here. Stratigraphy follows Martin et al. (in press); Gutiérrez-Marco and Martin (2016–in this issue); Lefebvre et al. (2016–in this issue), and Vaucher et al. (2016–in this issue). Stages Slices follow Bergström et al. (2009).

gastropods or tergomyans were reported from the Lower Fezouata Member, as understood at that time, while the Upper Fezouata Member yielded the signature taxa *Thoralispira* (two species), *Carcassonnella*, and *Leseurilla* with 52, 11, 11, and 1 specimens respectively (Horný, 1997b). At two of the localities the gastropod or tergomyan taxa were not associated with other tergomyans and gastropods, while for the two other sites one had *Carcassonnella* associated with *Thoralispira* and one had *Carcassonnella* associated with *Lesueurilla*. Other associated fauna presented in the list of localities by Horný (1997b) does not generally give conclusive age constraint but two of the Destombes