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Late Viséan (Carboniferous) gastropods from the Gara El Itima (eastern Anti-Atlas, Morocco)

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Abstract

Diverse and well-preserved Late Viséan (Early Carboniferous) gastropod faunas from the eastern Anti-Atlas of Morocco are described herein. The new genus *Itimaspira* n. gen. is described as well as the six new species *Ananias weyeri* n. sp., *Itimaspira klugi* n. sp., *Nodospira krawczynskii* n. sp., *Baylea cordulae* n. sp., *Cinclidonema marocensis* n. sp., and *Schizostoma africanum* n. sp., together with specimens of the genera *Baylea*, *Orthonema*, ?*Knightella* sp. and *Macrochilina* in open nomenclature.

Introduction

The Early Carboniferous sedimentary succession in the Anti-Atlas of Morocco has long been in the shadow of the much wider distributed, locally more fossiliferous, and therefore more intensely studied Devonian succession. Early Carboniferous macrofossils from the Anti-Atlas have been described only rarely until the 1990's; one of the contributions is the ammonoid monograph by Delépine (1941). Termier & Termier (1950) reported 18 species of various gastropod genera (*Platyceras*, *Schizostoma*, *Straparollus*, *Microdoma*, *Anematina*, *Bellerophon*, *Euphemites*, *Worthenia*, *Ptychomphalina*, *Baylea*, "*Gosseletia*" [objective synonym erroneously used by Termier & Termier for *Gosseletina* Fischer, 1885], and *Zygopleura*) from different Viséan localities in Morocco, most in open nomenclature or in vague relation to gastropods from Belgium or Great Britain. Their plates figured 41 specimens, including 16 specimens in open nomenclature and 9 without generic determination, demonstrating the actual rudimentary knowledge of the Viséan gastropod fauna of Morocco.

Only the two genera *Straparollus* and *Baylea* that were reported by Termier & Termier (1950) from the Gara el Itima can be confirmed without taxonomic doubts. A revision of the Viséan gastropods described by Termier & Termier (1950) and of additional recently studied localities will be necessary in the future to elucidate the relationships and precise stratigraphic position of this earlier described material.

The extensive studies of the Palaeozoic rocks of the Anti-Atlas by Wendt et al. (1984) and Wendt (1985, 1988) have motivated special focus on the biostratigraphic subdivision of the Late Devonian and Carboniferous sequences (Fig. 1). The re-discovery, in the mid-1990's, of the ammonoid-bearing localities described by Delépine (1941) resulted in a first monograph on the Late Viséan ammonoid faunas from the area of Taouz (Korn et al. 1999), followed by a number of studies (Korn et al. 2002, 2003, 2005, 2007; Klug et al. 2006), during which the gastropod material described here was assembled. Therefore, all the material can precisely be assigned to distinct horizons in terms of ammonoid biostratigraphy (Fig. 2).

The present article is the first monographic description of Viséan gastropods from the Anti-Atlas. All studied specimens are well preserved; the moderate to large sizes suggest good feeding conditions. The increasing number of species and specimens within the three assemblages may have been supported by an improvement of living conditions at the bottom.

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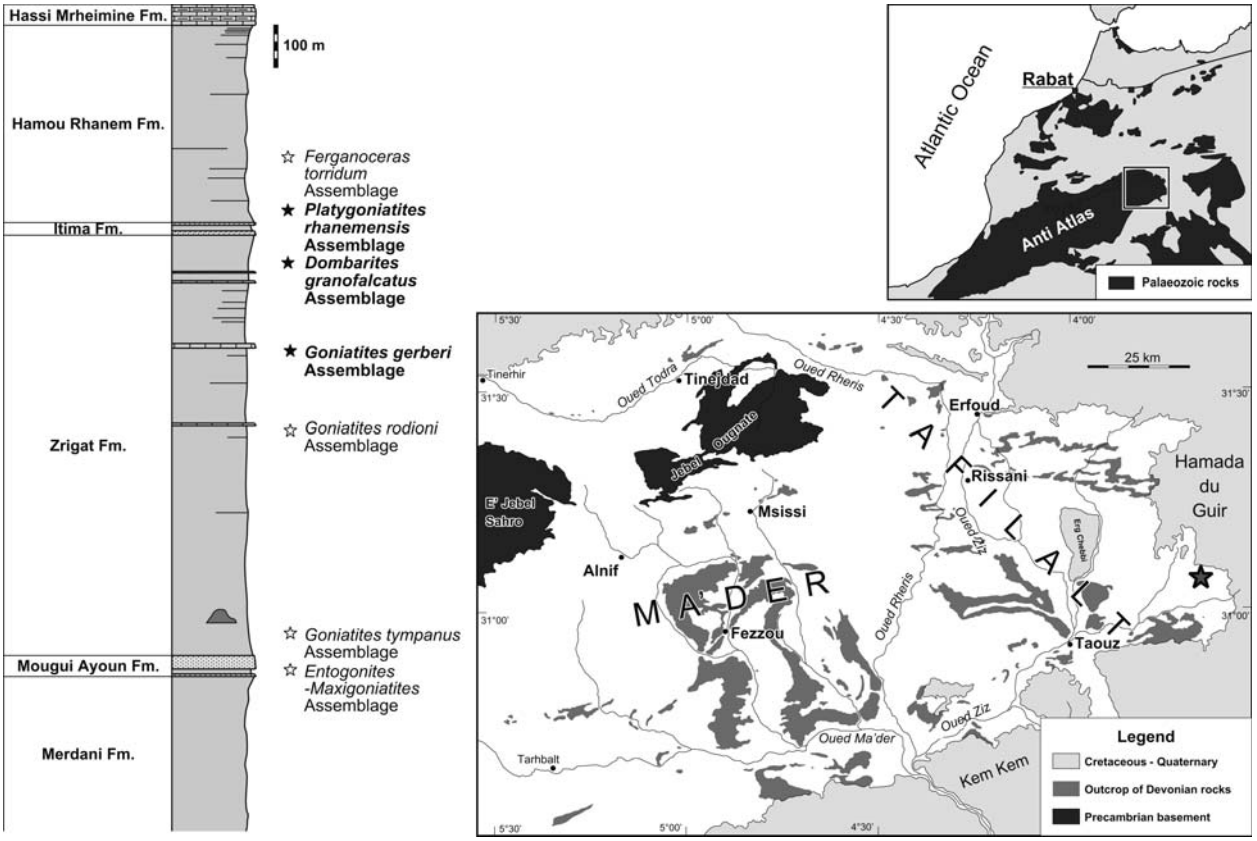

Figure 1. The geographic position of the Gara El Itima (marked by an asterisk) in the Anti-Atlas of Morocco and the lithostratigraphy with the gastropod-bearing fossil horizons.

Most of the genera are also known from Europe. However, there appears to be no match at the species level.

Stratigraphy of the assemblages

The entire material from the Gara el Itima described here has a Brigantian (Late Viséan) age; it derives from the Zrigat Formation and the Hamou-Rhanem Formation. Three of the ammonoid assemblages (Klug et al. 2006; Korn et al. 2007) also yielded gastropods, in ascending order:

Goniatites gerberi Assemblage – This assemblage is most probably of early Brigantian (middle Late Viséan) age because of the occurrence of advanced representatives of the genus *Goniatites*.

Dombarites granofalcatus Assemblage – The occurrence of the index species may indicate a middle Brigantian age, perhaps near the occurrence of the related genus *Lusitanoceras* in Central Europe.

Platygoniatites rhanemensis Assemblage – The co-occurrence of the genera *Platygoniatites*, *Neogoniatites*, *Hypergoniatites*, *Dombarites*, and *Sudeticeras* resembles faunas from the so-called Nm1a Zone of the South Urals (Ruzhencev & Bogoslovskaya 1971). This zone is situated below the entry of the genus *Cravenoceras*, and therefore, a late Brigantian age is most likely (Korn et al. 2007).

Material

In total, 93 specimens of gastropods were studied. All specimens are deposited in the fossil invertebrate collection of the Museum für Naturkunde at Berlin (Germany). They were collected during several field campaigns at the following places (terminology for localities and horizons following Klug et al. 2006):

Locality GI-A (C. Klug & S. Döring 1998 and D. Korn 1999 Coll.); Horizon GI-3 (= *Dombarites granofalcatus* Assemblage):
Cinclidonema marocensis n. sp.: 1 specimen (MB.Ga.2713)
Nodospira krawczynskii n. sp.: 3 specimens (MB.Ga.2718.1–MB.Ga.2718.3)
Orthonema sp.: 1 specimen (MB.Ga.2722)

Locality GI-B (D. Korn 1999 Coll.); Horizon GI-4 (= *Platygoniatites rhanemensis* Assemblage):
Itimaspira klugi n. gen. n. sp.: 1 specimen (MB.Ga.2728)
Schizostoma africanum n. sp.: 6 specimens (MB.Ga.2719.1–MB.Ga.2719.6)
Baylea cordulae n. sp.: 1 specimen (MB.Ga.2720)
Ananias weyeri n. sp.: 1 specimen (MB.Ga.2721)

Locality GI-I (V. Ebbighausen & D. Korn 2004 Coll.); Horizon GI-4 (= *Platygoniatites rhanemensis* Assemblage):
Cinclidonema marocensis n. sp.: 54 specimens (MB.Ga.2712.1–MB.Ga.2712.54)
Macrochilina aff. *acuta* de Koninck, 1881: 1 specimen (MB.Ga.2714)
?*Knightella* sp.: 1 specimen (MB.Ga.2715)
Itimaspira klugi n. gen. n. sp.: 4 specimens (MB.Ga.2716.1–MB.Ga.2716.4)

Locality GI-K (V. Ebbighausen & D. Korn 2004 Coll.); Horizon GI-2 (= lower *Goniatites gerberi* Assemblage):
Itimaspira klugi n. gen. n. sp.: 1 specimen (MB.Ga.2729)
Ananias weyeri n. sp.: 1 specimen (MB.Ga.2717)

Locality GI-N (new locality at the southern foot of the Gara el Itima; V. Ebbighausen & D. Korn 2008 Coll.); Horizon GI-2 (= upper *Goniatites gerberi* Assemblage):

Ananias weyeri n. sp.: 3 specimens (MB.Ga.2723.1–MB.Ga.2723.3)
Nodospira krawczynskii n. sp.: 10 specimens (MB.Ga.2724.1–MB.Ga.2724.10)
Baylea cordulae n. sp.: 2 specimens (MB.Ga.2725.1–MB.Ga.2725.2)
?*Baylea* cf. *concentrica* (Phillips, 1836): 1 specimen (MB.Ga.2726)
?Orthonemoid gastropod: 1 specimen (MB.Ga.2727)

Systematic palaeontology

Class **Gastropoda** Cuvier, 1797
Subclass **Archaeogastropoda** Thiele, 1925
Order **Vetigastropoda** von Salvini-Plawen, 1980
Family **Eotomariidae** Wenz, 1938

Ananias Knight, 1945

Type species. Phanerotrema? *welleri* Newell, 1935.

Diagnosis. Moderately high-spired, gradate shell; concave to flat selenizone forming the transition between a broad upper whorl surface and the outer whorl face and bordered by distinct lirae; ornamentation variable.

Remarks. Knight (1945) established the late Pennsylvanian genus *Ananias* to separate high-spired, gradate forms from more low-spired species of *Glabrocingulum* Thomas, 1940. Members of the genus *Ananias* always possess a concave selenizone bordered by spiral lirae instead of a convex selenizone as in the similar *Worthenia* de Koninck, 1883. Knight et al. (1960), Hoare (1961), Waterhouse (1963), and Gordon & Yochelson (1983, 1987) regarded *Ananias* as a subgenus of *Glabrocingulum*, while Batten (1989) suggested two separated genera. Kues & Batten (2001) then returned to the older subgeneric classification concept without any explication. However, the differences in shape and ornamentation between the gradate *Ananias* and the more trochiform *Glabrocingulum* are regarded important enough for us to support here Batten's (1989) suggestion. The convergence between *Ananias welleri* Knight, 1945 and *Worthenia tabulata* (Conrad, 1835) has been studied by Eldredge (1968).

Stratigraphic occurrence. *Ananias* ranges from the Early Carboniferous into the Permian.

Ananias weyeri n. sp.

Figure 3

Derivation of name. Named after Dieter Weyer (Berlin), in honour of his contributions to palaeontology.

Holotype. Specimen MB.Ga.2721 (V. Ebbighausen and D. Korn 2004 Coll.); illustrated in Figure 3A.

Type locality and horizon. Gara el Itima, locality GI-B (Klug et al. 2006); *Platygoniatites rhanemensis* Assemblage (late Brigantian, Viséan).

Paratype material. Specimen MB.Ga.2717 from locality GI-K (lower *Goniatites gerberi* Assemblage); illustrated in Figure 3B; three specimens (MB.Ga.2723.1–MB.Ga.2723.3) from locality GI-N (upper *Goniatites gerberi* Assemblage).

Diagnosis. Gradate, turbiniform shell with elevated spire; whorls with broad, oblique upper whorl surface; slightly concave to flat selenizone forming the angulation between upper and outer whorl face, bordered by distinct spiral lirae; outer whorl face slightly convex; suture distinct; ornamentation reticulate with many spiral and transverse lirae.

Description. Holotype MB.Ga.2721 possesses a gradate, turbiniform shell with at least 7 whorls; apex pointed; diameter of the whorls increasing regularly in height and width; pleural angle 60°; broad oblique upper whorl face (inclined about 50° down from the suture) bordered by a rounded angulation; whorl faces slightly

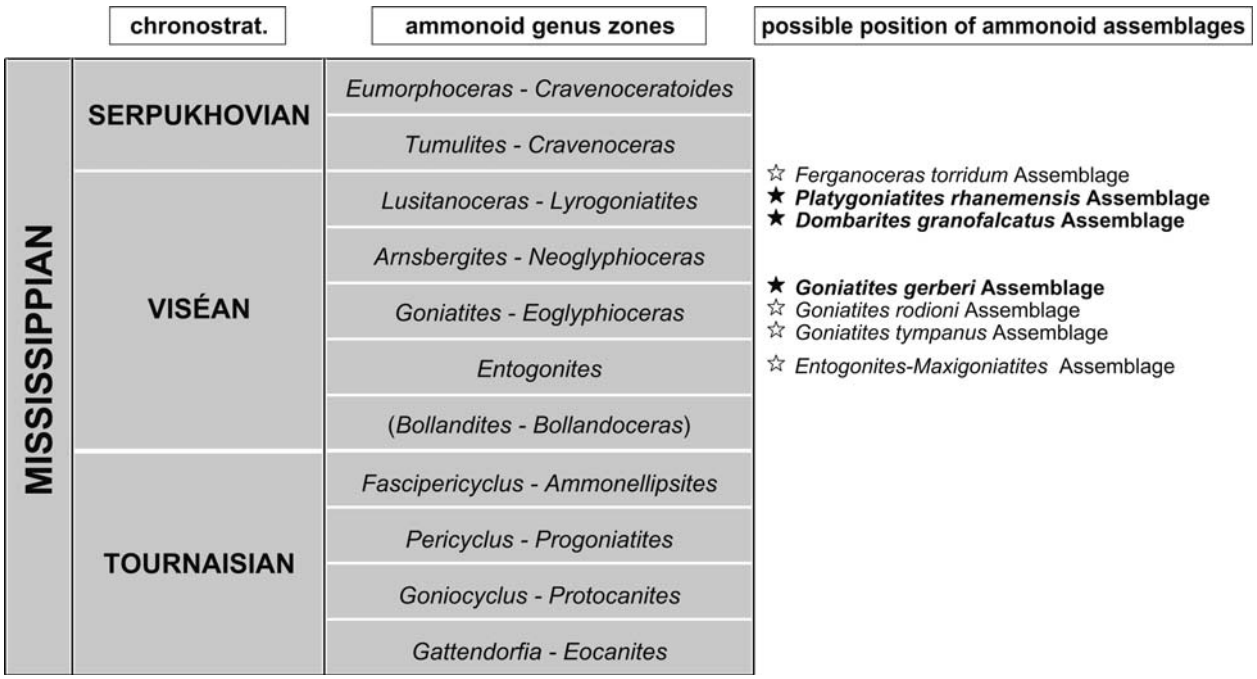

Figure 2. The ammonoid stratigraphy of the gastropod-bearing fossil horizons in the area of the Gara El Itima.

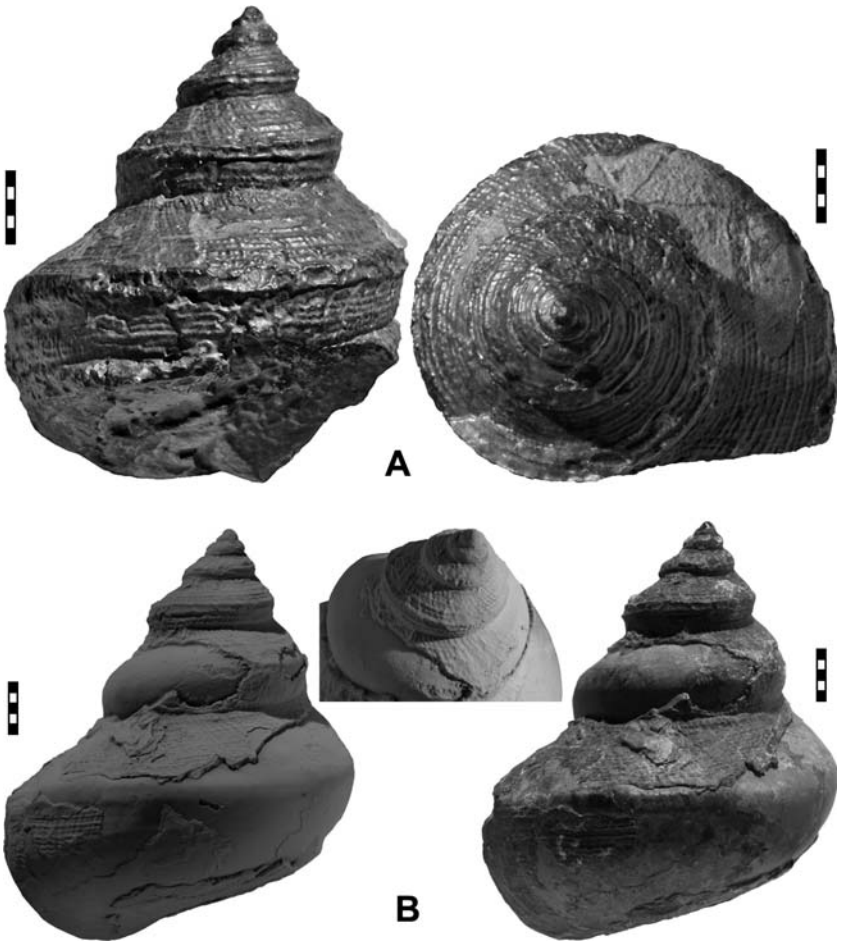

Figure 3. *Ananias weyeri* n. sp. from the Gara El Itima. **A.** Holotype MB.Ga.2721 from locality GI-B (*Platygoniatites rhanemensis* Assemblage), lateral and apical views; × 2.0. **B.** Paratype MB.Ga.2717 from locality GI-K (lower *Goniatites gerberi* Assemblage), lateral view (specimen whitened), obtuse apical view, lateral view (specimen not whitened); × 1.5. Scale bar equals in all figures 5 mm.

convex; periphery formed by the selenizone; broad, slightly concave selenizone directly on the transition between upper and outer whorl face on the last whorl, bordered by two distinct lirae, with widely spaced lunulae; sutures distinct; base convex, anomphalous; aperture nearly round; outer lip with deep slit generating the selenizone; ornamentation of numerous straight closely spaced growth lines and about 14 fine spiral lirae forming a reticulate pattern on the upper whorl surface; numerous fine, straight growth lines below the selenizone, bent somewhat backwards adapically near the selenizone, crossed by about 10 equidistant spiral lirae.

Discussion. The presence of a flat, bordered selenizone distinguishes the new species from the widespread Carboniferous species *Worthenia tabulata* (Conrad, 1835). *Ananias welleri* (Newell, 1935) and *A. wannense* (Newell, 1935) have fewer spiral lirae, show more prominent nodes and their sutures are not as deep as in *A. weyeri* n. sp. In comparison to *Itimaspira klugi* n. gen. n. sp., the species does neither have a concave outer whorl face nor two strong keels but rather a convex outer whorl face without lower keel. In contrast to the selenizone situated below the keel in *Itimaspira klugi* n. gen. n. sp., the selenizone here forms the upper angulation.

Many species assigned to the subgenus *Ananias* as defined by Knight et al. (1960) are much less gradate than the type species of *Ananias* and therefore are closer to the genus *Glabrocingulum*. Their names are here cited according to their original description. *Glabrocingulum* (*Ananias*) *talpaensis* Kues & Batten, 2001 has strongly developed spiral ornamentation and two or three subsutural lirae with conspicuous transverse nodes. It has a less incised suture than *Ananias weyeri*.

The lower spired *Glabrocingulum* (*Ananias*) *nodocostatus* Hoare, 1961 has only one subsutural row of nodes while *Ananias weyeri* does not develop any row of subsutural nodes. *Glabrocingulum* (*Ananias*) *campbelli* Waterhouse, 1963 is distinguishable by its typical prominent spiral lirae of three different orders and by a concave selenizone ornamented with spiral lirae. *Glabrocingulum* (*Ananias*) *seminudum* Gordon & Yochelson, 1983 has a short spire and the spiral lirae are much coarser. *Glabrocingulum* (*Ananias*) *nevadense* (Walcott, 1884), as figured in Gordon & Yochelson (1987), resembles *Ananias weyeri* n. sp. in size, general shape and the position of the selenizone. In contrast, its ornamentation is more pronounced and the number of spiral and collabral elements exceeds that of *A. weyeri*.

The following Permian representatives of the genus *Ananias* described by Batten (1989) possess well pronounced transverse subsutural nodes but the spiral lirae are weak or missing on the outer whorl faces. In addi-

tion, *Ananias labrectus* has nearly vertical outer whorl faces. The latter feature is also present in *Ananias permianus* as well as the dominance of spiral ornament. *Ananias ootomaria* has much more inflated globose whorls and a very convex base while *Ananias appeli* possesses a wide, flattened median selenizone.

"*Pleurotomaria*" *subscalaris* Meek & Worthen, 1861 (Meek & Worthen 1866: 360, pl. 28, fig. 10a, b) from the Coal measures of Illinois is also very close and only differs in having a less convex base than *Ananias weyeri* and about 20 spiral lirae on the last whorl instead of 14 above the selenizone and numerous on the base.

Family **Lophospiridae** Wenz, 1938
Subfamily **Ruedemanniinae** Knight, 1956

Itimaspira n. gen.

Derivation of name. Free combination of the name of the type locality Gara El Itima and the Latin *spira* (spire).

Type species. *Itimaspira klugi* n. sp.

Diagnosis. Gradate shell with concave outer whorl face between a distinct upper and lower keel; suture incised but not deep; narrow, indistinct flat selenizone with lunulae directly below upper angulation; ornamentation prosocline growth lines or cords on the adapical whorl face and opisthocline growth lines on the outer whorl face, no nodes.

Discussion. The new genus *Itimaspira* resembles *Worthenia* de Koninck, 1883, but lacks prominent nodose ornamentation. Additionally, the selenizone is rather weak, narrow and flat in the new genus instead of the convex, prominent selenizone in *Worthenia*. Species of the genus *Ananias* Knight, 1945 do not develop vertical outer whorl faces or a second spiral keel forming the transition between outer whorl face and base. *Trochonema* Salter, 1859 develops a slightly similar shell shape, but has no distinct selenizone and possesses more angulations by keels than *Itimaspira*. It also closely resembles the Silurian genus *Lophospira* Whitfield, 1886, which is higher spired without a selenizone.

Itimaspira klugi n. sp.

Figure 4

Derivation of name. Named after Christian Klug (Zürich) who discovered the Gara el Itima assemblages.

Holotype. Specimen MB.Ga.2716.1 (V. Ebbighausen and D. Korn 2004 Coll.); illustrated in Figure 4A.

Type locality and horizon. Gara el Itima, locality GI-I (Klug et al. 2006); *Platygoniatites rhanemensis* Assemblage (late Brigantian, Viséan).

Paratype material. Three specimens (MB.Ga.2716.2–MB.Ga.2716.4) from the type locality; one specimen (MB.Ga.2728) from locality GI-B (*Platygoniatites rhanemensis* Assemblage); one specimen (MB.Ga.2729) from locality GI-K (lower *Goniatites gerberi* Assemblage).

Diagnosis. Gradate, turbiniform shell with elevated spire, whorls with broad oblique upper whorl face and vertical flat to slightly concave outer whorl face bordered by two distinct sharp keels, narrow, flat selenizone below upper keel; ornamentation with prosocline growth lines.

Description. Gradate, turbiniform shell with at least 6 whorls, apex pointed, diameter of the whorls increasing slowly in height and width; pleural angle 65–70°; broad oblique upper whorl face below suture (inclined about 50°) bordered by a sharp narrow convex keel; outer whorl faces concave; lower edge of whorl face also bordered by a distinct, narrow keel; periphery formed by the upper keel; narrow, flat selenizone directly below the upper keel on the outer whorl face with numerous widely spaced lunulae; suture very shallow; base slightly convex; aperture nearly round; ornamentation of numerous closely spaced, prosocline growth lines on the upper whorl surface, curvature more distinct close to the keel; opisthocline growth lines on the outer whorl face.

Discussion. The presence of a narrow, flat selenizone below the keel is a clear distinguishing character to separate this species from similar species in other genera. *Worthenia* develops the selenizone as convex keel and has a rounded base without lower keel. Additionally, the selenizone of *Worthenia tabulata* (Conrad, 1835) is highly ornamented. The genus *Ananias* shows a concave selenizone bordered by two distinct keels and no basal angulation.

The similar "*Pleurotomaria*" *chesterensis* Meek & Worthen, 1861 (Meek & Worthen 1866: 303, pl. 24, fig. 1) develops a broad flat selenizone between the lateral angulations. The type species of *Trochonema*, *Pleurotomaria umbilicata* Hall, 1847, does not develop a selenizone. The whorls have four angulations in contrast to species of *Lophospira* Whitfield, 1886 with three angulations. Both genera are stratigraphically much older and do not develop a flat selenizone. The Permian *Worthenia corrugata* Chronic, 1952 figured in Kulas & Batten (1997: 44, pl. 2, figs. 6A–C, 7A–C) possesses a lower spire and smaller, less oblique upper whorl face of the whorls.

Nodospira Yochelson & Dutro, 1960

Type species. *Nodospira ornata* Yochelson & Dutro, 1960 (late Mississippian).

Diagnosis. Moderately high-spired shells with well rounded, convex whorls; periphery near mid-whorl height and peripheral, concave, raised selenizone, bordered by strong convex flanges; lower edge of the selenizone visible above the sutures; ornamentation of distinct collabral lirae.

Remarks. Yochelson & Dutro (1960) proposed the genus *Nodospira* to restrict the quite widely defined genus *Mourlonia* de Koninck, 1883. Their new genus is distinguished by well rounded whorls and distinct strong flanges which border the selenizone. It differs from *Ptychomphalina* Fischer, 1885 by its median selenizone and the well rounded convex whorls. *Lunulazona* Sadlick & Nielsen, 1963 has a distinctly flat upper

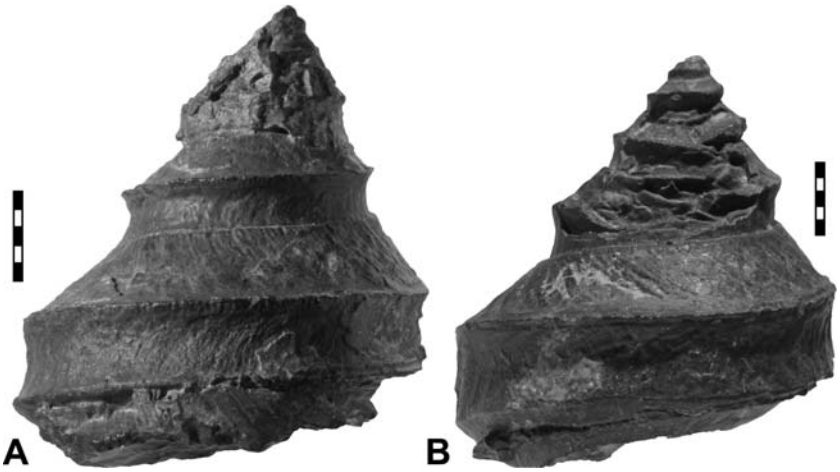

Figure 4. *Itimaspira klugi* n. gen. n. sp. from the Gara El Itima (locality GI-I; *Platygoniatites rhanemensis* Assemblage). **A.** Holotype MB.Ga.2716.1, lateral view, last whorl not preserved; ×2.5. **B.** Paratype MB.Ga.2716.2, lateral view; × 2.0.

whorl profile, a much broader selenizone and may develop subsutural riblets or nodes.

Nodospira krawczynskii n. sp.

Figure 5

Derivation of name. Named after Wojciech Krawczyński (Sosnowiec, Poland) in honour of his contributions to gastropod palaeontology.

Holotype. Specimen MB.Ga.2718.1 (D. Korn 1999 Coll.); illustrated in Figure 5A.

Type locality and horizon. Gara el Itima, locality GI-A (Klug et al. 2006); *Dombarites granofalcatus* Assemblage (middle to late Brigantian, Viséan).

Paratype material. The two specimens MB.Ga.2718.2 and MB.Ga.2718.3 from the type locality and 10 specimens (MB.Ga.2724.1–MB.Ga.2724.10) from locality GI-N (upper *Goniatites gerberi* Assemblage).

Diagnosis. Moderately conical shells with convex whorls; narrow subsutural convex ramp; periphery slightly below mid-whorl height and peripheral, raised, slightly concave selenizone bordered by two sharp spiral keels; selenizone visible above the sutures; anomphalous; ornamentation of strong, distinct prosocline equidistant lirae curving obliquely backwards at the upper whorl faces; on the base with nearly straight and slightly oblique strong lirae.

Description. Conical shell nearly as wide as high, about 6 convex whorls; whorl profile with small convex ramp below the suture, then moderately convex; distinct, prominent peripheral selenizone slightly below mid-whorl height, but always distinctly above the suture, bordered by two sharp spiral keels, selenizone slightly concave, lunulae strong, distinct, and widely spaced; suture not deep; anomphalous; base moderately convex; ornamentation on the upper whorl faces with strong, equidistant, prosocline lirae curving obliquely backwards and on the base with strong, slightly oblique, straight lirae, the submedian lirae being slightly less strong than the upper lirae.

Discussion. The specimens studied here show two variable forms: Variety A (holotype MB.Ga.2718.1, paratypes MB.Ga.2718.2, MB.Ga.2718.3, MB.Ga.2724.1, MB.Ga.2724.2, MB.Ga.2724.6, MB.Ga.2724.10) is higher than wide, has more rounded whorls; the selenizone of the upper whorls is distinctly above the suture and the prosocline lirae are dense and very oblique. Variety B (paratypes MB.Ga.2724.3–MB.Ga.2724.5, MB.Ga.2724.7–MB.Ga.2724.9) has a lower spire, the upper whorl face is very oblique, the selenizone is directly above the suture and the transverse lirae are strong and have broader distances than in Variety A with intersected fine ones. Most of the specimens regarded as belonging to Variety B are fragments. Transition between the two varieties can be observed. Up to now the material does not allow the establishment of two different species.

Nodospira krawczynskii differs from the type species *N. ornata* Yochelson & Dutro, 1960 in developing a narrow subsutural ramp especially on the last whorl. The lirae on the upper whorl faces are bent more backwards on *N. krawczynskii* than on *N. ornata*, whereas the basal lirae of *Nodospira ornata* are prosocline below the selenizone instead of straight. *N. krawczynskii* is distinguished from the rather similar *N. subconoidea* (de Koninck,

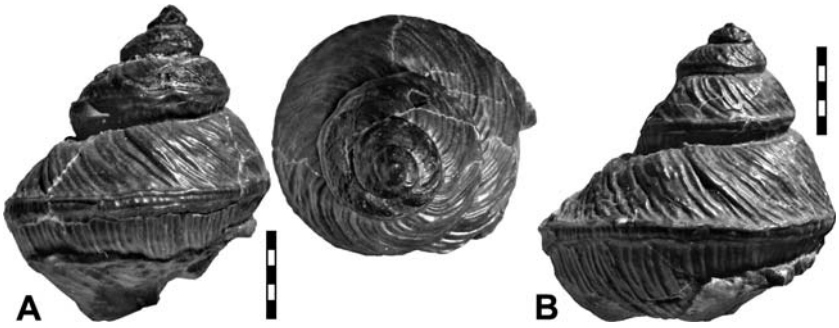

Figure 5. *Nodospira krawczynskii* n. sp. from the Gara El Itima (locality GI-A; *Dombarites granofalcatus* Assemblage). **A.** Holotype MB.Ga.2718.1, lateral view and apical view; ×2.5. **B.** Paratype MB.Ga.2718.2 lateral view; ×2.5.

1883) by the position of the selenizone which is always distinctly above the sutures in the new species. It differs from *N. conimorpha* (de Koninck, 1883) by higher whorls and more arcuate transverse lirae above the selenizone, the latter being more salient than on *N. conimorpha*. ?*N. perstriata* (de Koninck, 1883) possesses much finer lirae on the adapical whorl face and a smooth base. *N. conica* (Phillips, 1836) shows an ornament with additional fine spiral lirae. The interspaces between the transverse lirae of *N. lodanensis* (Holzapfel, 1889) are wider and the lirae are less pronounced. *Mourlonia carinata* (Sowerby, 1812) does not develop a subsutural ramp, the lirae are more dense and weaker, and the selenizone is low on whorls instead of being in a median position.

Family **Raphistomatidae** Wenz, 1938
Subfamily **Omospirinae** Wenz, 1938

Baylea de Koninck, 1883

Type species. *Trochus yvanii* Léveillé, 1835 (Early Carboniferous).

Diagnosis. Turbiniform shell with gradate spire; peripheral, slightly oblique, concave selenizone on the upper angulation of the whorls; ornamentation of spiral elements.

Remarks. Representatives of the genus *Baylea* are widespread in Middle Devonian to Permian strata.

Baylea cordulae n. sp.

Figure 6

Derivation of name. Named after Cordula Schmid, who encouraged the studies of the senior author.

Holotype. Specimen MB.Ga.2720 (D. Korn 1999 Coll.); illustrated in Figure 6.

Type locality and horizon. Gara el Itima, locality GI-B (Klug et al. 2006); *Platygoniatites rhanemensis* Assemblage (late Brigantian, Viséan).

Paratype material. 2 specimens (MB.Ga.2725.1, MB.Ga.2725.2) from locality GI-N (upper *Goniatites gerberi* Assemblage).

Diagnosis. Moderately large species of the genus *Baylea* with low spire and prominent concave selenizone at the upper angulation of the whorl bordered by two distinct spiral lirae; whorls concave below the selenizone, then becoming convex; shell always wider than high; ornamentation of numerous spiral lirae equal in strength and in distance crossed by very fine prosocyrt growth lines.

Description. The holotype possesses a turbiniform shell of at least six whorls developing a broad, oblique upper whorl face and a distinct peripheral prominent angulation; outer whorl face below the angulation somewhat concave, then slightly convex. Base well rounded towards the minute umbilicus. Sutures distinct and deep. Broad, concave, prominent selenizone bordered by two spiral lirae, situated at the upper angulation. Ornamentation with many predominant, strong equidistant spiral cords of equal strength and weak prosocyrt growth lines on the lower whorl surface.

Discussion. *Baylea leveillei* de Koninck, 1883 is similar in size and resembles *B. cordulae* n. sp. in the general shape of the shell. In contrast, *B. cordulae* n. sp. develops a very prominent selenizone on the last whorl; it is ornamented with equally sized spiral lirae, and its whorl profile is distinctly concave below the selenizone. The Early Carboniferous *B. spirolirata* Batten, 1966 (p. 24, pl. 3, figs 2, 3), *B. turritoidea* de Koninck, 1883, *B. communis* de Koninck, 1883, *B. duplicostata* de Koninck, 1883, and *B. yvanii* (Léveillé, 1835) are more slender and display more elevated spires. *B. luxurians* de Koninck, 1883 develops a reticulate ornamentation while in other species of *Baylea* the spiral lirae are predominant. The last whorl of *B. concentrica* (Phillips, 1836) has much wider and more obtuse upper whorl face; its spiral lirae are arranged at irregular distances. *B. simplex* de Koninck, 1883 is smaller and shows denser spiral lirae than *B. cordulae.*

The Permian *Baylea huecoensis* Batten, 1989 is much more turreted and develops interference nodes between the subsutural spiral lirae. *B. kuesi* Batten, 1995 has a more conical shell and also shows small interference nodes between the spiral lirae. Kues & Batten (2001) discussed the generic assignment of the variable Middle Pennsylvanian *Baylea*? *inclinata* (Weller, 1929), which possesses a small selenizone. Its ornamentation with 10–12 spiral lirae with intersected smaller lines distinguishes *B.*? *inclinata* from *B. cordulae*. The Devonian representatives of *Baylea* do not exceed 25 mm in height and 17 mm in width.

Figure 6. *Baylea cordulae* n. sp. from the Gara El Itima (locality GI-B; *Platygoniatites rhanemensis* Assemblage). Holotype MB.Ga.2720, lateral, apertural, and basal view; ×1.5.

?*Baylea* cf. *concentrica* (Phillips, 1836)

cf. 1836 *Pleurotomaria concentrica* Phillips: 228, pl. 15, fig. 23.
? 1883 *Baylea concentrica* (Phillips). – de Koninck: 72, pl. 28, figs 15–18.
pt 1950 *Baylea* cf. *concentrica* (Phillips). – Termier & Termier: 17, pl. 78, fig. 29.

Material. 1 specimen (MB.Ga.2726) from locality GI-N (upper *Goniatites gerberi* Assemblage).

Description. The turbiniform specimen (MB.Ga.2726) is 28.5 mm high and 30.0 mm wide with four convex whorls preserved; whorls with moderately broad upper whorl face and slightly convex outer whorl faces; periphery at about mid-whorl height; selenizone very small, flat, bordered by two weak spiral lirae, forming the transition between upper and outer whorl face; sutures moderately deep; base well rounded; ornamentation with distinct equidistant, somewhat nodulous spiral lirae.

Discussion. The only studied specimen is a fragment of 4 whorls with its shell only preserved in little parts. Therefore, a satisfying, precise determination is not yet possible. The specimen differs from *Baylea cordulae* n. sp. and the Belgian specimens figured by de Koninck (1883) as *Baylea concentrica* (Phillips) in not developing a distinct adapical keel forming the transition between upper and outer whorl face. Termier & Termier (1950) figured two Viséan specimens from Bir Meghrane, which they called *Baylea* cf. *concentrica* (Phillips). The two figures on pl. 78 look quite different: Figure 29 shows an apparently deformed specimen of probably a different species, while Figure 30 illustrates a reticulate pattern on the upper whorls. The determination of the two latter specimens seems to be questionable and requires a revision.

Suborder **Trochomorpha** Naef, 1911
Family **Holopeidae** Wenz, 1938
Subfamily **Gyronematinae** Knight, 1956

Cinclidonema Knight, 1945

Type species. *Cinclidonema texanum* Knight, 1945 (Pennsylvanian).

Diagnosis. Turbiniform shell with ramp below suture; anomphalous; columellar lips slightly reflexed; ornamentation with numerous spiral cords and collabral threads; spiral ornament slightly dominant.

Remarks. The genus *Cinclidonema* ranges at least from the Late Carboniferous to the Middle Permian.

Cinclidonema marocensis n. sp.

Figure 7

Derivation of name. Named after Morocco where the new species has been recorded.

Holotype. Specimen MB.Ga.2712.1 (V. Ebbighausen and D. Korn 2004 Coll.); illustrated in Figure 7A.

Type locality and horizon. Gara el Itima, locality GI-I (Klug et al. 2006); *Platygoniatites rhanemensis* Assemblage (late Brigantian, Viséan).

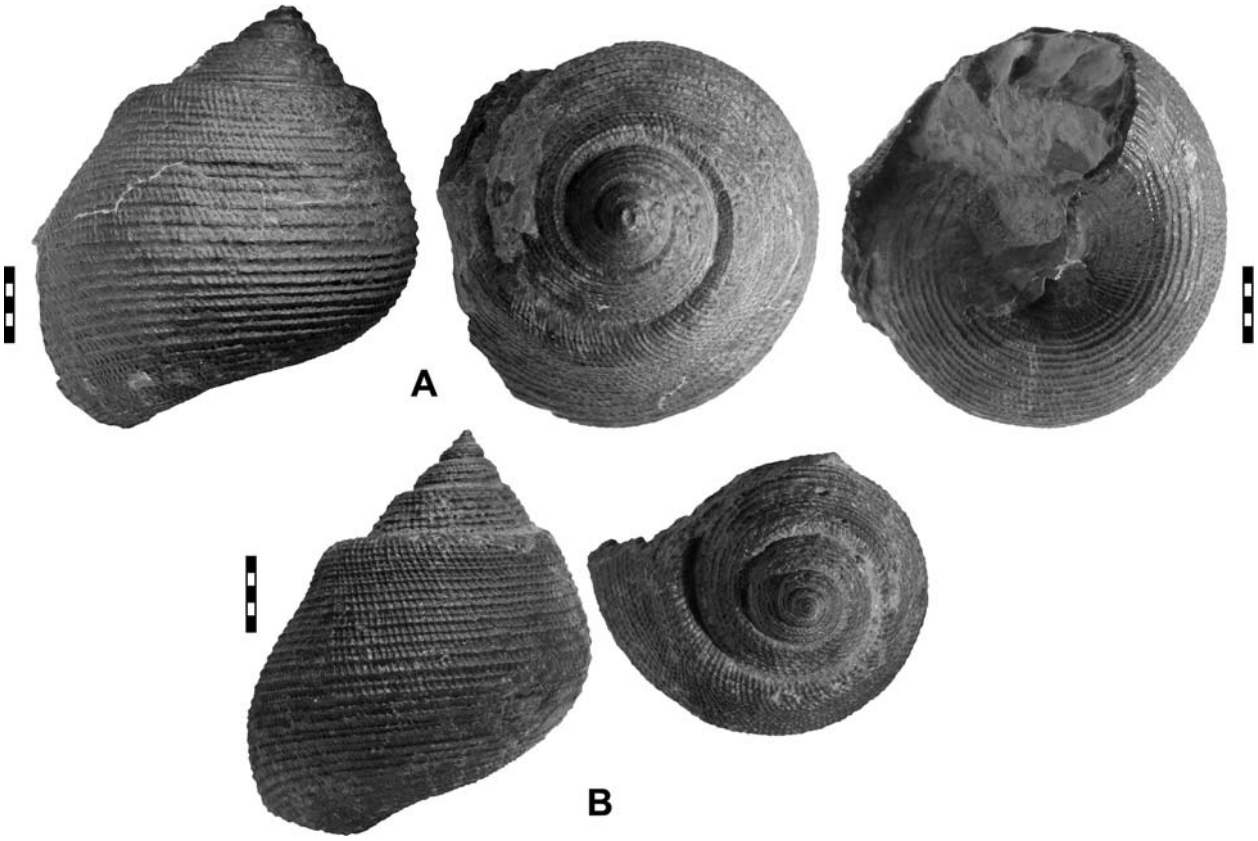

Figure 7. *Cinclidonema marocensis* n. sp. from the Gara El Itima (locality GI-I; *Platygoniatites rhanemensis* Assemblage). **A.** Holotype MB.Ga.2712.1, lateral, apical, and basal view; ×2.0. **B.** Paratype MB.Ga.2712.2 lateral and apical view; ×2.0.

Paratype material. 53 specimens, (MB.Ga.2712.2–MB.Ga.2712.54) from the type locality; one specimen (MB.Ga.2713) from locality GI-A.

Diagnosis. Turbiniform shell with elevated spire and small but distinct convex ramp; whorls higher than broad; ornamentation of collabral and spiral lirae.

Description. Turbiniform shell with six whorls, apex pointed, diameter of the whorls increasing slowly in height and width, last whorl larger than spire, covering about two thirds of total shell height; pleural angle about 70°; first whorls convexly rounded; elevated, small distinct convex ramp below upper suture on the last whorl, upper third of the whorl slightly concave, then only slightly convex, more convex curvature low on whorl forming transition between flank and base; periphery low on whorls; sutures deep and incised; base convex; minute false umbilicus covered by the reflexed columellar lip; aperture nearly round, outer lip slightly oblique to shell axis; ornamentation of numerous closely spaced spiral cords (more than 50 on the last whorl) and prosocline collabral threads forming small nodes when crossing; intercalation of slightly weaker spiral cords in the abapical part of the last whorl; in younger specimens spiral elements slightly dominant, in older specimens spiral and collabral elements in nearly same strength; ornamentation even entering the umbilical area.

Discussion. Cinclidonema marocensis is the most abundant gastropod species known from the Gara El Itima. In contrast to the American late Pennsylvanian *C. texanum* (Knight 1945: 584, pl. 80 figs 4a–c), *C. marocensis* has a more elevated apex and spire. Immediately below the rounded ramps, the whorl flanks are somewhat concave and the whorls are higher than broad. Our specimens show a certain variability concerning the ratio of height and width and the shape of the last whorl. The upper ramps may be more or less convex.

Subclass **Euomphalomorpha** Bandel & Frýda, 1998
Superfamily **Euomphaloidea** de Koninck, 1881
Family **Euomphalidae** de Koninck, 1881

Schizostoma Bronn, 1835

Type species. *Helix catillus* Martin, 1793 (Early Carboniferous).

Diagnosis. Planispiral shell with many whorls; apical and umbilical keel on the last whorl; umbilicus very wide, showing all whorls; ornamentation with orthocline growth lines.

Discussion. According to Knight (1941) the holotype is lost. Knight et al. (1960) synonymised *Schizostoma* Bronn, 1835 with *Euomphalus* de Koninck, 1881 having only one keel on the apical surface. We here follow the interpretation of Bandel & Frýda (1998) who regarded *Schizostoma* as a distinct genus.

Schizostoma africanum n. sp.

Figure 8

Derivation of name. Named after the continent Africa where the material was collected.

Holotype. Specimen MB.Ga.2719.1 (D. Korn 1999 Coll.); illustrated in Figure 8A.

Type locality and horizon. Gara El Itima, locality GI-B (Klug et al. 2006); *Platygoniatites rhanemensis* Assemblage (late Brigantian, Viséan).

Paratype material. Five specimens (MB.Ga.2719.2–MB.Ga.2719.6) from the type locality.

Diagnosis. Moderately sized, discoical shell with distinct peripheral keel on the apical whorl face, a weak, rounded peripheral keel on the umbilical whorl face; outer whorl face gently arched; umbilicus very wide; ornamentation with orthocline distinct growth lines.

Description. Medium discoidal shell; first whorls depressed; four whorls with nearly horizontal to obtuse concave apical whorl face developing a sharp peripheral keel; outer whorl face slightly convex, near upper

Figure 8. *Schizostoma africanum* n. sp. from the Gara El Itima (locality GI-B; *Platygoniatites rhanemensis* Assemblage). **A.** Holotype MB.Ga.2719.1, apical and umbilical view; ×2.0. **B.** Paratype MB.Ga.2719.2 apical and lateral view; ×2.0.

keel sometimes flat to concave; weak, rounded, more median keel on the umbilical surface; sutures distinct; umbilicus wide and shallow, showing all whorls; ornamentation with distinct orthocline radial growth lines.

Discussion. The aperture of the species is not known. *Schizostoma africanum* differs from *S. catillus* (Martin, 1793) by its moderate size and in developing only a weak and more rounded keel on the umbilical whorl face. *S. crateriforme* de Koninck, 1881 has a larger diameter, consists of more whorls, and the outer whorl face is less convex. In *S. calyx* (Phillips, 1836), the umbilicus is wider than the apical surface. *Euomphalus plummeri* (Knight, 1934) and *E. serratus* (Knight, 1934), as figured in Kues & Batten (2001), possess a less sharp, more rounded apical keel. *E. intermedius* (Gordon & Yochelson, 1983) has whorls with trapezoidal cross section and flattened umbilical whorl faces.

Subclass **Caenogastropoda** Cox, 1959
?Order **Palaeocaenogastropoda** Bandel, 1993
Superfamily **Orthonematoidea** Nützel & Bandel, 2000 (emend. by Bouchet & Rocroi 2005)
Family **Orthonemidae** Nützel & Bandel, 2000

Knightella Longstaff, 1933

[pro *Knightia* Longstaff, 1933, suppressed objective synonym by Knight (1941)]

Type species. *Knightia irregularis* Longstaff, 1933 (Early Carboniferous).

Diagnosis. Slender high-spired shell with many rounded whorls; periphery low on whorls; moderately deep sutures; outer lip of aperture with very shallow sinus; ornament with numerous fine growth lines.

Remarks. According to Nützel (1998), the protoconch is smooth with one spiral lira on the larval shell. It evidently differs from ornamented protoconchs of the Pseudozygopleuridae Knight, 1930.

?*Knightella* sp.

Figure 9A

Material. Specimen MB.Ga.2715 (V. Ebbighausen and D. Korn 2004 Coll.); illustrated in Figure 9A from Gara El Itima, locality GI-I (Klug et al. 2006); *Platygoniatites rhanemensis* Assemblage (late Brigantian, Viséan).

Diagnosis. Large, high-spired shell, whorls wider than high; ornamentation with fine, dense, slightly opisthocyrt, fine axial threads.

Description. The holotype is a large and slender, high-spired shell; five whorls preserved; whorls always wider than high (ratio height/width 0.61), whorl profile within a small flattened band adpressed near suture and gently rounded below, periphery below mid-whorl height; sutures shallow but distinct; apex and last whorl not preserved; ornamentation with numerous opisthocyrt, densely arranged axial threads which are only slightly curved above periphery, maximum curvature at about mid-whorl.

Discussion. Only one incomplete specimen with five whorls is available; it shows neither apex nor aperture or umbilical area. The generic assignment of the specimen is therefore only tentative. The classification within the genus *Knightella* Longstaff, 1933 remains uncertain as long as no specimen with preserved protoconch has been found.

The type species, *Knightella irregularis* (Longstaff, 1933), is characterized by additional spiral lirae. *K. gundyensis* (Yoo, 1994) has a minute shell with 7 smooth whorls. *K. minima* Nützel, 1998 and *K. donaldinopsis* Nützel, 1998 also represent very minute representatives of the genus.

?*Knightella* sp. resembles somewhat to *Microptychis expetendus* Hoare & Sturgeon, 1981, but has finer and no sigmoidal threads. *M. turbineus* Hoare & Sturgeon, 1981 has grooved sutures and a flattened whorl profile. "*Melania*" *tumida* Phillips, 1836 shows a slight resemblance in general shape of the shell but has straight growth lines.

A doubtful second specimen (MB.Ga.2727) from locality GI-N is only preserved as a fragmentary steinkern.

Orthonema Meek & Worthen, 1861

Type species. *Eunema salteri* Meek & Worthen, 1861 (Pennsylvanian).

Diagnosis (based on Anderson et al. 1985). High-spired shell; whorls with subsutural shelf ending in a spiral thread or carina, below whorl

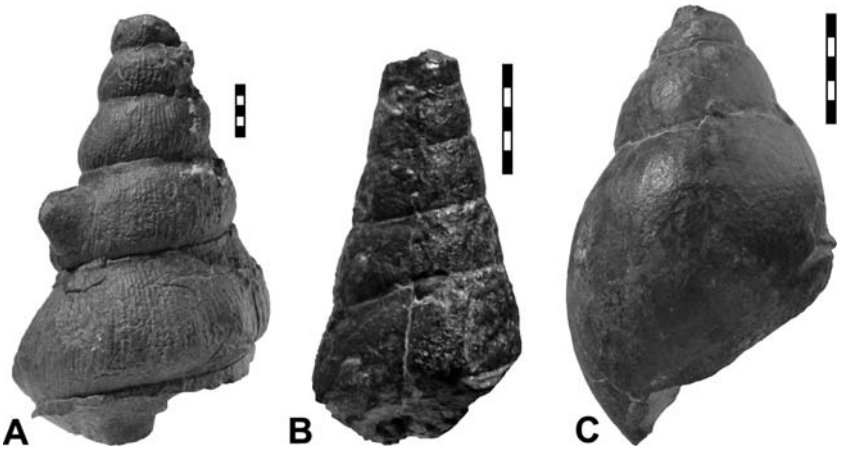

Figure 9. Gastropods from the Gara El Itima. (locality GI-B; *Platygoniatites rhanemensis* Assemblage). **A.** ?*Knightella* sp., MB.Ga.2715, locality GI-I (*Platygoniatites rhanemensis* Assemblage), lateral view; ×1.5. **B.** *Orthonema* sp., specimen MB.Ga.2722, locality GI-A (*Dombarites granofalcatus* Assemblage) lateral view; ×3.0. **C.** *Macrochilina* aff. *acuta* de Koninck, 1881, specimen MB.Ga.2714, locality GI-I (*Platygoniatites rhanemensis* Assemblage) lateral view; ×3.0.

profile nearly straight; base rounded; anomphalous; ornamentation with two or more threads, color bands or carinae below the subsutural thread; protoconch of about two to three smooth, rounded whorls, larval shell with a submedian spiral lira (Herholz 1992; Bandel 2002).

Remarks. Batten (1985) remarks that specimens of *Orthonema* usually occur in low numbers within faunas of other abundant gastropod species. This fact can be confirmed for the fauna from the Gara El Itima.

***Orthonema* sp.**

Figure 9B

Material. Specimen MB.Ga.2722 (D. Korn 1999 Coll.).

Type locality and horizon. Gara El Itima, locality GI-A (Klug et al. 2006); *Dombarites granofalcatus* Assemblage (middle to late Brigantian, Viséan).

Description. High-spired shell with many whorls; whorl profile slightly convex, whorls wider than high, increasing very slowly; sutures very shallow; base slightly convex; surface apparently smooth.

Discussion. Since the only preserved specimen is damaged and consists of only five whorls, a final determination is not yet possible. The specimen appears to be close to the Permian *Orthonema*? sp. Kulas & Batten, 1997, which is also poorly known. The generic assignment is only tentative.

Family **Soleniscidae** Wenz, 1938

***Macrochilina* Bayle, 1880**
***Macrochilina* aff. *acuta* de Koninck, 1881**

Figure 9C

Material. Specimen MB.Ga.2714 (V. Ebbighausen and D. Korn 2004 Coll.).

Type locality and horizon. Gara El Itima, locality GI-I (Klug et al. 2006); *Platygoniatites rhanemensis* Assemblage (late Brigantian, Viséan).

Description. Fusiform shell with at least six whorls, apex pointed, whorls increasing slowly in width but rapidly in height; pleural angle 50°; whorl faces only little convex; periphery below mid-whorl height; sutures shallow, not much incised; base convex; aperture pear-shaped; smooth whorl face.

Discussion. Only one incomplete specimen with four whorls is available, and neither apex nor aperture or umbilical area is preserved. The specific assignment is thus only tentative.

Acknowledgements

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Appendix

Shell dimensions and ratios of gastropods from the Gara El Itima.

	height	width	width/height	comments
Ananias weyeri n. sp.				
Holotype MB.Ga.2721	35.0	34.0	0.97	
Paratype MB.Ga.2717	41.0	33.0	0.80	
Paratype MB.Ga.2723.1	36.5	37.0	1.01	
Paratype MB.Ga.2723.2	28.0	27.0	0.96	
Paratype MB.Ga.2723.3	31.0	27.0	0.87	internal mould
Itimaspira klugi n. sp.				
Holotype MB.Ga.2716.1	28.0	23.0	0.82	last whorl not preserved
Paratype MB.Ga.2716.2	30.0	27.0	0.90	
Paratype MB.Ga.2716.3	21.0	25.0	1.19	
Paratype MB.Ga.2716.4	30.0	36.0	1.20	last whorl damaged
Paratype MB.Ga.2728	33.0	33.0	1.00	apex damaged, 4 whorls preserved
Paratype MB.Ga.2729	30.0	30.0	1.00	
Nodospira krawczynskii n. sp.				
Holotype MB.Ga.2718.1	17.0	15.0	0.88	
Paratype MB.Ga.2718.2	18.5	18.0	0.97	
Paratype MB.Ga.2718.3	17.0	23.0		fragment of three whorls
Paratype MB.Ga.2724.1	19.0	18.0	0.95	
Paratype MB.Ga.2724.2	12.0	13.0	1.08	base not preserved
Paratype MB.Ga.2724.3	16.5	18.5	1.12	
Paratype MB.Ga.2724.4	17.0	19.0	1.11	
Paratype MB.Ga.2724.5	16.0	16.0	1.00	
Paratype MB.Ga.2724.6	20.0	19.0	0.95	
Paratype MB.Ga.2724.7	17.0	19.5		fragment with 2 whorls
Paratype MB.Ga.2724.8	12.0	16.0		fragment with 3 whorls
Paratype MB.Ga.2724.9	11.0	19.0		fragment with 2 whorls
Paratype MB.Ga.2724.10	13.0	12.0	0.92	
Baylea cordulae n. sp.				
Holotype MB.Ga.2720	28.5	31.0	1.09	
Paratype MB.Ga.2725.1	33.0	33.0	1.00	
Paratype MB.Ga.2725.2	27.0	33.0	1.22	internal mould with 3 whorls
?*Baylea* cf. *concentrica* (Phillips, 1836)				
Specimen MB.Ga.2726	28.5	30.0	1.05	
Cinclidonema marocensis n. sp.				
Holotype MB.Ga.2712.1	31.0	27.5	0.89	
Paratype MB.Ga.2712.2	28.0	25.0	0.89	
Paratype MB.Ga.2712.3	29.0	26.0	0.89	

Appendix (continued)

	height	width	width/height	comments
Paratype MB.Ga.2712.4	27.0	23.5	0.87	
Paratype MB.Ga.2712.37	19.0	18.0	0.95	
Paratype MB.Ga.2712.53	38.0	34.0	0.89	
Schizostoma africanum n. sp.				
Holotype MB.Ga.2719.1	10.0	26.0	2.60	
Paratype MB.Ga.2719.2	10.5	30.0	2.86	
Paratype MB.Ga.2719.3	9.0	24.5	2.72	
Paratype MB.Ga.2719.4	10.0	21.5	2.15	
Paratype MB.Ga.2719.5	8.0	16.0	2.00	
Paratype MB.Ga.2719.6	5.5	12.0	2.18	
?*Knightella* sp.				
Specimen MB.Ga.2715	41.0	25.0	0.61	
(?) Specimen MB.Ga.2727	31.0	20.0	0.65	internal mould with 3 whorls
Orthonema sp.				
Specimen MB.Ga.2722	18.0	10.0	0.56	5 whorls preserved
Macrochilina aff. *acuta* de Koninck, 1881				
Specimen MB.Ga.2714	21.0	13.0	0.57	