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FOSSILS FROM THE LOWER GLOBIGERINA LIMESTONE FORMATION AT WARDIJA, GOZO (MIOCENE, AQUITANIAN), WITH A DESCRIPTION OF SOME NEW PTEROPOD SPECIES (MOLLUSCA, GASTROPODA)

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ABSTRACT

Phosphatised fossil assemblages of four samples from the Lower Globigerina Limestone Formation at Wardija (SE Gozo, Malta) were analysed, with special emphasis on holoplanktonic molluscs (Gastropoda: Heteropoda and Pteropoda). The upper sample (sample 4) is from the lower main phosphorite level (C 1), samples 1 to 3 are respectively from c. 3 m, 5 m and 7.50 m above the base of the Lower Globigerina Limestone. Phosphatised faunal elements were separated from the limestone sediment by formic acid treatment.

The fossil assemblages yielded a surprising number of species new for the Maltese Archipelago, or even new to science. Comparison with other holoplanktonic mollusc assemblages, especially those from the Aquitaine Basin in France demonstrates that there is a certain resemblance with the Chattian fauna of *e.g.* St. Etienne-d'Orthe (*Spoelia torquayensis*, *Vaginella* ? *tricuspidata*), but the presence of some other species, such as *Gamopleura melitensis* and *Vaginella sannicola* indicate that the age of the Lower Globigerina Limestone presumably is Early Aquitanian.
Samples 2-3 yielded also a comparatively rich assemblage of benthic molluscs (especially small-sized gastropods), most of which are illustrated here (Pls 1-3). The holoplanktonic molluscs are illustrated on Pls 3-4.

The following species are introduced: *Heliconoides vanderweideni* sp. nov., *Bowdenatheca miocenica* sp. nov., *Clio* (s. lat.) *ghawdexensis* sp. nov., and *Edithinella bonaviai* sp. nov.

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INTRODUCTION

Fossils in the Maltese Globigerina Limestone Formation are predominantly found as phosphoritic casts. Two main phosphorite levels separate the three subdivisions of this formation (Rehfeld & Janssen, 1995) and a varying number of subordinate levels containing phosphoritic nodules or clasts is present in the Middle and Upper Globigerina Limestone. Up to now such subordinate occurrences were not yet known from the Lower Globigerina Limestone, of Aquitanian age, below the main phosphoritic level C1, separating the Lower and Middle Globigerina Limestone.
Mr Charles Galea Bonavia (Attard, Malta), however, drew my attention to a locality, where a level bearing phosphorites is present below C1, and he was kind enough to demonstrate the site during a visit in October 2000. Further details on this section were observed on February 7, 2001, at that time also two additional levels with small phosphorites were found below C1, more samples were collected and a concise description of the section was made.

Abbreviations used in this paper:

MNHN:	Musée National d'Histoire Naturelle, Paris, France.
NHMM:	Natural History Museum, Mdina, Malta
RGM:	Nationaal Natuurhistorisch Museum 'Naturalis', Leiden, The Netherlands (Palaeontology Department, Cainozoic Mollusca), formerly Rijksmuseum van Geologie en Mineralogie.
H:	shell height
W:	shell width
H/W-ratio:	shell height/shell width x 100

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LOCALITY

The locality is situated at Wardija, near Wardija Point, on the extreme SW corner of the island of Gozo, at coordinates UTM 268.886 (Fig. 1).

At this place the C1 phosphorite level crops out as a significant harder level on top of the Lower Globigerina Limestone, which in turn overlies the Lower Coralline Limestone, rising from the sea as a high (>125 m) vertical cliff. Situated close to the studied site is a Punic-Hellenistic "sanctuary" (Buhagiar, 1988), a deep excavation in the top of the Lower Globigerina Limestone, roofed by the solid sediment of the C1 phosphorite level. Above C1 a small portion of Middle Globigerina Limestone may still be present, but was not observed.

The eroded coastal Miocene sediments are unconformably overlain in this area by presumably Holocene sediments (grey sandy clay) up to a thickness of some 6 meters, that especially in their basal part contain a terrestrial mollusc fauna yielding species in an assemblage hardly or not differing from the actual living fauna. An overview of the locality is given in Fig. 2

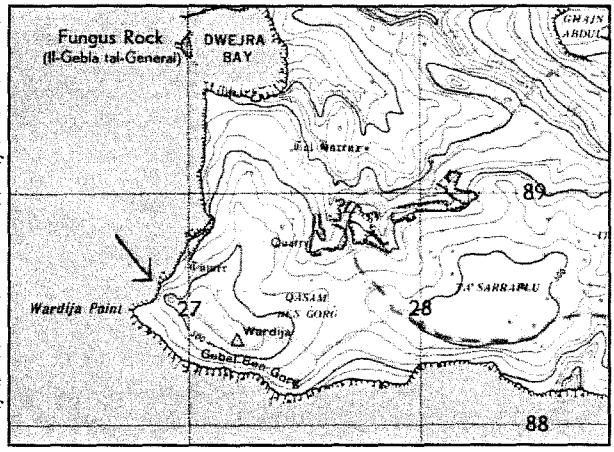

Fig. 1. Situation of sample locality, at Wardija, near Wardija Point, Gozo, Malta.
(Topographical map of Malta 1 : 25.000)

The thickness of the Lower Globigerina Limestone could not be measured accurately but is estimated to be c. 11 m. Several thin layers of concentrated fossil material are present below the base of C1. Most of this fossil material consists of non-phosphatised fragments of irregular sea urchins, but three levels below C1 also contain small phosphorite concretions. Each of these three levels yielded pteropods: even in the field internal casts of *Vaginella sannicola* could be recognised, as well as some rare specimens of *Gamopleura melitensis*.

The same Lower Globigerina Limestone is intensively quarried for building stone, at a distance of less than 1 km (indicated on the map of Fig. 1).

DESCRIPTION OF SECTION

11.25 - 11.50 m Phosphorite concentration with many corals and specimens of the pteropod *Gamopleura melitensis* (main phosphorite level C1) (sample 4) (top level visible in Figs. 2 and 5).

7.50 - 11.25 m yellowish to light yellowish-brown limestone (Fig. 4), with some burrowing; in the basal 25 cm dispersed small phosphorite concretions (sample 3), rare pectinids, the pteropods *Vaginella sannicola* (common) and *Gamopleura melitensis* (rare), and some specimens of the bivalve *Pycnodonte* (Fig. 5). At c. 8 and 9.50 m thin levels (few cm only) of abundant echinoid fragments, without visible phosphorite. Some larger and isolated burrows are completely filled with echinoid fragments (one visible in Fig. 4). Burrows from the overlying C1 reach the base of this level. The top of this limestone-part is indurated (Fig. 5).

5 - 7.50 m light yellowish-brown limestone with many burrows, and dispersed echinoids and pectinids. At the base a concentration of pectinids and some small phosphorite concretions (sample 2).

3 - 5 m light yellowish brown, burrowed limestone with dispersed echinoids and pectinids. At the base a concentration of pectinids (mainly *Amussiopecten*) and some small phosphorite concretions (sample 1). Burrows into the underlying level clearly visible because of differences in colour (Fig. 3).

0 - 3 m Light yellowish limestone overlying Lower Coralline Limestone, basal 2 m inaccessible in vertical cliff.

Microtectonic features (< 0.50 m) are visible in the upper 5 m of this section.

MATERIAL AND METHODS

Sample weights: sample 4 - 3.8 kg; sample 3 - 9.8 kg; sample 2 - 4.9 kg; sample 1 - 4.2 kg.

Fig. 2. Overview of Wardija locality. (February 2001)

Fig. 3. Boundary at c. 3 m. Note burrows into the underlying sediment. Pectinid concentration and some small phosphorites just above the boundary. (February 2001)

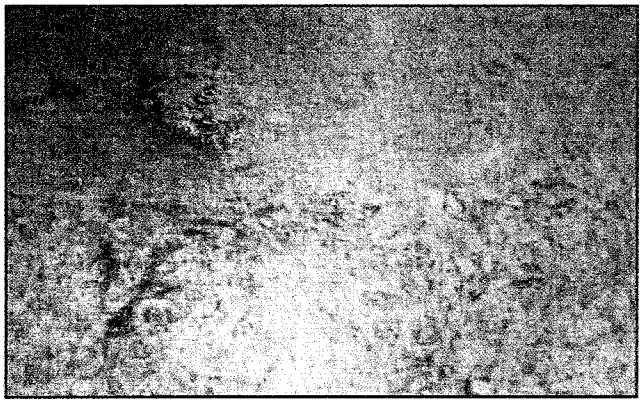

Fig. 4. Boundary at c. 7.5 m. Note burrow filled with echinoid fragments. (February 2001)

Fig. 5. Top of section with C1 as upper-most level. Base of hammer is on the boundary at c. 7.50 m. (February 2001)

The limestone of all four samples was reduced in size to pieces of c. 4 cm at the most and subsequently treated with diluted formic acid for 24 hours, after which the remaining residue was washed with tap water, the clay fraction carefully and repeatedly removed by decantation, and the fraction < 4 mm separated. This treatment was repeated several times (varying from 5 times for sample 4 to 7 times for sample 3) until no more limestone could be dissolved by the acid in the coarse fraction. The remaining residues < 4 mm were given a final formic acid treatment and washed several times with tap water, subsequently dried and fractionated using a standard set of sieves, with 90 μm as the finest mesh. Inspection of the residues was executed using a Wild M5 binocular microscope. Undissolved limestone pieces were inspected with a watchmaker's lens. Drawings were made by the author, using a *camera lucida* device.

Sample 3 was the most difficult, and the least successful to treat (some 4 kg of the limestone was not dissolved) because of a high clay content.

LISTS OF SPECIES

Below the fossil contents of samples 1 to 4 is specified. All benthic material mentioned here is housed in the Cainozoic Mollusc Collection of the Nationaal Natuurhistorisch Museum Naturalis, at Leiden, the Netherlands (RGM registration numbers). The holoplanktonic molluscs are in the same collection, but temporarily housed in Xewkija, Gozo. Illustrations of many benthic molluscs are given, but the holoplanktonic molluscs are important for a chronostratigraphic assignment, for which reason this fossil group is given special attention in the systematical part following the lists of species.

Sample 1. The large number of small bony fish skeleton parts and the virtual absence of Foraminifera in the residue of this sample are especially striking . The fraction < 250 μm contains glauconite. The benthic mollusc assemblage resembles that of sample 3, the bivalve Carditidae sp. is common in this sample.

RGM 429.982	Protozoa	Foraminifera	indet.	c. 25
RGM 429.983	Annelida		indet.	many
RGM 429.984	Porifera	sponges	indet.	3
RGM 429.985	Coelenterata	Anthozoa	indet.	c. 10 fragments
RGM 429.986	Crustacea	Decapoda	indet.	18 fragments
RGM 429.987	Bryozoa	lunulitiform	indet.	2 colonies, many zooecia
RGM 429.988		incrusting	indet.	2
RGM 429.989	Echinodermata	Echinoidea, Irregularia	indet.	5 fragments
RGM 429.990		Asteroidea	indet.	5 ossicles
RGM 429.991		Crinoidea	indet.	1 fragment
RGM 429.992	Mollusca	Bivalvia	Nuculidae sp.	2/1
RGM 429.993			Nuculanidae sp. 1	6/1
RGM 429.994			Lucinidae ? sp.	3/1
RGM 429.995			Carditidae sp.	20/1
RGM 429.996			*Corbula* sp.	1/1
RGM 429.997			indet.	6/2
RGM 429.998		Scaphopoda	Dentaliidae sp.	many
RGM 429.999			*Cadulus* sp.	5
RGM 457.000			Siphonodentaliidae sp.	5
RGM 457.001		Gastropoda	*Scissurella* sp.	3
RGM 457.002			*Circulus* sp.	2
RGM 457.003			Naticidae sp.	3
RGM 457.004			Xenophoridae sp.	2 fragments
RGM 457.005			*Mitrella* ? sp.	1
RGM 457.006			Nassariidae sp.	10
RGM 457.007			*Vexillum* ? sp.	5 damaged
RGM 457.008			Marginellidae sp. 1	1
RGM 457.009			Olividae ? sp.	1
RGM 457.010			Neogastropoda sp. 1	2
RGM 457.011			Neogastropoda sp. 2	8
RGM 457.012			Epitoniidae sp.	18
RGM 457.013			Pyramidellidae sp. 2	1 fragment
RGM 457.014			*Retusa* sp.	18
RGM 457.015			*Volvulella* sp.	3
RGM 457.019			*Heliconoides tertiaria* (Tate, 1887)	4
RGM 457.020			*Limacina valvatina* (Reuss, 1867)	1
RGM 457.021			*Limacina* an *L. gramensis* (Rasmussen, 1968)	1
RGM 457.022			*Spoelia torquayensis* A.W. Janssen, 1990	1
RGM 457.023			*Clio* (s. lat.) *ghawdexensis* sp. nov.	6

RGM 457.024			*Gamopleura melitensis* A.W. Janssen, 1995	2 fragments
RGM 457.025			*Vaginella sannicola* A.W. Janssen, 1990	13
RGM 457.016			Gastropoda non det. 8	6
RGM 457.017			Gastropoda non det. 10	1
RGM 457.018			Gastropoda indet.	many
RGM 457.026	Pisces	Chondrichthyes	Elasmobranchii indet.	5 teeth
RGM 457.027			Elasmobranchii indet.	8 dermal scales
RGM 457.028		Teleostomi	teeth & skeleton parts	many
RGM 457.029	Pisces ?		coproliths	many
RGM 457.030	residues		sorted residue	1
RGM 457.031			unsorted residue	1

Sample 2

The residue of this sample contains in the coarser fraction many pieces of undissolved limestone, whereas in the finer fractions (< 250 μm) a considerable part of the residue consists of glauconite and unphosphatised echinoderm fragments, that survived the formic acid treatment. These finer fractions yield very few fossils (*e.g.* strikingly low numbers of globigerinids), and were only partly sorted out. Among the holoplanktonic molluscs *Clio ghawdexensis* sp. nov. is especially interesting. One further fragment of this species was recorded from sample 4.

RGM 429.911	Protozoa	Foraminifera	indet.	1
RGM 429.912	Coelenterata	Anthozoa	indet.	17 fragments
RGM 429.913	Annelida		indet.	16 fragments
RGM 429.914	Porifera	sponges	indet.	1
RGM 429.915	Crustacea	Decapoda	indet.	15 fragments
RGM 429.916		Cirripedia	*Scalpellum* sp. (not phosphatised)	1 fragment
RGM 429.917		Ostracoda	indet.	20/1
RGM 429.918	Echinodermata	Echinoidea	Irregularia	many fragments
RGM 429.919		Asteroidea	indet.	many ossicles
RGM 429.920		Crinoida	indet.	1fragment
RGM 429.921		Crinoida ?	indet.	8 fragments
RGM 429.922	Bryozoa	lunulitiform	indet.	1 colony, many zooecia
RGM 429.923		incrusting	indet.	4 colonies
RGM 429.924		incrusting	indet.	4 colonies, 9 zooecia
RGM 429.925	Mollusca	Bivalvia	Nuculanidae sp. 1	61/1
RGM 429.926			Nuculanidae sp. 2	4/1
RGM 429.927			Nuculanidae sp. 3	1/1
RGM 429.928			*Nucinella* sp.	1/1
RGM 429.929			Carditidae sp.	1/2
RGM 429.930			Lucinidae sp. 2	1/1
RGM 429.931			*Corbula* sp.	6/2

RGM 429.932			*Xylophaga* sp.	1/2
RGM 429.933			indet.	4/1
RGM 429.934		Scaphopoda	Dentaliidae sp.	many
RGM 429.935			*Pseudantalis* sp.	3 fragments
RGM 429.936			*Cadulus* sp.	13
RGM 429.937			Siphonodentaliidae sp.	17
RGM 429.938		Gastropoda	*Scissurella* sp.	10
RGM 429.939			Cerithiidae sp.	1
RGM 429.940			Naticidae sp.	6
RGM 429.941			Naticidae ? sp.	2
RGM 429.942			Calyptraeidae sp.	3
RGM 429.943			Xenophoridae sp.	1
RGM 429.944			*Atlanta* sp.	1, 4 fragments
RGM 429.945			Nassariidae sp.	14
RGM 429.946			*Vexillum* ? sp.	1
RGM 429.947			Marginellidae sp. 1	11
RGM 429.948			Marginellidae sp. 3	6
RGM 429.949			Neogastropoda sp. 2	2
RGM 429.950			Neogastropoda sp. 3	9
RGM 429.951			Epitoniidae sp.	14
RGM 429.952			*Ringicula* ? sp.	1
RGM 429.953			Actaeonidae sp. 2	1
RGM 429.954			*Retusa* sp.	9
RGM 429.955			*Volvulella* sp.	2
RGM 429.955			*Volvulella* sp.	2
RGM 429.956			*Cylichna* sp.	6
RGM 429.957			Philinidae sp.	1
RGM 429.962			*Heliconoides tertiaria* (Tate, 1887)	c. 50
RGM 429.964			*Heliconoides vanderweideni* sp. nov.	5
RGM 429.963			*Limacina valvatina* (Reuss, 1867)	5
RGM 429.965			??*Limacina* an *L. gramensis* (Rasmussen, 1968)	1 fragment
RGM 429.966			*Bowdenatheca miocenica* sp. nov.	2
RGM 429.967			*Spoelia torquayensis* A.W. Janssen, 1990	33
RGM 429.968			*Spoelia torquayensis* ? A.W. Janssen, 1990	1
RGM 429.969			*Clio* (s. lat.) *ghawdexensis* sp. nov.	c. 40 fragments
RGM 429.970			*Clio* (s. lat.) *ghawdexensis* sp. nov.	6 fragments
RGM 429.971			*Edithinella bonaviai* sp. nov.	many
RGM 429.972			*Gamopleura melitensis* A.W. Janssen, 1995	10 fragments

RGM 429.973			*Vaginella sannicola* A.W. Janssen, 1990	68
RGM 429.974			*Vaginella* ? *tricuspidata* Zorn & Janssen, 1993	3 fragments
RGM 284.003			*Vaginella* ? *tricuspidata* Zorn & Janssen, 1993	1 fragment
RGM 284.004			*Vaginella* ? *tricuspidata* Zorn & Janssen, 1993	1 fragment
RGM 429.975			*Sphaerocina* sp. nov. ?	2 fragments
RGM 429.958			Gastropoda non det. 8	9
RGM 429.959			Gastropoda non det. 10	1
RGM 429.961			Gastropoda indet.	many
RGM 429.960			Gastropoda non det. div.	6 umbilical moulds
RGM 429.976	Pisces	Chondrichthyes	Elasmobranchii sp. (teeth)	4
RGM 429.977			Elasmobranchii sp. (dermal scales)	15
RGM 429.978		Teleostomi	teeth & skeleton parts	many
RGM 429.979	Pisces ?		coproliths	many
RGM 429.980	residues		sorted residue	1
RGM 429.981			unsorted residue	1

Sample 3:

Material for this sample was collected on two occasions, viz. October 2000 and February 2001, both from the same level, but at places several tens of meters apart. From the formic acid residues it is obvious that there are local differences in this level: the October sample yields in the finer fractions large numbers of globigerinids, which in the other sample are far less abundant. The same is true for glauconite. The February sample contains fair amounts of small limonite particles, which may be a weathering product of the glauconite. The fossil contents (apart from the foraminifera) of both samples does not differ substantially and was not kept separate. Sample 3 yielded only small phosphorites, most of them being fossils. Several non-phosphatised echinoid fragments did not dissolve during the formic acid treatment.

Especially striking in sample 3 is the variation in the benthic molluscs. Although they are all small to very small specimens (just one specimen reaches more than 1 cm) the number of species is strikingly high. As the preservation as internal moulds is quite good it wasdecided to give outline illustrations of most of these molluscs (see Pl. 1-3), as hardly anything is known about this fossil group in this area. Identification, however, had to remain at family or genus level at best. Several holoplanktonic molluscs from this sample are illustrated on Pl. 3-4.

The material includes abundant internal moulds of mainly benthic Foraminifera (unsorted in one collection item). This material, only partly picked from the residues, might offer excellent possibilities for a specialist to study foraminiferal internal structures. To a lesser degree this is also true for other fossil groups (e.g. Bryozoa).

A surprising number of holoplanktonic molluscs was present in sample 3. The material includes several species as yet unknown from the Maltese Archipelagoas well as several species new to science. This material offers interesting aspects considering the age assignment, which will be discussed later.

RGM 429.788	Protozoa	Foraminifera	non det.	many
RGM 429.789	Porifera	(sponges)	non det.	7
RGM 429.790	Annelida		non det.	c. 25
RGM 429.791	Coelenterata	Anthozoa	non det.	c. 25 fragments
RGM 429.792	Echinodermata	Echinoidea, Irregularia	non det.	many fragments

RGM 429.793	Echinodermata	Asteroidea	non det.	c. 30 ossicles
RGM 429.794	Crustacea	Decapoda	non det.	13 fragments
RGM 429.795		Ostracoda	non det.	15/1
RGM 429.796	Bryozoa	incrusting	colonies	10
RGM 429.797		lunulitiform	colonies & zooecia	many
RGM 429.798	Mollusca	Bivalvia	Nuculidae sp.	7/1
RGM 429.799			Nuculanidae sp. 1	356/1
RGM 429.800			Nuculanidae sp. 2	9/1
RGM 429.801			*Nucinella* sp.	8/1
RGM 429.802			*Bathyarca* sp.	2/1
RGM 429.803			Montacutidae sp.	2/1
RGM 429.804			Lucinidae sp.	/1
RGM 429.805			Lucinidae ? sp.	2/1
RGM 429.806			*Kelliella* ? sp.	2/1
RGM 429.807		Scaphopoda	*Pseudantalis* sp.	5 fragments
RGM 429.808			Dentaliidae sp.	many fragments
RGM 429.809			*Cadulus* sp.	5
RGM 429.810			Siphonodentaliidae sp.	25 fragments
RGM 429.811		Gastropoda	*Scissurella* sp.	many
RGM 429.812			Lepetellidae sp.	1
RGM 429.813			*Solariella* sp.	7
RGM 429.814			Trochidae sp.	1
RGM 429.815			Trochacea sp. 1	1
RGM 429.816			Trochacea sp. 2	4
RGM 429.817			Trochacea sp. 3	1
RGM 429.81°			*Circulus* sp.	2
RGM 429.81°			*Atlanta* sp.	1
RGM 429.820			*Atlanta* sp.	19 (incl. fragments)
RGM 429.821			Rissoacea sp.	7
RGM 429.822			Archaeogastropoda sp. 1	3
RGM 429.823			Archaeogastropoda sp. 2	12
RGM 429.824			*Trivia* sp.	2
RGM 429.825			Naticidae sp. 1	1
RGM 429.826			Naticidae sp. 2	3
RGM 429.827			Naticidae sp. div.	c. 25
RGM 429.828			Naticidae ? sp.	35
RGM 429.829			*Eulima* sp.	fragments
RGM 429.830			Xenophoridae sp.	12
RGM 429.831			Muricidae sp.	20
RGM 429.832			*Mitrella* sp.	6
RGM 429.833			Buccinidae sp. 1	1

RGM 429.834	Mollusca	Gastropoda	Buccinidae sp. 2	2
RGM 429.835			Nassariidae sp.	many
RGM 429.836			*Vexillum* ? sp.	12 fragments
RGM 429.837			Cancellariidae ? sp.	11
RGM 429.838			Marginellidae sp. 1	many
RGM 429.839			Marginellidae sp. 2	3
RGM 429.840			Marginellidae sp. 3	10
RGM 429.841			Marginellidae sp. 4	c. 30
RGM 429.842			Turridae sp. 1	1
RGM 429.843			Turridae sp. 2	1 fragment
RGM 429.844			Epitoniidae sp.	c. 20 fragments
RGM 429.845			Neogastropoda sp. 1	1
RGM 429.846			Neogastropoda sp. 2	c. 20
RGM 429.847			Neogastropoda sp. 3	4
RGM 429.848			Actaeonidae sp. 1	1
RGM 429.849			Actaeonidae sp. 2	1
RGM 429.850			*Ringicula* ? sp.	5
RGM 429.851			Pyramidellidae sp. 1	4
RGM 429.852			Pyramidellidae sp. 2	2 fragments
RGM 429.853			Retusidae sp. div.	many
RGM 429.854			*Volvulella* sp.	8
RGM 429.855			*Cylichna* sp.	many
RGM 429.856			*Roxania* sp.	9
RGM 429.857			*Haminea* sp.	2
RGM 429.858			Philinidae sp.	5
RGM 429.858			Philinidae sp.	5
RGM 429.874			*Heliconoides tertiaria* (Tate, 1887)	1
RGM 429.875			*Heliconoides tertiaria* (Tate, 1887)	many
RGM 429.872			*Heliconoides vanderweideni* sp. nov.	1
RGM 429.873			*Heliconoides vanderweideni* sp. nov.	6
RGM 429.878			*Heliconoides vanderweideni* sp. nov.	1
RGM 429.879			*Heliconoides vanderweideni* sp. nov.	16
RGM 429.876			*Limacina valvatina* (Reuss, 1867)	1
RGM 429.877			*Limacina valvatina* (Reuss, 1867)	24
RGM 429.880			*Limacina* an *L. gramensis* (Rasmussen, 1968)	1RGM 429.881
RGM 429.881			*Limacina* an *L. gramensis* (Rasmussen, 1968)	9

RGM 429.883	Mollusca	Gastropoda	*Bowdenatheca miocenica* sp. nov.	1
RGM 429.884			*Bowdenatheca miocenica* sp. nov.	11 fragments
RGM 429.882			*Styliola subula* (Quoy & Gaimard, 1827)	1 fragment
RGM 429.885			*Spoelia torquayensis* A.W. Janssen, 1990	1
RGM 284.010			*Spoelia torquayensis* A.W. Janssen, 1990	1
RGM 284.011			*Spoelia torquayensis* A.W. Janssen, 1990	1
RGM 429.886			*Spoelia torquayensis* A.W. Janssen, 1990	c. 40 fragm.
RGM 429.887			*Clio* (s. lat.) aff. *saccoi* Checchia-Rispoli, 1921	1
RGM 429.888			*Clio* (s. lat.) aff. *saccoi* Checchia-Rispoli, 1921	2
RGM 429.889			*Clio* (s. lat.) ? sp.	1 fragment
RGM 429.890			*Edithinella bonaviai* sp. nov.	1 fragment
RGM 429.891			*Edithinella bonaviai* sp. nov.	1 fragment
RGM 429.892			*Edithinella bonaviai* sp. nov.	many fragments
RGM 429.893			*Gamopleura melitensis* A.W. Janssen, 1995 ?	1 juv.
RGM 429.894			*Gamopleura melitensis* A.W. Janssen, 1995	10
RGM 429.895			*Vaginella sannicola* A.W. Janssen, 1990	many (hundreds)
RGM 429.896			*Vaginella ? tricuspidata* Zorn & Janssen, 1993	7 fragments
RGM 429.897			*Sphaerocina* sp. nov.	1 fragment
RGM 429.898			*Sphaerocina* sp. nov.	1 fragment
RGM 429.899			*Peraclis* sp.	1
RGM 429.900			Gymnosomata sp. 1	1
RGM 429.901			Gymnosomata sp. 1	5
RGM 429.902			Gymnosomata sp. 2	1
RGM 429.859			non det. 1	1
RGM 429.860			non det. 2	8
RGM 429.861			non det. 3	1
RGM 429.862			non det. 4	1
RGM 429.863			non det. 5	3

RGM 429.864	Mollusca	Gastropoda	non det. 6	1
RGM 429.865			non det. 7	1
RGM 429.866			non det. 8	4
RGM 429.867			non det. 9	1
RGM 429.868			non det. 10	1
RGM 429.869			non det. 11	1
RGM 429.870			non det. 12	1
RGM 429.871			indet.	many fragments
RGM 429.903	Pisces	Chondrichthyes	Elasmobranchii indet., teeth	10
RGM 429.904			Elasmobranchii indet., dermal scales	12
RGM 429.905		Teleostomi	indet. (teeth + skeleton parts)	many
RGM 429.906	Pisces ?		coproliths	many
RGM 429.907	fossils or phosphorites ?			many
RGM 429.908	residues		unsorted residue October 2000	1
RGM 429.909			unsorted residue February 2001	1
RGM 429.910			sorted residue	1

Sample 4

The fraction > 4 mm of this sample contains many coarse phosphorite concretions up to 50 mm Ø. Specimens of ahermatypic corals and the pteropod *Gamopleura melitensis* are very common. Finer fractions consist for the greater part of coral fragments, isolated during the washing procedure. Fractions < 250 μm yield hardly any useful fossils (very small numbers of foraminifers) and only restricted parts were picked. The fraction < 125 μm contains some glauconite.

RGM 429.748	Foraminifera		indet.	c. 25
RGM 429.749	Porifera	Spongia (?)	indet.	2
RGM 429.750	Annelida		indet.	48
RGM 429.751	Coelenterata	Anthozoa	*Flabellum* sp.	1
RGM 429.752			ahermatypic corals	many
RGM 429.753	Echinodermata		Regularia & Irregularia	16 fragments
RGM 429.754		Irregularia	*Echinocyamus* sp.	1
RGM 429.755		Asteroidea	indet.	5 ossicles
RGM 429.756			Ophiuridae sp.	10 ossicles
RGM 429.757	Crustacea	Decapoda	indet.	1 fragment
RGM 429.758	Bryozoa	incrusting	indet.	3 specimens
RGM 429.759			indet.	9 fragments
RGM 429.760	Brachiopoda		Terebratulidae sp.	1/1
RGM 429.761	Mollusca	Bivalvia	Nuculanidae sp.	12/1
RGM 429.762			*??Barbatia* sp.	1/2
RGM 429.763			Pectinidae sp.	1 fragment
RGM 429.764			Cardiidae sp.	1/2

RGM 429.765	Mollusca	Bivalvia	indet.	7/1, 7/2
RGM 429.766		Scaphopoda	Dentaliidae sp.	22 fragments
RGM 429.767		Gastropoda	*Emarginula* sp.	1
RGM 429.768			*Calliostoma* sp.	1 damaged
RGM 429.769			*Xenophora* sp.	5, 3 fragments
RGM 429.770			Fasciolariidae sp.	1
RGM 429.771			Marginellidae sp.	1
RGM 429.772			*Cylichna* sp.	1 damaged
RGM 429.773			*Heliconoides tertiaria* (Tate, 1887)	57
RGM 429.774			*Heliconoides vanderweideni* sp. nov.	7
RGM 429.775			*Limacina* an *L. gramensis* (Rasmussen, 1968)	14
RGM 429.776			*Styliola subula* (Quoy & Gaimard, 1827)	1
RGM 429.777			*Spoelia torquayensis* A.W. Janssen, 1990	1
RGM 429.778			*Clio* (s. lat.) *ghawdexensis* sp. nov.	1 damaged
RGM 429.779			*Gamopleura melitensis* A.W. Janssen, 1995	322
RGM 284.001			*Gamopleura melitensis* A.W. Janssen, 1995	1
RGM 429.780			*Vaginella sannicola* A.W. Janssen, 1990	166
RGM 429.781			*Vaginella sannicola* A.W. Janssen, 1990	1 protoconch
RGM 429.782			indet.	many
RGM 429.783	Pisces	Chondrichthyes	Elasmobranchii indet.	c. 13 teeth
RGM 429.784			Elasmobranchii, dermal scales	1
RGM 429.785		Teleostomi	indet.	c. 45 teeth
RGM 429.786	Pisces ?		coproliths	c. 30
RGM 429.787	unsorted residue < 250 µm			1

List of fossils

The Ophiuridae ossicles are not phosphatised, but anyhow did not dissolve by the formic acid treatment. The Fasciolariidae specimen was found as an external cast in a piece of undissolved limestone. Part of the phosphatised fossils (especially the asteroid ossicles, *Vaginella sannicola*, *Gamopleura melitensis* and some other species) show distinct signs of transportation.

SYSTEMATICAL DESCRIPTION OF HOLOPLANKTONIC MOLLUSCS

1881 (year in roman)	the cited reference contributes to the knowledge of the taxon
*	first valid introduction of the taxon
.	responsibility for the identification is accepted by the present author
(no symbol)	responsibility for the identification not accepted by present author, but there is no reason for doubt
?	in the opinion of the present author there is reason to doubt the identification
v	the original material of this reference was studied by the present author.

Symbols used in the lists of synonyms in this chapter are those of Richter (1948):

Phylum Mollusca Linné, 1758

Class Gastropoda Cuvier, 1797
Superorder Caenogastropoda Cox, 1959
Order Sorbeoconcha Ponder & Lindberg, 1997
Suborder Hypsogastropoda Ponder & Lindberg, 1995
Infraorder Littorinimorpha Golikov & Starobogatov, 1975
Superfamily Carinarioidea Blainville, 1818
Family Atlantidae Rang, 1829

Genus *Atlanta* Lesueur, 1817

Type species: *Atlanta peroni* Lesueur, 1817 (Recent).

***Atlanta* sp.** (Pl. 3, fig. 15a-b)

Description -- Small dextral gastropod with tight first whorls, elevated to a low cone. After this protoconch the whorl expands widely, and becomes flattened and carinated at the periphery. In a frontal view the early whorls are just visible. The aperture is elongated cordiform, just very slightly indented by the penultimate one. The base of the shell is flattened, with a central umbilicus, in which the penultimate whorl is visible. On the apical side of the shell some distant growth undulation are visible on the ultimate part of the body whorl, strongly curved in apertural direction.
Material Sample 2 (1 specimen, 4 fragments, RGM 429.944), sample 3 (20 specimens and fragments, RGM 429.819-20).
Discussion Specimens of the genus *Atlanta* are not rare in sample 3. As all other molluscs they are preserved as internal phosphoritic moulds, which means that any original external ornament of the shell has disappeared. Identification at species level is therefore not attempted. In the actual fauna from the various oceans species of *Atlanta* are common, and represented by numerous very similar species. As fossils were described: *Atlanta cordiformis* Gabb, 1873, from the (?) Late Miocene of Santo Domingo. It resembles the Recent *A. inflata* Souleyet, 1852 so strongly that they might very well be synonyms. Furthermore, from the Pliocene of Jamaica: *A. diamesa* Woodring, 1928, which seems to be closely related to the Recent *A. peroni* (Lesueur, 1817).

Superorder Heterobranchia Gray, 1840
Intraorder Euthyneura Spengler, 1881
Order Thecosomata Blainville, 1823
Suborder Euthecosomata Meisenheimer, 1905
Superfamily Limacinoidea Gray, 1847
Family Limacinidae Gray, 1847 (see the recently proposed classification for this family in Janssen, 2003).
Genus *Heliconoides* d'Orbigny, 1836

Type species: *Heliconoides inflata* (d'Orbigny, 1836) (Recent)

***Heliconoides tertiaria* (Tate, 1887)** (Plate 3, fig. 16a-b)

v. 1887 *Spirialis tertiaria* spec. nov., Tate, p. 196, non pl. 20, fig. 12a-c = *Heliconoides inflata* (d'Orbigny, 1836).
? 1891 *Spirialis atlanta* Koen. -- Trabucco, p. 10 (non von Koenen).
v. 1897 *Limacina tertiaria*, Tate (sp.) -- Harris, p. 19 (partim ?).
1903 *Limacina tertiaria* Tate -- Dennant & Kitson, p. 94.
1965 *Spiratella tertiaria* - Curry, p. 368.
1981 *Spirialis tertiaria* Tate -- Curry, p. 38.
1982 *Spiratella tertiaria* Tate -- Bernasconi & Robba, p. 215.
v. 1990 *Limacina tertiaria* (Tate, 1887) -- Janssen, p. 19, pl. 3, figs. 1-10, pl. 4, figs. 1-6, pl. 11, figs. 1-2.
v. 1995 *Limacina tertiaria* (Tate, 1887) -- Janssen, p. 24, pl. 1, figs. 8-10.

Description *Heliconoides tertiaria* is a small (diameter c. 1 mm) sinistral gastropod with a flat to slightly concave apical side showing all whorls. The number of whorls is about three, the first 1½ of them are slightly raised, and usually visible in a frontal view. The aperture is large and oval, protruding below the base of the penultimate whorl. The apertural margin of the body whorl is suddenly widened in adult specimens, as a reinforcing structure. The base is rounded and has a distinct umbilicus, which is usually filled with matrix.

Material Sample 1 (4 specimens, RGM 457.019), sample 2 (c. 50 specimens, RGM 429.962), sample 3 (many specimens, RGM 429.874-5), sample 4 (57 specimens, RGM 429.773).
Discussion *Heliconoides tertiaria* initially was described from the Australian Miocene (Batesfordian to Bairnsdalian = roughly Langhian). The first specimens recorded from the Mediterranean (various localities in Italy, see Janssen, 1995, who also mentioned specimens from Malta) are all of Langhian age. In the meantime the species was also recognised in deposits of the same age in SW France. A somewhat older, but closely related species was described from the Early Miocene of New Zealand, *viz. Heliconoides ferax* (Laws, 1944) (as *Spiratella ferax*), differing only slightly from *H. tertiaria.*

The present specimens from Wardija do not differ from specimens higher in the Globigerina Limestone, and are no doubt conspecific, they do not show the characteristics of *H. ferax*. These are the first records of Early Miocene age in the Mediterranean.

***Heliconoides vanderweideni* sp. nov.** (Pl. 3, figs. 17a-b, 18a-c)

Diagnosis Shell globose, slightly higher than wide, spire with convex tangents. Apertural margin with a slightly oblique reinforcing fold that is interrupted at two thirds of its height. Some specimens with a more depressed spire are included in this species.
Holotype RGM 429.878, Pl. 3, fig. 17a-b.
Type locality Wardija, near Wardija Point, on the extreme SW corner of the island of Gozo, Maltese Archipelago; at coordinates UTM 268.886 (Fig. 1).
Stratum typicum Lower Globigerina Limestone Formation, c. 7.50 -7.75 m above base, in yellowish to light yellowish-brown limestone, with some burrowing and dispersed small phosphorite concretions (sample 3); Miocene, Aquitanian.
Derivatio nominis This species is named after Wim van der Weiden, retiring director of the National Museum of Natural History 'Naturalis', Leiden, the Netherlands, who in a few years time succeeded in integrating two separate museums into one truly (inter)national institute, to realise magnificent newly built premises inclusive of a fabulous exhibition, and to motivate a constantly increasing staff to perform more than everybody thought possible.
Description Shell sinistral, slightly higher than wide, with c. three convex whorls that increase gradually in width. The general shell form is globose, with convex tangents, as the younger whorls attach below the middle of the preceding whorl. All whorls are separated by distinct sutures. The base of the shell is convex, and distinctly umbilicate, the umbilicus usually is filled with matrix. The apertural margin of the available internal moulds shows a strengthening device consisting of an internal thickening or fold of the shell (the difference cannot be seen on internal moulds, but a fold seems more probable than a thickening), that at c. two thirds of its height is interrupted. At this place the apertural margin is slightly carinated in frontal view. In some specimens of the available material (Pl. 3, fig. 18a-c) the spire is distinctly lower, which makes the shell even more globular. The apertural structure, however, indicates that they belong to the same species indeed.
Paratypes Sample 2 (5 specimens, RGM 429.964); sample 3 (7 specimens, RGM 429.872-3; 17 specimens, RGM 429.878-9); sample 4 (7 specimens, RGM 429.774).
Discussion The presence of apertural reinforcements distinctly refers this species to the genus *Heliconoides*. A related species, as yet undescribed, is known from the Late Oligocene of St. Etienne d'Orthe (France, Aquitaine Basin). This species, of which specimens in shell preservation are available, remains slightly smaller, and the apertural margin has an oblique and uninterrupted fold. The specimens with a depressed spire resemble the Paratethys species *Limacina andrussowi* (Kittl, 1886) (compare Janssen, 1984, pl. 2, figs. 2-9; with lectotype designation). In this species, however, the whorls are attached above mid-height of the preceding whorl, and apertural structures are absent. Still, juvenile specimens of the present species, in which the aperture is not yet completely developed may resemble *L. andrussowi* strongly.

Genus *Limacina* Bosc, 1817

Type species: *Limacina helicina* (Phipps, 1774) (Recent)

***Limacina valvatina* (Reuss, 1867)** (Pl. 3, fig. 19a-b)

Description The shell is sinistral, and usually more or less as high as wide, with straight tangents along its spire. There may be as many as 6 rounded whorls, rather convex, and regularly increasing in diameter. The base of the shell is also rounded, with a narrow central umbilicus. The aperture is semicircular, usually c. half as high as the complete shell. There are no apertural reinforcements.
Material Sample 1 (1 specimen, RGM 457.020); sample 2 (5 specimens, RGM 429.963); sample 3 (25 specimens, RGM 429.963-4).

Discussion This species has its main distribution in the northern Atlantic realm and is predominantly known from the North Sea and Central Paratethys basins, where it occurs from the Late Oligocene to the Late Miocene. Its H/W-ratio (height/width x 100) is rather variable, and ranges from c. 80 to 110. From the Mediterranean it is known from the Middle Miocene of Gargano and Salentino (Italy) and the Maltese archipelago, usually as dwarf individuals. The present material from Wardija, however, comprises well-developed specimens with a typical H/W-ratio of c. 100.

***Limacina* sp. an *L. gramensis* (Rasmussen, 1968)** (Pl. 3, fig. 20a-b)

Description The sinistral shell has c. 6 convex whorls, separated by distinct sutures. The height/width-ratio is difficult to estimate, as only juvenile or incomplete adult specimens are available, but in general will equal about 150. The whorls increase gradually and regularly in width, and attach below the middle of the preceding whorl, resulting in a conical shell with straight tangents. The aperture has no reinforcement structures, and is relatively small.
Material Sample 1 (1 specimen, RGM 457.021); sample 2 (1 fragment, RGM 429.965); sample 3 (10 specimens, RGM 429.880-1); sample 4 (14 specimens, RGM 429.775).
Discussion This species resembles strongly the northern European species *L. gramensis* (Rasmussen, 1968), occurring during the Late Miocene, a distinctly younger evolutionary stage of *L. valvatina* (see Gürs & Janssen, 2002), which indicates that the present material, being considerably older, cannot be considered to be conspecific. As no distinguishing characteristics can be observed I decided to indicate this material, for the time being, as *Limacina* sp. an *L. gramensis* (Rasmussen, 1968). *L. gramensis* from the Central Paratethys demonstrates irregular growth when reaching the adult stage (see Janssen & Zorn, 1992).

Superfamily Cavolinioidea FISCHER, 1883
Family Creseidae RANG, 1828

Genus *Bowdenatheca* Collins, 1934

Type species: *Bowdenatheca jamaicensis* Collins, 1934 (Pliocene)

***Bowdenatheca miocenica* sp. nov.** (Pl. 3, fig. 22a-d)

Diagnosis Slender, straight, initially round, later dorso-ventrally flattened shell with two margin-parallel furrows developing on the ventral side, the right one stronger than the left.
Holotype RGM 429.883, Pl. 3, fig. 22a-d.
Type locality Wardija, near Wardija Point, on the extreme SW corner of the island of Gozo, Maltese Archipelago; at coordinates UTM 268.886 (Fig. 1).
Stratum typicum Lower Globigerina Limestone Formation, c. 7.50 -7.75 m above base, in yellowish to light yellowish-brown limestone, with some burrowing and dispersed small phosphorite concretions (sample 3); Miocene, Aquitanian.
Derivatio nominis This species is named after the Miocene age of the samples.
Description Just fragmentary specimens of this species were found. They are conical, apical angle c. 13°, with a circular transverse section in the oldest available shell part, becoming dorso-ventrally flattened towards the aperture. On one side (presumably ventral) two grooves develop in the apertural half of the shell. The right one of these is stronger than the other, which results in an oval apertural transverse section, showing a strong and a weak indentation.
Paratypes Sample 2 (2 specimens, RGM 429.966); sample 3 (11 specimens, RGM 429.884).
Discussion Although nothing is known yet on its protoconch morphology it is believed that this species fits best in the family Creseidae because of its initially round and later flattened transverse section. There is a fair resemblance with *Bowdenatheca jamaicensis*, a species described from the Caribbean Pliocene, but subsequently also recorded from the Mediterranean Messinian and Pliocene (Zorn, 1997; Janssen, 1998), and, with some doubt, from Japan (as *Bowdenatheca* sp., in Ujihara, 1996). *B. jamaicensis* has a similar outline, but is slightly curved lengthwise. Instead of the two furrows this species demonstrates but a slight ventral swelling There is a certain similarity with *Clio ghawdexensis* sp. nov., described below, but in that species the shell is more slender and flattened right from the beginning. Also the two grooves are of the same strength and lay closer to the sides.

Genus *Styliola* GRAY, 1850

Type species: *Styliola subula* (QUOY & GAIMARD, 1827) (Recent)

***Styliola subula* (Quoy & Gaimard, 1827)** (Pl. 3, fig. 21a-b)

Description Specimens of this species are easily recognisable by their straight conical shell form and the presence of an

oblique furrow running from near the apex to the aperture.
Material Sample 3 (1 fragment, RGM 429.882); sample 4 (1 specimen, RGM 429.776).
Discussion *Styliola subula* is a long ranging species known from the Late Oligocene (Chattian) onwards, and still occurring in tropical and subtropical seas nowadays.

Family Cuvierinidae van der Spoel, 1967

Genus *Spoelia* A.W. Janssen, 1990

Type species: *Spoelia torquayensis* A.W. Janssen, 1990 (Oligocene)

***Spoelia torquayensis* A.W. Janssen, 1990** (Pl. 3, figs. 23a-d, 24, 25a-c)

*v 1990 *Spoelia torquayensis* sp. nov., Janssen, p. 42, pl. 7, figs. 1-5.

Description This surprisingly abundant species mainly occurs in samples 2 and 3. In spite of its fragmentary condition is can easily be recognised by its conical shell form, the apical part of which is slightly curved, with a round transverse section. On both sides of the shell squarish lateral carinae develop, that disappear already before reaching the aperture of adult specimens, where the transverse section becomes regularly elliptical. From material in shell preservation (Chattian of Aquitaine, France) it is known that the aperture is reinforced by a weak fold, which is obliquely positioned in a lateral view. Protoconchs of this species were not found previously at Wardija.
Material Sample 1 (1 specimen, RGM 457.022); sample 2 (34 specimens, RGM 429.967-8); sample 3 (3 specimens, c. 40 fragments, RGM 284.010-1, RGM 429.885-6); sample 4 (1 specimen, RGM 429.777).
Discussion *Spoelia torquayensis* was initially introduced from Late Oligocene deposits in southern Australia and equally old sediments in the Aquitaine Basin (France). In the meantime it was also recognised in boulders of Chattian age (so-called 'Sternberger Gestein') in the North Sea Basin.

Family Clioidae van der Spoel, 1967

Genus *Clio* Linné, 1767

Type species: *Clio (Clio) pyramidata* Linné, 1767 (Recent).

Subgenus ?

***Clio* (s. lat.) *ghawdexensis* sp. nov.** (Pl. 4, figs. 1a-d, 2a-d, 3a-c, 4a-c, 5a-c, 6)

Diagnosis Extremely slender, straight, biconvex, dorso-ventrally flattened shell with two margin-parallel furrows developing on one side.
Holotype RGM 429.970, Pl. 4, fig. 1a-d.
Type locality Wardija, near Wardija Point, on the extreme SW corner of the island of Gozo, Maltese Archipelago; at coordinates UTM 268.886 (Fig. 1).
Stratum typicum Lower Globigerina Limestone Formation, c. 7.50 -7.75 m above base, in yellowish to light yellowish-brown limestone, with some burrowing and dispersed small phosphorite concretions (sample 3); Miocene, Aquitanian.
Derivatio nominis This species is named after the island of Gozo, Malta (= Għawdex in Maltese language), where the type locality is situated.
Description This new species is represented by quite a number of fragments, from which an almost complete reconstruction could be composed, apart from the embryonal parts and the aperture, which were not found. The complete shell has a straight elongated conical form with an apical angle of just 7° and is dorso-ventrally flattened. The earliest shell part available has a dorso-ventral diameter of about half the shell width and a gradually curved ventral side, whereas the dorsal side shows a week central carina, which disappears at a shell width of c. 0.4 mm. Here the transverse section of the shell is biconvex. At a shell width of c. 0.7 mm two margin parallel furrows or grooves appear, becoming stronger towards the aperture. In the largest available fragment the furrows are still present. Because of these grooves the transverse section becomes biconvex, with the ventral part considerably wider than the dorsal. In the largest fragment the aperture has a width of 1.32 mm, and a dorso-ventral diameter of 0.5 mm. Reconstruction demonstrates that complete specimens reach a shell height over 1 cm.
Paratypes Sample 1 (6 fragments, RGM 457.023); sample 2 (c. 45 fragments, RGM 284.005-9, RGM 429.969), sample 4 (1 fragment, RGM 429.778).
Discussion Nothing similar has been described as yet, but a closely related species is known to me from the Late Oligocene of the Aquitaine Basin (SW France). In that species, to be published soon (Janssen, in prep.), the general shell form resembles strongly the juvenile specimens from Wardija. The sides of the shell, however, are developed as squarish carinae, whereas

they are rounded in the Gozitan species. In the available material from France no margin-parallel grooves are seen, but the apertural width of the largest specimen is only 0.6 mm. In this material in shell preservation the embryonal shell is present. It consists of two swellings caused by a double constriction. The tip swelling (protoconch I) is slightly higher than wide, and rounded. It may be expected that the protoconch of *C. ghawdexensis* is of a similar morphology.
It is as yet unclear to which subgenus this new species might belong. It is interesting to note that this species, relatively common in samples 1 and 2, is absent from sample 3. Apparently it became extinct after deposition of the level at c. 5 m. The single specimen from sample 4 no doubt is reworked.

***Clio* (s. lat.)** aff. ***saccoi* Checchia-Rispoli, 1921** (Pl. 3, fig. 26a-c)

Description Shell triangular, dorso-ventrally compressed, with ventral side somewhat more convex than dorsal side. Typical are two narrow lateral flattened zones developing after the apical shell part, which still has a circular transverse section. These zones are more clearly defined on the ventral side. The aperture is oval, c. twice as wide as high, with the flattened zones clearly separated next to the rounded carinae.
Material Sample 3 (3 specimens, RGM 429.887-8).
Discussion *Clio saccoi* was originally described from the Langhian of Gargano (Italy) and subsequently found in many localities of the same age in the Mediterranean, inclusive of the Maltese Upper Globigerina Limestone. The restricted material from Wardija is considerably older and might represent a forerunner species. In the absence of better preserved specimens, inclusive of the embryonal shell parts, I have to refrain from introducing a new taxon.
Clio (Nudiclio) chadumica Korobkov, 1966, might represent a forerunner species of the *C. saccoi*-complex. It is equally a compressed triangular species with separated lateral flattened zones, but its apical angle is considerably smaller than in *C. saccoi*. It was introduced from Oligocene (Rupelian) deposits in the Caucasus (Prearal area, compare Korobkov, 1966, p. 91, pl. 3, figs. 10-18).

Recently (Janssen, 2000), I overlooked the fact that Korobkov (1966, p. 90) designated *Clio pedemontana* (Mayer, 1868) type species of his subgenus *Nudiclio*. This species is related to a group of Oligocene to Recent *Clio* species characterised by the possession of transverse ornament on both ventral and dorsal sides combined with some longitidinal elements, which I proposed to concentrate in the subgenus *Balantium* Children, in Gray, 1823 [type species *Clio (Balantium) recurva* (Children, in Gray, 1823) - Recent]. *Clio pedemontana*, however, differs from this group by the absence of the longitudinal elements, for which reason I included it only in *Balantium* with a query. Should it be decided that *C. pedemontana* belongs in a separate subgenus, than the name *Nudiclio* should be used, otherwise *Nudiclio* is a junior subjective synonym of *Balantium*. Species like *C. saccoi*, however, do not possess transverse ornament and belong to yet another, still unnamed subgenus.

***Clio* (s. lat.) ? sp.** (Pl. 3, fig. 27a-b)

Description A single fragment of an unknown *Clio* (?)-species was found. Apical and apertural parts are missing. The shell is conical, dorso-ventrally somewhat flattened, and has two sharp lateral carinae. Both sides are convex but towards the carinae the surfaces become very slightly concave. Where light reflects on its shiny surface it can be seen that these concave parts bear very thin and distant, somewhat irregular transverse lines, that disappear towards the centre of the shell.
Material Sample 3 (1 fragment, RGM 429.889).
Discussion Nothing similar has ever been before me. The specimen somewhat resembles the internal mould of a *Diacria* apical spine, in which case the transverse lines could represent the wrinkles caused by shell metamorphosis. That genus, however, has not been found yet in deposits of this age. The present specimen also has no trace of any longitudinal ornament as seen for example in *Diacria trispinosa* (Blainville).

Family Cavoliniidae Fischer, 1883
Genus *Edithinella* A.W. Janssen, 1995

Type species *Edithinella undulata* (Gabb, 1873) (Miocene)

***Edithinella bonaviai* sp. nov.** (Pl. 4, fig. 7a-d, 8a-d)

Diagnosis Straight *Edithinella* species with an apical angle of c. 17°. Ventral and dorsal surfaces convex. Initial shell part with circular transverse section, flattened in apertural direction. Lateral furrows developed as weak depressions close to the margins of the dorsal shell part, transverse ornament absent. Protoconch as yet unknown.
Holotype RGM 429.890, Pl. 4, fig. 7a-d.
Type locality Wardija, near Wardija Point, on the extreme SW corner of the island of Gozo, Maltese Archipelago; at coordinates UTM 268.886 (Fig. 1).

Stratum typicum Lower Globigerina Limestone Formation, c. 7.50 -7.75 m above base, in yellowish to light yellowish-brown limestone, with some burrowing and dispersed small phosphorite concretions (sample 3); Miocene, Aquitanian.
Derivatio nominis This new species is named after Mr Charles Galea Bonavia, of Attard, Malta, who demonstrated the Wardija locality to me.
Description The shell is vaginelliform, straight, and elongated triangular in frontal view, with an apical angle of c. 17°. The initial shell part has a circular transverse section, becoming more flattened towards the aperture. Close to the aperture the shell width is c. 1.6 times the dorso-ventral diameter. Weak lateral furrows are developed all along the sides, becoming more clearly defined in the younger part of the shell. In the part close to the apex these furrows are weak, and therefore the sides look more or less carinated. Later on the furrows develop more to one, presumably the dorsal side of the shell. There is no trace of transverse ornament.
Material Sample 2 (many specimens, RGM 429.971); sample 3 (many fragments, RGM 429.891-2).
Discussion It is with some hesitation that I assign this species to the genus *Edithinella*, as some of the main characteristics, such as transverse ornament and a longitudinally curved shell, are not present, which makes this species look like a *Vaginella*, especially in its basal part. Therefore apical fragments are sometimes difficult to recognise. In the more apertural fragments the two furrows are always evident, and exclude *Vaginella.* Protoconchs of any *Edithinella* species are as yet unknown. The only true *Vaginella* species, occurring in the present samples are *V. sannicola* and *V.* ? *tricuspidata*, both of which have different apical angles, which makes a distinction evident.

The only *Edithinella* species known to me from the Maltese strata so far are *E. varanica* (Sirna, 1968), known from the Upper Globigerina Limestone Formation (Langhian), above the C2 main phosphoritic level and the Blue Clay Formation (Serravallian), and *E. caribbeana* (Collins, 1934), found in the basal Green Sand Formation, as reworked elements from an eroded and completely disappeared deposit of Tortonian age (Kienel *et al.*, 1995).

Genus *Gamopleura* Bellardi, 1873

Type species *Gamopleura taurinensis* (Michelotti, 1847) (Miocene)

Gamopleura melitensis **A.W. Janssen, in Rehfeld & Janssen, 1995** (Pl. 4, fig. 9a-c, 10a-c)

1982 'Qanneb' - *Hyalaea* sp., Zammit-Maempel, p. 11, pl. 1, fig. 6.
1987 *Cavolinia* -- Carbone et al., p. 45.
*v1995 *Gamopleura melitensis* Janssen sp. nov., Rehfeld & Janssen, p. 103, pl. 20, figs. 1-4, pl. 21, figs. 1-5

Description Only internal moulds are available, occcasionally with some remnants of the actual shell preserved. This species is of moderate size (H to c. 8 mm), cavoliniform, bilaterally symmetrical along a plane through the apex and the aperture, perpendicular to the dorsal and ventral sides. Both ventral and dorsal shell parts are convex. The ventral side remains lower than the dorsal one and is therefore relatively wider and slightly more convex, somewhat flattened below the ventral apertural margin. The apertural margin of the dorsal shell part is overhanging the ventral part (lateral view). Ventral and dorsal shell parts join on a connate, threadlike produced carina surrounding the shell and are only interrupted at aperture and apex, leaving no lateral slits as seen in *Cavolinia* or *Diacria.* The larval shell is shed, and the opening is closed with a small septum. No wrinkles are seen close to the apex, as present in most *Cavolinia* and/or *Diacria* species. The shell's outline (frontal view) is rounded rectangular, with straight and practically parallel lateral margins. The lower margins left and right of the slightly protruding septum are in line. Transitions between the posterial and lateral margins, and between these and the aperture are gradually rounded.

The aperture is positioned anteriorly and faces ventrally as a result of the difference in height of ventral and dorsal shell part. The ventral margin is straight and is recurved as a strengthening device. Externally the dorsal margin is reinforced by an apertural rim, which is only rarely preserved. The ornament of the dorsal side consists of two oblique radial furrows in the apertual half of the shell. Occasionally both ventral and dorsal parts show a vague transverse striation that when visible on the ventral side has a weak adapical inclination in the centre.
Material Sample 1 (2 fragments, RGM 457.024); sample 2 (10 fragments, RGM 429.972); sample 3 (10 specimens, ? 1 juvenile, RGM 429.893-4); sample 4 (322 specimens, RGM 284.001, RGM 429.779).
Discussion Most available specimens from Wardija are either damaged or have severe traces of transportation, so many of the above described details are difficult to see. Up to now this species was predominantly known from the Maltese C1 main phosphorite level, in which it is an extremely common species. As many specimens from that horizon demonstrate distinct traces of transportation it was clear already that they are for a great deal reworked from an older level. This has now indeed been demonstrated: all three levels below C1 bearing phosphorite clasts (samples 1-3) yielded specimens of this species. *Gamopleura melitensis*, the only pteropod with a vernacular Maltese name (Zammit-Maempel, 1982; see

synonyms) has not yet been recorded from outside the Maltese Archipelago, which considering its abundance there is at least curious. The type species of *Gamopleura*, *G. taurinensis* (Michelotti, 1847), is known from Burdigalian (?) deposits in the Turin Hills (Italy)(see Janssen, 1995, p. 130). A single specimen of this latter species, also of Burdigalian age, is known from the Aquitaine Basin (France) (Janssen, in prep.).

An apparently very juvenile cavoliniid specimen (pl. 4, fig. 10a-c) was found in sample 3. It is a widely triangular specimen dorso-ventrally curved and compressed, with a slightly globular protoconch, that unfortunately is not completely preserved. Protoconchs of *Gamopleura* are unknown to date, as they are shed in adult specimens, so this might be the first one known. By its swollen initial shell it resembles more closely the protoconchs of *Diacria* and/or *Diacrolinia* than those of *Cavolinia*. As *Gamopleura melitensis* is the only related species found in these samples it seems most likely that this is a very juvenile specimen of that species indeed. If this is the case it would imply that shell metamorphosis in this species does take place, in spite of the absence of wrinkles in the basal part of the adult shell.

Genus *Vaginella* Daudin,1800

Type species: *Vaginella depressa* Daudin, 1800 (Miocene)

***Vaginella sannicola* A.W. Janssen, 1990** (Pl. 4, fig. 11a-d)

1921 *Clio (Vaginella) depressa* Daudin -- Checchia-Rispoli, p. 15, fig. 6 (non Daudin).
1968 *Vaginella depressa* Daudin, 1800 -- Sirna, p. 424, fig, 12a-b (non Daudin, excl. syn.)
1979 *Vaginella* aff. *depressa* Daudin, 1800 -- d'Alessandro et al., p. 86, text-figs. 23-24.
v. 1980 *Vaginella eligmostoma* Tate -- d'Alessandro & Robba, p. 623, pl. 63, figs. 4-5; pl. 64, figs. 1-5 (non figs. 6-7 = *V. depressa* Daudin); pl. 65, figs. 1-3 (non Tate).
1982 *Vaginella depressa* Daudin -- Bernasconi & Robba, p. 215 (partim, non Daudin).
*v. 1990 *Vaginella sannicola* sp. nov., Janssen, p. 69, pl. 9, figs. 7-9.
v. 1995 *Vaginella sannicola* Janssen, 1990 -- Janssen, p. 155, pl. 12, fig. 5a-c.

Description The shell is small (H < 4 mm), barely more than twice as high as wide, shaped as a miniature amphora, bilaterally symmetrical on a plane perpendicular to dorsal and ventral sides. Specimens retaining their protoconch are as yet unknown. Both dorsal and ventral shell parts are convex, especially in the base, and the shell becomes flattened towards the aperture. A preapertural constriction is sometimes indicated, but absent in most specimens. Weak but distinct lateral carinae are present in the basal part of the shell, but disappear upward.

The aperture is elongated elliptical, always less wide than the maximal shell width which is situated at mid height, or slightly lower. Two weak folds are present on ventral and dorsal apertural margins, situated closer together on the ventral side.
Material Sample 1 (13 specimens, RGM 457.025); sample 2 (68 specimens, RGM 429.973); sample 3 (several hundreds of specimens, RGM 429.895), sample 4 (166 specimens, 1 protoconch (?), RGM 284.002, RGM 429.780-1).
Discussion This species is very common in main phosphorite level C1, and the present research also demonstrates its common occurrence in levels below C1. It was originally described, however, from limestones in Gargano (Italy), the age of which is still disputed (d'Alessandro & Robba, 1980), but in my opinion is Langhian. This seems to agree with a possible recurrence of this species in the Upper Coralline Limestone, which I hope to document in a forthcoming paper.

***Vaginella* ? *tricuspidata* Zorn & Janssen, 1993** (Pl. 4, figs. 12, 13a-c)

? *v 1993 *Vaginella tricuspidata* sp. nov., Zorn & Janssen, p. 63, pl. 1, pl. 2, figs. 1-5; pl. 3; pl. 4, figs. 1-5.
? v 2002 *Vaginella* aff. *tricuspidata* -- Gürs & Janssen, p. 124, tab. 7.

Description Shell vaginelliform, medium-sized, elongate, transverse section almost cylindrical in the apical part, dorso-ventrally flattened towards the aperture, bilaterally symmetrical. In front view the apical part is slender conical, near to the apertural part of the shell the sides become parallel. There is no preapertural constriction, and therefore the greatest width of the shell is at the aperture.

In the Wardija material the larval shell is for the greater part preserved in just one specimen. It is elongately globose, separated from the teleoconch by a clear constriction and deviates slightly in ventral direction from the shell's long axis. Two weak lateral carinae are seen in the basal part of the shell, that disappear gradually at c. mid height.

The aperture (not preserved in the Wardija specimens) is elliptical, but a bit widened in its central part (apertural view). Two weak folds parallel to the shell's long axis run from the dorsal apertural margin in apical direction over a short distance. Three small cusps ornament the dorsal margin.The ventral margin is almost straight, slightly lower than the dorsal one. Close to the ventral apertural margin the shell is slightly inflated in its centre.
Material Sample 2 (5 fragments, RGM 284.003-4, RGM 429.974); sample 3 (7 fragments, RGM 429.896).
Discussion This species was described originally from the Late Oligocene (Chattian) of SW France and Hungary, and was subsequently also recorded from sediments of the same age in the North Sea Basin. A further record from the Early Miocene in the North Sea Basin could only be identified as *V.* aff. *tricuspidata.* Also the present material, exclusively in a fragmentary state, shows the elongate shell form of *Vaginella tricuspidata*, but the ultimate proof that we are indeed dealing with this species, i.e. the presence of three cusps on the dorsal apertural margin, could not be demonstrated in the Wardija samples because of internal mould preservation. Therefore I prefer to apply this name here with a query.

Family Sphaerocinidae Janssen & Maxwell, in Janssen, 1995

Genus *Sphaerocina* Jung, 1971

Type species: *Sphaerocina formai* (Audenino, 1897) (Miocene)

***Sphaerocina* sp. nov. ?** (Pl. 4, fig. 14a-d)

Description Just a few fragments were found of what apparently is a *Sphaerocina* species. These are conical, strongly bent internal moulds, their maximal dimension is slightly more than 2 mm. The ventral (convex) side is gradually curved, whereas the dorsal (concave) side has a longitudinal swelling, which is not exactly in the middle, but a bit shifted to the left side.
Material Sample 2 (2 fragments, RGM 429.975); sample 3 (2 fragments, RGM 429.897-8).
Discussion These fragments resemble *Sphaerocina formai* (Audenino, 1897), described from the Langhian of the Turin Hills (Italy), but also occurring at many other places (southern Italy, Sicily, Malta, Carribbean, New Zealand). The age of all these localities seems to be Langhian, the Maltese specimens (not yet recorded in the literature) originate from the Upper Coralline Limestone. As the Wardija specimens are few, and very incomplete, and as their age seems to be considerably older I prefer to list them in open nomenclature. They might represent a yet undescribed species. Another species of this genus (compare Janssen, 1995, p. 164) is known, but not yet described, from the Late Oligocene Marnes de St. Etienne-d'Orthe, in SW France. Furthermore some specimens of an undoubtedly new *Sphaerocina* species were collected from Pliocene deposits at Pangasinan, Philippines (RGM collections, as yet unpublished).

Suborder Pseudothecosomata Meisenheimer, 1905
Superfamily Peraclidoidea Tesch, 1913
Family Peraclididae Tesch, 1913
Genus *Peraclis* Forbes, 1844 (emend. Pelseneer, 1888)

Type species: *Peraclis reticulata* (d'Orbigny, 1836) (Recent)

***Peraclis* sp.** (Pl. 4, fig. 15)

Description A single internal mould was found. It is slightly over 1 mm high, sinistral, and has almost three whorls. The first whorl is planispiral and therefore the shell has a blunt apex. The last two whorls attach far below the periphery of the preceding ones, resulting in convex whorls and deep sutures. The aperture is simple, without any strengthening devices, and rounded elliptical in front view. A columellar seam is not detectable with any certainty on this phosphoritic mould. The surface of the whorls is smooth, without a trace of subsutural crests, as frequently seen in *Peraclis*.
Materia*l* Sample 3 (1 specimen, RGM 429.899).
Discussion This specimen shows some resemblance with *Peraclis lata* (Krach, 1979) (compare Janssen & Zorn, 1993, p. 210, pl. 5, fig, 4; pl. 6, fig. 1), described from the Badenian of Poland. That species, however, is more thick-set, with a distinctly lower H/W-ratio, and demonstrates clear subsutural crests. As just one specimen is available from Wardija we have to wait for additional material, before it can be introduced as a new species.

Order Gymnosomata Blainville, 1823

The Gymnosomata are so-called 'naked' pteropods, as the adult animal has no shell. The embryonic shell, presumably present in all species, is shed shortly after hatching (Lalli & Conover, 1976). Such embryonic shells have only been described as yet for a restricted number of Recent species. Quaternary fossil specimens in shell preservation were

recorded for the first time by van der Spoel & Diester-Haas (1976).Two Miocene species, as yet unidentified, are recorded here for the first time from the Wardija samples, but much more material, also belonging to other species, is available from many Mediterranean Miocene localities from which fossils in phosphoritic internal mould preservation are available. This material deserves a special biometric study by means of SEM imaging.

Gymnosomata sp. 1 (Pl. 4, fig. 16)

Description Very small (H less than 0.3 mm), conical internal moulds of the larval shell. The initial part (embryonic shell) is an elliptical globe with rounded tip, separated by a clear constriction from the younger, postembryonic part, with is conical, with an apical angle of c. 23°. The transverse section of both parts is circular.
Material Sample 3 (6 specimens, RGM 429.900-1).
Discussion Considering the size and the shape of the present specimens they cannot represent the embryonal shell of one of the pteropod species. There is a remote resemblance with the larval shell of a gymnosomatous species, *viz. Clione limacina* (Phipps, 1774) (compare Lalli & Gilmer, 1989, p. 198, fig. 69). In that species, however the embryonic shell is not elliptical, but rather pointed, whereas the postembryonic part, separated by a less obvious constriction, has a wider apical angle and an elliptical transverse section.

Gymnosomata sp. 2 (Pl. 4, fig. 17)

Description Very small (H c. 0.15 mm), internal mould of the larval shell. The embryonic shell is globular in frontal view, slightly higher than wide. The postembryonic shell part is separated by a distinct constriction. It does not reach half the height of the initial globe and has an apical angle of c. 40°. In both shell parts the dorso-ventral diameter is less than the shell width, resulting in an elliptical aperture.
Material Sample 3 (1 specimen, RGM 429.902).
Discussion The present specimen shows a distinct relationship with the Recent gymnosomatous species *Paedoclione doliiformis* Danforth, 1907, as described *e.g.* by Lalli & Conover (1976, p. 241, fig. 5). The embryonic shell illustrated by them has a height of c. 0.2 mm in which the initial part is less globular, and the constriction between embryonic and post-embryonic shell is less obvious. Only one specimen was found in sample 3 of Wardija, but very similar, if not identical specimens were collected in large numbers from the Upper Globigerina Limestone Formation of Malta and Gozo. The same is true for many samples of similar age from Italy (Gargano, Salentino, Sicily, all unpublished, RGM collection).

AGE ASSIGNMENT USING HOLOPLANKTONIC MOLLUSCA

The holoplanktonic mollusc material extracted from the four Wardija samples yielded some surprises: several species were encountered that are new for the Cainozoic of the Maltese Archipelago, and a number of species are even new to science. The following species were collected:

Name	Sample 4	Sample 3	Sample 2	Sample 1
Atlanta sp.	-	20	5	-
Heliconoides tertiaria (Tate, 1887)	57	many	50	4
Heliconoides vanderweideni sp. nov.	7	25	5	-
Limacina valvatina (Reuss, 1867)	-	26	5	1
Limacina sp. an *L. gramensis* (Rasmussen, 1968)	14	10	1	1
Bowdenatheca miocenica sp. nov.	-	12	2	-
Styliola subula (Quoy & Gaimard, 1827)	1	1	-	-
Spoelia torquayensis A.W. Janssen, 1990	1	43	34	1
Clio (s.lat.) *ghawdexensis* sp. nov.	1	-	46	6
Clio (s. lat.) aff. *saccoi* Checchia-Rispoli, 1921	-	3	-	-
Clio (s. lat.) ? sp.	-	1	-	-
Edithinella bonaviai sp. nov.	-	many	many	-
Gamopleura melitensis A.W. Janssen, 1995	322	11	10	2
Vaginella sannicola A.W. Janssen, 1990	167	many	68	13
Vaginella ? *tricuspidata* Zorn & Janssen, 1993	-	7	5	-
Sphaerocina sp. nov. ?	-	2	2	
Peraclis sp.	-	1	-	-
Gymnosomata sp. 1	-	6	-	-
Gymnosomata sp. 2	-	1	-	-

Several of these species are long-ranging in time. *Styliola subula* is known from the Late Oligocene onwards and is still found living. *Limacina valvatina* is known from the central Paratethys and the North Sea Basin, ranging from Late Oligocene to Late Miocene. *L. tertiaria* is known from the Early to Middle Miocene of Australia, Aquitanian to Langhian from the Mediterranean, and Langhian from the Aquitaine Basin (this latter occurrence still unpublished).

Clio ghawdexensis sp. nov. is closely related to a new species, also from the Chattian of the Aquitaine Basin. Indicators for a Chattian age are *Spoelia torquayensis*, know from the Late Oligocene of Australia, the Aquitaine and the North Sea basins, and *Vaginella* aff. *tricuspidata*, which is known from the Late Oligocene of Aquitaine, Hungary and the North Sea Basin. A doubtful record is from the Early Miocene in the North Sea Basin.

Clio aff. *saccoi* might be identical with *C. saccoi*, which so far is only known from the Mediterranean Langhian. Gymnosomata sp. 1 and 2, or at least very similar forms, are found also in higher portions of the Maltese Globigerina Limestone of Langhian age, as well as in Italian deposits of similar age. *Sphaerocina* sp. resembles an as yet undescribed species known from the Late Oligocene of Aquitaine, but on the other hand might be a juvenile form of *Sphaerocina formai*, which is known from the Langhian (Caribbean, New Zealand, Mediterranean).

Vaginella sannicola up to now is exclusively known with certainty from the Mediterranean Aquitanian, as most of the Langhian localities in Italy where this species was recorded from (Gargano, Salentino) up to now were considered to represent reworked faunas (d'Alessandro & Robba, 1980). Still, this species is also know from the Sicilian Ragusa Formation and the Maltese Upper Globigerina Limestone, which indeed are Langhian in age. *Heliconoides vanderweideni* sp. nov., *L.* sp. an *L. gramensis*, *Bowdenatheca miocenica* sp. nov., *Clio ghawdexensis* sp. nov., *Edithinella bonaviai* sp. nov. and *Peraclis* sp. are new or presumably new, and only known from the present samples. Summarizing, the ranges of the various species are given in the table below:
A certain similarity is found between the present assemblages and the one found in for example the Late Chattian locality

Species	Chattian	Aquitanian	Burdigalian	Langhian	younger
Atlanta sp.	-	+	+	+	+
Heliconoides tertiaria	-	+	+	+	-
Heliconoides vanderweideni sp. nov.	-	-	-	-	-
Limacina valvatina	+	+	+	+	+
Limacina sp. an *L. gramensis*	-	-	-	-	-
Bowdenatheca miocenica sp. nov.	-	-	-	-	-
Styliola subula	+	+	+	+	+
Spoelia torquayensis	+	-	-	-	-
Clio (s. lat.) *ghawdexensis* sp. nov.	-	-	-	-	-
Clio (s. lat.) aff. *saccoi*	-	-	-	?	-
Clio (s. lat.) ? sp.	-	-	-	-	-
Edithinella bonaviai sp. nov,	-	-	-	-	-
Gamopleura melitensis	-	+	-	-	-
Vaginella sannicola	-	+	-	?	-
Vaginella ? *tricuspidata*	+	?	-	-	-
Sphaerocina sp. nov.	-	-	-	?	-
Peraclis sp.	-	-	-	-	-
Gymnosomata sp. 1	-	-	-	+	-
Gymnosomata sp. 2	-	+	-	+	-

of St. Etienne-d'Orthe, in the Aquitaine Basin. In the French assemblage, however, common species of Wardija, such as *Gamopleura melitensis, Vaginella sannicola, Heliconoides tertiaria, H. vanderweideni* or *Edithinella bonaviai* are not found, nor are these species recorded from the Aquitanian deposits in France. This might indicate a depositional hiatus between the Chattian and Aquitanian sediments in SW France, and some of the Chattian holoplanktonic mollusc species (*Spoelia torquayensis, Vaginella tricuspidata)* might range into the Early Aquitanian. A common species occurring in the French Aquitanian is *Vaginella depressa* Daudin, 1800, which so far in the Maltese Archipelago is known only from the Middle Globigerina Limestone (unpublised). These considerations lead to the supposition that the Lower Globigerina Limestone Formation is of Early Aquitanian age.

PLATES

Plate 1. Benthic Mollusca

Bivalvia (figures 1-11, 13: X 12½, fig. 12: X 6; a = dorsal view, b = frontal view).

Fig. 1. Nuculidae sp., sample 3, RGM 429.798.
Fig. 2. Nuculanidae sp. 1, sample 3, RGM 429.799.
Fig. 3. Nuculanidae sp. 2, sample 3, RGM 429.800.
Fig. 4. Nuculanidae sp. 3, sample 2, RGM 429.927.
Fig. 5. *Nucinella* sp., sample 3, RGM 429.801.
Fig. 6. *Bathyarca* sp., sample 3, RGM 429.802.
Fig. 7. *Kelliella* ? sp., sample 3, RGM 429.806.
Fig. 8. Lucinidae sp., sample 3, RGM 429.804.
Fig. 9. Lucinidae ? sp., sample 3, RGM 429.805.
Fig. 10. Montacutidae sp., sample 3, RGM 429.803.
Fig. 11. Carditidae sp., sample 2, RGM 429.929.
Fig. 12. *Corbula* sp., sample 2, RGM 429.931.
Fig. 13. *Xylophaga* sp., sample 2, RGM 429.932.

Scaphopoda (figures 14-20, X 12½; a = frontal; view, b = lateral view).

Figs.14-17. Dentaliidae sp., sample 3, RGM 429.808.
Fig. 18. *Pseudantalis* sp., sample 3, RGM 429.807.
Fig. 19. *Cadulus* sp., sample 3, RGM 429.809.
Fig. 20. Siphonodentaliidae sp., sample 3, RGM 429.810.

Gastropoda (figures 26, 35, X 6; other figures X 12½; a = apical view, b = frontal view).

Figs.21-22. *Scissurella* sp., sample 3, RGM 429.811.
Fig. 23. *Solariella* sp., sample 3, RGM 429.813.
Fig. 24. Trochacea sp. 1., sample 3, RGM 429.815.
Fig. 25. Trochacea sp. 2., sample 3, RGM 429.816.
Fig. 26. Trochacea sp. 3, sample 3, RGM 429.817.
Fig. 27. *Circulus* sp., sample 3, RGM 429.818.
Fig. 28. Rissoacea sp., sample 3, RGM 429.821.
Fig. 29. Archaeogastropoda sp. 1, sample 3, RGM 429.822.
Figs.30-31. Archaeogastropoda sp. 2, sample 3, RGM 429.823.
Fig. 32. Cerithiidae sp., sample 2, RGM 429.939.
Fig. 33. Calyptraeidae sp., sample 2, RGM 429.942.
Fig. 34. Xenophoridae sp., sample 3, RGM 429.830.
Fig. 35. Xenophoridae sp., sample 3, RGM 429.830.
Fig. 36. *Eulima* sp., sample 3, RGM 429.829.

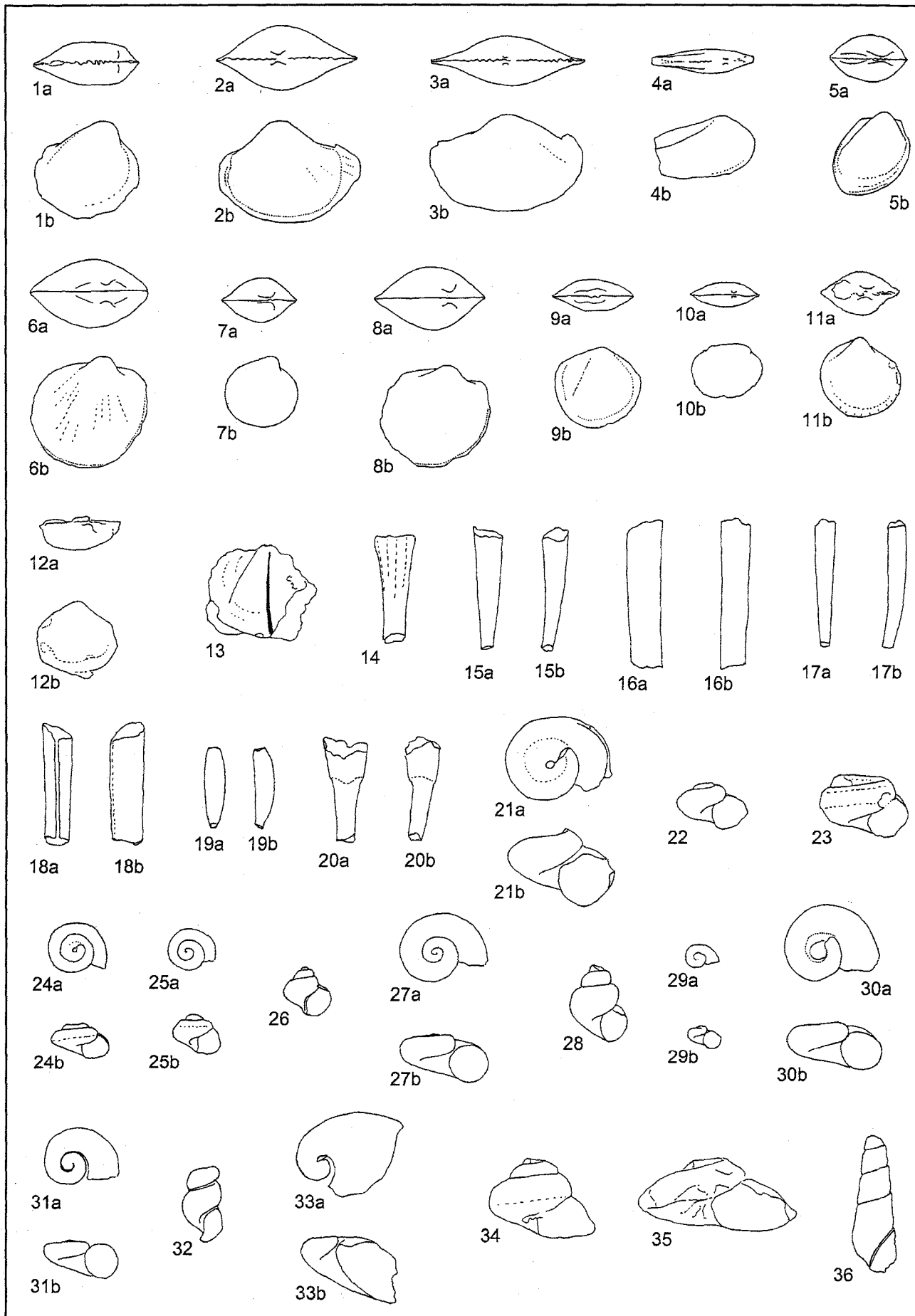
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Plate 2. Benthic Gastropoda

All figures X 12½, a = apical view, b = frontal view.

Fig. 1. *Trivia* sp., sample 3, RGM 429.824.
Fig. 2. Naticidae sp. 1, sample 3, RGM 429.825.
Fig. 3. Naticidae sp. 2, sample 3, RGM 429.826.
Figs. 4-5. Naticidae sp. div., sample 3, RGM 429.827.
Fig. 6. Muricidae sp., sample 3, RGM 429.831.
Fig. 7-8. *Mitrella* sp., sample 3, RGM 429.832.
Fig. 9. Buccinidae sp. 1, sample 3, RGM 429.833.
Fig. 10. Buccinidae sp. 2, sample 3, RGM 429.834.
Figs.11-12. Nassariidae sp., sample 3, RGM 429.835.
Fig. 13. *Vexillum* ? sp., sample 3, RGM 429.836.
Fig. 14. Cancellariidae ? sp., sample 3, RGM 429.837.
Fig. 15. Marginellidae sp. 1, sample 3, RGM 429.838.
Fig. 16. Marginellidae sp. 2, sample 3, RGM 429.839.
Figs.17-18. Marginellidae sp. 3, sample 3, RGM 429.840.
Fig. 19. Marginellidae sp. 4, sample 3, RGM 429.841.
Fig. 20. Turridae sp. 1, sample 3, RGM 429.842.
Fig. 21. Turridae sp. 2., sample 3, RGM 429.843.
Fig. 22. Neogastropoda sp. 1, sample 3, RGM 429.845.
Figs.23-26. Neogastropoda sp. 2, sample 3, RGM 429.846.
Fig. 27. Neogastropoda sp. 3, sample 3, RGM 429.847.
Fig. 28. Pyramidellidae sp. 1, sample 3, RGM 429.851.
Fig. 29. Pyramidellidae sp. 2, sample 3, RGM 429.852.
Figs.30-31. Epitoniidae sp., sample 3, RGM 429.844.
Fig. 32. Actaeonidae sp. 1, sample 3, RGM 429.848.
Fig. 33. Actaeonidae sp. 2, sample 3, RGM 429.849.
Figs.34-35. *Ringicula* ? sp., sample 3, RGM 429.850.
Figs.36-40. Retusidae sp. div., sample 3, RGM 429.853.
Fig. 41. *Volvulella* sp., sample 3, RGM 429.854.
Figs.42-43. *Cylichna* sp., sample 3, RGM 429.855.
Fig. 44. *Roxania* sp., sample 3, RGM 429.856.
Fig. 45. *Haminea* sp., sample 3, RGM 429.857.
Fig. 46. Philinidae sp., sample 3, RGM 429.858.

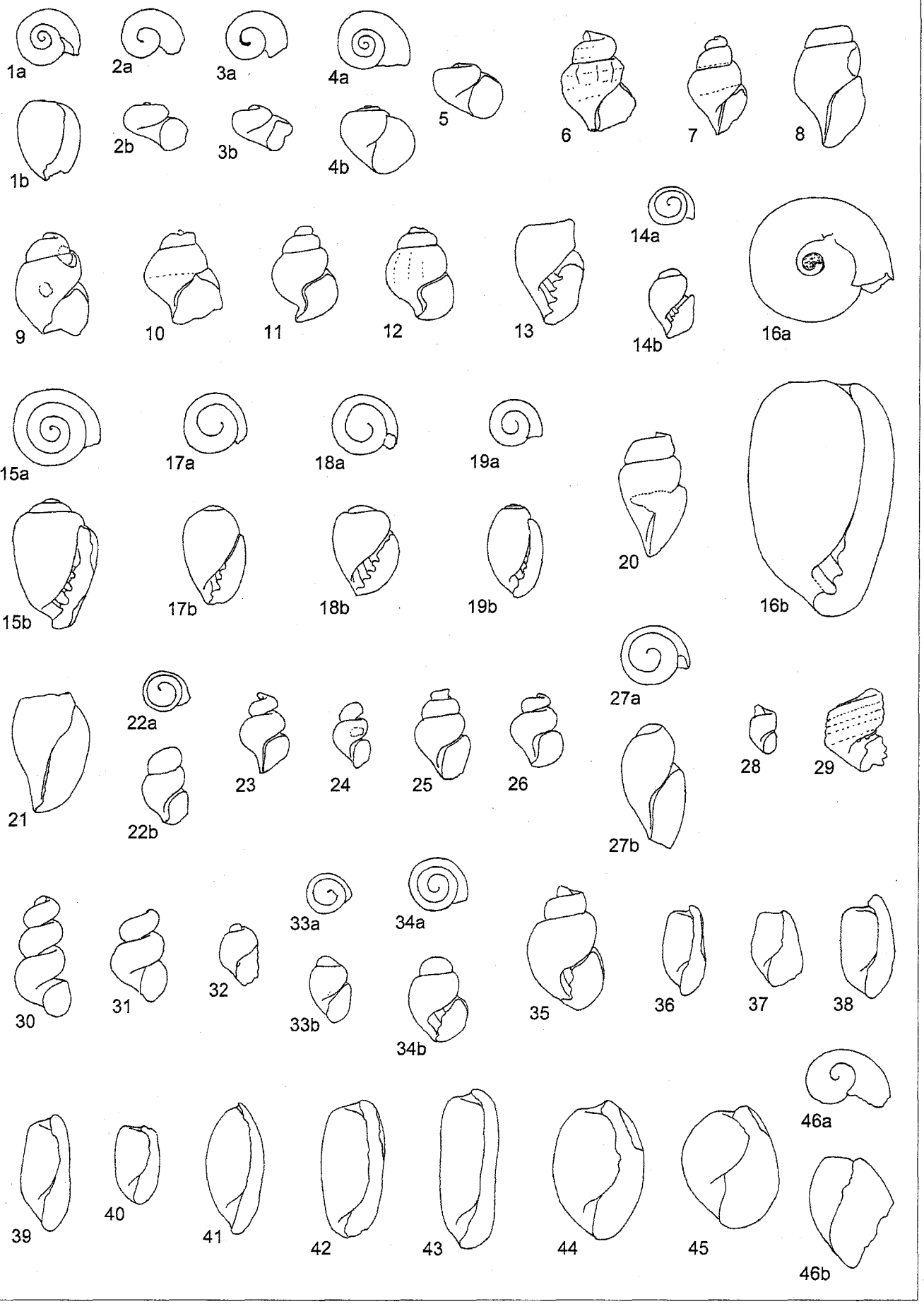
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Plate 3. Benthic and holoplanktonic Gastropoda

Benthic Gastropoda (all figures X 12½, a = apical view, b = frontal view).

Fig. 1. Gastropoda non det. 1, sample 3, RGM 429.859.
Figs. 2-3. Gastropoda non det. 2, sample 3, RGM 429.860.
Fig. 4. Gastropoda non det. 3, sample 3, RGM 429.861.
Fig. 5. Gastropoda non det. 4, sample 3, RGM 429.862.
Fig. 6. Gastropoda non det. 5, sample 3, RGM 429.863.
Fig. 7. Gastropoda non det. 6, sample 3, RGM 429.864.
Fig. 8. Gastropoda non det. 7, sample 3, RGM 429.865.
Fig. 9. Gastropoda non det. 8, sample 3, RGM 429.866.
Fig. 10. Gastropoda non det. 9, sample 3, RGM 429.867.
Fig. 11. Gastropoda non det. 10, sample 3, RGM 429.868.
Fig. 12. Gastropoda non det. 11, sample 3, RGM 429.869.
Fig. 13. Gastropoda non det, 12, sample 3, RGM 429.879.
Fig. 14. Gastropoda indet., umbilical mould, sample 2, RGM 429.960.

Holoplanktonic Gastropoda

Fig. 15 *Atlanta* sp., sample 3, RGM 429.819; a: apical view, b: frontal view.
Fig. 16. *Heliconoides tertiaria* (Tate, 1887), sample 3, RGM 429.874; a = apical view, b = frontal view; X 25.
Fig. 17. *Heliconoides vanderweideni* sp. nov., holotype, sample 3, RGM 429.878; a = apical view, b = frontal view, X 25.
Fig. 18. *Heliconoides vanderweideni* sp. nov., paratype (depressed form), sample 3, RGM 429.872; a: apical view, b: frontal view, c: lateral view; X 25.
Fig. 19. *Limacina valvatina* (Reuss, 1867), sample 3, RGM 429.876; a: frontal view, b = lateral view; X 25.
Fig. 20. *Limacina* sp. an *L. gramensis* (Rasmussen, 1968), sample 3, RGM 429.880; a: frontal view, b: lateral view; X 25.
Fig. 21. *Styliola subula* (Quoy & Gaimard, 1827), sample 4, RGM 429.776; a: apertural view, b: frontal view, X 25.
Fig. 22. *Bowdenatheca miocenica* sp. nov., holotype, sample 3, RGM 429.883; a apical view, b: frontal view, c: apical view, d: lateral view; X 12½.
Fig. 23. *Spoelia torquayensis* A.W. Janssen, 1990, sample 3, RGM 429.885; a: apertural view, b: frontal view, c: apical view, d: lateral view; X 12½.
Fig. 24. *Spoelia torquayensis* A.W. Janssen, 1990, sample 3, RGM 284.010; lateral view; X 12½.
Fig. 25. *Spoelia torquayensis* A.W. Janssen, 1990, sample 3, RGM 284.011; a: apertural view, b: lateral view, c: apical view; X 12½.
Fig. 26. *Clio* (s. lat.) aff. *saccoi* Checchia-Rispoli, 1921, sample 3, RGM 429.887; a: apertural view, b: frontal view, c: lateral view; X 12½.
Fig. 27. *Clio* (s. lat.) ? sp., sample 3, RGM 429.889; a: apertural view, b: frontal view; X 25.

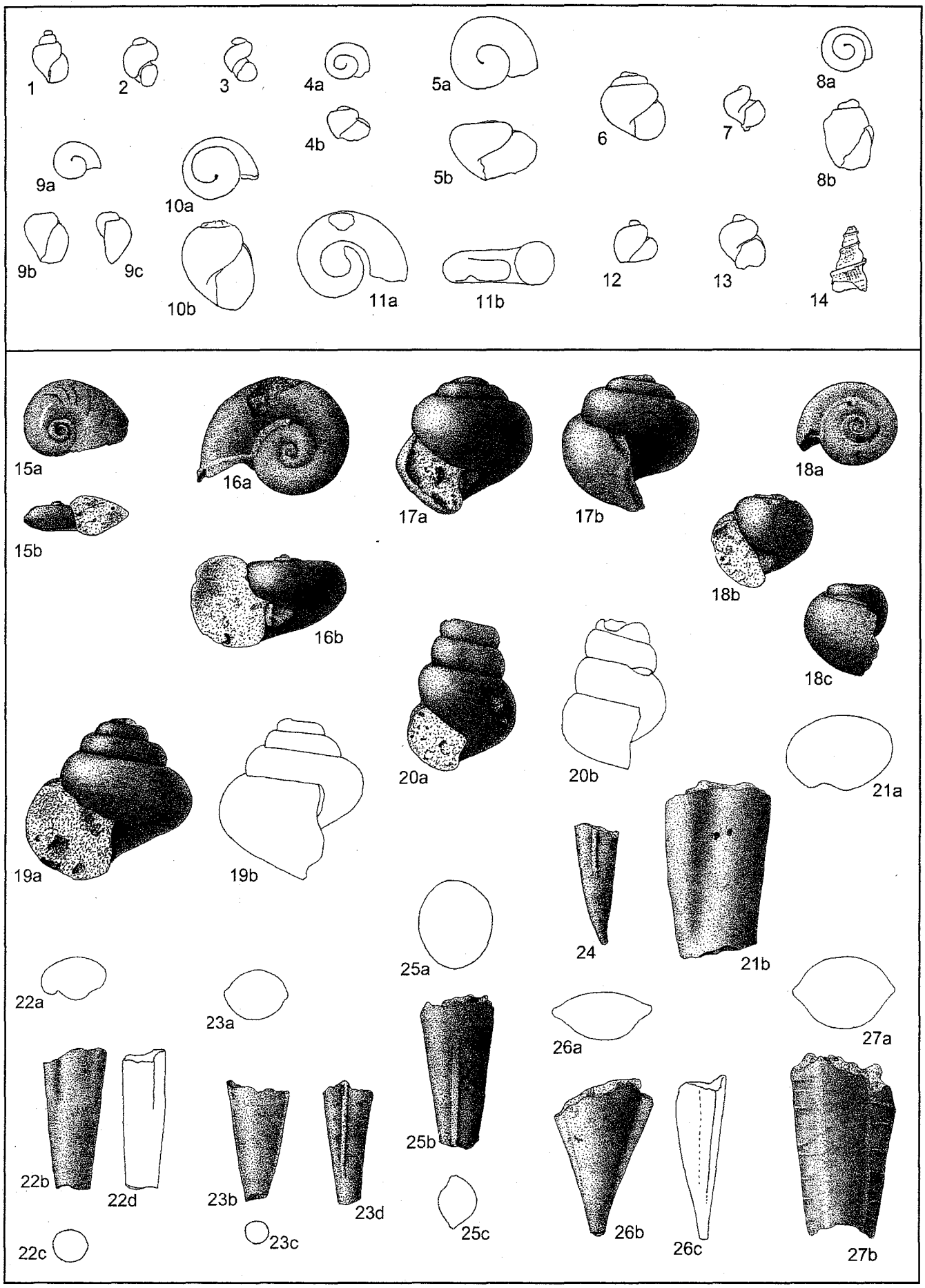
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Plate 4. Holoplanktonic Gastropoda

Fig. 1. *Clio* (s. lat.) *ghawdexensis* sp. nov., holotype, sample 2, RGM 429.970; a: apertural view, b: frontal view, c: apical view, d: lateral view; X 12½.

Figs. 2-6. *Clio* (s. lat.) *ghawdexensis* sp. nov., paratypes, sample 2, RGM 284.005-9; a: apertural view, b: frontal view, c: apical view, d: lateral view; X 12½.

Fig. 7. *Edithinella bonaviai* sp. nov., holotype, sample 3, RGM 429.890; a: apertural view, b: frontal view, c: apical view, d: lateral view; X 12½.

Fig. 8. *Edithinella bonaviai* sp. nov., paratype, sample 3, RGM 429.891; a: apertural view, b: frontal view, c: apical view, d: lateral view; X 12½.

Fig. 9. *Gamopleura melitensis* A.W. Janssen, 1995, sample 4, RGM 284.001; a: ventral view, b: dorsal view, c: lateral view; X 6.

Fig. 10. *Gamopleura melitensis* A.W. Janssen, 1995, juvenile ?, sample 3, RGM 429.893; a: ventral view, b: dorsal view, c: lateral view; X 12½.

Fig. 11. *Vaginella sannicola* A.W. Janssen, 1990, sample 4, RGM 284.002; a: apertural view, b: ventral view, c: lateral view, d: dorsal view; X 6.

Fig. 12. *Vaginella* ? *tricuspidata* Zorn & Janssen, 1993, sample 2, RGM 284.003; lateral view; X 12½.

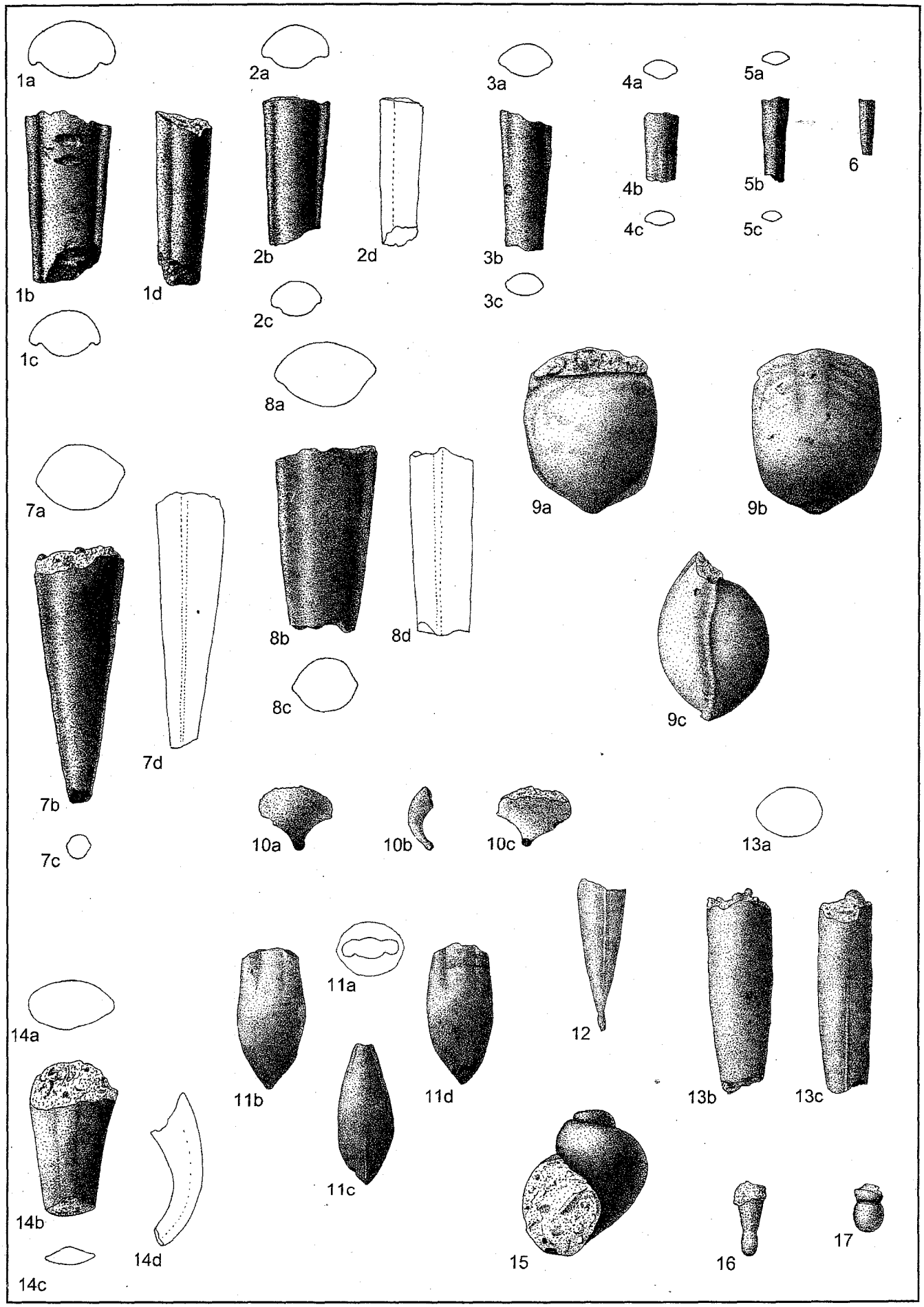
Fig. 13. *Vaginella* ? *tricuspidata* Zorn & Janssen, 1993, sample 2, RGM 284.004; a: apertural view, b: frontal view, c: lateral view; X 12½.

Fig. 14. *Sphaerocina* sp. nov. ?, sample 3, RGM 429.897; a: apertural view, b: dorsal view, c: apical view, d: lateral view; X 25.

Fig. 15. *Peraclis* sp., sample 3, RGM 429.899; frontal view; X 25.

Fig. 16. Gymnosomata sp. 1, sample 3, RGM 429.900; frontal view; X 50.

Fig. 17. Gymnosomata sp. 2, sample 3, RGM 429.902; frontal view; X 50.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