

The *Zonitidae* of the South-East Aegean islets  
(*Gastropoda: Pulmonata*)

ADOLF RIEDEL<sup>1</sup> and MOYSIS MYLONAS<sup>2</sup>

<sup>1</sup>Polish Academy of Sciences, Museum and Institute of Zoology, Wilcza 64, 00-679 Warsaw, Poland

<sup>2</sup>Department of Biology, University of Crete, P.O.Box 1470, 711-10 Iraklion, Crete, Greece

**ABSTRACT.** An abundant material was collected in 1989 by a Greek zoological expedition from 12 islets of the SE part of the Aegean Archipelago, which zoologically is one of the least explored regions. Eight taxa of the *Zonitidae*, one of the most diversified families in the area, were recorded. Their affinities with related taxa are discussed. Except for the circum-Mediterranean *O. hydatinus*, all the other taxa are local endemics. *Zonites nautarum* and *Z. invitus* are new to science. Based on the affinities and distribution of the species, the area may be regarded as a remnant of the SE part of the central Aegaeis plateau.

**Key words:** Malacology, *Gastropoda*, *Zonitidae*, taxonomy, zoogeography, Greece.

#### INTRODUCTION

A group of uninhabited islets is situated in the SE part of the Aegean Archipelago, between Astypalaia and Anafi in the north-west and Karpathos and Kasos in the south-east (Fig. 1). Since no safe anchorages exist on these islets, which are situated far from inhabited islands, from natural history viewpoint they constitute the least explored region of the whole Archipelago. On the other hand, their considerable geographic isolation, and their location on the borderline between the Asian and European biogeographic subregions, suggest their possible importance for faunistic and biogeographic studies.

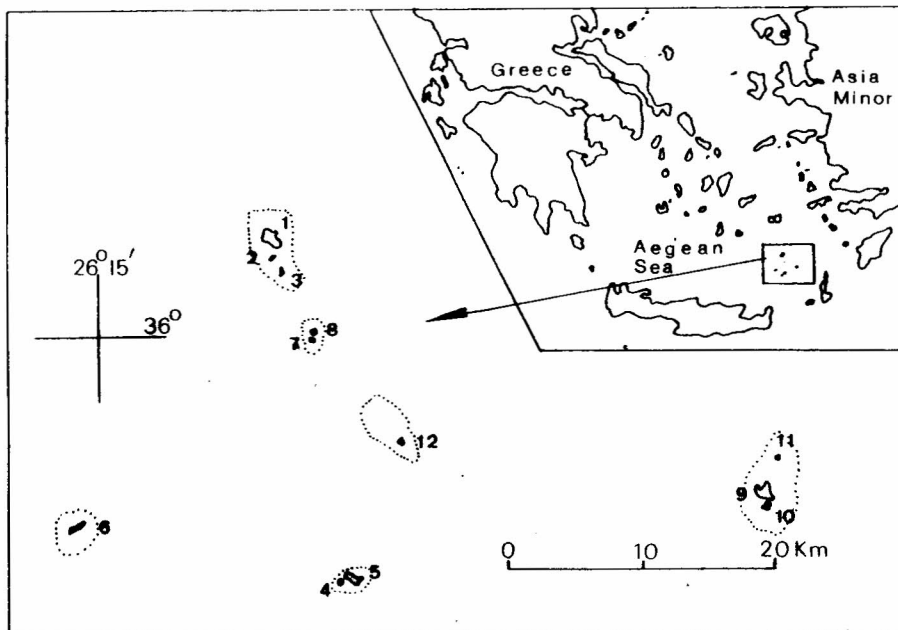
The importance of terrestrial molluscs for the studies of island biogeography in general, and their significance for the ecology of the Aegean Archipelago in

particular have been stressed by many authors (HELLER 1976, MYLONAS 1982, RIEDEL 1992). The families *Enidae*, *Clausiliidae*, *Zonitidae* and *Helicidae* have been found to be the most diverse and informative.

The existing information on the zonitids of the islets in question was based exclusively on the material collected during two short zoological trips by O. WETTSTEIN in 1935 and by H. PIEPER in 1971. Each resulted in a discovery of a new, endemic species of the genus *Zonites* MONTFORT, namely *Z. embolium* FUCHS and KAÜFEL, 1936 and *Z. astakidae* RIEDEL, 1985, respectively. However, descriptions of both species were based on very few shells, some of them juvenile, poorly preserved and thus doubtful.

In April 1989 one of us - M. MYLONAS, then from the University of Athens - organized a zoological expedition to these islets. This would have been impossible without the assistance of the Greek Navy. Most of the fairly abundant zoological material collected during the trip is now kept at the Section of Ecology and Taxonomy of the University of Athens.

Having examined the material, in this paper we present the zonitid fauna of the region and discuss its significance.



1. The studied islets: 1 - Megalo Sofrano, 2 - Kentriko Sofrano, 3 - Mikro Sofrano, 4 - W Ounio, 5 - E Ounio, 6 - Chamili, 7 - Megalo Karavonisi, 8 - Mikro Karavonisi, 9 - Astakida, 10 - Astakidopoula, 11 - Foka, 12 - Avgo

## STUDY AREA

Twelve islets of the Aegean Archipelago, the smallest being no more than 0.1, and the largest 1.1 kilometer square (table 1) were studied. Their altitudes vary from 40 to 227 m. The islets are built of limestone, except for a small marl area on Megalo Sofrano. Smaller islets are usually semi-conical, with one side collapsed and the other forming a very steep slope. Approach and climbing are very difficult. Soil exists only at the top or in carstic crevices. Larger islets have from one to three rocky peaks exceeding an altitude of 100 m, and at least one smooth slope. Sometimes even alluvial terraces exist. Stones, screes and rock crevices provide abundance of hiding places for snails.

Bioclimatically, the islets represent a warm, semi-arid Mediterranean type (MAVROMMATIS 1978). Though the annual precipitation is one of the lowest in Greece (below 400 mm), and the wet period does not exceed three months, the high level of relative humidity throughout the year counteracts the dryness.

The vegetation constitutes a mosaic of phrygana and herbaceous plants. Dominant plants vary between islets. The most common plant species are *Euphorbia dendroides*, *Thymelaea hirsuta*, *Atriplex recurva*, *Teucrium polium*, *Frankenia hirsuta* and *Urginea maritima*. On S Karavonisi the vegetation consists only of herbs and grasses (*Dactylis* sp., *Lavatera arborea*, *Leopoldia* sp.).

Fauna and flora of Avgo have been totally exterminated, the islet being used as a shooting area by the navy and airforce. No zonitid species has been found on the islet of Foka.

Table 1. Characteristics of the studied islets

islet	area [km <sup>2</sup> ]	altitude [m]	refuges	terraces	vegetation	distance [km] @
1	1.15	227	abundant	+	phrygana	36
2	0.15	80	common	-	phg.-herb.	0.5
3	0.20	60	rare	-	phg.-herb.	1.5
4	0.25	90	common	-	phg.-herb.	7
5	0.10	40	rare	-	herbaceous	0.5
6	0.20	80	(*)	+	—————	11
7	0.10	50	rare	-	phg.-herb.	2
8	1.00	200	abundant	+	phrygana	31
9	0.25	80	common	-	phg.-herb.	0.3
10	0.30	60	rare	-	phg.-herb.	20
11	0.55	150	abundant	+	phrygana	26
12	0.30	100	abundant	+	phrygana	0.5

Explanations: 1 - Megalo Sofrano, 2 - Kentriko Sofrano, 3 - Mikro Sofrano, 4 - Megalo Karavonisi, 5 - Mikro Karavonisi, 6 - Avgo, 7 - Foka, 8 - Astakida, 9 - Astakidopoula, 10 - Chamili, 11 - E Ounio, 12 - W Ounio; (\*) - on Avgo abundant refuges exist due to its bombing; @ - distance given is that from the nearest larger island

## SYSTEMATIC REVIEW

Three zonitid genera, *Vitrea*, *Zonites* and *Oxychilus*, represented by seven taxa, have been collected in the studied area (table 2) by the nautical expedition, *Zonites* being the most diversified. Besides, an extinct species of *Zonites*, probably new, has been found. Another genus and species, represented in the area, is *Eopolita protensa protensa*, not found however on any of the twelve visited islets.

Table 2. Species recorded and their distribution on the studied islets.

Species/islet	1	2	3	4	5	6	7	8	9	10	11
<i>Vitrea clessini</i>	+	+	+	+	+	-	-	-	+	-	-
<i>Zonites astakidae</i>	-	-	-	-	-	-	-	-	+	+	-
<i>Zonites</i> sp. 1	-	-	-	+	+	-	-	-	-	-	-
<i>Zonites nautarum</i>	+	-	-	-	-	-	-	-	-	-	-
<i>Zonites invitus</i>	-	+	-	-	-	-	-	-	-	-	-
<i>Zonites embolium</i>	-	-	+	-	-	-	+	-	-	-	-
<i>Zonites</i> sp.2	-	-	-	-	-	+	-	-	-	-	-
<i>Oxych. hydatinus</i>	-	-	-	-	-	-	-	-	+	-	-

Explanations: 1 - Megalo Sofrano, 2 - Kentriko Sofrano, 3 - Mikro Sofrano, 4 - W Ounio, 5 - E Ounio, 6 - Chamili, 7 - Megalo Karavonisi, 8 - Mikro Karavonisi, 9 - Astakida, 10 - Astakidopoula, 11 - Foka.

### 1. *Vitrea clessini* (HESSE, 1882)

Terra typica: Island of Tinos, Kyklades.

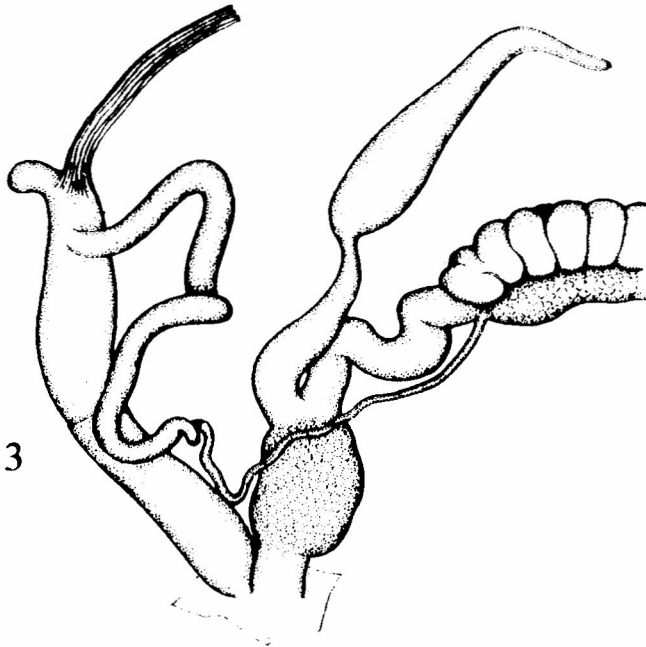
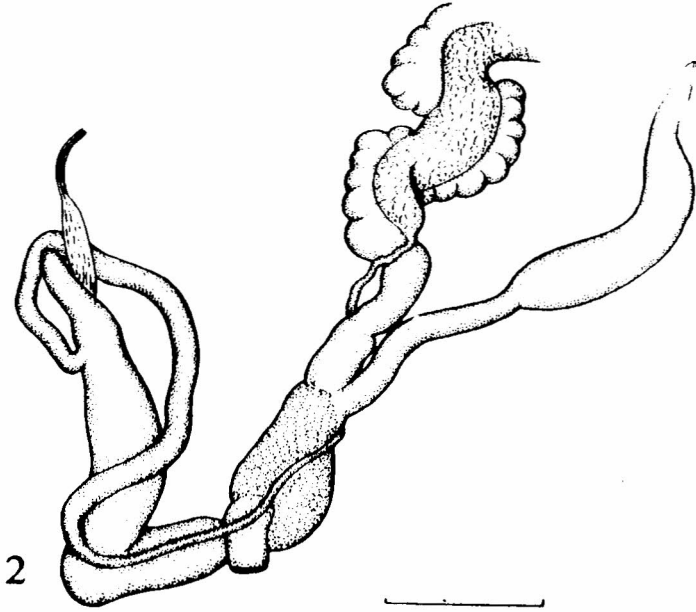
Material examined: Megalo Sofrano - 19 spec., Kentriko Sofrano - 1, Mikro Sofrano - 1, W Ounio - 7, E Ounio - 10, Astakida - 28.

The species is characteristic of the Kyklades Archipelago. It reaches the islands of Saronikos Bay in the west, and the Kriti island in the south (RIEDEL 1992). Its previous doubtful records from Kriti have been recently confirmed based on new material from several localities (K. VARDINOYANNIS leg.). In the south-east, on the island of Karpathos (K. VARDINOYANNIS leg.), a rather atypical form was found.

### 2. *Zonites astakidae* RIEDEL, 1985

Locus typicus: islet of Astakida.

Material examined: Astakida - 17 adults in alcohol, Astakidopoula - 1 juvenile and 3 adult shells.



2, 3. *Zonites astakidae* from the island of Astakida, genitalia of two specimens. Scale bar 5 mm

The species was hitherto known from 4 shells collected by H. Pieper. The types are kept at the Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw.

Shell (Figs 8, 9). The examined specimens from Astakida agree with the types and original description (RIEDEL 1985: 51, pl.IV, figs 46-48). The largest is 24.6 mm in diameter, long axis height 16.6 mm, oblique axis height 14.0 mm; the respective measurements of the smallest specimen, though already fully mature (anatomically examined), are: 19.3, 13.2 and 11.4 mm. The size variation is thus considerable; some variation was also observed in the degree of shell flattening, though the shell is principally semi-spherical to short conical. The number of whorls is 5-5.5, usually c. 5.25.

Specimens from the islet of Astakidopoula (Fig. 9) are wider and more flattened than those from the typical population from Astakida, but the difference is not sufficient to regard them as a separate subspecies. Their measurements [mm] are given below:

No	major diameter	long axis height	oblique axis height	number of whorls
1	27.5	17.3	14.3	5.75
2	26.3	16.7	14.2	5.75
3	25.6	15.6	13.7	5.5

In all the specimens, both from Astakida and Astakidopoula, the embryonic whorls are smooth, devoid of sculpture, though no juvenile shells, on which the sculpture is best visible, have been found; when the sculpture is very delicate, it may become obliterated with age, as is the case of e.g. *Z. nautarum*.

Anatomy. Three specimens have been anatomically examined. The genitalia (Fig. 2, 3) are typical of *Zonites s. str.* The penis is approximately cylindrical or somewhat broader in its mid portion, with a rather short, rapidly narrowing terminal flagellum which has a shape of a narrow cone (Fig. 2) or terminates with a "bud" (Fig. 3). The penial retractor inserts close to the flagellum base. The epiphallus is as long as or slightly longer than the penis and flagellum combined. The vagina is short, its distal 2/3 being surrounded by a large gland. The oviduct is approximately as long and thick as the vagina. The spermatheca is slender, with a comparatively short and thin terminal process.

The inner walls of the penis on its entire length, from the gonopore to the base of flagellum, are densely covered with papillae each of which terminates with a sharp, slightly bent spine. In the proximal portion of the penis the papillae form fairly irregular longitudinal rows, while in the distal portion they are rather randomly arranged.

The shape of the penis and flagellum, its internal structure and proportions of the female reproductive organs are completely different from those found in *Z. casius* MARTENS (cf. RIEDEL 1985), a species which is conchologically very similar to *Z. astakidae*.

Radular formula (one specimen):

$$33 \text{ M}/1 + 8 \text{ L}/2 + \text{C}/1(3?) + 41 \times 74$$

Distribution. The species is endemic to the islets of Astakida and Astakidopoula.

### 3. *Zonites embolium* FUCHS et KAÜFEL, 1936

Locus typicus: "Karawi Nisia, nordliche grosse der beiden Inseln" (= Megalo Karavonisi).

Material examined: islet of Megalo Karavonisi - 7 adults in alcohol; Mikro Sofrano - 4 recent shells, somewhat corroded.

The original description was based on two corroded shells, at present kept at the Museum of Natural History in Vienna. The species was also recorded from the islands of Dyo Adelfoi, eastern (1 subfossil shell, paratype of *Z. embolium!* - FUCHS and KAÜFEL, 1936); Megalo Sofrano (2 juvenile shells and one fragment - RIEDEL 1985) and West Ounio (1 subfossil shell - RIEDEL 1985). It has turned out now that these shells do not belong to *Z. embolium* or at least do not represent its typical form (see below *Zonites* sp. 1 and *Z. nautarum* sp. n.).

Shell (Figs 10-12). It is strongly flattened, discoid, with a low body whorl and poorly elevated spire. In its general appearance it is very similar to *Z. siphnicus* FUCHS et KAÜFEL. The number of whorls is 5.25-5.5, the body whorl being distinctly broadened before the aperture, twice as broad as the penultimate and rounded in profile. Only the penultimate whorl (parietal aperture wall in adult shells) is bluntly angled at half its height. The suture of the embryonic shell, and also that between the penultimate and body whorls is deep; between the remaining whorls it is shallow, with a marked suprasutural depression. Underneath, the shell is the most convex close to the umbilicus (and not in the midline of the whorl), like in *Z. astakidae*. The umbilicus is broadly open; aperture oval.

Shell measurements [mm] of anatomically examined individuals (all sexually mature):

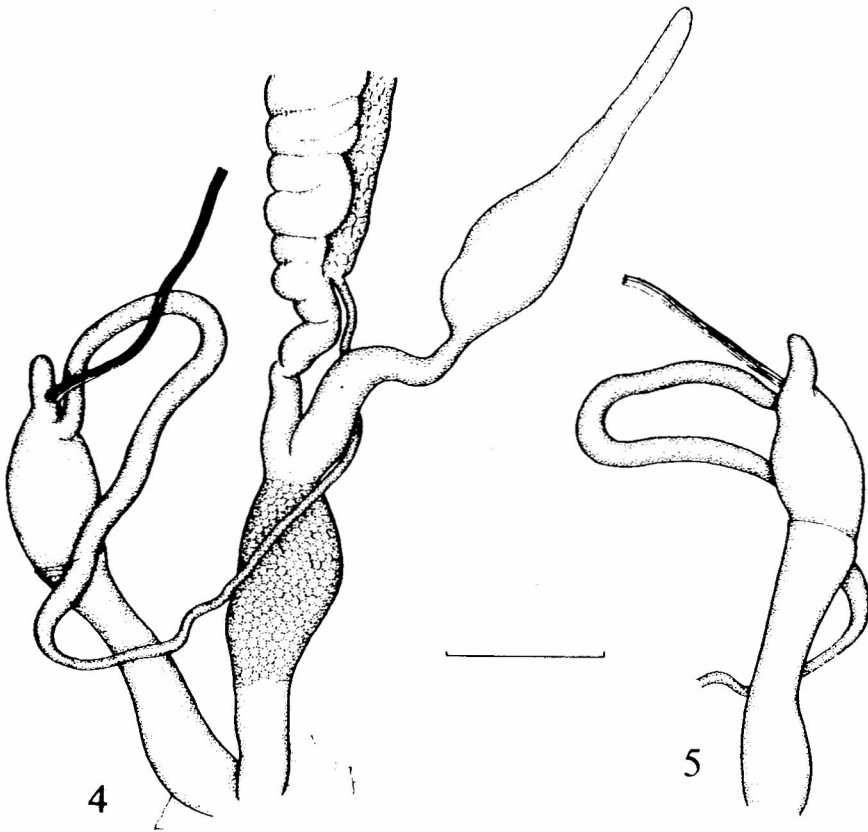
No	major diameter	long axis height	oblique axis height	number of whorls
1	31.9	16.8	14.3	5.5
2	30.5	16.3	13.7	5.3
3	28.4	14.5	12.6	5.5

The remaining 4 specimens from Megalo Karavonisi have their shells 29.6-29.9 mm in diameter.

Shells of living or recently dead individuals are distinctive in their exceptionally light colour, unusual in the genus *Zonites*. Similarly light-coloured shells are rarely found only in *Z. algirus* (LINNAEUS). They are dirty creamy, only the initial whorls being light horn-yellow. Some growth lines on the body whorl are darker brownish.

The embryonic whorls are convex, smooth, with no sculpture but only weakly shiny, usually with a greasy sheen. (Juvenile shells of this species are unknown; data on the microsculpture of the embryonic shell given for *Z. embolium* by RIEDEL (1985: 50) actually pertain to *Z. nautarum* sp. n.). On the definitive whorls there is a rather weak, spirally arranged granulation, which is more distinct on the penultimate or body whorl, and on the underside of the shell.

The shell variation is insignificant. It involves only the degree to which the sculpture (granulation) is pronounced. Specimens from Mikro Sofrano have shell structure like those from the typical population, the only difference being that they are more delicate, thin-walled, while those from Megalo Karavonisi have strong, thick-walled shells.



4, 5. *Zonites embolium* from the island of Megalo Karavonisi: 4 - genitalia, 5 - male genitalia viewed from the other side. Scale bar 5 mm



Anatomy. Three specimens have been dissected. Another two specimens had their penes partly everted (c. 8 mm). This portion of penis is devoid of any papillae or spines, but has thick, roll-like longitudinal folds.

The genitalia (Fig. 4, 5) are typical of *Zonites s. str.* The penis is of a rather characteristic shape, approximately club-like, somewhat constricted in its mid portion, widened at the base and distinctly distended in its distal portion. The terminal flagellum is of medium length, thin, finger-shaped, the penial retractor being inserted close to its base. The epiphallus is as long as or longer than the penis and flagellum combined. The vagina is long, longer and thicker than the oviduct, its distal 2/3-3/4 being surrounded with an elongate perivaginal gland. The terminal process of the spermatheca is long, constituting almost half length of the entire fairly slender spermatheca, its thickness being as in Fig. 4 or less.

Internal structure of penis. On the inner walls of the proximal part of the penis there are thick longitudinal folds with no spines or papillae. In the mid, narrowed section the folds gradually disappear, while on the folds there are very few spines devoid of basal papillae. Only the distended distal part of the penis is densely lined with papillae (not forming regular rows), each terminating with a thick, feebly bent spine.

Radula (examined in one specimen) has the formula:

$$31 M/1 + 12 L/2 + C/1(3?) + 43 \times 73$$

Distribution. Typical forms are found only on the islets of Megalo Karavonisi and Mikro Sofrano (cf. notes on the next taxon).

#### 4. *Zonites* sp. 1 (*embolium* ssp. nova?)

? *Zonites embolium* FUCHS et KAUFEL 1936: 612 (partim!, from Dyo Adelfoi).

*Zonites* sp. 3 aff. *rhodius* (?): RIEDEL 1973: 21 ("West-Unia").

*Zonites embolium*: RIEDEL 1985: 49 (partim! from West Ounio), pl. IV, figs 43-45. Non *Zonites embolium* FUCHS et KAUFEL, 1936 from Karavonisi.

Material examined: Islet of East Ounio - 1 adult shell well preserved and 4 badly damaged or juvenile; all subfossil. A single subfossil shell from West Ounio (= Unia), earlier published by RIEDEL (1973, 1985).

The above material from East Ounio appears to include two forms of different degree of shell flattening and umbilicus diameter. Two shells (the larger 28.3 mm in diameter) strongly resemble *Z. embolium* from Megalo Karavonisi; another two shells (including the largest and best preserved specimen of 29.6 mm diameter, 18.6 mm long axis height, 15.5 mm oblique axis height and 5.75 whorls) are identical with the shell from West Ounio and differ considerably from typical *Z. embolium*. They are distinctly higher (more elevated spire, body whorl higher by more than 1 mm), their body whorl next to the aperture is narrower than in the typical form, the umbilicus is considerably narrower and the inner whorls are barely visible inside it.

The shell sculpture (granulation) is practically nonexistent in both forms from the Ounio islets, which may result from the strong corrosion of the shells.

The scanty and badly preserved material makes it impossible to ascertain if two distinct forms (species?) are actually concerned, or a very wide individual variability is the case. In all events high shells with narrow umbilicus can not just be classified as *Z. embolium* and should be probably regarded as a separate and in all likelihood extinct subspecies. It is noteworthy that the only other subfossil shell, known from one of the islands of Dyo Adelfoi (paratype of *Z. embolium*), appears to be identical with the "high form" from the Ounio islets (cf. FUCHS and KAÜFEL 1936, RIEDEL 1985).

The islands of Ounio and Dyo Adelfoi are c. 70 km apart, with Karavonisi and Mikro Sofrano situated inbetween and inhabited by the typical form of *Z. embolium*. It can not be excluded that one conchologically variable species is concerned, which in the past inhabited various islands of the area. While it became extinct on the marginal islets, it survived in a somewhat different form, as "typical" *Z. embolium*, in the centre of its earlier range.

### 5. *Zonites nautarum* sp. n.

*Zonites* sp. 4: RIEDEL 1973: 21 (from "Megali Zafrano").

*Zonites embolium*: RIEDEL 1985: 49 (partim!, from Megalo Sofrano), fig.40 (juvenile shell).

Locus typicus: islet of Megalo Sofrano.

Holotype (shell): 21 April 1989, leg. M. MYLONAS; one paratype (anatomically examined, same date and collector), both kept at the Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw; three paratypes (shells; same date and collector) are in the collection of M. MYLONAS (Iraklion).

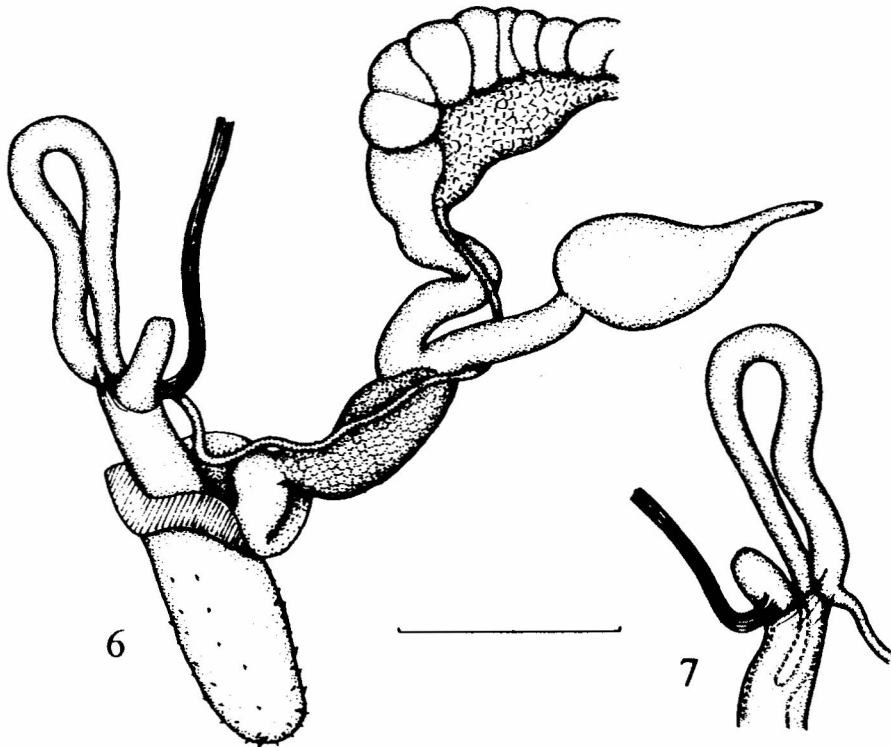
Other material: two juvenile and one badly damaged subadult shell collected on Megalo Sofrano by PIEPER and previously (RIEDEL 1985) erroneously determined as *Z. embolium*.

Derivatio nominis. The species is dedicated to the participants of the nautical expedition of the Greek zoologists.

Shell (Figs 13-15). Measurements: holotype - diameter 26.9 mm, long axis height 13.8 mm, oblique axis height 12.1 mm; it has almost 5.75 whorls; diameter of paratypes: 22.7 mm (anatomically examined mature specimen), 24.4 mm, 24.7 mm, 25.2 mm. The shell is small, not exceeding 27 mm in diameter, lenticular, with a distinctly, gently elevated spire (i.e. whorls not "shouldered") and somewhat flattened apex. The whorls (5.5 to almost 5.75) are very weakly convex (only the embryonic whorls slightly more so), slowly and regularly increasing, the body whorl being somewhat broader before the aperture, 1.5 to 2x wider than the penultimate.

The suture is very shallow, as if covered by the keel of the preceding whorl; it is slightly deeper on the protoconch and next to the aperture. The suprasutural depression is found only in places in some specimens. The periphery of the body whorl is sharply angled in profile at half of its height; in juvenile individuals the sharp keel is situated in the upper half of the whorl (see RIEDEL 1985: fig.40, sub *Z. embolium*). The underside of the shell is irregularly convex, the most so next to the umbilicus. The umbilicus is rather broad, equals c. 1/6 shell diameter, but not completely open, the inner whorls being only poorly visible. The aperture is slightly incised by the penultimate whorl, oval, flattened, its width considerably exceeding the height, the outer margin very sharply bent, sometimes forming almost a blunt angle.

The shell is dirty horn-yellow, slightly lighter underneath, mat, fairly thick-walled, almost opaque. The protoconch in adults is almost smooth, with rather poorly marked radial lines; in juvenile specimens spiral lines are also visible in



6, 7. *Zonites nautarum* sp. n., paratype from the island of Megalo Sofrano: 6 - genitalia (penis partly everted), 7 - distal part of male genitalia. Scale bar 5 mm

places, resulting in delicate spiral rows of radial wrinkles; there is no regular granulation. On the definitive whorls there are also dense radial striae, the spiral sculpture being poorly developed and granulation not very distinct and irregular. A more distinct and regular granulation is present on the underside of the shell.

In its shape *Z. nautarum* sp. n. resembles somewhat certain specimens of *Z. pergranulatus cycladicus* PFEFFER from the island of Astypalaia (cf. RIEDEL 1985: 37, pl. II, figs 23, 24, and RIEDEL 1987: 32, pl. V, figs 55-60). The latter species, though conchologically very variable, has as a rule a markedly higher shell, which is conical instead of lenticular, and in exceptionally flattened specimens the periphery is more sharply angled. The upper side of the shell is horn-brown, darker than that of *Z. nautarum* sp. n. Most of all, the embryonic whorls of *Z. pergranulatus cycladicus* have always a very regular spiral granulation, which is absent in *Z. nautarum* sp. n. In this respect the new species is close to the other members of *Zonites* discussed here (*astakidae*, *embolium*, *invitus* sp. n.) from which it differs considerably in its shell shape.

Anatomy (Figs 6, 7). The only anatomically examined specimen had its penis partly everted, and thus the male efferent ducts were observed in an unnatural position and somewhat misshapen. On the everted proximal part of the penis there are numerous sharp spines (with no basal papillae), but there are no folds - a marked difference compared to *Z. embolium*. The characteristic features of *Zonites* s. str. are distinct. The penis terminates with a long flagellum whose basal half is thin, the distal half being broadened, with a broad, blunt tip (Fig. 7). The penial retractor is inserted laterally, approximately half length of the flagellum (in the specimen examined the basal part of flagellum and epiphallus outlet were hidden by the penis sheath, and they could be observed - distorted - after the sheath had been cut and removed). The epiphallus is approximately as long as the penis including flagellum. The vagina is long, somewhat longer than the oviduct, its distal 2/3 surrounded by an elongate, not very well developed gland. The spermatheca has a rather characteristic shape, distended and then rapidly narrowing into a thin terminal process.

The internal structure of the penis is known only from its proximal part (see above).

Radular formula:

$$38 M/1 + 9 L/2 + C/1(3?) + 47 \times 48$$

For its modest size, *Z. nautarum* sp. n. has a high number of radular teeth.

Distribution. Endemic to the island of Megalo Sofrano.

## 6. *Zonites invitus* sp. n.

Locus typicus: islet of Kentriko Sofrano

Holotype (adult shell), 21 April 1989, leg. M. MYLONAS; three paratypes (juvenile shells), same date, same collector. The holotype and the smallest paratype are kept at the Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw; the remaining two paratypes - in the collection of M. MYLONAS (Iraklion).

Derivatio nominis: the Latin *invitus* means unwelcome.

The snail is not very characteristic and, compared to the vast majority of the other members of *Zonites*, inconspicuous. Nonetheless, it can not be classified with any of the known species.

Shell (Figs 16-18). Measurements: holotype - diameter 25.1 mm, long axis height 13.8 mm, oblique axis height 12.1 mm, number of whorls almost 5.75; diameter of paratypes: 18.8 mm, 18.3 mm, 14.2 mm. The shells are all recent but, except the smallest, more or less corroded. It is one of the smallest species of *Zonites*. The shell is flat conical, with a rather strongly, scalariform elevated spire and prominent apex. Both the embryonic and definitive whorls are convex, separated by a deep suture, with no trace of suprasutural depression; they increase slowly, the body whorl being slightly broader before the aperture and c. 1.5 broader than the penultimate. The body whorl is low, flattened, though its periphery in profile is regularly rounded, with no trace of angle; juvenile shells have a blunt keel on the periphery. The underside of the shell is regularly convex, descending as a gentle curve to the umbilicus. The latter is broad, approximately 1/5 shell diameter, funnel-like, all the whorls being clearly visible inside. The aperture is low, flattened, elongatedly-oval.

The colour of the fresh shell is horn-yellow, with a slight greenish tint; on its embryonic whorls there are dense radial wrinkles, only the centre being smooth and shiny. In the adult shell the sculpture of the embryonic whorls is obliterated. The sculpture of definitive whorls varies between individuals (spiral rows of short radial wrinkles or spiral granulation), in places it may disappear or become very irregular, though mostly radial elements dominate over spiral ones. On the underside of the shell the sculpture is rather poorly pronounced, though the surface is neither smooth nor shiny.

*Z. invitus* sp. n. is most similar to *Z. osmanicus* RIEDEL from inland Asia Minor (Denizli), the latter species, however, has the periphery of the body whorl angled, usually sharply, and a sculpture in the form of a regular, distinct granulation including also the entire protoconch. Almost the same distinctive characters can be listed compared to *Z. (Turcozonites) wandae* RIEDEL from the vicinity of Antalya. Besides, in *Z. osmanicus* the apex is blunt (flattened) and the embryonic whorls less convex, whereas in *Z. wandae* the protoconch is smaller, whorls somewhat narrower and more numerous, and the underside of the shell is smooth (with no sculpture) and strongly shiny.

Anatomy. The anatomy is unknown, but the position of the new species in *Zonites* s. str. seems doubtless because of the type of sculpture of the embryonic whorls, not found in *Turcozonites* RIEDEL.

Distribution. Endemic to the island of Kentriko Sofrano.

Note. At present a vast majority of recent Greek species of the genus *Zonites* have been anatomically examined (exceptions: *Z. kobelti* O. BOETTGER, *Z. nikariae* PFEFFER, *Z. invitus* sp. n., *Z. sariae* RIEDEL and *Z. festai* POLLONERA), and all have

turned out to be members of *Zonites* s. str. It seems thus that the occurrence of the subgenus (or genus) *Turcozonites* in Greece should be excluded. The distribution area of that group is most probably limited to the central and eastern parts of the Mediterranean coast of Asia Minor and adjacent Taurus Mts.

#### 7. *Zonites* sp. 2 (nova?)

Material examined: island of Chamili, W of Ounio - remnants of a subfossil shell in three fragments: one including the first four whorls (diameter 14 mm), with a well preserved embryonic shell, the other two are fragments of the underside of the body(?) whorl.

Based on the above remnants it is difficult to imagine the shape of an adult shell, though it can be said that the fragments do not belong to any of the above species. Perhaps this is an unknown, probably extinct species. It is distinct - as the only one of the species inhabiting these small islets - in having a very pronounced, fine and dense spiral granulation on the protoconch. On the definitive whorls there are strong, dense radial ribs, while the granulation and its component spiral lines are very poorly pronounced. The suture is shallow, there is a suprasutural depression. Whorls of a juvenile shell are strongly flattened, low, with a sharp keel on the periphery. On the fragment of the body whorl, in spite of its bad corrosion, there is a coarse, sparse, spiral granulation on the underside of the shell, almost reaching the umbilicus. The periphery of the whorl is rounded, not distinctly angled.

Relationships with *Z. anaphiensis* RIEDEL et MYLONAS, and the extinct *Z. santoriniensis* RIEDEL et NORRIS are not excluded, but the form discussed is not identical with any of them.

#### 8. *Oxychilus hydatinus* (ROSSMÄSSLER, 1838)

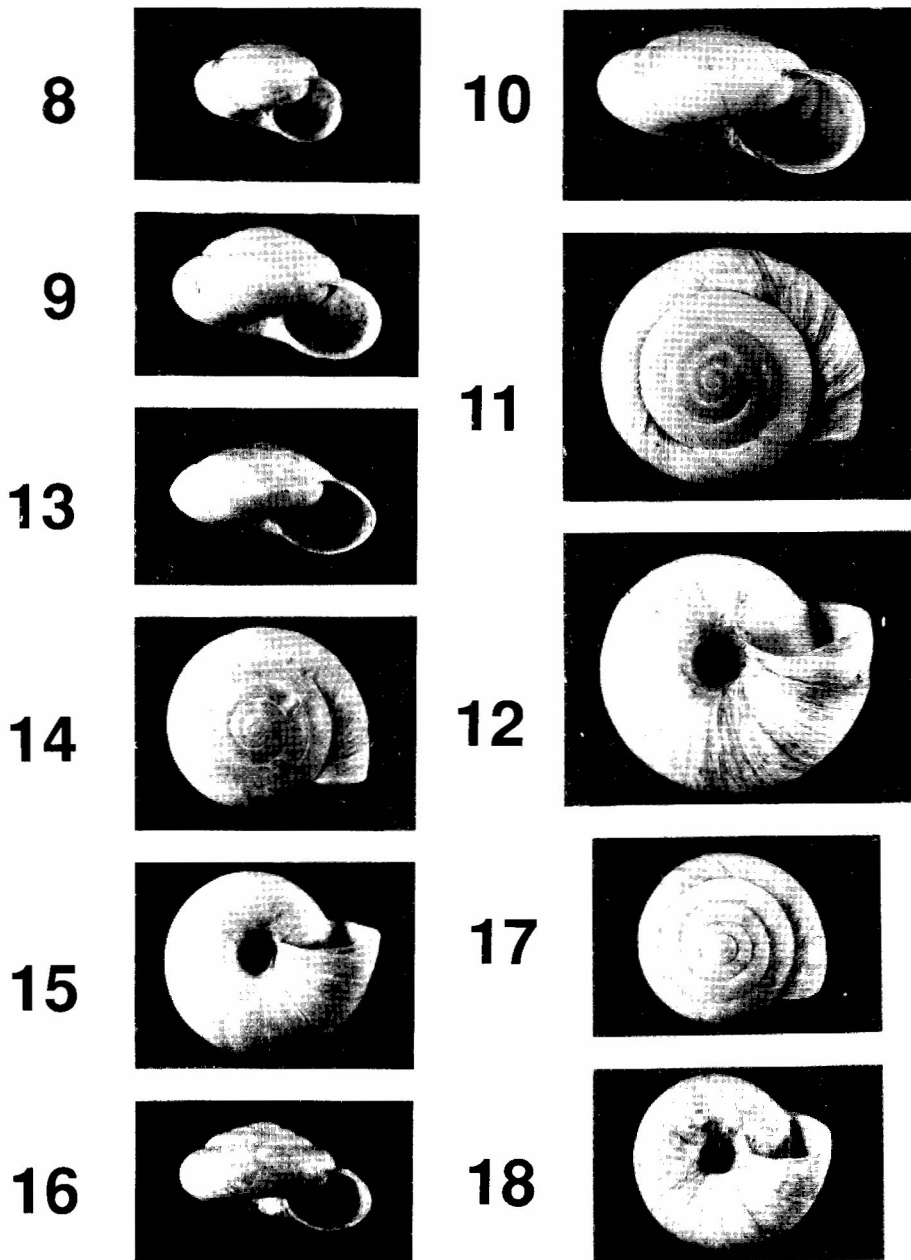
Terra typica: island of Kerkira.

Material examined: island of Astakida - 8 shells.

It is a circum-Mediterranean species, very common throughout Greece. Specimens from Astakida represent a typical form.

#### - *Eopolita protensa protensa* (FERUSSAC, 1832)

The snail is common in the entire Aegean area (RIEDEL 1992: map 35). It has not been found on the islets under study, but H. PIEPER found it on the island of Syrina (RIEDEL 1973) which is situated between Dyo Adelfoi and the remaining of the twelve studied islets.



8-18. Shells (roughly natural size). Photo T. PŁODOWSKI. 8, 9 - *Zonites astakidae*: 8. the smallest mature specimen from Astakida (diam. 19.3 mm); 9. the largest specimen from Astakidopoula (diam. 25.6 mm); 10-12 - *Zonites embolium* from Megalo Karavonisi (diam. 30.5 mm); 13-15 - *Zonites nautarum* sp. n. from Megalo Sofrano, holotype (diam. 26.9 mm); 16-18 - *Zonites invitus* sp. n. from Kentriko Sofrano, holotype (diam. 25.1 mm)

## ZOOGEOGRAPHICAL NOTES

The presence and diversity of the recorded taxa is related to the paleogeographic history and the geographic position of the studied islets.

*Vitrea clessini* is a characteristic endemic species of the central Aegean islands (Kyklades, Kriti, Karpathos) and its present distribution can be attributed to the Tortonian period (11-9 myr ago), when central Aegeis was a continuous land mass (CREUTZBURG 1963).

The differentiation of the genus *Zonites* into six local endemic species and subspecies may be regarded as a result of the long-lasting isolation of the islets and the tendency of the genus to produce local forms. The loose but detectable affinities of *Z. nautarum* sp. n., *Zonites* sp.1 and sp.2 with those distributed on the islands of south Kyklades (Thira, Anafi, Astypalaia) are in agreement with the paleogeographic data. The islets were formed after the Messinian crisis (DERMITZAKIS 1989); previously they constituted the south-eastern part of the central Aegaeis plateau.

The absence of any relations with any zonitid fauna of Dodekanisos is a good evidence that the zonitids of the studied area originated after the establishment of the mid-Aegean channel. Except for *Z. astakidae*, we can not relate the differentiation and the affinities of the observed *Zonites* taxa to the connections between the islets that formed during the Pleistocene glaciations as a result of the decrease in the sea level. Even during the maximum of sea regression (c. 150 m), in the Riss glacial period, the islets remained mostly isolated, since the surrounding depths considerably exceed 200 m. Only minor inter-island connections were formed: all Sofrano islets were joined together, the two Karavonisi, the two Ounio and also Astakida, Astakidopoula and Foka. The affinities of *Z. embolium*, for example from Ounio islets, Karavonisi and Dyo Adelfoi, can not be attributed to the Pleistocene land bridges, but to the more extended land mass that existed between the Messinian and the Pleistocene periods.

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