

**The *Orculella* species of the South Aegean island arc,
a neglected radiation (Gastropoda, Pulmonata, Orculidae)**

E. GITTENBERGER

National Museum of Natural History Naturalis, P.O. Box 9517,
NL 2300 RA Leiden, The Netherlands; Gittenberger@Naturalis.NNM.NL

& B. HAUSDORF

Zoologisches Museum der Universität Hamburg,
Martin-Luther-King-Platz 3, D 20146 Hamburg, Germany; hausdorf@zoologie.uni-hamburg.de

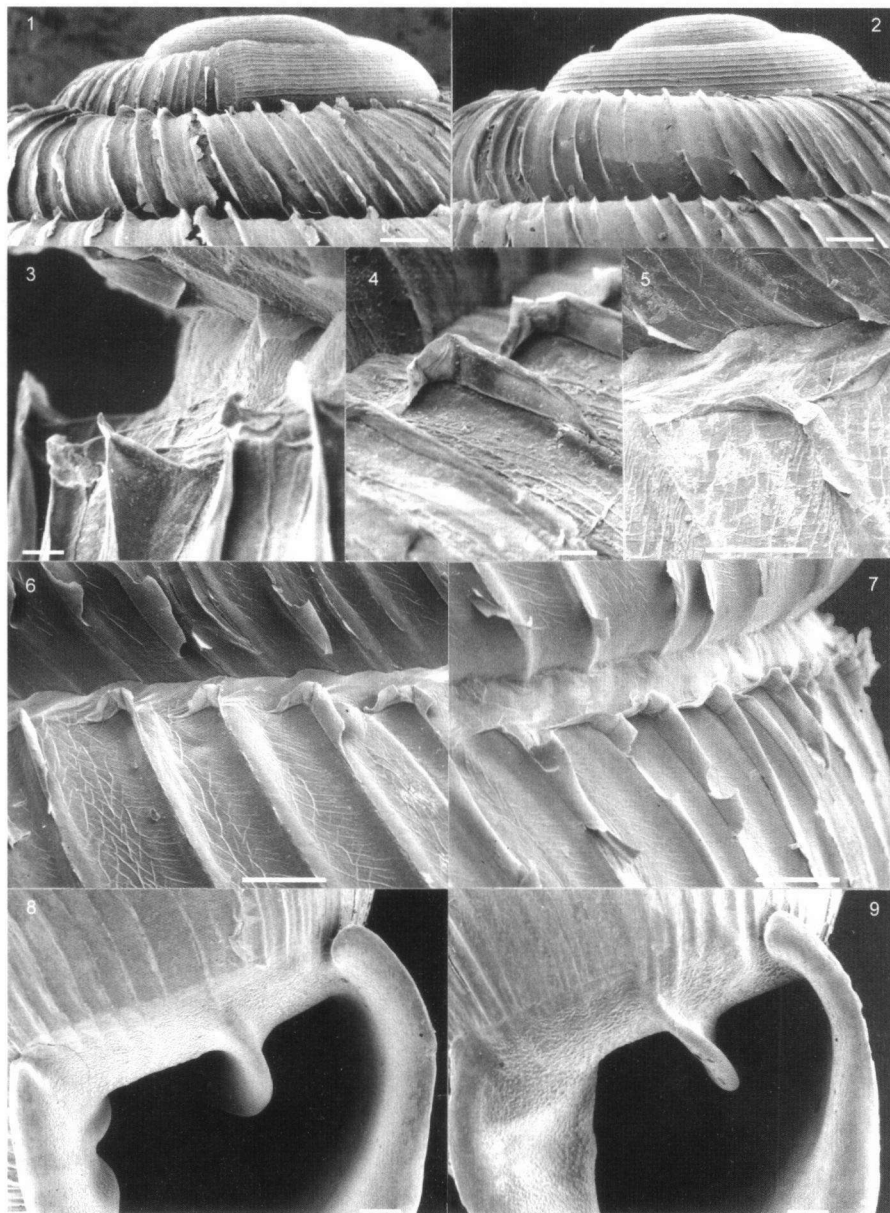
INTRODUCTION

The genera *Orcula* Held, 1837, and *Orculella* Steenberg, 1925, can clearly be diagnosed anatomically (Hausdorf, 1996). In addition there are slight conchological differences. In *Orcula*, the apex of the shell is more or less depressed conical, whereas it is more domed in *Orculella*. More useful as a diagnostic character is a difference in sculpture of the protoconch whorls. In *Orculella* these whorls have prominent spiral striae, whereas in *Orcula* they are devoid of any distinct sculpture. *Orculella* cannot be separated conchologically from *Sphyradium* Charpentier, 1837, and *Schileykula* Gittenberger, 1983, however.

The genus *Orculella* is particularly speciose in the Cyrenaica in N. Libya (Brandt, 1956) and Asia Minor (Hausdorf, 1996). More isolated species are known from elsewhere in the Mediterranean area, e.g. Sicily (Hausdorf, 1988) and N. Morocco (Gittenberger, 1983: 334). Exceptionally widespread is or was *O. bulgarica* (Hesse, 1915), which is not known from Greece, but has been reported, partly from Holocene deposits only, from Spain, Bulgaria, Turkey, Caucasian Russia, Armenia and Azerbaijan (Bank, 1986; Gittenberger, 1983: 329; Hausdorf, 1996: 15). Such a disjunct pattern is exceptional in western Palaearctic gastropod species.

In southern mainland Greece, the Peloponnese and many Greek islands, *O. critica* (Pfeiffer, 1856) occurs. *Orculella* is very rare in the northern part of Greece; from that region some records of *O. ignorata* Hausdorf, 1996, are known. *Orculella ignorata* is also relatively widespread. It is most common on the eastern Aegean islands and along the west and south coast of Asia Minor as far eastward as Antalya. Because *O. critica* and *O. ignorata* cannot always be distinguished on the basis of shell characters only, their ranges are still partly unclear. These two species are dealt with here only so far as their occurrence in the South Aegean island arc is concerned. They will be dealt with more extensively in their entire range in a separate paper.

On the South Aegean island arc between Asia Minor and the Peloponnese, *Orculella* is represented by several endemic, partly sympatric species, most of them new to science. Although probably more than eight species occur in Crete, none of these has ever been named and described; these Cretan taxa were cited infrequently and, if so, with incorrect names (Von Martens, 1889: 188 "*Pupa doliolum*"; Sturany, 1904: 109 "*Pupa (Orcula) doliolum* .. var. *scyphus*"; Haas, 1935: 112 "*Orcula (Sphyradium) scyphus graeca*"; Seidl, 1978: 165 "*Pupa (Orcula) doliolum*" [after Von Martens, 1889]). In species richness this part of Greece is comparable with Asia Minor and the Cyrenaica. As long as most of the *Orculella* species are not or hardly known anatomically, and in the absence of any DNA data, their phylogenetic relationships will remain largely obscure.



Figs 1-9. *Orculella* spec., conchological details. 1-2, apical and initial teleoconch sculpture of *O. creantirudis* (1), type locality, 0.1 km N. of Galaniana (RMNH 56279) and *O. cretiminuta* (2), Crete, Lasithi, Agios Nikolaos (IZPAN). 3-7, teleoconch sculpture with sutural canal in *O. exaggerata* (3-5), Karpathos, 1 km SW. of Spoa, 400 m alt. (RMNH) and *O. creticostata* (6-7), Crete, Hania, Samaria gorge, 120 m alt. (RMNH 56461). 8-9, parietal side of the aperture in *O. creantirudis* (8) [see 1] and *O. exaggerata* (9) [see 3-5]. Scale bars: figs 1-2, 0.1 mm; 3-4, 0.02 mm; 5, 0.1 mm; 6-7, 0.1 mm; 8-9, 0.2 mm. SEM photographs by J.H.C. Krom, Leiden.

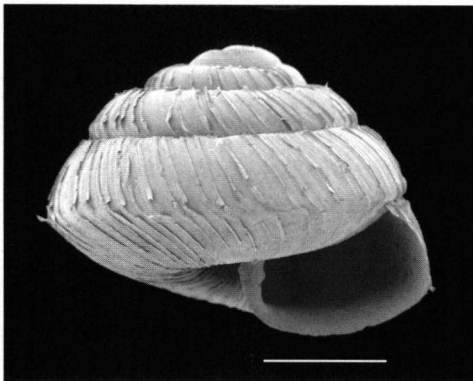


Fig. 10. *Orculella cretoreina*, juvenile, Hania, NE. of 'Katifigio Kalergi', 1600 m alt. (RMNH 97299). Scale bar 1 mm. SEM photograph by J. Goud, Leiden.

MATERIAL AND METHODS

The following abbreviations indicate the collections which could be used in the present study: BUT, L.J.M. Butot, Bilthoven (in ZMA); HAU, B. Hausdorf, Hamburg (in ZMH); HEM, J. Hemmen, Wiesbaden; HNC, Haus der Natur, Cismar; IZPAN, Zoological Institute and Museum of the Polish Academy of Sciences, Warsaw (A. Riedel leg.); MAA, W.J.M. Maassen, Duivendrecht (in RMNH); MHNG, Muséum d'Histoire naturelle, Genève, NEU, W.H. Neuteboom, Heemskerk (in RMNH); NMG, Naturhistoriska Museet, Göteborg, Sweden; NMW-Kle, Naturhist-orisches Museum, Wien, Vienna, colln W. Klemm; RÄH, W. Rähle, Tübingen; REI, P.L. Reischütz, Horn; REN, C. & A. Renker, Jena; RMNH, Nationaal Natuurhistorisch Museum (formerly: Rijksmuseum van Natuurlijke Historie), Leiden; SMF, Senckenberg-Museum, Frankfurt am Main; SUB, P. Subai, Aachen; WIN, A.J. de Winter, Wageningen (in RMNH); ZMA, Zoölogisch Museum Amsterdam; ZMH, Zoologisches Museum der Universität Hamburg. In the locality descriptions, "d." is used for "in the direction of" and "rkm" is used for a distance measured in km along a road. H is used for shell height.

Under the heading Material the research material is listed. Unless stated otherwise, the specimens referred to for new species are to be considered paratypes. The islands are listed alphabetically. Apart from that, the localities are arranged according to their UTM codes.

This paper deals with a group of *Orculella* species, characterized by (sub)cylindrical shells with domed apices. The embryonic $1\frac{1}{2}$ to $1\frac{3}{4}$ whorls have a distinct, calcified, spiral sculpture. This microsculpture has not been analyzed in detail (with a scanning electron microscope) in all the species, although for example the number of the spiral lines might be at least partly diagnostic for certain taxa. The teleoconch whorls have a periostracal microsculpture of irregularly connected wrinkles. The umbilicus is very narrow and often hardly discernible. A palatal lamella is not developed.

The inner course of the apertural lamellae could be studied reliably only by making holes into the shell wall to enable inside inspection of the shell. Especially the course of the parietalis can be diagnostic; this lamella, which may be distinctly flaring inside the body whorl, may reach its greatest absolute height after about $\frac{1}{8}$ whorl, whereas its greatest relative height is always reached (much) deeper inside the body whorl. Because relatively few specimens have been artificially damaged, this complex of characters is described after only a reduced number of shells.

Only a very limited number of specimens was available for dissection to study the



Figs 11-14. *Orculella* spec., showing the lamella parietalis. 11-12, *O. creantirudis*; 11, Antikythira, 0.2 km S of Galaniana (RMNH 56277) (H 6.2 mm); 12, NW. of Kastelli, 250 m alt. (RMNH 97284) (H 5.5 mm); 13, *O. cretiminuta*, Hania, E. of the Phalasarna ruins, 25 m alt. (RMNH 56515) (H 4.3 mm); 14, *O. cretioreina*, NE. of mountain-cabin 'Katifigio Kalergi', 1600 m alt. (RMNH 97269) (H 8.1 mm).

anatomy. This implies that intraspecific variation cannot be described in some detail. The penial appendix is described after Schileyko (1984: 69, 121) and Hausdorf (1996: 8, fig. 4); two of its five segments, i.e. A2&3, are considered fused in *Orculella*.

The diagnoses apply to shell characters only. The conchological terminology used by Hausdorf (1996) in his monograph on Asian Orculidae is accepted here. This implies for the two most commonly present columellar folds, that the lower one is referred to as columellaris and the upper one as supracolumellaris. According to Hausdorf (1996: 3), the lamella referred to here as 'spiral' because of its location parallel to the parietalis at the columellar side, might not be homologous with the true spiralis in other Pupilloidea and should better be called 'parallel lamella'. This might cause confusion with the clausiliid



Fig. 15. *Orculella cretimaxima*, three columellar lamellae, and the lamellae parietalis with the spiralis forming a narrow canal. Photograph by J. Goud, Leiden.

'lamella parallela' however, which is situated close to the suture, without even positional homology. The sculpture of the protoconch is usually not mentioned in the descriptions, because it is very similar in all species. The initial whorls are always more convex than the majority of the lower whorls; in the descriptions we refer to the latter category only.

For practical reasons, the species from the islands of (1) Antikythira and Crete with satellite islets, (2) Dia, and (3) Karpathos, Kasos, Rodhos and Saria, are dealt with separately. Only a single *Orculella* species, i.e. *O. critica*, is known from large areas in Greece. A conchologically similar species, i.e. *O. ignorata*, is known from various E. Aegean Greek islands and from Asia Minor (Hausdorf, 1996). Both species have a limited distribution in the South Aegean island arc, where they are restricted to parts of group (3).

SYSTEMATICAL PART

Pupilloidea Turton, 1831

Orculidae, Orculinae Pilsbry, 1918

Orculella Steenberg, 1925

The eight species of *Antikythira* and Crete

The radiation of *Orculella* in Crete is amazing, as is the fact that it has been overlooked for such a long time.

Orculella creantirudis spec. nov. (figs 1, 8, 11-12, 18, 35-37, 47)

Material (paratypes, unless stated otherwise). — *Antikythira*. 0.2 km S. of Galaniana, among plants and rocks, GE07 (HAU/1; RMNH 56277/11); 0.1 km N. of Galaniana, on NE. exposed rocky slope, GE07 (HAU/1; RMNH 56278/holotype, 56279/10; SMF 307785/1); 0.2 km E. of Potamos, among boulders on NW. exposed slope, GE07 (RMNH 56280/5).

Crete. Hania: 6.5 km NW. of Kastelli, 250 m alt., GE3534 (RMNH 97284/20); Gramvousa peninsula, 6 rkm N. of Kaliviani, GE3638 (MAA/27); Polirrinia, castle, GE4026 (ZMH/2); 2 km S. of Topolia, near Koutsomatados, GE4322 (MAA/10); 2 km S. of Topolia near cave Ag. Sofia, 450 m alt., GE4322 (MAA/14; RMNH 97283/18); upper part of gorge between Paleohora and Anidri, GE4603 (REI/3); 2 rkm S. of Kakopetros, GE4823 (MAA/1); 1 rkm S. of Kakopetros (= 19 rkm N. of Kandanos), GE4923 (MAA/5); 5 km from Anidri to Prodromi, GE5005 (REI/1); 1.3 rkm S. of Vandes (= 2.3 km S. of Mournies), 180 m alt., KV2827 (RMNH 97279/1); Almirida - Plaka, 50 m alt., KV4726 (RMNH 97282/11); 2 km W. of Georgioupolis, KV4916 (MAA/42).

Rethimno: 1.5 km SW. of Zonridi, road to Aryiroupolis, KV5808 (HNC 10242/3); near bridge 5 km SE. of Rethimnon, KV7313 (MAA/14); Xiro Chorio (3.5 km ESE. of Rethimnon), KV7314 (IZPAN/43; RMNH 56276/2); Xiro Chorio, S. side, KV7314 (MAA/79; RMNH 97287/13); 1 km NW. of Mourtzana, 150 m alt., KV9714 (RMNH 99363/4).

Lasithi: 0.6 km N. of Kato Metochi, 790 m alt., LU5795 (MAA/20; RMNH 97280/8); 0.5 km N. of side-road to Ag. Georgios from road to Sitia, 320 m alt., MU1587 (RMNH 97278/24); 1 km E. of Aghia Fotia, MU2394 (MAA/1).

Diagnosis. — Shell medium-sized, cylindrical, whorls flattened, with a prominent, irregular radial sculpture; sutural canal unclear, palatal apertural lip strongly protruding.

Shell (figs 1, 8, 11-12, 18). — Shell cylindrical with a domed apex, with $7\frac{1}{4}$ - $8\frac{1}{2}$ moderately inflated to strongly flattened whorls. The initial teleoconch whorls have coarse, rather irregular, widely spaced, radial, calcified ribs; this sculpture becomes less prominent but not obsolete on the following whorls. In fresh specimens these ribs are partly ornamented by periostracal riblets, which turn abruptly forward with very short spurs just before reaching the suture of the previous whorl. The sutural canal formed this way is narrower and, as a consequence, less clearly discernible than in e.g. *O. exaggerata* and *O. creticostata*. In the canal the fine calcified sculpture is directed backwards. Above the aperture on the penultimate whorl there are 9-11 ribs per mm. Aperture ascending up to between the lower third and the periphery of the penultimate whorl.

Apertural lip thickened, white and strongly reflected throughout. Palatal lip distinctly protruding. Parietal callus rather inconspicuous, with an inconspicuous subangularis or without it. In front view two columellar denticles are seen; the supracolumellar denticle may be obsolete while it runs more obliquely inside (seen from the side). The col-

umellaris is the most prominent lamella, especially so left lateral in the body-whorl, where it is much higher than the supracolumellaris. Deeper inside the shell both columellar lamellae are about equally low; they remain discernible along more than $1\frac{1}{2}$ whorls. The parietalis is relatively high after $\frac{1}{8}$ whorl and, once more, approximately behind the insertion of the columellar apertural lip, measuring $\frac{1}{3}$ to over $\frac{1}{2}$ of the whorl height at that site; moderately and evenly flaring initially, the parietalis can be followed diminishing in height up to over $1\frac{1}{2}$ whorl inside the shell. The lowering in the parietalis after c. $\frac{1}{8}$ whorl, is not always distinctly seen.

Height 5.7-7.8 mm; width 2.6-3.5 mm.

Genitalia (figs 35-37). — We examined three specimens, from localities in Crete and Antikythira (UTM: GE07), respectively. In the two Cretan (UTM: KV7314) specimens the very long penial appendix inserts where the proximal part of the penis adjoins to the distal part, which is about half as long. Its segment 1 measures nearly $\frac{2}{3}$ of the total length of the appendix. The segment 2&3 is short, spindle-shaped, whereas segment 4 is as broad as the narrowest parts of segment 1 or narrower; the lengthened bursa is slightly or more clearly broader than the canal in segment 4 and not conspicuously differentiated. The proximal part of the penis is somewhat broader than the distal part and longer than the penial caecum, which is more or less clearly tapering from the base on. The penial retractor inserts where the penis, its caecum and the epiphallus come together. The epiphallus is gradually broadened and then narrowed again towards its distal end, where up to about eight septa can vaguely be seen in the lumen of the translucent specimen. The vagina is shorter than the distal part of the penis. The oviduct is about half as broad as the vagina, measuring three times its length. The bursa copulatrix is rather gradually tapering from its broad base on, without a bursa at its end.

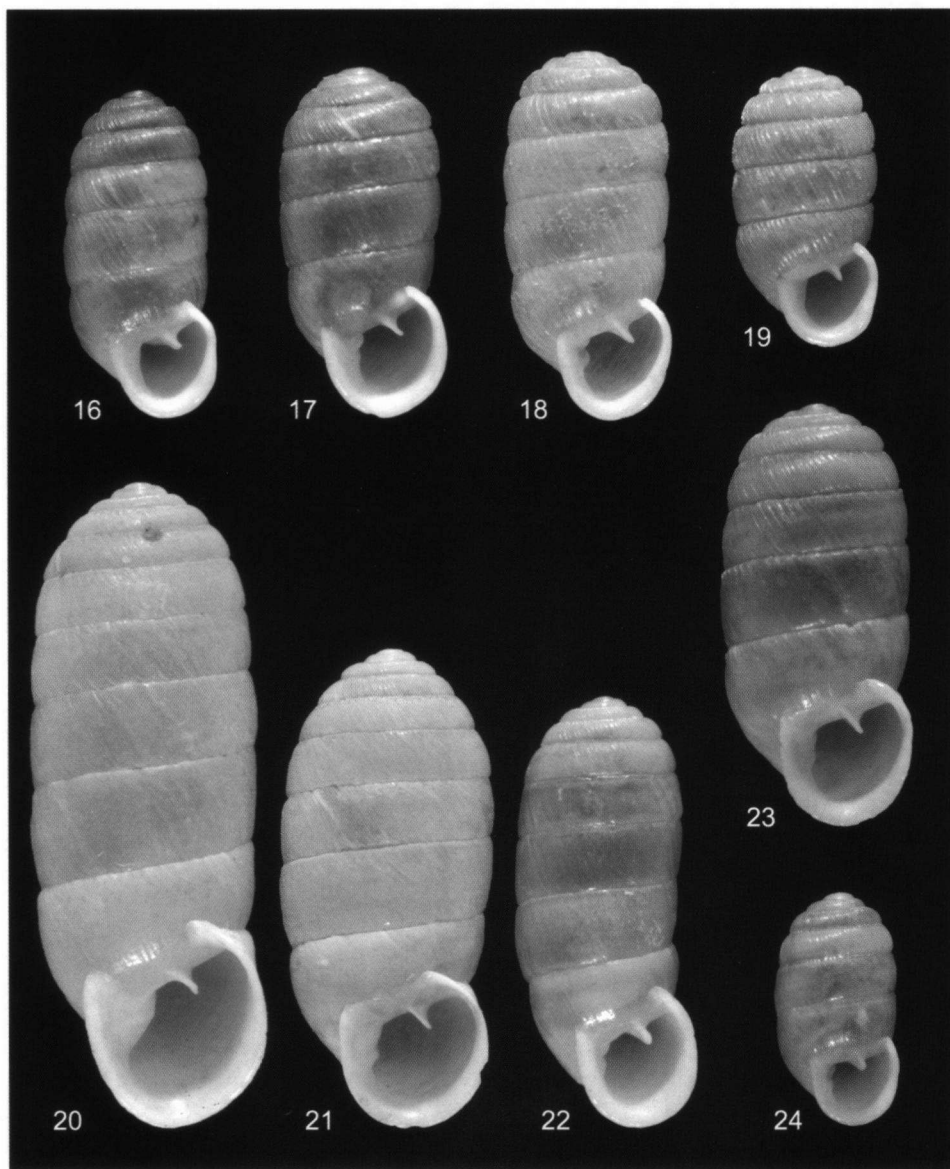
The specimen from Antikythira (fig. 35) differs by an even longer penial appendix, with a shorter, more globular segment 2&3, a relatively longer segment 4, measuring $\frac{2}{3}$ of segment 1 in length, and a longer bursa (segment 5). The simple penial caecum is shorter, i.e. as long as the distal part of the penis. The oviduct is broader than the vagina and twice as long.

Distribution (fig. 47). — *Orculella creantiridis* is known from the islet of Antikythira and from many places in the lowlands of Crete. *Orculella creantiridis* is one of the species indicating the conspicuous biogeographical borderline between the neighbouring islands of Kythira and Antikythira.

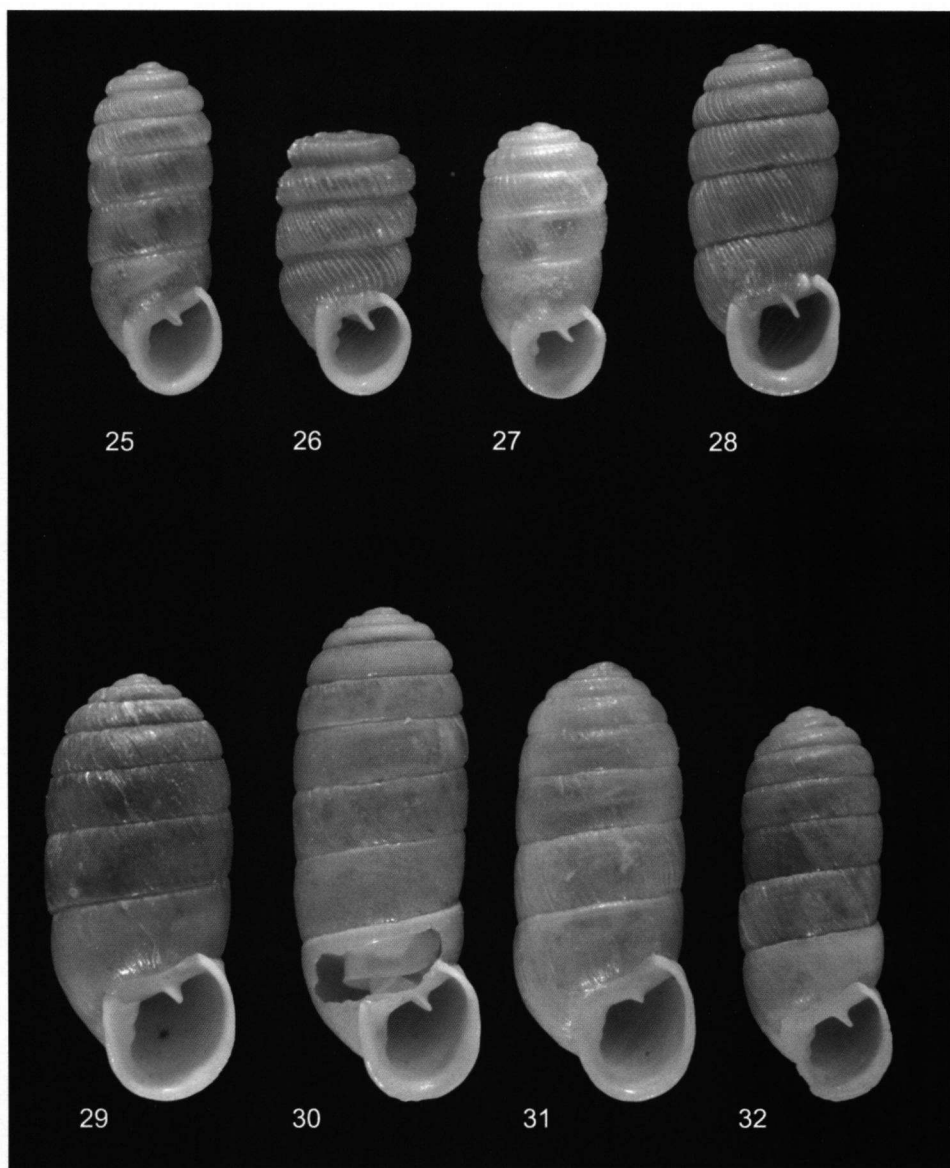
Notes. — *Orculella creantiridis* is the only *Orculella* species known from the islet of Antikythira. In several parts of the genitalia the single specimen from Antikythira that could be dissected differs clearly from the two specimens from Crete that were studied. Because the intraspecific variation in the structure of the genital organs and the variation on the basis of their functional state are unknown, we still consider the populations from Antikythira conspecific with those from Crete on the basis of shell characters. *Orculella creantiridis* is probably not closely related with *O. critica*, the only *Orculella* species occurring in Kythira; it might be more closely related with *O. exaggerata* from Kasos and Karpathos. In both species there is a sutural canal -very prominent in the latter species- and the palatal border of the aperture is conspicuously protruding at its insertion.

The shells are rather variable in size and shape. In Pleistocene deposits on Antikythira (Gittenberger & Goodfriend, 1993), *Orculella* is represented by what may be considered a dwarf form of *O. creantiridis*. Seven full-grown shells were studied. These have only 6-7 whorls and measure 4.5-5.4 mm in height and c. 2.6 mm in width. The apertural lamellae are less prominent.

Orculella creantiridis was found in sympatry with *O. cretiminuta* in the upper part of the gorge between Paleohora and Anidri (GE4603) and 5 km from Anidri to Prodromi



Figs 16-24. *Orculella* spec. (in RMNH). 16, *O. critica*, Rodhos, Gennadion (H 5.6 mm); 17, *O. ignorata*, Rodhos, Kalavarda (H 6.0 mm); 18, *O. creantirudis*, holotype, Antikythira, 0.1 km N. of Galaniana (RMNH 56278) (H 6.4 mm); 19, *O. creticostata*, holotype, Crete, Hania, Samaria gorge, 120 m alt. (RMNH 56461) (H 4.8 mm); 20, *O. cretimaxima*, holotype, Crete, Iraklio, Kamariotis (RMNH 97311) (H 11.3 mm); 21, *O. astirakiensis*, holotype, Crete, Iraklio, Sklavokampos-Astiraki, 420 m alt. (RMNH 56519) (H 8.3 mm); 22, *O. fodela*, holotype, Crete, Iraklio, NE. side of Fodele (RMNH 56521) (H 7.5 mm); 23, *O. cretilasithi*, holotype, Crete, Lasithi, Seli Ambelou, 900 m alt. (RMNH 99364) (H 7.4 mm); 24, *O. cretiminuta*, holotype, Crete, Hania, Phalasarna ruins (RMNH 97292) (H 4.0 mm). Photographs by J. Goud, Leiden.



Figs 25-32. *Orculella* spec. (in RMNH). 25, *O. diensis*, holotype, Dia, LV4023 (RMNH 99370) (H 5.7 mm); 26, *O. scalaris*, holotype, Dia, LV385.248, 190 m alt. (RMNH 99372) (H 4.5 mm); 27, *O. franciscoi*, holotype, Dia, LV3822 (RMNH 99374) (H 4.7 mm); 28, *O. exaggerata*, Karpathos, 2 km S. of Menetes (H 6.2 mm); 29-32, *O. cretioreina*; 29, holotype, Hania, NE. of 'Katifigio Kalergi', 1600 m alt. (RMNH 97299) (H 7.5 mm); 30, Crete, Rethimno Antonios cave, 1 km N. of Patsos (H 8.4 mm); 31, Crete, Rethimno, Mt Psiloritis, 2200 m alt. (H 7.6 mm); 32, Crete, Rethimno, W. of Mt Kedros summit, 1400 m alt. (H 6.8 mm). Photographs by J. Goud, Leiden.

(GE5005).

Derivatio nominis. — The epithet *creantirudis* refers to the occurrence in both Crete (*cre*) and Antikythira (*anti*), and the rough (*rudis*) surface of the shell.

Orculella creticostata spec. nov. (figs 6-7, 19, 38, 46)

Material (paratypes, unless stated otherwise). — Hania: Omalos, 1000 m alt., GE6315 (IZPAN/2); N. of Omalos near a cave, GE6315 (MAA 15313/2; RMNH 56272/1; Sub/1); 6.5 km N. of Omalos, road to Hania, GE6318 (SMF 247239/5; Sub/36); upper end of the Samaria gorge (= 7 km SE. of Omalos), GE6510 (MAA 15314/2); 1 km E. of the upper end of the Samaria gorge, GE6610 (MAA/2); lower end of the Samaria gorge, NE. side of the lowest narrow part, 120 m alt., GE6905 (RMNH 56461/holotype, RMNH 99415/19 & genitalia-slide 1075); 1 km N. of Theriso (= 9 km S. of Hania), GE7022 (MAA/1); 4 km N. of Theriso (= 6 km S. of Hania), GE7124 (MAA/6); E.-exposed rocks above Loutro (= 5 km W. of Hora Sfakion), 5-30 m alt., KV3398 (RMNH 56463/6); gorge at Aradena (= 7 km WNW. of Hora Sfakion), 400-500 m alt., KV3201 (REN/1; RMNH 56462/3, 97297/4); Imbros gorge, 4.0 km NE. of Khora Sfakion, 470 m alt., KV4102 (RMNH 30815/1).

Diagnosis. — Shell with convex whorls with prominent, regularly spaced radial ribs; columellar lamellae obsolete, parietalis low.

Shell (figs 6-7, 19). — Shell rather small, cylindrical with a domed apex, with 6-7¼ rather convex whorls. Teleoconch whorls with distinct, regularly spaced, radial ribs. Above the aperture on the penultimate whorl there are 9-11 ribs per mm. The upper ends of the calcified ribs do not reach the suture of the previous whorl; in fresh specimens these upper rib segments are provided with relatively short, periostacal riblets, which have very short spurs that are abruptly curved forward (figs 6-7). In this way a sutural canal is formed, which is also discernible in more worn specimens because of the presence of a vague calcified sculpture of riblets pointing backward from the upper ends of the main radial ribs. Aperture ascending only slightly to nearly the periphery of the penultimate whorl.

Apertural lip thickened, white, especially its basal part strongly reflected. Palatal lip slightly protruding. Parietal callus inconspicuous, without a subangularis. In front view columellar lamellae or denticles are not or hardly (the columellaris) discernible; dorsally on the columella there is a short (less than a whorl), more or less obsolete columellaris. The parietalis reaches already dorsally its greatest relative height, which is c. ¼ of the whorl height at that site; with a very markedly flaring edge and gradually diminishing it runs inward up to c. the penultimate whorl.

Height 4.2-5.9 mm; width 2.45-2.7 mm.

Genitalia (fig. 38). — We examined a specimen from the lower part of the Samaria gorge (UTM: GE6905). The penial appendix inserts about halfway on the penis, which is about equally broad at both sides of the insertion. Its segment 1 is broader than segment 4 and somewhat longer than half the total length of the appendix. The spindle-shaped segment 2&3 is conspicuously broadened, i.e. to over twice the width of segment 1; the small bursa is elliptical. Only close to its base the penial caecum is tapering; it is about as long as half the penial length. The penial retractor inserts close to halfway the distal part of the penis. The epiphallus is not broadened at its distal end, where about six septa can be seen in the lumen of the translucent specimens. The vagina is extremely short if not considered to be lacking completely; the oviduct is about as broad as the penis and longer than half the penial length. The pedunculus of the bursa copulatrix is slightly broadened in its proximal third and provided with an inconspicuously broadened bursa.

Distribution (fig. 46). — *O. creticostata* is known from the surroundings of Omalos, the Samaria gorge, the Imbros gorge, and the southern slope of the Lefka Ori, all in the Nomos Hanion, in W. Crete.

Note. — The shells of this species can easily be recognized because of the diagnostic, very constant sculpture. In the southern part of the Omalos Plateau the range of this species overlaps with that of *O. cretioreina*.

Derivatio nominis. — The epithet *creticostata* indicates that it concerns a Cretan *Orculella* with prominent costae.

Orculella cretimaxima spec. nov. species group

The three following taxa are considered separate species because their shells differ considerably in size, general shape and sculpture of the initial teleoconch whorls. They share the presence of a distinctly inclined border of the abruptly lowering part of the parietalis, in combination with a short spiralis. The parietalis and the spiralis together form a conspicuous, narrow canal (fig. 15). In two of the species there may be three columellar lamellae inside the body-whorl. The distribution patterns are disjunct and inconclusive. Hybrid zones or clear areas of sympatry are unknown.

A similar combination of parietalis and spiralis was described and illustrated by Hausdorf (1996: 32, pl. 3 fig. 32) for *O. sirianocoriensis* from the Anatolian south coast in Turkey and the island of Cyprus. This is another species with very large shells. It remains unknown whether these similarities result from common ancestry or convergent evolution.

Orculella cretimaxima spec. nov. (figs 15, 20, 39, 46)

Material (paratypes, unless stated otherwise). — Rethimno: 2.5 km W. of Kamariotis (= 3 km N. of Anogia), 560 m alt., LV0709 (RMNH 97315/13); near Sisses, LV0716 (HNC 24997/5); 3.5 km along the road from Sisses to Aloides, 10 km N. of Anogia, 450 m alt., LV0817 (RMNH 56524/2 & slide 1096).

Iraklio: Kamariotis (= 3.5 km NE. of Anogia), LV0909 (BUT 5323/30; RMNH 97311/holotype, 97312/14); 0.5 km WNW. of Kamariotis (= 4 km NE. of Anogia), 600 m alt., LV0909 (RMNH 97314/2); Gonies, LV1008 (HNC 24995/6); 0.8 km from Aidonohori, along the road to Kamariotis (= 4.4 km NE. of Anogia), 600 m alt., LV1109 (RMNH 56523/9); SE. of Achlada, LV1617 (HNC/1); 3.2 km (along the road) NW. of Rogdhia (= Rodia) to Moni Savvathianon, 400 m alt., LV1915 (RMNH 97313/34).

Diagnosis. — Shell very large, slender cylindrical; whorls flattened and with growth-lines only; columellar apertural wall concave, palatal lip not protruding. Aperture with a spiralis and sometimes a third columellar lamella inside.

Shell (figs 15, 20). — Shell cylindrical or with a slightly broadened upper half, with 9½-11 (strongly) flattened whorls, that are separated by narrowly indented sutures; the doomed apical part measures less than ¼ of the total height. Only the initial teleoconch whorls are provided with irregular riblets; most whorls are sculptured with irregular growth-lines only. There is no sutural canal. Aperture slightly to moderately ascending.

Apertural lip thickened, white, broadly reflected. Palatal lip not protruding. Parietal callus thin, in particular in the middle of the parietal wall; subangularis lacking. In front view two about equally prominent columellar lamellae are seen, which reach hardly beyond the columella on the relatively wide and slightly concave columellar wall. The columellaris reaches 1⅓ whorls or, after a more or less clear interruption, as far as 2⅓ whorls

into the shell; the supracolumellaris is clearly more prominent and reaches further inside. There may be a third, small, columellar lamella running for over a whorl above the supracolumellaris. Starting from the aperture, the high parietalis gets somewhat lower until slightly more than $\frac{1}{2}$ whorl, slowly increasing in relative height again deeper inside. Opposite the palatal apertural lip insertion or somewhat deeper inside the parietalis reaches its considerable, optimal relative height, i.e. far over half the whorl-height at that place. The parietalis is hardly flaring inside the body-whorl; where its abrupt lowering starts and immediately after that, its border is sharply curved upwards towards the short spiralis, forming a short but very distinct kind of canal (fig. 15).

Height 9.1-12.7 mm; width 4.0-4.2 mm.

Genitalia (fig. 39). — We examined a specimen from 10 km N. of Anogia (UTM: LV0817). The very long penial appendix inserts where the proximal part of the penis, broadening from the genital atrium on, adjoins to the somewhat broader distal part, which is about half as long. Its segment 1 measures about $\frac{2}{3}$ of the total length of the appendix. The segment 2&3 is short, inflated, whereas segment 4 is about as broad as the narrowest parts of segment 1; the lengthened bursa is less than twice as broad as the canal and not conspicuously differentiated. The proximal part of the penis is about as long as the penial caecum, which is only slightly narrowing towards its end. The penial retractor inserts where the penis, its caecum and the epiphallus come together. The epiphallus is clearly broadened at its distal end, where about three septa can vaguely be seen in the lumen of the translucent specimen. The vagina is about as long as both the proximal part of the penis and the oviduct. The pedunculus of the bursa copulatrix has a broadened basal part, which is about as long as the epiphallus and a longer, much narrower distal part, leading towards the elongated bursa.

Distribution (fig. 46). — This most conspicuous *Orculella* species from Crete is known from only a small area in Rethimno and Iraklio, vikariant with the ranges of *O. astirakiensis* and *O. fodela*.

Notes. — This very large *Orculella* was discovered by J. Biekart, who collected 29.iii.1981 a large sample at Kamariotis, 2 km NE. of Anogia. Surprisingly there are no records in the literature even of this species.

Derivatio nominis. — The epithet *cretimaxima* is introduced for the largest *Orculella* known from the island of Crete.

Orculella astirakiensis spec. nov. (figs 21, 46)

Material (paratypes, unless stated otherwise). — Iraklio: 1.6 km along the road Sklavokampos-Astiraki (= 5 km W. of Tilissos), 420 m alt., LV1409 (RMNH 56519/holotype, 56520/24 paratypes); 2.0 km along the road W. of Tilissos to Astiraki, LV1409 (MAA/135; RMNH 97319/10); 1.5 km E. of Marathos (= 4 km SW. of Rodia), 450 m alt., LV1612 (RMNH 97318/1); road Iraklion-Marathos, 2 km E. of Marathos, near km 18 sign, LV1712 (HEM/17, 11 in alc.; RMNH 97320/2, 8 in alc.); idem, 2.3 km E. of Marathos, near km 18.5 sign (= 6 km NNW. of Tilissos), 500 m alt., LV1712 (RMNH 97317/2); idem, 2.7 km E. of Marathos, near km 19 sign, 450 m alt., LV1612 (RMNH 97316/2).

Diagnosis. — Similar to *O. cretimaxima* but far less slender, short subcylindrical, body-whorl distinctly narrowed; columellar apertural wall not clearly concave. With a spiralis, but always with two columellar lamellae only.

Shell (fig. 21). — Shell large, subcylindrical to elongated ovoid in the smallest specimens, broadest about halfway the spire; with a clearly narrowed body-whorl. The $8\frac{1}{4}$ - $9\frac{1}{2}$ flattened whorls are separated by narrowly indented sutures. The initial teleoconch

whorls are densely sculptured with radial lines that are spaced at about their own width or less.

Apertural lip white and broadly reflected, but not clearly thickened; palatal lip not protruding. The columellar apertural wall flattened, not concave. In front view two columellar denticles are seen, corresponding with the supracolumellaris and the columellaris; the latter may be more prominent. The high parietalis gets somewhat lower after $\frac{1}{8}$ whorl, increasing in relative height deeper inside, where it reaches its optimal relative height, i.e. over $\frac{1}{2}$ the whorl-height, near the insertion of the palatal apertural lip. It is moderately flaring inside the body-whorl; where the abrupt lowering starts, its border is sharply curved towards the short spiralis, forming a short but very distinct canal (see fig. 15).

Height 7.4-9.3 mm; width 3.8-4.0 mm.

Genitalia. — We examined three specimens from 2 km E. of Marathos (UTM: LV1712). The very long penial appendix inserts where the proximal part of the penis adjoins to the distal part, which is about equally broad and half as long. Its segment 1 measures about half the total length of the appendix. The segment 2&3 is short, spindle-shaped. Segment 4 is only half as broad as segment 1; the bursa is short and conspicuously broadened at its end. The proximal part of the penis is about as long as the penial caecum, which narrows to less than half its basal width towards its end. The penial retractor inserts where the penis, its caecum and the epiphallus come together. The epiphallus is clearly broadened at its distal end, where about six septa can be seen in the lumen of the translucent specimens. The vagina is about as long as the proximal part of the penis and the oviduct in one specimen; the oviduct is somewhat longer in the two other specimens. The oviduct is clearly narrower than the vagina. The pedunculus of the bursa copulatrix is not partially broadened and not clearly differentiated from the bursa.

Distribution (fig. 46). — This species is known from only a small area in Iraklio, vikiarant with the ranges of *O. cretimaxima* and *O. fodela*.

Notes. — In the sample collected by J. Hemmen 2 km E. of Marathos, near the km 18 sign, there are 19 typical, empty, worn shells of this subspecies together with a single shell measuring 10.8×4.0 mm, which cannot be distinguished from *O. cretimaxima*. Maybe the two taxa are sympatric indeed in this area, showing their status as separate species.

Derivatio nominis. — The epithet *astirakiensis* is formed after the village called Astiraki.

Orculella fodela spec. nov. (figs 22, 46)

Material (paratypes, unless stated otherwise). — Iraklio: NE. side of Fodele, LV1417 (RMNH 56521/holotype, 56522/4); Fodele, LV1417 (MAA/12 + 4 [heavily damaged]; SMF 325512/1); 2.5 km SW. of Tilissos, 350 m alt., LV1706 (RMNH 97322/3).

Diagnosis. — Similar to *O. cretimaxima* but much smaller, with more widely spaced ribs on the initial teleoconch whorls. In *O. astirakiensis* the shells are much broader and clearly less slender.

Shell (fig. 22). — Shell medium-sized, cylindrical (the upper half may be slightly broadened), with $8\frac{3}{4}$ -9 $\frac{3}{4}$ whorls. The initial teleoconch whorls are provided with regular ribs, separated by interstices that are clearly broader than the ribs themselves.

Apertural lip white, strongly thickened and broadly reflected; palatal lip not or slightly protruding. Running inside, the parietalis is moderately flaring and keeps about the same absolute height until opposite the palatal lip, where it measures $\frac{2}{3}$ of the height of the whorl; where it increases abruptly in prominence, the border is sharply curved

towards a short spiralis (see fig. 15). As a low lamella the parietalis can be followed up to just below the beginning of the penultimate whorl. In front view only the supracolumellaris and the columellaris are seen; $\frac{1}{4}$ whorls from the apertural border a supercolumellaris starts and $\frac{1}{2}$ whorl deep there are three prominent columellar lamellae, viz. supercolumellaris, supracolumellaris and columellaris, increasingly prominent in this sequence, all running up to the beginning of the penultimate whorl.

Height 6.8-8.4 mm; width 3.0-3.3 mm.

Genitalia. — Not known.

Distribution (fig. 46). — This species is only known from some places in , vikariant with the ranges of *O. cretimaxima* and *O. astirakiensis*.

Note. — The three shells collected 2.5 km SW. of Tilissos at 350 m alt. are relatively broad (7.6-8.4 × 3.2-3.3 mm), with more narrowly spaced radial riblets at the apex, but otherwise most similar to this species.

Derivatio nominis. — The epithet *fodela* is supposed to remind of the village Fodele.

Orculella cretimituta spec. nov. (figs. 2, 13, 24, 42, 48)

Material (paratypes, unless stated otherwise). — Hania: near Moni Hrissoskalitissas, GE2909 (HNC/3); 3 km N. of Moni Hrissoskalitissas (= 15 km NW. Paleohora), GE3212 (MAA/38); 0.2 km E. of the Phalasarna ruins (= 7 km W. of Kastelli), 25 m alt., GE3332 (RMNH 97292/holotype, 56515/27; SMF 325513/1); 6.5 km NW. of Kastelli, 250 m alt., GE3534 (RMNH 56517/1); S. of Agios Theodori, GE3805 (REI/3); [Kout]Katsamatados (= 10 km S. of Kastelli), GE4320 (MAA 15322/4); upper part of gorge between Paleohora and Anidri, GE4603 (REI/20); 5 km from Anidri to Prodromi, GE5005 (REI/3); Kolimvari (= 13 km E. of Kastelli), GE 5136 (NMW-Kle 65743/1); 15 km NNE. of Paleohora, side-road to Spina, GE5015 (REI/1); gorge W. of Sougia, GE50 (REN/4); Lissos ruins, 3 km SW. of Sougia, GE5303 (RÅH/1); W. side of the river 1.0 km N. of Sougia (= 13 km SW. of Omalos), 30 m alt., GE5504 (RMNH 48963/8); 5.8 km along the road N. of Sougia (= 13.2 km ENE. of Paleohora), 250 m alt., GE 5508 (RMNH 48964/1); Platarias, GE6531 (HNC 29093/4); Gavdhos [island], KU2960 (HNC 29737/1), KU3059 (HNC 29737/6), KU3159 (HNC 29680/10; 29737/16), KU3161 (HNC 29737/9), KU3162 (HNC 29737/2), KU3257 (HNC 29737/2), KU3259 (HNC 29737/5), KU3260 (HNC 29737/2), KU3261 (HNC 29737/2), KU3358 (HNC 29681/8, 12; 29682/1; 29737/12), KU3359 (HNC 29737/2), KU3360 (HNC 29737/7), KU3361 (HNC 29737/9), KU3457 (HNC 29737/1), KU3458 (HNC 29737/9), KU3459 (HNC 29737/17), KU3460 (HNC 29737/7), KU3560 (HNC 29683/7, 16; 29737/5), KU3660 (HNC 29737/2); small hill 8 km E. of Hora Sfakion, 95 m alt., KU4698 (RMNH 61398/4).

Rethimno: 4 km S. of Agios Ioannis, KU6299 (MAA/3); gorge 4 km NE. of Asomatos (= 7 km WSW. of Spili), KU6999 (MAA/20; RMNH 97293/3); near Spili, KU7598 (HNC 26761/1); E. side of Spili, rocky slope, 450 m alt., KU7599 (RMNH 48965/3); 4 km after Kato Saktouria along the road to the sea (= 30 km SSE. of Rethimnon), 180 m alt., KU7988 (RMNH 97294/4); Paximadia, E. island, KU8076 (HNC 24982/19); 4 km SE. of Akumia along the road to Melambes, KU8192 (SMF 325516/1).

Iraklio: W. of Kali Limenes, KU9367 (HNC/1); do., KU9466 (HNC/2); do., KU9567 (HNC/2 & 1); do., KU9667 (HNC/1); do., KU9767 (HNC 29736/4); 2 km W. of Kamares, KU9992 (MAA/1); 0.5 km W. of Kamares, LU0092 (MAA/1); Pombia (= 10 km NE. of Kali Limenes), LU0671 (HNC 24999/13); near Lentas (= 12 km E. of Kali Limenes), LU0768 (HNC 24998/3); do., LU1567 (HNC 29094/1); do., LU1667 (HNC 29095/1); do., LU1867 (HNC 29096/1); Moni Koudouma (= 32 km E. of Kaloi Limenes), LU2469 (HNC 29102/3); Keratokampos (= 21 km E. of Pargos), LU5975 (HNC 25002/17); 2 km W. of Tilissos along the road, LV1409 (MAA/2 [in poor condition: no types]).

Lasithi: gorge N. of Mythi, N. of Mirtos, LU7075 (MAA/4); S. of Males, LU7081 (HNC/2); E. of Kroustas, LU7889 (HNC/1); 1 km E. of Ellinika along the road to Elunda (= 5 km NNE. of Agios Nikolaos), LU8499 (SMF 325514/1); 1 km NE. of Prina (= 10.5 km SSW. of Agios Nikolaos), 380 m alt., LU8084 (RMNH 56516/1); S. of Ag. Nikolaos, LU8194 (HNC/ 4); 1 km E. of Istron, LU8587 (MAA/1); Agios

Nikolaos, LU89 (IZPAN/14); 7 km E. of Ierapetra, LU9174 (MAA/1); 2 km NW. of Kavousi, 5-50 m alt., LU9488 (RMNH 56275a/1); Psira island, LU9795 (HNC 24952/15); N. of Ag. Georgios, LV8210 (HNC/1); road to Mochlos, MU0190 (MAA/1); SE. of Hrisopigi, MU0484 (HNC/1); Tourloti, MU0491 (HNC 25005/-1); W. of Kato Kria, MU0986 (HNC/1); S. of Kato Kria, MU1085 (HNC/1); S. of Ahladia, MU1491 (HNC/1); small valley along the road to Sitia, 0.5 km N. of the cross-road to Ag. Georgios (= 8.6 km NW. of Ziros), 320 m alt., MU1587 (RMNH/ 97295/1); 1 km E. of Handras (= 11 km WSW. of Zakros), 580 m alt., MU1882 (RMNH 56273/1); 1 km E. of Agia Fotia, MU2394 (MAA/8); S. of Ziros, MU2178 (HNC/1); Ziros, MU2181 (HNC 39001/5; NMW-Kle 65745/2); 10 km E. of Sitia near the Toplou monastery, MU2898 (IZPAN/8); near Zakros, MU3283 (HNC 39002/3); S. side of Kato Zakros (= 5 km SE. of Zakros), 20 m alt., MU3284 (MAA/34; RMNH 56274/1); 1 km W. of Kato Zakros, MU3182 (MAA/47; RMNH 56518/3); near Palaioastron, MU3194 (HNC 39005/4), MU3291 (HNC 39004/7); 0.9 km WSW. of Palaioastron, 20 m alt., MU3395 (RMNH 48966/23); SE. Kato Zakros, archeological site, MU3383 (MAA/52); Dionisades islands, Gianisada, MV2510 (HNC 24710/2); Cape Sideros, N. of the ruins at Itanos (= 17 km ENE. of Sitia), MV3302 (SMF 325515/1).

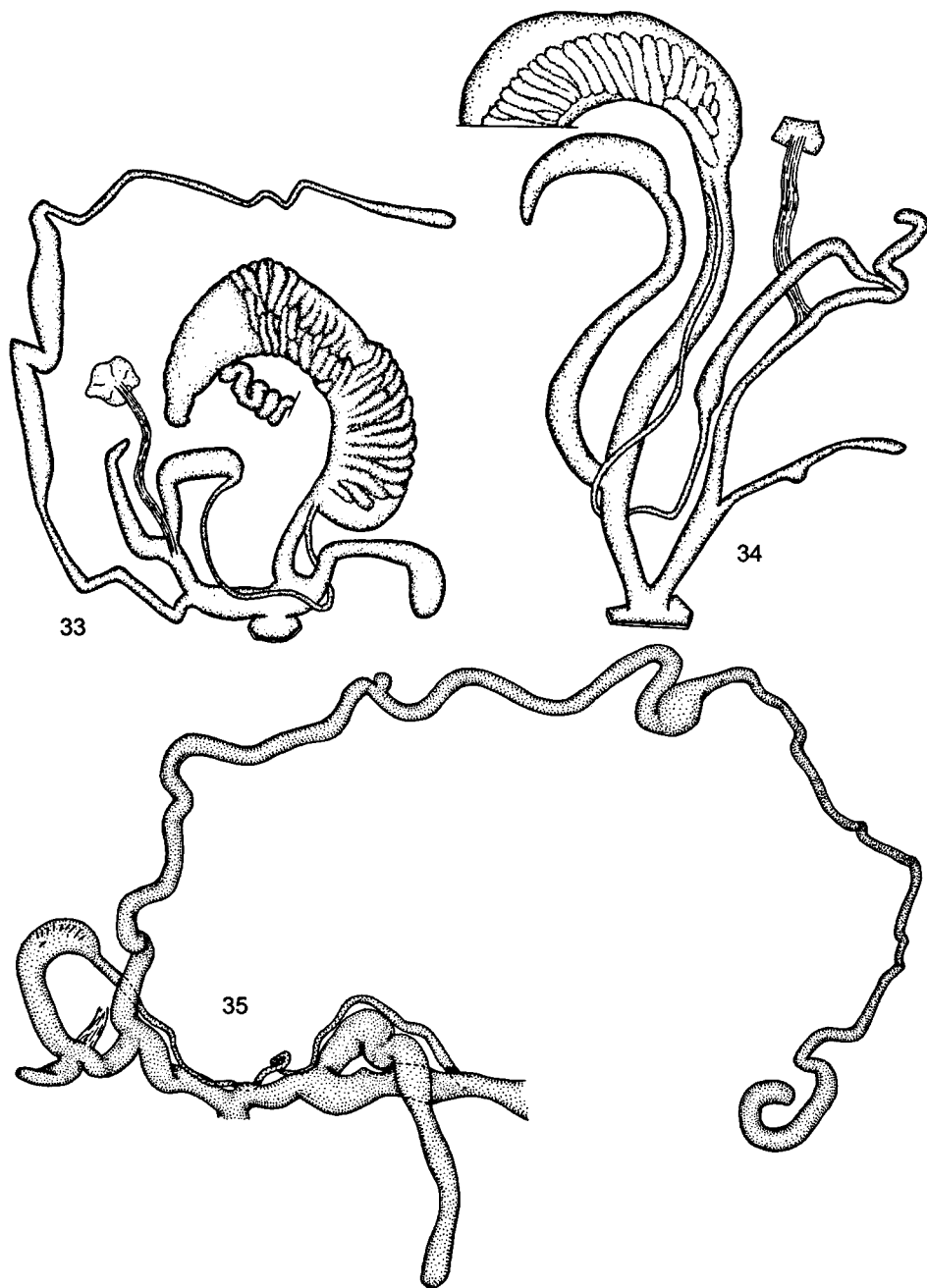
Diagnosis. — A small and relatively broad, nearly ovoid *Orculella*, with a prominent radial sculpture only on the initial teleoconch whorls; without a sutural canal; with two long columellar lamellae and a high parietalis.

Shell (figs 2, 13, 24). — Shell small, subcylindrical to elongate-ovoid, with $6\frac{1}{4}$ -7 whorls; light greyish yellow, glossy. The protoconch sculpture is relatively coarse (figs. 16, 18). The initial c. two teleoconch whorls have regularly spaced, prominent, radial ribs, ornamented by periostracal riblets; on the following whorl the sculpture becomes increasingly irregular and indistinct. The penultimate and the body whorl are devoid of any distinctive sculpture. Apical whorls convex, the following ones gradually becoming (much) more flattened. There is no distinct sutural canal. Aperture ascending up to the lower third to nearly the periphery of the penultimate whorl.

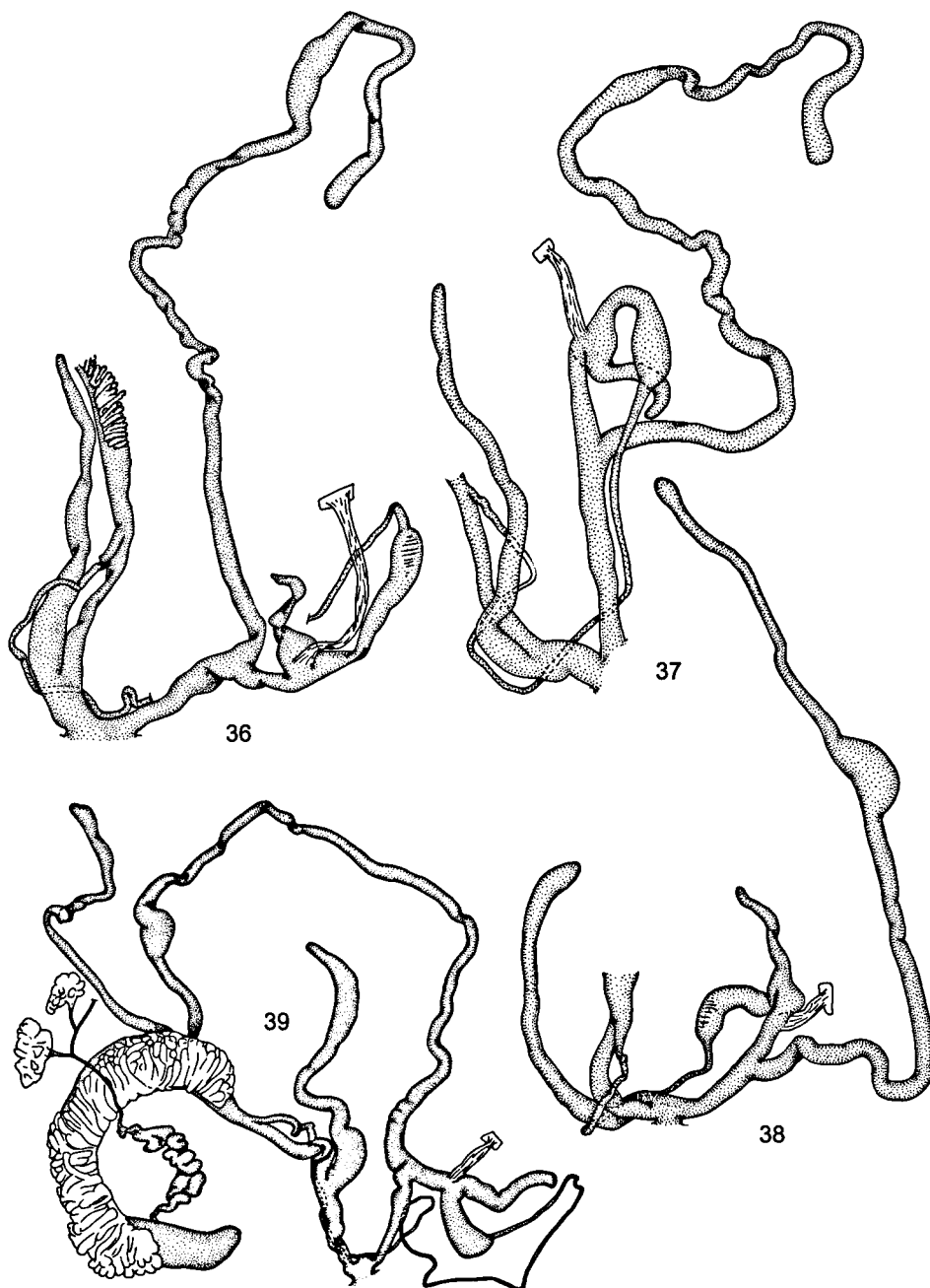
Apertural lip thickened and white, especially its basal part strongly reflected. Palatal lip not clearly protruding. Parietal callus usually inconspicuous; subangularis sometimes moderately prominent, but usually hardly or not discernible. In front view two low columellar denticles are seen, which may be vaguely lengthened over a short distance on the columellar wall. The columellaris may be slightly more prominent than the supracolumellaris. The two columellar lamellae run for about $1\frac{1}{2}$ whorl inside the shell. At the left lateral side the columellaris reaches its maximal height; here it is over twice as high as the supracolumellaris, which is much more constant in height over its entire length. The parietalis reaches its greatest relative height left ventro-laterally, approximately behind the insertion of the columellar lip. The lamella is 'flaring' there; its edge is curved upward. At that site it is at least half as high as the whorl in which it occurs. Further inside the parietalis, which initially has a markedly inflaring edge, becomes rather abruptly lower, ending close to the beginning of the body whorl.

Height 3.6-4.9 mm; width 2.2-2.45 mm.

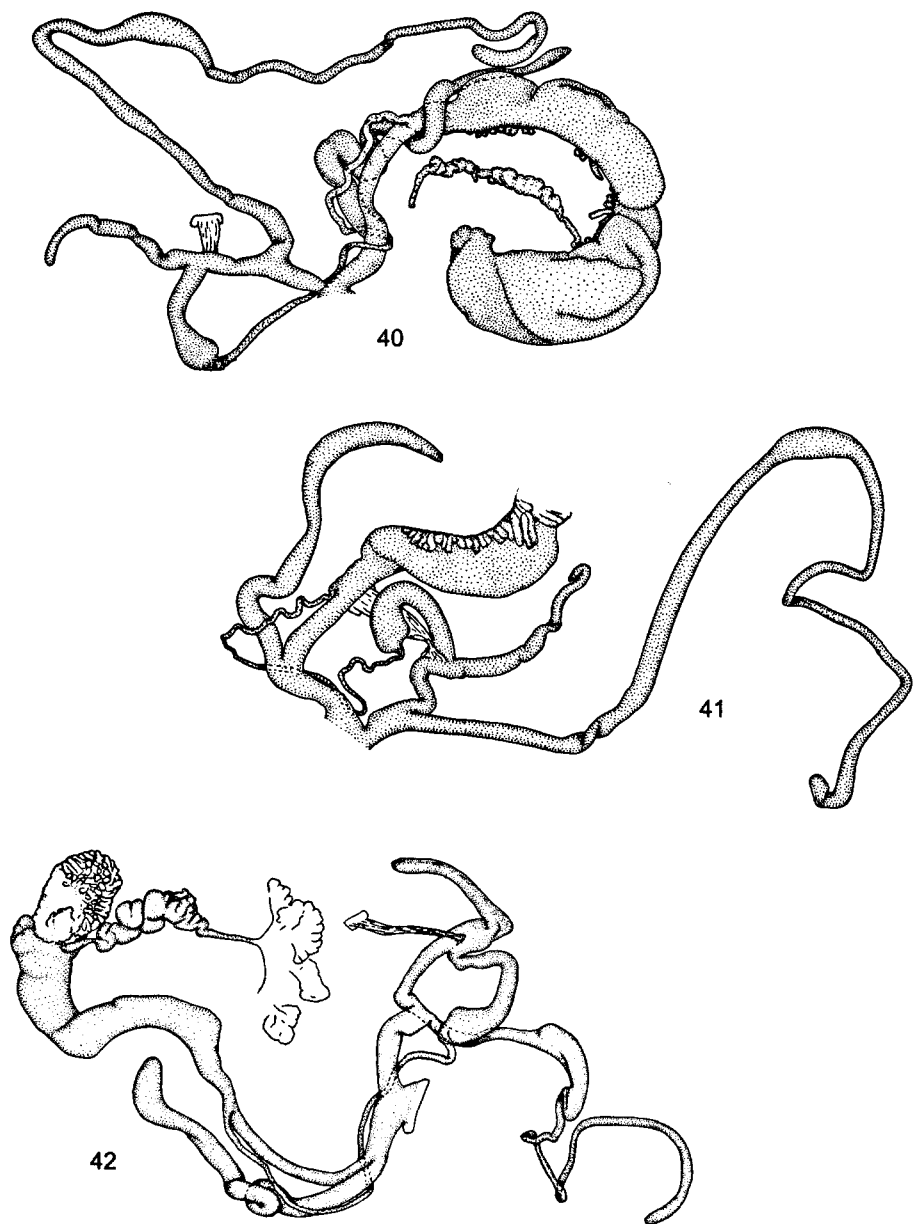
Genitalia (fig. 42). — We examined a specimen from Kato Zakros (UTM: MU3284). The penial appendix inserts about halfway at the penis with segment 1, which is about as broad as the distal part of the penis and equally long. The proximal part of the penis is only partially narrower than segment 2&3 of the appendix and about equally long; segment 4 is longer than segments 1-3 together and relatively narrow, i.e. narrower than segment 1 over its entire length although its width is increasing very gradually towards the bursa, which is not differentiated. The penial caecum is somewhat longer than half the penial length and narrowing towards its end. The penial retractor inserts where the penis, its caecum and the epiphallus come together. The epiphallus is broadest at its distal end, where four septa can vaguely be seen in the lumen of the translucent specimen. The vagi-



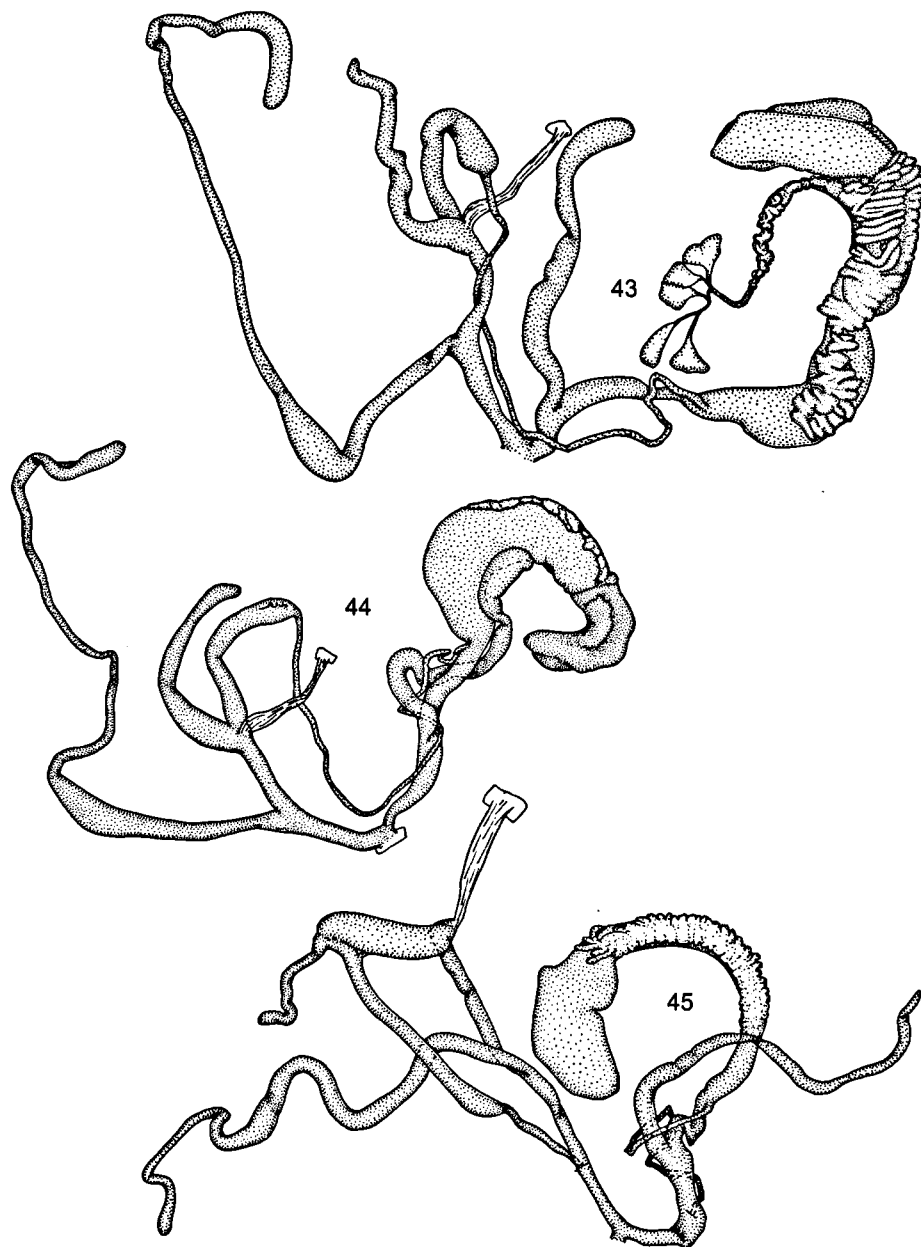
Figs 33-35. Genitalia of *Orculella* spec. 33, *O. critica*, Peloponnisos, Arkadhia, Ay. Sofia (after Hausdorf, 1996: 25, fig. 6); 34, *O. ignorata*, Rodhos, Monolithos (after Hausdorf, 1996: 25, fig. 8); 35 *O. creantirudis*, Antikythira, 0.2 km S. of Galaniana (RMNH slide 1074).



Figs 36-39. Genitalia of *Orculella* spec. 36-37, *O. creantirudis*, Crete, Rethimno, Xiro Chorio, S. side (RMNH slides 1078, 1080); 38, *O. creticostata*, Samaria gorge, 120 m alt. (RMNH slide 1075); 39, *O. cretimaxima*, Rethimno, 10 km N. of Anogia, 450 m alt. (RMNH slide 1096).



Figs 40-42. Genitalia of *Orculella* spec. 40-41, *O. cretilasithi*, Crete, Lasithi, Seli Ambelou, 900 m alt. (RHNH slides 1081-1082); 42, *O. cretiminuta*, Crete, Lasithi, S. side of Kato Zakros, 20 m alt. (RNMNH slide 1099).



Figs 43–45. Genitalia of *Orculella* spec. 43–44, *O. cretioreina*, Crete, Iraklio, Mt Psiloritis, 2200 m alt. (RMNH slides 1076–1077); 45, *O. scalaris*, Dia, UTM LV3722 (RMNH slide 1100).

na measures about half the length of the proximal part of the penis; it is much broader than the oviduct, which is three times longer. The pedunculus of the bursa copulatrix is equally broad over its entire length and not clearly differentiated from the bursa.

Distribution (fig. 48). — *O. cretiminuta* is endemic in Crete and some nearby islets. The species is not clearly restricted to a certain part of the island.

Notes. — *O. cretiminuta* has an isolated position among the Cretan *Orculella* species, conchologically because of its size and shape, and zoogeographically because of its occurrence all over the island, sometimes sympatric with *O. creantirudis*, i.e. near Koutsomatados, in the gorge between Paleohora and Anidri, and 5 km from Anidri to Prodrumi.

Derivatio nominis. — The epithet *cretiminuta* emphasizes that this is the smallest Cretan *Orculella* known.

Orculella cretilasithi spec. nov. (figs 23, 40-41, 48)

Material (paratypes, unless stated otherwise). — Lasithi, 0.6 km N. of Kato Metochi (= 4.8 km S. of Avdhou), 790 m alt., LU5795 (MAA/12 & 18; RMNH 99367/6); mountain pass Seli Ambelou, NW. of Pinakiano, 900 m alt., LU5997 (MAA/20; RMNH 99364/holotype, 99365/3); 5 km W. of Kritsa, 1000 m alt., LU7190 (RMNH 99368/1); 1 km N. of Nofalias, LV7708 (MAA/56).

Diagnosis. — Shell broadly cylindrical to elongated ovoid, with regular, dense riblets on the initial teleoconch whorls only, palatal apertural lip not clearly protruding.

Shell (fig. 23). — Shell medium-sized, broadly cylindrical to elongated ovoid with a domed apex, with about $7\frac{1}{2}$ - $8\frac{1}{4}$ strongly flattened whorls. The initial two teleoconch whorls have rather regular, densely spaced, radial, calcified ribs; the ribs become more widely spaced on the following whorls and more or less obsolete on the penultimate and the last whorl. The suture is narrowly incised. Close to the suture the radial sculpture is abruptly curved to the right at the upper ends of the ribs and more gradually so at their lower ends (in front view). In some specimens the ribs form a row of papillae below the suture. The few remains of the periostracum, still present on the initial teleoconch whorls, do not reach the preceding whorl. Aperture ascending up to shortly below the periphery of the penultimate whorl. Apertural lip thickened, white and strongly reflected throughout. Palatal lip not distinctly protruding. Parietal callus prominent, with an inconspicuous or more rarely a rather prominent subangularis. In front view two co-lumellar denticles are seen; the supracolumellar denticle may be obsolete while it runs more obliquely inside (seen from the side). The columellaris is the most prominent lamella, especially so left lateral in the body-whorl, where it is over a short distance much higher than the supracolumellaris. Deeper inside the shell both columellar lamellae are about equally low; they remain discernible along at least two whorls. The parietalis reaches its greatest relative height left ventro-laterally, where it is distinctly flaring, shortly before the insertion of the columellar lip; deeper inside its edge is clearly curved upwards over a short distance and, quickly becoming lower, it reaches hardly or not into the penultimate whorl behind the insertion of the columellar apertural lip.

Height 5.7-7.8 mm; width 3.0-3.7 mm.

Genitalia (figs 40-41). — We examined two specimens from NW. of Pinakiano (UTM: LU5997). The conspicuous penial appendix inserts about halfway at the penis with segment 1, which is about as broad as the penis and equally long. Segment 1 is about as long as segments 2-4 together; it is clearly narrower than the spindle-shaped segment

2&3 and broader than segment 4. The lengthened bursa is about as broad as segment 1. The slender penial caecum is gradually tapering towards its end; it is clearly longer than the penis, which is slightly longer than the epiphallus. The penial retractor inserts where the penis, its caecum and the epiphallus come together. The epiphallus is broadest at its distal end, where one or two septa can vaguely be seen in the lumen of the translucent specimens. The vagina measures about half the length of the penis; it is hardly or not broader than the oviduct, which is about equally long. The pedunculus of the bursa copulatrix is equally broad over its entire length and is not clearly differentiated from the bursa.

Distribution (fig. 48). — The species is known from a few localities in Lasithi, both recent and as a fossil.

Notes. — This species was initially known as a fossil only, found together with *O. cretairudis* without any intermediate specimens. In *O. cretilasithi* the shells are broader and somewhat less cylindrical, the apical sculpture is less irregular, the insertion of the palatal apertural border is not protruding and the parietalis reaches less far inside. *Orculella cretimaxima* differs by the presence of a spiralis, forming a narrow canal with the curved border of the parietalis. In *O. cretioreina* the shells are usually more slender cylindrical and less prominently sculptured, especially the initial teleoconch whorls.

In the literature only "*Pupa (Orcula) doliolum*" has been reported, without any description, from the Lasithi mountains, by Seidl (1978: 165), who published a check-list concerning Cretan non-marine mollusks, said to be composed in 1904 by Sturany.

Derivatio nominis. — The epithet *cretilasithi* is composed to indicate that this Cretan species is only known from the Lasithi region.

Orculella cretioreina spec. nov. (figs 10, 14, 29-32, 43-44, 47)

Material (paratypes, unless stated otherwise). — Hania: 5 km S. of Omalos, Mt Gingolos, GE6509 (MAA/2 + 1); S. side of the Omalos Plateau, GE6510 (RMNH 99369/1); 0.2 km NE. of mountain-cabin 'Katifigio Kalergi', 4 km E. of Omalos, 1600 m alt., GE6715 (RMNH 97299/holotype, 97268/47, 97269/30); 0.3 km N. of mountain-cabin 'Katifigio Kalergi', 4 km E. of Omalos, 1650 m alt., GE6715 (RMNH 97258/12).

Iraklio: Psiloritis, 1 km ESE. of summit, 2200 m alt., KU9799 (RMNH 97277/36), 2 km ESE. of summit, 2200 m alt., KU9899 (RMNH 97276/4), 3 km ESE. of summit, 2000 m alt., KU9998 (RMNH 97272/5, 97275/30); near Kamares, 2160 m alt., LU0098 (HNC24990/12); do., 1700 m alt., LU0196 (HNC24992/1); do., 1910 m alt., LU0197 (HNC24993/4); do., altitude not known, LU0998 (HNC24994/1).

Rethimno: near Antonios cave, 1 km N. of Patsos, 5 km NE. of Spili, 350 m alt., KV7803 (RMNH/11); 5 km E. of Spili, 2.4 km W. of Gerakari, 770 m alt., KU7999 (RMNH/34); W. of Mt Kedros summit, 1210 m alt., KU8096 (RMNH97261/1), 1400 m alt., KU8195 (RMNH 97259/4), 1700 m alt., KU8295 (RMNH 97260/1), 1600 m alt., KU8295 (RMNH 97262/3); Nithavris, 2250 m alt., KU9999 (HNC24989/1); 2 km SSW. of cave Ideo Andro, 1900 m alt., LU0196 (RMNH 97274/17); path to Skinakas observatory, LU0697 (RMNH 97264/1); side-road to Skinakas, from Anogia – Ideo Andro, 1400 m alt., LU0799 (RMNH 97265/15); do., 1500 m alt., LU0899 (RMNH 97266/1); Mt Skinakas, 9 km S. of Anogia, 1400 m alt., LU0898 (RMNH 97271/2); near Kamares, 2050 m alt., LU0198 (HNC24987/1); do., altitude not known, LU0199 (HNC24988/1); do., altitude not known, LU0298 (HNC24984/2); do., altitude not known, LU0397 (HNC 24986/9); do., altitude not known, LU0799 (HNC24983/7); do., altitude not known, LU0898 (HNC24985/15); 1.5 km N. of cave Ideon Antron, 1550 m alt., LV0100 (RMNH 97270/8); 6.9 rkm from Anogia to cave Ideon Antron, 1100 m alt., LV0704 (RMNH 97263/1).

Diagnosis. — Shell more or less slender cylindrical, whorls flattened; light yellowish

brown, rather glossy, with irregular riblets on the initial teleoconch whorls only, sutural canal unclear, palatal apertural lip not clearly protruding.

Shell (figs 10, 14, 29-32). — Shell medium-sized, more or less slender cylindrical, short specimens may be somewhat ovoid; with $7\frac{3}{4}$ - $9\frac{1}{2}$ flattened to slightly convex whorls; light yellowish brown, rather glossy. The initial teleoconch whorls have irregular, radial, calcified ribs, sometimes with inconspicuous, low periostracal segments, which do not reach the suture. The sculpture becomes more or less obsolete on the lower whorls. Suture clearly indented; a sutural canal is not clearly discernible, but close to the suture the growth-lines are curved to the right (frontal view) and the periostracal elements, whenever present, stop where the indentation towards the suture begins, shortly after reaching their maximal height (fig. 10). Aperture ascending up to the lower third of the penultimate whorl or sometimes higher, but usually not reaching the periphery.

Apertural lip thickened, white and strongly reflected throughout. Palatal lip not distinctly protruding. Parietal callus clearly discernible, with an inconspicuous subangularis at most. In front view the columellaris is often discernible as a low denticle, but the supracolumellaris is nearly always hidden behind the columella. In some populations both columellar lamellae can only be seen in oblique view. Left lateral in the body-whorl the columellaris is higher than the supracolumellaris, but deeper inside both columellar lamellae are about equally low, or the infracolumellaris becomes the highest one when the two lamellae reach more than $1\frac{1}{2}$ whorls inside. The columellar lamellae are longest when the parietalis is relatively long. In front view the parietalis varies between $\frac{1}{4}$ of the apertural height and totally obsolete; inside it gradually increases in height to reach a maximum varying from somewhat less (when the parietalis is relatively short) to clearly more than half the internal height of the whorl (when it is relatively long). Where it is highest and immediately afterwards, where its abrupt lowering starts, the parietalis is conspicuously flaring and its border is curved upwards. That site varies from left lateral, still before the insertion of the columellar apertural lip, to close to right lateral in the beginning of the penultimate whorl.

Height 6.4-9.4 mm; width 2.8-3.5 mm.

Genitalia (figs 43-44). — We examined two specimens from 1 km ESE. of the summit of Mt Psiloritis, at 2200 m altitude (UTM: KU9799). The penial appendix inserts about halfway on the penis, which is about equally broad at both sides of the insertion. Its segment 1 is about twice as broad as segment 4, or clearly broader, but much shorter, measuring about one third of its length. The spindle-shaped segment 2&3 is about half as long as segment 1; the lengthened bursa is clearly broader than most of segment 4, but not clearly differentiated from that part. Only near its base the penial caecum is tapering; it is about as long as the epiphallus and clearly longer than half the penial length. The penial retractor inserts where the penis, its caecum and the epiphallus come together. The epiphallus is more or less clearly broadened at its distal end, where some septa are vaguely seen in the lumen of the translucent specimens. The vagina is as long as the oviduct in one specimen and measures only $\frac{1}{3}$ of the length of the oviduct in the second specimen. The pedunculus of the bursa copulatrix is about equally broad over its entire length and provided with a slightly broadened, lengthened bursa.

A poorly preserved specimen from the type locality differs considerably, especially in the structure of the penial appendix: segment 1 is very long, measuring more than half the total length of the appendix.

Distribution (fig. 47). — *Orculella cretioreina* is disjunctly distributed, usually at high altitudes. See also the notes.

Notes. — In the island of Crete, in areas with limestone rocks, at altitudes of 1000-2250 m, *Orculella cretioreina* may be among the most common gastropod species. At the

highest localities it is the only *Orculella* known. The shells show clinal variation, which differs in different areas, maybe because more than a single species is involved. With increasing altitudes the shells usually become smaller and relatively more slender, and the apertural teeth may become increasingly less prominent to obsolete. At higher altitudes in the region of Mt Kedros the columellar lamellae become obsolete in front view, but the parietalis remains relatively high, whereas the shells are relatively small and slender (fig. 32). In the range of Mt Idi (= Psiloritis), with increasing altitudes, both columellar denticles and the parietalis change to obsolete in front view (fig. 31). The longest parietalis and comparably long columellar lamellae are known from populations at only 350 m and 770 m altitude, E. and NE. of Spili (fig. 30); shells in which these lamellae are only slightly shorter are also known from the Kedros area (altitudes unknown). Next to some clines some local forms can be vaguely distinguished. From south of Mt Psiloritis short, more ovoid shells are known. A more detailed analysis has to be postponed until more complete distributional and morphological data on the shells and the genitalia are available. Some populations are represented by very few worn shells only, which implies that details on the shell sculpture are unknown. The data on the genitalia are also far too limited. Most probably more than a single species is involved, but there is a morphological gap between *O. cretioreina* as defined here and the other Cretan taxa, in shell sculpture, the attachment of the palatal apertural border, and colour.

Derivatio nominis. — This Cretan species (*creti*) is mainly an inhabitant of relatively high altitudes in the mountains (*oreina*).

The three species of the islet of Dia

The terrestrial molluscan fauna of the islet of Dia was dealt with extensively by Schultes & Wiese (1990), mainly on the basis of material collected by Dr. Welter-Schultes. It turned out that there are three endemic *Albinaria* species (Pulmonata, Clausiliidae) of unclear taxonomic affinities on this islet of only 12.5 km². Here we describe the three *Orculella* species that were discovered in Dia, all of which are also endemic and clearly differentiated from the many nearby Cretan species of the genus.

Orculella diensis spec. nov. (fig. 25)

Material (paratypes, unless stated otherwise). — Island of Dia: LV3922 (HNC 23687/1); LV4023 (HNC 14059/3, RMNH 99370/holotype); LV4023 (HAU/1; HNC 23688/8; RMNH 99371/2).

Diagnosis. — Shell small, very slender cylindrical, with strongly inflated upper whorls and a distinct sutural canal. Penultimate and preceding whorl flattened, with irregular, more or less obsolete ribs.

Shell (fig. 25). — Shell very slender cylindrical with a domed apex, with 7¼–8¼ whorls. The upper whorls strongly inflated, the lower ones clearly flattened but separated by an indented suture. Initial teleoconch whorls with prominent, rather regularly spaced, radial ribs, which become increasingly weaker and more irregular on the lower whorls. There is a narrow but distinct sutural canal. Aperture ascending only slightly to nearly up to the lower third of the penultimate whorl.

Apertural lip thickened, white and slightly reflected; palatal lip clearly protruding. Parietal callus (rather) inconspicuous, with or without a subangularis. In front view, two columellar denticles are seen, but the supracolumellaris is often more or less obsolete. Left

lateral in the body-whorl, the columellaris is much higher than the supracolumellaris, which may be lacking completely there; deeper inside the shell both lamellae are about equally low. The parietalis reaches its optimal height approximately above the insertion of the columellar apertural lip, measuring nearly half the height of the whorl at that site; it can be followed upwards, gradually getting lower, for about $1\frac{1}{2}$ whorls.

Height 4.8-5.9 mm; width 2.0-2.3 mm.

Distribution. — *O. diensis* is only known from the islet of Dia.

Derivatio nominis. — The epithet *diensis* is formed after the name of the islet of Dia.

Orculella scalaris spec. nov. (fig. 26)

Material (paratypes, unless stated otherwise). — Island of Dia: LV3722 (HAU/4; HNC 14061/1, 23700/13); LV3724 (HNC 23699/2); LV3822 (HNC 23694/1); LV385.248, 190 m alt. (RMNH 99372/holotype, 99373/79); LV3922 (HNC 23691/1); LC3923 (HNC 23698/2); LV 3924 (HNC 14060/2, 23692/2); LV3925 (HNC 23693/1); LV4021 (HNC 23689/7); LV4022 (HNC 23690/1, 23695/1); LV4023 (HNC 23696/5); LV4024 (HNC 23697/1).

Diagnosis. — Shells rather small and not very slender, with a very conspicuously flattened apex and very strongly inflated whorls, provided with prominent regular ribs; without a distinct sutural canal.

Shell (fig. 26). — Shell rather small, short cylindrical with a conspicuously flattened apex, with $6\frac{1}{4}$ - $7\frac{3}{4}$ very strongly inflated whorls. Teleoconch whorls with prominent, rather regular, calcareous, whitish, radial ribs; above the aperture on the penultimate whorl 7-10 per mm. The ribs are ornamented by fragile, thin, periostracal lamellae, which are damaged and partly missing at least, even in very fresh specimens. The uppermost parts of the calcified ribs are adapically curved spurs, which results in an indistinct sutural band; the periostracal parts of the lamellae end without being curved and do not touch the preceding whorl.

Aperture ascending only slightly to nearly up to the lower third of the penultimate whorl. Apertural lip thickened, white and slightly reflected; palatal lip not protruding. Frontal $\frac{1}{8}$ to (basally) about $\frac{1}{4}$ of the last whorl thickened and whitish therefore. Parietal callus prominent, its border crenulated by the radial ribs, usually with a vague subangularis. In front view, two columellar denticles are seen, which may be somewhat extending towards the apertural border; they are about equally prominent or the supracolumellaris is less conspicuous. In some specimens an inconspicuous, third columellar lamella is discernible. Dorsally in the body-whorl, the columellaris is much higher than the supracolumellaris; both lamellae can be followed more than one whorl deep inside the shell. The parietalis is relatively high after $\frac{1}{8}$ whorl and once more after $\frac{1}{2}$ whorl, measuring over $\frac{1}{3}$ of the internal height of the whorl there and conspicuously flaring. Deeper inside the shell, the parietalis decreases abruptly in size, ending ventrally in the body-whorl.

In juvenile shells two prominent, sharp, columellar lamellae encircle the columella, with usually the supracolumellaris reaching further towards the columellar border than the columellaris; the parietalis starts as a low lamella at the border of the parietal callus, slowly increasing in height deeper inside the shell, where it is conspicuously twisted. The peristome may be thickened in juvenile shells, especially basally, as has been described for *Orculella bulgarica* (see Gittenberger, 1983).

Height 4.0-6.1 mm; width 2.4-2.7 mm.

Genitalia (fig. 45). — We examined a specimen from the type locality. The penial appendix inserts about halfway on the long and narrow penis. Its segment 1 is slightly

broad than the penis and longer than the parts 2-5 together; outside, segment 2&3 can vaguely be distinguished from segment 1 because it is somewhat broader initially, gradually narrowing towards the very narrow, slightly longer segment 4, which ends with an inconspicuous short bursa. The penis is about as long as the two parts of the epiphallus together. There is a broad, slender, spindle-shaped, proximal part of the epiphallus, with a conspicuously muscular wall; it is clearly separated from the much narrower and longer -less than half its diameter and nearly twice its length- distal part by the insertion of a simple, slender tubular penial caecum. Initially the distal part of the epiphallus is connected to the proximal part by some muscular fibers. The penial retractor inserts far away from the penial caecum where the penis and the epiphallus come together. Close to the distal end of the epiphallus four (maybe five) septa can be seen in the lumen of the translucent specimen. The vagina measures slightly less than half the length of the penis; it is much shorter than the oviduct. The bursa copulatrix, without a real bursa, clearly reaches the glandula albuminifera.

Distribution. — *Orculella scalaris* is only known from the islet of Dia.

Notes. — Conchologically at least this is one of the most conspicuous species of the genus. The genitalia are somewhat aberrant because of the shape of the epiphallus and the insertion of the penial retractor muscle.

Derivatio nominis. — The epithet *scalaris* refers to the shape of the shell, resembling a winding staircase.

Orculella franciscoi spec. nov. (fig. 27)

Material (paratypes, unless stated otherwise). — Island of Dia : LV3822 (HNC 23686/2; RMNH 99374/holotype); LV4023 (HNC 23688/1).

Diagnosis. — Shell small, moderately slender cylindrical, with convex upper whorls and increasingly more flattened lower ones. Penultimate and preceding whorl with irregular, rather obsolete ribs.

Shell (fig. 27). — Shell small, moderately slender cylindrical with a domed, depressed apex; with $6\frac{3}{4}$ - $7\frac{1}{4}$ whorls. The convex, initial teleoconch whorls with rather regular, radial ribs, which become increasingly more obsolete and less regularly spaced on the lower whorls. Lower whorls increasingly more flattened. There is a distinctly indented suture. Aperture ascending only slightly to nearly up to the lower third of the penultimate whorl.

Apertural lip thickened, white and slightly reflected; palatal lip slightly protruding. Parietal callus and subangularis inconspicuous. In front view, two columellar denticles are seen, but the supracolumellaris is often more or less obsolete. Inside the body-whorl, the columellaris is initially more prominent than the supracolumellaris. The parietalis is relatively high after $\frac{1}{8}$ whorl and once more after $\frac{1}{2}$ whorl, measuring nearly half the internal height of the whorl, where it is conspicuously flaring, with its border clearly curved upwards. Further inside it decreases rather abruptly in height, ending ventrally in the body-whorl.

Height 4.6-5.1 mm; width 2.2-2.3 mm.

Distribution. — *Orculella franciscoi* is only known from the islet of Dia.

Notes. — *Orculella franciscoi* differs from *O. diensis*, with which it occurs sympatrically, by its smaller, relatively broader shell, with up to only $7\frac{1}{4}$ whorls. The apical part is more depressed. Its initial teleoconch whorls are less strongly inflated, contrasting less with the lower ones; the whorls are more widely and less distinctly sculptured.

Derivatio nominis. — The epithet *franciscoi* is given in honour of Dr. Francisco Welter-Schultes, who discovered most of the malacological treasures of the islet of Dia.

The three species of the islands of Karpathos, Kasos, Rodhos and Saria

From the neighbouring islands of Karpathos and Saria two *Orculella* species are known, i.e. the endemic *O. exaggerata* and the more widespread *O. ignorata*. The latter species occurs with *O. critica* also in Rodhos.

Orculella exaggerata (Fuchs & Käufel, 1936) (figs 3-5, 9, 28)

Orcula (*Sphyradium*) *doliolum exaggerata* Fuchs & Käufel, 1936: 544, fig. I.4A, B ("Insel Karpathos: Umgebung von Pigadia").

Material. — Karpathos: 1.5 km E. of Lefkos, 200 m alt., NV0737 (RMNH); 2 km NNW. of Piles, 200 m alt., NV1033 (RMNH); 4 km NW. of Volada, 1000-1200 m alt., NV1137 (RMNH); 1 km SW. of Spoa, 400 m alt., NV1142 (RMNH); Pigadia, NV12 (NMW-Kle 16270/4; SMF 64126/2); 3 km WSW. of Menetes, 150 m alt., NV1226 (RMNH); Stes, 2 km WSW. of Volada, 500 m alt., NV1233 (RMNH); 3 km NW. of Volada, 900 m alt., NV1236 (RMNH); Volada, 500 m alt., NV13 (IZPAN/7); 2.5 km NW. of Menetes, 350 m alt., NV1329 (RMNH); 1.5 km NW. of Volada, 800 m alt., NV1335 (RMNH); 5.5 km NNW. of Aperi, 250 m alt., NV1339 (RMNH); 2 km S. of Menetes, 500 m alt., NV1425 (RMNH); 0.5 km NW. of Menetes, 275 m alt., NV1427 (RMNH); Volada, path to chapel Stavros, 450 m alt., NV1434 (RMNH); 1.5 km S. of Aperi, 225 m alt., NV1532 (RMNH); 4.5 km N. of Olimbos, path to Ag. Ioannis, 200 m alt., NV1559 (RMNH); 3 km SE. of Aperi, 200 m alt., NV1732 (RMNH).

Saria: E. side of Palatia, 50-75 m alt., NV2070 (RMNH).

Kasos: NE. and NW. of Khelathros harbour, 9 km SW. of Fry, 25 m alt., MV8811 (RMNH); Poli (= 3 km S. of Fry), MV91 (IZPAN/2); 3 km SSE. of Fri, between Poli and Panagia, MV91 (IZPAN); Arvanitochori (= 5 km SW. of Fri), MV91 (IZPAN/3); in the cave Selai, 4 km SW. of Fry, 300-350 m alt., MV9016 (RMNH).

Diagnosis. — The entire teleoconch of the shell with a prominent radial sculpture of ribs that are accentuated by lamelliform periostracum, a conspicuous sutural canal, and a strongly protruding palatal lip.

Shell (figs 3-5, 9, 28). — Shell rather small, slender cylindrical with a domed apex, often with its optimal width above the middle; with $7\frac{1}{2}$ - $8\frac{1}{2}$ moderately inflated whorls, provided with a regular and prominent radial sculpture. Above the aperture on the penultimate whorl there are 8-10 ribs per mm. In fresh specimens the calcified ribs are ornamented by periostracal riblets, which are curved abapically at the upper ends of the calcified radial ribs, which do not reach the suture (figs 3-5). As a consequence of this, there is a narrow but conspicuous sutural canal, which is sculptured with coarse striae, running adapically from the upper ends of the radial ribs. Aperture ascending up to between the lower third and the periphery of the penultimate whorl.

Apertural lip thickened, white and strongly reflected throughout. Palatal lip distinctly protruding (fig. 9). Although the parietal callus is usually inconspicuous, there is a very prominent angular denticle, protruding c. as far as the upper end of the palatal apertural lip (in the figured specimen, the subangularis is exceptionally obsolete). There are no conspicuous columellar lamellae; in front view an obsolete columellar denticle may be seen at most. The columellaris reaches c. $\frac{3}{4}$ whorl or less far inside. The parietalis is moderately (most strongly in its left lateral part) and evenly flaring and reaches its optimal relative height ventrally or slightly less deep inside the body whorl, where it measures over $\frac{1}{3}$ to half the local whorl height.

Height 5.8-7.6 mm; width 2.6-2.8 mm.

Distribution. — This very characteristic species is known from the islands of Karpathos and Saria, where *O. ignorata* is also known from, and from Kasos.

Orculella critica (Pfeiffer, 1856) (figs 16, 33)

Pupa critica Pfeiffer, 1856: 177 ("Insel Syra" [= Siros]).

Orcula turcica Letourneux, 1884: 298 (lectotype [MHNG], design. Hausdorf [1996: 17], "Santorin [= island Santorini, = Thira], .. Messa Vouno").

Orcula scyphus graecus Pilsbry, 1922: 36, pl. 3 figs 2-4 ("Chalcis, Euboea" [= Khalkis, Evvoia]).

Orcula (*Sphyradium*) *doliolum turcica*; Fuchs & Käufel, 1936: fig. I-1.

Orculella critica; Hausdorf, 1996: 17, fig. 6, map 3, pl. 1 figs 5-6.

Material. — Rodhos: Chalki (islet), castle, 300 m alt., NA50 (SMF 110731/37); 5 km N. of Sianna, NA70 (MAA); Gennadion, 50 km SW. of Rodhos town, on the beach, NV88 (BUT; MAA; RMNH); Lindos, NV99 (IZPAN; MAA; NEU; NMG); 1.5 km WNW. of Lindos, NV99 (NMG); 1 km E. of Archangelos, road to Stegena, PA00 (NMG); S. of Kolymbia (= Kolibia), PA01 (NEU); Rodini park, 3 km SSW. of Rodhos town, PA03 (MAA).

Diagnosis. — Shell rather small, cylindrical, upper teleoconch whorls prominently ribbed, lower ones usually only striated; parietalis often not clearly extending into the penultimate whorl. The relatively complex penial appendix is diagnostic versus *O. ignorata*.

Shell (fig. 16). — Shell rather small, more or less cylindrical with a domed apical part, with $7\frac{1}{4}$ - $9\frac{1}{4}$ moderately inflated whorls; its upper half often slightly narrower than the lowest whorls. The initial teleoconch whorls are provided with coarse, calcified, rather irregularly arranged, radial ribs, ornamented with periostracal riblets; on lower whorls this radial sculpture becomes increasingly irregular and more obsolete, with periostracal elements often lacking completely. The upper ends of the calcified ribs are very shortly curved backward and reach the suture; a sutural canal cannot be distinguished. Aperture ascending up to the lower third of the penultimate whorl.

Apertural lip thickened, white and strongly reflected. Palatal lip hardly or not protruding. Parietal callus (rather) inconspicuous, usually with a moderately prominent subangularis. In front view, two columellar denticles may be observed deep inside the aperture; they can be more or less obsolete or lacking completely. Dorsally in the body-whorl, the columellaris is usually somewhat higher than the supracolumellaris; the former lamella is often shorter than the latter one, which remains discernible inside the penultimate whorl. The parietalis is moderately and evenly flaring; it is relatively high after $\frac{1}{8}$ whorl and, once more, left lateral inside the body-whorl. While diminishing in prominence, upward in the shell, the parietalis reaches and sometimes shortly enters the penultimate whorl. Distinct palatal folds are missing, but very rarely an obsolete callosity has been observed, reminding of the palatal fold in *Schileykula* Gittenberger, 1983.

Height 5.0-7.6 mm; width 2.2-2.9 mm.

Genitalia (fig. 33). — We examined seven specimens, from six different localities. The very conspicuous penial appendix inserts where the proximal part of the penis adjoins to the somewhat shorter and narrower distal part. Its segment 1 is shorter and considerably narrower than the dominating, broad segment 2&3, which is about as long as the very narrow segment 4, gradually changing into the relatively short bursa (5). The penis is about as long as the gradually tapering penial caecum, which is as long as the epiphallus or slightly shorter; the penial retractor inserts where these three parts come together. The

epiphallus is broadest at its distal end, where six septa can be seen in the lumen of translucent specimens. The vagina is shorter than the distal part of the penis and much shorter than the oviduct, which is about half as long as the bursa copulatrix.

Distribution. — *O. critica* is widespread in eastern Central Greece, the Peloponnese, the N. Sporadhes, the islands of Kythira and Evvoia, some islands of the Kikladhes and the Dodekanissos. Most records of *O. critica* for Rodhos are from the east side of the island, but there is also a sample from the northern slope of Mt Attaviros, 850 m alt., at the west side. From the Turkish west coast two localities have been reported recently (Hausdorf, 1996).

Notes. — *O. critica* has often been confused with *O. ignorata* Hausdorf, 1996. In the former species, the shell is more regularly cylindrical in general shape and tapering towards the apex over a longer distance, whereas in the latter one the upper half of the shell may be slightly broadened. In addition, *O. ignorata* has a more prominently protruding palatal lip and its parietalis is still high at the ventral side of the shell, where it usually has already distinctly decreased in height in *O. critica*. Dorsally in the body whorl in *O. critica*, the columellaris is usually higher than the supracolumellaris, whereas at the same position in *O. ignorata* the two columellar lamellae are about equal in size in most cases. The two species may occur sympatrically, as is the case at some localities on the island of Rodhos; here the distinction is relatively easy, because both species may have populations with relatively large shells, clearly showing the diagnostic characters just mentioned, whereas *O. critica* is additionally characterized by a distinct radial sculpture all over the shell.

O. critica tends to develop local forms, especially so on the Aegean islands (as for example in the N. Sporadhes, Thira and Rodhos). These geographic forms cannot be delimited well enough to be given subspecific status. With additional, not only conchological data this might be possible, however.

The rather uniform populations of the Peloponnese are chosen as a reference here. As compared to these, most of the snails of the Kikladhes (for example from the island of Thira) have a smoother and more cylindrical shell, with a parietalis that does extend less far into the shell, often ending ventrally; generally the columellar lamellae are less prominent. These forms clearly differ from those of the island of Rodhos, which may be relatively large and are often distinctly striated all over the shell. From the islet of Khalki, c. 15 km W. of Rodhos, a population is known, characterized by comparatively large, especially broad, shells (height 6.2-7.6 mm; width 2.6-2.9 mm) with a parietalis that is still high at the ventral side, a prominent subangularis and a columellaris that is very high in left lateral position inside the body-whorl. Populations with equally large specimens are known from some places on Rodhos as well. Because populations with (considerably) smaller shells are also known from Rodhos, it has to be concluded that on this single island the variation in size is larger than it is in the entire Peloponnese. (See also the notes on *O. ignorata*.)

Orculella ignorata Hausdorf, 1996 (figs 17, 34)

Pupa doliolum; Roth, 1839: 18 (part.). Not Bruguière, 1792.

Pupa scyphus; Mousson, 1854: 394 (part.). Not Pfeiffer, 1848.

Orcula doliolum turcica; Pilsbry, 1922: 23, pl. 2 figs 5, 6 (part.). Not Letourneux, 1884.

Orcula (Sphyradium) doliolum turcica; Fuchs & Käufel, 1936: 544 (part.), fig. I-2A-C.

Orcula scyphus; Pieper, 1970: 272, fig. 4. Paget, 1976: 702, pl. 1 fig. 1b, c. Not Pfeiffer, 1848.

Orcula sp.; Pieper, 1970: 272, figs 5-7.

Orculella ignorata Hausdorf, 1996: 19, figs 8-9, pl. 1 figs 11-12 (holotype: SMF54265, Turkey, Anatolian west coast, Fethiye).

Material. — Karpathos: Volada, 500 m alt., NV13 (IZPAN/1; SMF198326/7); 5.5 km NNW. of Aperi, 250 m alt., NV1339 (RMNH); 5 km N. of Olimbos, path to Tristomo harbour, 250 m alt., NV1861 (RMNH).

Rodhos: Mt Attaviros, above Embonas, NA70 (SMF 110726/4); Ay. Isidoros, NA70 (SMF 110728/1); Embonas, NA70 (NMG); Kastellos, NA71 (SMF 54281/1); Salakos, NA81 (SMF 198328/1); Profitis Ilias near Salakos, 6 km S. of Kalavarda, 750 m alt., NA81 (MAA); Mt Elias, NA81 (SMF 110729/3); Kalavarda, NA82 (BUT 2425/3; MAA; RMNH; WIN 1300/1); Feraclos castle near Haraki, 5 km SSW. of Arhangelos, NA90 (MAA); Eleoussa, NA91 (NMG); Epta Pigai, 6 km SW. of Afandou, NA91 (MAA); Monolithos, NV69 (MAA; NEU/1; NHMW/5; SMF 325510/holotype, 325511/paratype); Gennadion, 50 km SW. of Rodhos town, on the beach, NV88 (MAA/few); 1.5 km WNW. of Lindos, NV99 (NMG); Archangelos, PA00 (NMG); 1 km E. of Archangelos, road to Stegena, PA00 (NMG); S. of Kolymbia (= Kolibia), PA01 (NEU); Mt Tsambika, PA01 (NMG); Filerimos, 8 km WSW. of Rodhos town, PA02 (MAA); gorge 2 km NE. of Koskinou, PA02 (NMG); Kalitheas spring, PA12 (NMG); cape Ladiko, 13 km S. of Rodhos town, PA0820 (NMG).

Saria: E. side of Palatia, 50-75 m alt., NV2070 (RMNH).

Diagnosis. — Shell with upper teleoconch whorls prominently ribbed, lower ones only striated and often slightly narrowed; parietalis clearly reaching into the penultimate whorl. The relatively simple penial appendix is diagnostic versus *O. critica*.

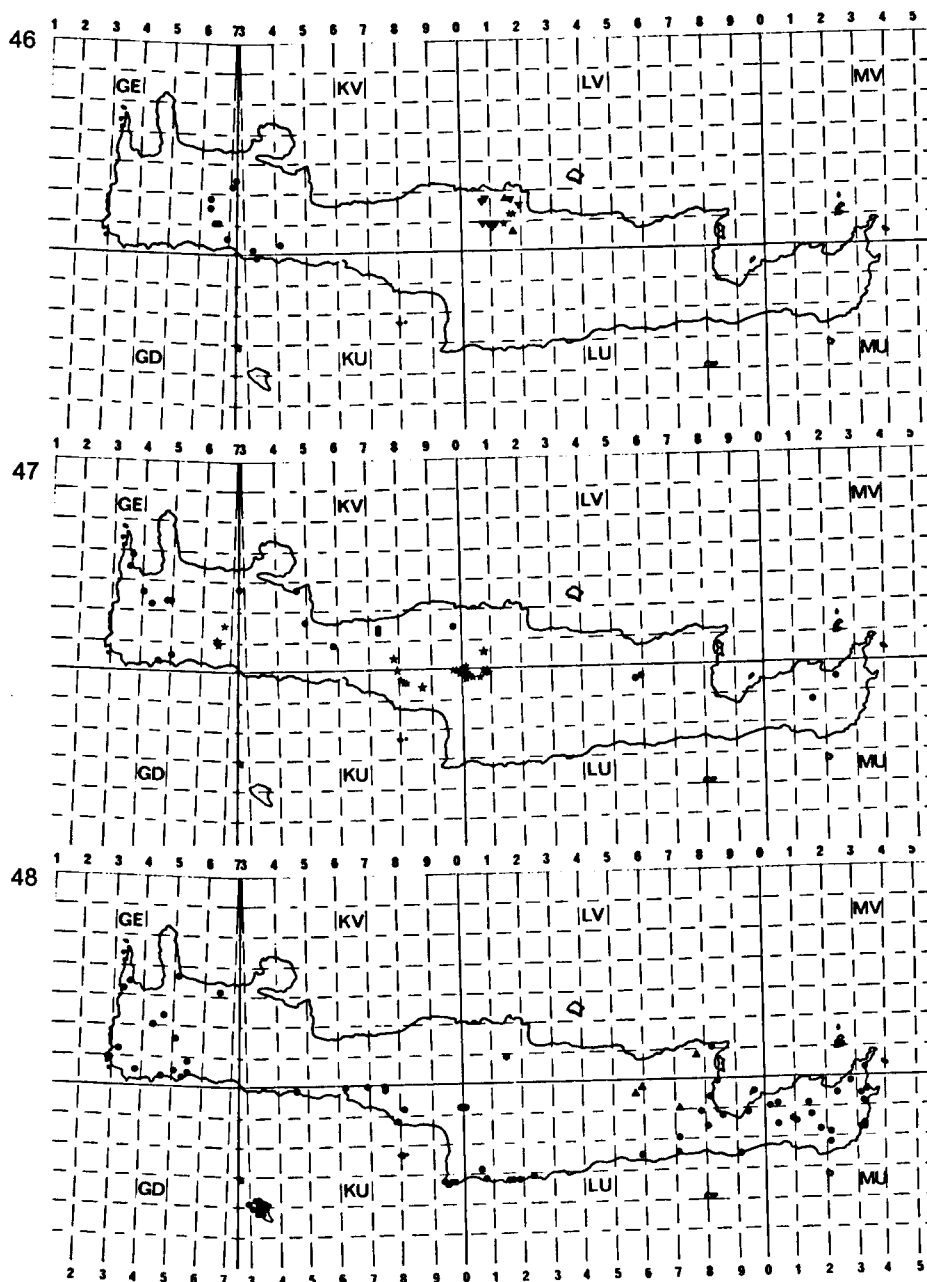
Shell (fig. 17). — Shell small to medium-sized, more or less (broadly) cylindrical with a domed apical part, with $7\frac{1}{4}$ – $8\frac{3}{4}$ moderately inflated whorls; its upper half often slightly broader than the lowest whorls. The initial teleoconch whorls have coarse, rather irregular, radial ribs, which become increasingly more irregular and indistinct on the following whorls. There is no distinct sutural canal. Aperture ascending up to between the lower third and the periphery of the penultimate whorl.

Apertural lip thickened, white and strongly reflected. Palatal lip slightly to distinctly protruding. Parietal callus rather inconspicuous, usually with a distinct subangularis. In front view, two columellar denticles may be observed deep inside the aperture; they can be more or less obsolete. Dorsally in the body-whorl, the columellaris and the supracolumellaris are usually about equally well developed, but their relation is very variable. The parietalis is moderately and evenly flaring initially; it is relatively high after $\frac{1}{8}$ whorl and, once more, at the left side about ventrolateral in the body-whorl. The parietalis reaches into the penultimate whorl.

Height 4.8–8.1 mm; width 2.4–3.4 mm.

Genitalia (fig. 34). — Only a single complete genital system of an adult specimen could be examined. This specimen is from Monolithos, Rodhos. Apart from a spherical swelling somewhat before the middle and a vague indication of a bursa, the penial appendix is a simple thin tube, which is shorter than the epiphallus; it is attached at the end of the proximal, broadest quarter of the penis. The penial retractor inserts at $\frac{3}{4}$ of the penial length, clearly distant of the basis of the caecum. The epiphallus is broadest at its distal end and narrows towards its branching off, about halfway between the attachment of the retractor muscle and the tip of the short caecum. The epiphallus measures $\frac{3}{4}$ of the length of the penis and the vagina less than $\frac{1}{3}$ of it; the latter is less than half as long as the oviduct. The elongated spermatheca measures half the length of the spermathecal duct, which is slightly longer than the oviduct.

Some subadult specimens from Rodhos and from the Anatolian south coast and the cave Öküzün, 6.5 km N. of Yeniköy, are rather similar to the specimen from Monolithos; about halfway, their inconspicuous appendices have also swellings. However, on the



Figs 46-48. Records of *Orculella* species. 46, *O. creticostata*, dots; *O. cretimaxima*, triangles pointing downwards; *O. astirakiensis*, triangles pointing upwards; *O. fodela*, stars. 47, *O. creantirudis*, dots; *O. cretioreina*, stars. 48, *O. cretiminita*, dots; *O. cretilasithi*, triangles.

appendix of an adult, incomplete (female parts missing) specimen from Rodhos, Salakos, such an inflated part is not seen. These various specimens differ quite conspicuously in the relative dimensions of the genitalia and it remains unclear whether this should be considered intraspecific variation. However, *O. ignorata* clearly differs from *O. critica* in (1) the short and simple penial appendix and (2) the penial retractor, inserting clearly proximal of the basis of the caecum. In addition there are several differences in relative lengths of various parts of the genitalia.

Distribution. — *O. ignorata* has mainly been found on the west side of Rodhos, but there is also a record for the east side, at Tsambika. The ranges of *O. ignorata* and *O. critica* overlap in Rodhos and according to Paget (1976: 706) both species occur sympatrically at Mt Tsambika. Pieper (1970: 272) reported another sympatric occurrence from Lindos; however, the specimen identified with "*O. scyphus*" (SMF 198331) by Pieper, turned out to belong to *O. ignorata*.

Populations that are considered *O. ignorata* are known from Macedonia, Thracia, the island of Thasos, the islands off the Anatolian coast and the Anatolian west and south coast (Hausdorf, 1996: 18, 20, map 3). In Rodhos the taxon is widespread and not restricted to the west side of the island as Paget (1976: 706) thought.

Notes. — Despite the fact that *O. ignorata* and *O. critica* are very different in the structure of the genitalia, their shells are not always distinguishable with certainty. Apart from conchological variation, convergent evolution, for example in the reduction of certain lamellae, has obscured the differences.

At some places in Rodhos sympatric populations of the two species occur, which can easily be identified, however, because they differ distinctly, even in their shells. Some forms of *O. ignorata* from Rodhos are very large, whereas certain populations of *O. critica* from the island are distinctly striated. Maybe this results from character displacement or niche partitioning and divergent adaptation.

Shells from the islands of Karpathos and Saria look similar to specimens of *O. critica* from the Kikladhes, but are more slender (height 5.1-7.5 mm; width 2.2-2.5 mm - see Pieper, 1970: 273). The form of Karpathos is relatively small and slender and thus quite different from the medium-sized to large and not particularly slender specimens from the neighbouring island of Rodhos.

For nomenclatorial data, see Hausdorf (1996).

ACKNOWLEDGEMENTS

We are grateful to our colleagues and friends for presenting or sending us material in loan for study. In particular we thank Messrs. L.J.M. Butot (Bilthoven), K. Edlinger (Vienna), G.H. Engelhard (Bergen, Norway), E.J. Gittenberger (Leiden), J. Goud (Leiden), J. Hemmen (Wiesbaden), R. Janssen (Frankfurt am Main), M. Lombaerts (Alphen aan de Rijn), W.J.M. Maassen (Duivendrecht), the late W.H. Neuteboom (formerly Heemskerk), P.L. Reischütz (Horn), A. Riedel (Warsaw), H. Sattmann (Vienna), J.W.F. Slik (Leiden), C. [& Ms. A.] Renker (Jena), P. Subai, (Aachen), V. Wiese, (Cismar), and A.J. de Winter (Wageningen). We are especially grateful to Dr. F. Welter-Schultes for giving us the possibility to study the fascinating material that he collected from the islet of Dia.

REFERENCES

- BANK, R., 1886. Over *Orculella bulgarica* (Hesse, 1915) in Turkije. — Correspondentieblad van de Nederlandse Malacologische Vereniging 230: 160-161.
- BRANDT, R.A., 1956. Zur Orculidenfauna der Cyrenaika. — Archiv für Molluskenkunde 85: 69-82.
- FUCHS, A., & F. KÄUFEL, 1936. Anatomische und systematische Untersuchungen an Land- und Süßwasserschnecken aus Griechenland und von den Inseln des Ägäischen Meeres. — Archiv für Naturgeschichte (N. F.) 5: 541-662.
- GITTENBERGER, E., 1983. Beiträge zur Kenntnis der Pupillacea. IX. Nochmals über Orculidae. — Proceedings Koninklijke Nederlandse Akademie van Wetenschappen (C) 86: 325-342.
- GITTENBERGER, E., & G.A. GOODFRIEND, 1993. Land snails from the last glacial maximum on Andikithira, southern Greece and their palaeoclimatic implications. — Journal of Quaternary Sciences 8: 109-116.
- HAAS, F., 1935. Kurze Bemerkungen V. — Archiv für Molluskenkunde 67: 107-112.
- HAUSDORF, B., 1988. Zur Kenntnis von *Orculella templorum* (Benoit 1862) aus Sizilien (Gastropoda: Orculidae). — Archiv für Molluskenkunde 119: 77-81.
- HAUSDORF, B., 1996. Die Orculidae Asiens (Gastropoda: Stylommatophora). — Archiv für Molluskenkunde 125: 1-86.
- LETOURNEUX, A., 1884. Excursions malacologiques dans l'île Santorin. — Bulletin de la Société Malacologique de France 1: 287-304.
- MARTENS, E. VON, 1889. Griechische Mollusken. Gesammelt von Eberh. von Örtzen. — Archiv für Naturgeschichte 55 (I): 169-240.
- MOUSSON, A., 1854. Coquilles terrestres et fluviatiles, recueillies par M. le Prof. Bellardi dans un voyage en Orient. — Mittheilungen der naturforschenden Gesellschaft in Zürich 3: 389-402.
- PAGET, O.E., 1976. Die Molluskenfauna der Insel Rhodos. 1. Teil. Ergebnisse der von Dr. O. Paget und Dr. E. Kritscher auf Rhodos durchgeführten zoologischen Sammelreisen. 17. Mollusca 1. — Annalen des naturhistorischen Museums, Wien 80: 681-780.
- PFEIFFER, L., 1848. Diagnosen neuer von Frivaldsky gesammelter Landschnecken. — Zeitschrift für Malakozoologie 5: 6-12.
- PFEIFFER, L., 1856. Bericht über weitere Mittheilungen des Herrn Zelebor. — Malakozoologische Blätter 3: 175-186.
- PIEPER, H., 1970. Die Orculiden der SO-Ägäis. — Archiv für Molluskenkunde 100: 271-274.
- PILSBRY, H.A., 1922. Pupillidae (Orculinae, Pagodulinae, Acanthinulinae, etc) [part.]. — Manual of Conchology 27: 1-80.
- REISCHÜTZ, P.L., 1985. Ein Beitrag zur Molluskenfauna von Léros (Dodekanes, Griechenland). — Malakozoologische Abhandlungen 11: 17-24.
- ROTH, J.R., 1839. Molluscorum species, quas in itinere per orientem facto comites clariss. Schuberti doctores M. Erdl et J.R. Roth collegunt: 1-27. München.
- SCHILEYKO, A.A., 1984. Nazemnye molljuzki podotjrada Pupillina fauny SSSR (Gastropoda, Pulmonata, Geophila). — Fauna SSSR. Molljuzki. III (3): 1-400.
- SCHULTES, W. & V. WIESE, 1990. Die Gattung *Albinaria* auf Kreta: IV. Zur Verbreitung der Landschnecken auf Dia. — Schriften zur Malakozoologie 3: 23-47.
- SEIDL, F., 1978. Zur Molluskenfauna von Kreta: I. Historische Aufzeichnungen. — Mitteilungen der zoologischen Gesellschaft Braunau 3: 157-193.
- STURANY, R., 1904. Ueber Kreta-Mollusken. — Nachrichtenblatt der deutschen malakozoologischen Gesellschaft 36: 108-112.