On the only Greek *Sphincterochila* species, two Libyan close relatives, *Cerigottella* subgen. nov., and an extended diagnosis of the Sphincterochilidae (Mollusca, Gastropoda Pulmonata)

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From Greece, based on conchological characters, a single, endemic *Sphincterochila* species has been reported about a century ago. Its occurrence is still thought to be restricted to the islet of Andikithira. The structure of the genitalia, hitherto unknown, demonstrates that it concerns a separate species indeed; its closest relatives known are two Libyan species. These three species differ from the *Sphincterochila* species studied so far most clearly by the stimulatory organ, inserting not on the genital atrium but far more distally on the vagina. They are classified within *Cerigottella* subgen. nov.

Introduction

The circum-Mediterranean genus *Sphincterochila* Ancey, 1887 is considered to contain the only extant representatives of a peculiar group of gastropod species with (very) thick calcareous white shells, without any additional colour pattern, that are globular or more or less prominently keeled. The species can endure dry and warm to extremely hot habitats. Forcart (1972) summarized the data concerning this genus from the literature, adding and discussing newly acquired information as well; unless stated otherwise, general data are taken from his paper. On the basis of typological arguments, Forcart (1972) accepted three and later on (1974) four subgenera.

The systematic position of *Sphincterochila* is unclear. According to Nordsieck (1987: 17, 18), presenting his view with a combination of both cladistic and more subjective, typological arguments, the Sphincterochilidae are an isolated family ("muss als isoliert bezeichnet werden") within the superfamily Helicoidea. Schileyko (1991: 215) follows Forcart (1972) in accepting even a superfamily Sphincterochiloidea for the single extant genus; he classifies this superfamily with the infraorder Zonitinia, thus considering *Sphincterochila* more closely related to zonitid than to helicid snails. Forcart did not give his opinion concerning this point.

Only a single *Sphincterochila* species has ever been reported from Greece, i.e. from the islet of Andikithira (between NW Crete and the island of Kithira and the Peloponnese) by Boettger (1894: 5) as "var. *insularis*" of *Sphincterochila* (*Albea*) *candidissima* (Draparnaud, 1801). Zilch (1966: 96, pl. 1 fig. 10) ranked this taxon as a separate species, without being able to add to our knowledge of this geographically isolated taxon; a subgeneric assignment could not be given because of the lack of anatomical data.

The endemic occurrence of *S. insularis* was one of the main reasons to visit the excitingly isolated, barren islet of Andikithira. The species was recorded there on

August 4th, 1988. Shells as well as live animals withdrawn behind their epiphragms, apparently in aestivation but hardly sheltered, were found midday, with an air temperature of over 30°C, on hot sandstone slabs.

Dissection made clear that Zilch was right in giving species status to this form. The species cannot be classified with one of the already described subgenera of *Sphincterochila;* its characters imply an extension of the generic diagnose.

Two *Sphincterochila* species from Libya, characterized conchologically by Kaltenbach (1950), and represented by specimens in alcohol in the RMNH, Leiden, proved to have the same bauplan of the genitalia as found in *S. insularis.* Therefore, these species are also considered to belong to *Cerigotella* subgen. nov. They have not been studied anatomically in great detail. Biogeographically a connection between Greece and Libya is not exceptional (see e.g. Bank & Gittenberger, 1993).

Cerigottella subgen. nov.

Type species: *Sphincterochila* (*Cerigottella*) *insularis* (Boettger, 1894).

Additional species: *Sphincterochila* (*Cerigottella*) *cyrenaica* Sturany, 1908 [based on dissection of *S.* (*C.*) *c. tocraensis* Kaltenbach, 1950]; *S.* (*C.*) *mixta* Kaltenbach, 1950.

Etymology: The name refers to Andikithia, called Cerigotto in ancient times.

Subgeneric diagnosis

The relatively simple stimulatory organ, consisting of a spherical glandular part with a duct provided with an appendicula only, inserts far distally on the vagina. At and proximal of this insertion, the lumen of the vagina has a conspicuously wrinkled wall-segment, bordered by two ridges. The male part of the genitalia consists of a penis and a clearly narrower, about equally long epiphallus, which is provided with a prominent flagellum.

Sphincterochila (Cerigottella subgen. nov.**) insularis** (Boettger, 1894) (figs. 1-6)

Two specimens have been studied anatomically. The animals were collected 4.viii.1988, 0.1 km SW of Potamos, islet of Andikithira.

Foot.— The published data concerning the structure of the sole in *Sphincterochila* are somewhat confusing still. In the species under discussion, in animals preserved in alcohol, it is clearly tripartite. In living *S. insularis* the sole has not been inspected.

Genitalia (figs. 1, 2).— The right ommatophoran retractor muscle runs free, next to the genitalia. The proximal part of the ductus hermaphroditicus is provided with accessory vesiculae seminalis. The penis is about as long as the epiphallus and slightly broader over its entire length. The flagellum measures less than half the length of the penis. The penial lumen is provided with 10-15 longitudinal, fine, irregular and partly interconnected ridges, some of which curve into a ring-like structure, marking the distal end of the penis (fig. 2a). The lumen of the epiphallus has only three or four, rather large longitudinal ridges, growing together opposite the penial pseudo-

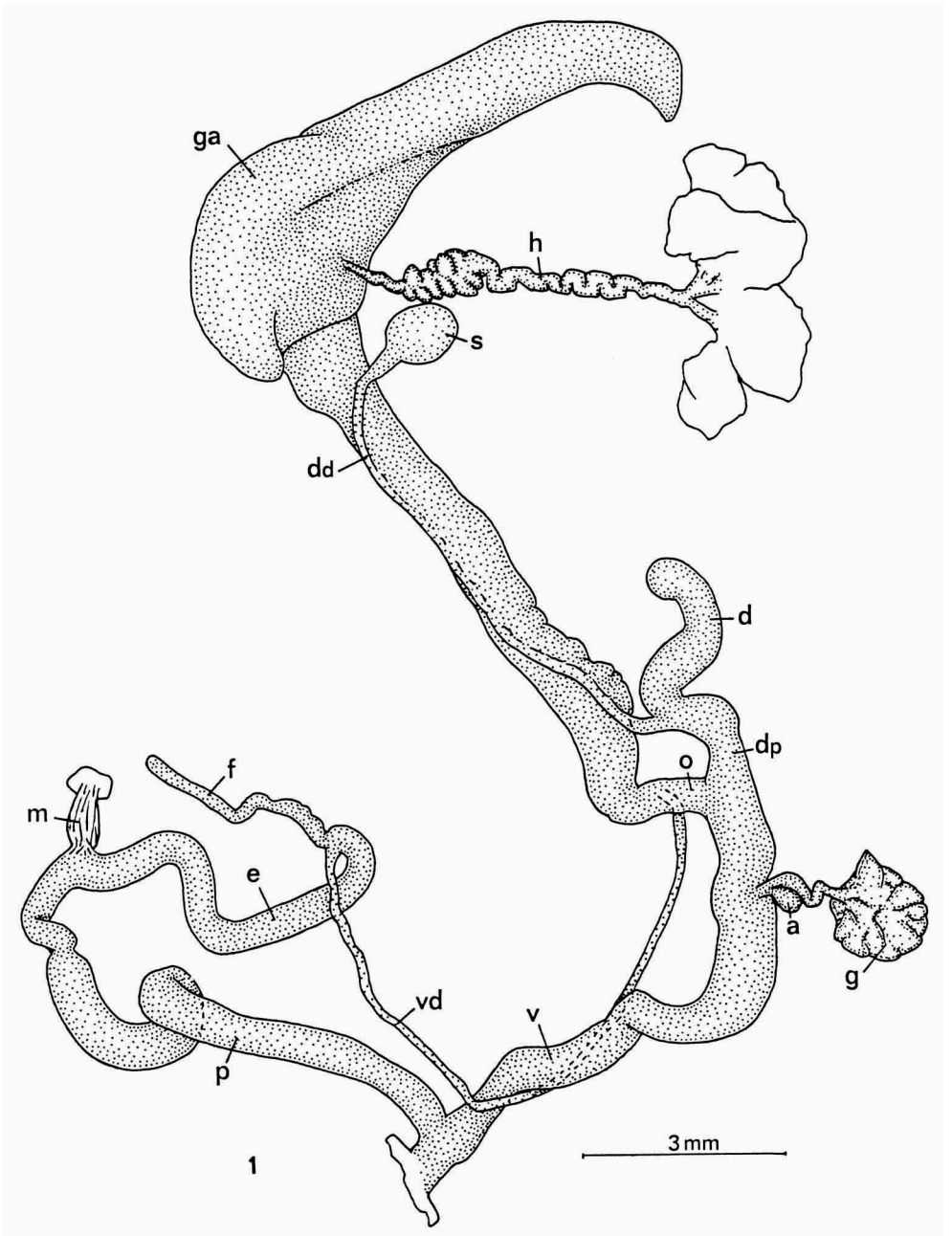


Fig. 1. *Sphincterochila* (*Cerigottella* subgen. nov.) *insularis* (Boettger, 1894), genitalia. Abbreviations: a, appendicula of the stimulatory organ; d, diverticle of the spermathecal duct; dd & dp, distal & proximal part of the spermathecal duct; e, epiphallus; f, flagellum; g, glandular part of the stimulatory organ; ga, glandula albuminifera; h, ductus hermaphroditicus; m, retractor muscle; o, oviduct; p, penis; pr, prostata; s, spermatheca; v, vagina; vd, vas deferens. See also fig. 2.

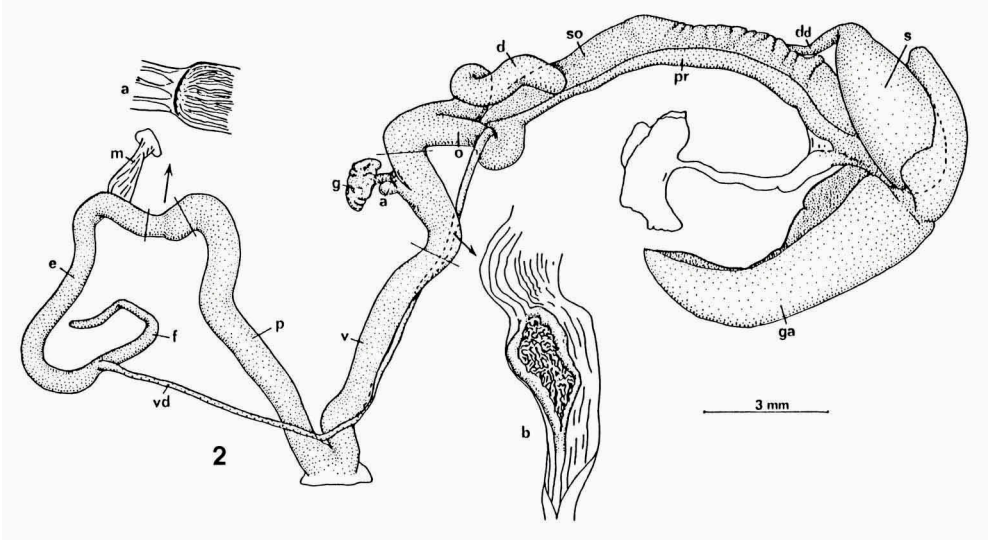


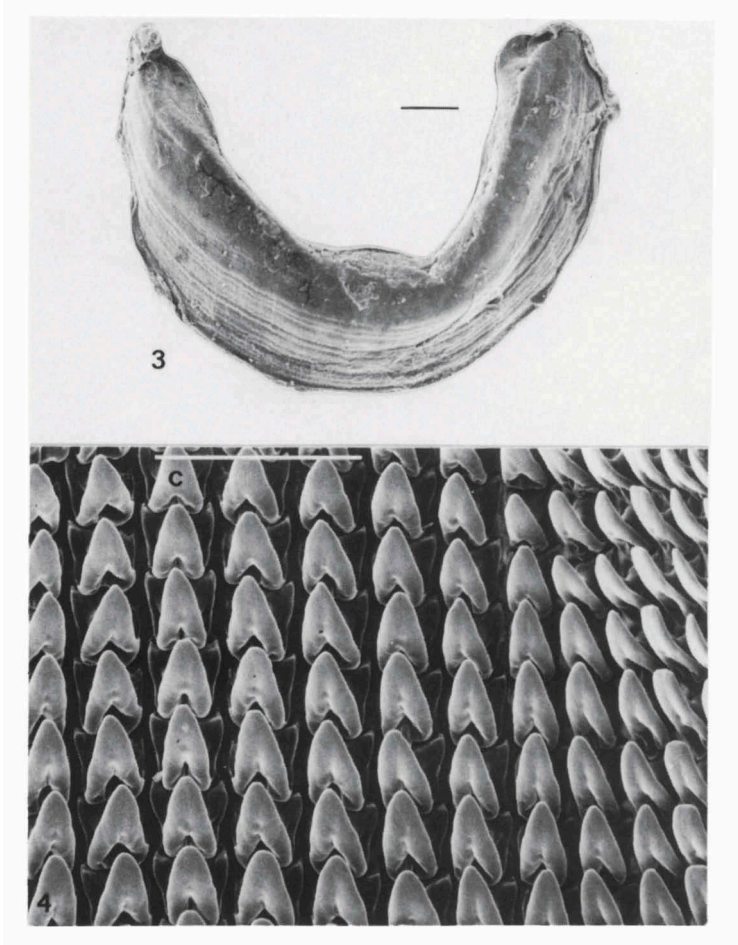
Fig. 2. *Sphincterochila* (*Cerigottella* subgen. nov.) *insularis* (Boettger, 1894), genitalia, with details of the luminal surface (a) near the transition between penis and epiphallus and (b) near the insertion of the stimulatory organ. For an explanation of the abbreviations, see the legends with fig. 1.

papilla (fig. 2a). The retractor muscle inserts on the epiphallus, close to its proximal end. The vagina is about as long as the penis; the stimulatory organ, consisting of a spherical glandular part, a duct about as long as the diameter of this part and a small appendicula, inserts close to the distal end of the vagina. Apart from several more or less irregular, fine, longitudinal ridges, the vaginal luminal wall has a conspicuous part with narrowly and very irregularly wrinkled, high and fine ridges, bordered by two broad, simple ridges that are united above and below; the stimulatory organ inserts at the distal end of this wrinkled zone.

The oviduct is very short. The spermoviduct is bordered by a long prostata. The proximal part of the spermathecal duct and the spermathecal diverticle form a morphological entity; they are hardly narrower than the vagina, whereas the distal part of the spermathecal duct is much narrower. The spermatheca is situated free from the spermoviduct because its duct is curved away from it (fig. 1), or touches it (fig. 2), which may be only the case when it is filled and relatively large, however.

Mandibula (fig. 3).— As usual in *Sphincterochila*, the mandibula is oxygnathous. On SEM inspection no particular microstructures were seen.

Radula (figs. 4-6).— As in the congeneric species studied so far, the radula is of the "rock-scraping" type (cf. Breure & Gittenberger, 1982), i.e. it is characterized by a unicuspid central tooth, bordered by zones with unicuspid lateral teeth. In the two radulae 120 and 133 rows of teeth were counted; this difference may at least partly be caused by a less complete dissection of the former radula. An obsolete ectocone becomes discernible from teeth 12-15 on; an endocone is very vaguely visible from about the same teeth on. The main cusp is always recognizable as such. The endocone is situated much higher on the main cusp than the ectocone. A half row contains 27-28 teeth; after the broad, uniformous middle zone with unicuspid teeth, the

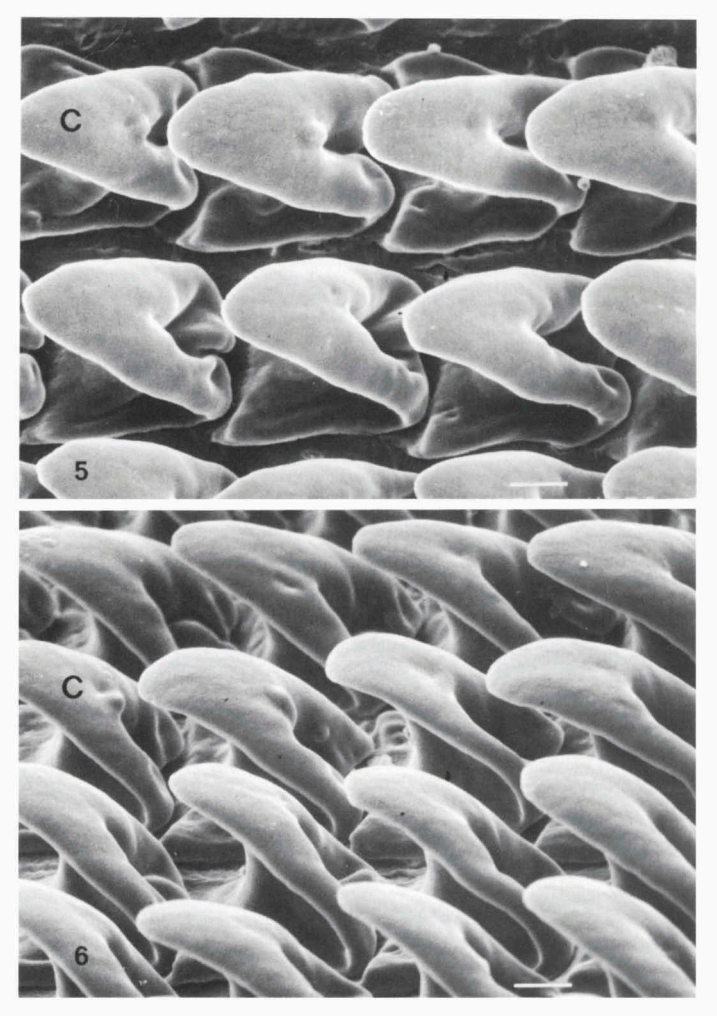


Figs. 3, 4. *Sphincterochila* (*Cerigottella* subgen. nov.) *insularis* (Boettger, 1894), mandibula (3) and a detail of the radula, with the central tooth (c) and adjoining unicuspid teeth (4). Scale lines 0.1 mm. Photos J. Goud.

teeth change very gradually in shape and size towards the margin of the radula, where they have become rudimentary. See figs. 4-6 for details of the single teeth from the middle zone of the radula. There is a very large hinge-indentation in the dorsal side of each main cusp, splitting the lower half of these cusps.

Sphincterochila (Cerigottella) cyrenaica tocraensis Kaltenbach, 1950

One specimen of this subspecies has been dissected. The bauplan is that of *Cerigottella*, differing from the type species most clearly by a more prominent, larger, wrinkled zone in the vaginal lumen, and a penis and epiphallus that are more clearly differing in width.



Figs. 5, 6. *Sphincterochila* (*Cerigottella* subgen. nov.) *insularis* (Boettger, 1894), details of the central part of the radula (central tooth = c). Scale lines 0.01 mm. Photos J. Goud.

Sphincterochila (Cerigottella) mixta Kaltenbach, 1950

One specimen of this species has been dissected. The genitalia cannot easily be distinguished from those of *S.* (*C.*) *insularis*. There might be quantitative differences, however. The two taxa are conchologically different. After shell characters, Zilch (1966: 92) listed this taxon as a subspecies of *S.* (*Albea*) *candidissima*.

Phylogenetic relationships

Nordsieck (1987: 38) argued that the stimulatory organ inserting on the genital

atrium, as in all *Sphincterochila* species known those days, is the plesiomorphous condition within the Helicoidea. Taking the generally accepted view that this "isolated" genus is a monophyletic taxon, this would imply that the insertion distally on the vagina is an autapomorphy of *Cerigottella*. The fact that the same place of insertion is found in the Helicidae would have to be interpreted as resulting from convergent evolution. The peculiar, wrinkled segment in the vaginal luminal wall can be seen as one more autapomorphy. To be able to interpret the structure of the male part of the genitalia, with a penis and an epiphallus that differ in width and are about equally long, the other *Sphincterochila* species should be studied anatomically in more detail, in particular the lumina of the ducts. Maybe in *S.* (*S.*) *aharonii* (Kobelt, 1913) the male part of the genitalia is similar to that in *Cerigottella* (cf. Forcart, 1972: fig. 6), but without data on the structure of the lumen more cannot be concluded.

The sister group of *Cerigottella* might be the monotypic subgenus *Albea* Pallary, 1909, which has a similar, relatively simple stimulatory organ, that can be considered representing the plesiomorphous condition. In the other two (Forcart, 1972) or three (Forcart, 1974) subgenera of *Sphincterochila* the stimulatory organ has additional structural elements, that might be considered apomorphic.

Further speculations concerning the phylogeny (and the biogeography) of this fascinating genus are premature. Detailed anatomical and histological studies can bring more clarity.

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