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On Conus mediterraneus and Conus guinaicus

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INTRODUCTION

In the literature there is considerable confusion regarding *Conus mediterraneus* Hwass in Bruguière, 1792, in respect to its taxonomy and distribution. Nordsieck (1968) states that *C. mediterraneus* is a synonym of *C. ventricosus* Gmelin, 1791, and lives in the Mediterranean as well as on the West African coast, the Portuguese coast and the Canary Islands. The related *C. guinaicus* Hwass in Bruguière, 1792, is not mentioned by Nordsieck.

During visits to Jandia (southern Fuerteventura, Canary Islands), and Banyuls-sur-Mer (French Mediterranean) the first author (K. Bandel) collected Conidae on the sea shore. Egg masses were collected and kept in an aquarium until the young hatched. Specimens from both localities and preserved in alcohol were taken to the Institut für Paläontologie of the university of Bonn. Here the radulae were extracted and photographed, using a scanning electron microscope. Similar photographs were also made from the shells of freshly hatched specimens from both localities. Egg capsules preserved in alcohol and formalin were drawn by Mrs. G. Bandel-Van Spaendonk.

The second author (E. Wils) has been studying taxonomic problems in the genus *Conus*. A large collection of shells of the species mentioned here were examined from his own material as well as from the collections of the museums in Amsterdam, Brussels, and London.

TAXONOMY

Considerable confusion exists with regard to the names of *C. ventricosus* and *C. mediterraneus*. Kohn (1968) regarded the in Europe widely accepted name of *C. mediterraneus* as a junior synonym for *C. ventricosus*. His decision is solely based on a figure of Kaemmerer (1786) and the fact that Dautzenberg (1920) gave priority to the name *C. ventricosus*. Kohn also selected the figure of Kaemmerer as the lectotype for *C.ventricosus*. The identification of this species, from the lectotype, represents many problems, five of which are mentioned below.

- The lectotype has not been chosen from specimens, but from a very doubtful drawing.
- Neither Kaemmerer nor Gmelin mentioned a type locality in their descriptions.
- The lectotype measures 59 mm in length and is therefore exceptionally large for a Mediterranean respresentative of the genus *Conus*.
- Kaemmerer's figure can only with considerable imagination be recognized as the well known Mediterranean *Conus*.
- The diagnosis of Gmelin, in contrast to his usual practise, is very extensive and allows recognition of three different species, one of which happens to be *C. guinaicus*, which is also treated in this study. Gmelin's diagnosis contains more data pertaining to *C. guinaicus* than to *C. mediterraneus*. We therefore agree with Wagner & Abbott (1967) in considering the name *C. ventricosus* as belonging to an indeterminate species. The species described by Hwass in Bruguière, contrary to Gmelin, have the advantage of very exact descriptions and well defined type localities.

In the following we shall only consider the differences between *C. mediterraneus* and *C. guinaicus*, as described by Hwass in Bruguière. Juveniles of *C. guinaicus* are very similar to *C. mediterraneus* in shape and shell colour. A lot of variation may be found within the first species, especially with regard to pattern and coloration. Until now all littoral Conidae from the Canary Islands have been considered as belonging to *C. mediterraneus*. One of the reasons for this confusion was the list of synonyms presented by Tomlin (1937) and Wagner & Abbott (1967), comprising no less than 60 synonyms. This number does not reflect reality, as besides *C. guinaicus*, it includes other species of the genus *Conus* from the North-West African coast. Wagner & Abbott (1967), also state that *C. guinaicus* has to be regarded a synonym of *C. guineensis* Gmelin, 1791. Kohn (1968) has solved the confusion by designating as lectotype a specimen of *C. guinaicus* from the Hwass collection.

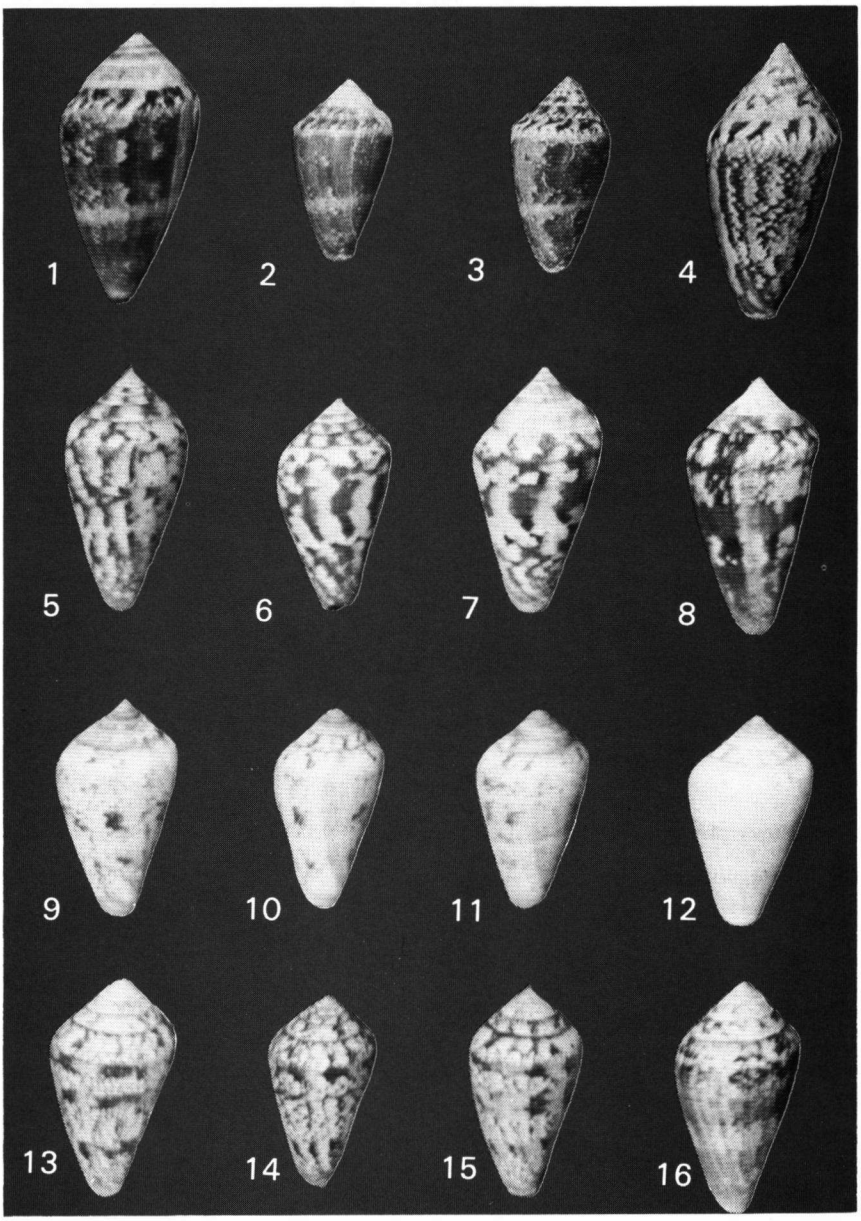
Conus mediterraneus Hwass in Bruguière, 1792
Figs. 1-4

Encycl. Méth., p. 701, pl. 330, fig. 4.

Type locality.-Mediterranean, Algerian coast, Italian coast (Napoli), Corsica, French coast (Provence).

Original diagnosis.- "C., testa conica livida, albo fasciata, lineis punctisque fuscis, spira convexacuta (striata)".

This diagnosis is not quite sufficient, but the description added by Hwass leaves no



Figs. 1-16. Variation in colour pattern in *Conus mediterraneus* Hwass in Bruguière, 1792, and *C. guinaicus* Hwass in Bruguière, 1792. 1-4. *C. mediterraneus*: 1, Haifa, Israel; 2-3, Banyuls-sur-Mer, France; 4, Corfu, Greece. 5-16. *C. guinaicus*: 5-8, Arecife, Lanzarote, Canary Islands; 9-12, Jandia, Fuerteventura, Canary Islands; 13-16, Teneriffe, Canary Islands. Photographs L. Letens.

doubt. The lectotype is the figure mentioned above. This lectotype is figured by Kohn (1968: pl. 5, fig. 5).

Variability.-In the shallow waters of Djerba (Tunisia), shells of 50 mm and more of *C. mediterraneus* may be found. Lately they have also been found at Zezova Island (Jugoslavia). Similar forms have been described by Bucquoy, Dautzenberg & Dollfus (1882) as var. *major*. Yellowish colour varieties of this species, found in sponges near Marseille, were described by these authors as var. *lutea*. Off the French Rivièra coast in deeper water (20-25 m) also specimens of a deep red to red-brown colour, var. *rubens* Bucquoy, Dautzenberg & Dollfus, 1882, occur.

Description.- Material from the following localities has been studied: Haifa (Israel), Corfu (Greece), Zezova Island (Jugoslavia), Djerba (Tunisia), Melilla (Morocco), Rimini (Italy), Le Lavendou and Banyuls-sur-Mer (France), and Benicarlo (Spain).

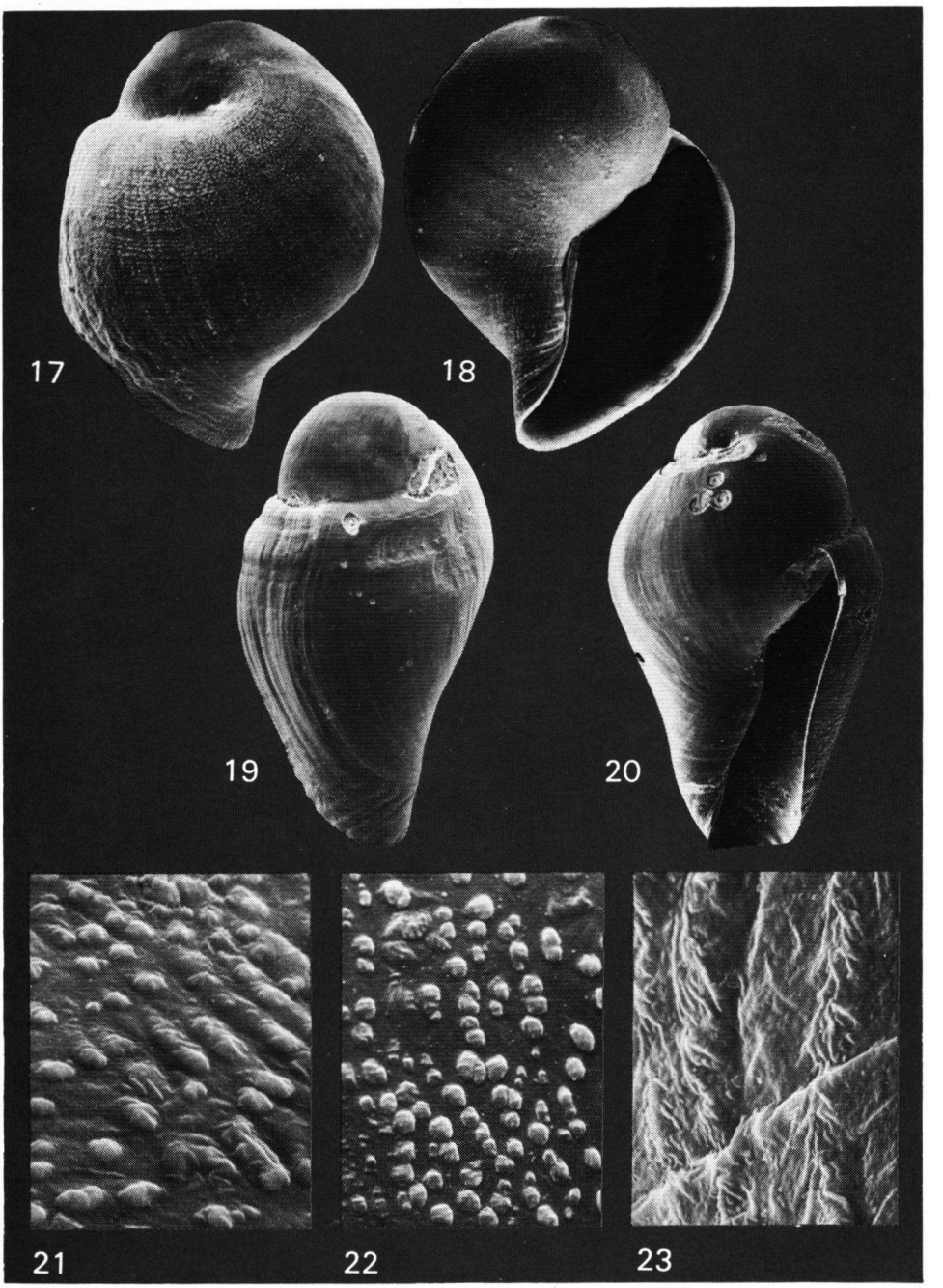
Shape in adult shells is the same for extremely large and the more usual small individuals, juveniles are less bulbous. Spire moderately elevated with seven to nine smooth, convex whorls. The peripheral shoulder is rounded, aperture moderately wide. The last whorl covered with spiral ridges, in variable number (30-50), the larger ones near the base. The ground colour is dirty white, marked with longitudinal marks which are variable in colour. There is a light coloured spiral band at the lower middle of the last whorl, on adults as well as juveniles. Spire usually dark brown with a few white blotches. The periostracum is thin, transparent, and yellowish-olive. With lengths of 15 to 25 mm, the specimens from Banyuls-sur-Mer (figs. 2-3) can be regarded as quite typical for the species.

Ecology.- The specimens in the bay of Banyuls-sur-Mer prefer muddy and sandy substrates in shallow, quiet water between the tidal lines and approximately 3 m depth. Here they hunt for prey. As Alpers (1932) showed, *C. mediterraneus* feeds on polychaetes. The radula tooth is injected into the body of the worm. Through it the venom is injected paralyzing the prey. The inactive worm is then swallowed as a whole. As Peile (1939) suggested, the denticle at the base of the tooth might serve to retain the tooth within the proboscis when the prey is attacked. In periods of inactivity, or during feeding, the individuals of this species are usually buried under the surface of the substrate. They are only seen on top when in search of food, usually at night.

During the months of May and June mature males and females tend to congregate on the lower sides of the rocks in shallow water (0.2 to 1 m depth), generally attracted by a spawning female. Here copulation and deposition of the egg capsules can be observed.

Egg capsules.- The egg capsules (fig. 30) are attached to the bottom of rocks within or just below the tidal zone. Here more than one female may be engaged in egg case production, so that joint egg masses may be formed. One female usually produces 3-6 egg capsules, each containing an average of eleven yellow eggs. The 3-4 mm wide, 6 mm high,

Figs. 17-23. Scanning electron micrographs of embryonic shells of *Conus mediterraneus* and *C. guinaicus*. 17. *C. guinaicus*, apical view, x67. 18. Do., apertural view, x66. 19. *C. mediterraneus*, apical view with beginning of the first post-nuclear whorl, x60. 20: Do., apertural view, x58. 21. *C. guinaicus*, tubercles and ridge sculpture on the siphonal canal of the embryonic shell, x1035. 22. Do., tuberculous ornamentation on the last whorl of the embryonic shell, x950. *C. mediterraneus*, wrinkled ridges in the siphonal canal of the embryonic shell, x1450.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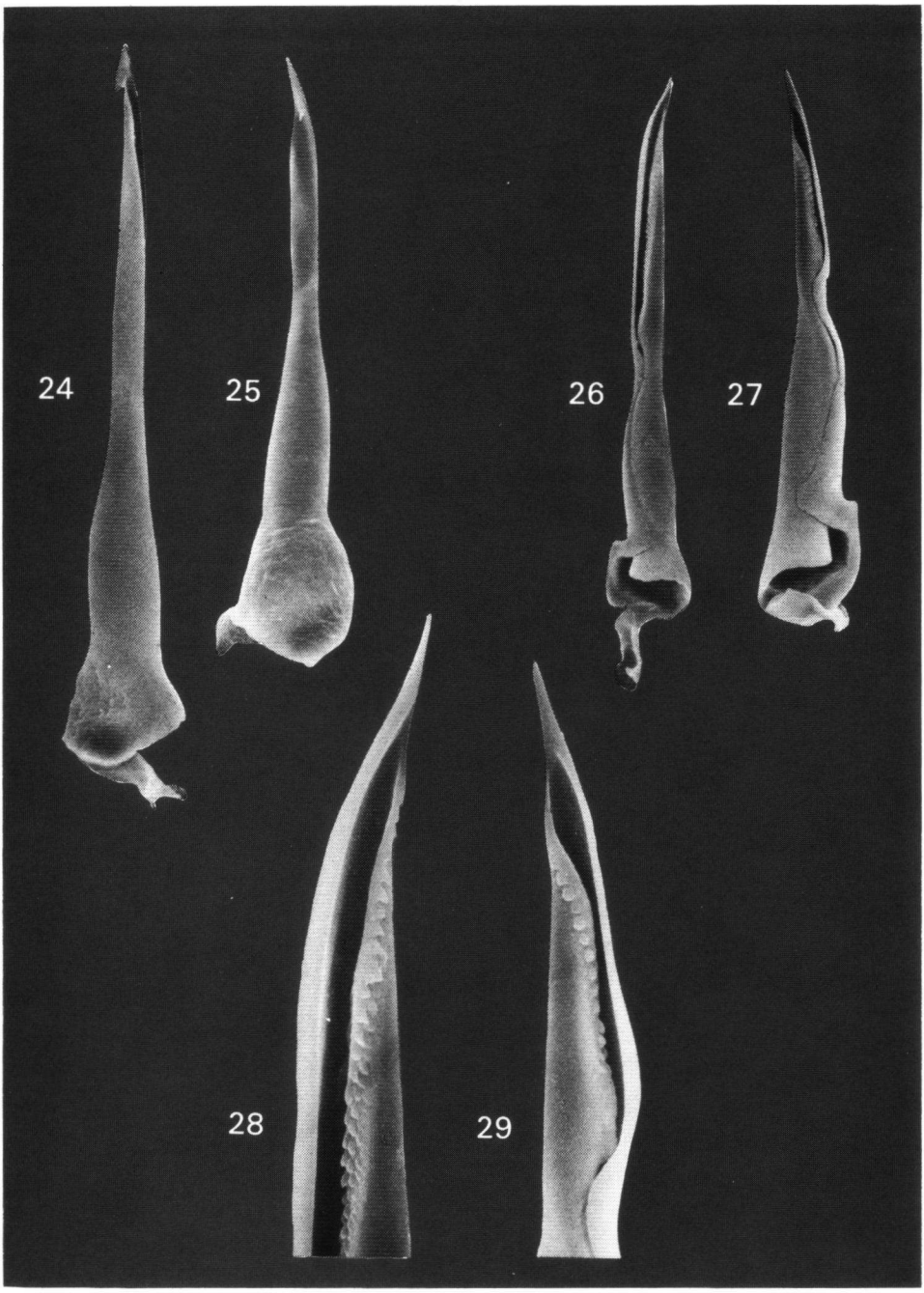
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and about 1 mm thick egg capsules are arranged in a row, the convex side of one capsule following the concave side of its neighbour. Each capsule is attached to the substrate by a firm, broad, basal membrane. Neighbouring basal membranes of capsules in each row overlap each other at the rim thus forming a common base of attachment for each spawn. Each capsule is attached to the substrate by means of a solid peduncle somewhat laterally displaced. It is tongue-shaped and possesses opaque white walls, with a convex upper side and an almost smooth to slightly concave lower side. Its apical plate is tilted towards the lower side and bordered by two folds, the upper one of which extends into a collar-like rim. The narrow oval escape aperture is closed by a transparant concave membrane dissected along its long axis by a suture. This suture continues from the narrow ends of the escape aperture down both narrow sides towards the basal membrane. Each suture is accompanied on the narrow sides by folds or wrinkles continuing into the apical side. They usually peter out before reaching one of two central ridges which start from the edges of the aperture and are continued on to the peduncle. Often a short longitudinal fold may be developed between the lateral ridges and central ribs. The lower side of the capsule shows two ridges starting from the apertural edges and curving and petering out towards the centre of this side. Otherwise the lower side is smooth.

Embryonic shell.- For description and figures of freshly hatched specimens see also Bandel (1975b: pl. 6, figs. 2, 3, 9).

All eleven eggs of each capsule develop within three weeks into crawling juveniles that hatch through the escape aperture when its membrane has been dissolved. Metamorphosis of the embryonic veliger stage to the crawling post-veliger stage is completed within the egg capsule.

The embryonic shell consists of 1.7 whorls and is 0.94-1.1 mm high (figs. 19-20). It is spirally coiled with rapid extension of the diameter of the whorl. The protoconch (first secreted cup-like shell) is 0.14-0.19 mm wide, smooth and well rounded. The whole embryonic shell does not show any ornamentation except for growth lines. Only on the siphonal canal 12-20 longitudinal wrinkled ridges of 3-4μ width are developed (fig. 23). The aperture is narrow and oval in outline and three times as high as wide.

The smooth embryonic shell is abruptly followed by the ornamented shell, which is typical for the adult shell secreted only after hatching. It is characterized by strong growth lines as well as weak spiral ribs on the sides of the whorl. In the neighbourhood of the siphonal canal 5-6 strong spiral ribs are developed.

Radula.- See figs. 25, 27, 29. Two teeth in each row are loosely fixed to the basal radula ribbon and each measure 0.3 mm. The venom sac is attached to a broad (0.05-0.06 mm) base, characterized by the presence of a foreward projecting denticle. The basal shaft shows in profile a round outline, and is 0.03-0.04 mm wide. Before onset of the adapical opening the shaft is somewhat constricted. At its tip each tooth carries a barb. A single row of denticles is arranged along the internal edge of the adapical opening. Each denticle is about 2μ wide, and only up to 15 of them form the row (fig. 29).

Figs. 24-29. Scanning electron micrographs of radular teeth of *Conus mediterraneus* and *C. guinaicus*. 24. *C. guinaicus*, x150. 25. *C. mediterraneus*, x270. 26. *C. guinaicus*, x100. 27. *C. mediterraneus*, x240. 28. *C. guinaicus*, adapical opening of the radula tooth, x370. 29. *C. mediterraneus*, adapical opening of the radula tooth, x665.

Conus guinaicus Hwass in Bruguière, 1792
Figs. 5-16

Encycl. Méth., p. 697, pl. 337, fig. 6.

Type locality. – Guinea, West Africa.

Original diagnosis. – "C., testa conica rubiginosa, fascis obseletis albidis fusca variegatis, spira obtusa maculata".

The lectotype is in the museum of natural history at Geneva. It is figured by Kohn (1968: pl. 5, fig. 52).

Variability. – Some specimens of *C. guinaicus* almost lack colour spots and therefore have a very uniform gray-blue coloration. These shells are called var. *caerulescens* Bucquoy, Dautzenberg & Dollfus, 1882.

C. grayi Reeve, 1843, described without locality, is a junior synonym of *C. guinaicus*. Two syntypes of *C.grayi* are in the British Museum (Natural History) in London. They are similar to the lectotype of *C. guinaicus* from the Hwass collection.

Individuals of *C. guinaicus* of the rocky shore of Teneriffe differ greatly in colour from those collected at Arecife (Lanzarote). The first agree well with the shells described without locality as *C. hybridus* by Kiener (1849). Kiener himself noted the close relationship to *C. guinaicus* but did not identify his *Conus* with that from the Guinean coast.

The great variability of colour patterns is documented here with individuals from Fuerteventura (figs. 9-12). At this locality a lot of extremely light coloured, even white shells, are found. *C. aemulus* Reeve, 1844, again without locality, has to be regarded as one of the many transitional forms within the colour pattern variability of *C. guinaicus*. The lectotype of *C. aemulus* was also studied in the British Museum (Natural History) (measurements: 43 x 19 mm), and was found to be indistinguishable from Fuerteventura shells of *C. guinaicus*.

Description. – Material from the following localities has been studied: Fuerteventura, Lanzarote, Gran Canaria, Teneriffe (all Canary Islands), Cadiz (southern tip of Spain), and Spanish Morocco.

Shell 30 to 45 mm long. Shape in adult shells alike for both small and large individuals. The peripheral shoulder is rounded, spire moderately high. The ground colour is white with a grayish-blue sheen, marked with longitudinal flames. Often the light spiral band beneath the lower middle of the last whorl is not prominent.

Usually there are three zones of colour-intensity on the sides of the last whorl, the darkest near the spire and the lightest near the base. Spire with just as many white blotches as the last whorl. Flammulation brown to chestnut-brown, juveniles often darker than adults. Interrupted spiral lines form flammulations. Spiral threads variable and ridge-like near the base.

The shells from Jandia (Fuerteventura) measure 30 to 37 mm in length. Their colour is bluish-white with yellowish-brown, red-brown, to dark brown mottling. Fresh specimens are covered by a rather thin, yellowish-olive-brown periostracum. They are usually of a lighter colour than those from the other islands of the Canary Islands and the African coast.

Ecology. – The specimens from Jandia (Fuerteventura) prefer a sandy substrate in

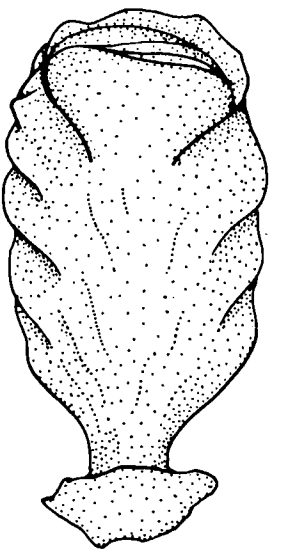

Fig. 30. Egg capsule of *Conus mediterraneus*, highly enlarged.

shallow water close to the rocky shore. Normally they are hidden in the sand and will only leave their resting of feeding place when in search for prey, which consists of polychaete worms. The radular tooth is used to catch the prey by piercing its epidermis. The poison from the venom sac attached to the base of the tooth, is passed through its lumen into the prey. With the barb at the tip of the tooth the worm is held until the poison has inactivated it. The broad base of the tooth anchors it to the proboscis during the process of piercing, injecting, and holding of the victim. After this the prey is swallowed whole, along with the used radula tooth.

On the eastern side of Jandia, which is protected from the open Atlantic and where wave action is not very high during the months of May and June, numerous adult individuals of *C. guinaicus* migrate into the lower intertidal zone and attach their spawn to the bottom of the rocks. It is only then that many individuals of this species may be seen, close to each other.

Egg capsules. – During May and June adult females and males congregate underneath rocks in the lowermost tidal zone or just below the tidal zone in a few cm of water. Not only members of this species will meet here, but also individuals of *Thais haemastoma* (L., 1758) are attracted by the spawning females. Therefore large communal egg masses consisting of the column-like egg cases of *T. haemastoma* (cf. Bandel, 1976), and the tongue-like egg capsules of *C. guinaicus* are attached to the rocks.

The egg capsules of *C.guinaicus* are up to 10 mm high, 6 mm wide and up to 1.5 mm thick. They are attached by a basal membrane extending from a short, solid penduncle.

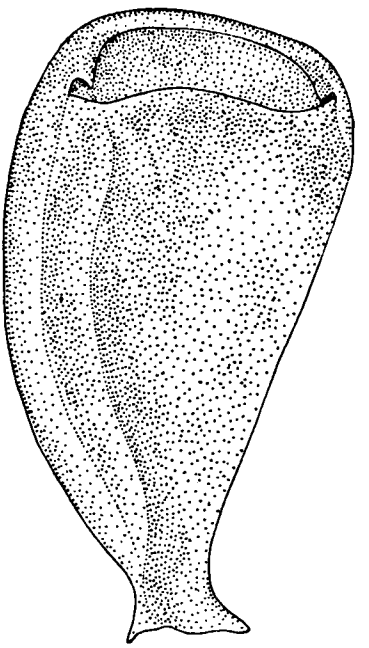

Fig. 31. Egg capsule of *Conus guinaicus*, highly enlarged.

The opaque white egg capsule shows a concave lower side and a convex upper side. Both sides are fused on the rounded narrow sides in a suture. This suture continues across the transparent membrane closing the long-oval, in outline rounded, escape aperture which is inclined towards the concave side. Capsules attached to the surface of the rock are arranged in short rows. Each following layer of capsules is attached to the lower layer, often glued with their basal membranes across their apertures. Thus rounded egg masses may consist of many layers of capsules one on top of the other. The 30 to 40 white eggs held in each capsule will develop and hatch as crawling youngsters which just completed metamorphosis, or as veliconchae.

Embryonic shell. – For notes and figures of freshly hatched specimens see also Bandel (1975a: 89, pl. 19, fig. 12).

At hatching, just after or just before completion of their metamorphosis, the young will leave the now open escape aperture in the crawling stage or as veliconchae. In the latter case the hatching individual can crawl as well as swim for a few hours until metamorphosis is completed and the velum is lost. At hatching the embryonic shell consists of 1.3 helicoid whorls with a height of 0.9 mm and a width of 0.7 mm (figs. 17-18). The whorls grow rapidly, forming a convolute shell. The protoconch measures about 0.25 mm in width and is, with exception of growth lines and wrinkles,

almost smooth. The first quarter of the embryonic shell only shows growth lines. The following three quarters of the embryonic whorl are ornamented by 3 to 4μ wide tubercles arranged in spiral lines (fig. 22). These tubercles, round in outline, show a pattern of up to six radially arranged lateral folds. The siphonal canal is ornamented with about 15 longitudinal ridges, 5μ wide, consisting of rows of single tubercles (fig. 21). The aperture is drop-like in shape and about two times higher than wide.

Radula. – See figs. 24, 26, 28. Two teeth in each row are fixed to the basal ribbon of the radula. Each harpoon-like tooth is 0.6 to 0.7 mm long. The broad base has a denticle directed forward towards the pointed tip of the tooth. At the base each tooth measures 0.09 to 0.013 mm in width. In its lower part the tubular shaft measures 0.06 to 0.07 mm in width. It is composed of a folded sheet forming a round injection tube. The adapical opening consists of a long slit ending in a barbed point. The internal edge of the fold shows a double row of serrations, each consisting of about 25 small denticles, 3 to 4μ in diameter (fig. 28).

DISCUSSION

C. mediterraneus and *C. guinaicus* can hardly be distinguished conchologically. Shells of *C. mediterraneus* are usually smaller than those of *C. guinaicus*. The colour pattern in *C. mediterraneus* is composed of dots forming longitudinal ziczac stripes, while *C. guinaicus* shows a flame pattern, the flames being composed of short spiral lines. Dark colours in *C. guinaicus* tend more towards reddish to chestnut-brown, while in *C. mediterraneus* they are olive-brown. The spire shows more white mottling in *C. guinaicus* than in *C. mediterraneus*. On the whole, identification by means of colour and size differences is hampered by the fact that both species show a considerable amount of variation. Their choice of food is to be regarded as quite common for most species of the genus *Conus*, which are normally vermivorous (Lim, 1969; Kohn, Nybakken & Van Mol, 1972; Endean & Rudkin, 1965). Also in their ecological requirements both species are very similar and prefer soft substrates close to the shore.

Both species can be separated satisfactorily by studying their distribution, egg cases, embryonic shells and radulae.

C. mediterraneus seems to be restricted to the Mediterranean and is the only member of the genus there. To our knowledge, *C. guinaicus* penetrates the Mediterranean only near the Strait of Gibraltar, but otherwise is a Lusitanic species (Portuguese south coast, North-West Africa, Canary Islands).

Studies of *Conus* spawn of different species show that members of this genus produce egg capsules which are very similar in shape (Bandel, 1975b). All capsules are flattened and tongue-like, standing on a short, solid peduncle, and possessing an apical escape aperture with slit-like or oval outline. Details of the morphology of the capsules often allow one to distinguish them at the species level. The egg capsules of *C. mediterraneus* are arranged in rows and usually not attached on top of the other. They show a pattern of folds and ridges on their sides and contain about eleven yellow eggs each. The egg capsules of *C. guinaicus* usually are not deposited in rows and glued on top of each other forming rounded egg masses. They are smooth and contain up to forty white eggs and are mostly larger than those of *C. mediterraneus*.

As Bandel (1975a: 88-89, pl. 19,21) has noted for members of the genus *Conus* from the Caribbean, we can find all transitions, from richly ornamented embryonic shells to shells showing only growth lines. This (tubercle) ornamentation is related to the degree of shell development with which the young hatch from their egg capsules. Species hatching as veligers will develop a richly ornamented shell; species hatching as veliconchae or just metamorphosed crawling young carry shells with a reduced ornamentation (*C. guinaicus*), while species which hatch long after having completed their metamorphosis within the egg capsule have growth lines only (*C. mediterraneus*).

The radulae of both species show a pattern of teeth of the same general appearance, but with clear differences in detail. The teeth of *C. guinaicus* are more slender than those of *C. mediterraneus*. The restriction of the diameter of the shaft below the apical opening is more pronounced in *C. mediterraneus*. *C. guinaicus* has a double row of up to 25 denticles at the inner edge of the adapical opening, whereas *C. mediterraneus* possesses only one row with about 15 denticles.

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SUMMARY

Conus ventricosus Gmelin, 1791, is considered an undeterminable species based on a hardly recognizable figure without a locality. The authors propose to conserve the name of *C. mediterraneus* Hwass in Bruguière, 1792.

The distribution, ecology, shell morphology, embryology and radula of *C. mediterraneus* and *G. guinaicus* Hwass in Bruguière, 1792, were studied, and it is concluded that they represent two distinct species, although very similar in conchological characters.

SAMENVATTING

Conus ventricosus Gmelin, 1791, wordt beschouwd als een niet te determineren soort. Het typeexemplaar bestaat uit een slechte afbeelding zonder vindplaats. De auteurs stellen voor de bekende naam *C. mediterraneus* Hwass in Bruguière, 1792, te behouden in plaats van *C. ventricosus*.

Daarentegen zijn *C. mediterraneus* en *C. guinaicus* Hwass in Bruguière, 1792, twee aparte soorten. Ze zijn beiden vermivoor en leven op zachte substraten. De schelpen verschillen weinig van elkaar. In het algemeen zijn de schelpen van *C. guinaicus* iets groter, met kastanjebruine kleuren en een vlammenpatroon (fig. 5-16). *C. mediterraneus* is meer olijfbruin met een zigzag vlekkenpatroon (fig. 1-4).

De verspreidingsgebieden zijn van elkaar gescheiden. *C. mediterraneus* komt voor in het gehele Middellandse-Zee-gebied en is daar de enige soort van het geslacht *Conus*. *C. guinaicus* komt voornamelijk voor aan de kust van Noordwest-Afrika, de zuidkust van Portugal en de Canarische Eilanden.

De eikapsels van *C. mediterraneus* zijn gerimpeld (fig. 30) en worden in rijen afgezet, elk kapsel bevat ongeveer 11 gele eitjes. De eikapsels van *C. guinaicus* zijn glad (fig. 31), worden op elkaar afgezet en vormen zo ronde pakketten. Per kapsel zijn er 30-40 witte eitjes.

C. mediterraneus heeft geen vrijlevend veligerstadium; uit het ei komt een jong slakje met een slank en glad embryonaal schelpje (fig. 19-20). Uit het ei van *C. guinaicus* komt een veliconcha of jong slakje met een boller en geknobbeld embryonaal schelpje (fig. 17-18).

De radula van *C. mediterraneus* heeft aan de punt een enkele rij met 15 tandjes (fig. 29), die van *C. guinaicus* heeft èen dubbele rij met ongeveer 25 tandjes (fig. 28).

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