Underwater Observations on Two Rare Southern Caribbean Cones, (Mollusca, Gastropoda) - *Conus mappa* (Lightfoot) 1786 and *Conus centurio* Born 1778 in Trinidad & Tobago

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INTRODUCTION

IN the past, several workers have published excellent papers on *Conus*, a gastropod genus of the Phylum Moclusca. They have written extensively on the complex and potent venom systems used in conjunction with their very specialized "harpoon-like" radular teeth to capture prey. Also, there have been detailed references relating *Conus* radula morphology and structure to the diet of these molluscs (Kohn, 1959, 1960, 1966; Endean & Rudkin, 1965, Nybakken, 1970, 1970a).

In March 1974, the author completed a paper on lengthy underwater observations on the behaviour and econogy of *Conus ermineus* Born 1778 (Percharde, 1974). This paper was the first part of a detailed study of the three largest *Conus* species found in the waters of Trinidad and Tobago.

Conus ermineus was found to be a piscivore, feeding on small fish which are captured at night and very rapidly digested in the gut. Although *Conus ermineus* is fairly common in its habitat areas continuing this work has been a problem because *Conus mappa* and *Conus centurio* are quite rare. In consequence, deep dives to observe and collect can often be non-productive. Carefully following the numerous mollusc tracks in the fine silt of the habitat areas only to find at the termination of the track either a different species of mollusc or the unmistakable signs that some predatory crab or fish has been there before you can be quite frustrating. Sometimes, the freshly broken shell fragments are from what must have been a large handsome specimen of the very species under study. A high degree of self-discipline is required to ensure that enthusiasm for the search does not interfere with sound diving practice and adequate decompression.

The study of the tracks left by molluscs is of considerable interest and the author has found that an accurate identification of the genus of a mollusc can often be made from the type of track observed.

The rarity of the two species under study make it impossible to carry out as comprehensive a review of these two species as was alone for *Conus ermineus*. However, many interesting observations have been made concerning the econogy and behaviour of these two rare molluscs, and the author has once again been able to confirm the validity of Nybakken's Key, which refers *Conus* radula tooth structure to diet (Nybakken in A. Myra Keen's "Seashells of Tropical West America" and Nybakken, 1970, 1970a).

One of the more interesting aspects of the study of the diets of *Conus* species in a given habitat area in the Caribbean faunal province is the possibility of making comparisons with the situation which is known to exist in the Indo-Pacific where many species of the genus *Conus* can exist together with a high population density, but without competition, because of their widely differing diets. In the southern Caribbean, with a much reduced number of *Conus* species, it was considered that there would be far fewer species — specific dietary preferences. However, studies on the three largest species of *Conus* in the waters of Trinidad & Tobago, revealed that *Conus ermineus* is a piscivore, *Conus mappa* is a vermivore feeding on the Amphinomidae (Fire worms) *Conus centurio* may be a molluscivore, although the evidence is by no means conclusive.

CONUS MAPPA AND *CONUS CENTURIO* IN THE LITERATURE

Conus mappa (Lightfoot, 1786) is the present name of a mollusc that has had a very interesting past history in the conchological world and in taxonomy. This history dates back to the early 1700's, when it was known as the "Matchless Cone" or *Conus cedonulli*. See figures (d), (e) and (f). Plate 1.

Dance (1966) published a detailed account of the past history of this then famous species in which he explained how some of the uncertainty concerning the true identify of this shell came about. However, in a footnote, Dance advises us that Linnaeus gave the name "cedonulli" to the shell in 1767, basing this on a figure published by A. Seba in his Thesaurus (Vol. 3 pl. 48, Fig. 8). Dance concluded that this figure suggests a form of *Conus ammiralis* which is an Indo-Pacific species. It is difficult to argue over old lithographed figures but the author possesses one specimen, and has examined many, almost identifical to Seba's published figures. These are specimens of *Conus mappa* from the Island of St. Vincent and were obtained a few years ago, when extensive dredging was being carried out (see under habitat).

Recently Dunn (1971) published a recommendation that *Conus mappa* be again named *Conus cedonulli* Linné, 1767 restoring the old original name. However, Holman and Kohn (1970), had attempted to clear up some of the confusion that existed concerning the taxonomy of this species. In this work they considered that *Conus mappa* (Lightfood, 1786) was the valid name and that *Conus insularis* Gmelin 1791, *Conus aurantius* Hwass 1792, *Conus dominicanus* 1792 and also Hwass's infraspecific taxa of *Conus cedonulli* are synonyms. Most recently, Vink (1977) has published a detailed review of the *Conus cedonulli* complex.

The author is in agreement with these views, especially after comparing the behaviour and examining the radular teeth of most of the above listed forms of this very variable species of cone from aseveral areas of the Southern Caribbean. It is also considered that *Conus mappa* is very closely related to the more common *Conus regius* Gmelin.

The radular teeth are very similar and the strange diet of amphinomid works is common to all these previously mentioned forms. Nybakken (1970) referred to work and figures published by Van Mol, Tursch and Kempf (1967) and predicted that with the very specilized type of tooth, figured for *Conus regius*, he expected that this species would feed on amphinomids. This diet can be confirmed, since during the course of this present study the author has examined two specimens of *Conus regius* from the northern Caribbean and found that both specimens con-

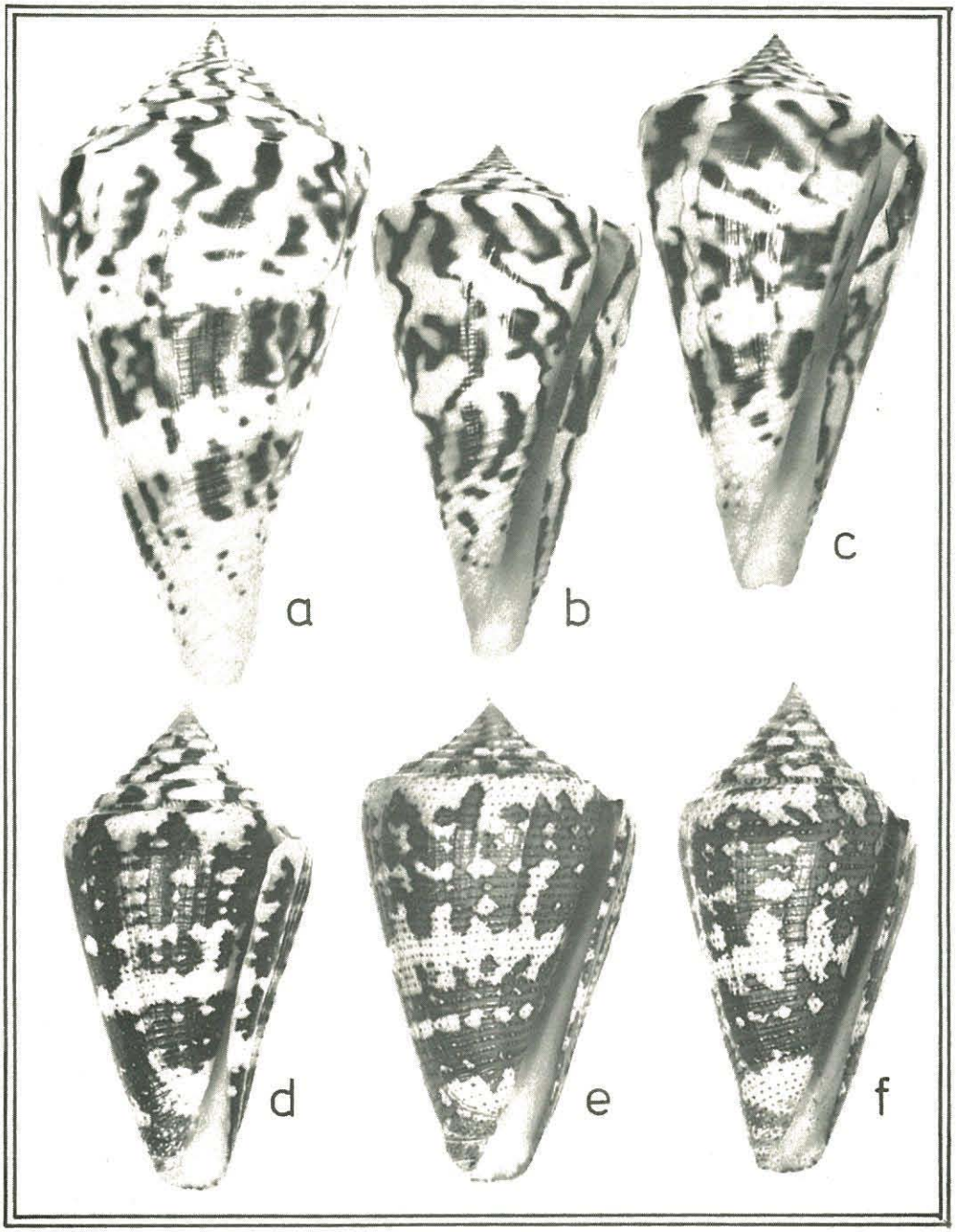

PLATE 1. Specimens of the two rare Conus *species from the First Boca.*

FIGURE (a): Conus centurio, *very large male — 82 mm from 40 metres depth.*

FIGURE (b): Conus centurio, *female 55 mm from 42 metres depth.*

FIGURE (c) Conus centurio, *female — 63 mm from 38 metres depth.*

FIGURE (d): Conus mappa, *male — 50 mm from 37 metres depth.*

FIGURE (e) Conus mappa, *female 48 mm from 30 metres depth.*

FIGURE (f) Conus mappa, *male — 51 mm from 28 metres depth.*

tained packets of amphinomid setae in thick mucus.

Many excellent figures of *Conus mappa/Conus cedonulli* in both black and white and in full colour, have been published in the past but the author has been unable to find any detailed references to the species's behaviour or ecology other than that of Seamon & Seamon (1967) and Van Pel (1969).

Conus centurio Born 1778 is by no means as well known as the previous species. It is, however, a most handsome and interesting mollusc. See Figures (a), (b) and (c). Plate 1. In 1970 Clench figured a specimen that had been donated to the Harvard Museum of Comparative Zoology by the author. This specimen was the largest the author had observed or collected and it measured 91 mm in length. It was obtained from the flat silty ledge at 49 metres off Miramar Bay in the First Boca of Trinidad.

Wagner & Abbot (1967) cited *Conus bifasciatus* Gmelin 1791, *Conus woolseyi* Smith 1946, and *Conus tribunus* Gmelin

1791 as synonyms. Clench (1942) mentioned that little is known concerning this species except that it had been dredged in 5 fathoms (9 metres) of water in the harbour of Puerto Plata in the Dominican Republic. No specimens of *Conus centurio* have been collected or observed in water as shallow as this in the waters of Trinidad & Tobago.

Nowell-Usticke (1959) figured a beautiful specimen of this species from Ham Bay, St. Croix, U.S. Virgin Islands but did not give ecological or habitat data.

Warmke & Abbott (1961) figured two specimens from Puerto Rico, both appeared worn, shallow-water specimens.

Rios (1970), figured two specimens from Itapua, Brazil and cited several other locations off the Brazilian coast ranging in depth from 17 to 106 metres. Marsh & Rippingale (1964) figured a specimen from the British Museum (Natural History) from the de Burgh collection; the locality was given as Amboina! However, it is pointed out that this is in error, as *Conus centurio* is an endemic West Indian or Caribbean faunal province species. It is possible that there is a relationship between *Conus centurio* and *Conus delessertii* Recluz 1843 of the northern Caribbean (Florida) area. The shells are similar and so are the radular teeth but the author has been unable to find any ecological or behavioral studies on *Conus delessertii* for comparison. It is also possible that *Conus centurio* is a cognate species with *Conus recurvus* from the Panamic Province, and Nybakken has advised that the teeth are very similar (personal communication).

OBSERVATIONS ON HABITAT

In Trinidad & Tobago, the adult forms of both *Conus mappa* and *Conus centurio* share the same habitat (see map Plate 3). The adult shells of *Conus mappa* measure 50 mm — 70 mm in length. Juvenile specimens of *Conus mappa* can be found in shallow water habitats where there is calcareous grit. They are often found in transitional areas where grit and muddy silt meet. These areas are marked by the presence of red algae.

Vink of Curacao, Netherlands Antilles, has reported that he found both juvenile and adult forms of *Conus aurantius* in shallow water (4.6 — 9 metres) habitats, buried in coral rubble (personal communication). Vink is a diver and has studied the *Conus mappa / Conus aurantius* problem intensively; he does not support the view that these species are identical. However, he has recently confirmed that *Conus aurantius* feeds on amphinomid worms (Vink 1974).

The only large adult specimens of *Conus mappa* found by the author in shallow water have been dead shells transported up the slopes by hermit-crabs. Surprisingly, no specimens of *Conus centurio* have been found above 30 metres and even crab occupied shells are only found in deep water. In these deep water habitats *Conus mappa* is rare but can be found by careful searching and by feeling through the silt, especially in small depressions, close to specimens and aggregations of the deep water octocoral *Leptogorgia setacea.*

Conus mappa shares this same habitat. On several occasions, the author has collected large specimens of both species partially buried in the silt 20 cm to 30 cm apart, in the same shallow depression. The very large specimen of *Conus centurio* donated to the Harvard Museum was collected in daylight in an octo-coral area on the eastern side of the First Boca.

Clench (1970), published the author's observations on the habitat of both these *Conus* species. At that time other molluscs found in association were listed as *Polystira albida* (Perry), *Cyphoma intermedium* (Sowerby) and *Murex cabritti* Bernardi. The listing of this latter species was in error, as the author has now found, thanks to the late G. Radwin of the San Diego Natural History Museum, that the long siphoned, spiny muricid, from this deep water habitat is *Murex donmoorei* Bullis 1964. Recent diving at night time has not really furthered the study on the two *Conus* species, but has revealed that another species of rare *Conus* shares this deep water habitat. This is *Conus stimpsoni* Dall 1902. This species remains buried in the silt during daytime and only emerges after 2200 hours each night. It is quite common at this time but the author has not found one living specimen during daylight hours.

The most consistently productive habitat area for the two species of *Conus* under study however, has been the flat silt areas of the First Boca off Morris Bay, Miramar Bay and Scotland Bay.

No specimen of these species has been found at similar depths in either the Second or Third Bocas. This may be due to the fact that the substrate in these areas is either coarse or medium grit and lacks the muddy silt.

Recent diving and collecting observations (1974 and 1977) carried out by the author have revealed that both species of *Conus* are out on the seabed actively moving and feeding during the month of December. At this time, owing to upwelling cold water, the temperature in the habitat area has always been below 19°C and on one or two occasions it has been below 17.2°C. The surface water temperature was 26.6°C on an average.

In Grenada, to the north of Trinidad, the author has collected several specimens of *Conus mappa* buried in calcareous sand in coral reef areas at depths between 6 and 9 metres. The water temperatures in these areas are between 26.1°C and 27.2°C. As mentioned previously, dredging work in St. Vincent a few years ago produced many beautiful specimens of *Conus mappa.* Many of these specimens had been dead for a considerable period of time and had remained buried in the carbonate sand and grit. It is the author's opinion that burial in carbonate sand for lengthy periods enhances the colour and the three-dimensional effect of the patterns on the shell of *Conus mappa* specimens. The author possesses two specimens, one from St. Vincent and one from Morris Bay, Trinidad. Both had been buried for long periods, prior to collection.

Three of the specimens figured by Cameron (1961) exhibit this enhanced three-dimensional effect and also the shift of the colouring towards the lighter reds and orange-reds. The specimen figured by Dunn (1971) from the Usticke collection is also cited as coming from St. Vincent. This specimen exhibits the marked three-dimensional effect in the pattern of the shell.

FORMS AND VARIABILITY OF *CONUS MAPPA* AND *CONUS CENTURIO*

The past taxonomic history of *Conus mappa* will no doubt prepare any worker studying this species for acceptance of the great variability in both colour and pattern, and to a certain extent also, the form of this shell. Specimens in Trinidad & Tobago appear to be fairly consistent in these features, except for sexual dimorphism which is quite marked. Females are larger and the angle of the spire of the shell is 80° — 100°. In males, the spire angle is 70° — 80°. The shells of comparably sized females also tend to be more dense and often appreciably heavier than those of males. Both males and females possess narrow apertures and internally there appears to be a further narrowing or a rounded plication on the internal section of the columella by way of the siphonal end of the aperture. This feature renders the removal of the soft parts of the molluscs for dissection extremely difficult.

It is apparent that whilst *Conus mappa* is consistent in form in a specific geographical or isolated habitat area, considerable variation exists in specimens from differing geographical areas. The coasts of north and east Brazil and the northern coast of South America (including Trinidad & Tobago) appears to produce consistently similar forms. This consistency extends as far as the Paraguana Peninsula of Venezuela. The Caribbean coast of Columbia appears to produce specimens of considerable variation. In fact Vink (1977) has created a new taxon for the species found off the Columbian coast — *Conus sanctaemarthae* Vink.

The islands of Curacao, Aruba and Bonaire, which lie some distance offshore from the northern South American coastline, produce their own distinctive endemic forms. The islands of Grenada and St. Vincent in the Windward group, again produce forms of considerable variation, with the specimens from St. Vincent being the most distinctive of all.

Conus centurio does not appear to be very variable at all. All the specimens and figures examined by the author, exhibit

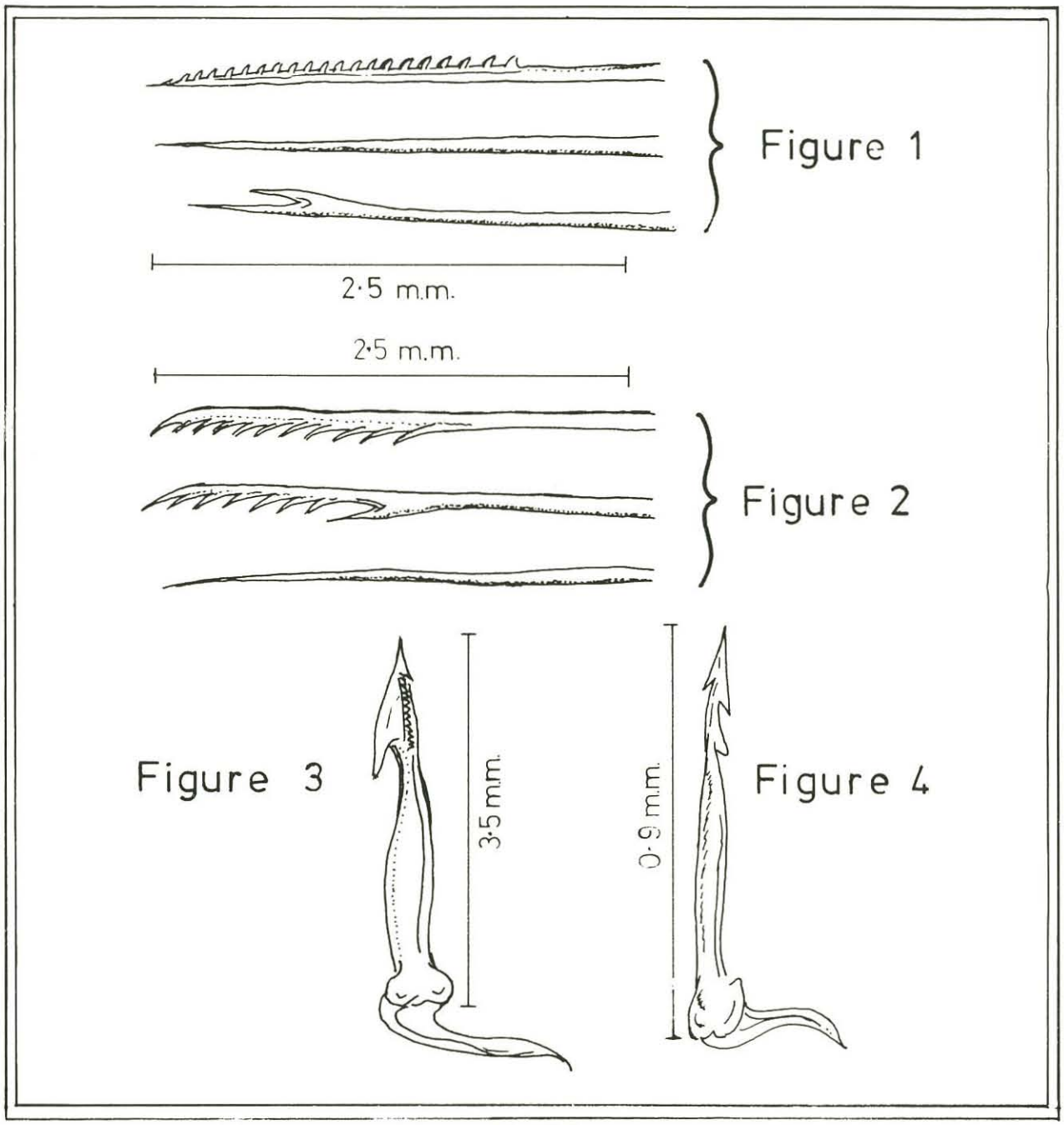

PLATE 2

FIGURE 1: Specimens of Amphinomid venomous setae found in thick mucus packets in specimens of Conus mappa. *These setae believed to be from the amphinomid (fire worm)* Evrythoe complanata *(Pallas).*

FIGURE 2: Specimens of setae taken from Conus mappa *which had been feeding on the amphinomid* Hermodice carunculata *(Pallas).*

FIGURE 3. "Harpoonlike" radular tooth from Conus mappa.

FIGURE 4: Radular tooth from Conus centurio.

uniformity in form, pattern and coloration. The specimen figured by Nowell-Usticke is almost identical to specimens from Trinidad or those collected by shrimp-trawlers off the Brazilian coasts These localities are approximately two thousand miles apart.

Sexual dimorphism is apparent in *Conus centurio.* Once again, the females tend to be larger and the spires of the shells are of greater angle: females 100° — 120°, males 90° — 100°. *Conus centurio* does not possess the restriction in the aperture that is found in *Conus mappa.* The shell of *Conus centurio* is very light and fragile. Even in a large specimen, the outer lip is always thin and sharp.

Recently, the author has collected two recently dead specimens of *Conus centurio* without the distinctive three yellow, horizontal bands around the shell. There was also a marked reduction of the brown pattern. These specimens appear very similar to *Conus clerii* Reeve. Except for these marked differences in the pattern and coloration, the shell morphology appeared almost identical to the typical *Conus centurio.* The author is endeavouring to obtain a live or preserved specimen of *Conus clerii* from off the Brazilian coast to examine and compare with *Conus centurio.*

EXAMINATION OF THE SOFT PARTS, RADULAR TEETH AND ASSOCIATED VENOM SYSTEMS

One of the problems the author has experienced during this study concerns the removal of the soft parts from specimens of *Conus mappa*. No difficulty has been experienced in removing the soft parts from shells of *Conus centurio* despite the fact that the aperture in this species is also narrow and the lip of the shell very fragile. The problem with *Conus mappa* concerns the restricted aperture and the rounded plication on the columella which causes even further restriction in the internal aperture.

This structure, which is not found in either *Conus ermineus* or *Conus centurio* is most probably related to the strange diet of this species. Pulling a "harpooned" amphinomid worm into the siphonal or head end of the aperture of the shell, suitably lubricated with mucus, would be analogous to pulling coarse wool through the eye of a darning needle. All the venomous setae of the prey, would be deflected outwards, thus preventing the mollusc being pierced and poisoned. However, it must be noted, that this restriction is not found in either *Conus aurantius* or *Conus regius*, which also feed on amphinomid worms.

During the author's previous studies on *Conus ermineus*, Nybakken had advised (personal communication), that in order to kill *Conus* specimens and at the same time arrest the digestive processes in the gut, specimens should be boiled for a few minutes in sea water as soon as possible after being collected. This has proven to be of great help for all species of *Conus*, other than *Conus mappa*. Boiling, even for short periods, hardens the musculature of *C. mappa* and with the restricted aperture, subsequent removal is impossible without either breaking up the animal or the shell. Attempts to relax the animal, using conventional chemicals have not been very successful.

The internal anatomy of both *Conus mappa* and *Conus centurio* is typical of all *Conus* species. In *Conus mappa* the foot and proboscis are coloured bright red or orange-red. In males the penis is quite large, the latter two-thirds being a flattened blade, coloured bright red. It is positioned on the right side, well back from the mollusc's head.

The venom system, comprising associated glands, ducts and explusion bulb, is much smaller than that of an equivalent sized specimen of *Conus ermineus*. The radular teeth are 3 — 4 mm in length; they are typical of the specialized type of tooth used by *Conus* species feeding on amphinomid polychaete worms (Nybakken, 1970a; see figure (3) Plate 2.)

Only six or eight teeth are found fully developed ready for use with the venom system.

In *Conus centurio*, the coloration of the foot and proboscis is a bright sulphur yellow. Other parts of the musculature are white. In males the penis or verge is often coloured bright yellow with an orange-yellow margin around the blade. This is also positioned on the right side of the mollusc.

The venom system is typical and once again the organs, when compared to those from equivalent sized specimens of *Conus ermineus*, are smaller, approximately two-thirds the size. They are, howevr, comparable to those in similar sized specimens of *Conus mappa*. The radula sac is small and contains 12 — 14 teeth. The teeth (see figure (4) Plate 2) are not typical of those *Conus* species which feed solely on other molluscs, and it is possible that *Conus centurio* has a more complex or varied diet (see Food and Feeding). Both *Conus centurio* and *Conus mappa* possess smaller heads, eyes and tentacles than specimens of *Conus ermineus* of equivalent size.

REPRODUCTION

Neither egg cases nor any form of reproductive behaviour has been observed in either species. It is possible, however, that the increased activity in both species under study during the month of December may be related to reproduction. Continued observation may produce more evidence but the rarity of these species in their deep habitat areas is not conducive to observations being made on short term events. Observations in aquaria may be of help but the maintaining of the correct temperature, approximately 5 — 15°F below ambient air temperatures, would pose many problems. The author has also observed that many species of female molluscs from other genera automatically produce egg capsules and lay infertile eggs as soon as they are collected and placed in aquaria, possibly due to the trauma of being collected and placed under much reduced hydrostatic pressure and higher temperatures.

FOOD AND FEEDING

As mentioned in the introduction, it is in the area of food an feeding that the genus *Conus* has generated tremendous interest for malacologists during the past ten years. The discovery that there was a definite relationship between the structure of their radular teeth and their observed dietary preferences of differing vertebrate and invertebrate prey has stimulated considerable interest in the genus. However, accurate work in this field can only come from repeated observation and the examination of the gut contents of many specimens. The author has often marvelled at the density of different *Conus* species in a relatively small habitat area in the Indo-Pacific. In these areas the collection and examination of large numbers of specimens pose few problems. Marsh (1971) was able to carry out valuable work on vermivorous *Conus* species on the Barrier Reef of Australia because he could examine many specimens of many species.

Great difficulty is experienced, however, when attempting to carry out work on rare species. During the course of this present study, the author has been faced with two choices. Either collecting and examining the gut contents of each and every specimen of *Conus mappa* and *Conus centurio* found, or observing as much as possible on the sea-bed and only collecting selected specimens at night or early in the morning when there is a better chance of finding undigested food in the gut.

Conservation must be a guiding factor in a study such as this and after adopting the second choice the author has observed that over a six year period there has been a decline in populations. Frozen specimens from friends on shrimp trawlers have been of help but it is impossible to obtain meaningful data, since the small crew are usually fully engaged in shrimping activities.

The author's observations on the gut contents of *Conus mappa* have confirmed that they feed on amphinomid worms. Two different groups of setae have been found (see figures 1 & 2 Plate 2). Sixty percent of the setae examined were found to be from *Hermodice carunculata*. The remaining 40% are from an amphinomid yet to be positively identified (see drawings), but suspected to be *Eurythöe complanata* (Pallas, 1766). In the waters of Trinidad & Tobago *Hermodice carunculata* lives in shallow water habitats usually under coral or rock slabs. Recent observations however, have revealed that they often move down into deep water sponge beds at night. The specialized tooth structure of amphinomid-eating *Conus* species is distinctive and unlike any other vermivorous *Conus* species (Nybakken 1970a).

The author has been unable to advance any further theory as to the specific advantage of this tooth structure in the capture of amphinomid prey, but it must be related to obtaining a very secure hold on the worm, injecting the venom and then pulling the worm in through the restricted aperture to avoid the venomous setae. It is interesting to note that some specimens of *Hermodice carunculata* are five or six times the length of an adult specimen of *Conus mappa*.

Observations on the feeding behaviour of *Conus centurio* should have raised no problems as the author had collected specimens in 1969 apparently feeding on the mollusc *Cyphoma intermedium*. *Cyphoma intermedium* has always been considered rare, and specimens have only been obtained by dredging in other areas but in Trinidad, this small ovulid gastropod species is fairly common in the deep water habitat areas shared by *Conus mappa* and *Conus centurio*. *Cyphoma intermedium* exhibits the same affinity for the octocorals as the shallow water Caribbean species of *Cyphoma*. *Cyphoma intermedium* lives and feeds on the

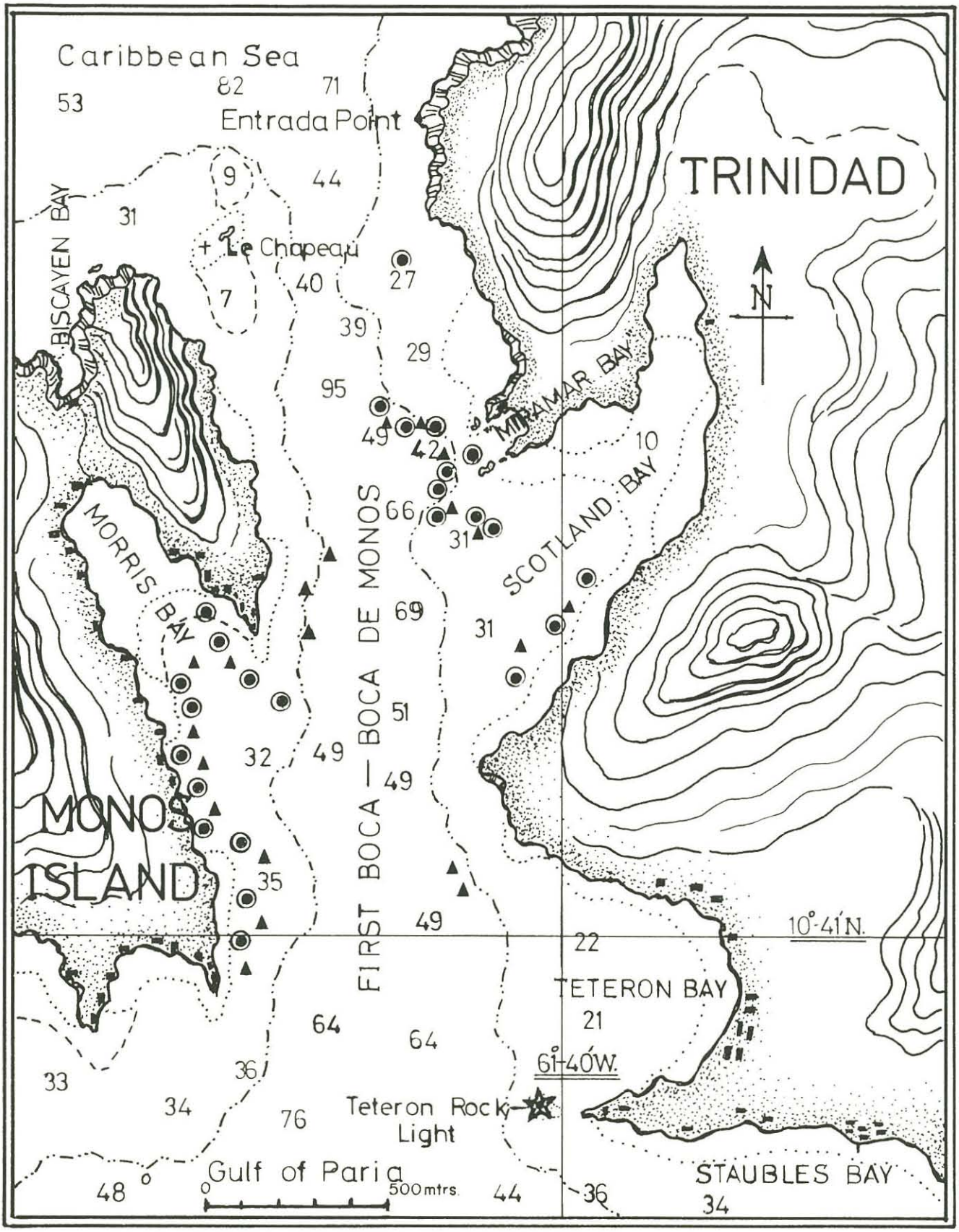

PLATE 3:

CHART of study area — First Boca, Boca de Monos, off the Northwest peninsula of Trinidad. Soundings in metres.

⊙ = *Collection or observation site on* Conus mappa.

▲ = *Collection or observation site on* Conus centurio.

polyps of the deep water octocoral *Leptogorgia setacea*. This is a small green coloured species, which resembles a marine plant and is fairly common in areas where there are currents. *Cyphoma intermedium* is often found on the sandy silt substrate in octocoral areas, moving from one octo-coral host to another. During this movement, they are preyed upon by *Conus centurio*. Three observations of *Conus centurio* preying on this small ovulid mollusc have been made. What concerns the author, however, is the fact that the tooth structure of *Conus centurio* is not typical of molluscivorous *Conus*. Recent examination of the gut contents of a male specimen of *Conus centurio* revealed the partially digested remains of a small mollusc which was possibly a species of *Marginella*. However, examination of the gut contents of a large female specimen of *Conus centurio* definitely revealed the remains of an enteropneust (Acorn worm) or similar marine invertebrate but certainly not a mollusc. This uncertainty is disappointing to the author as it may take many years of underwater investigations before sufficient evidence can be obtained to make a positive determination of the diet of *Conus centurio*.

ENEMIES

Very few specimens of either *Conus mappa* or *Conus centurio* are found without the signs of serious shell demage. This damage to the lip of the shell has usually been repaired by the continuation of the whorls. This type of damage is mainly caused by a deep water crab, *Calappa* sp. The author has often been puzzled by this type of damage to molluscs and especially to *Conus* species. In view of the power and persistence of *Calappa* as a predator on molluscs, the question arises as to what factor causes them to abandon an attack on a *Conus* species after seriously damaging only the outer lip of the shell.

In the same habitat area, not one specimen of *Polystira albida* has ever been observed or collected by the author, without the marks of shell damage and subsequent repair. On one occasion a juvenile specimen of *Conus centurio* was removed from the interior of an asteroid. The asteroid had ingested the entire 36 mm specimen of *Conus centurio* which produced a very large proturbence. Observations on asteroids ingesting and consuming *Oliva reticularis* in more shallow areas are quite common in the waters of Trinidad. Some of the more common predators on molluscs such as rays, turtles, spiny lobsters and toad fishes have not been observed by the author in the colder deep water habitat areas frequented by the *Conus* species under study. However, the batrachoid fish, *Amphichthys cryptocentrus*, which is very common in the shallow waters above the habitat areas of *Conus centurio* and *Conus mappa*, is a voracious predator on mulluscs.

CONCLUSION

In the waters of Trinidad & Toabgo, which offer a very wide range of ecological and environmental niches, the genus *Conus* is poorly represented, and although the author has collected fourteen species in the course of sixteen years, a collector would experience difficulty in finding more than six or seven species today. By far the most common is *Conus ermineus*, a fish eater. This interesting species appears to have adapted itself to many differing habitats and can be found in fair numbers from depths between 3 and 50 metres.

Conus mappa and *Conus centurio* are recognized as being rare species throughout the Caribbean area. In Trinidad & Tobago, however, small groups of these two rare, but quite distinctively separate species, have been found sharing the same cold, deep water habitat.

Conus mappa is a mollusc with a long and interesting taxonomic history exhibiting many variations of colour and pattern in isolated populations of the Southern Caribbean. This has been responsible for the erection of many synonyms. All these forms, however, share the same unusual diet of amphinomid worms and possess the highly distinctive type of radular teeth characteristic of *Conus* species which prey on amphinomids (Kohn, Nybakken & Van Mol 1972).

The more common *Conus regius* is considered to be very closely related as it possesses a similar shell, the same diet and almost identiical radular tooth structure.

Conus centurio has always been considered rare, although specimens have been collected from locations as far apart as Puerto Rico and Brazil.

Unlike *Conus mappa*, *C. centurio* does not appear to be very variable; in fact, specimens and figures examined reveal uniformity in morphology, colouration and pattern.

Although several observations have been made on the diet of this species, no positive determination can be made as to whether it is a molluscivore or not.

Subsequent to completing most of this paper, the author has learnt from Dr. J. Nybakken that his observations on the Western American *Conus* species have revealed that *Conus diadema* feeds on both worms and molluscs (Nybakken, pers. comm.).

The radular structure of *Conus diadema*, however, is not similar to that found in *Conus centurio*. The tooth of *Conus diadema* although small, is morphologically similar to the radular structure possessed by molluscivorous species of *Conus*.

The study of molluscs in the Southern Caribbean poses many problems which are usually related to endemic species living in very restricted localities. There are many examples of this — *Ancilla tankervillei*, *Cypraea mus*, *Fusinus closter*, *Murex argo*, *M. margaritensis* to name a few (Abbot 1958).

At first the author considered that some of the *Conus* species would fall into this same restricted category. However, this is not so. *Conus ermineus* appears to be very widely distributed. *Conus mappa* has produced two or three endemic forms, whilst *Conus centurio* is found in its true habitat, in deep water close to rock slopes or ledges, areas in which it is difficult to collect by trawling or dredging.

The association of *Conus mappa* and *Conus centurio* that was found in this study may be peculiar to the waters of Trinidad only.

During the course of many years of underwater observations the author has observed that many species of mollusc present in these waters exhibit two quite distinct forms — a shallow water and a deep water form. Owing to upwelling of cold bottom water in certain areas along the north coast and in the Bocas many species of deep water molluscs have been collected in water depths not greater than 46 metres. *Conus mappa* can be found in much shallower depths in other areas of the Southern Caribbean in much warmer water. *Conus centurio* has been found as far North as Puerto Rico whilst *Conus mappa* is still restricted to the Southern Caribbean.

Underwater observations in the northern areas of the Caribbean may reveal that *Conus centurio* is not so rare once its habitat is recognized. In fact it may be recognized that *Conus centurio* and *Conus delessertii* have the same close relationship as *Conus mappa* and *Conus regius*. *Conus mappa* may not be found in the north, as it is probably represented in these areas by *Conus regius*. Only extensive diving will provide the answers.

REFERENCES

ABBOTT, R.T. (1958) — The Trophical Western Atlantic Province. Proc. Phiiadelphia Shell Club 1958.

CLENCH, W.J. (1942) — The Genus *Conus* in the Western Atlantic. Johnsonia 1/6. 1 — 40.

CLENCH, W.J. (1970) — The Genus *Conus* in the Western Atlantic. Johnsonia 4/48 Review Number.

DANCE, S.P. (1966) — Shell Collecting. An illustrated History. University of California Press. Berkeley & Los Angeles, California.

DUNN, W.R. (1971) — On the Identity of *Conus cedonulli* Linnaeus 1767. The Veliger. Vol. 13, No. 3. P. 209.

ENDEAN, R. & RUDKIN, C. (1965) — Further studies on the venom of *Conidae*. Toxicon 2: 225 — 229.

HOLEMAN, J. & KOHN, A.J. (1970) — The Identity of *Conus mappa* (Lightfoot), *Conus insularris* Gmelin, *Conus aurantius* Hwass, in Bruguiere and Hwass's infraspecific taxa of *Conus cedonulli*. J. Conch. 27: 135 — 137 (1970).

KEEN, A.M. (1971) — Sea Shells of Tropical West America. Second Edition. Stanford University Press, Stanford, California.

KOHN, A.J. (1959) — The ecology of *Conus* in Hawaii. Ecol Monogr. 29: 47 — 90.

KOHN, A.J. (1960) — Ecological notes on *Conus* (Mollusca: Gastropoda) in the Trincomalee region of Ceylon. Ann. Mag. Nat. Hist. Ser. 13, 2: 309 — 320.

KOHN, A.J. (1966) — Food specilization in *Conus* in Hawaii and California. Ecology 47: 1041 — 1043.

KOHN, A.J., NYBAKKEN, J. & VAN MOL, J.J. (1972) Radula tooth structure of the gastropod *Conus imperialis* elucidated by scanning electron microscopy. Science, Vol. 176: 49 — 51.

MARSH, Helene (1971) — Observations on Food and Feeding of some Vermivorous *Conus* on the Great Barrier Reef. Veliger Vol. 14 No. 1 pp 45-53.

MARSH J.A. & RIPPINGDALE, O.H. (1964) — Cone Shells of the World. Jacaranda Press. Sydney and Melbourne Australia.

NOWELL-USTICKE, G.W. (1959) — A check list of the Marine Shells of St. Crois. Lane Press. Burlington. Vermont, USA.

NYBAKKEN, J.W. (1970) — Radular Anatomy and Systematics of the West American Conidae (Mollusca, Gastropoda) Am. Mus. Nov. 2414, 1 — 29.

NYBAKKEN, J.W. (1970a) — Correlation of Radula Tooth Structure and Food Habits of three Vermivorous Species of *Conus*.

PERCHARDE, PETER L. (1974) — Underwater Observations on *Conus ermineus* Born 1778 in Trinidad & Tobago. Verhandl. Naturf. Ges. Basel. Vol. 84 No. 1 pp 501-507.

RIOS, E.C. (1970) — Coastal Brazilian Seashells. Fundačao Cidade de Rio Grande. Museu Occeanográfico de Rio Grande. R.S. XI 1970.

SEAMON, N. & SEAMON, E. (1967) — Observations on the habitat, locality and range of the rare *Conus aurantius* Hwass 1792. Hawaiian Shell News 15 (12): 1, 8 Figs. 1 — 5.

VAN MOL, J.J., TURSCH, B. & KEMPH, M. (1967) — Campagne de la "Calypso" au large des cotes Atlantiques de l'Amerique du Sud (1961 — 1962) 16 Mollusques Prosobranches: Les Conidae du Brèsil. Ann. Inst. Oceanogr. Monaco 45: 233 — 255.

VAN PEL, P.L. (1969) — Additional notes on *Conus aurantius*. Hawaiian Shell News 17 (10): 5.

VINK, D.L.N. (1974) — A strange food preference of *Conus aurantius*. Hawaiian Shell News Vol. XXII No. 12. New Series No. 180 December 1974.

VINK, D.L.N. (1977) — The *Conus cedonulli* complex. Zoologische Mededelingen. Leiden Vol. 51, No. 5 pp. 79 — 93.

WAGNER, R. & ABBOT, R.T. (1967) — Standard Catalog Shells 2nd Ed. D. Van Nostrand Co. Princeton New Jersey, U.S.A.

WARMKE, G. & ABBOT, R.T. (1967) — Caribbean Sea Shells. Livingston Publishing Co., Narberth, Penna, U.S.A.