

Studies on the Neotropical Fauna

Beiträge zur neotropischen Fauna

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**Egg Masses of 27 Caribbean Opisthobranchs
from Santa Marta, Columbia**

by

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(Bonn)

INTRODUCTION

Since the opisthobranchs of the area of Santa Marta have been recently described, additional data concerning the morphology of the spawn, length of development of the embryo, and the type of hatching young can be provided for many of the same species, even individuals, which constituted the material Dr. Marcus studied.

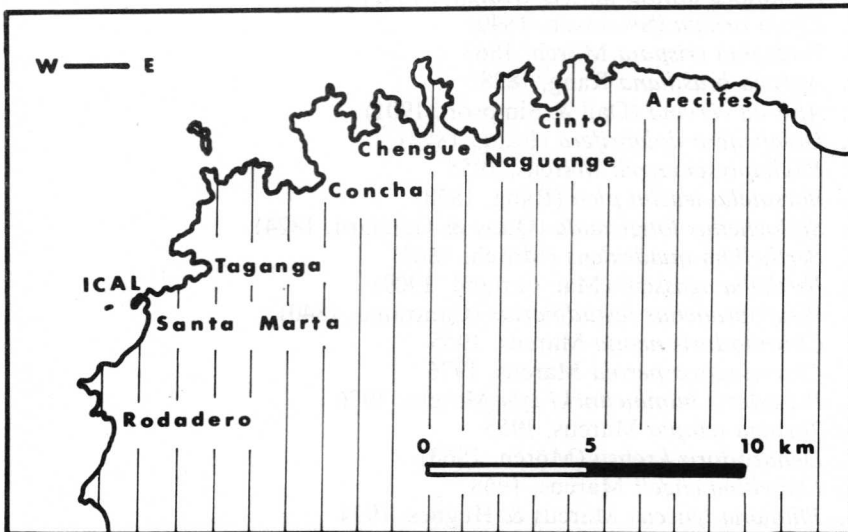


Fig. 1. Map of the coastline near Santa Marta showing the general locations where opisthobranchs were collected.

The animals included here were all collected off the coast near Santa Marta at the Caribbean sea shore of Colombia, in the vicinity of the Instituto Colombo Aleman (ICAL). Ecological data on most species mentioned here can be found in the publication of Dr. Marcus. Adult animals were collected in the sea and then kept in seawater running 12 hours a day or jars with seawater exchanged daily. Here in the aquarium spawn was produced frequently in no apparent relation to the seasons of the year. Additional egg masses were collected at the livingplace of the species in the sea.

The study was financed by the Deutsche Forschungsgemeinschaft and carried out by the author as guest of the Instituto Colombo Aleman in Santa Marta. I am very grateful to both organisations. The drawings were made on living spawn by my wife. I like to thank her very much here.

DESCRIPTION

The egg masses of the following species are described. The list follows the order used by Dr. Marcus.

1. *Bulla solida* Gmelin, 1791
2. *Hydatina vesicaria* (Solander, 1786)
3. *Aglaja evelinae* (Marcus, 1955)
4. *Atys riiseanus* Mörch, 1875
5. *Haminoea elegans* (Gray, 1825)
6. *Haminoea antillarum* (D'Orbigny, 1842)
7. *Elysia ornata* (Swainson, 1840)
8. *Tridachia crispata* Mörch, 1863
9. *Aplysia brasiliana* Rang, 1828
10. *Aplysia cervina* (Dall & Simpson, 1901)
11. *Dolabrifera dolabrifera* (Rang, 1828)
12. *Phyllaplysia engeli* Marcus, 1955
13. *Bursatella leachii pleii* (Rang, 1828)
14. *Stylocheilus longicauda* (Quoy & Gaimard, 1824)
15. *Berthellina quadridens* (Mörch, 1863)
16. *Berthella agassizii* (Mac Farland, 1909)
17. *Pleurobranchus testudinarius* (Cantraine, 1840)
18. *Chromodoris neona* Marcus, 1955
19. *Chromodoris perola* Marcus, 1976
20. *Peltodoris hummelincki igla* Marcus, 1976
21. *Taringa telopia* Marcus, 1955
22. *Dendrodoris krebsii* (Mörch, 1863)
23. *Flabellina engeli* Marcus, 1968
24. *Phidiana lynceus* Marcus & Hughes, 1974
25. *Favorinus branchialis* (O. F. Müller, 1806)
26. *Dondice occidentalis* (Engel, 1925)
27. *Spurilla neapolitana* (Delle Chiage, 1823)

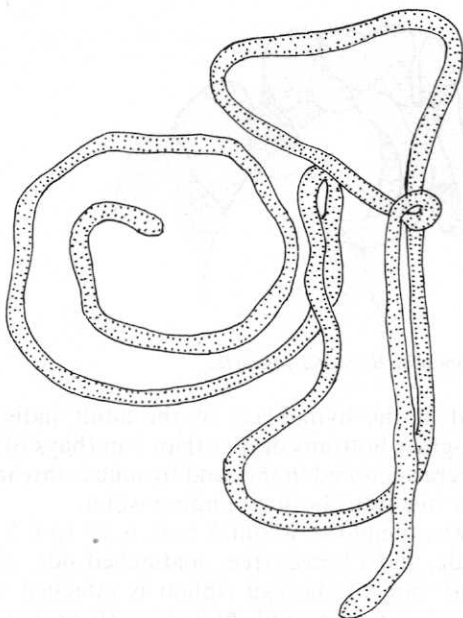
1. *Bulla solida*

Fig. 2. Egg string of *Bulla solida*.

Individuals collected recently in the sea spawned in the aquarium within the first one or two days. The egg string was attached to all kinds of hard substrates as well as algae. In the sea spawn was commonly found within the brackish water of an artificial pond at Santa Marta Rodadero, glued to plants and rock near water surface and a few centimeters below it.

The egg string, twined like a ball of yarn, is up to 2.5 cm long, 1.0-1.5 mm wide and of round section. The outer gelatinous string layer often shows agglutinations of sand, silt, and other small particles which thus camouflage the egg mass. The length and diameter as well as the number of eggs included in the egg string of one female depend very much on the size of the individual. 2000 to 200.000 eggs may be secreted in one egg mass of one individual female at different stages of its ontogenetic development. 1 mm of egg string holds 75 embryos. Each, or two of each, are held within a round, 0.06 mm wide egg capsule. Capsules are arranged in single rows with neighbouring ones usually touching each other, and if not, are connected to each other by irregular, narrow threads. After 6 days of development the yellowish eggs have been transformed into transparent, colourless veligers that hatch from the disintegrating egg mass.

2. *Hydatina vesicaria*

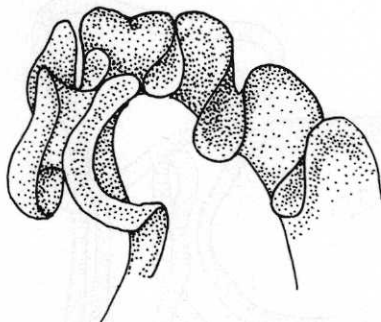


Fig. 3. Section of the egg ribbon of *Hydatina vesicaria*.

Egg masses were found at the livingplace of the adult individuals of this species in the sea on sea-grass bottoms deeper than 3 m (bays of Santa Marta, Cinto, Arecifes). They were anchored in the sand by mucus threads and extended in rosette-like masses free into the surrounding water.

Each egg ribbon shows a height of about 5 mm, is up to 0.5 mm wide and shows a shorter basal side, and a longer free, unattached side, which therefore is undulating. The short side of the egg ribbon is attached to an opaque, elastic string that continues into the sand, branching there and thus anchoring the mass to the substrate. The jelly ribbon is crowded with 0.1-0.15 mm wide egg capsules, each containing 7-12 eggs. Walls of neighbouring capsules touch, thus take irregular hexagonal shape. They form one layer near the attached ribbon side, two layers near the center of the ribbon and 3-5 layers at the broader, unattached ribbon side. In 1 mm of egg ribbon about 1200 eggs can be counted. A ribbon may be up to 40 cm long. About half a million small transparent veligers hatch.

3. *Aglaja evelinae*

Animals held in the aquarium fixed their spawn to the plastic walls. In the sea females usually used the undersides of rocks in 1-2 m of depth for attachment of their egg masses.

The spawn consists of a cup-shaped gelatinous mass that is attached to the substrate with its base and one side of the cup. The upper opening of the cup is narrow. In diameter the egg mass measures up to 1 cm and is about just as high. The matrix of the cup-like egg mass is composed of slightly opaque, gelatinous material in which strings of 0.08 mm wide capsules are embedded. In a transverse section of a cup-wall up to 4 rows can be counted besides each other. The row of capsules is contained in a tube and continuous throughout the whole egg mass. Each round egg capsule in this row is connected with both its neighbours by a string or touches their sides. On one side of the egg-cup about 60 egg rows can be counted above each other. Usually the capsule

tubes are oriented more or less parallel to the cups edges, but some oblique to it. Therefore the general appearance of the egg mass, seen laterally, is somewhat irregularly striated transversally. Each egg capsule contains only one white egg or embryo. After 4-5 days of development about 15000 transparent, colorless veligers hatch from the disintegrating egg mass.

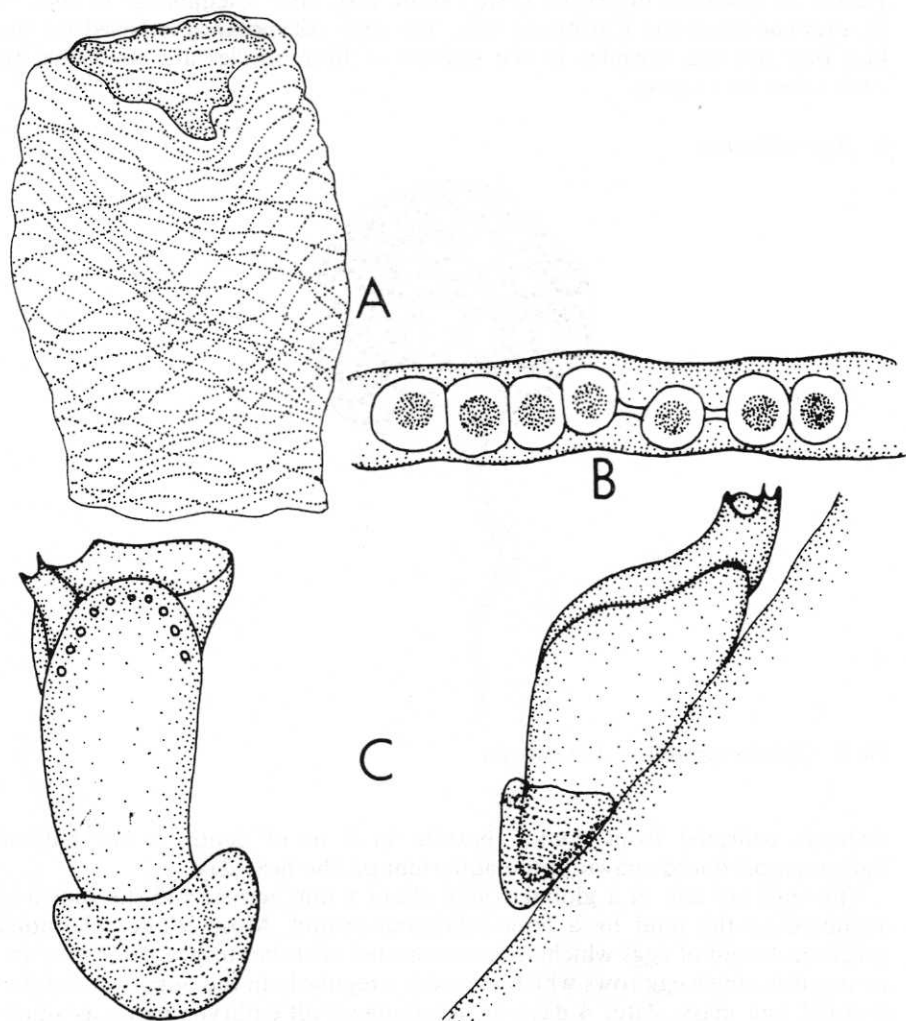


Fig. 4. Egg-mass of *Aglaja evelinae*: A. View of the whole mass seen from the side; B. Section of the egg string showing egg tube and connections between the egg capsules; C. Egg mass producing female in scetches from the side and the front.

The female producing this cup-like spawn starts with the bottom of the cup and secretes about 2 cm of egg-string within a minute and attaches it into the egg mass with lateral movements of the body. It keeps part of its body within the gelatinous cup until completion of the egg mass. Only then it withdraws and crawls away.

The egg masses of *Aglaja diomedea* (Bergh, 1893) from the northern Pacific as described by Hurst (1967) show very little resemblance to that of *A. evelinae* from the Caribbean Sea. The only resemblance is based on the fact that the egg capsules in the spawns of both species are connected to each other by a string.

4. *Atys riiseanus*

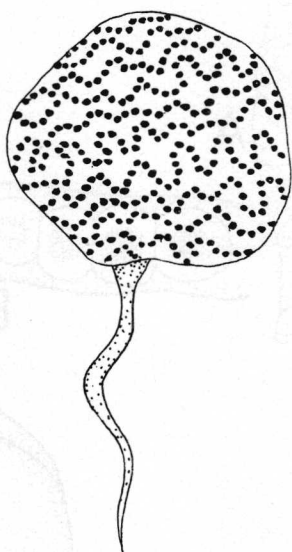


Fig. 5. Globular egg mass of *Atys riiseanus*.

Animals collected from muddy bottom in 5 m of depth in the bay of Tanganga produced spawn in the aquarium on the next day.

The eggs are laid in a globular jelly about 8 mm across, and the spawn is anchored to the mud by a long gelatinous strand. Most of the gelatinous sphere is devoid of eggs which are concentrated near the surface. Here they are arranged in single egg rows which meander irregularly in the outer layer of the globular egg mass. After 4 days of development all embryos hatch as small veligers that carry a colourless, transparent shell and show some reddish violet pigment in their soft body.

The egg mass of *Atys riiseanus* resembles that of *Philine aperta* (Linné) and *Philine scabra* Müller as described and figured by Thorson (1946) in its shape.

In difference to these the spawn described here only contains eggs at the surface of the mass, while the gelatinous interior is devoid of them. The egg masses of *Philine japonica* Lischke as described by Hamatani (1961) from Japan are filled with eggs like those from the North Sea.

5. *Haminoea elegans*

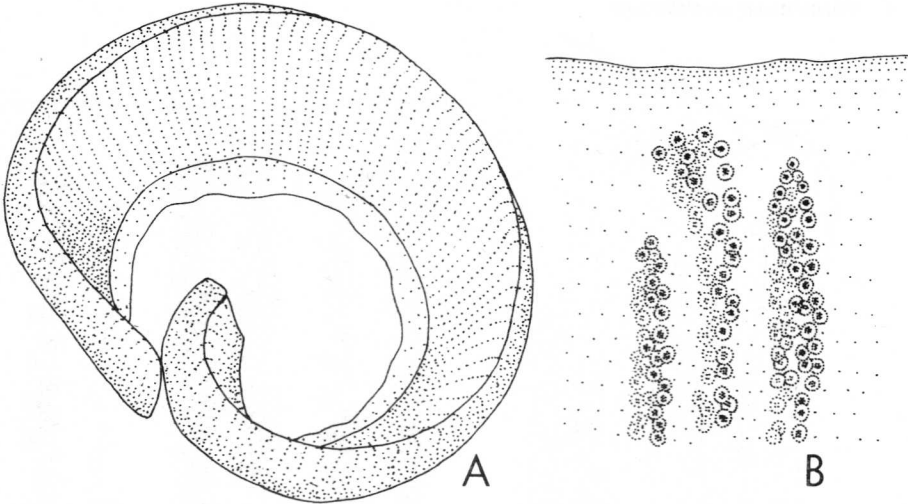


Fig. 6. Egg ribbon of *Haminoea elegans*: A. View of the whole egg mass; B. Section of the egg ribbon showing the uneven high loop endings of the coiled egg string at the unattached side.

Animals recently collected at Santa Marta Rodadero from the artificial pond, with slightly brackish seawater, spawned in the aquarium within short time (1-2 days). The egg ribbon was attached to the plastic walls mainly, but also to different kinds of substrates. At the edge of the canal leading into the Rodadero pond numerous characteristic egg masses occurred upon rocks, algae, twigs, etc., in water of a few centimeters depth.

The egg ribbon is attached to the substrate in an open coil or may form one whorl of a spiral. It is up to 9 cm long and 1.5 cm high and stands erect. It is attached to the substratum by an egg-less gelatinous portion. The free narrow edge of the ribbon also shows a gelatinous zone devoid of eggs and is of the same length as the attached side. Within the jelly ribbon the individual eggs are arranged in continuous spiral rows of alternating egg capsules in contact to each other. One white embryo is contained in each 0.07 mm wide capsule. The rows are somewhat looped in themselves but run down one side of the ribbon and come up the other in a compressed spiral coil. The innermost area of the egg ribbon is often hollow and filled with seawater, which has access from openings at the ends of the mass. The gray white egg

ribbon appears striated by 170 rows with about 350 eggs in each spiral whorl. Toward the upper rim of the egg ribbon not all whorls reach the same height and thus form a somewhat irregular crest. After 4 days of development about 60000 veligers hatch from the dissolving mass.

A similar egg mass was described by Hurst (1967) from *Haminoea virescens* (Sowerby, 1833) from the northern Pacific.

6. *Haminoea antillarum*

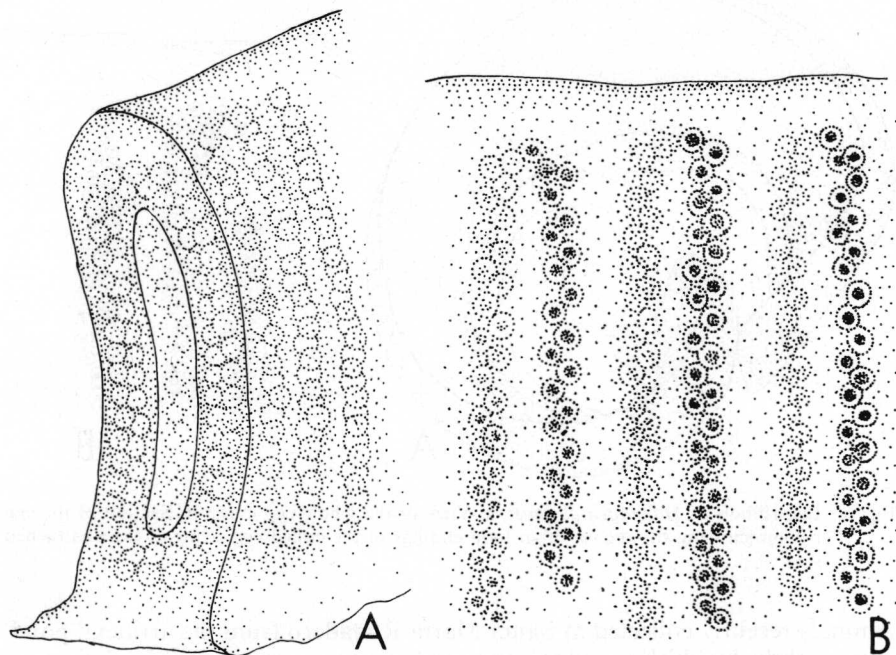


Fig. 7. Egg ribbon of *Haminoea antillarum*: A. Egg ribbon in section demonstrating the inner cavity of the bilaterally compressed jelly tube; B. Section of the egg ribbon showing the even loop endings of the coiled egg string at the unattached ribbon side.

Even more commonly than spawn of *H. elegans* the egg ribbons of *H. antillarum* were found attached to rocks on the edges of the canal leading from the sea into the artificial pond at Rodadero. Individuals just collected spawned frequently when put into the aquarium.

The egg ribbon consists of a narrow, gelatinous mass which contains continuous spiral rows of egg strings which produce a striated appearance. In contrast to *H. elegans*, there may be more than one egg in each capsule but not more than three. Capsules with one egg are the usual and measure about 0.06 mm in width. Also, in contrast to the dull white of the *H. elegans* spawn, the eggs of *H. antillarum* show a bright yolk-yellow

coloration. Therefore, even though the gelatinous matrix substance of the egg mass is colourless transparent, the whole mass appears quite yellow. The ribbon is attached to smooth substrates in a regular half whorl or a complete whorl of a spiral coil. On irregular basements more irregular shapes of egg ribbons may be found. Each ribbon measures between 2 and 12 cm in length, 1-2 mm in thickness, and 6-8 mm in height. Often long ribbons show just as many eggs as short ones because of differences in the density of egg rows. Therefore a 3 cm long ribbon with 120 rows showed just the same number of rows as an 11 cm long ribbon. The egg capsules are arranged in smooth double rows in contact to each other in spiral loops which all end at the same level on the free narrow side of the ribbon. Each spiral whorl contains 300-400 embryos. It is turned narrowly at the attached side of the ribbon and forms a wide bend at the free side of the ribbon. After 4 days of development all young hatch as small veligers with a colourless transparent shell.

Davis (1967) has described spawn of *H. antillarum* from Jamaica. The only difference to the spawn from Santa Marta may be seen in the fact that in the latter the spiral rows of the egg capsules are more regularly arranged.

7. *Elysia ornata*

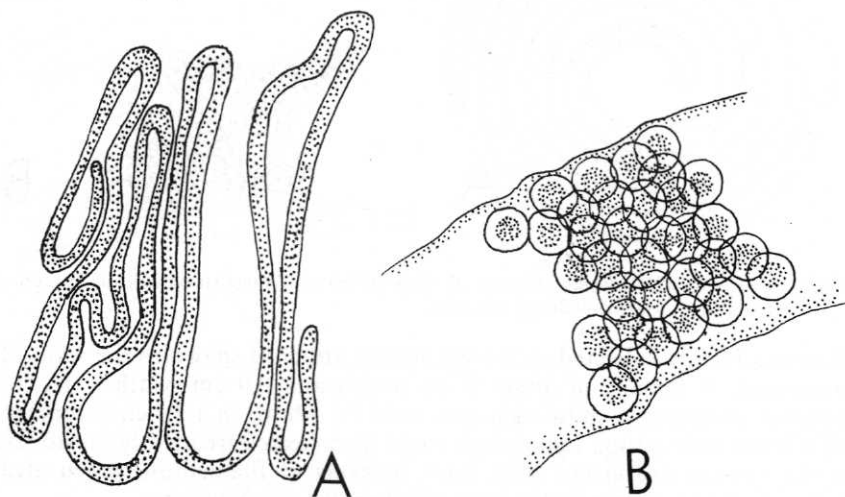


Fig. 8. Egg string of *Elysia ornata*: A. Portion of the egg mass demonstrating tight meanders of the string; B. Section of the egg string crowded with egg capsules.

Animals held in the aquarium on *Sargassum* used the fronds of this alga as substrate for oviposition. On *Sargassum* growing just below the ICAL within or a few cm below the tidal zone spawn belonging to this species was often found also attached to the fronds of the bushels.

The somewhat bilaterally flattened egg string is attached to the leaves with one broad side. It is arranged in narrow, irregular meanders with the sides of the individual loops often touching each other. The 0.5 mm wide and about 0.3 mm high string is transparent colourless and about 12 cm long. It is crowded in its interior with round, transparent, about 0.08 mm wide capsules each containing one greenish-yellow egg. All eggs are attached to each other by an irregularly spirally coiled thread. 1 mm of egg string contains about 100 embryos. After 5 days of development a single egg mass sheds around 12000 small veligers that carry transparent brownish shells with a reddish-brown umbilical region.

An attachment of neighbouring capsules to each other by a fine connection was also described by Reid (1964) from *Elysia maoria*. *E. viridis* spawn from the North Sea as described by Thorson (1946) is dissimilar to that of *E. ornata* in the fact that it shows egg capsules without the connecting string.

8. *Tridachia crispata*

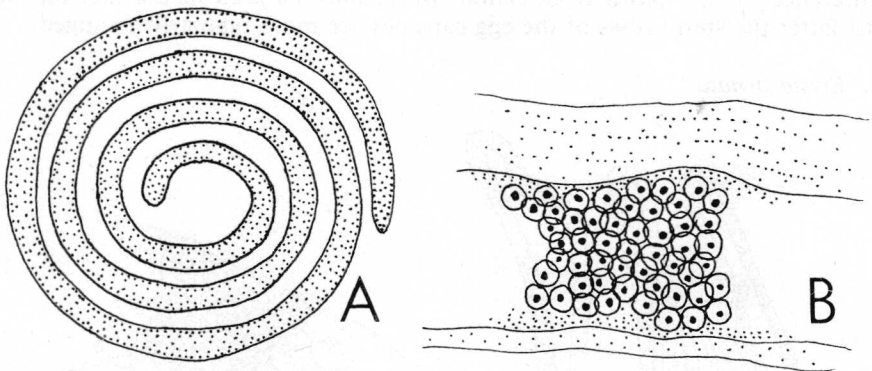


Fig. 9. Egg mass of *Tridachia crispata*: A. View of the whole egg string coil; B. Section of the egg string crowded with egg capsules.

Animals freshly collected in the sea usually attached spawn to the walls of the aquarium. A female, of about 3 cm length and 0.9 cm width in its frontal portion, produced a spiral egg mass with $3\frac{1}{2}$ whorls in a 2.5 cm diameter coil of a 2 mm wide string. Egg masses could be collected frequently on stones and rocky bottom overgrown with thick blankets of filamentous green algae in 1-2 mm of waterdepth in the bays of Chengue and Nague.

The very regular spirally arranged egg mass consists of a gelatinous flattened string, which is glued to the substrate by one broad side. The gelatinous outer layer of the tube-like string covers a smooth, transparent inner tube which contains oval, 0.08 mm wide capsules. These are arranged in tubes which run vertically within the egg ribbon. Within this 0.09 mm wide tube small angular compartments each contain one egg capsule. These tubes are invisible in fresh, living egg masses but show up more clearly in alcohol-

preserved material. Each capsule holds one whitish-olive to greenish-yellow egg. 1 mm of tube contains about 30 eggs. After 14 days of development glass-clear, smooth, naked snails hatch from the string. A day before hatching the embryos had shed their calcified shell which had grown to the size of one whorl. The veliger stage therefore concludes before hatching of the crawling young, and the shells remain in the egg mass.

9. and 10. *Aplysia brasiliana* and *A. cervina*

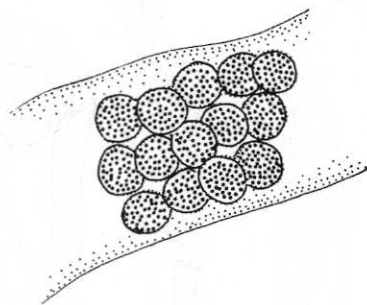


Fig. 10. Section of the egg string of *Aplysia cervina*.

The egg masses of both closely related species of *Aplysia* are identical and cannot be kept apart. In the aquarium recently collected individuals as well as such kept over long periods on a diet of filamentous green algae spawned frequently. In the area of sea-grass flats in the larger bays near Santa Marta communal egg masses of the size up to a football could be found produced by individuals of both species. Often these communal egg masses also contained the very similar egg string of *Bursatella leachii pleii*. Egg masses were especially common after prolonged periods of algal growths following the trade wind seasons. The hermaphrodite animals copulated in chains of a few individuals. The lowermost individuals acted as female, and may have begun to spawn during the copulation. After having spawned the individuals were often washed up onto the beach where they died. At the sand beach of the bay of Santa Marta and of Concha thus at times zones covered with dead and dying large individuals were found.

The gelatinous, 0.7 mm wide egg string is tube-like with a round diameter, elastic, and quite resistant to pull and abrasion. It may show 3-5 m length and is continuously produced by one female. It forms a rubbery yellowish, later brown tangled mass. 1 mm of egg tube contains 8-9 round, 0.17 mm wide egg capsules which crowd each other within the tube. In a transversal section of the egg string 2-3 egg capsules are cut open. Each egg capsule contains 10-15 eggs or embryos. Therefore an average egg mass produced by a single female may shed after 6 days of development about 400000 veligers. The colour of the spawn changes during development from yellow of the eggs to the brown of the veligers, while the egg string itself is colourless transparent.

Aplysia punctata Cuvier from the North Sea owns egg capsules that are connected with their neighbours by a thin string (Thorson, 1946). This was not seen in the egg strings of both Caribbean species, where capsules are crowded together so closely that they deform each other and therefore take almost hexagonal shape. *Aplysia californica* (Cooper) (Mac Gintie, 1934) and *Aplysia* sp. from the Persian Gulf (Thorson, 1940) are quite similar to the Caribbean species and show crowded egg capsules.

11. *Dolabrifera dolabrifera*

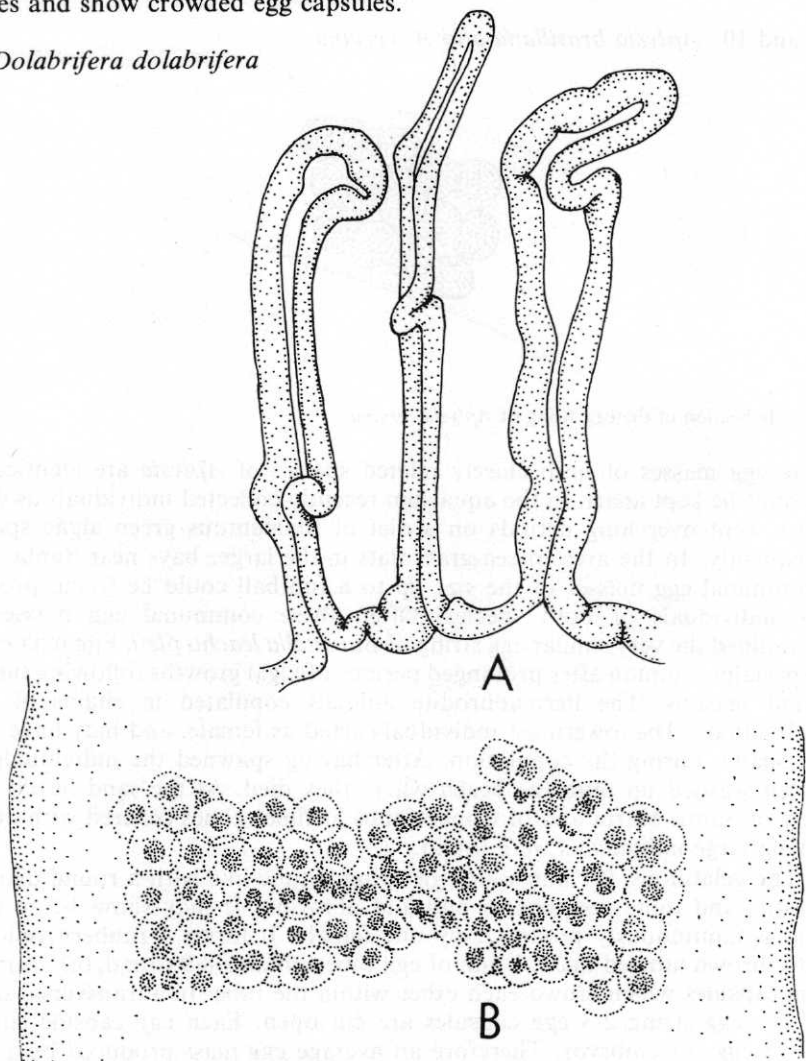


Fig. 11. Egg string of *Dolabrifera dolabrifera*: A. Section of the egg mass demonstrating the meandering egg ribbon; B. Portion of the bilaterally flattened egg ribbon with egg capsules.

Animals kept in the aquarium and fed with algae often attached their spawn to the plastic walls or to stones. In the sea spawn was found attached to the undersides of rocks in the area of the low water line in the quiet embayment of Taganilla, just below the ICAL, as well as in the canal leading into the artificial brackish pond of Santa Marta Rodadero.

The egg string is attached to hard substrates and arranged in tight meanders. It measures 30 to 105 cm in length, about 1 mm in width, and 0.2 mm in height. Each loop is up to 2 cm long. The egg string is bilaterally flattened and attached to the substrate by one broad side. The brownish embryos are contained in round, 0.07 mm wide egg capsules which are crowded tightly within the gelatinous egg tube. One third of the capsules contain one, two thirds two embryos. One mm egg string contains an average of 80 embryos. Up to 80000 embryos may hatch from one mass as small veligers after 7 days of development.

12. *Phyllaplysia engeli*

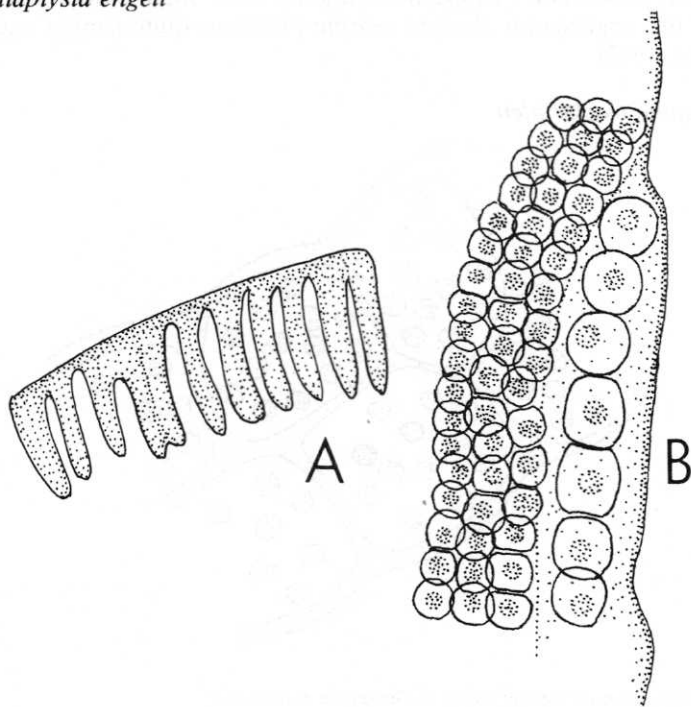


Fig. 12. Egg ribbon of *Phyllaplysia engeli*: A. Comb-shaped egg mass; B. enlarged section of the mass demonstrating the egg strings in their tight packing.

This species is well camouflaged with the blades of the marine angiosperm *Thalassia*. It attached its spawn to newly grown basal parts of the leaves which were not yet settled by bryozoans, hydrozoans, or algal crusts

(collected at the bays of Santa Marta, Concha, Chengue, and Cinto). Animals held in the aquarium also preferred *Thalassia* leaves as substrate for oviposition, but rarely attached their spawn also to the glass walls.

The egg mass is irregularly rectangular to round in outline, sometimes shaped like a comb. It is up to 1 cm long and 4 mm wide, and consists of a continuous thin tube. Mostly the walls of this tube touch or overlap somewhat in each loop. Many masses consist of two tubelayers on top of each other. Rarely (on glass) the egg mass has a comb-like appearance. Here the loops on the inner loop side all touch each other, but are on the outer side, thus forming the pins of the comb. Often the 0.04 to 0.08 mm wide capsules are packed so tightly to each other that they deform each other and take hexagonal shape. Each tube measures up to 0.1 mm in width and each capsule contains one white egg. During the development of the embryo coloration changes from white to green due to the secretion of the greenish shell. After 6-9 days about 400 veligers hatch from one individual egg mass.

Petalifera punctulata (Tapparone-Canefri) from Japan which lives on the leaves of the angiosperm *Zostera marina* produces quite similar egg masses (Hamatani, 1962).

13. *Bursatella leachii pleii*

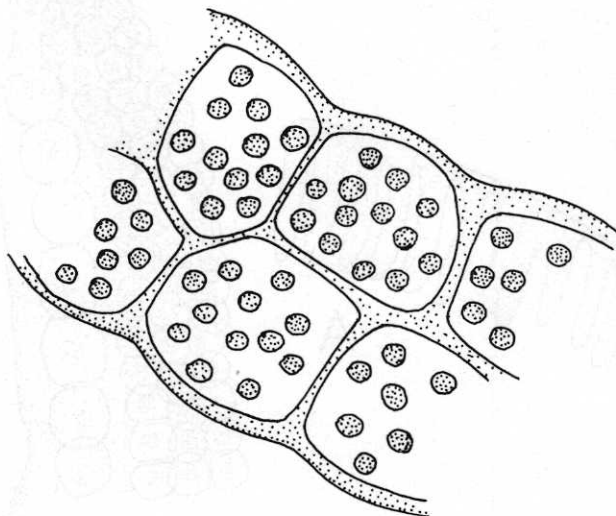


Fig. 13. Short portion of the egg string of *Bursatella leachii pleii*.

In the sea individuals of *Bursatella leachii pleii* form communal egg masses together with *Aplysia brasiliana* and *A. cervina*. Newly collected individuals spawned in the aquarium, attaching their tangled egg string to algae as well as rocks and aquarium walls.

Spawn of this species fits into the description given for the two species of

Aplysia. The egg strings are with 1.0 to 1.2 mm somewhat wider than that of *Aplysia*. They also measure a few meters in length. Almost round, up to 0.5 mm wide egg capsules fill the interior of the egg string tube. Each capsule contains 10-15 eggs. After 4 days of development veligers hatch.

Spawn of *Bursatella pleii* was described by Davis (1967) from Jamaica. It proves to be quite the same as that from Santa Marta.

14. *Stylocheilus longicauda*

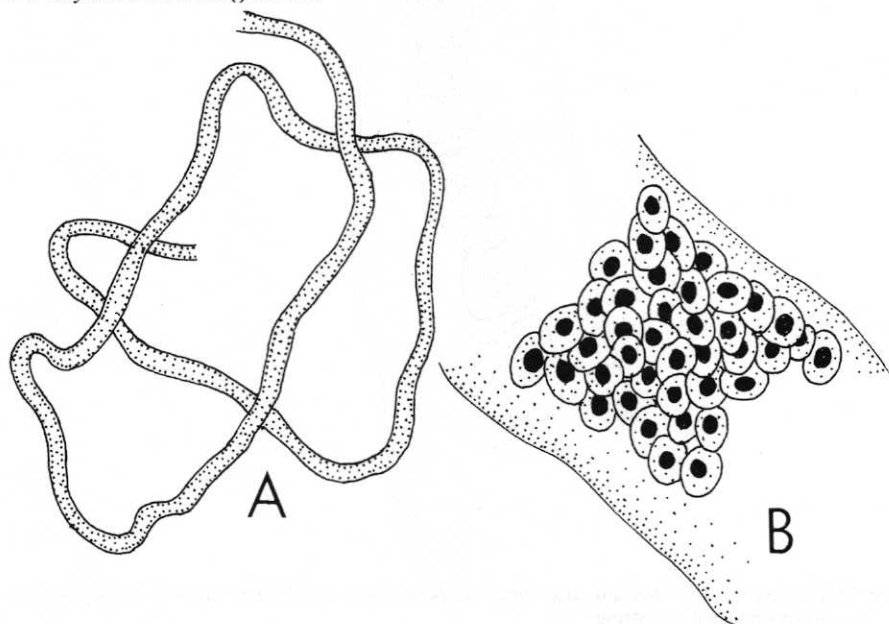


Fig. 14. Egg mass of *Stylocheilus longicauda*: A. Part of the egg string of the tangled mass; B. Short portion of the egg string demonstrating crowded egg capsules.

In the sea *Stylocheilus longicauda* attached its egg masses to the fronds and stems of *Sargassum* on which the adults live well camouflaged. In the aquarium *Sargassum* as well as the walls were used for oviposition.

The tangled mass consists of one continuous, 0.5 mm wide, in diameter almost round, up to 6 cm long, elastic tube. 1 mm of this tube contains about 150 round, 0.05 mm wide capsules, each holding one egg. The embryo at first is yellowish-white, later changes colour to a reddish-white. Its shell shows after 4-5 days of development a reddish apertural rim and a red umbilical region, while the remainder appears transparent colourless. After 6-7 days about 9000 veligers hatch from the egg mass.

A similar spawn produced by *Dollabella* from Japan was described by Hirase (1929). In this species egg capsules show long thin strings attached to them. Nothing like that could be observed with the spawn of *Stylocheilus*, where egg capsules are so crowded that they deform each other.

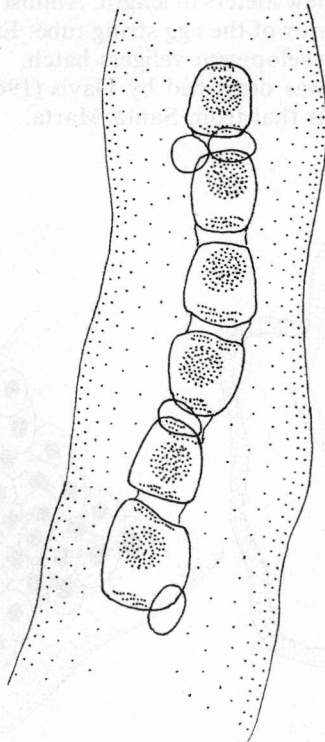
15. *Berthellina quadridens*

Fig. 15. Portion of the internal egg tube of *Berthellina quadridens* spawn containing the interconnected egg string.

Animals held in the aquarium produced egg masses shortly after they had been collected in the sea. They attached their spawn to the walls of the aquarium or to the free underside of stones. The bright orange female produced a brownish-yellow egg ribbon of about 7 cm length.

The egg ribbon consists of a gelatinous, quite soft, massive ribbon of 2 cm width. It is attached to the substrate with the flattened side in an open coil. The free side shows a rounded surface. Within this transparent jelly-mass a continuous thin walled tube forms bilaterally flattened spiral loops which in themselves are irregularly bent back and forth. The major loops or whorls are crowded so close to each other that they touch each other, and thus produce the striated appearance to the ribbon. But due to irregular special twisting of the major loops, under the binocular, no regular pattern of arrangement is evident. The tube contains one row of round capsules with one egg in each. Between each neighbouring capsule a smaller short tube or tiny capsule is situated, thus forming a chain of larger, egg bearing capsules connected with

each other by smaller egg-less capsules. In 1 mm of egg ribbon about 30 eggs can be counted, so that up to 50000 veligers hatch after 15 to 16 days of development.

In general shape and arrangement of the eggs similarities can be noted with the egg mass of *Stiliger niger* Lemche as described by Rasmussen (1952) from the North Sea and *Stiliger berghi* Baba as described by Hamatani (1963) from Japan. The smaller size of the egg masses, regularity of row pattern, and the direct contact of egg capsules to each other differentiate these spawns from that of *Berthellina quadridens*.

16. *Berthella agassizii*

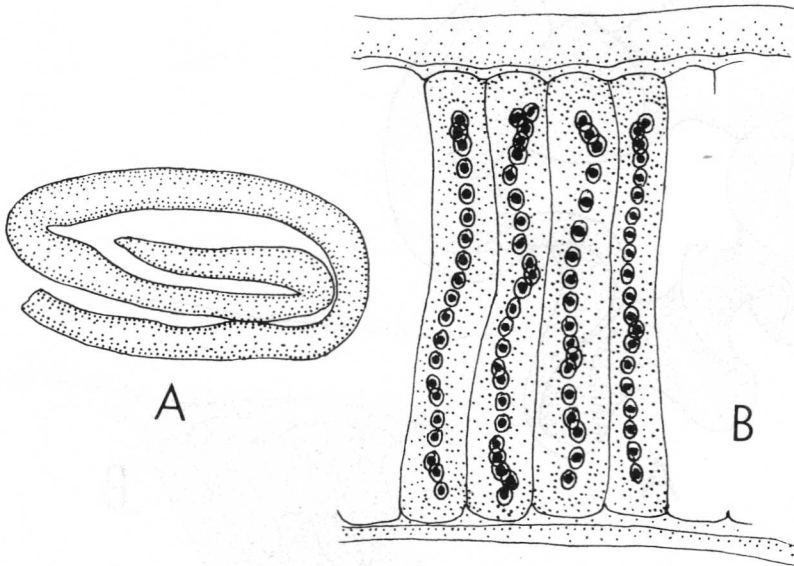


Fig. 16. Egg mass of *Berthella agassizii*: A. coiled egg string; B. section of the egg ribbon demonstrating the coiled egg string.

Recently collected animals glued spawn to the walls of the aquarium after short periods.

The egg rod is round in section, up to 7 cm long, and 2 mm wide. It is arranged in an irregularly compressed coil. Only a narrow foot attaches it along the whole rod to the substrate. The rod consists of an outer thick gelatinous cover and an inner tube separated from each other by a smooth thin membrane. This inner tube is filled by a continuous thin, spirally arranged, smaller tube which in itself holds the capsules in a single row. These egg capsules often touch each other and form a single row looped and bent within the innermost spiral tube. Each capsule contains one white embryo or egg. 1 mm of egg rod contains 250 eggs. Shortly before hatching the spawn changes its

white coloration into violet. After 7 days of development about 20000 veligers hatch from each single spawn.

In general shape the spawn of *Rostanga* from the northeast Pacific (Hurst, 1967) and the Persian Gulf (Thorson, 1940), and of *Eubranchus* (Hamatani, 1961) and *Catriona pinnifera* (Baba) (Hamatani, 1961) from Japan are similar to that of *Berthella*. The arrangement of the egg capsules in inner tubes differentiates *Berthella* spawn from all these which show no regular pattern of egg capsules inside the egg rod.

17. *Pleurobranchus testudinarius*

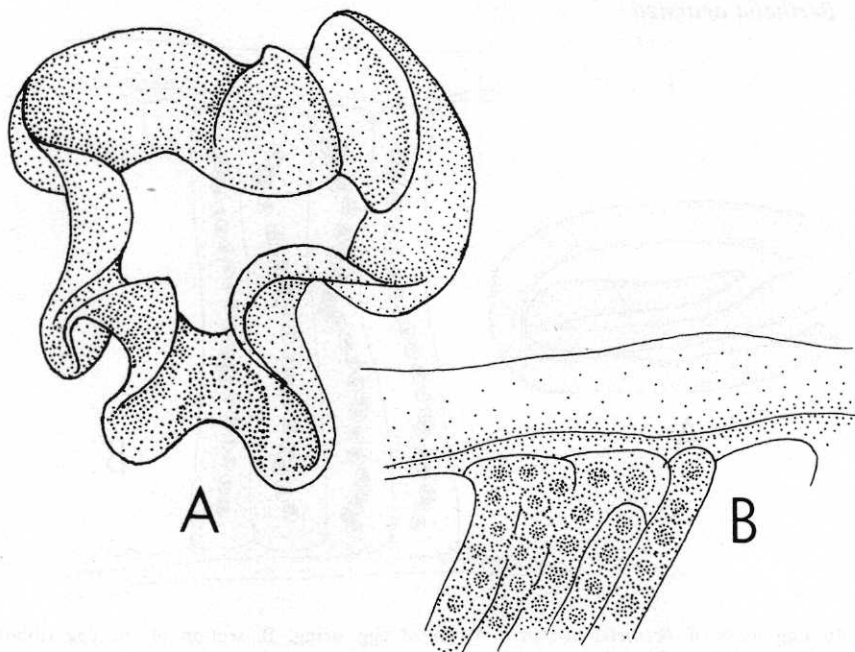


Fig. 17. Egg ribbon of *Pleurobranchus testudinarius*: A. View of the whole egg mass; B. Portion of the egg ribbon demonstrating the turning point of the egg strings near the upper, unattached side of the ribbon.

Animals held in the aquarium attached their egg ribbons to all kinds of hard substrates.

The egg mass is spirally arranged. The ribbon has a shorter attached edge and a longer free edge which than is fluted resembling a rosette. It shows a length of over 10 cm, is 0.8-1.0 mm wide, and about 8 mm high. Within the gelatinous ribbon narrow tubes are arranged in meanders with wall touching each other. These are not oriented vertically within the ribbon but oblique to it. The internal tubes are filled tightly with 0.08 mm wide capsules in such a way that close to the ribbon base capsules form a single row, at the center of the

ribbon 2-3 alternate side by side, and in the upper end of the ribbon up to 10 capsules may be situated alongside. Here the egg ribbon, and with it the tube in its bends, is widened. Each egg capsule holds one white egg. Shortly before hatching the ribbon acquires a pink tinge. After 10 days of development about 300000 pink veligers hatch showing a bilobate velum with long cilia.

18. *Chromodoris neona*

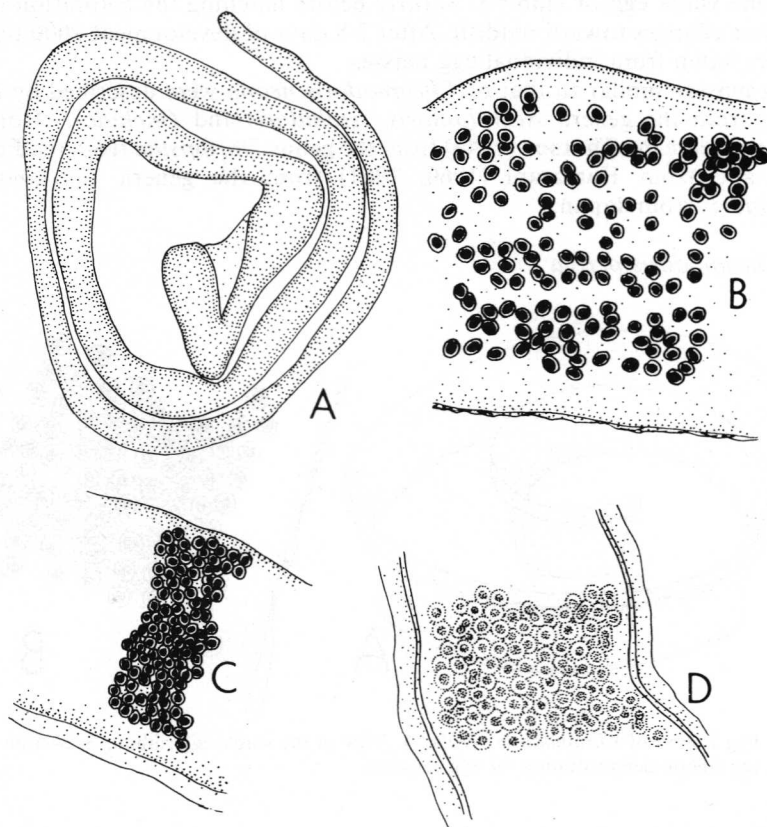


Fig. 18. Egg ribbon of *Chromodoris neona*: A. View of the whole egg mass; B. Section of the ribbon with loose filling of egg capsules; C. Section demonstrating crowded egg capsule filling; D. Section of ribbon which was attached to the surface film of the water.

Animals held in the aquarium produced spiral egg ribbons attached to all kinds of hard substrates. In standing water a female attached its egg ribbon to the surface film of the water.

The egg ribbon is bilaterally flattened and shows equal length of the free and the attached narrow sides. Egg ribbons attached to the surface film show two narrow egg-free ribbons, while on such glued to hard substrates only one

such ribbon forms the attachment. Each jelly ribbon measures up to 5 cm in length, up to 2 mm in height, and 0.4 mm in width. A large variety of patterns of the 0.07 mm wide egg capsules can be observed in different egg ribbons of different individuals. Some show loosely distributed egg capsules in the ribbon (fig. 18b). Others again show a striated appearance due to a capsule pattern in rows or compressed whorls of spiral coils (fig. 18c). Therefore 1 mm of egg ribbon may count only 80 or up to 150 eggs. Each round egg capsule contains only one white egg or embryo. Shortly before hatching the coloration of the egg mass changes toward reddish. After 7-8 days of development 2000 to 7000 veligers hatch from individual egg masses.

Egg masses similar to that of *Chromodoris neona* were described by Hurst (1967) from the genera *Acanthodoris*, *Archidoris* and *Onchidoris* from the eastern Pacific, by Thorson (1940) from the genus *Doriopsilla* from the Persian Gulf, and from Hamatani (1960, 1961) from the genera *Catriona* and *Goniodoris* from Japan.

19. *Chromodoris perola*

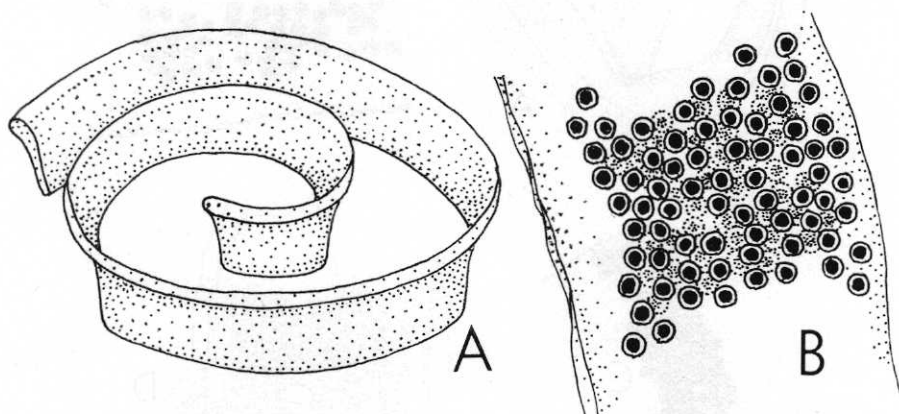


Fig. 19. Egg ribbon of *Chromodoris perola*: A. View of the whole egg ribbon; B. Section of the egg ribbon demonstrating the egg capsules.

Recently collected animals produced very regular spiral egg ribbons on the aquarium walls or on the surface film of the water (hanging down from it).

The ribbon measures about 12 mm in length, 1.5 mm in height, and 0.4 mm in width. It forms a spiral with 1 to 2 whorls and a diameter of 4-5 mm. The ribbon shows the same length along the attached and the free narrow sides. Its upper rim is bent toward the outside of the coil, and thus a concave outside ribbon face is formed. Each round egg capsule contains one white egg. They are distributed at random within the jelly mass of the ribbon. 1 mm of ribbon contains about 150 eggs. After 8-9 days of development up to 2000 glass-clear, colourless veligers hatch.

20. *Peltodoris hummelincki igla*

The orange, coiled spawn of this species was found under a rock in about 3 m of depth in the bay of Santa Marta at the Isla Moro. An animal collected here along with its spawn two days later produced another egg mass now attached to the walls of the aquarium.

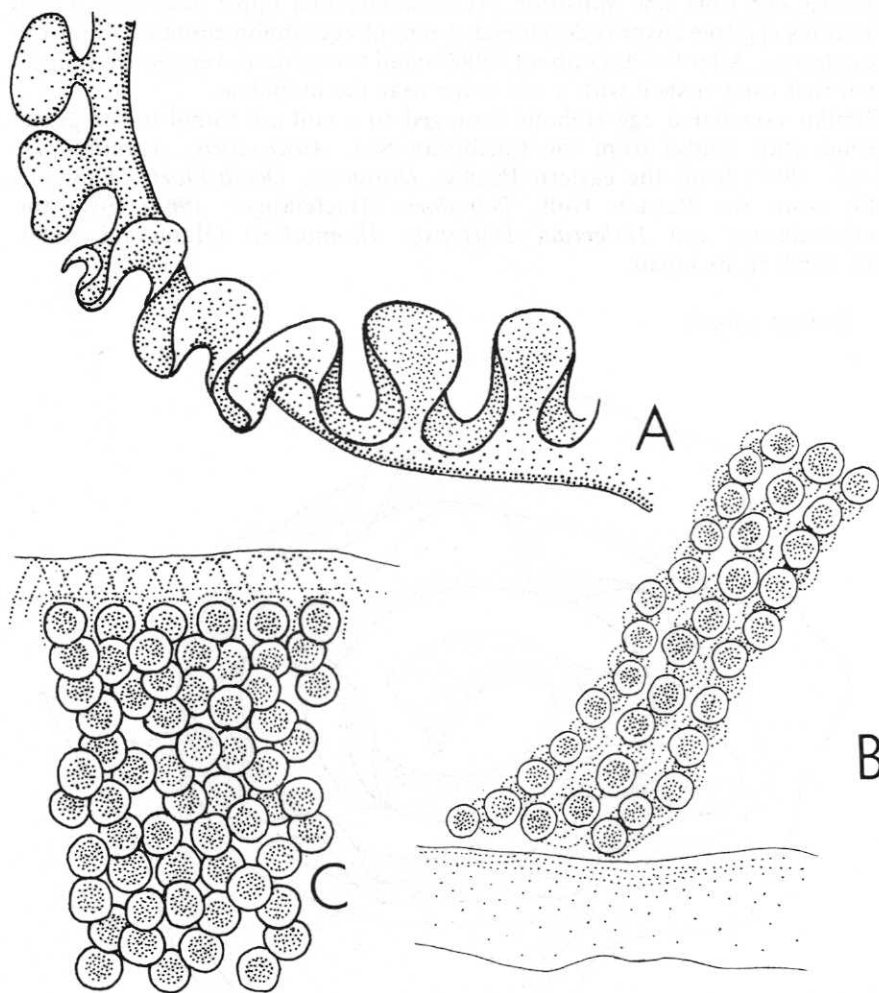


Fig. 20. Egg ribbon of *Peltodoris hummelincki igla*: A. Portion of the egg ribbon coil; B. Section of the lower (attached) part of the egg ribbon demonstrating regular egg strings; C. Section of the upper (free) part of the egg ribbon with capsule crowding.

The egg ribbon is about 23 cm long, 7 mm high, 0.3 mm wide, and attached in a regular coil. The narrow side, that forms the attachment to the substrate, is shorter than the free side. Therefore the ribbon is arranged into strong crenulations. Round egg capsules contain one egg each, and are held in very thin and barely visible tubes in the inside of the ribbon. The jelly mass is filled with one continuous tube which is arranged in a compressed spiral coil with whorls touching each other. Near the attachment a wide gelatinous belt separates egg rows and substrate. At the crenulated upper edge only a thin gelatinous egg-free cover is developed. 1 mm of egg ribbon contains about 150 egg capsules. After 6-7 days about 35000 small transparent, very active veligers hatch that carry a shell with a red stripe near the umbilicus.

Similar crenulated egg ribbons arranged to a coil are found in the genus *Taringa* (this study) from the Caribbean Sea, *Austrodoris*, *Acanthodoris* (Hurst, 1967) from the eastern Pacific, *Disodoris*, *Dendrodoris* (Thorson, 1940) from the Persian Gulf, *Peltodoris* (Haefelfinger, 1961) from the Mediterranean, and *Halgerda*, *Doriopsis*, *Homiodoris* (Hamatani, 1960, 1961, 1962) from Japan.

21. *Taringa telopia*

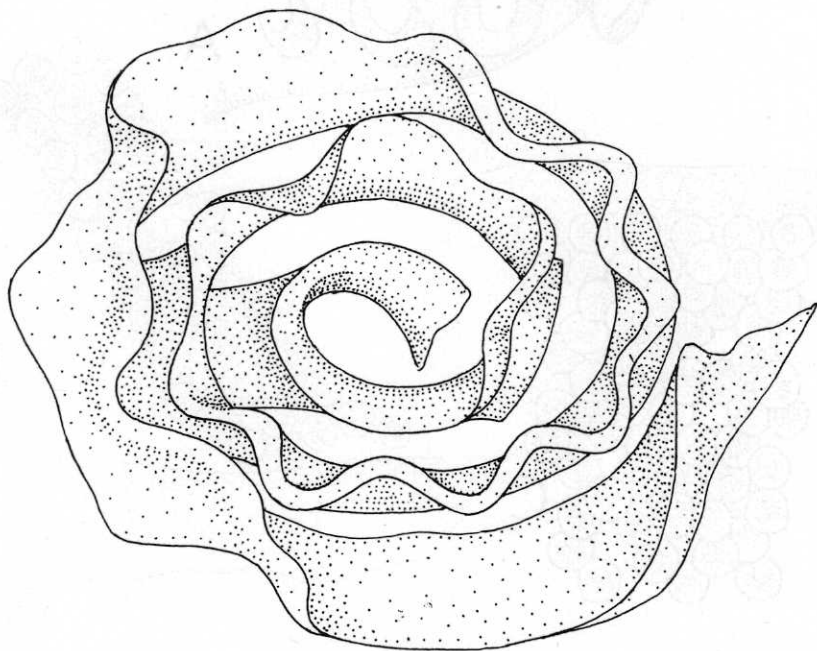


Fig. 21. Egg ribbon of *Taringa telopia*.

The pink, quite conspicuous egg mass was collected in the sea from the underside of rocks in 50 cm of water-depth below the ICAL. Animals just collected spawned frequently in the aquarium attaching their egg ribbon to different substrates.

The narrow, bilaterally compressed gelatinous egg ribbon is attached in spiral arrangement. The coil measures about 8 mm in diameter and counts 2-3 whorls. The ribbon measures 2 mm in height, and 0.5 mm in thickness. It shows a smooth base of attachment and a crenulated free narrow end. Each round egg capsule contains one pink egg and shows a random arrangement within the jelly egg ribbon. After 4-5 days of development small veligers with a transparent light red shell hatch.

22. *Dendrodoris krebssii*

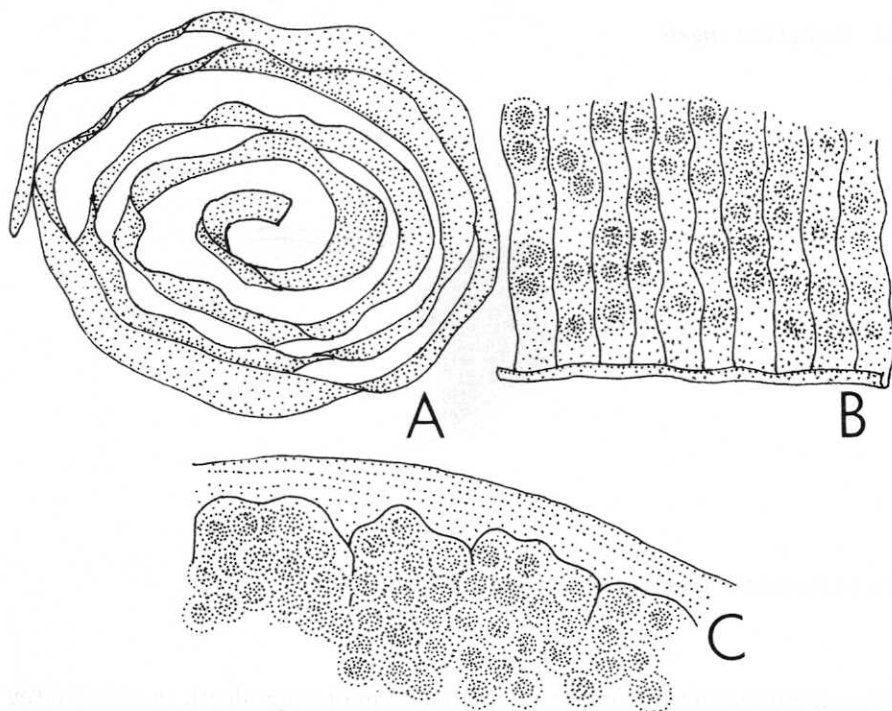


Fig. 22. Egg ribbon of *Dendrodoris krebssii*: A. View of the whole egg mass; B. Section of the attached side of the egg ribbon demonstrating regular egg strings; C. Section of the unattached side of the egg ribbon showing irregular crowding of the egg capsules.

In the sea spiral egg ribbons of this species were collected in 30-50 cm deep water (Santa Marta, Concha, Chengue, Arecifes). They were attached to the undersides of rocks near beaches with moderate or no wave action. In the

aquarium recently collected individuals usually attached their spawn to the glass or plastic walls.

One female produces an up to 10 cm long egg ribbon within or in less than one hour. The 1.5 to 5 mm high, bilaterally compressed, up to 0.5 mm thick egg ribbon is attached in the pattern of a spiral coil with 4-5 whorls and about 1.5 cm diameter. The coil usually shows very regular spacing of the base of attachment. The unattached side is somewhat wider and therefore undulated. The ribbon shows regular segmentation in sheets with one layer of capsules loosely packed at the base, and less clear segmentation and many capsules besides each other tightly packed near top. Each round, 0.07 mm wide capsule contains one white egg. Attachment of the ribbon to the substrate is achieved by a very narrow gelatinous ribbon, while the free edge of the egg development up to 25000 transparent veligers hatch from a single egg mass.

23. *Flabellina engeli*

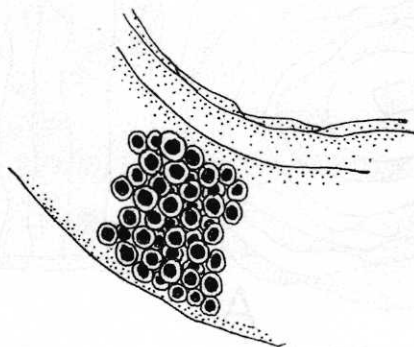


Fig. 23. Portion of the egg coil of *Flabellina engeli*.

The animals collected from stones in about 1 m of water depth spawned in the aquarium attaching their egg mass on the surface film of the water.

The white egg mass is laid in a coil looking like a watch spring. It consists of a 1 cm long, and 0.5 mm wide transparent gelatinous egg string which in section demonstrates a round outline. Attachment to hard substrates or to the surface film of the water is achieved by a narrow gluey ribbon. The egg string contains rounded capsules in tight packing, 5 or 6 capsules deep. Each capsule contains one white egg. After 4 days of development about 300 veligers hatch which carry a colourless transparent shell.

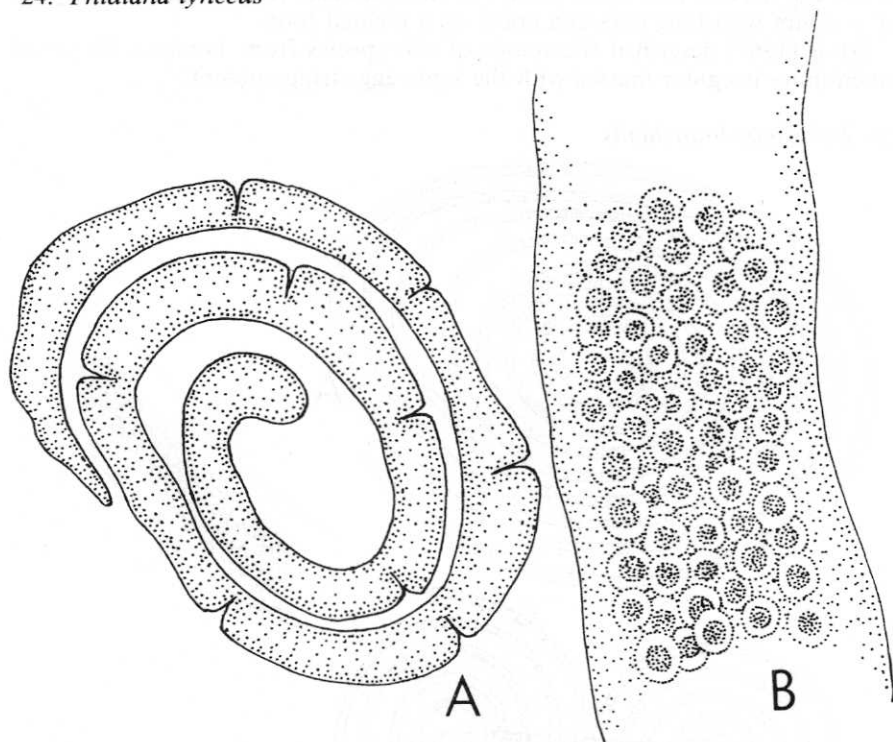
24. *Phidiana lynceus*

Fig. 24. The coiled egg string of *Phidiana lynceus*: A. View of the whole egg mass; B. Section of the egg string with egg capsules crowding in its interior.

Below the ICAL and in the bay of Concha the spiral coil of the egg mass of this species was often found attached to the underside of rocks in about 50 cm deep water. Recently collected animals often attached egg masses to the walls of the aquarium.

The egg mass is arranged in a 3,5 to 5.5 mm wide coil with 1.5 to 2.5 whorls and up to 2.5 cm long string. It is glued to the substrate with a continuous basal narrow ribbon. The string is round in section, measures about 0.4 mm in thickness, and consists of a smooth outer membrane and undulating inner membrane. Within the tube formed by the inner membrane round, 0.1 mm wide egg capsules are crowded to a tight packing. They are arranged in a single row of capsules touching each other. The row is tightly entangled with itself. 1 mm of tube holds 36 to 50 capsules which contain one white egg each. A single egg mass contains 300 to 5000 eggs. Shortly before hatching the embryos turn to become transparent colourless, therefore the white coloration

of the egg mass is lost. After 6 days of development veligers hatch that swim by a velum with long cilia and crawl on a ciliated foot.

Davis (1967) described the spawn of this species from Jamaica. He found much more irregular masses with the same egg string content.

25. *Favorinus branchialis*

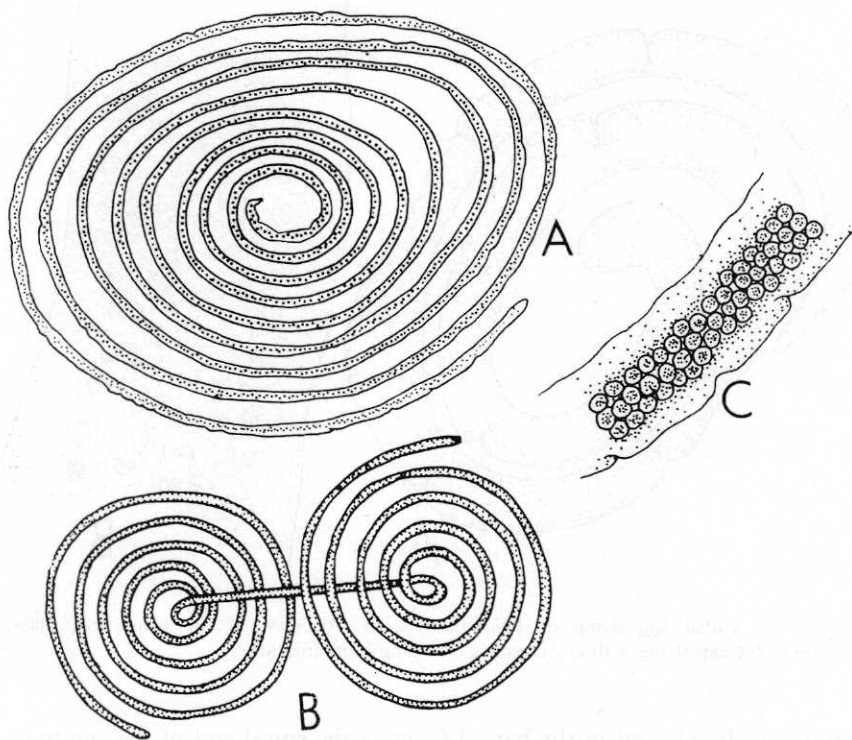


Fig. 25. Egg mass of *Favorinus branchialis*: A. Large coil; B. Egg ribbon produced by one female showing clockwise and anticlockwise coiled parts; C. Short portion of egg ribbon with egg capsules.

Newly collected individuals attached their spawn to the walls of the aquarium. Some also used the surface film of the water for attachment.

The egg string consists of a round, fragile, 0.2 mm wide jelly tube. It is laid in an extremely neat spiral coil that measures 7.5 to 18 mm in diameter, and shows 7 to 18 whorls. These are very regularly spaced to each other. The egg string is round in section and crowded with egg capsules in its interior. 1 mm of string contains about 30 white eggs, each of which is included into a round, up to 0.05 mm wide capsule. The female starts production of the egg coil either with its largest whorl, or begins with the centre (the

smalles whorl). A single spawn sometimes consists of two spiral coils connected to each other in such a way that a left and a right coil show a string bridge between their centres. The first formed coil was started by the clockwise moving female with the largest whorl and continued to the centre. Then the female moved away from the first coil and started a second from the centre in clockwise movement toward the largest and last whorl of the second coil. The clockwise or anticlockwise coiling in this case depends solely on the point of egg string production by the female within the coil. After 4-5 days of development 1700 to 2000 veligers hatch from the mass.

Flabellina engeli, *Phidiana lynceus*, and *Favorinus branchialis* from the Caribbean Sea show very similar egg masses. Hurst (1967) described simple coiled masses from the genera *Coryphella* and *Olea* from the Pacific, and Haefelfinger (1960) such from *Trapania* and *Polycera* from the Mediterranean. *Favorinus branchialis* from the North Sea (Rasmussen, 1951) secretes similar spawn to the here described, but the spacing of the whorls of the coil is much tighter than that of the Caribbean representative of this species.

26. *Dondice occidentalis*

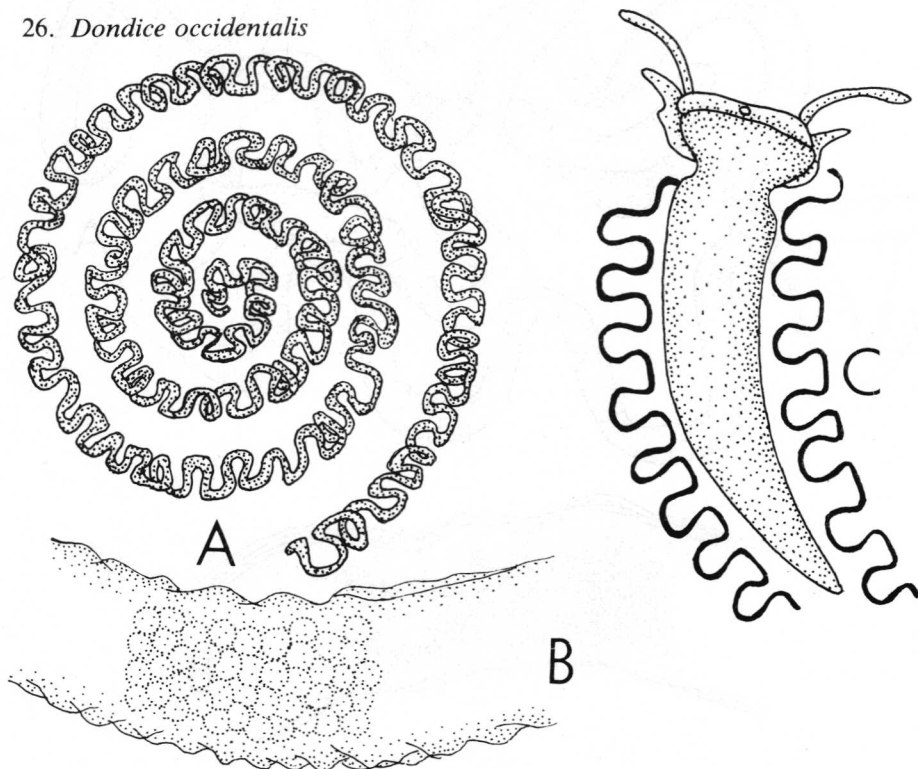


Fig. 26. Egg mass of *Dondice occidentalis*: A. View of the whole egg mass; B. Portion of the egg string demonstrating crowded egg capsules; C. Female producing the egg string in very regular spacing of following whorls.

Animals recently collected in the sea produced spawn and attached it to the walls of the aquarium.

The regularly spirally coiled egg mass shows 4-5 whorls. Distance between whorls coincides with the breadth of the egg laying female (fig. 26c). The soft jelly tube is attached to the substrate by a discontinuous sticky ribbon. Therefore attached egg string alternates with a free string which then forms free loops. The female secretes about 2 mm of egg string per minute. Egg capsules 0.05 mm wide are crowded tightly in the tube interior; each contains one egg. About 100 eggs may be counted in 1 mm of egg string. After 4 days of development clear transparent veligers hatch.

27. *Spurilla neapolitana*

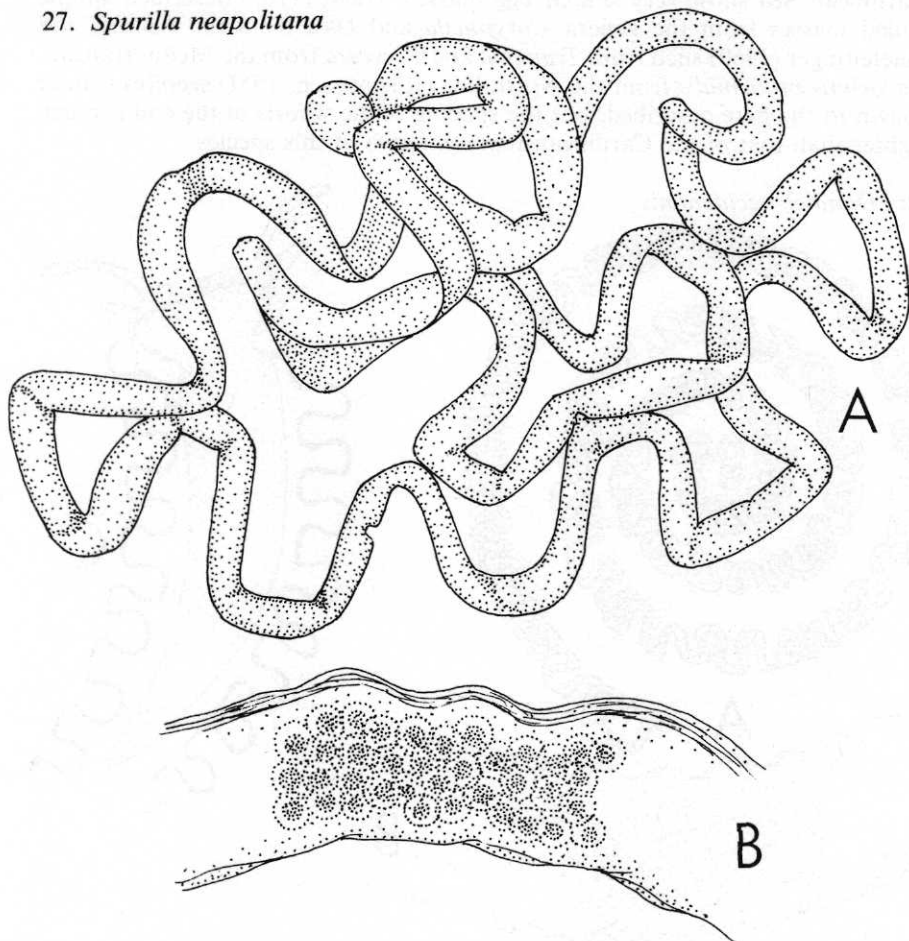


Fig. 27. Egg mass of *Spurilla neapolitana*: A. View of the whole egg mass; B. Portion of the egg string with capsular filling.

The egg masses of this species were commonly found attached to the undersides of rocks just below the ICAL in 30 cm deep water. Recently collected animals spawned in the aquarium attaching their egg strings to the walls.

The spiral coil of the egg string shows an irregular appearance because attachment to the substrate is achieved by a discontinuous sticky ribbon. Spacing in the attached parts of the string of *S. neapolitana* is wider than that found in the spawn of *Dondice occidentalis*. Therefore free loops are larger and those of different whorls in the coil may touch or overlap each other. The tube-like string shows a round diameter of 1 mm width and is arranged in a coil showing somewhat more than two whorls and a diameter of 7-11 mm. A straightened egg string measures up to 7 cm in length. The eggs are contained in round, 0.05 mm wide capsules with 1-3 in one. They are arranged in a capsule string with neighbouring capsules touching each other. 1 mm of egg string contains 50-80 eggs. Shortly before hatching the white spawn changes its coloration to a bright red. After 5 days of development reddish veligers hatch.

Similarly arranged egg masses as those found with *Dondice* and *Spurilla* from the Caribbean Sea were described by Hurst (1967) from the genera *Aeolidia*, *Dendronotus*, *Tritonia*, *Coryphella* from the Pacific, and by Haefelfinger (1961) from the genus *Hervia* of the Mediterranean Sea.

DISCUSSION

The types of opisthobranch spawn described here can be differentiated into 12 different morphological groups. Hurst (1967) distinguished 4 groups, 3 of which are also represented in this study. Her group of the egg masses of type A includes egg ribbons of dorids just as well as such of *Haminoea*. Egg masses of type B include the fragile aeolid spawn as well as more durable types of saccoglossans. Type C of Hurst includes ovoid to globular jelly masses attached by a jelly string, and type D combines small, often sac-like spawns, not represented in this study.

A further differentiation of the egg masses of opisthobranchs described here is represented:

I. Group of *Atys riiseanus*:

Globular gelatinous egg masses anchored to the substrate by an elastic string. Egg capsules 1 egg each.

II. Group of *Berthellina quadridens*:

Ovoid, soft jelly mass attached broadly to the substrate. Egg capsules 1 egg each.

III. Group of *Berthella agassizii*:

Long, in section ovoid rods arranged spirally. Egg capsules 1 egg each.

IV. Group of *Aglaja evelinae*:

Cup-shaped jelly mass. Egg capsule 1 egg each.

V. Group of *Favorinus branchialis*:

Soft, fragile egg string of round diameter, on smooth substrates attached

along whole base in clockwise or anticlockwise coiled spirals. Egg capsule one egg each. (Here also *Flabellina engeli*, *Phidiana lynceus*).

VI. Group of *Spurilla neapolitana*:

Like VI but with alternating free and attached string portions. Egg capsules 1-3 eggs each. (here also *Dondice occidentalis*.)

VII. Group of *Bulla solida*:

Resistant egg string of round or somewhat ovoid diameter attached irregularly or in meanders. Egg capsules 1-3 eggs each. (here also *Elysia ornata*, *Dolabrifera dolabrifera*, *Stylocheilus longicauda*.)

VIII. Group of *Aplysia cervina*:

Rubbery, resistant egg string of round diameter forming twisted irregular masses. Egg capsule 10-15 eggs each. (here also *Aplysia brasiliana*, *Bursatella leachii pleii*.)

IX. Group of *Pleurobranchus testudinarius*:

Narrow ribbon attached to smooth substrates in coil. Free side smooth or crenulated. Egg capsules 1 egg each. (here also *Tridachia crispata*, *Chromodoris neona*, *C. perola*, *Peltodoris hummelincki igla*, *Taringa telopia*, *Dendrodoris krebsii*.)

X. Group of *Hydatina vesicaria*:

Egg ribbon attached along whole length to elastic central string that extends into the substrate and anchors the mass there. Egg capsules more than 5 eggs each.

XI. Group of *Haminoea antillarum*:

Egg ribbon consisting of bilaterally compressed, hollow gelatinous tube. Egg capsules 1-3 eggs each. (here also *H. elegans*.)

XII. Group of *Phyllaplysia engeli*:

Flat, rectangular to comb-like egg masses. Egg capsules one egg each.

Gelatinous egg masses as those described from different opisthobranchs in this study can be found in similar arrangement and composition in all gastropod subclasses and in many orders. Within the subclass *Opisthobranchia* (Classification used: Myra Keen, 1971) the jelly masses, to our knowledge, are the normal type of spawn, while in the subclass *Prosobranchia* both gelatinous masses as well as solid egg cases can be found, and in the subclass *Pulmonata* even calcareous egg-shells may be developed.

Within the *Prosobranchia* gelatinous egg masses can only be found among the lower mesogastropods, as Bandel (1976) demonstrated. The irregularly looped egg string united in the group of *Cerithium litteratum* (Bandel, 1976) may be compared in shape, with those of the group of *Bulla solida*, but in consistency more with the groups of *Favorinus branchialis* and *Spurilla neapolitana*. Coiled egg strings of the group of *Alaba incerta* (Bandel, 1976) have quite the same shape as that of the egg masses in the group of *Favorinus branchialis*. Egg ribbons of the group of *Modulus modiolus* can well be compared with those of *Haminoea*. Both show an internal egg mass cavity and consist of spirally coiled egg tubes in a jelly cover. The egg masses of *Architectonica nobilis* are attached to the soft substrate similarly as those of *Hydatina*

vesicaria, with mucoid roots. Attachment of individual capsules by threads or empty capsules as seen in *Aglaja evelinae*, and *Berthellina quadridens* may be found in the group of spawn characterized by *Architectonica nobilis* (Bandel, 1976) with some mesogastropods, pyramidellids, and marine pulmonates. The rubbery, gelatinous egg ribbons of the *Aplysia cervina* group show similarities to strombacean spawn (Bandel, in press).

If opisthobranch spawn is compared with such of some *Archaeogastropoda*, as for example from the superfamilies *Pleurotomariaceae*, *Patellaceae*, and *Trochaceae* or of marine pulmonates (Haven, 1973; Voss, 1959) or with gelatinous egg masses of lower mesogastropods the closest links can be seen to the later. This may perhaps reflect taxonomic relationships between lower *Mesogastropoda* on one side and *Opisthobranchia* on the other.

SUMMARY

The morphology and structure of the spawn of 27 different opisthobranch gastropods is described, 24 for the first time. The time necessary for development and the type of hatching young are noted. Relationships of the Caribbean opisthobranch egg masses to opisthobranch and prosobranch egg masses known from the literature are discussed.

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