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New forms of *Diacria quadridentata* (de Blainville, 1821),
Cavolinia longirostris (de Blainville, 1821) and *Cavolinia*
uncinata (Rang, 1829) from the Red Sea and the
East Pacific Ocean (Mollusca, Pteropoda)

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ABSTRACT

Two subspecies new to science: *Diacria quadridentata erythra* and *Cavolinia uncinata pulsatapusilla* are described from the Red Sea. The formae: *D.q. quadridentata* forma *schmidti*, *D.q. erythra* forma *erythra*, *D.q.e.* forma *crassa*, *C. longirostris* forma *flexipes*, *C. uncinata pulsatapusilla* forma *pulsatapusilla* and *C.u.p.* forma *pulsatoides* new to science are described from the Pacific Ocean and Red Sea.

INTRODUCTION

This paper deals with a small collection of Cavoliniinae, collected in the Red Sea by Drs. Ch. Lewinsohn and L. Fishelson and, with one sample of the Dana Expedition from the East Pacific Ocean. The Red Sea material is preserved in the Department of Zoology of the Tel-Aviv University and in the Zoological Museum in Amsterdam, the Dana sample is preserved in the Zoological Museum in Copenhagen and in the Institute of Taxonomic Zoology (Zoological Museum) in Amsterdam. Four new formae in two new subspecies are described from the Red Sea viz.: *Diacria quadridentata* (de Blainville, 1821) subsp. *erythra* forma *erythra* and forma *crassa* and *Cavolinia uncinata* (Rang, 1829) subsp. *pulsatapusilla* forma *pulsatapusilla* and forma *pulsatoides*. *Cavolinia longirostris* (de Blainville, 1821) from the Red Sea proved to differ also slightly from all known formae and the new forma *flexipes* is erected for these specimens. The new forma *crassa* is compared with the larger representatives of *Diacria quadridentata* recorded by Tesch (1948) from the

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East Pacific. These East Pacific specimens prove to belong to a fifth new forma for which the name *schmidti* is proposed.

It is clear that the present author takes the risk of being criticized as a splitter who does not describe new valid taxa. The "forma" has no nomenclatorial status, and all these new formae give considerable difficulties with the identification indeed; but distinguishing different formae makes it possible to practise real zoogeography with planktonic animals.

ZOOGEOGRAPHY

The shallow depth near Hanisch Island forms a barrier between the Red Sea and Indian Ocean populations, but this barrier does not absolutely prevent migration of specimens through the entrance of the Red Sea. Important is perhaps the high temperature and salinity of the Red Sea and the unusual conditions of this sea at greater depth, below 300 meter. The ecological influences and the effects of selection by mere ecological factors on shell shape are very important (van der Spoel, 1970). Speciation in the Red Sea may have started as an effect of the aberrant ecological circumstances and of the, though not absolute, barrier between Indian Ocean and Red Sea (cf.: Klausewitz, 1969).

The Red Sea is relatively new; it developed in the Tertiary period and was completely separated from open oceans during the first glacial period. The recent influence of the Suez canal can be neglected for planktonic pteropods, as the canal is too shallow, and migration is only successful in northward direction.

Geological evidences concerning *Diacria* and *Cavolinia* are given by Herman-Rosenberg (1965). This author refers only to *Diacria* spp., *Cavolinia* spp. and *Cavolinia longirostris*, but it is clear from the accompanying data and figures given that the unidentified specimens belong chiefly to resp. *Diacria quadridentata*, *Cavolinia longirostris* and *C. uncinata* (see also Herman, in the press).

Diacria spp. (cf. *quadridentata*) is found in the Red Sea between 17°N and 26°N in the last interglacial period, south of 17°N it occurred during the last glacial period and north of 26°N it occurred in the postglacial.

Cavolinia spp. (cf. *uncinata*) is found south of 26°N since the last interglacial and north of 26°N only since the last glacial.

From the tables given by Herman-Rosenberg (1965) it is clear that the populations of *Diacria* and *Cavolinia* disappeared during each relative cold period, so that we must assume that the recent populations have developed in postglacial times. This implies that the formae described below are not likely to be autochthonous relicts from the Tethyan fauna.

The occurrence of endemic elements in the Gulf of Aqaba is as well known as the occurrence of endemic species in the Red Sea, but it is more difficult to explain. An additional problem is that the formae of *Cavolinia uncinata* and *Diacria quadridentata* described below from the Gulf of Aqaba resemble more the representatives of these species from the Indian and Pacific Oceans

than their relatives from the Red Sea. The Gulf of Aqaba is a rather isolated basin but how did speciation start here. There is a possibility that specimens of the two species have been brought to the Gulf by ships in water used as ballast. This would explain the greater resemblance of the Aqaba populations, sampled near the larger harbours of Elath and Aqaba, with specimens from the open ocean. But I do not believe that a transport of this kind would be effective as the animals are not likely to survive a period of several days in the ship's tank. That the specimens in the Gulf of Aqaba are the descendants of a Tethyan fauna occurring there before the first glacial period is hardly possible. In the second glacial period, the time in which the Red Sea complex stopped to receive Tethyan fauna elements, the Gulf of Aqaba did not exist: a further indication that we are not dealing with autochthonous relicts of the Tethyan fauna.

The resemblance of Erythrean species with East Pacific species is also found in Foraminifera (Herman-Rosenberg, 1965). The specimens of *Globorotalia menardii* (d'Orbigny, 1826) from the Quarternary sediments of the southern Red Sea and the Gulf of Aqaba differ from the typical form and resemble the specimens from tertiary deposits of the equatorial Eastern Pacific. This distribution is explained by Herman-Rosenberg (1965) as a possible relict of a Tethyan fauna, though she also gives much attention to ecological factors independent from the Tethyan. Other examples of infraspecific taxa which have developed in the East Pacific Ocean are the distinct East Pacific forms of the circumglobal Amphipods *Phronima colletti* Bovallius, 1887 and *P. stebbingi* Vosseler, 1901 (Shih, 1969).

In my opinion it is correct to consider the populations from the Gulf of Aqaba and the Red Sea as directly descending from Indian Ocean populations. In the Erythrean populations speciation started under the influence of external conditions without complete isolation which may result in concentration of different genes (cf. van der Spoel, 1971) in different parts of the range. In favour of this hypothesis is the fact that the Red Sea specimens of both species are smaller than the Indian Ocean specimens while the specimens of both species from the Gulf of Aqaba are larger than those from the Red Sea and also larger than those from the Indian Ocean.

ACKNOWLEDGEMENTS

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TAXONOMY

Genus **Diacria** Gray, 1847

Diacria quadridentata (de Blainville, 1821)

In this species three formae were known: forma *quadridentata* from the Atlantic and Indian Oceans, forma *orbignyi* from Atlantic, Indian and Pacific

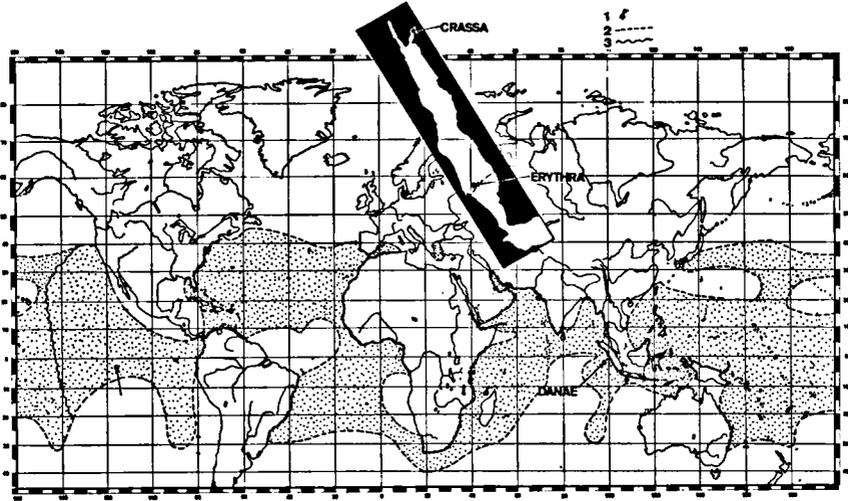


FIG. 1. Map of *Diacria quadridentata* with the type locality of the three formae described;

- 1 locality where the formae *danae* is found (cf. van der Spoel, 1969; Frontier, 1963).
- 2 border of the distribution of the subspecies *quadridentata*.
- 3 probable west border of the distribution of the forma *schmidtii* (cf. Tesch, 1948).

Oceans and forma *danae* from the Indian and Atlantic Oceans. These three formae belong to one subspecies *D.q.* subsp. *quadridentata*. From the Red Sea a subspecies, a geographic isolate, new to science is recorded for which the name *erythra* is proposed; this subspecies is divided into the forma *crassa* from the Gulf of Aqaba and the forma *erythra* from the Red Sea near the Dahlak Archipelago. The third forma new to science from the East Pacific is considered to belong to the subspecies *quadridentata* from the open ocean; the name *schmidtii* is proposed for it. The distribution of the species is given in figure 1.

Diacria quadridentata (de Blainville, 1821) subsp. ***quadridentata*** (de Blainville, 1821) forma ***quadridentata*** (de Blainville, 1821); (Fig. 5).

Synonymy: *Hyalaea quadridentata* de Blainville, 1821: 81 (see also: van der Spoel 1967, 1968, 1969; correction: last sentence under fig. 2 van der Spoel, 1969 — read: *orbigny*; C: forma *quadridentata* —).

Distinguishing characters: Dorsal ribs less developed, transversal striation on dorsal and ventral surface faint, posterior part of ventral surface concave, lateral spines well developed curved caudad, small part of ventral side visible in dorsal view. Shell length 2.2—2.9 mm, shell length/width ratio 1.0—1.3, diameter caudal spine mark 0.92—1.12 mm.

Diacria quadridentata (de Blainville, 1821) subsp. **quadridentata** (de Blainville, 1821) forma **orbignyi** (Souleyet, 1852); (Fig. 4).

Synonymy: *Hyalaea orbignyi* Souleyet, 1852: 40, pl. 3, figs 16—18 (see also van der Spoel, 1967, 1968).

Distinguishing characters: Dorsal ribs very well developed, transversal striation on dorsal and ventral surface well developed, ventral side regularly rounded, lateral spines less developed not curved caudad. The distance between these spines is relatively small, dorsal striae are imbricate and more than four in number. Shell length 1.9—2.3 mm, shell length/width ratio 1.05—1.35, diameter caudal spine mark 0.72—0.92 mm.

Diacria quadridentata (de Blainville, 1821) subsp. **quadridentata** (de Blainville, 1821) forma **danae** van der Spoel, 1968; (Fig. 3).

Synonymy: *Hyalaea minuta?* Sowerby, 1878: pl. 2, fig. 9
Diacria quadridentata forma *danae* van der Spoel, 1969: 105, figs 1—2.

Distinguishing characters: Dorsal ribs normally developed, transversal striae on dorsal and ventral surface moderately developed, ventral surface regularly vaulted, lateral spines rather well developed, dorsal striae imbricate and about three in number. Shell length 1.3-1.9 mm, shell length/width ratio 1.12-1.36, diameter caudal spine mark 0.50—0.72 mm.

Diacria quadridentata (de Blainville, 1821) subsp. **erythra** n. subsp. forma **erythra** n. forma; (Fig. 6).

Etymology: the name *erythra* is derived from Erythrea (= Red Sea).

Description: The upper lip is provided, as in the forma *orbignyi*, with a thickened band and curves only slightly ventral. The dorsal surface is supplied with five rather strong ribs which come gradually to an end caudad. There are about 8—9 imbricate very clear-cut transversal striae on the dorsal surface besides numerous finer ones more caudally. The ventral surface is vaulted as in the forma *quadridentata* and provided with sharp imbricate transversal striae. The caudal spine mark is of a moderate diameter; the line connecting the corners of the mark, the posterior spines, and the lateral or anterior spines, is only slightly concave. The ventral side is slightly broader than the dorsal side so that it is usually projecting with a small strip outside the dorsal side. The distance between the tops of the lateral spines is slightly larger than the greatest width of the upper lip in the dorsal view; the width of the upper lip is measured between the outbulging points of the lip just above the closing mechanism. The ventral shell lip is free from the ventral side but very small. The colour pattern is almost lost in the dry specimens and the only remains of colour are found on the dorsal lip and ventral lip. The shell resembles most that of the forma *orbignyi*, morphometric characters also indicate a certain relation with this forma (Fig. 2).

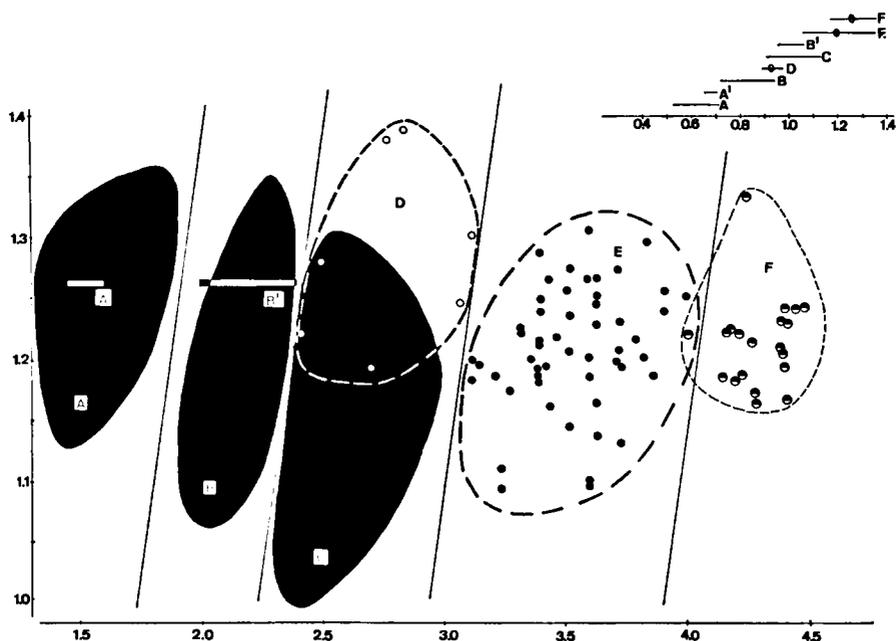


FIG. 2. Graph of shell length on x axis and the ratio shell length/width on y axis of *Diacria quadridentata quadridentata* forma *danae* (A) forma *orbignyi* (B) forma *quadridentata* (C), *D.q. erythra* forma *erythra* (D), forma *crassa* (E) and of *D.q.q* forma *schmidti* (F), with the length variation of the forma *danae* and *orbignyi* as found by Frontier, 1963 indicated with A' and B' resp. Inset gives the variation of the diameter of the caudal spine mark in mm (signes comparable with those in the graph).

| | Shell length | width | thickness | diam. caudal spine mark | length/width ratio |
|-------|--------------|---------|-----------|-------------------------|--------------------|
| Max.: | 3.12 mm | 2.48 mm | 2.28 mm | 0.96 mm | 1.39 |
| Min.: | 2.46 mm | 2.00 mm | 1.80 mm | 0.90 mm | 1.19 |

Type locality: Dahlak Archipelago, 15°32'30''N 40°23'E, 22-X-1965, 60 fath. Coll. L. Fishelson, ISRSE/65 3592. The holotype is kept (dry) in the Department of Zoology of the Tel-Aviv University together with two paratypes, one paratype is kept in the Zoological Museum of the University of Amsterdam.

Distinguishing characters: Dorsal ribs well developed, transversal striae on dorsal and ventral surface very well developed, ventral side thicker than in the known formae but not as thick as in the forma *crassa*. Lateral spines as in the forma *danae* directed somewhat cranially, up to 9 imbricate dorsal striae.

Diacria quadridentata (de Blainville, 1821) subsp. **erythra** forma **crassa** n. forma; (Fig. 7).

Etymology: the name *crassa* means thick.

Synonymy: probably considered as forma *quadridentata* by previous authors.

Discription: Upper shell lip not thickened by a band as in the other formae, but by a tongue-shaped margin. The upper lip projects far ventrad. The dorsal surface is provided with five very strong longitudinal ribs which continue up to the border of the spine mark. About 6 thin but distinct, imbricate transversal striae are found on the dorsal surface and numerous faint ones more caudally. Most typical for the dorsal ribs is that they are separated by depressions which are U-shaped in cross-section. The ventral surface is strongly vaulted and provided with numerous clear transversal striae. The bulging of the ventral side is so strong that shell thickness becomes equal to shell width. The caudal spine mark is relatively narrow. The line between the corners of the caudal spine mark and the lateral spines is only slightly concave which is typical for the subspecies *erythra*. Another typical character in the subspecies is the fact that the ventral side is clearly visible when the animal is inspected in dorsal view. The distance between the lateral spine tops is slightly smaller than the greatest width of the dorsal lip in dorsal view. The ventral lip is not rising upright from the ventral side of the shell but it is curled so strongly that it becomes coiled against the ventral side. The colour pattern is nearly completely lost in the dry specimens but a brown hue still covers the dorsal lip and upper half of the ventral surface so that these parts may have been dark brown in the living specimens. From fig. 2 the morphometric place of this forma is clear. The shell shape resembles that of the other formae of the species it is only an exceptionally large form. The size of this forma is only exceeded by that of specimens of the species collected in the East Pacific Ocean.

| | Shell length | width | thickness | diam. caudal spine mark | length/ width ratio |
|-------|-----------------|---------|-----------|----------------------------|------------------------|
| Max.: | 4.00 mm | 3.32 mm | 3.16 mm | 1.36 mm | 1.29 |
| Min.: | 3.12 mm | 2.60 mm | 2.40 mm | 1.04 mm | 1.09 |

Type locality: Near Elath, Israel, 6-IX-1966, Coll. Ch. Lewinsohn, NS 5995. The holotype and 12 paratypes are kept (dry) in the Department of Zoology of the Tel-Aviv University, 4 paratypes are preserved in the Zoological Museum of Amsterdam.

Distinguishing characters: Dorsal ribs very strongly developed, transversal striation on the ventral and dorsal surfaces very well developed, ventral surface strongly vaulted so that thickness is equal to shell width, and the ventral side is clearly seen in dorsal view. Lateral spines faintly developed and placed far caudad. Dorsal striae imbricate, about 6 in number.

Diacria quadridentata (de Blainville, 1821) subspecies **quadridentata** (de Blainville, 1821) forma **schmidti** n. forma; (Fig. 8).

Etymology: The name *schmidti* is given in honour to the leader of the Dana Expeditions, Dr. J. Schmidt.

Synonymy: *Hyalaea inermis?* Gould, 1852: 487 (1856) pl. 51 fig. 604^{a-c}; "lager form", Tesch, 1948: 24.

Description: The upper lip, provided by a thickened band, is not projecting far ventrally, this is comparable with the structure in the forma *orbigny*. The dorsal side is supplied with five moderately developed ribs coming gradually to an end before the border of the caudal spine mark. On the dorsal surface only two distinct imbricate transversal striae and numerous faint ones are found. The ventral surface is strongly vaulted but not as heavy as in the forma *crassa*, faint transversal striae in which the imbricate structure is hardly visible are found on this side. The caudal spine mark is relatively small in diameter. The line connecting the corners of the caudal spine mark with the lateral spine tops is clearly concave, lunar shaped, like in the other formae of this subspecies. Though this forma is much larger than the forma *crassa* only a narrow strip of the ventral side is sometimes seen in dorsal view of the shell. The distance between the points of the lateral spines is about equal to the greatest width of the upper lip in dorsal view. The ventral shell lip is small but freely projecting from the ventral shell surface. The colour pattern in this forma consists, in the alcohol material, of a slight brown hue over the whole cranial half of the shell while the shell becomes white near its caudal spine mark. This forma is described together with the Red Sea material to show its difference with the large forma *crassa*. This forma is larger than the other formae in the species as shown in figure 2.

| | Shell length | width | diam. caudal spine mark | length/width ratio |
|-------|-----------------|---------|----------------------------|-----------------------|
| Max.: | 4.48 mm | 3.80 mm | 1.36 mm | 1.33 |
| Min.: | 4.00 mm | 3.20 mm | 1.16 mm | 1.16 |

Type locality: Dana stat. 3561^z, 4°20'S 116°46'W, 24-IX-1928, 21³⁰ hrs. The holotype is kept (in alcohol) in the Universitetets Zoologiske Museum Copenhagen with 15 paratypes, five paratypes are kept in the Zoological Museum of Amsterdam.

Distinguishing characters: Dorsal ribs moderately developed, transversal striae on ventral and dorsal surface weakly developed, the ventral surface is regularly rounded and in some specimens this side is seen when they are inspected in dorsal view. The lateral spines are well developed and bent dorsad. The imbricate dorsal ribs are only 2 or 3 in number.



FIG. 3. *Diacria quadridentata quadridentata* forma *danae* in dorsal (A), ventral (B) and lateral (C) view. (x 10 approx.).

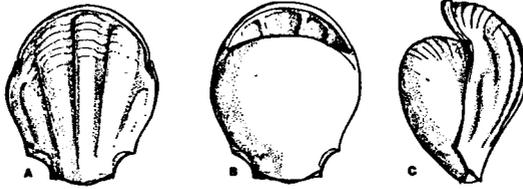


FIG. 4. *Diacria quadridentata quadridentata* forma *orbigny* in dorsal (A), ventral (B), and lateral (C) view. (x 10 approx.).

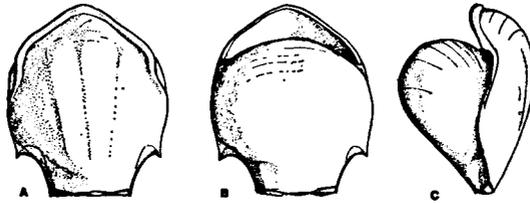


FIG. 5. *Diacria quadridentata quadridentata* forma *quadridentata* in dorsal (A), ventral (B), and lateral (C) view (x 10 approx.).

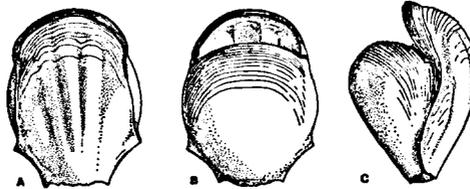


FIG. 6. *Diacria quadridentata erythra* forma *erythra*, the holotype, in dorsal (A), ventral (B), and lateral (C) view (x 10 approx.).

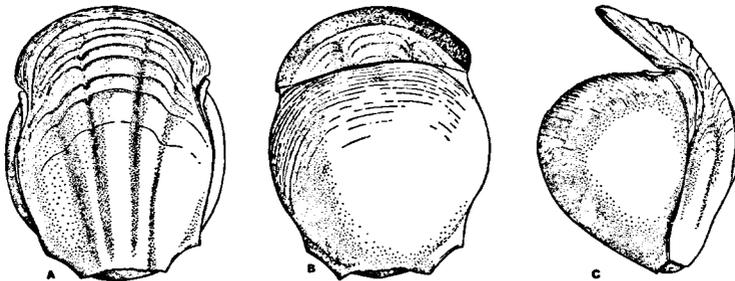


FIG. 7. *Diacria quadridentata erythra* forma *crassa*, the holotype, in dorsal (A), ventral (B), and lateral (C) view (x 10 approx.).



FIG. 8. *Diacria quadridentata quadridentata* forma *schmidti*, the holotype, in dorsal (A), ventral (B), and lateral (C) view (x 10 approx.).

Genus *Cavolinia* Abildgaard, 1791

Cavolinia uncinata (Rang, 1829)

In this species three formae are known: forma *uncinata* from the Atlantic Ocean, forma *pulsata* from the Indian and probably Pacific Ocean (cf. McGowan, 1968) and forma *roperi* from the North Atlantic Ocean. These formae together are considered to form the subspecies *uncinata*. The two formae, *pulsatapusilla* and *pulsatoides* new to science from the Red Sea, are considered to constitute the other subspecies new to science for which the name *pulsatapusilla* is proposed. The distribution of this species is in general similar to that of *Diacria quadridentata* given in figure 1.

Cavolinia uncinata (Rang, 1829) subsp. *uncinata* (Rang, 1829) forma *uncinata* (Rang, 1829): (Fig. 13).

Synonymy: *Hyalea uncinata* Rang, 1829: 114 (see also van der Spoel, 1967, 1969).

Distinguishing characters: Shell not coloured, nearly straight projecting lateral spines, short caudal spine bending slightly dorsad, the shell aperture is either wide or narrow. On the ventral surface a slight hammered structure is found. Shell length is 5.5—7.5 mm and shell width is 4.0—6.6 mm.

Cavolinia uncinata (Rang, 1829) subsp. *uncinata* (Rang, 1829) forma *pulsata* van der Spoel, 1969: (Fig. 14).

Synonymy: *Cavolinia uncinata* forma *pulsata* van der Spoel, 1969: 193, figs 4, 6^a, 7^a.

Distinguishing characters: Shell with a brown hue, lateral spines curved strongly caudad, the short caudal spine bends slightly dorsad, the shell aperture is wide, and the shell surface shows a strong hammered structure. Shell length 6.0—9.2 mm, shell width 4.5—7.0 mm.

Cavolinia uncinata (Rang, 1829) subsp. **uncinata** (Rang, 1829) forma **roperi** van der Spoel, 1969; (Fig. 10).

Synonymy: *Cavolinia uncinata* forma *roperi* van der Spoel, 1969: 194, figs 5, 6^b, 7^a.

Distinguishing characters: Shell with dark brown colour patches, lateral spines curved slightly caudad, the long caudal spine is strongly curved dorsad. The shell aperture is narrow; on the ventral surface a faint hammered structure is found. Shell length 3.5—5.0 mm, shell width 3.0—4.5 mm.

Cavolinia uncinata (Rang, 1829) subsp. **pulsatapusilla** n. subsp. forma **pulsatapusilla** n. forma; (Fig. 11).

Etymology: this small forma, resembling *pulsata*, is named the small (= *pusilla*) hammered (= *pulsata*).

Description: The shell shows faint growth-lines and a longitudinal striation which cause a hammered structure on the ventral surface like in the forma *pulsatoides*. The dead shells are completely colourless and bright hyaline. The imbricate transversal striae, about eight in number, on the ventral side are very fine. The embryonic shell is usually broken off; the long caudal spine is bent slightly dorsad. The lateral spines do not bend dorsad but they project far caudad. The line connecting the tops of lateral and caudal spines is not regularly curved but usually nearly straight in the middle. The aperture is narrow slit-like caudal to the closing mechanism and wide in its median part, but not as triangular in shape as in *pulsatoides* and *pulsata*. The ventral surface and lip are depressed near the median line. The ventral lip develops gradually out of the ventral side. The dorsal lip differs from the dorsal surface by the lack of the dorsal ribs, this dorsal surface is very flat and the dorsal ribs are very faint and invisible when illumination is not optimal. The ventral surface is regularly rounded. This forma is a small copy of the forma *pulsata*; in size (Fig. 9) it is an intermediate between the forma *roperi* and the forma *pulsata* but it cannot be a genetic intermediate.

| | <i>Shell length</i> | <i>Shell width</i> |
|-------|---------------------|--------------------|
| Max. | 6.14 mm | 4.98 mm |
| Min.: | 4.64 mm | 3.56 mm |

Type locality: Hawakil Bay, 15°18'N 40°23'E, 16-X-1965, 30 fathm, coll. Ch. Lewinsohn, ISRSE/65 3555. The holotype is kept (dry) in the Department of Zoology of the Tel-Aviv University with 12 paratypes, 4 paratypes are kept in the Zoological Museum of Amsterdam.

Distinguishing characters: Most typical, besides the small size, is the long caudal spine curved moderately dorsad and the flat dorsal surface on which the five dorsal ribs are less developed. The lateral spines are directed caudad and the line between the tips of caudal and lateral spines is not curved regularly but shows a straight middle section.

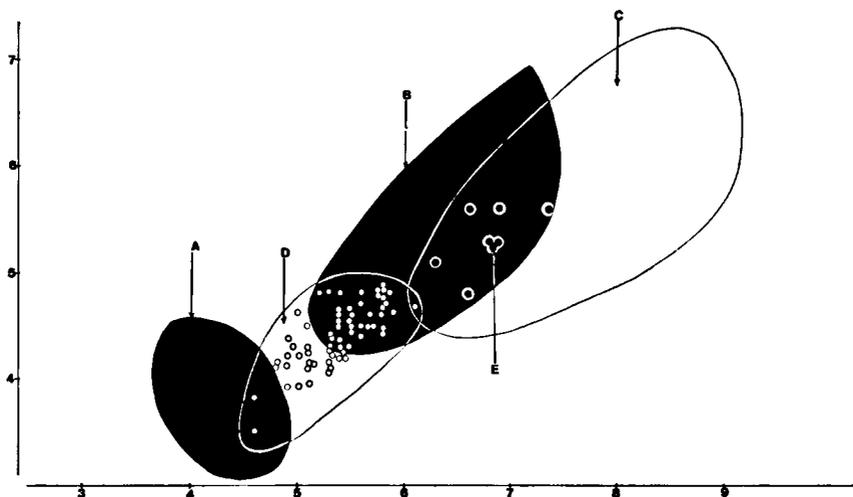


FIG. 9. Graph of shell length in mm on x axis and shell width on y axis in *Cavolinia uncinata uncinata* forma *roperi* (A), forma *uncinata* (B), forma *pulsata* (C), *C.u. pulsatapusilla* forma *pulsatapusilla* (D), and forma *pulsatoides* (E).

***Cavolinia uncinata* (Rang, 1829) subsp. *pulsatapusilla* forma *pulsatoides* n. forma; (Fig. 12).**

Etymology: the name *pulsatoides* means: like *pulsata*.

Description: The shell surface shows faint growth lines and, perpendicular to these, longitudinal lines; this criss-cross system causes a coarse hammered structure. The colour pattern has nearly vanished in the dry specimens but a brown hue is seen on the upper ventral surface and ventral lip. On the ventral surface about 7 transversal lines, imbricate in structure, are found. Typical for this forma is the basal strip along the ventral lip. In a lateral view the ventral lip is not seen as a direct continuation of the ventral side but it is preceded by a smooth band laying not in the level of the vaulted ventral surface. The embryonic shell is usually broken off leaving a hole in the short and strongly curved caudal spine. The line connecting the tips of the lateral spine and the caudal spine is regularly concave. The lateral spines do not curve dorsad. The aperture of the shell is narrow slit-like caudad of the closing mechanism but the median part is wide like in the forma *pulsata* and also triangular in shape. The ventral surface and lip show a median depression. The dorsal side is rather flat in comparison with the forma *pulsata* but not as flat as in the forma *pulsatapusilla*. The distal part of the dorsal lip shows no dorsal ribs, which are moderately developed on the rest of the dorsal surface and arranged as in the forma *uncinata* (cf. van der Spoel, 1969). The ventral surface is convex as in the forma *uncinata*. This forma resembles in size the larger specimens of the forma *uncinata* and the smaller specimens of the forma *pulsata* (see fig. 9).

| | <i>Shell length</i> | <i>Shell width</i> |
|--------|---------------------|--------------------|
| Max. : | 7.47 mm | 5.81 mm |
| Min. : | 6.30 mm | 4.89 mm |

Type locality: Near Elath, 7-IX-1966, 21—25 fathm, Coll. Ch. Lewinsohn, NS 5967. The holotype is kept (dry) in the Department of Zoology of the Tel-Aviv University with 4 paratypes. One paratype is kept in the Zoological Museum of Amsterdam.

Distinguishing characters: The ventral lip is preceded by a band which is not laying in a level with the ventral surface, the distance between the lateral spines is relatively large, the caudal spine is short and heavily curved dorsad. The line between the tops of the lateral and the caudal spines is regularly concave.

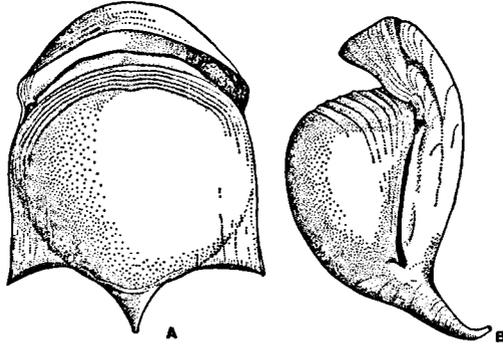


FIG. 10. *Cavolinia uncinata uncinata* forma *roperi* in ventral (A), and lateral (B) view (x 10 approx.).

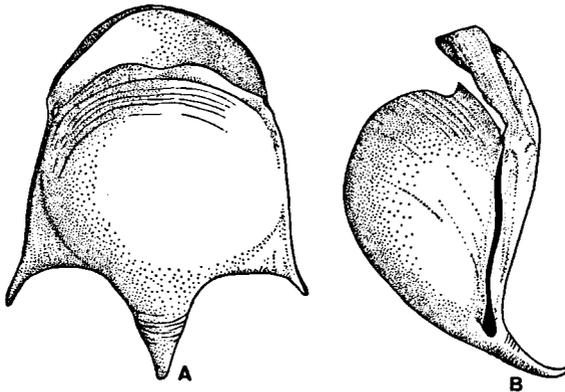


FIG. 11. *Cavolinia uncinata pulsatapusilla* forma *pulsatapusilla*, the holotype, in ventral (A), and lateral (B) view (x 10 approx.).

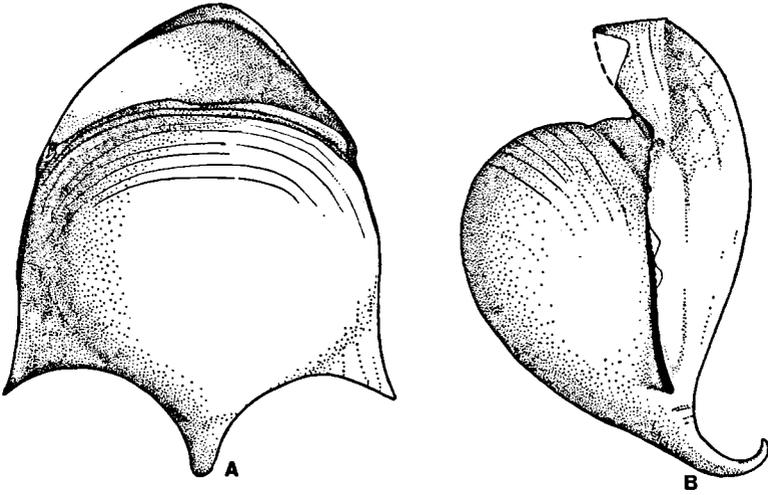


FIG. 12. *Cavolinia uncinata pulsatapisilla* forma *pulsatoides*, the holotype in ventral (A), and lateral (B) view (x 10 approx.).

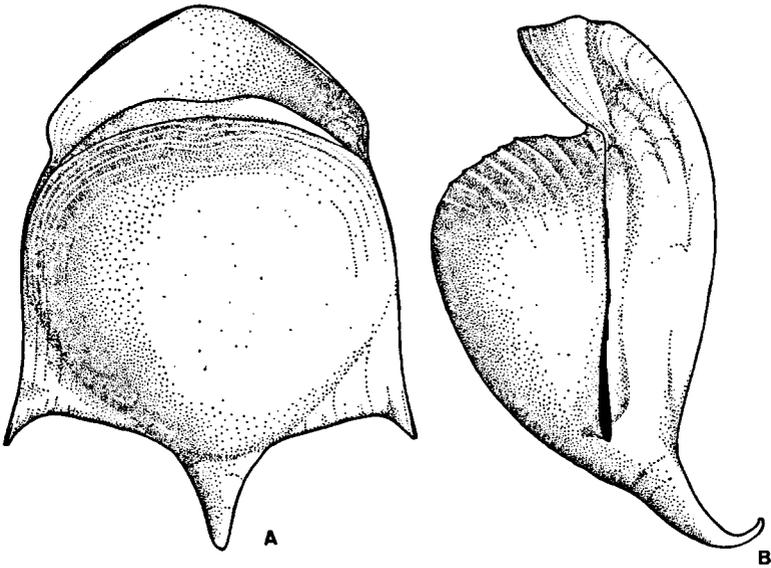


FIG. 13. *Cavolinia uncinata uncinata* forma *uncinata* in ventral (A), and lateral (B) view (x 10 approx.).

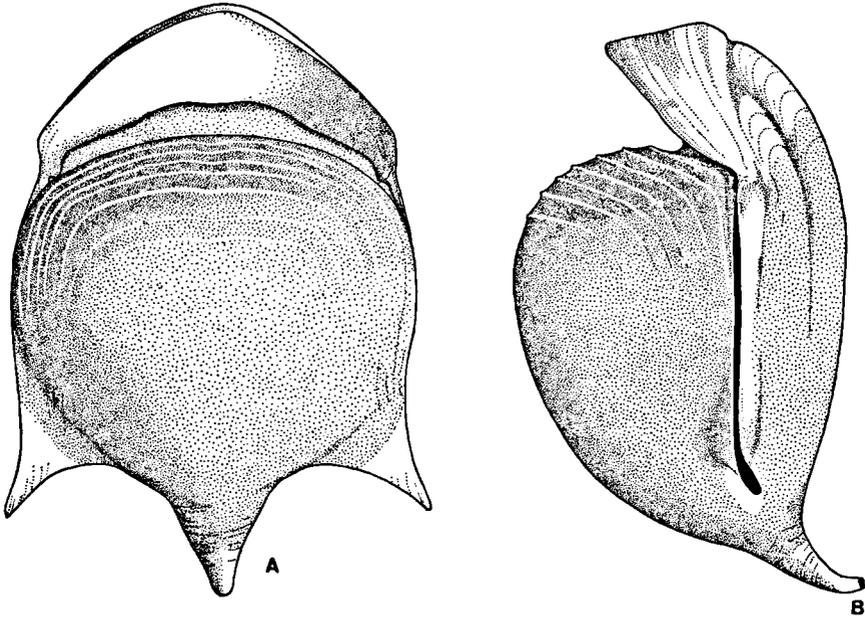


FIG. 14. *Cavolinia uncinata uncinata* forma *pulsata* in ventral (A), and lateral (B) view (x 10 approx.).

***Cavolinia longirostris* (de Blainville, 1821)**

In this species four formae are recognized: forma *longirostris*, forma *limbata*, forma *angulosa* and forma *strangulata*. The distribution of these formae is not well known, as most scientists did not distinguish the different formae when referring to the species. The present species has been recorded from the Red Sea but in literature no indication is found of a special forma living there. Fossil records from the Red Sea are scarce (Herman-Rosenberg, 1965; Herman, in the press) and the only thing which seems clear is that the species penetrated the Red Sea in post-glacial times.

The specimens from the Red Sea, at my disposal, are larger than those of the forma *longirostris* collected at comparable latitudes in other seas. They are of the same size as those of the forma *strangulata* and smaller than those of the forma *limbata*. There was too little material from the Gulf of Aqaba to allow a conclusion, but the few specimens found do not seem to differ from the Red Sea material.

***Cavolinia longirostris* (de Blainville, 1821) forma *longirostris* (de Blainville, 1821); (Fig. 20).**

Synonymy: *Hyalaea longirostris* de Blainville, 1821: 81;
Hyalaea longirostra d'Orbigny, 1836: 100 (1846) Pl. 6 figs
6—10 (see also van der Spoel, 1967).

Distinguishing characters: Shell width varies between 1.5—4.0 mm, shell

length varies between 2.0—6.0 mm. Dorsal lip with gutter-shape rib bends regularly ventrad without a swelling or incision which separates the lip from the rest of the dorsal side. Lateral spines directed more or less caudad.

Cavolinia longirostris (de Blainville, 1821) forma **limbata** (d'Orbigny, 1836); (Fig. 18).

Synonymy: *Hyalaea limbata* d'Orbigny 1836: 101 (1846)
Pl. 6 Figs 11-15 (see also van der Spoel, 1970).

Distinguishing characters: Shell width varies between 3.0—8.0 mm, shell length varies between 5.0—10.0 mm. Lateral spines project laterally and they do not bend caudad. No incision or constriction which separates off the gutter shaped dorsal lip is found.

Cavolinia longirostris (de Blainville, 1821) forma **strangulata** (Deshayes, 1823).

Synonymy: *Cleodora strangulata* Deshayes, 1823: 204;
Cavolina strangulata Hedley, 1917: 106 (see also van der Spoel, 1967).

Distinguishing characters: Lateral spines as in the forma *longirostris*. An abrupt lateral constriction in the rostrum which gives rise to a tubercle distally separated from the rest of the dorsal side. Shell a little larger than that of the forma *longirostris*, width varies between 3.0—7.0 mm, shell length varies between 4.5—8.0 mm (van der Spoel, 1970).

Cavolinia longirostris (de Blainville, 1821) forma **flexipes** n. forma; (Figs 15—16, 19, 21).

Etymology: this forma is named *flexi*-(bent) *pes* (foot) as the lateral tops are bent strongly dorsal.

Description: The hyaline shell is triangular in dorsal view. The shells

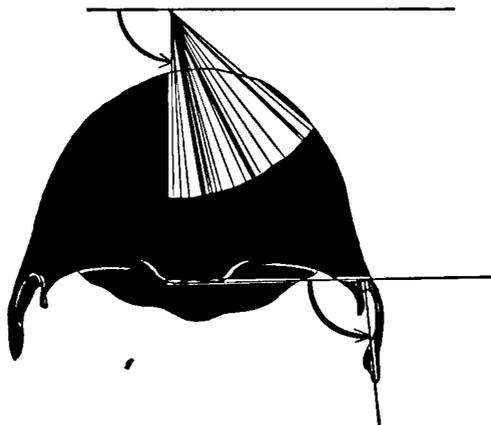


FIG. 15. Diagram to show position of the lateral spines of *Cavolinia longirostris* forma *flexipes* when the shell is seen from posterior.

collected from the sediment, are white in colour and provided with a light brown strip along the median line of the dorsal side. The dorsal lip is long, gutter shaped with a slight incision in the middle but it is never separated from the dorsal shell side. The dorsal lip curves slightly ventrad. The ventral lip, curved ventrad, shows a small depression in the middle; a clear depression in the ventral side is not present. In the area of the aperture no special colour patterns are found, which may be due to the fact that the animals were collected dead. On the dorsal side a strong median, two small lateral and two very faint lateral ribs are found. Growth-lines are present on dorsal and ventral sides. The lateral spines, chiefly formed by the ventral shell side, are curved extremely dorsad, they do not bend in a caudal direction. The embryonic shell and caudal spines are always lost. The opening left is closed by a small vault of the ventral side covering the opening and slightly protruding over the dorsal side. The ventral side is regularly rounded and shows especially near the aperture clear transversal ribs. In size the shell resembles most that of the forma *strangulata*, shell length varies also between 4.5 mm and 8.0 mm.

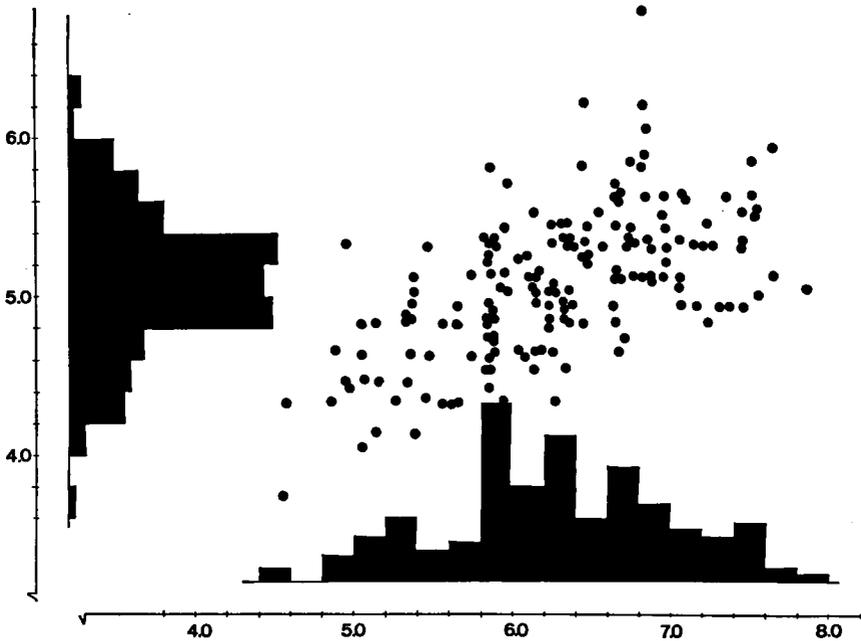
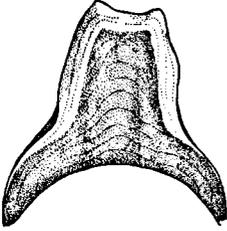


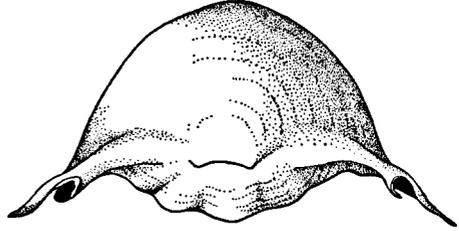
FIG. 16. Graph of shell length (x axis) and shell width (y axis) in mm in *Cavolinia longirostris* forma *flexipes*, with histograms of the number of specimens in relation to shell length and width.

Type locality: David Bay, Entedebir, 14-III-1962, coll. Ch. Fishelson, E62/317. The holotype is kept (dry) in the Department of Zoology of the Tel-Aviv University with 17 paratypes. Three paratypes are kept in the Zoological Museum of Amsterdam.

Distinguishing characters: The lateral spines curve strongly caudad (over 40° to 90°). No constriction separating dorsal shell lip from the dorsal side. Shell width varies from 3.6—6.6 mm, shell length varies between 4.5—8.0 mm.



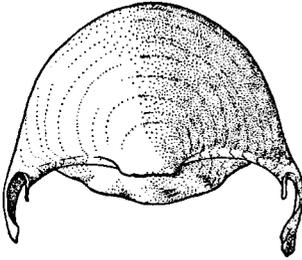
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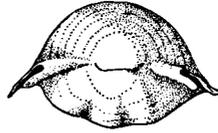
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FIG. 17. Dorsal shell lip of *Cavolinia longirostris* forma *flexipes* to show the slight resemblance with forma *strangulata* of some specimens.

FIG. 18. *Cavolinia longirostris* forma *limbata* in posterior view (x 10 approx.).



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FIG. 19. *Cavolinia longirostris* forma *flexipes* in posterior view (x 10 approx.).

FIG. 20. *Cavolinia longirostris* forma *longirostris* in posterior view (x 10 approx.).

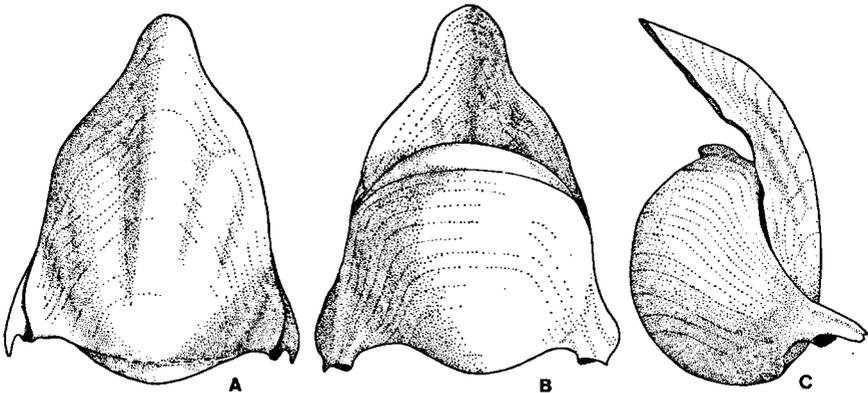


FIG. 21. *Cavolinia longirostris* forma *flexipes*, the holotype in dorsal (A), ventral (B) and lateral (C) view (x 10 approx.).

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