

MORPHOLOGICAL OBSERVATIONS OF LIVING *GEPHYROCAPSA CRASSIPONS*

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Abstract: The morphology of *Gephyrocapsa crassipons* was studied under an SEM, and was compared with that of *Gephyrocapsa ericsonii* and *Reticulofenestra parvula* var. *tecticentrum*. *G. crassipons* can be distinguished from *G. ericsonii* and *R. parvula* var. *tecticentrum* by possessing a combination of overcalcified inner tube and small distal shield, and dextrally-oriented bridge-plates, respectively.

Introduction

Gephyrocapsa crassipons, which was originally reported as *Gephyrocapsa* sp.A from the tropical central Pacific Ocean (Okada & Honjo, 1973), bears small placoliths with two thick bridge-plates constructed of several elements, and a thick collar surrounding a central column (Okada & McIntyre, 1977). Okada & Honjo (1973) reported that this species formed upto 20% of the coccolithophore flora in the tropical Pacific Ocean. The species, however, has not been recorded in subsequent studies, and there exist no supplementary taxonomic studies based on SEM observations. The reason why *G. crassipons* has not been recorded in the studies of the last 24 years is possibly because all the authors have regarded *G. crassipons* as synonymous with other, better-known species (Jordan *et al.*, 2000).

Throughout our recent studies of the coccolithophore flora in the tropical and subtropical Pacific Ocean, *G. crassipons* occurred commonly. Here, we present SEM observations of *G. crassipons*, and compare them with those of *Gephyrocapsa ericsonii* and *Reticulofenestra parvula* var. *tecticentrum*, species with similarly minute cell-size.

Material and methods

A set of filtered surface-water samples, collected from the equatorial and subequatorial Pacific Ocean by Dr. Andrew McIntyre (formerly at Lamont-Doherty Earth Observatory) on various legs of *R/V Conrad* and *R/V Vema*, were examined to study the surface distribution of coccolithophore floras in the equatorial and subequatorial Pacific Ocean. As a result of this floral investigation, a total of 35 samples were found to contain *Gephyrocapsa crassipons* (Table 1).

The water-samples were filtered on-board using Millipore filters (47mm diameter, normal pore-size of 0.8µm) and were dried at room temperature. Filters were stored in plastic Petri dishes. A portion of each filter was mounted on a brass stub. Samples were sputter-coated with platinum and examined under an SEM.

Observations of *Gephyrocapsa crassipons*

Gephyrocapsa crassipons (Plate 1, Figures 1-4) occurred in the eastern tropical Pacific Ocean where the surface-

Cruise Code	Station	Location		Date	
Leg 9 of <i>R/V Conrad</i>	66A	17°33'S	73°09'W	Feb. 5	1969
	Leg 10 of <i>R/V Conrad</i>	139	05°40'N	127°20'W	Mar. 6 1966
Leg 11 of <i>R/V Conrad</i>	142	03°31'N	129°43'W	Mar. 7	1966
	121	12°19'S	136°57'W	Sep. 12	1967
	122	10°23'S	134°57'W	Sep. 24	1967
	123	06°60'S	122°30'W	Sep. 26	1967
	124	03°22'S	122°06'W	Sep. 28	1967
	125	04°00'S	117°53'W	Sep. 31	1967
	126	05°59'S	115°37'W	Oct. 1	1967
	127	09°09'S	113°00'W	Oct. 2	1967
	128	08°48'S	110°48'W	Oct. 3	1967
	129	11°26'S	106°50'W	Oct. 5	1967
	130	13°19'S	100°57'W	Oct. 7	1967
	131	11°36'S	95°38'W	Oct. 9	1967
Leg 12 of <i>R/V Conrad</i>	132	08°17'S	87°46'W	Oct. 12	1967
	40	19°20'N	105°12'W	Feb. 23	1968
	66	02°37'N	148°53'W	Mar. 11	1968
	68	06°33'N	149°02'W	Mar. 13	1968
	81	07°30'N	164°60'W	Apr. 2	1968
	82	04°30'N	165°02'W	Apr. 3	1968
	84	02°20'N	165°12'W	Apr. 4	1968
	Leg 24 of <i>R/V Vema</i>	26	06°15'N	90°40'W	Feb. 25 1967
	29	01°25'N	100°18'W	Feb. 28	1967
	31	01°43'N	106°54'W	Mar. 2	1967
	32	01°49'N	112°44'W	Mar. 4	1967
	33	01°46'N	117°12'W	Mar. 5	1967
	34	01°40'N	120°20'W	Mar. 6	1967
	35	01°54'N	124°29'W	Mar. 7	1967
	36	01°51'N	129°01'W	Mar. 8	1967
	37	02°05'N	134°43'W	Mar. 10	1967
	38	06°15'N	138°49'W	Mar. 11	1967
	39	02°50'N	149°52'W	Mar. 14	1967
	40	03°04'N	155°35'W	Mar. 15	1967
	41	03°45'N	157°07'W	Mar. 16	1967
	44	16°47'N	156°09'W	Mar. 21	1967

Table 1: Water samples yielding *Gephyrocapsa crassipons*.

water is eutrophic due to upwelling (Hagino & Okada, in prep.). The highest absolute and relative abundances of *G. crassipons* were 1.7x10⁴ cells per litre (St.129, Leg 11 of *R/V Conrad*) and 34.7% (St.130, Leg 11 of *R/V Conrad*), respectively.

Terminology

Okada & McIntyre (1977) described the inward thickening of the inner tube-wall of *Gephyrocapsa crassipons* as a

'collar'. In this paper, we substitute the term 'inner tube' for 'collar' because this feature grows centrally not vertically in *G. crassipons*.

Description of coccosphere

The monomorphic, spherical coccosphere consists of 10 to 25 interlocked placoliths. Coccosphere size varies from 2.5 to 3.8 µm in diameter.

Description of coccoliths

The placolith is elliptical in plane-view, convex distally, concave proximally. The length ranges from 1.3 to 2.3 µm, and the width from 1.0 to 1.8 µm. The distal shield is the same size as the proximal shield, or slightly smaller (Plate 1, Figure 1, arrows). The proximal side of the central area is covered by a grill or a perforated plate. The distal side consists of the distal shield and inner tube. The proximal and distal shields are formed of radially-arranged, equal numbers of elements, ranging between 20 and 30 in total. Due to the centripetal overgrowth, the general form of the inner tube varies even within a single coccosphere: fractured (Plate 1, Figure 2), expanded inwards to make bridge-like features (Plate 1, Figures 1, 3), or covering the central area completely (Plate 1, Figure 4, arrow). Etched specimens expose dextrally-rotated tube-core elements between the distal shield and inner tube (Plate 1, Figure 2, arrow). The number of the tube-core elements is equal to that of the proximal and distal shield elements. The bridge-plates span the central area diagonally with dextral offset. The number of elements forming a bridge-plate ranges from one to three, and is not consistent even within a single coccosphere. The horizontal angle of the bridge varies greatly, but the vertical projection is always maintained in low profile. The junction of the bridge-plates with the rim is disjunctive or conjunctive.

Discussion

Gephyrocapsa ericsonii (Plate 1, Figure 5) bears small placoliths (<3 µm in length), each having two bridge-plates that span the central area, as observed in *Gephyrocapsa crassipons*. Coccoliths of *Reticulofenestra parvula* var. *tecticentrum* (Plate 1, Figures 6-8) do not have bridge-plates, but have a collar, the elements of which are often overgrown. This pattern of overgrowth can be misidentified as bridge-plates. Therefore, it is plausible that *G. crassipons* may have been misidentified as *G. ericsonii* or *R. parvula* var. *tecticentrum* in previous studies.

Okada & McIntyre (1977) mentioned that coccoliths of *G. crassipons* differ from those of *G. ericsonii* in the number of elements forming a bridge-plate, and in the presence of a collar (= thickened inner tube). Although no small *Gephyrocapsa* coccosphere with a combination of coccoliths with thickened inner tubes (= *G. crassipons*) and with thin inner tubes (= *G. ericsonii*) have been observed, the number of elements forming a bridge-plate is not consistent within a single coccosphere. Some specimens possess both types of bridge-plates, i.e. consisting of a single element or of several elements (Plate

1, Figures 1, 4). Therefore, the combination of centripetal thickening of the inner tube and low-profile bridges, rather than the number of elements composing a bridge-plate, should be the criterion to distinguish *G. crassipons* from *G. ericsonii*.

Some of the collar elements of *R. parvula* var. *tecticentrum* protrude centrally (Plate 1, Figure 6, arrows), and they sometimes converge in the central area causing a similar appearance to the bridge-plates of *G. crassipons* (Plate 1, arrow (a) in Figure 7). The bridge-plates of *G. crassipons*, however, can be distinguished from the overgrown collar-elements of *R. parvula* var. *tecticentrum* because the former span the central area diagonally with a dextral offset (Plate 1, Figures 1-4), whereas the latter span the central area in irregular orientations (Plate 1, arrows in Figure 6 and arrow (a) in Figure 7). The inward overgrowth of the inner tube of *G. crassipons* sometimes covers the central area completely (Plate 1, Figure 4, arrow), giving a similar appearance to the highly-overgrown *R. parvula* var. *tecticentrum* (Plate 1, arrow (b) in Figure 7 and coccoliths of Figure 8). However, the embedded bridge of an overcalcified *G. crassipons* protrudes, and can be clearly distinguished from overgrown *R. parvula* var. *tecticentrum*, which has a flat or depressed central area (compare Plate 1, Figure 4 with Figure 8).

Both *G. crassipons* and *R. parvula* var. *tecticentrum* are characterised by a highly-calcified inner tube-structure, and occurred only in the samples from the equatorial upwelling zone, in the tropical and subtropical Pacific Ocean (Okada & Honjo, 1973; Hagino & Okada, in prep). The inward expansion of the inner tube-structure of these two species, a feature of overcalcification, is likely to be related to a particular eutrophic condition associated with the equatorial upwelling system.

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Plate 1

Scanning electron micrographs of *Gephyrocapsa crassipons*, *Gephyrocapsa ericsonii* and *Reticulofenestra parvula*. Scale bars indicate 1 μ m. Negatives of all photographs are archived in the Micropalaeontology Collection of the National Science Museum, Tokyo. Numbers preceded by MPC are the specimen numbers in the collection.

Fig.1: Cocosphere of *G. crassipons*. Note distal shield equal in size to, or smaller than, proximal shield (arrows). MPC-03696.

Fig.2: Etched specimen of *G. crassipons*. Note tube-core elements exposed between distal shield and inner tube-elements (arrow). MPC-03697.

Fig.3: Highly-overgrown specimen of *G. crassipons*. MPC-03698.

Fig.4: Highly-overgrown specimen of *G. crassipons*. Note degree of inward overgrowth of inner tube-elements varies within single coccosphere. Central area of coccolith facing front completely covered by overgrown inner tube-elements (arrow). MPC-03690.

Fig.5: *G. ericsonii*. MPC-03700.

Fig.6: Weakly overgrown specimen of *R. parvula* var. *tecticentrum*. Note presence of two protruding collar-elements (arrows). MPC-03701.

Fig.7: Moderately overgrown specimen of *R. parvula* var. *tecticentrum*. Note moderately overcalcified coccolith with partly covered central-area (arrow a) and highly overgrown coccolith with completely covered central-area (arrow b). MPC-03702.

Fig.8: Highly overgrown specimen of *R. parvula* var. *tecticentrum*. MPC-03703.

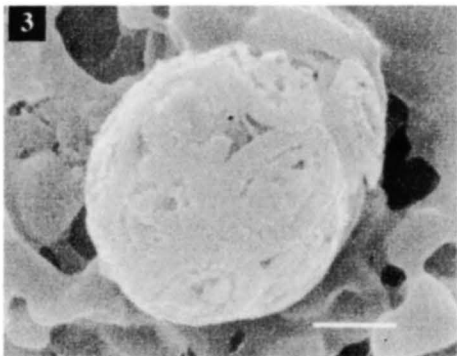
PLATE 1



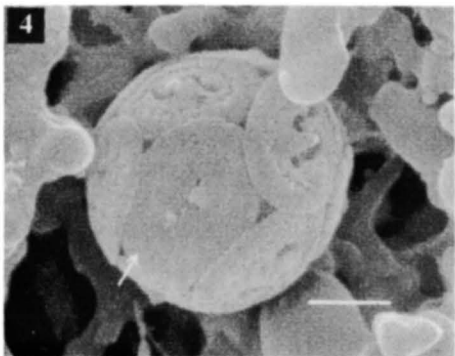
G. crassipons



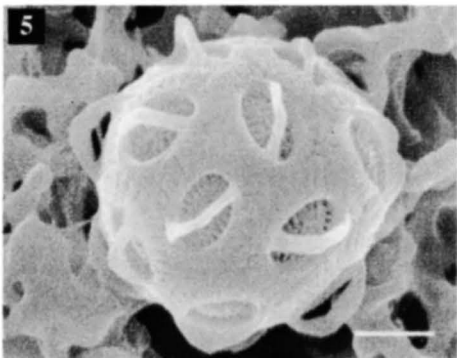
G. crassipons



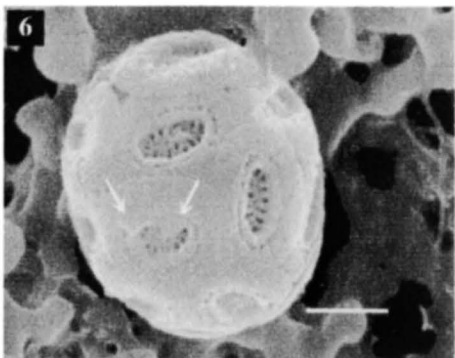
G. crassipons



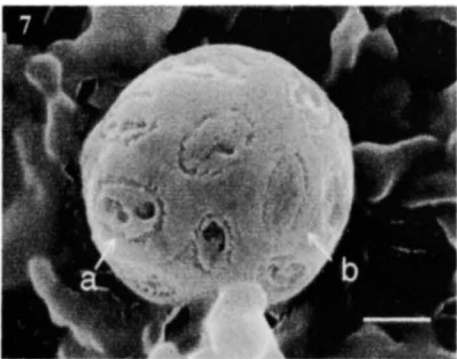
G. crassipons



G. ericsonii



R. parvula var. *tecticentrum*



R. parvula var. *tecticentrum*



R. parvula var. *tecticentrum*