

**Distribution and re-description of *Abraliopsis lineata* Goodrich, 1896
(Cephalopoda: Enoploteuthidae) from the Arabian Sea**

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The enoploteuthid cephalopod *Abraliopsis lineata* is re-described and its generic position discussed. Specimens for the present study were captured during the Indian Ocean Expedition of RV *Meteor* in 1987, where the species occurred in considerable numbers. The geographical distribution of *A. lineata* is described and discussed. The detailed analysis of the photophore pattern of the present specimens differs from the original description. The diagnostic features in the male, especially the structure of the hectocotylus which separates *A. lineata* easily from the members of the subgenus *Pfefferiteuthis*, are outlined. The morphological differences which separate *A. lineata* from *A. gilchristi*, the only other member of the subgenus *Micrabralia*, are summarized.

KEYWORDS: *Abraliopsis*, Arabian Sea, Cephalopoda, distribution, Enoploteuthidae, re-description.

Introduction

Knowledge of the biology and species composition of the oceanic cephalopod fauna in the Indian Ocean is still very poor. This is due primarily to the strong swimming ability and net-avoidance of oceanic cephalopods, which makes them very difficult to sample adequately. Another reason is the limited amount of scientific sampling for cephalopods in the Indian Ocean. One of the few comprehensive reports on the cephalopod fauna of the Indian Ocean was published by Silas (1968), who described the cephalopods of the *Varuna* collection from off the western coast of India and who compiled a catalogue of all cephalopod species known so far from the Indian Ocean. Other recent studies (Filippova, 1968; Nesis, 1970, 1974, 1986; Okutani, 1970, 1971, 1983) give detailed information about only single species, or report on small collections from various sites of the tropical Indian Ocean.

During the German expedition with RV *Meteor* to the northern Indian Ocean from March to June 1987, a comprehensive sampling programme was conducted to collect zooplankton and micronekton in three hydrographically and ecologically different parts of the Arabian Sea (Nellen *et al.*, 1988). A major object of these studies was a detailed analysis of the distribution patterns of the early life stages of fishes and cephalopods. First results revealed a typical tropical micronekton fauna with myctophids dominating amongst the fish larvae, and cranchiids and enoploteuthids amongst the early life stages of cephalopods (Roepke *et al.*, 1990; Piatkowski and Welsch, 1991).

According to Nesis (1987) the enoploteuthid squid *Abraliopsis lineata* is a tropical Indo-West Pacific species which is distributed from eastern Africa to Polynesia. The species occurs sporadically and was reported from the Andaman Sea (Pfeffer, 1900) and the Seychelles (Nesis, 1986).

It was originally described as *Abralia* based on a single male collected from the Andaman Sea, and a single female from off the Ganjam coast, Bay of Bengal (Goodrich, 1896). Pfeffer (1900) established the genus *Micrabralia* in the family Enoploteuthidae based on *Abralia lineata*, and later Pfeffer (1908) ranked *Micrabralia* a subgenus of the genus *Abralia sensu* Pfeffer, 1908 [= *Abraliopsis*]. In Chun (1910) a male of *A. lineata* (dorsal mantle length, DML = 16 mm) collected from the *Valdivia* station 254 (0°29'S, 42°47'E, 977 m) was described and illustrated (Pl. 8, Figs 1, 2, 4, 6; Pl. 9, Figs 1, 5; Pl. 10, Figs 2, 6) as part of the account of '*Abralia morrissi*' (Nesis, 1982).

Both descriptions are unsatisfactory and the type specimens in the Calcutta Museum are no longer extant.

In the *Meteor* collection, however, *A. lineata* was a common component of the cephalopod fauna (Piatkowski and Welsch, 1991). Altogether, 30 juvenile and adult specimens were identified from the samples (Table 1). Besides a brief description of its geographical distribution in the Arabian Sea our study will present a detailed re-description of *A. lineata* that is based on six adult specimens from the collection.

Materials and methods

During the *Meteor* cruise the cephalopods reported upon here were collected by an Isaacs-Kidd midwater trawl (IKMT) which had a mouth opening of 2.5–4.0 m², and mesh size of 4.5 mm. The standard haul was a double-oblique tow from 0 to 1000 m depth and back to the surface, which lasted about 5 hours. Additionally some specimens were caught by a modified MOCNESS (multiple-opening/closing-net and environmental sensing system; Wiebe *et al.*, 1976) with a mouth opening of 1 m² and a mesh size of 300 µm. The sampling depth ranged from 1000 to 0 m; ship's speed during these oblique hauls was approximately 2 knots. Further, a few specimens were captured using a large pelagic trawl (PT) with an opening of about 300 m² and with 12 mm mesh size at the cod end.

Table 1. Station number, date, locality, sampling method and number of specimens of *Abraliopsis lineata* collected during the METEOR-expedition to the Arabian Sea in 1987.

Station no.	Date, 1987	Latitude	Longitude	Sampling depth (m)	Gear	No. of specimens
435	30 April	18°42'N	65°39'E	0–1000–0	IKMT	3
462	3 May	18°37'N	65°17'E	0–1000	MOCNESS	1
498	13 May	18°14'N	66°47'E	0–1100–0	IKMT	2
499	13 May	18°25'N	66°39'E	0–1200–0	IKMT	1
501	13 May	18°36'N	66°42'E	0–100–0	PT	6
504	14 May	19°23'N	66°31'E	0–1000–0	IKMT	4
510	16 May	21°24'N	65°56'E	0–1000–0	IKMT	2
511	16 May	21°48'N	65°50'E	0–1000–0	IKMT	4
512	16 May	21°59'N	65°47'E	0–900–0	IKMT	3
527	23 May	22°43'N	66°11'E	0–≈40–0	PT	2
585	5 June	23°14'N	65°52'E	0–1000–0	IKMT	1
601	8 June	23°59'N	62°51'E	0–1000–0	IKMT	1

Station data, type of gear and numbers of *Abraliopsis lineata* specimens collected during the expedition are summarized in Table 1.

Immediately after the hauls, samples were fixed in 4% formalin-seawater solution. In the home laboratories cephalopods were sorted from the samples, carefully washed and measured according to the guidelines compiled by Roper and Voss (1983). After examination the specimens were transferred into 70% ethanol.

Results

Distribution

The enoploteuthid species *Abraliopsis lineata* was a common component of the cephalopod fauna during the *Meteor* expedition to the Arabian Sea. It was collected over the continental slope regions off Pakistan and northwestern India with a slight increase of successful catches towards the southern parts of the sampling area (Fig. 1).

Considering the wide range of the IKMT's sampling depth, which ranged from approximately 1000 m to the surface, no conclusion can be drawn about the depth layers in which the specimens were distributed. However, their occurrence in the tows of the pelagic trawl from 100 m to the surface and 40 m to the surface, respectively, suggests that *A. lineata* does not live permanently in the oxygen-poor water layers below 100 m depth.

Taxonomy

Abraliopsis lineata (Goodrich, 1896)

Abralia lineata Goodrich, 1896, p. 10, Pl. 3, figs 46–50.

Micrabralia lineata, Pfeffer, 1900, p. 167.

Abraliopsis morrisi, Chun, 1910, p. 78 (pars).

Abralia (Micrabralia) lineata, Pfeffer, 1912, p. 152.

Abraliopsis lineata, Clarke, 1966, p. 176.

Material examined. Nine specimens: specimen no. 1, male (DML = 22.6 mm), *Meteor* St. 435 (30 April 1987) 18°42'N, 65°39'E, 0–1000 m; no. 2, male (DML = 22.9 mm), ditto; no. 3, female (DML = 22.9 mm), ditto; no. 4, male (DML = 25.7 mm), *Meteor* St. 501 (13 May 1987) 18°36'N, 66°42'E, 0–110 m; no. 5, male (DML = 27.3 mm), ditto; no. 6, female (DML = 26.5 mm), ditto; no. 7, female (DML = 18.7 mm), *Meteor* St. 527 (23 May 1987) 22°43'N, 66°11'E, 0–40 m; no. 8, female (DML = 25.8 mm), ditto; no. 9, female (DML = 25.8 mm), *Meteor* St. 601 (8 June 1987) 23°59'N, 62°51'E, 0–1000 m. Of these nine specimens which were in a good condition six were still provided with the most important body parts and characteristics (Table 2). They were chosen for the detailed re-description.

Description. The body is small for the genus. The mantle is weakly muscular, short conico-cylindrical, terminating in a blunt-ended short tail. The mantle width is about 35–50% of DML. The anterodorsal end forms an obtuse angle in the middle, while the anteroventral margin is broadly emarginated leaving rounded lateral angles on both sides (Figs 2 and 3).

The fins are transversely broad, sagittate in outline with blunt lateral angles. The fin length is about 65–80% of DML, while the width attains about 95–115% of DML. The widest part of the fin width is located at about 40% distally of the fin length.

The head is sub-cubic and narrower than the mantle opening. The eyelid has a shallow anterior sinus. There are four pairs of crests on the posterior periphery of the

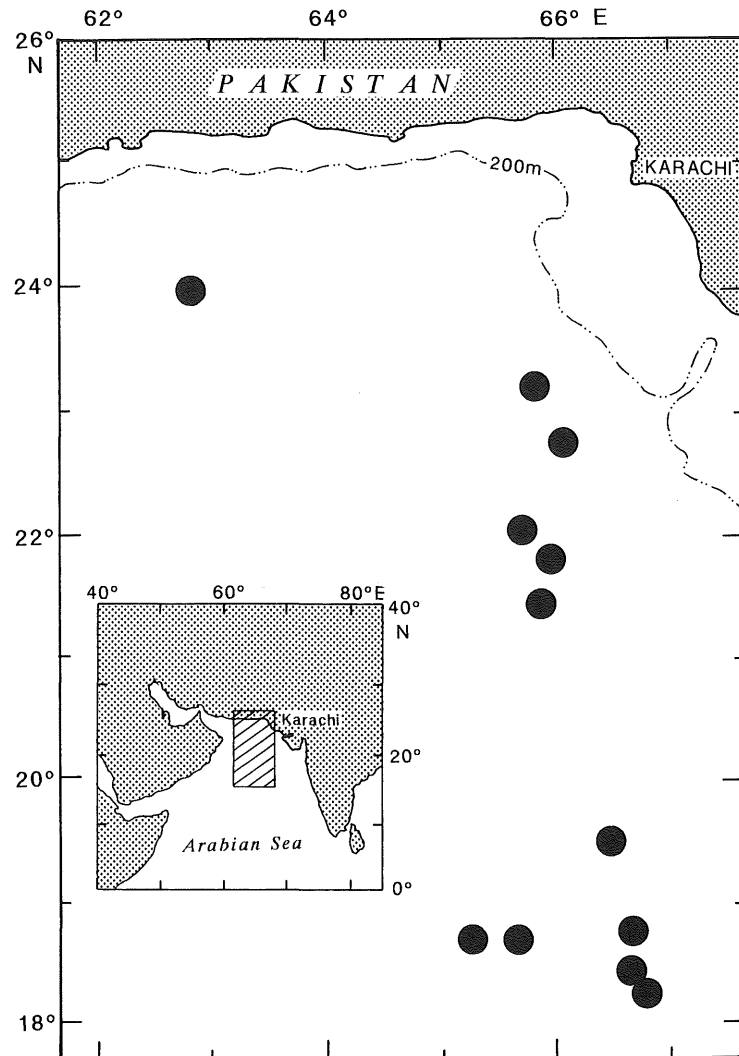


FIG. 1. *Abraliopsis lineata*: geographical distribution in the Arabian Sea during *Meteor* cruise, 1987.

head: a pronounced low ridge-like one on the posterior rim of the funnel groove, a rectangular fleshy one posterior to the tentacle, a lunate fleshy one posterior to arm III and another membranous one just behind arm II. The two dorsal ones are indistinctly connected with each other (Fig. 4).

The funnel is moderate in size. The funnel groove is rather narrow with a well-developed posterior rim. The dorsal element of the funnel organs is V-shaped with developed rami carrying a prominent fleshy ridge on top and a delicate papilla at the anterior end. The ventral pads are sub-quadrangle in outline (see Fig. 7).

The funnel cartilage (Fig. 5) is spatulate, slightly expanded posteriorly, and has a shallow groove in the middle. The width of the funnel cartilage is about 40% of its length. The mantle cartilage is a simple and straight ridge. The nuchal cartilage (Fig. 6) is spatulate and slightly expanded anteriorly. The width of the nuchal cartilage is about 35–40% of its length. The funnel cartilage is subequal in length to the nuchal cartilage.

Table 2. Measurements, character indices and sucker and hook counts of *Abrialiopsis lineata* from the Arabian Sea.

Specimen station	No. 5 501		No. 4 501		No. 2 435		No. 6 501		No. 9 601		No. 3 435	
Sex	male		male		male		female		female		female	
DML	27.3 mm		25.7 mm		22.9 mm		26.5 mm		25.8 mm		22.9 mm	
MWI	35.9		48.6		40.2		37.7		38.4		37.1	
FLI	72.9		78.6		67.7		72.8		72.5		68.6	
FWI	98.5+		107.0		97.4		105.3		115.5		112.2	
HWI	34.4		35.4		32.3		29.8		30.6		40.6	
ALI												
I	50.2	52.7	61.9	61.5	48.5	46.3	38.5+	43.4	47.3	50.4	44.5	44.5
II	50.2	54.9	56.0	53.3	53.7	38.9+	45.7	49.1	56.2	59.3	50.2	45.1
III	45.4	46.9	50.6	49.0	48.0	45.4	42.6	39.6	51.9	54.3	45.4	42.8
IV	59.7	57.1	58.0	57.6	55.9	55.9	49.1	49.4	67.4	66.7	56.8	55.9
HcLI	37.7	—	34.6	—	32.8	—	—	—	—	—	—	—
TLI	—	112.5	—	—	—	133.2	—	—	169.8	159.3	111.8	122.7
CLI	—	20.9	—	—	—	22.3	—	—	23.6	24.4	25.3	24.0
ASC (AHC)												
I	(23)16	(23)20	(24)19	(21)23	(23)23	(25)23	(14)+	(14)16	(15)18	(16)15+	(15)23	(14)22
II	(22)16	(19)18	(22)21	(21)23	(22)15	(13+)+	(15)20	(16)22	(17)14+	(18)15+	(16+)12+	(17)15
III	(22)13	(21)11	(21)17	(20)14	(22)15	(16)17	(16)17	(10+)15	(17)17	(18)14	(18)14	(16)11+
IV	(12) 0	(13) 0	(10) 0	(12) 0	(11) 0	(12) 0	(11) 0	(11) 0	(10) 0	(10) 0	(12) 0	(11) 0

DML: Dorsal mantle length; MWI: mantle width index; FLI: fin length index; FWI: fin width index; HWI: head width index; ALI: arm length index; HcLI: hectocotylus length index; TLI: tentacle length index; CLI: club length index; ASC: arm sucker counts; AHC: arm hook counts; indices and counts in the left column are for the right body part of the specimens and those in the right column are for the left part). The index gives a direct proportional relationship to the mantle length. All abbreviations and indices follow the guidelines of Roper and Voss, 1983.

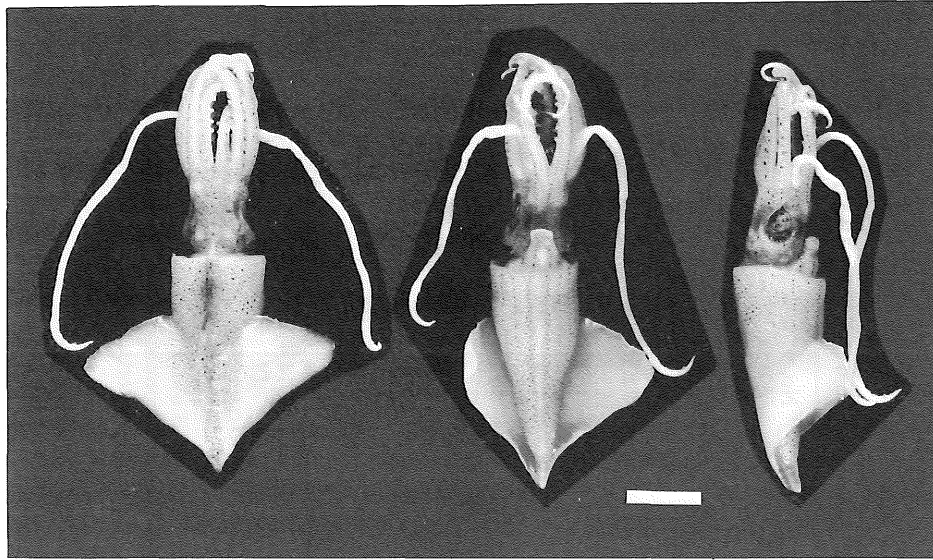
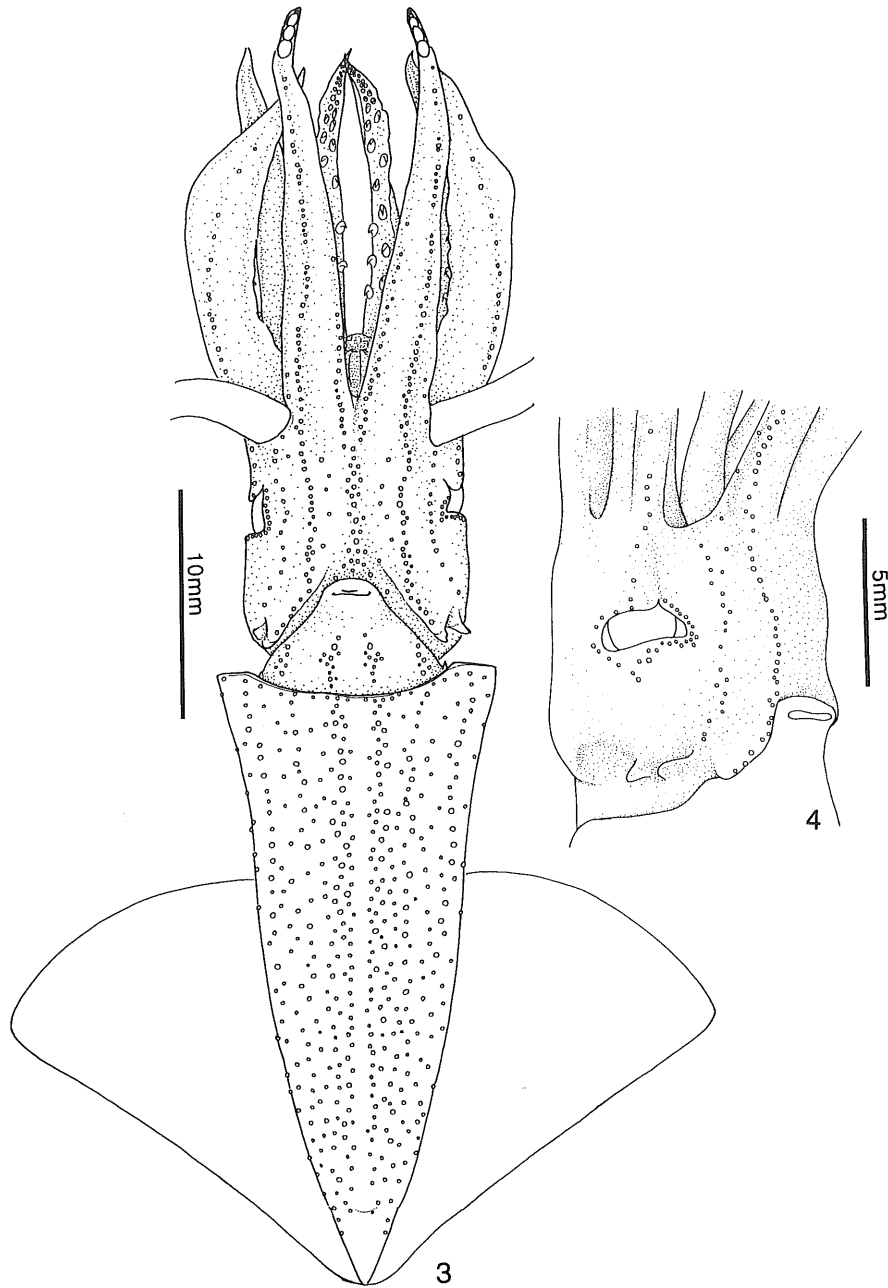


FIG. 2. *Abraliopsis lineata*. Three views of the specimen no. 7 (scale bar: 10 mm).

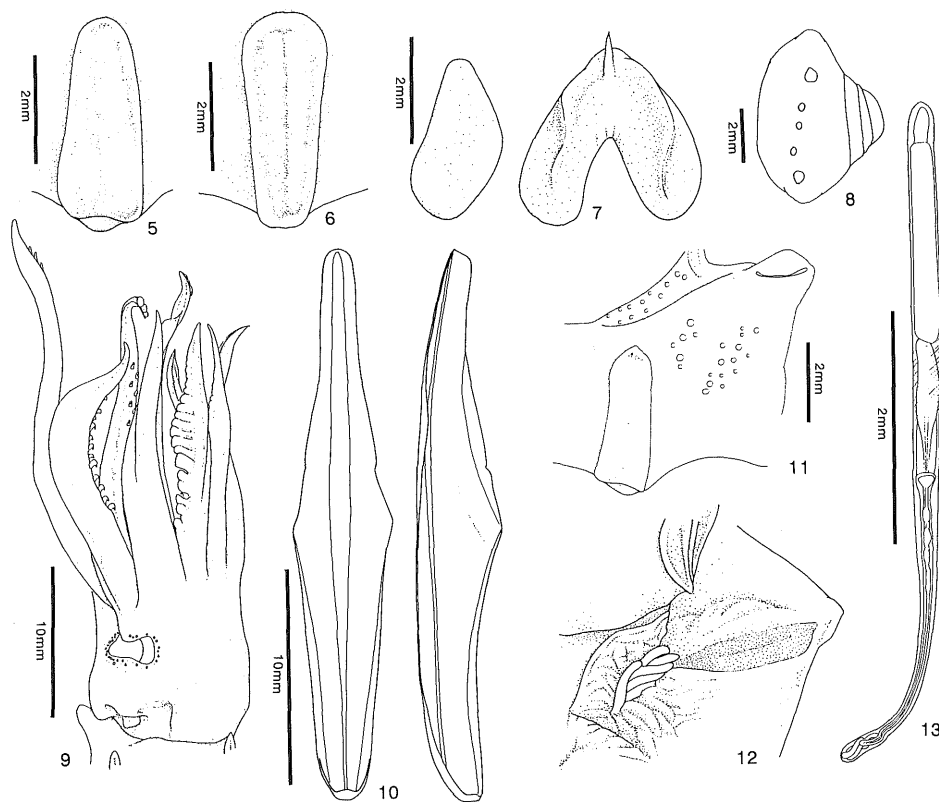
Arms are moderate in length and rather strong (see Fig. 9). The arm formula is IV, II, I, III in female, and IV, I = II, III in male. The longest arm attains about 50% of DML in female and 60% in male. The arms I and II have a narrow aboral keel on the distal half of their length. The arms III have a broad aboral keel on the entire length. The narrow aboral keel of arms IV is an interbrachial web covering the base of the tentacles. The arms I to III have a protective membrane with trabeculae along the ventral side, which are lacking along the dorsal side. The arms IV lack a protective membrane. The armatures of all arms are composed of proximal hooks (14–18 in females and 19–25 in males on arms I to III, 10–13 on arms IV) and suckers (11–23 except on arms IV). The inner ring of the arm sucker has about 9–11 wedge-shaped teeth on the entire edge, of which the distal ones are prominent. The outer ring has two rows of stout pegs and a narrow row of marginal plates. Some pegs on the proximal side of the outer row are compressed and the circle of this row is incomplete on the distal side (see Fig. 19).

The right ventral arm of the male is hectocotylized. Three different types of crest characterize the hectocotylized arm: the proximal crest is long, quadrate and waved, and extends from the distal-most hook along a ventral margin to the position of about 70% of arm length. The second crest has a triangular form and extends from about the middle of the proximal crest to about 80% of the arm length along its dorsal margin. The distal crest is laterally lunate, extending from the distal end of the proximal crest to the terminal photophore along the ventral margin of the arm (Fig. 14). The counter arm of the hectocotylized arm is normal.

The protective membrane of both arms I in the male is well-developed on the dorsal and ventral side. Its trabeculae are swollen and flattened. The oral surface of arm I is ornamented with numerous small, granular papillae (Fig. 17). The proximal parts of arms II are swollen and twice as large as the normal arm. Gelatinous tissue is prominent on the oral surface, and each hook row is clearly separated by a bare area. The ventral protective membrane is modified like that of arms I with some pronounced small papillae upon it (Fig. 16). On arms III the dorsal protective membrane is slightly



FIGS 3, 4. *Abraliopsis lineata*. (3) Ventral view of the specimen no. 3. (4) Head, lateral view of the same specimen.

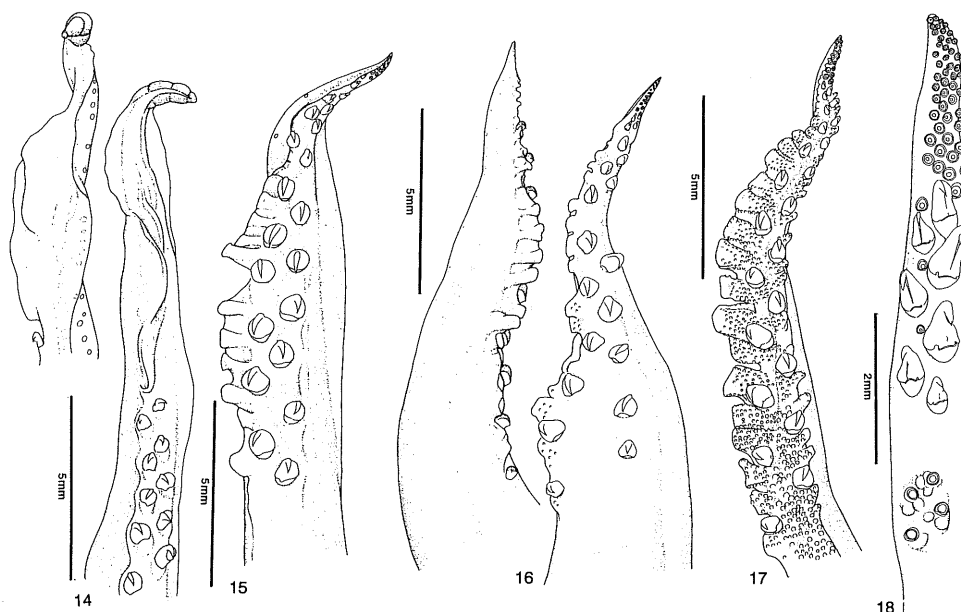


FIGS 5–13. *Abraliopsis lineata*. (5) Funnel cartilage of the specimen no. 2. (6) Nuchal cartilage of the same. (7) Funnel organs of the same. (8) Eyeball of the specimen no. 9. (9) Profile of head and arms of the specimen no. 2. (10) Gladius, ventral and lateral views of the specimen no. 3. (11) Funnel, lateral view of the specimen no. 2. (12) Spermatophore receptacle of the specimen no. 3. (13) Spermatophore of the specimen no. 2.

modified, while the papilla is not prominent (Fig. 15). The hooks on the middle part of arms II and III are slightly enlarged but depressed.

The tentacles are rather weak with a totally naked stalk. The club is not thickened and expanded. The ventral flap and an aboral keel are not prominent. The carpal group consists of 4 suckers and 4 pads. The manus has 3 or 4 large ventral hooks and 3 or 4 small dorsal hooks. The dactylus suckers are arranged in approximately 4 longitudinal, and 12 to 14 transverse rows (Fig. 18). The inner ring of the carpal suckers is entirely smooth, while the outer ring has small, irregularly and densely arranged pegs (Fig. 20). The inner ring of the dactylus suckers is entirely smooth on its proximal part while it has some teeth on its distal part (Fig. 21).

The ventral surface of mantle, funnel, head and arms III and IV is ornamented with photophores. The photophores are monotypic and of variable size with a white centre. On the ventral mantle more than 400 light organs are sparsely scattered without a central strip in the posterior half, while larger light organs are arranged linearly and form 6 longitudinal rows on the anterior half. At the anterior-most part, there are some interposed organs which form two medial rows with 2 or 3 sub-rows. In some specimens, however, only 1 medial row of photophores occurs. On the lateral sides of the mantle the photophores are sparsely scattered on the anterior half of the mantle. On

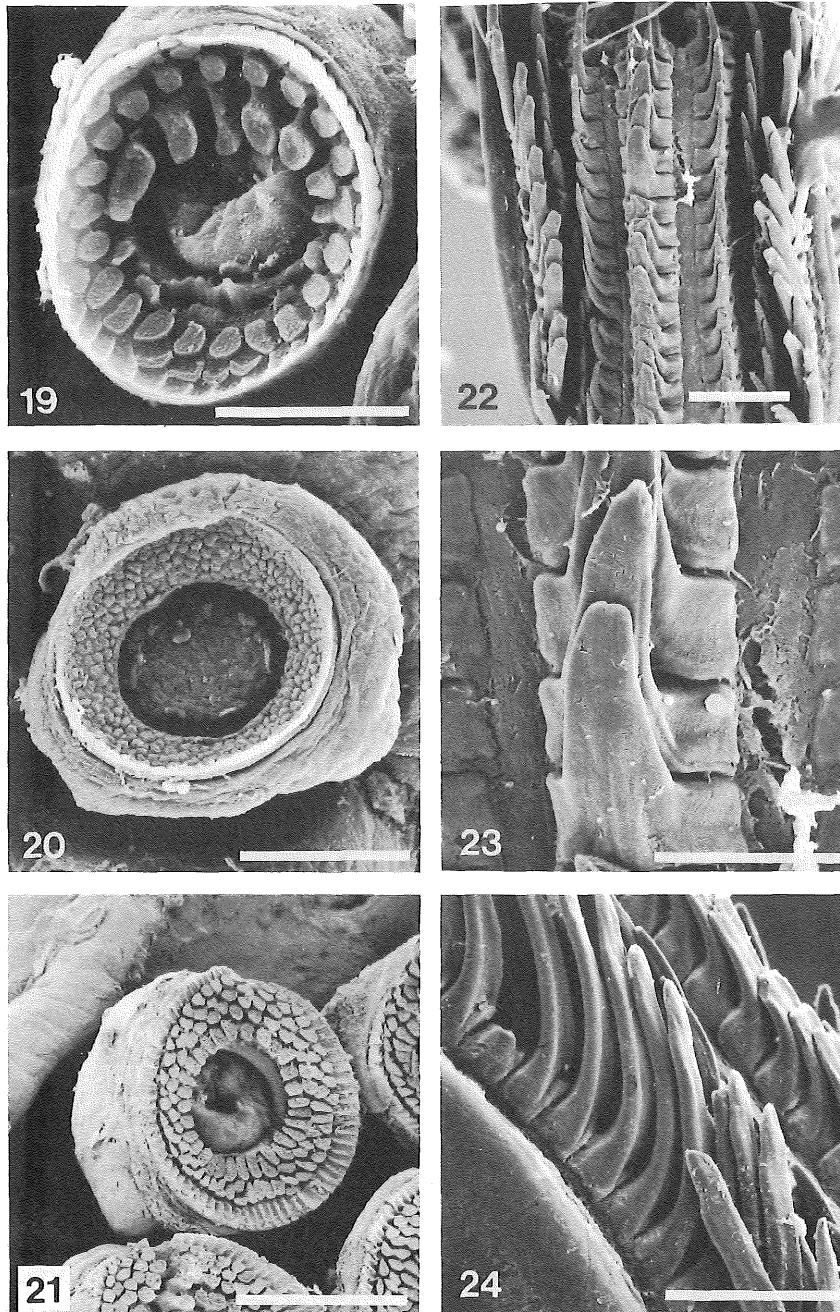


FIGS 14–18. *Abraliopsis lineata*. (14) Right arm IV (hectocotylized arm), lateral and oral views of the specimen no. 1. (15) Right arm III of the specimen no. 3. (16) Right arm II, lateral and oral views of the specimen no. 2. (17) Right arm I of the same. (18) Left tentacular club of the specimen no. 7.

the tail, only 2 or 3 lateral light organs are present. Both dorsal and ventral surfaces of the fins have no light organ. Photophores of the ventral funnel form 2 pairs of longitudinal rows, of which the inner rows are composed of 11–14, and the outer rows of 5 or 6 light organs (Fig. 11). Twelve to 14 photophores are present on each side of the retractor muscle. On the ventral side of the head, there are about 120 to 150 photophores which are arranged in 5 longitudinal and 2 interposed short rows. Three longitudinal photophore rows are present on the arms IV, among which the dorsal row consists of only 3–5 light organs. The ventral row is composed of 16–23 light organs which do not reach to the tip of the arm, while the medial row, with 37–44 light organs, reaches the tip of the arm. The large distal light organs of this row occur with some interruptions. On the arms III a row of 18–21 photophores is present along the ventral side of the aboral keel. At the distal tip of the arms IV three or four hemispherical, black terminal photophores occur. Thirty-one to 38 photophores border the orbit. Five monotypic, orange, semispherical photophores (size formula LSMSL) are arranged linearly and are widely spaced along the ventral periphery of the eyeball (Fig. 8).

The buccal membrane has eight lappets. The buccal connectives are connected to the dorsal side of arms I, II and IV and to the ventral side of arms III (DDVD-type).

The spermatophore (Fig. 13) is about 6 mm in length. The sperm mass is moderate in length (about 30% of the spermatophore length) and does not reach the aboral tip. The cement body, which attains about 20% of the spermatophore length, has a fusiform, simple, depressed conical oral connective complex. The ejaculatory apparatus is about 50% of the entire spermatophore length. Its aboral part is supplied with many intricate polygonal depressions. The outer surface of the spermatophore has many dextral spiral folds in the region of the cement body.



FIGS 19–24. *Abraliopsis lineata*. (19) Distal sucker of the arm III of the specimen no. 2. (20) Carpal sucker of the same. (21) Dactylus sucker of the same. (22) Radula of the same. (23) Rachidian tooth. (24) Outer marginal tooth (scale bar: Figs 19 and 23 = 50 μm ; Figs 20–22 and 24 = 100 μm).

The spermatophore receptacle in the female is located between the anterior stellate ganglion and forms the saccular nuchal pocket which is purple (Fig. 12). The nuchal cartilage in females that have copulated is slightly modified with the formation of a seminal pocket. The seminal mass is also present at the proximal corner of both sides of the nuchal cartilage.

The radula has seven teeth in each row. Each tooth is rather blunt (Fig. 22). The rachidian (Fig. 23) is single-cusped with a rectangular, rather flat base. Both inner and outer lateral teeth have a single cusp and a rectangular base. The marginal tooth (Fig. 24) is highest and thickest of all with a single cusp.

The gladius (Fig. 10) is robust and penniform. The boundary between the vane and the rachis is indistinct. The vane is about 80% of the gladius length. The rachis is rather broad, about 75–80% of the gladius width and gradually tapers posteriorly to the short blunt cone. The gladius width is about 15–20% of the gladius length. The anterior margin of the vane has an incision. The angle in cross-section of the gladius is 100–120° in its median portion.

Measurements and indices, see Table 2.

Discussion

Abraliopsis (Micrabralia) lineata (Goodrich, 1896) is a small-sized species in this genus and it has hitherto been known only from the type specimens, which are no longer extant. According to the original description, *A. lineata* is characterized by its fasciolate photophore arrangement on the mantle and head, the absence of both carpal flap and aboral keel on the tentacular club, and the prominent rectangular teeth on the inner ring of the arm suckers. These characters match well those of the specimens under present examination. However, some important characters, such as enumeration of the arm armature, the mode of hectocotylization, and a detailed description of the photophore arrangement, were not presented in the original description.

The detailed arrangement of the photophores from the present specimens seems to be slightly different from that given in the short original description. The short photophore row between the median row and the lateral rows on the head was not mentioned by Goodrich (1896), while photophores on the ventral mantle side do not form distinct fasciolate rows with many interposed photophores. Only large photophores are arranged in six longitudinal rows on the mantle.

Male *A. lineata* have distinct features which make separation from members of the subgenus *Pfefferiteuthis* easy (Tsuchiya and Okutani, 1988). The right arm IV is modified to become the hectocotylus with three offset crests, without the modification of the counter arm. The oral surfaces of arms I and II are ornamented with small papillae. The arms II of the male are enlarged by gelatinous tissue, which is also observed in *Pfefferiteuthis* species, although not to the same degree.

Nesis (1982) designated and identified part of *Abraliopsis morrissi* described in Chun (1910; Pl. 8, Figs 1, 2, 4, 6, Pl. 9, Figs 1, 5, Pl. 10, Figs 2, 6) to be *A. lineata* based on the above-mentioned characters.

Abraliopsis lineata is the type species of the subgenus *Micrabralia* Pfeffer, 1900, and subgeneric relationship was discussed in a previous paper (Tsuchiya and Okutani, 1988). The subgenus *Micrabralia* now contains only two species: *A. lineata* and *A. gilchristi* (Tsuchiya and Okutani, 1988).

Abraliopsis gilchristi (Robson, 1924) is a medium-sized species from subtropical and temperate waters in the southern Pacific. *A. gilchristi* is easily separated from *A. lineata* by the possession of a prominent, wide carpal flap and an aboral keel on the tentacular

club, normally developed arms II in the male, the sharp pointed arm sucker teeth, as well as the different photophore arrangements on the mantle and head (Voss, 1967). Such a large discrepancy between these two species may warrant distinction at the subgeneric level.

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References

- CHUN, C., 1910, Die Cephalopoden, *Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition 'Valdivia'*, **18**, 1–552.
- CLARKE, M. R., 1966, A review of the systematics and ecology of oceanic squids, *Advances in Marine Biology*, **4**, 91–300.
- FILIPPOVA, J. A., 1968, New data on the Cephalopoda of the Indian Ocean, *Proceedings of the Symposium on Mollusca, Part I, Marine Biological Association of India*, pp. 257–264.
- GOODRICH, E. S., 1896, Report on a collection of Cephalopoda from the Calcutta Museum, *Transactions of the Linnean Society of London*, **7**, 1–24.
- NELLEN, W., SCHNACK, D. and ZEITZSCHEL, B., 1988, Expeditionsbericht über die 'Meteor'-Reise 5, Abschnitt 3, *Berichte aus dem Zentrum für Meeres- und Klimaforschung der Universität Hamburg*, **1**, 1–165.
- NESIS, K. N., 1970, Occurrence of a rare squid, *Chaunoteuthis mollis* Appellöf (Family Onychoteuthidae) in the Indian Ocean, *The Veliger*, **12**, 290–292.
- NESIS, K. N., 1974, Cephalopod larvae in the western Arabian Sea, *Oceanology*, **14**, 441–445.
- NESIS, K. N., 1982, *Abridged key of the cephalopod mollusks of the World Ocean*, (Moscow: Light and Food Industry Publishing House), 355 pp. [in Russian].
- NESIS, K. N., 1986, Cephalopods of seamounts in the Western Indian Ocean, *Oceanology*, **26**, 91–96.
- NESIS, K. N., 1987, *Cephalopods of the World* (Neptune City, USA: T.F.H. Publications), 351 pp.
- OKUTANI, T., 1970, A small collection of gastropod and decapod mollusks from the Seychelles Bank, Indian Ocean, by the training vessel 'Koyo-Maru' in 1968, *Venus*, **29**, 123–130.
- OKUTANI, T., 1971, Preliminary Note on Planktonic Oegopsida Cephalopod Larvae obtained by the International Indian Ocean Expedition, *Marine Biological Association of India*, pp. 52–53.
- OKUTANI, T., 1983, *Abralia marisarabica*, a new enoploteuthid squid from the Arabian Sea (Cephalopoda: Oegopsida), *Bulletin of the National Scientific Museum of Tokyo, Series A*, **9**, 161–168.
- PFEFFER, G., 1900, Synopsis der oegopsiden Cephalopoden, *Mitteilungen des Naturhistorischen Museums in Hamburg*, **17**, 146–198.
- PFEFFER, G., 1908, Teuthologische Bemerkungen, *Jahrbuch der hamburgischen wissenschaftlichen Anstalten*, **25**, 287–295.
- PFEFFER, G., 1912, Die Cephalopoden der Plankton Expedition. Zugleich eine monographische Übersicht der oegopsiden Cephalopoden, *Ergebnisse der Plankton-Expedition der Humboldt-Stiftung*, **2**, 1–815.
- PIATKOWSKI, U. and WELSCH, W., 1991, On the distribution of pelagic cephalopods in the Arabian Sea, *Bulletin of Marine Science*, **49**.
- ROBSON, G. C., 1924, On the Cephalopoda obtained in South African waters by Dr J. F. D. Gilchrist in 1920–21, *Proceedings of the Zoological Society of London*, **39**, 589–686.
- ROEPKE, A., PIATKOWSKI, U. and WELSCH, W., 1990, A comparative study on the vertical distribution of fish and cephalopod larvae in three hydrographically and ecologically different areas of the Arabian Sea (Preliminary results), *International Council for the Exploration of the Sea (ICES), Biological Oceanography Committee L:89*, 22 pp.

- ROPER, C. F. E. and VOSS, G. L., 1983, Guidelines for taxonomic descriptions of cephalopod species, *Memoirs of the National Museum of Victoria*, **44**, 49–63.
- SILAS, E. G., 1968, Cephalopoda of the west coast of India collected during the cruises of the research vessel 'Varuna', with a catalogue of the species known from the Indian Ocean, *Proceedings of the Symposium on Mollusca, Part I, Marine Biological Association of India*, pp. 277–359.
- TSUCHIYA, K. and OKUTANI, T., 1988, Subgenera of *Enoploteuthis*, *Abralia* and *Abraliopsis* of the squid family Enoploteuthidae (Cephalopoda: Oegopsida), *Bulletin of the National Science Museum of Tokyo, Series A*, **14**, 119–136.
- VOSS, G. L., 1967, Some bathypelagic cephalopods from South African waters, *Annals of the South African Museum*, **50**, 61–88.
- WIEBE, P. H., BURT, K. H., BOYD, S. H. and MORTON, A. W., 1976, A multiple opening/closing net and environmental sensing system for sampling zooplankton, *Journal of Marine Research*, **34**, 313–326.