

## *Abraliopsis pacificus*, a New Species of the Squid Family Enoploteuthidae from the Northwest Pacific

By

Kotaro TSUCHIYA and Takashi OKUTANI

Tokyo University of Fisheries, Tokyo

**Abstract** *Abraliopsis (Abraliopsis) pacificus* n. sp. is described. This species is characterized by having diffused photophore arrangement on head, developed carpal flap and aboral keel on tentacular club, unequal offset crests on hectocotylus and rectangular arm sucker ring teeth. It is distributed commonly in the midwater of Northwest Pacific Basin.

During the systematic study on the Family Enoploteuthidae mainly based on the midwater samples of the R/V *Kaiyo-Maru* from the Northwest Pacific Ocean, some new facts including undescribed species have been discovered. The previous paper described a new species of the genus *Abralia* GRAY, 1849, *A. similis* OKUTANI et TSUCHIYA, 1987, and here another new species of the genus *Abraliopsis* JOUBIN, 1896 is described. This series of study is aiming at not only describing new taxa of this diverse family, but also making a critical revision of the family Enoploteuthidae.

The nominal species of the genus *Abraliopsis* hitherto known are as follows:

*Abraliopsis hoylei* (PFEFFER, 1884): Western Indian Ocean

*Abraliopsis lineata* (GOODRICH, 1896): Indian Ocean

*Abraliopsis pfefferi* JOUBIN, 1896: Atlantic

*Abraliopsis affinis* (PFEFFER, 1912): Eastern Tropical Pacific

*Abraliopsis gilchristi* (ROBSON, 1924): South Africa and New Zealand

*Abraliopsis felis* MCGOWAN et OKUTANI, 1968: Northern North Pacific, Transitional

*Abraliopsis falco* YOUNG, 1972: California Current to Northwest Pacific

*Abraliopsis tui* RIDDELL, 1985: New Zealand

*Abraliopsis chuni* NESIS, 1982: Western Indian Ocean

*Abraliopsis atlantica* NESIS, 1982: Tropical and subtropical Atlantic

In addition to this, OKUTANI (1985) has early recognized the existence of an undescribed species of this genus in the Northwest Pacific. This is the new species here described.

The measurements and terminologies mostly follow ROPER and VOSS (1983).

Before going further, we wish to extend our thanks to Drs. T. UMEZU, K. TABATA and M. MURATA for generous offer of such an interesting material at our disposal. We are grateful to Captain S. SUYEKI and the crew of the R/V *Kaiyo-Maru* for their greatest effort in sampling the biological specimens. We also send our gratitude to Dr. K. N. NESIS, Institute of Oceanology, Moscow, and Dr. L. A. BURGESS, New

Jersey, for their useful information that improved this paper.

*Abraliopsis pacificus* n. sp.

*Abraliopsis* sp. OKUTANI, 1985, p. 44 (name only).

*Abraliopsis hoylei hoylei*: NESIS, 1982, p. 169 (pars).

*Abraliopsis* n. sp. A TSUCHIYA & OKUTANI, 1988, p. 129.

*Materials examined.* Holotype, NSMT-Mo 66998, male (26.1 mm DML), *Kaiyo-Maru* St. 49-5 (Apr. 24, 1987) 32°47.3'N, 147°58.7'E, 0-102 m; Paratype 1, NSMT-Mo 66999, female (36.3 mm DML), *Kaiyo-Maru* St. MT15B (June 9, 1979) 30°02.7'N, 143°33.0'E, 0-800 m; Paratype 2, NSMT-Mo 67000, male (25.7 mm DML), *Kaiyo-Maru* St. 49-5 (Apr. 26, 1987) 32°47.3'N, 147°58.7'E, 0-102 m; Paratype 3, NSMT-Mo 67001, female (34.7 mm DML), ditto; Paratype 4, NSMT-Mo 67002, male (24.9 mm DML), *Kaiyo-Maru* St. 1 (D) (July 25, 1972) 36°04.5'N, 157°55.6'E, 150-300 m; Paratype 5, NSMT-Mo 67003, female (34.0 mm DML), *Kaiyo-Maru* St. 49-5 (Apr. 26, 1987) 32°47.3'N, 147°58.7'E, 0-102 m; Paratype 6, USNM, male (24.8 mm DML), ditto; Paratype 7, USNM, female (32.3 mm DML), *Kaiyo-Maru* St. 49-5-2 (Apr. 26, 1987) 32°47.8'N, 147°59.4'E, 0-95 m; Paratype 8, USNM, male (23.3 mm DML), ditto; Paratype 9, USNM, female (28.3 mm DML), *Kaiyo-Maru* St. KOC16 (June 10, 1982) 30°00'N, 147°00'E, 0-876 m.

*Diagnosis.* A medium-sized *Abraliopsis* with irregular photophore arrangement on the ventral head, arm sucker with rectangular teeth on its inner ring, both ventral flap and well-developed aboral keel on the tentacle, and without modification of left ventral arm of male.

*Description.* The mantle is rather weak but muscular, conico-cylindrical, terminating in a blunt end of the short tail. The mantle width is about 35 to 45% of DML. The antero-dorsal end forms an obtuse angle in the middle, while antero-ventral margin is broadly emarginated with blunt lateral angles on both sides (Figs. 1-2).

The fins are transversely broad, wider than long, rhombic in outline with blunt lateral angles. The fin length is about 70 to 80% of DML, while the width attains about 85 to 100% of DML. The widest part of the fin width is located at distal 60 to 70% of the fin length (Fig. 2).

The head is subcubic and slightly narrower than the mantle opening with large eyes on both lateral sides. The eyelid has a shallow sinus in front. There are three pairs of fleshy crests on the posterior periphery of the head: A pronounced one far posterior to the Arm III, another one just behind the eye, and the third one just behind the dorsal edge of the eyelid. On the dorsal side of the ventralmost crest, a single papilla is present and it is fused to the crest (Fig. 3).

The funnel is moderate in size. The funnel groove is rather narrow with well developed posterior rim. The dorsal element of the funnel organs is V-shaped with developed rami carrying a prominent fleshy crest on top, and a delicate papilla at the anterior end. The ventral pads are drop-shaped in outline (Fig. 6).

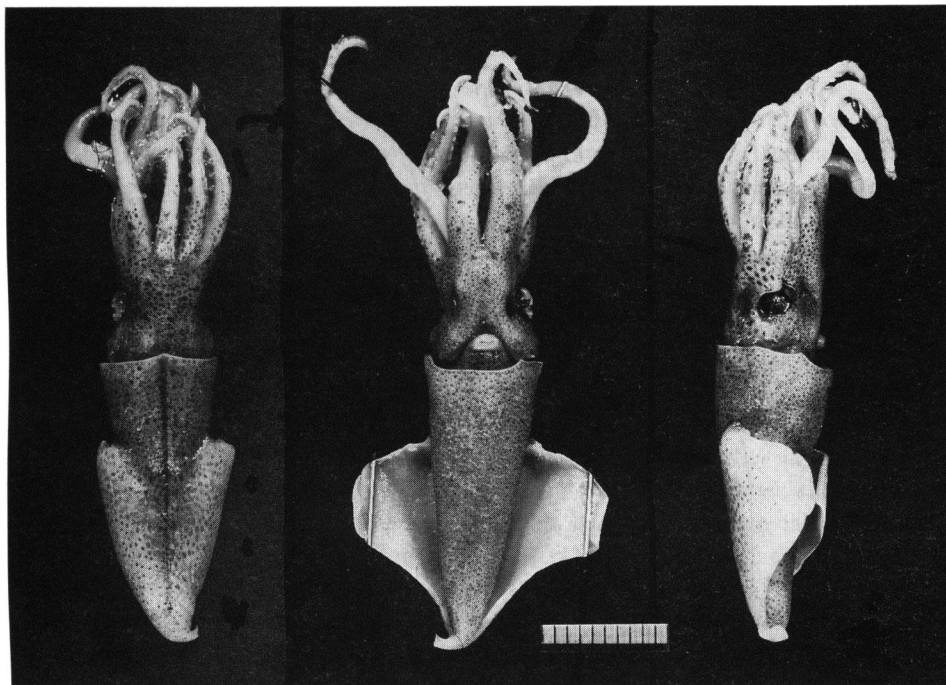
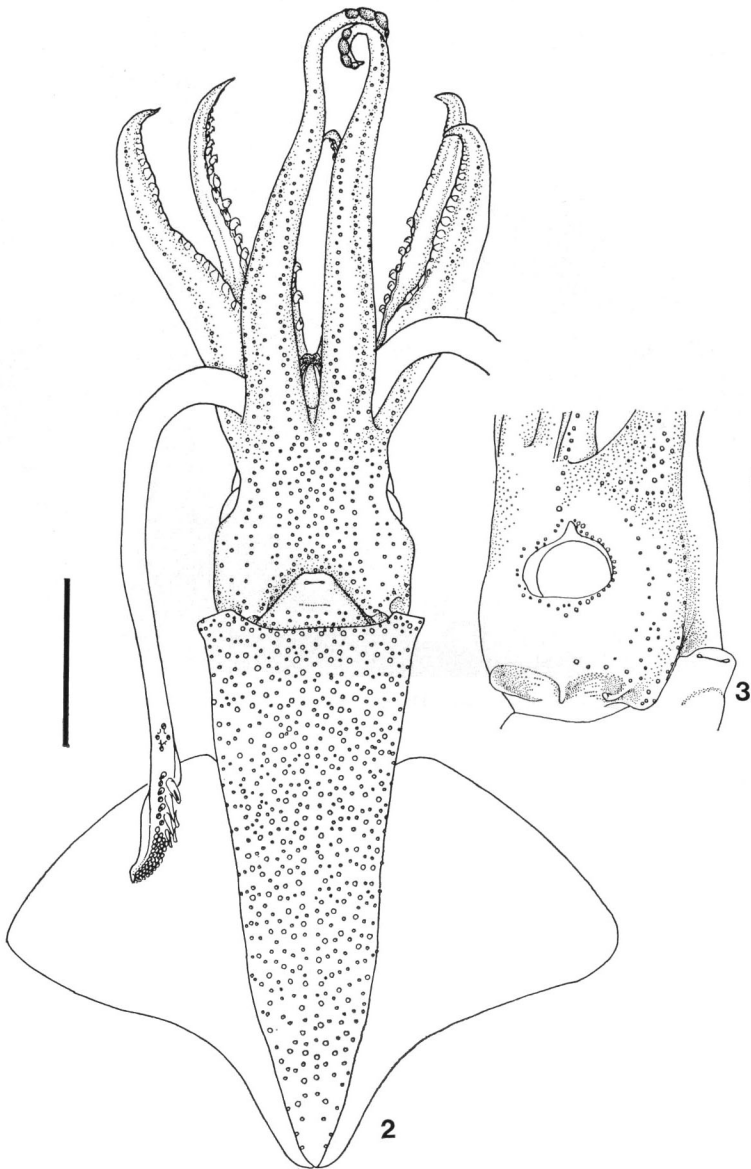


Fig. 1. *Abraliopsis pacificus* n. sp. — Three views of the holotype. Scale bar 10 mm.

The funnel cartilage (Fig. 4) is spatulate, slightly expanded posteriorly, and have a shallow groove in the middle. The width of the funnel cartilage is about 40% of its length. The mantle cartilage (Fig. 5) is a simple straight ridge. The nuchal cartilage is elongated elliptical and slightly expanded anteriorly. The width of the nuchal cartilage is about 40% of its length. The funnel cartilage is subequal in length to the nuchal cartilage.

Arms are long, slender, and very weak. The arm formula is IV, II, III, I in male, while IV, III=II, I in female. The longest arm attains about 60 to 75% of DML. The Arms I to III have aboral keels, and that in the Arm III is the highest of all. The protective membrane of the Arms I to III is prominent only along the ventral margin. The low aboral keel of the Arm IV is an interbrachial web covering the base of the tentacle basally. The Arm IV lacks a protective membrane. The armatures of all arms are composed of proximal hooks (16 to 30, mainly 16 to 23) and distal suckers (about 10 to 25 except on the Arm IV) arranged in two rows. The chitinous ring of the distal sucker has 3 to 5 rectangular teeth (Fig. 14).

The right ventral arm of the male is hectocotylyzed. In the hectocotylyzed arm, there are two offset crests of very different size: The proximal crest is long, trapezoid and slightly bilobed, originated at the fifth or sixth ventral hook, and extended to the distance of about 3 pairs of hooks distally. The distal crest is a weak and short



Figs. 2-3. *Abraliopsis pacificus* n. sp. — 2. Ventral view of the paratype No. 3 (female). Scale bar 10 mm. 3. Lateral view of the head of the paratype No. 5 (female). Scale bar 5 mm.

lunate membrane originated near the distal end of the proximal crest and extended to the distance of about 3 hooks (9th to 10th ventral hook) distally. The hooks in the modified portion of the hectocotylized arm seem to be arranged in a single row.

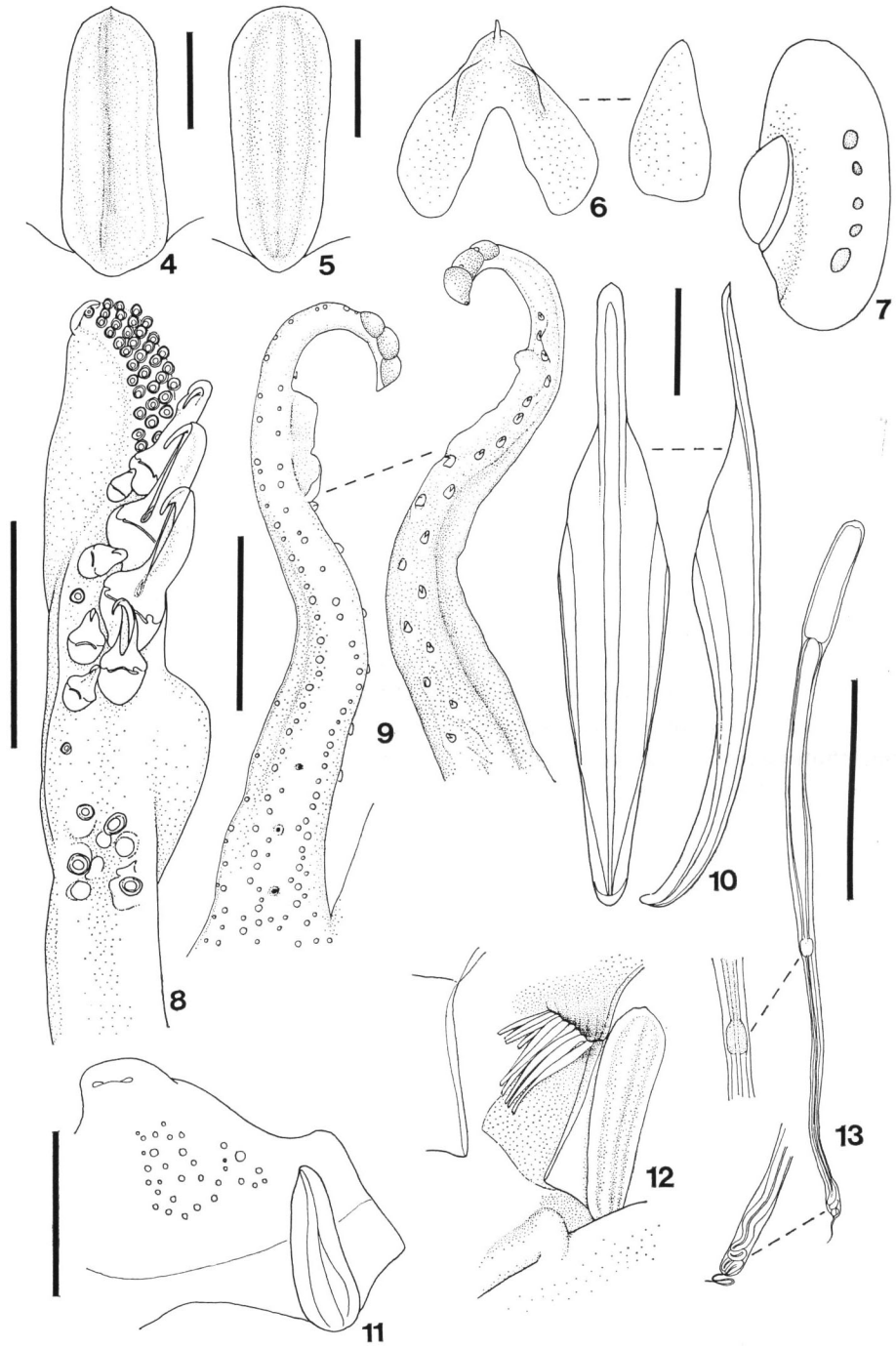
The proximal hooks to the proximal ventral crest are 8 to 11 in number (Fig. 9).

The tentacle is rather weak and its stalk is totally naked. The club is slightly thickened. The carpal group consists of 3 to 5 suckers and 3 to 6 pads. The manus has 3 or 4 large hooks on dorsal and 3 to 5 small hooks on the ventral row, respectively, with 3 to 4 suckers interposed between adjoining hooks. The dactylus suckers are arranged approximately in 4 longitudinal and 10 to 12 transverse rows. The ventral flap is lunate in shape, extending along the lateral side of club from the middle of carpus to the first dorsal hook. The aboral keel is extended from the second ventral hook of the club to the tip (Fig. 8). The chitinous ring of the dactylus sucker is entirely lacking of distinct teeth (Fig. 15).

The whole surface of the mantle, funnel, head and the Arms III and IV are ornamented with photophores. The photophores consist of two different types: The large organs with gray center and small organs with black center. On the ventral mantle, about 450 to 600 small photophores are scattered rather uniformly with an indistinct midventral photophore-less strip. On the ventral funnel, there is a cluster of about 20 photophores on the right and left halves. On each lateral side of the funnel, there are 7 to 8 photophores (Fig. 11). On the outer surface of each retractor muscle and dorsal funnel, there are about 20 to 25 photophores. On the mid-ventral surface of the head, there are about 250 to 270 photophores that are irregularly arranged. Two longitudinal photophore rows are present on each ventro-lateral side, of which the inner row originates at the posterior rim of the funnel groove and continuous to the middle photophore row on the Arm IV, and the other row originates at the posterior position of the orbit on the nuchal periphery and continuous to the dorsal photophore row in the Arm IV. The dorsal surface of the head is lacking in photophore. Three longitudinal photophore rows are present on the Arm IV. The dorsal row of them extends from the base to the proximal 30% of the arm length. The ventral row extends from the base to the proximal 80% of the arm. The mesial row extends from the base to the distal tip of the arm (Fig. 9). On the Arm III, a row of about 25 to 30 photophores are running along the ventral side of the aboral keel from the dorsal side of eyelid sinus to the distal tip. About 40 to 45 photophores are bordering the orbit. There are 5 monotypic, orange subocular photophores that are sized as LSMSL or LSLSL, arranged linearly and spaced. They are all hemispherical (Fig. 7). At the distal tip of the Arm IV, there are 3 or 4 hemispherical, black terminal photophores (Fig. 9).

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

The lower jaw plate (Fig. 16) is darkened gradually without spot or hook-like staining. The rostral edge is about a half of the wing length. The depth is about 70% of the length of the baseline. The wing angle is about 90° in degree. The rostral edge is slightly curved. There is no distinct hook at the rostral tip. The hood lies close to the crest. The crest is almost straight in profile. There is a notch in the pigmented part of the lateral wall near the jaw angle. The free corners of the lateral



wall are slightly separated. The posterior edge of the hood has a broad and shallow notch. The hood is dome-shaped in profile. The surface of the hood has a ridge running from the rostral tip to the middle of posterior margin of lateral wall. There is a low wing fold hindering the jaw angle. The wing fold is rounded and broad with cartilaginous knob on the inner wing fold. The shoulder forms an elongate ridge. At the shoulder, wing is developed inner laterally and creates a blunt angle to the lateral wall. Cartilage on the shoulder is absent. The jaw angle is curved and indistinct. The region below the jaw angle is darkened and has no step. The darkening of the anterior part of the lateral wall near the jaw angle forms a round curve joining the front of the shoulder. The crest is moderate and thick.

The whole outer surface of the mantle, head and arms are ornamented by brownish purple chromatophores. The dorsal surface of the fins has chromatophores but the ventral surface lacks them. The whole outer surface of the funnel has chromatophores. The collar also has chromatophores. The chromatophores form longitudinal bands both on oral and aboral surfaces of the tentacular stalk. The inner surface of the mantle has no chromatophore. The penis, oviducts and rectum have chromatophores, while gill lacks them. Some chromatophores are present around the ganglia. The outer surface of the buccal membrane is stained monotonously with purple.

The spermatophore (Fig. 13) is 6.5–7 mm in length. The sperm mass is proportionally short, about 15% of the spermatophore length and it does not reach the aboral tip. The cement body is long, about 45% of the spermatophore length, and fusiform with simple, cylindrical oral connective complex. The ejaculatory apparatus length is about 40% of the spermatophore length.

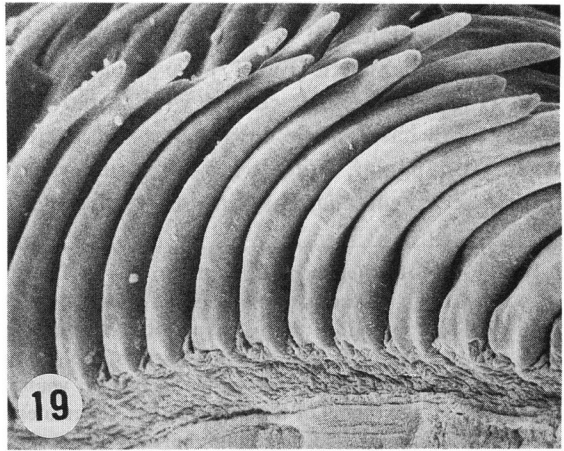
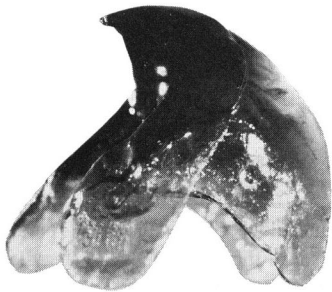
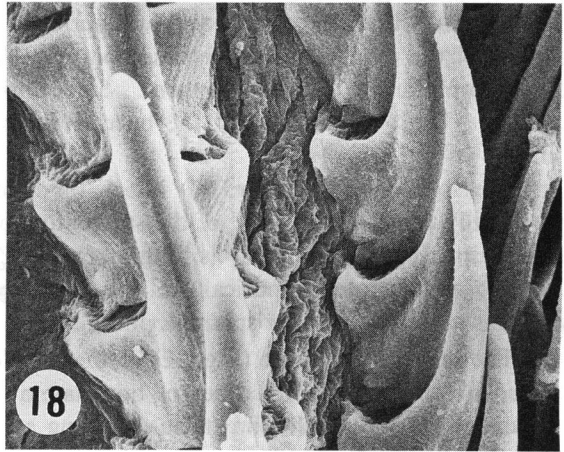
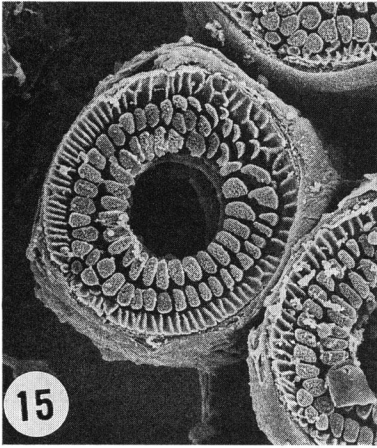
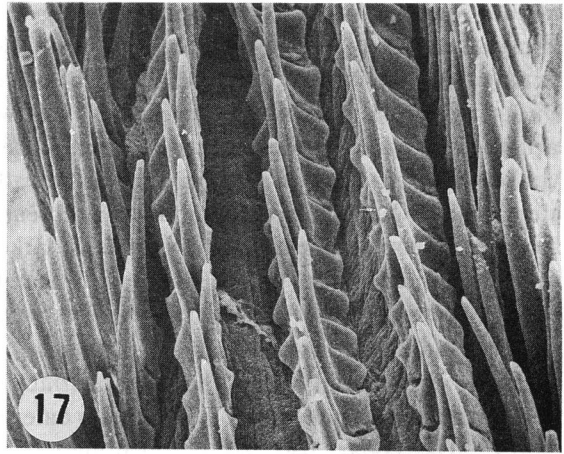
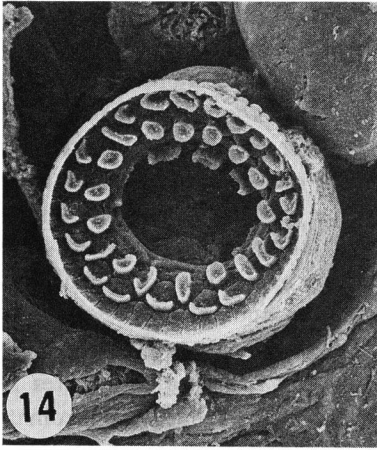
The seminal receptacle (Fig. 12) of the female is located on the inner surface of the collar at the anterior corner of both lateral sides of the nuchal cartilage. The surface of the receptacle and its surrounding are stained with dark purple.

There is a pair of leaf-shaped palps on both lateral sides of the anus. The orifice of the penis is bilobed.

The radular teeth (Fig. 17) are seven in a row with rather blunt tips. The rachidian (Fig. 18) is single-cusped with trapezoid bases incurved on both sides. The lateral tooth has a single cusp and rather narrow, triangular, inner lateral wing and broad, rectangular, outer wing. The inner marginal tooth has a single cusp and narrow, rectangular lateral wings on both sides. The outer marginal tooth (Fig. 19)

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Figs. 4–13. *Abrialopsis pacificus* n. sp. — 4. Left funnel cartilage of the paratype No. 5 (female). 5. Nuchal cartilage of the same. 6. Funnel organ of the paratype No. 3 (female). 7. Right eyeball of the paratype No. 7 (female). 8. Left tentacular club of the paratype No. 2 (male). 9. Hectocotylized arm of the paratype No. 6 (male); aboral and oral views. 10. Gladius of the paratype No. 4 (male); ventral and lateral views. 11. Vento-lateral view of the funnel of the paratype No. 5 (female). 12. Seminal receptacle of the paratype No. 7 (female). 13. Spermatophore. (4, 5, 8, 13—scale bar 2 mm; 3, 9, 10, 11—scale bar 5 mm).





is highest of all and has a single cusp and a low longitudinal keel on outer lateral side, while it is not prominent on inner lateral side.

The dorsal dome of the statolith is small and indistinguishable from the lateral dome. It is slightly rounded antero-dorsally. The lateral dome is dorso-ventrally elongated, extending anteriorly with the dorsal dome and with the rostrum when viewed laterally. The rostrum is proportionally short and trapezoid in shape. The anterior rostral lobe is well-developed and produced exceeding the ventral end of the rostrum, while the lateral rostral lobe is indistinct. The ventral end of the rostrum is almost pointed. The tip of the rostrum is curved towards either anteriorly or posteriorly. The rostrum and lateral dome create an obsolete rostral angle laterally. The rostral surface to the wing is rough as if eroded. The attachment area or anterior side of the wing has a shallow dorsal and a ventral indentations separated by the spur. The indentation is slightly wider ventrally than dorsally in anterior view. The spur separates the dorsal and ventral indentations and slopes ventrally. There is a shallow hollow on the lateral side of the spur. The spur is flexed towards the anterior surface of the statolith, forming a distinct protrusion on the surface. The dorsal end of the dorsal indentation is thickened to form the anterior dorsal ridge. Just ventral to this the wing has three small mesial fissures. The dorsal end of the spur creates the distinct posterior ventral ridge. The posterior dome groove develops and separates the lateral and dorsal domes from the wing and rostrum (Fig. 20).

The gladius (Fig. 10) is robust and penniform. The vane is about 80% as long as the length. The rachis gradually tapers to the posterior blunt end with a short end cone. The gladius width is about 15% of the length. The anterior margin of the vane has an incision. The angle in cross section of the gladius is 100° to 110° in the median portion.

*Measurements.* See Table 1.

*Type depository.* Holotype and 5 Paratypes in the National Science Museum, Tokyo and 4 Paratypes in the U. S. National Museum.

*Type locality.* Lat. 32°47.3'N, long. 147°58.7'E, 0–102 m deep (The R/V *Kaiyo-Maru* St. 49–5: April 26, 1987).

*Distribution.* Northwest Pacific Basin and Shikoku Basin, approximately between latitude 30° and 35°N (Fig. 21). Vertical distribution in sampling data is 900–500 m deep in daytime, and 263 m up to 102 m deep at night.

*Remarks.* The present new species belongs to the subgenus *Abrialiopsis* s. str. on the basis of the definition by TSUCHIYA and OKUTANI (1988). Three related species are *A. hoylei* (PFEFFER, 1884), *A. pfefferi* JOUBIN, 1896, and *A. tui* RIDDELL, 1985.

*Abrialiopsis tui* RIDDELL, 1985 from New Zealand waters, is a medium-sized

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Figs. 14–19. *Abrialiopsis pacificus* n. sp. — 14. Sucker on the Arm III of the female (32.4 mm DML) from 87 St. 49–5. ×250. 15. Dactylus sucker on the tentacular club of the same. ×250. 16. Lower jaw plate of the paratype No. 3 (female). 17. Radula of the female (34.5 mm DML) from 87 St. 49–5. ×240. 18. Rachidian and inner lateral teeth of the same. ×750. 19. Marginal teeth of the same. ×380.

Table 1. Measurements, indices and counts of *Abraliopsis pacificus* n. sp.

Sex	Holotype (NSMT-Mo 66998) 87St.49-5		Paratype 2 (NSMT-Mo 67000) 87St.49-5		Paratype 4 (NSMT-Mo 67002) 72St.1(D)		Paratype 6 (USNM) 87St.49-5		Paratype 8 (USNM) 87St.49-5	
	male	mm	male	mm	male	mm	male	mm	male	mm
DML	26.1	33.0+	25.7	36.6	24.9	45.4	24.8	46.0	23.3	46.4
MWI	34.1	48.7	38.9	44.8	36.1	53.0	37.9	50.0	43.8	59.2
FLI	76.6	42.2	81.2	38.9	78.3	49.4	72.2	41.5	77.7	53.7
FWI	90.8	69.4	87.9	64.2	95.2	61.9	89.1	70.6	92.3	75.8
HWI	30.7	—	33.9	—	34.9	—	37.5	—	39.9	—
ALI	36.4+	33.0+	35.8	36.6	37.4	45.4	46.0	44.4	42.5	46.4
I	43.3	48.7	32.3	44.8	51.4	53.0	50.0	52.0	49.4	59.2
II	46.7	42.2	41.3	38.9	44.2	49.4	41.5	50.8	53.2	53.7
III	65.1	69.4	64.2	63.8	62.3	61.9	70.6	61.3+	74.7	75.8
IV	32.2	—	35.4	—	35.7	—	38.7	—	44.6	—
HeLI	102.7	103.1	102.3	98.4	102.8	94.8	94.0	100.4	—	—
TLI	19.9	18.8	22.2	21.0	20.1	24.1	17.7	17.7	—	—
CLI										
ASC & (AHC)										
I	(20) 5+	(16+) +	(21) 24	(22) 23	(28) 23	(20) 19	(18) 25	(18) 26	(18) 24	(18) 23
II	(23) 16	(23) 20	(19+) +	(24) 23	(25) 24	(23) 31	(19) 23	(21) 21	(21) 20	(21) 18
III	(21) 9	(21) 12	(21) 19	(21) 16	(22) 14	(21) 15	(19) 18	(19) 15	(20) 13	(20) 17
IV	(17) 0	(17) 0	(16) 0	(20) 0	(16) 0	(16) 0	(19) 0	(18) 0	(16) 0	(16) 0

	Paratype 1 (NSMT-Mo 66999) 79MT15B	Paratype 3 (NSMT-Mo 67001) 87St.49-5	Paratype 5 (NSMT-Mo 67003) 87St.49-5	Paratype 7 (USNM) 87St.49-5	Paratype 9 (USNM) 82KOC16B
Sex	female	female	female	female	female
DML	36.3 mm	34.7 mm	34.0 mm	32.3 mm	28.3 mm
MWI	36.4	34.3	34.1	39.0	40.3
FLI	76.9	75.5	74.7	76.2	73.5
FWI	91.2	90.2	90.3	92.9	95.1
HWI	33.4	32.9	30.9	33.8	32.9
ALI					
I	46.3	40.4	45.0	49.9	39.6
II	52.9	45.2	54.1	52.9	49.5
III	47.7	43.5	49.1	54.8	45.2
IV	74.9	63.1	67.4	72.1	65.7
HcLI	—	—	—	—	—
TLI	114.9	112.1	100.0	138.1	97.5
CLI	24.2	19.3	21.8	21.7	20.9
ASC & (AHC)					
I	(20) 20	(19) 25	(16) 21	(18) 23	(17) 18
II	(21) 20	(23) 13+	(22) 19	(22) 20	(20) 18
III	(25) 16	(22) 16	(19) 18	(20) 16	(16) 16
IV	(20) 0	(13+) 0	(19) 0	(18) 0	(16) 0

\* Brachial indices and counts in the left column are for the right of the specimens and those in the right column for the left.

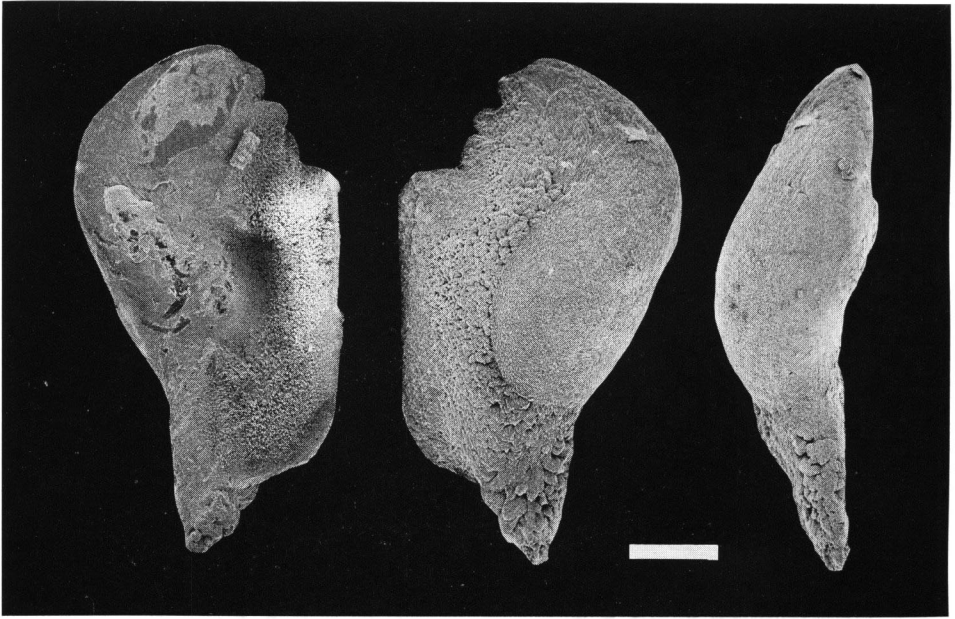


Fig. 20. *Abraliopsis pacificus* n. sp. — Three views of the statolith of a female (34.5 mm DML) from St. 49-5. Scale bar 100  $\mu$ m.

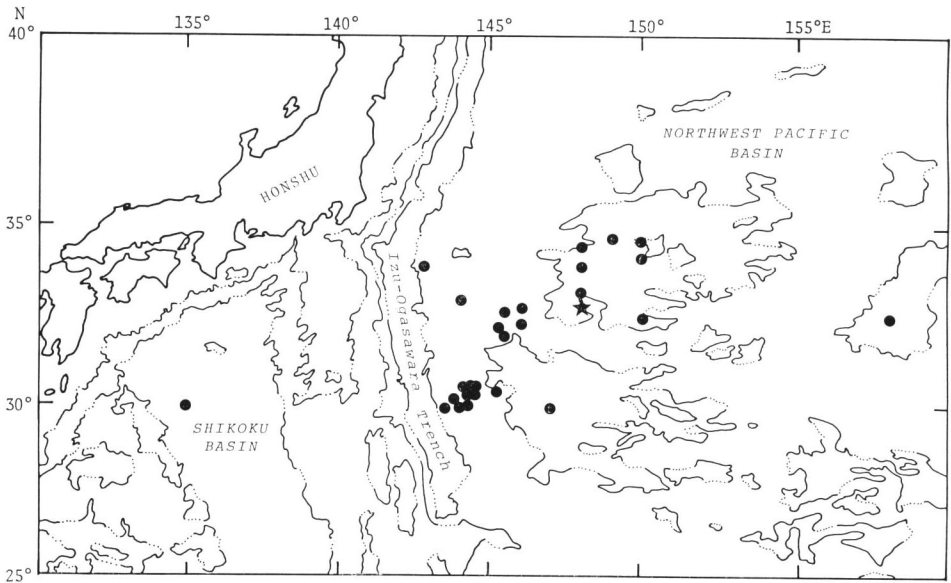


Fig. 21. Distribution (collecting stations) of *Abraliopsis pacificus* n. sp. A star indicates the type locality. Bathymetrical contours in the Pacific are 2,000 m, 4,000 m and 6,000 m.

species. The hectocotylized arm of *A. tui* is composed of only a single, long, trapezoid crest on the ventral margin, while the present new species has a small lunate distal crest on the dorsal margin in addition to the ventro-proximal trapezoid one. *A. tui* has three pairs of crests on the posterior periphery of the head, of which dorsal two are connected with each other, while these crests are not connected in the present new species. Several indices of *A. tui* are different from those of the present new species, such as wider fins (101–111 in FWI in *A. tui* versus 78–96), longer ventral arm (100–110 in ALI IV versus 63–77) and proportion of spermatophore (40% in SpMI versus 15%).

The present new species is distinguishable also from *A. pfefferi* with several indices (78–96 versus 102–110 in FWI, 63–77 versus 94–101 in ALI IV) and the characters on the nuchal crests as was mentioned in the above comparison with *A. tui*. In addition, the proportion of spermatophores is clearly different from each other (ca. 25% in SpMI versus 15%) (CAIRNS, 1976).

*Abraliopsis hoylei* (PFEFFER, 1884) was established based on a female, 31 mm DML, from Mascarenes, western Indian Ocean. *A. hoylei* is separable from the present new species by such characters as development of the aboral keel (narrow in *A. hoylei* versus broadly expanded) and number of dactylus suckers (more than 14 transverse rows versus 10 to 12 rows). The ventral flap of the tentacle is extended from the base of the first hook to the base of fourth ventral hook in *A. hoylei*, while from the middle of carpus to the first ventral hook in the present new species (PFEFFER, 1912, Taf. 17, fig. 9). The photophores on the ventral head is less in number in *A. hoylei* than in the present new species. YOUNG (1972) re-examined the type specimen of *A. hoylei* and described its arm sucker dentition. It has pointed teeth on the inner ring of the first few distal suckers, while the present new species has truncate teeth.

The taxonomical status of three *Abraliopsis* species, *A. hoylei* (PFEFFER, 1884), *A. pfefferi* JOUBIN, 1896 and *A. tui* RIDDELL, 1985 is rather subtle and contradictory.

NESIS (1982) allocated *A. pfefferi* as a subspecies of *A. hoylei*. He probably included *A. hoylei* of BERRY (1914, 1916), which was identified as *A. tui* by RIDDELL (1985), into *A. hoylei hoylei*. NESIS (pers. comm.) divides *Abraliopsis* (s. s.) species-group into two subspecies, the Indo-Pacific *A. hoylei hoylei* and the Atlantic *A. hoylei pfefferi*, and he considers that *A. tui* is synonymized with the former. It is most probable that NESIS (op. cit.) may take the present new species to be a part of *A. hoylei hoylei*, as he claims that *A. hoylei* contains a number of local forms.

Based on the sucker dentition, *A. hoylei* is closer to *A. felis* than to *A. tui* or the present new species (MCGOWAN & OKUTANI, 1968; YOUNG, 1972). TSUCHIYA and OKUTANI (1988) allocated *A. hoylei* into the subgenus *Abraliopsis* s. s. based on only tentacle. The dentition of the arm suckers may be one of subgeneric characters. The 'carpal flap' mentioned by YOUNG (1972) may be an only developed protective membrane and not the same as the carpal flap sensu OKUTANI (1974) and TSUCHIYA and OKUTANI (1988). Thus, it is suitable that *A. hoylei* is allocated into the subgenus *Boreabraliopsis* and *A. pfefferi* and *A. tui* are different in the species level.

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