

## On Eleven New Species of the Cephalopoda from Japan, Including Two New Genera of Octopodinae

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### I INTRODUCTION

In several years past I could get a lot of Cephalopod specimens from several localities ranging from Hokkaidô to Kyûshû, among which 11 new species (3 Architeuthacea and 8 Octopoda species) have been found, and they are described in this paper. For the description of colour of the specimen, I followed WADA's standard (1931).

Herewith I wish to express my hearty thanks to those gentlemen who assisted me in collecting specimens as well as relevant informations, especially to Mr. Kohman Y. ARAKAWA, of the Hiroshima Prefectural Fisheries Experiment Station, Hiroshima, by whose enthusiasm 3 new species of Octopoda were found, two of which are of rather large size and a new genus is established here, one of which emits phosphorescent light on the skin at stimulus, a phenomenon hitherto unknown in littoral Octopoda. My thanks are also due to Prof. Toshiji KAMOHARA of Kôchi University, Mr. Satoshi HIRANO of Chôshi City, Chiba Prefecture, Mr. Shôichirô HAYASHI, of Isshiki-chô, Aichi Prefecture, Mr. Kazuo KUROHARA of Tosa-Shimizu City, Kôchi Prefecture, Mr. Hisakatsu SAKAMOTO, of the Kushiro Branch of the Hokkaidô Regional Fisheries Research Laboratory, Mr. Katsuchiyo ITô, of the Kasumi Branch of the Japan Sea Regional Fisheries Research Laboratory, Mr. Saburô NISHIMURA, of the Seto Marine Biological Laboratory of the Kyoto University, all of these gentle-

men forwarded valuable specimens with informations to me. I am also grateful to the staff of the Zoological Institute of Kyoto University for the loan of a specimen of *Calliteuthis*, whose kindness enabled me to describe a new species of this genus based on an intact specimen; to Prof. G. L. Voss, chairman of Division of Biological Sciences, Marine Laboratory, University of Miami, Florida, U. S. A., and Mr. I. TAKEUCHI, of Hakodate Branch of Hokkaidô Regional Fisheries Research Laboratory, on the facilities of literature.

## II Description of *Onykia japonica* TAKI, n. sp.

Family Onychoteuthidae  
Subfamily Onychoteuthinae  
Genus *Onykia* LESUEUR 1821

*Onykia japonica* TAKI, new species (Pl. 1, fig. 1; Text-figs. 1-10)

### Measurements (in mm) :

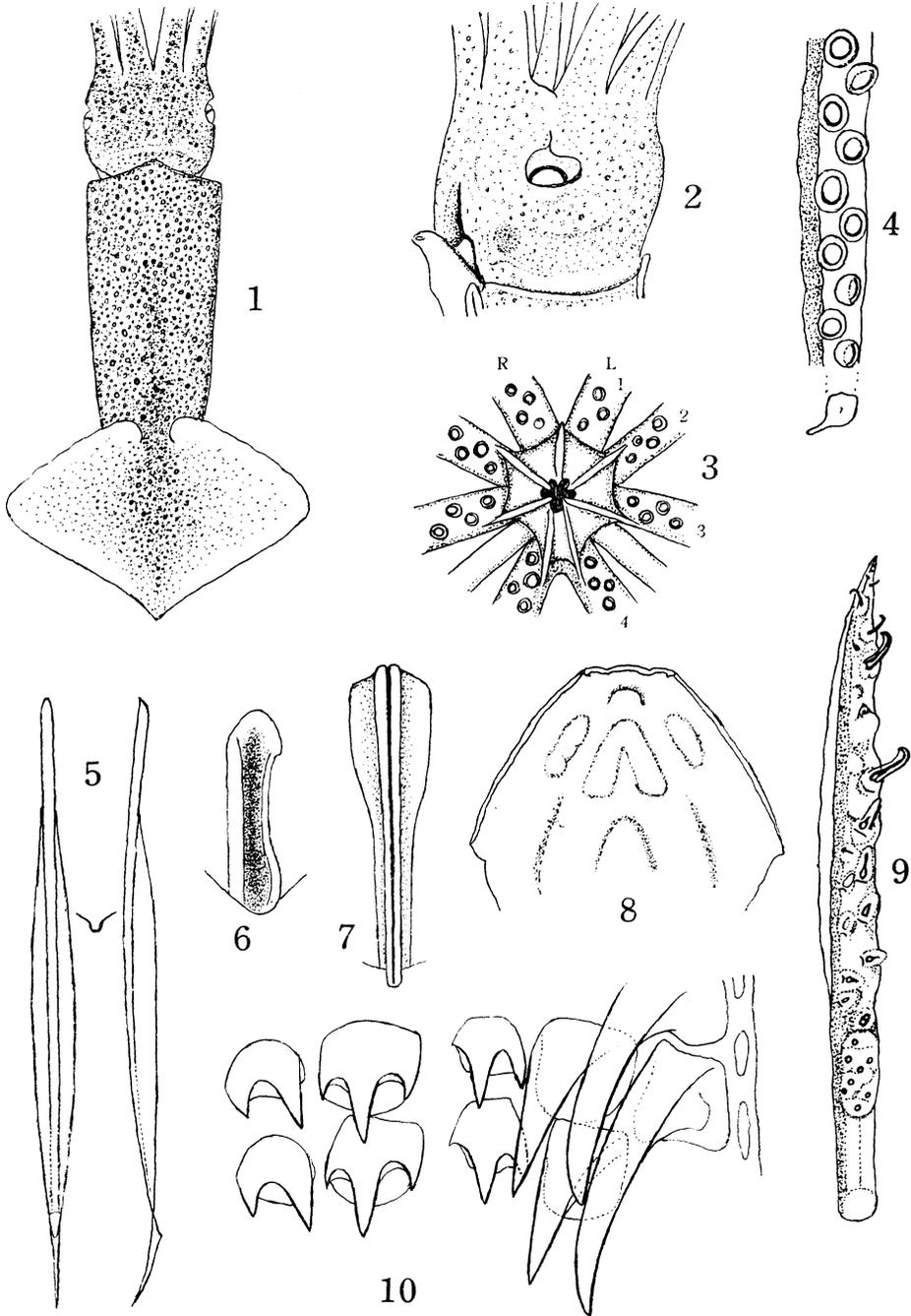
Mantle length (dorsal)	60		
" "	(ventral)	56	
" width		18	
Head width		17	
Fin length		31.5	
" width		41	
		L	R
Arm	1	50	46
	2	54	57
	3	53	52
	Tentacle	95	(mutilated)
	4	55	57

Locality: Western part of Tosa Bay to Bungo Channel, 120-230 m, caught by the trawl-net, obtained by Mr. Kazuo KUROHARA, April 1961.

Body (Pl. 1, fig. 1; text-fig. 1) roughly elongate conical, its width 30 % of mantle length, its anterior half nearly cylindrical, but widest at the anterior margin and gradually tapers posteriorly, posterior half of mantle conical and the posterior  $\frac{1}{5}$  abruptly tapers to a narrow tube, its diameter ca.  $\frac{1}{10}$  of the maximum width of mantle. On the dorsal side the anterior margin protrudes in a low  $\wedge$ -form, its tip obtuse.

Fins taken together roughly quadrangular, occupying the posterior half of the mantle length, making an angle of ca.  $120^\circ$  at the posterior margin, outer angle ca.  $80^\circ$ , anterior margin attenuated, interspace between both fins  $\frac{1}{6}$  the entire width of two fins taken together anteriorly, each fin free at anterior  $\frac{1}{5}$  of its length.

Head (Text-fig. 2) only a little narrower than mantle-opening, nearly cubic in shape, ventral side flat, funnel groove  $\wedge$ -shaped, occupies about posterior half of its length, deeply excavated, with two slender adductors which connect the funnel.



Text-figs. 1-10. *Onykia japonica* TAKI, n. sp.

1. Dorsal view of the animal, ca.  $\times 1$ ; 2. Left side view of the head,  $\times 1.8$ ;  
 3. Oral view of buccal membrane; 4. Right third arm, middle portion,  $\times 2.8$ ;  
 5. Gladius, ventral and right side views,  $\times 1.4$  6. Funnel cartilage; 7. Nuchal cartilage;  
 8. Funnel cut open,  $\times 2.5$ ; 9. Left tentacular club,  $\times 2.8$ ; 10. Radula,  $\times 95$ .

There is an olfactory crest, a thin film, at the posterior corner of ventral side of the head, with a small papilla at the middle. Buccal membrane (Text-fig. 3) with seven prominent radial ridges.

Eye of moderate size, eye-opening transversely elongated ellipsoid in shape, with a median sinus which projects anteriorly.

Funnel broad, its width a little narrower than half the mantle opening. Funnel-organ (Text-fig. 8) ^-shaped, each limb rather wide, with an oblique, elongate ellipsoid ventral pad on each side.

Funnel cartilage (Text-fig. 6) elongate oblong, 8 mm long and 3 mm wide, about  $2\frac{1}{2}$  as long as wide, the outer ridge slightly concave at the middle; mantle cartilage 12 mm long and 0.5 mm wide, straight and thin. Nuchal cartilage (Text-fig. 7) 12 mm long and 3 mm wide, anterior part slightly wide, with a pair of parallel ridges which is 1 mm wide; mantle cartilage the same dimension as the nuchal cartilage, with a very narrow and low ridge along its median line.

Arms very long, its order of length 4. 2. 3. 1, the longest is slightly shorter than the mantle length, quadrangular in cross section; the third arm only has a thin keel on the aboral side at the middle of its length, ca. 18 mm long and 2 mm high. Arm suckers (Text-fig. 4) biserial, the largest one ca. 1.8 mm in diameter, horny ring narrow in width, its inner margin entire, without teeth.

Tentacle (Text-fig. 9) longer than all the arms, its length about twice as long as the shortest arm (first arm), of uniform width, squarish in cross section, club 28 mm long, about  $\frac{1}{3}$  of its length, compressed, with a thin, narrow keel at the aboral side, carpal fixing organ 2 mm wide and 4.5 mm long, with 8 suckers, which are 0.5 mm in diameter, equipped with a quite thin round horny ring, manus portion with two rows of hooks, their number about 18, of which those on the dorsal side are smaller, the largest one measures about 3 mm in length, which is curved as a fish-hook.

Gladius (Text-fig. 5) brown in colour; 60 mm long and 4 mm wide, rhachis 1.8 mm wide at the anterior tip; vane ca. 36 mm long and 2.5 mm wide, widest at about the middle of its length; end-cone 10 mm long, very thin in consistency, its anterior orifice oblique, 2 mm long, tapers to the posterior end.

Radula (Text-fig. 10): rhachidian tooth with a squarish base, tricuspid, of which the central cusp very long and ectocone shorter and smaller; first lateral bicuspid, the inner cusp longer than the outer one; second lateral thick and its cusp long and pointed, nearly four times as long as the central cusp of the rhachidian; third lateral about  $1\frac{1}{2}$  as long as the second lateral, very thick and its tip of the cusp slightly curved.

Colouration. The animal is coloured as a whole cameo pink, the chromatophores (of which the largest one about 0.5 mm in diameter) old rose, fin light pinkish cinnamon.

Generic position; The genus *Onykia* was established by LESUEUR in 1821 and MENKE (1830) emended it as *Onychia*, which is preoccupied by *Onychia* HÜBNER (1816) (Lepidoptera) and also HALIDAY (1829-30) (Hymenoptera) and VERRILL proposed its replacement name *Teleoteuthis* in 1885, though he states that his propo-

sition to be 1881, which is not duly recognized. But JOUBIN thinks that to be 1882 (1900, p. 67). THIELE (1935), ROBSON (1948) and VOSS (1956) do not seem apparently pay attention about this matter, and I think that the genus should be spelt in the original form, without emendation. Etymologically *Onykia* may be to be spelt as *Onychia* by the presence of the hook in the tentacle, as in *Onychoteuthis*, but the original spelling should be retained, even though it is based on an error of transliteration of Greek word, unless the original author corrects its spelling. This is also an adequate way to avoid confusion by the emergence of a synonym by preoccupation.

In the family Onychoteuthidae this genus is most closely related to *Moroteuthis*, in the absence of nuchal folds and photophores, but separated from it by the absence of an end-cone in the gladius, which is represented by a mere spine while it is present in *Onykia*. Also this is distinguished from the subgenus *Moroteuthopsis* PFEFFER 1908 in the genus *Moroteuthis* by the absence of the mid-dorsal groove in the gladius, and moreover in the point of locality; that subgenus occurring in the Patagonian sea.

However, the present specimen lacks the suckers in the manus portion of the tentacular club, which is equipped with hooks only. According to PFEFFER (1912, p. 45) this character is somewhat variable in species of the genus, and in a few species (for example, *O. caribbaea*) the four rows of armature are represented by two median rows of hooks and one peripheral row of suckers on each side, which is small and shows a tendency of atrophy. It is surmised that the two rows of hooks in this species are reached by the progress of this tendency, and this variation may not be so important as to change its generic position.

Comparison with related species; Species of this genus were fully described with sufficient illustrations by PFEFFER (1912), and this species is distinguished from those species by the fact that, the animal is larger than either of them, the mantle, fin, arm and tentacle are morphologically prominently different from them. VOSS (1956, p. 126) synonymized *Teleoteuthis agilis* VERRILL 1885 with *Onykia caribbaea* LESUEUR 1821, the type-species of this genus, by examining the type-specimen.

*Teleoteuthis compacta* (BERRY 1913; 1914) was described from the sea near Kauai Island, Hawaiian Islands, which differs from the present species by the fact that, that species is very small (dorsal mantle length 21 mm), the mantle is shorter and thicker, all arms and tentacles shorter, fin very large (width across fins is the same as the mantle length), and also in the tentacular club there is only one row of hooks and one row of suckers.

In 1948, ROBSON reported two species of *Onykia* (= *Teleoteuthis*) from the Eastern Pacific, of which one is unnamed, mantle length 3–13 mm (91 specimens) and the other, mantle length 27 mm. The former is evidently a juvenile form and not appropriate for specific identification, and the latter, somewhat juvenile (*appellöfi*, mantle length 38 mm), if actually identified as *appellöfi*, differs from the present species in many characters, such as shape of mantle, arm, tentacular armature and gladius etc.

In conclusion, this species is the unique representative of this genus in the sea near Japan; this is the first record of the occurrence of this genus in Japanese waters.

III Description of *Enoploteuthis theragrae* TAKI, n. sp.

Family Enoploteuthidae Subfamily Enoploteuthinae

Genus *Enoploteuthis* ORBIGNY 1839*Enoploteuthis theragrae* TAKI, new species

(Pl. 1, fig. 2 ; Text-figs. 11-20)

## Measurements (in mm)

		Paratype No. 1		Type
Sex		♀		♂
Mantle length (dorsal)		80		60
" "	(ventral)	70		54
" "	width	24		18
Head	width	24		19
Fin	{	width	50	43
		length	40	28
Arm	{	L R		L R
		(mut.) (mut.)		35 32
		1	38 (mut.)	35 35
		2	40 (mut.)	35 40
		3	73 (mut.)	50 54
	Tentacle	35 (mut.)	35 33	
	4			

Locality: Two specimens (type and paratype no.1), off Fukui Prefecture, Japan Sea, 15th and 19th, Oct. 1962, found from the stomach of a cod, *Theragra chalcogramma* (PALLAS), by Mr. Saburo NISHIMURA; five specimens, mantle length 20-40 mm, off Hyôgo Prefecture, Japan Sea, found from the same fish in spring 1957, by Mr. Katsuchiyo IRÔ.

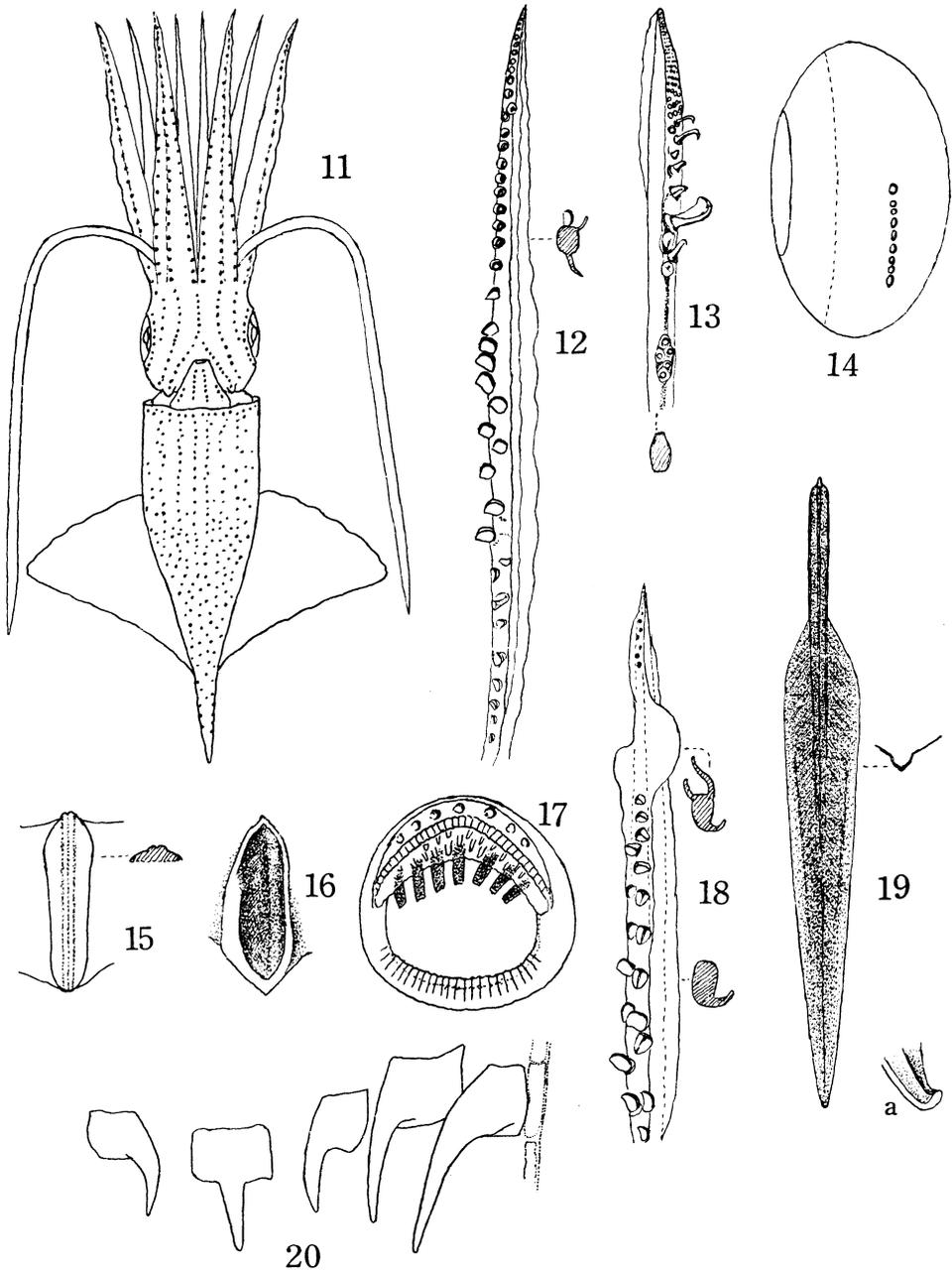
Animal of moderate size, as a whole rather soft, somewhat gelatinous, but arms and tentacles fleshy in consistency.

Mantle (Pl. 1, fig. 2; text-fig. 11) elongate conical in shape, its width 30 % of its length, widest at the anterior margin and the lateral margin nearly straight; posteriorly it tapers to the slender extremity, which is conveniently expressed as a tail, occupying about  $\frac{1}{4}$  of the whole length of the mantle, where the tissue is very soft, easily flexible, gelatinous and transparent. The ventral side of the anterior margin is shallowly concave near the base of the funnel, and on both sides of this insinuation the margin is slightly produced; at the mid-dorsal line the anterior margin is a little projected.

Fins taken together nearly squarish, its breadth longer than half the mantle length and its length about half the mantle length; the antero-lateral margin shallowly concave.

Head comparatively large, globular, its width as wide as the mantle, flattened at the ventral surface; eye very large, occupying the whole lateral margin of the head.

Funnel short and broad, its anterior tip reaching about the halfway of the length of head; funnel groove deeply excavated and the lateral margin of the groove is



Text-figs. 11-20. *Enoploteuthis theragrae* TAKI, n. sp.

11. Diagram of the outline of a juvenile specimen (ventral mantle length 28 mm, tail excluded), in which distribution of photophores is shown. Photophores are greyish white dots bounded by a larger dark semicircle, but in the figure they are shown as black dots, which are drawn a little than the actual size. Chromatophores on the surface and all armatures on arms and tentacles are entirely omitted.  $\times 1.3$  12. Left third arm. 13. Club of left tentacle. 14. Row of photophores on the right eye-ball,  $\times 3.2$  15. Nuchal cartilage,  $\times 2.6$  16. Right funnel cartilage,  $\times 2.6$  17. Armature of horny ring of the largest sucker of the left third arm,  $\times 42$  18. Hectocotyliized right fourth arm of male, type,  $\times 2.6$  19. Gladius, ventral view,  $\times 1.3$  a, oblique view of posterior cone. 20. Radula,  $\times 90$ . Figures 12-17, 19-20 are drawn from the paratype No. 1.

conspicuously elevated to form an oblique ridge, 1.5 *mm* wide and 10 *mm* long, parallel to the oblique side of the funnel. Funnel organ composed of rather slender  $\wedge$ -shaped inner pad, with an outer oblique pad on each side.

Funnel cartilage (Text-fig. 16) somewhat ellipsoidal, but it is narrower anteriorly than posteriorly, its width less than half of its length.

Nuchal cartilage (Text-fig. 15) oblong, its width ca.  $\frac{1}{3}$  of its length, weakly produced in front, the median ridge widely elevated.

Arms subequal in length, the pair of fourth arms squarish in cross-section, but the other arms (Text-fig. 12) conspicuously compressed and equipped with thin, semitransparent keel along the whole length of the arm. Armature of arms are composed of hooks and suckers. Hooks are arranged mostly uniserially, only in a short area biserially, their size small, short, inside of the hook is invariably filled with white fleshy substance; in the distal portion, about  $\frac{1}{5}$ - $\frac{1}{8}$  of the arm length, is armed with suckers (Text-fig. 17), which are exceedingly small (diameter of the largest sucker 0.69 *mm*), about 18 suckers in the left third arm; horny ring of these suckers have 7 oblong teeth on the distal side, with a number of minute short spines and tubercles on the upper margin.

Tentacle (Text-fig. 13) more slender than any arm, its length about the same as the ventral mantle length, evidently compressed and four-sided, 3 *mm* wide and 1 *mm* thick, club the same width as the stem, its length is about 25% of its length; a narrow, thin membrane on the distal part of the dorsal side of the club; fixing apparatus on carpus ellipsoid, 2.8 *mm* long and 1.5 *mm* wide, equipped with 5 suckers, which are 0.3 *mm* in diameter and flat, arranged biserially; manus portion 12 *mm* long and 1.5 *mm* wide, about 10 hooks are arranged biserially, of which one (paratype) or two (type) hooks only are exceedingly large, 3 *mm* long and the rest are rudimentary; distal portion is crowded with minute low suckers arranged quadriserially, the largest proximal sucker 0.3 *mm* in diameter.

Buccal membrane rather thin, broad, with eight ribs and their tip produced upward, the ribs are white and the membrane dark brownish purple.

The distal part of the right fourth arm in male (type) is distinctly hectocotylized (Text-fig. 18); in this part the protective membrane produced, which is rather thick in consistency, and the inner swelling (4.5 *mm* long and 4 *mm* wide) is shorter and wider than the outer one, both in alternate position. There are 21 hooks at the proximal  $\frac{2}{3}$  of the arm length and 10 minute suckers at the distal  $\frac{1}{5}$  of the arm; these hooks are all small in size and rudimentary.

Gladius (Text-fig. 19) deep brown in colour, 64 *mm* long and 8 *mm* wide, rhachis thick, 2 *mm* wide and 14 *mm* long, which is 22 % of the gladius length, vane thin, widest anteriorly and tapers to the posterior extremity, which terminates in a small, 0.5 *mm* long cone.

Radula (Text-fig. 20) very thin and transparent; base of rhachidian tooth squarish, its cusp slender and long, about twice the width of base; first lateral with oblong base, its cusp begins at the inner corner of the base, slender and pointed, slightly curved, a little shorter than the rhachidian tooth; second lateral larger than the first lateral and its cusp longer than it, nearly straight, rather wide; third lateral with

small square base, its cusp slender and longest of all cusps; marginal plate rudimentary, a very narrow oblong, transparent plate.

The arrangement of photophores in type and paratype specimens is rather diffuse, but in immature specimens (mantle length 35 mm, Text-fig. 11) the arrangement is somewhat regular, each photophore ca. 0.2 mm in diameter. They are distributed on the ventral side of the animal; there are 6 longitudinal rows on the ventral surface of the mantle, together with the ventral mantle margin, 4 rows on the funnel, 5 rows on head, 3 rows on the fourth arms, 1 row on the third arms. On the eye-ball (Text-fig. 14) there are 9 small photophores arranged lineally at the postero-ventral margin, its shape is variable from spherical to ellipsoid, the largest one measures 0.8 mm in diameter.

Colouration : The general colour is dark slate purple and Laelia pink, dorsum old rose, fin, arm and tentacle salmon pink and Corinthian pink.

Comparison with related species: The species of this genus are rather rare and hitherto the classification has been reviewed by several authors, such as TRYON (1879), CHUN (1910) and PFEFFER (1912) etc. The present new species shows many important differences in the form of mantle, length of arm, armature of tentacle, radula etc. from the well-known species, such as *E. leptura* LEACH (*smithii* LEACH), *margaritifera* RÜPPELL, *veranyi* RÜPPELL and *oweni* VÉRANY.

In Japan *E. chunii* was formerly described and furthermore, the following species have been known up to date from various localities of the world:

*E. chunii* C. ISHIKAWA 1914, p. 401; SHIMA 1928, p. 159-160, pl. 2, fig. 6;

SASAKI 1929, p. 238-242, pl. 21, figs. 1-5, text-figs. 120-122.

*E. galaxias* BERRY 1918, p. 211-221, pls. 59-60, text-figs. 1-4.

*E. neozelanica* DELL 1959, p. 6-8, text-figs. 11-13.

*E. dubia* ADAM 1960, p. 12-16, text-fig. 2.

*E. anapsis* ROPER 1964, p. 140-148, text-figs. 1-2.

In general these species show particular differentiation as species level and the existence of transient form seems improbable; the distinction of each species is tabulated as follows:

In the genus *Enoploteuthis* the radula has been reported in only a few species. In *E. leptura* THIELE (1921, p. 446, pl. 54, fig. 8) described it, and comparing it with the present species, the cusps of this species are generally slightly longer than that species. According to BERRY (1918, p. 217, fig. 4), in *E. galaxias* the cusps of rhachidian, first and second lateral teeth are evidently broader but the cusp of the third lateral is very slender and longer, as compared with *E. theragrae*.

In conclusion, this new species is the second one in the genus *Enoploteuthis* in Japan.

Table 1. Comparison of specific characters of six species of the genus *Enoplateuthis*.

Species name		<i>theragrae</i> TAKI, 1964	<i>chunii</i> C. ISHIKAWA, 1914
Mantle	length (dorsal)	80 mm	87 mm
	width	24 mm	25 mm
	width index	30 %	29 %
	tail	present ; slender and long	absent
Fin	width index	63 %	75 %
Arm	order of length	subequal	4.2. = 3.1.
	arm-mantle index	50 %	60 %
Hectocoty- lized arm	no. hooks	21	26
Photophores	on ventral surface of mantle	diffusely scattered over the surface; in juvenile state 6 longitudinal rows of photophores	8 longitudinal rows; each row composed of 2-3 trans- verse series of photophores
	on eye-ball	arranged lineally	arranged in zigzag direction
Locality		off Hyōgo and Fukui Prefectures, Japan Sea	Toyama Bay and Bungo Channel, Japan

<i>galaxias</i> BERRY, 1918	<i>neozelanica</i> DELL, 1959	<i>dubia</i> ADAM, 1960	<i>anapsis</i> ROPER, 1964
87 mm	37 mm	36 mm	79 mm
23 mm	14 mm	± 16 mm	(21 mm) <sup>1)</sup>
26 %	38 %	44 %	(26 %)
present; wide and long	absent	obscure	present ; very wide
63 %	95 %	100 %	(77 %)
4.3.2.1. or 4.3. = 2.1.	4.2. = 3.1.	subequal	4.2.3.1. or 4.3.2.1.
59 %	78 %	114 %	(78 %)
23 ±	23 ±	32	—
numerous, thickly scat- tered photophores, but evincing slight traces of any aggregation into definite longitudinal stripes	sparsely scattered ..... do not form any discernible pattern	6 longitudinal rows	4 longitudinal rows
in a single series	a ring of close spaced photophores	in a single series	—
off Cape Everard, Victoria, Australia	off east coast of Wellington, New Zealand	Eylath, Gulf of Aqaba, Red Sea	tropical Atlantic; Caribbean Sea; Madeira

1) Since actual dimension was not given by the author, I tentatively prepared these values by measuring the figures, which are shown in brackets.

IV Description of *Calliteuthis inermis* TAKI, n. sp.

## Family Histoteuthidae

Genus *Calliteuthis* VERRILL 1880*Calliteuthis inermis* TAKI, n. sp. Pl. 1, figs. 3-4 ; text-figs. 21-33

## Measurement (in mm)

		Type	Paratype No. 1	Paratype No. 2			
Mantle	length (dorsal)	42	46	35			
	" (ventral)	32	36	28			
	width	25	27	24			
Head	width	21	25	25			
Fin	length	23	25	16			
	width	30	38	25			
		L	R	L	R	L	R
Arm	1	57	58	51	52	38	(mut.)
	2	64	60	55	52	42	(mut.)
	3	57	54	54	56	44	45
	tentacle	92	121	(mut.)	(mut.)	(mut.)	(mut.)
	4	54	54	50	51	44	48

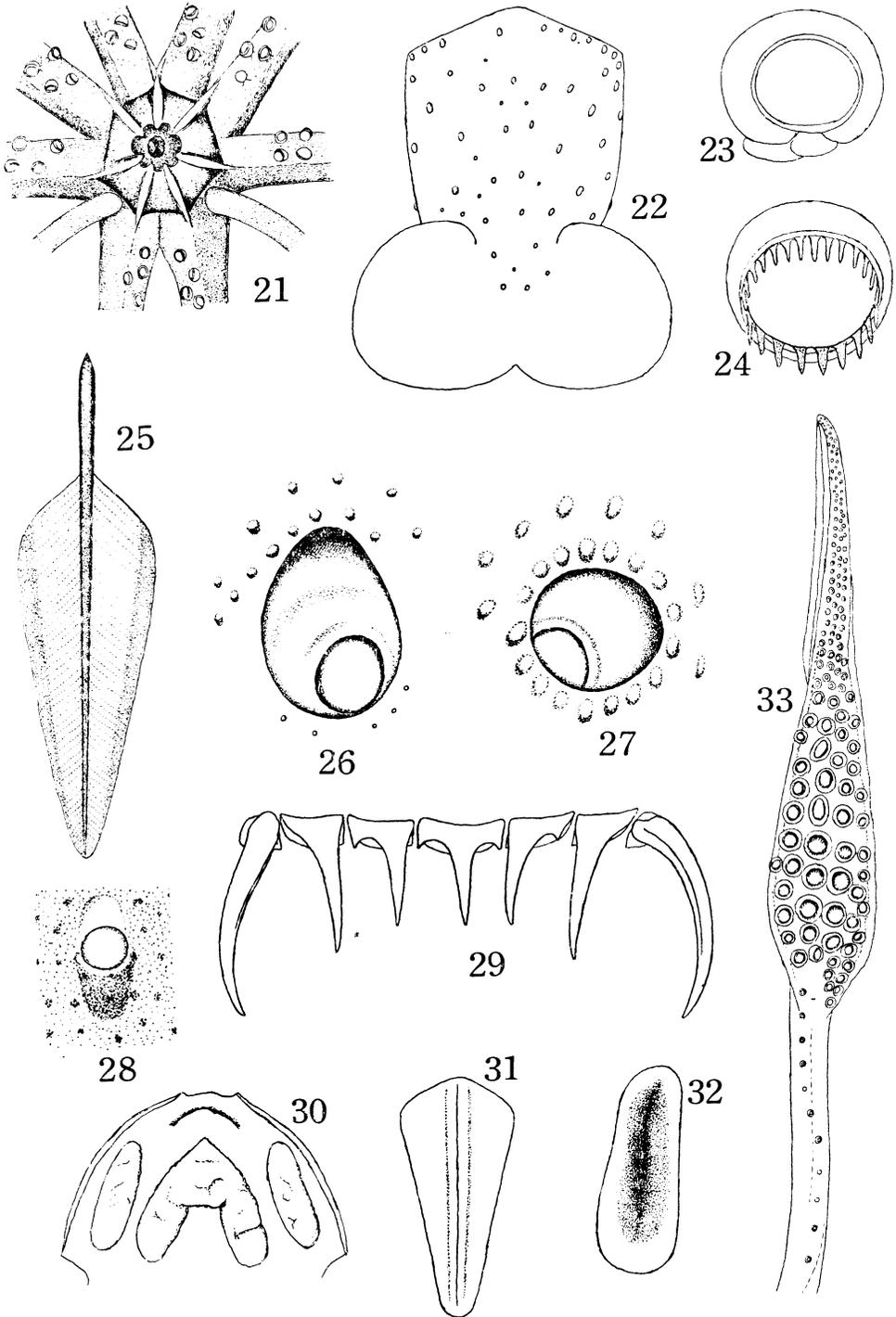
Locality : (Type) off Kambara, Suruga Bay, obtained by the late Prof. Kiichi NAKAZAWA, 1932 : preserved in the Zoological Institute, College of Science, Kyoto University. (Paratype no. 1) Tosa Bay, obtained by Mr. Akibumi TERAMACHI, in 1953. (Paratype no. 2) Tosa Bay, obtained by Prof. Toshiji KAMOHARA in 1936.

Animal (Pl. 1, figs. 3-4) fleshy, rather firm, mantle is very short and moderately swollen, short conic in shape, widest at about a little posterior to the mantle margin, both lateral sides gently convex and posterior extremity rounded, the antero-ventral margin broadly concave, antero-dorsal margin produced, forming an obtuse angle.

Fins (Text-fig. 22) rather broad, posterior margin a little projected beyond the mantle, each fin nearly circular, its length less than half the mantle length, width of both fins slightly longer than the ventral mantle length ; distance between both fins occupies about  $\frac{1}{3}$  the width of mantle where fins inserted.

Head somewhat cubic in shape, ventral side flat, a little narrower than mantle or as wide as mantle, posterior margin bordered transversely by an obtuse angle. Eye opening is larger in the left eye (Text-fig. 26) than the right (Text-fig. 27), the axial length of left eye is 1.55-1.7 times of that of right one. Olfactory crest is a thin, short, filmy outgrowth. Nuchal cartilage (Text-fig. 31) wedge-shaped, its width about  $\frac{1}{3}$  of its length, anterior margin obtusely produced.

Funnel low conic, width at base about half the head width, having two small dorsal supports. Funnel cartilage (Text-fig. 32) elongate ellipsoid in shape, somewhat dilated posteriorly ; funnel organ (Text-fig. 30) composed of a broad  $\wedge$ -shaped dorsal



Text-figs. 21-33. *Calliteuthis inermis* TAKI, n. sp.

21. Buccal membrane seen from above (paratype No.2).  $\times 1.1$

22. Arrangement of photophores on the dorsum of mantle (type), chromatophores omitted.  $\times 1.1$

23. Horny

24. Mouthparts

pad, with a broad ellipsoid ventral pad of similar length on each side. The buccal membrane (Text-fig. 21) has seven lappets and supports, which are highly projected.

Arms rather stout and muscular, its length 1.2-1.5 times as long as the dorsal mantle length, the order of length 2.1.3.4. or 2.3.1.4.; at base somewhat trapezoid in cross-section. The swimming keel of the third arm originates at about the proximal  $\frac{2}{5}$  of its length, gradually diminishing its height toward the tip.

Arm suckers of the fourth arm are smaller than those of other arms, their diameter about half that of the rest, the largest sucker 0.8 mm in diameter while that of the rest 1.8 mm; horny ring of suckers of all arms (Text-fig. 23) quite smooth, without any teeth.

Tentacle (Text-fig. 33) more than twice as long as the dorsal mantle length (in the type specimen the left tentacle is much longer than the right, which seems to be due to unnatural elongation of the stem by the post-mortem softening of the tissue, and similar phenomenon is often met with in many squids); rounded quadrangular in cross-section. Club occupies ca. 20 % of tentacle length, the manus dilated and dactylus tapers to a slender point; the manus nearly semicircular in cross-section, and a very low swimming keel on both sides. Carpal armatures composed of 9-11 elements, which include 5-7 suckers (diameter 0.5 mm) and 4 pads (0.3 mm) disposed lineally. On the manus suckers are arranged in 5-6 rows, of which median 2-3 rows are the largest, 2 mm in diameter, and the peripheral rows the smallest, 1 mm in diameter; horny ring (Text-fig. 24) has 23 teeth, which are rather slender and pointed, more slender and taller on the distal side and thicker and lower on the proximal side, and disposed equidistantly. Suckers on the dactylus are arranged in 4-6 rows, their size ranges from 0.6 mm to 0.2 mm in diameter, their horny ring entire.

The surface of the animal is decorated with numerous photophores; those found on the ventral side are more numerous than the dorsal side; the former comprise three kinds according to their size, the largest ones (Text-fig. 28) are scattered uniformly, roughly in 10 diagonal rows, each located regularly in quincuncial position; those on the mantle margin are of the second grade, about 14 in number; the smallest ones are found near the posterior part of the mantle.

Photophores on the ventral surface of head is of two kinds, larger and smaller; they are distributed in about six diagonal rows, and on the posterior margin they are arranged lineally, but they are missing near the left eye. The right eye-opening is margined with a row of 15-17 large photophores, while the left one with only 5 large ones at the anterior margin and 6 smallest ones at the posterior margin.

The proximal half of the aboral surface of the fourth arm is decorated with 3 longitudinal rows of large photophores, one row on its side margin, but 2 rows on

- |  |   |  |  |
|--|---|--|--|
| ring of sucker of third arm (paratype No. 1). × 27                   | 24. Horny ring of large sucker of manus of left tentacle (type). × 31 | 25. Gladius (paratype No. 2). × 2.2        | 26, 27. Photophores around (26) left and (27) right eye (type). × 2.8                        |
| about the middle of the ventral side of head (paratype No. 1). × 7.3 | No. 2). × 56  | 30. Funnel cut open (paratype No.2). × 2.8 | 28. Large photophore at about the middle of the ventral side of head (paratype No. 1). × 7.3 |
| (paratype No.1). × 3.4   | 32. Right funnel cartilage (paratype No.1). × 3.4                     | 33. Left tentacular club (type). × 7.3     | 29. Radula (paratype No. 2). × 56  |
|  |   |  | 31. Nuchal cartilage   |

the distal half of the arm. The first, second and third arms bear 7-12 large photophores on their outer margin, their number diminishing toward the dorsal side.

On the dorsal side of the mantle there are about 6 diagonal rows of photophores, of which those of the median part are smaller in size and as a whole more sparsely scattered than the ventral side. Also on the dorsal side of head small photophores are arranged in three diagonal rows.

Gladius (Text-fig. 25) deep brown in colour; its vane occupies 76 % of the gladius length and its width 28 % of the same; the rhachis deeply concave.

Radula (Text-fig. 29) : As compared with that of *Calliteuthis reversa* VERRILL (Voss & Voss 1962, p. 182, text-fig. 2d) the present species differs in that, the cusps in all teeth much narrower and longer, especially in the third lateral.

Colouration : Generally cameo pink (type) or Laelia pink (paratype no.1), fin and dorsal side Corinthian pink.

Remarks: In 1936 I was given a specimen of this genus from Tosa Bay, and in 1953 followed by one from the same sea; then I thought these specimens may represent a new species, but unfortunately both specimens lacked the tentacular club, which fact made my final decision difficult. However, later I could have the loan of a perfect specimen from collections in the Zoological Institute of Kyoto University and fulfill the missing part of description.

For many years past, the generic distinction among *Calliteuthis*, *Stigmatoteuthis* and *Meleagroteuthis* has been in confusion, but quite recently Voss (1960, '61, '62, '63) published his researches on these groups and succeeded in clarifying the generic relation, synonymizing *Stigmatoteuthis* and *Meleagroteuthis* (part) with *Calliteuthis*. Comparison with related species:

(1) *Calliteuthis reversa* VERRILL was reported by HOYLE (1886, p. 183-184, pl. 33, figs. 12-15) in the "Challenger" Report, which was collected in the sea off Enoshima, Sagami Bay; he adds (p. 284) that "the identification of a small specimen from New Zealand [to this species] is uncertain." This is the first record of the occurrence of a member of this genus in Japan. Later BERRY (1912) referred this species to *ocellata* OWEN 1881, but PFEFFER (1912, p. 284) gave it a new name *japonica* in *Stigmatoteuthis*, which was followed by SASAKI (1916; 1929). However, now this should be expressed as *Calliteuthis japonica* (PFEFFER). As HOYLE's description was rather brief and the figure of the whole animal was not given, it is fairly difficult to understand the general feature of this species, but it is clear that it is distinct from the present new species, namely: (a) suckers on the median portion of manus in tentacular club are not so much enlarged, (b) teeth of the horny ring of these suckers are seen only on the distal half and not on the proximal half, (c) vane in the gladius is very broad and the posterior extremity of gladius is reflected to form a small cup.

(2) *Calliteuthis dofleini* (PFEFFER)

*Stigmatoteuthis dofleini* PFEFFER 1912, p. 288-289; SASAKI 1929, p. 258-261, pl. 22, figs. 1-3, text-figs. 126-127; AKIMUSHKIN 1963, p. 193-195, fig. 54.

This is a large species (mantle length 210 mm), described by SASAKI in detail; but the animal is "nearly choroidal" in consistency, and is called "kurage-dako" (meaning jelly-fish octopus) in Japanese dialect (SASAKI 1929), and differs in so many

points that comparison with the present species seems unnecessary. It was known from Sagami Bay and off Ibaraki Prefecture, and also from south-east of Hokkaidô, at a depth of 5790 *m* (AKIMUSHKIN 1963).

From the Pacific Ocean the following three species have been known, and comparison between the present species and each of them is as follows:

(3) *Calliteuthis miranda* BERRY 1918, p. 221-228, pls. 61-62. (Locality: off Gabo Island, Victoria, Australia)

Species name		<i>inermis</i> TAKI, 1964	<i>miranda</i> BERRY 1918
Dorsal mantle length		46 <i>mm</i>	140 <i>mm</i>
Width of head		narrower than mantle or as wide as mantle	wider than mantle
Horny ring of arm sucker		toothless	with teeth
No. teeth of horny ring of large suckers in tentacle		23	50-60
Photophores		large and numerous, arranged thickly	small and scarce, scattered sparsely
"Ridgepole-like series of cartilaginous tubercles on dorsum and along outer side of four dorsal arms"		absent	present
Radula	○base of cusp of rhachidian tooth	narrow	wide
	○second lateral tooth	rather long	very long
	○third lateral tooth	fairly long ; 1.2 times as long as second lateral	particular long; about twice as long as second lateral

Species name		<i>inermis</i> TAKI 1964	<i>corona</i> VOSS & VOSS 1962
Mantle	outline	wider	narrower
	mantle width index	75.0-78.2 %	52-70 % (in specimens whose mantle length 16.8-96.0 <i>mm</i> )
Head	width	narrower than mantle or as wide as mantle	wider than mantle
Fin	outline width	nearly circular wide	nearly semicircular narrow
Horny ring of suckers in distal part of arm		entirely smooth	with numerous low teeth
No. teeth in horny ring of manus of tentacle		23	33-55

(4) *Stigmatoteuthis arcturi* was reported by ROBSON (1948, p. 122-123, text-figs. 5-6) from the Eastern Pacific; it was badly damaged and small in size (dorsal mantle length  $32 \pm mm$ ), perhaps juvenile. As compared with the present species, it differs in that the arms are proportionally longer and horny rings of "arm-sucker are equipped with a number of low, broad and closely-set teeth."

(5) *Calliteuthis corona* was described by Voss & Voss (1962, p. 191-198, figs. 5a-f, 6b-d) from Gulf of Mexico and Caribbean Sea. The present new species shows apparent resemblance to this species, though localities of both species are widely distant. However, this species can be discriminated as above:

(6) *Calliteuthis celetaria pacifica* was also described by Voss & Voss (1962, p. 174-175; 1963, p. 119-123, fig. 26) from the Philippines and Borneo, but the outline of the mantle of that species is elongate conical, the width index is about 40 % and the fin is much longer, its anterior extremity attains beyond the midpoint of mantle length, so that comparison of characters in detail between both species seems unnecessary.

This species is named *inermis* (L. unarmed, weaponless), by the feature of toothless horny ring of arms.

#### V Description of *Callistoctopus arakawai* TAKI, n. gen. et sp.

Family Octopodidae    Subfamily Octopodinae

Genus *Callistoctopus* TAKI, new genus

Diagnosis: An animal of large size and of robust and stout construction with muscular development; general appearance resembles *Octopus vulgaris* CUVIER, but decorated with particular colour pattern; radula robust, the number of cusps of rhachidian tooth 3-7; ligula elongate conical, liver, posterior salivary gland and branchial heart large, but ink-sac rudimentary.

Type-species: *Callistoctopus arakawai* TAKI, new species.

This genus is quite akin to the genus *Octopus*, in which numerous species having various characters are included. However, it seems appropriate to establish a new genus for two species described here, *C. arakawai* and *magnocellatus*, n. spp., by the characters, (1) large size, (2) robust construction, (3) characteristic colour pattern, (4) reduction of ink-sac.

*Callistocotopus arakawai* TAKI,<sup>1)</sup> n. gen. et sp.

Pls. 2-3; Text-figs. 34-41

Measurements (in mm)

1) This species was introduced in 1960 by Toba Aquarium with the Japanese name "shima-dako" (a striped octopus).

	Type				Paratype				
Sex	♂				♀				
Body length	762				870				
Mantle length (dorsal)	105				120				
"    "    (ventral)	95				94				
"    width	81				80				
Head width	54				50				
		s	L	R	s	s	L	R	s
Arm length	{	1	13 (540)	617	14	—	720+	600+	11
		2	— (473)	(510)	12	—	620+	620+	9
		3	11 (415)	270	11	—	640	720+	9
		4	9.5 (440)	(420)	10	—	590	560+	6.5
Web depth	{	A		55				62	
		B	52		53			67	
		C	48		55			60	
		D	58		55			64	
		E		50				43	

(s = diameter of sucker)

(Weight : 1.2 kg)

Locality : (Type) near Kamae Town, Minami-Amabe County, Ôita Prefecture, Kyûshû.

(Paratype) near Ôsatsu Town, Toba City, Mie Prefecture, Honshû. These localities lie on the Pacific side of the south-eastern Japan.

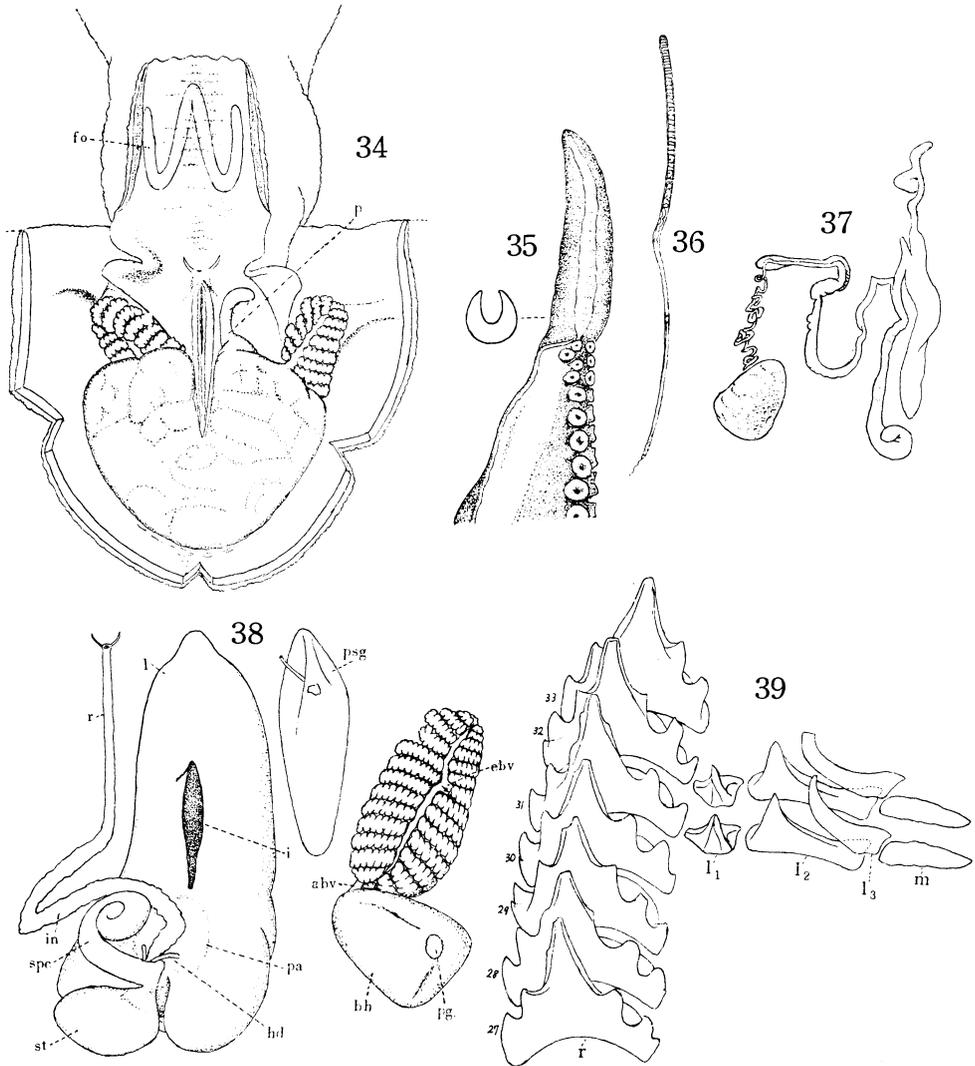
Animal (Pl. 2 ; Pl. 3, figs. 1-3) large for the subfamily Octopodinae ; the preserved specimen is very stiff with well-developed muscular system. Surface warty with a thick integument, uniformly crowded with low, roundish pustules, which are 1.0-1.5 mm in diameter.

Mantle ovoid, longer than wide, the widest part lying at about the posterior third, width index 67-77 %, rounded posteriorly. Head narrower than mantle, width index 42-51 %, weakly constricted both in front and behind; eyes moderately large, without ocular cirrus.

Arms stout, thick and long, the longest arm attains 81-84 % of total length, the order of length 1.2.4.3. in the type specimen, roughly quadrangular in cross-section, at the base of the first arm the dorsal surface ca. 25 mm in width, side slope ca. 20 mm wide; there is a corrugated, conspicuous longitudinal ridge of integument along the corner between the dorsal and lateral surfaces from the base to nearly the tip of arm, and in the terminal part of one arm the ridges on both sides of the dorsal surface are so much raised as to form a groove between.

Suckers are well developed ; no particular enlargement is seen in the type which is a mature male; the diameter of largest sucker attains 13 % of mantle length, but in the female (paratype) it is slightly smaller (9 %) than in male.

Third right arm conspicuously hectocotylyzed (Text-fig. 35), which is very short, its length is 257 % of mantle length and 65 % of the arm of opposite side. There are 80 pairs of suckers on the ordinary part of the arm ; seminal channel well developed, ca. 6 mm wide at base, the chromatophore-free groove sharply demarcated; calamus rather inconspicuous, ca. 2 mm long; ligula thick, conical, tip obtusely pointed, 20 mm



Text-figs. 34-39. *Callistoctopus arakawai* TAKI, n. gen. et sp.

34. Mantle and funnel cut open from the ventral side.  $\times 0.47$  fo, funnel-organ; p, penis. 35. Hectocotylus,  $\times 1.4$  36. Spermatophore.  $\times 0.94$  37. Male genital organ.  $\times 0.47$  38. Alimentary organs seen from ventral side; gill and branchial heart cut off and reflected outward.  $\times 0.6$  abv, afferent branchial vessel; bh, branchial heart; ebv, efferent branchial vessel; hd, hepatic duct; i, ink-sac; in, intestine; l, liver; pa, pancreas; pg, pericardial gland; psg, posterior salivary gland (left); r, rectum; spc, spiral caecum; st, stomach.
39. Radula,  $\times 26$ . r, rhachidian tooth; I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>, first, second and third lateral teeth; m, marginal plate. Numbers on the left show the serial number of the rhachidian tooth.

long and 7 mm wide, its length 7.4 % of hectocotylized arm, rolled with a deep groove along the ventral mid-line in the preserved specimen: numerous faint striations with a mid-rib are seen in the ventral side of the ligula.

Web composed of thick integument, rather narrow, the order of depth A=D.C.

B.E. (type) or B.D.A.C. E. (paratype), the deepest sector is 9.4 % of longest arm.

Radula (Text-fig. 39): Rhachidian tooth shows a B<sub>6</sub>-seriation, very stout and brownish in colour, base particularly thick, 5–7 cuspidate, mesocone longer than the length of its base, acutely pointed with a thin blade on each side; ectocone rather low and wide; first lateral short pyramid-shaped, the cusp stout and pointed, with an elongation to the inner side; second lateral with a broad base and its cusp moderately high; third lateral with a rather broad cusp, gently arcuated; marginal an oblong plate, elongated and pointed outwardly.

Funnel stout and large, ca. 28 mm wide at base, ca. 16 mm wide at the opening, ca. 28 mm high. Funnel-organ (Text-fig. 34, fo) composed of thin film, rather inconspicuous, **W**-shaped, each limb rather wide, inner limbs form an obtusely pointed end in front, and outer limbs shorter than inner ones.

Gill (Text-fig. 38, g) composed of 14 lamellae in outer demibranchs.

Internal organs (Text-fig. 38): posterior salivary gland (psg) elongate ovoid, 50 mm long and 15 mm wide; liver (l) particularly great and bulky, attains the whole length of the viscera, 90 mm long and 45 mm wide at the widest part, tapers anteriorly and decidedly bilobed posteriorly, pancreas (p) 25 mm wide and 20 mm long; ink-sac very small in comparison with the bulky liver, 28 mm long and 5 mm wide; gill ca. 40 mm long and 20 mm wide, efferent branchial vessel (ebv) starts at about the anterior third of the dorsal side of the gill; branchial heart (bh) disproportionately large, 30 mm wide and 22 mm long, 13 mm thick, with a large pericardial gland (pg), 4 × 7 mm.

Male genital organ (Text-fig. 37): the whole organ lies on the left anterior part of the visceral sac, and seen from the ventral side (Text-fig. 34) its greater part is concealed under the well-developed left kidney, quite different from *Octopus vulgaris* or *minor variabilis*, in which the testis is located at the posterior end on the mid-line. Testis nearly trigonal, ca. 18 mm long, 25 mm wide and 10 mm thick, rather small, perhaps exhausted after the spermatogenesis; vas deferens relatively thick, irregularly wound, proximal part of first spermatophoric gland dilated in club-shaped duct, its distal part serves to form the coiled portion of spermatophore, second part thickened, 3.5 mm wide, third part rather slender, accessory spermatophoric gland ca. 65 mm long and 3 mm wide, its proximal part particularly thickened and coiled; shunting duct obtusely pointed; spermatophoric sac thin-walled, ca. 60 mm long and 5 mm wide, in which 12 spermatophores were contained; penial duct ca. 10 mm; diverticulum of penis roughly trigonal, thick and muscular, and penis ca. 3 mm and 15 mm long; spermatophore (Text-fig. 36) 58 mm long and 1.3 mm wide, with ca. 45 coils in the distal part.

Colouration and pattern (Pls. 2–3): the observation is based on the preserved specimen, but according to Mr. K. Y. ARAKAWA the colour tone is similar to that of living state. The ground colour is dark purplish brown (a colour between Taupe brown and Cotinga purple), the ventral side is lighter in colour which is Vernonia purple, the dorsal and lateral sides of the animal is ornamented with conspicuous stripes and spots, which is Hermosa pink in colour. A stripe, about 5 mm wide, and partly interrupted, along the mid-dorsal line of the mantle is encircled on both sides by three similar, weakly arcuated stripes. On the dorsal side of the head there is a row of three spots, which is connected with the row on the arms. Each arm is

coloured with two longitudinal rows of ellipsoid, 15–25 mm long and 6–10 mm wide, patches, also a row of rather slender patches at the base of suckers on each side; the individual patch becomes gradually smaller towards the extremity. No patch is found on the web. Suckers greyish carneous.

Remarks: This species is rare in the type locality and not captured since then. The animal was transported alive to the Miyajima Aquarium in January 1960 for public exhibition; then it has been quite perfect and healthy for some time; Mr. K. Y. ARAKAWA found that the animal emits phosphorescent light when stimulated and took photographs (Pl. 3, figs. 2–3), but after two months' keeping in the aquarium a miserable autophagy has begun, so that he was compelled to kill and preserve the animal for study. Therefore the type specimen is unfortunately mutilated; the tip of arms except the right first and third (hectocotylized) arms have been bitten off, especially the left second arm was lost nearly from its basal portion. The length of the arm, except the intact ones, are calculated from many photographs on the basis of the length of mantle and intact arms, which were measured by myself.

In March 1960, a second specimen was caught with a fishing-pot ("tako-tsubo") at Toba, Mie Prefecture, which was exhibited in Toba Aquarium (Pl. 3, fig. 3) and later preserved there. I could examine and measure the specimen in August 1961, when I visited the Aquarium.

Though I have not seen the animal when alive, observations in both Aquaria are the same. Namely, the animal emits bluish phosphorescent light when stimulated; the light is emitted from the pink stripes and spots which are scattered all over the body surface except the ventral surface of body and arm; at that time the colour pattern looks thin-coloured than ordinary time.

Consideration on specific characters: the generic characters are discussed with the next species on p. 301. In this species the form of radula is very characteristic, namely the rhachidian tooth is armed with 7 cusps, and such tooth occurs in the genus *Octopus* rather rarely,<sup>1)</sup> but we do not know the true ecological significance of number of cusps. However, a radula with many stout cusps composed of thick substance might be related to the vigorous activity of mastication. Also I have never seen the gill with so many leaflets in Octopodinae; this may have some bearing on the high capacity of respiration; in this case it is the whole surface area of the gill in proportion to the body size and the degree of ramification of capillaries which control the respiratory activity, and the number of gill-leaflet is not the main subject of respiration (cf. ROBSON 1929, p. 14–15), but it seems premature to discuss this here, as our knowledge on the comparative anatomy of this group is not sufficient.

In conclusion, this species is distinguished in all respects from those species hitherto known.

#### Histology of Phosphorescent Integument:

The animal was narcotized by putting it in fresh water, and afterward preserved in 5 % formalin solution by Mr. Y. K. ARAKAWA. I examined the integument by

1) A rhachidian tooth with 7 cusps is also seen in *O. macropus* RISSO (cf. ADAM 1941, p. 5, fig. 3; 1945, p. 13, fig. 6), but the general form is very different.

cutting section in ordinary method. Three parts were taken for this purpose: (A) about 1 cm. sq. from the base of right second arm, in which portions of colour pattern and ground colour are included; (B) a smaller area of colour pattern at the base of left second arm; (C) about 5 mm. sq. at the central part of ventral surface of mantle. In all sections, the epithelial layer was entirely desquamated, possibly due to autolysis by keeping the animal in fresh water.<sup>1)</sup>

In the integument of dorsal surface (areas A and B) (Text-fig. 40), as in *Octopus vulgaris* (cf. BOLL 1869, p. 60–73, pl. 2, figs. 33–34), a layer of cutis is followed by a chromatophore layer (cr), in which chromatophores<sup>2)</sup> are included in a single or double layer, its diameter 50–60  $\mu$ . Just beneath this a particular layer is found in both areas, which seems to be responsible to the phosphorescence of the animal. The component cell (Text-fig. 41,p), 26–33  $\mu$  long and 9–10  $\mu$  in diameter, is eosinophilic, elongate cylindrical in outline and rounded on both ends, its cytoplasm is condensed, finely granular and homogeneous. The central core of the cell body is dilute in consistency. The nucleus of each cell is not easy to find, but at least found at the side of cell body, not at the interior. The arrangement of the cell is not always definite, namely transverse, parallel or oblique to the body axis. The cell is fairly compactly assembled, and in a section several cells (in thin case about 2 and in thick case about 10 cells) are found in a vertical direction to the surface. I propose here to call this cell ‘a phosphorescent cell’ and the layer ‘a phosphorescent layer.’ This layer is supplied with capillaries, but I could know none about its innervation. BOLL (loc. cit., p. 72–73) described a “Flitterschichte” just beneath the chromatophore layer, each cell of which includes guanin crystal compactly. Perhaps this layer corresponds to the guanophore layer, but no guanin crystal is observed in this layer. In Decembrachiata (=Decapoda) numerous luminous species having photophores are known, and accordingly there are a number of types of photogenic tissue (cf. HARVEY 1952), but there seems to be no histological similarity between this and those of Decembrachiata, and this difference is rather natural as the type of light emission is fundamentally different.

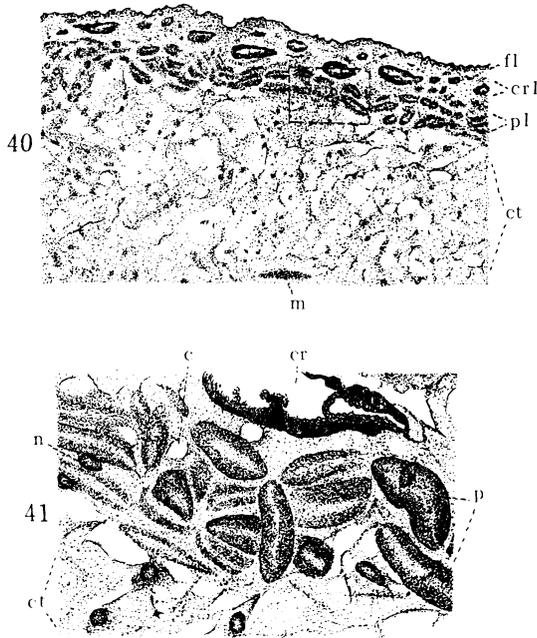
It is noted that there is no fundamental difference in the density of distribution of the chromatophore and phosphorescent cell, namely chromatophore is fairly uniformly distributed in both areas of colour pattern and ground colour, and also phosphorescent cells are denser in area of colour pattern and sparsely in area of ground colour, contrary to the macroscopic observation.

It is not certain by what mechanism the layer in question phosphoresces, but it may be able to suppose that, under excited condition, the granular cytoplasm emits phosphorescent light. In the integument of ventral surface of mantle (area C) neither chromatophore nor phosphorescent cell is observed. With these results, it is certain

1) This layer is liable to be desquamated under unfavourable condition, for example, I showed a similar case in *Octopus vulgaris* whose branchial gland has been extirpated by cauterisation (TAKI 1943, p. 146, pl. 1, fig. 1), and also in Helicid snails which were narcotized by keeping them in fresh water (unpublished).

2) These are better expressed as melanophores; two or three kinds of chromatophores are usually found in Octopod integument, but among them melanophores are most abundantly found and larger in size than other kinds of chromatophores.

that the phosphorescence occurs in all surface of the animal, except the ventral surface. In this case, the chromatophore layer seems to play a role in checking the weak light which propagates outward through the integument.



Text-figs. 40-41. Cross-section of the integument taken from the base of second right arm of *Callistoctopus arakawai* TAKI, n. gen. et sp. The epithelial layer which covers the surface was entirely lost. 40.  $\times 156$ ; 41. area of rectangle in Text-fig. 40,  $\times 617$ . c, capillary; cr, chromatophore; crl, chromatophore layer; ct, connective tissue; fl, fibrous layer (Faserschichte, BOLL); m, muscular fibre; n, nucleus of phosphorescent cell; p, phosphorescent cell; pl, phosphorescent cell layer.

#### VI Description of *Callistoctopus magnocellatus* TAKI, n. gen. et sp.

##### *Callistoctopus magnocellatus* TAKI, n. gen. et sp.

Pl. 4, figs. 1-2; Text-figs. 42-46

Locality: Iyeno-kushi, Uchi-umi Village, Minami-Uwa County, Ehime Prefecture, collected by a fisherman in September, 1962, and forwarded to me by Mr. K.Y. ARAKAWA.

A large octopodid with robust, stout musculature, specimens remarkably heavy (up to 2820g in preserved state), surface firm and integument thick.

Head rather broad, but narrower than mantle, with a weak constriction in front and behind, or without any constriction, continuing gradually to arms and mantle. Eye-ball large, prominently raised, ca. 35 mm long and 30 mm wide, 10 mm high, a

## Measurements (in mm)

		Type				Paratype											
Sex	♂	No.1				No.2				No.3							
		s	L	R	s	s	L	R	s	s	L	R	s	s	L	R	s
Body weight (in g)	2820	1950				1615				—							
Body length	(600)	(580)				(580)				560							
Mantle length (dorsal)	147	125				120				140							
"    width	95	85				85				82							
Head width	75	60				56				55							
Arm length	1	11 (mut.)	500	10	13	450	(450+)	—	12 (mut.)	520	—	16 (mut.)	(mut.)	12			
	2	15(480+)	(480+)	17	16	420	450	—	13	520	550	—	16 (mut.)	430	18		
	3	18	510	470	15	17 (mut.)	380	—	13	480	430	—	17	470	450	15	
	4	15 (mut.)	490	14	12	500	490	—	10	530	530	—	17 (mut.)	(mut.)	15		
Web depth	A	80				61				75				78			
	B	92		100	83		90	93	95	75		80					
	C	120		120	90		92	110	85	83		100					
	D	130		92	94		96	115	103	87		100					
	E	105				80				85				83			

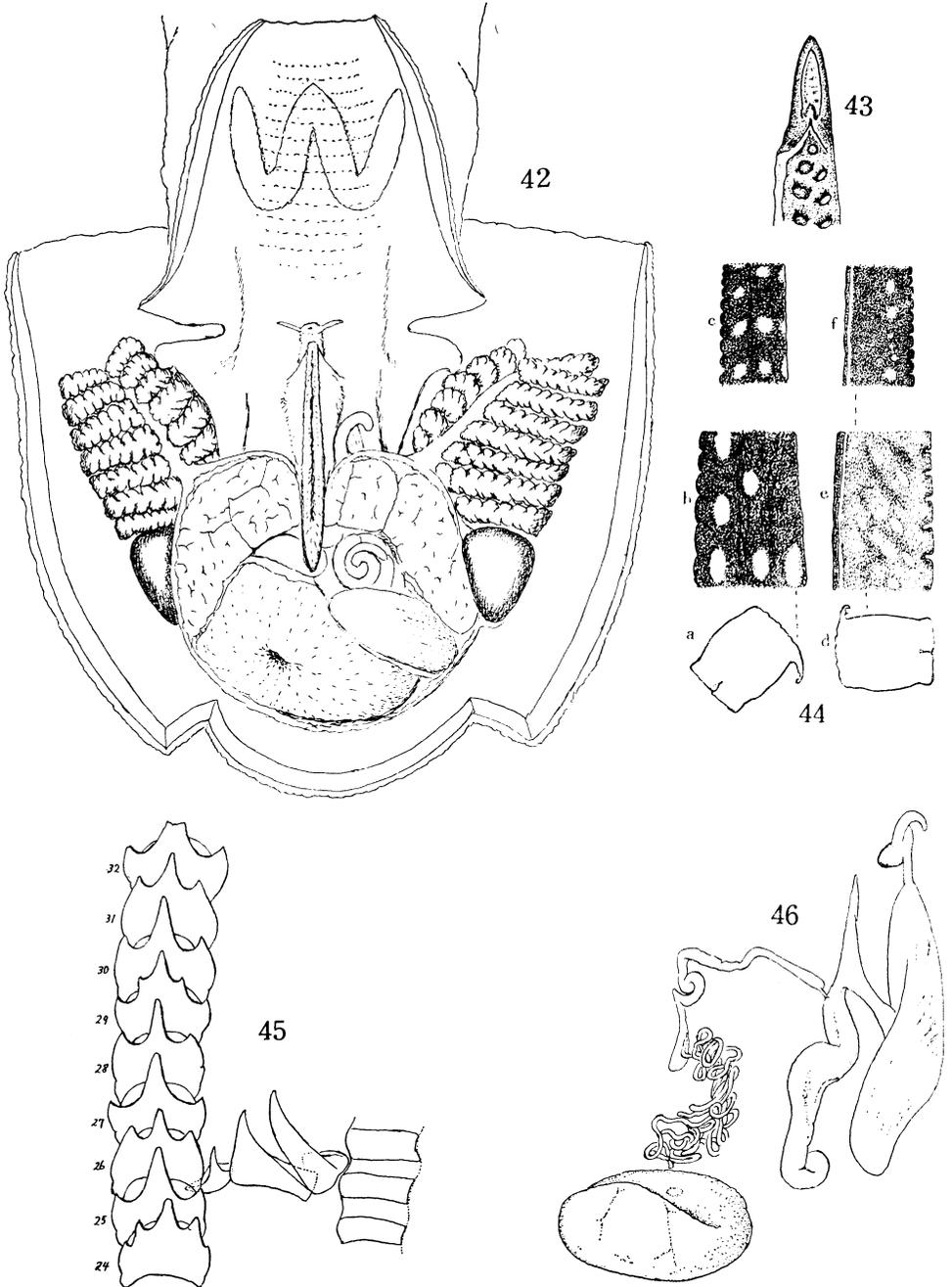
big ocular cirrus in front and behind eye.

Mantle longer than wide, elongate ovoid, length 20-24 % of total length, widest at about the midway of its length, width index 59-71 % of its length, posterior margin semicircular. Surface generally rugose with shallow complicated wrinkles, the area surrounded by these wrinkles measures 2-3 mm wide, the dorsal surface of the animal, namely mantle, head and basal part of first arms up to the web (except the peripheral part and ventral side) is prominently roughened with many low conical warts of various sizes, the largest one attaining ca. 10 mm long, 8 mm wide and 8 mm high; about 10 larger warts on the mantle and 10-15 on the head and base of first arms.

Arms very stout and big, length subequal (four specimens are males and some of the left arms are mutilated and arm-formula can not be made out, but in paratypes nos. 1 and 2, 4.1.2.3. and 2.4.1.3.), 84-92 % of total length, squarish in cross section, web continues along the outer side of the arm up to its tip as a contractile membrane which is as wide as 20 mm in preserved specimen. Arm suckers stout, its diameter 10-13 % of mantle length.

Third right arm hectocotylized, its length is 305-462 % of mantle length and 90-96 % of length of opposite arm. Seminal channel very narrow, unpigmented groove 3 mm wide at base, ligula (Text-fig. 41) 6 mm long and 3 mm wide at base, its length 1.3 % of hectocotylized arm, conical with a deep groove in the middle; calamus ca. 1 mm, very low and conical.

Radula (Text-fig. 45): rhachidian tooth shows B<sub>3</sub>-seriation; tri- to pentacuspid, mesocone longer than width of the base, acutely pointed; inner ectocone lies at midway between mesocone and outer ectocone; base of first lateral roughly trigonal, prominently extended inside, its cusp slender and long; base of second lateral axially



Text-figs. 42-46. *Callistoctopus magnocellatus* TAKI, n. gen. et sp.

42. Interior of body, funnel and mantle cut open from ventral side.  $\times 0.87$

43. hectocotylus,  $\times 2.3$

44. part of third right arm (type),  $\times 5.8$  a, b. cross-section (diagram) and left and dorsal sides of the middle portion,

c, distal part of the same.

d, e, f. right side of the same part of a, b, c.

45. Radula,  $\times 33$

46. Male genital organ,  $\times 0.58$

elongated, with a wide and long cusp; third lateral very wide and only slightly curved; marginal plate oblong.

Funnel stout (Text-fig. 42), ca. 30 mm long and 12 mm wide at aperture, funnel-organ **W**-shaped, each limb wide, anterior end of median limb sharply pointed, lateral limbs attain the level of median limb anteriorly.

Gill with 9 leaflets on each demibranch.

Internal organs (cf. Text-fig. 42): Alimentary organ generally resembles that of *C. arakawai*; (dissection of paratype no.1) liver elongate, 60 mm long, 30 mm wide and 30 mm thick, posterior salivary gland 23 mm long, 16.5 mm wide and 9 mm thick, stomach 30 mm long and 20 mm wide, pancreas 20 × 20 mm, ink-sac 35 mm long and 5-7.5 mm wide; branchial heart proportionally large.

Male genital organ (Text-fig. 46): testis large, 38 mm wide, 32 mm long, 22 mm thick: vas deferens 1 mm in diameter, very long, with numerous coils, spermatophoric gland 2.5-3 mm wide, accessory spermatophoric gland very large, its widest part measures 8 mm, ca. 40 mm long, shunting duct extremely long (ca. 20 mm), its anterior end attaining the base of penis diverticle; spermatophoric sac ca. 50 mm long and 13 mm wide, its wall very thin, containing numberless spermatophores; penis diverticle roughly trigonal, penis ca. 10 mm long and 3 mm wide at its base, prominently curved. Spermatophore 18 mm long, its widest part 0.3 mm wide, ca. 70 coils.

Colouration and pattern: the ground colour is madder brown (type) to brick red (paratype no.2), old rose on the lateral side, paler on the ventral side. At the base of second and third arms there is a large blackish ocellus pattern (Pl. 4, fig. 4), ca. 40 mm in diameter, width of ring 3-4 mm, with a round patch at its centre, which is ca. 22 mm in diameter. The space between the ring and patch is faintly orange coloured. Besides, the arms (Text-fig. 43) are decorated with numerous, oblong to round, apricot orange patches, of which the largest one 10 mm long and 5 mm wide, and the size becomes gradually smaller towards the tip, arranged in two rows on the dorsal side, one row on the lateral side. The inside of each arm is tinted in deep colour as its dorsal side, but the proximal half of outer lateral side is salmon pink, with numerous oblique blackish bands, and its distal half is as dark as the inner and dorsal sides. Though the apricot orange patches on the arms are conspicuous in their distal half, they seem to exist also in the proximal part, which are in a fading state in four specimens at hand. I surmise that it is probable that these orange patches, when the animal is stimulated, emit a phosphorescent light as in *C. arakawai*, and if this is true, the ocellus pattern in this species, when irritated, may realize a conspicuous warning mark.

Remarks: I can refer this species to the genus *Callistoctopus* by such characters as, (1) largeness of the size of the animal, (2) prominent development of the musculature as a whole, (3) stout integument, (4) form of hectocotylus, (5) form of penis, (6) pentacuspoid rhachidian tooth, (7) form of funnel-organ, (8) bright colour pattern in the arms. Though in detail this species exhibit prominent differences from *C. arakawai*, I think it most allied to that species, a second species of this new genus.

I name this species *magnocellatus* (L. having a large ocellus pattern).

Remarks on the genus *Callistoctopus*: Judging from the large body size, robust

construction, muscular development, skin sculpture, arm length, web, funnel-organ, hectocotylized arm and penis, etc., this species may be akin to the species-group of *vulgaris* in *Octopus*, or from some of the above-given characters, to the species-group of *macropus*.

Octopods of gigantic size are well-known, such as *Octopus dofleini* WÜLKER and *O. apollyon* BERRY, but these two species seem to be referable to *Paroctopus*, though PICKFORD (1963) retain them in *Octopus*. While the body of a large size and that of robust construction are a different feature, namely *Paroctopus dofleini* WÜLKER and *P. d. apollyon* BERRY have a rather soft body and this fact seems to be related to the depth of their habitat, namely they live in rather deep sea and not a littoral inhabitant.

In *Octopus* in a strict sense, *O. vulgaris* CUVIER attains a large size, the maximum size of this species is said to be 25 kg in weight (ROBSON 1929, p. 62), though I do not know animals of such gigantic weight in Japan. Also *O. macropus* RISSO grows to moderately large size, but *Callistoctopus arakawai* shows various differences to *O. macropus*, such as arm length formula and features of internal viscera, and it should not be treated along a similar line.

Our knowledge concerning the comparative anatomy of the visceral organs in Octopodinae is not yet satisfactory, but in so far as my observations go, these organs are astonishingly well developed in both species of *Callistoctopus*, especially the development of liver in *C. arakawai* is noticeable, namely it occupies the whole length of the viscera, and I never experienced to observe such a large liver in these groups, though my dissection is restricted to a single case.

I lay particular stress on the colour pattern of *Callistoctopus*, because it is unique and has not been known thus far. In *C. arakawai* the pattern, as shown in Pls. 2-3, is quite conspicuous and can be well preserved in dilute formalin solution till now. Moreover, the patches of light colour (which is pink) emits weak phosphorescent light when the animal is stimulated. In *C. magnocellatus*, it is surmised that the yellowish patches scattered mainly on the whole surface of arms except the sucker side may be phosphorescent, and in this species, though these patches are not so much conspicuous as in *C. arakawai*, is favoured by a large ocellus pattern on both sides of the head. The phenomenon of emission of phosphorescent light has not been known; the emission of light in Cephalopoda is confined to Decembrachiata and only little known in Octobrachiata, and also as a rule seen in inhabitants of deep sea.

These two species seem to inhabit shallow rocky bottom of warm seas, judging from the locality and the anatomical characteristics. It is known that *Vampyroteuthis infernalis* CHUN has two pairs of light organs on the dorsal surface of the mantle (PICKFORD 1949), but PICKFORD (1939) proposed to place this species out of the Octobrachiata, establishing a new order in Dibranchiate Cephalopoda. Also this species has a soft, gelatinous body and inhabit deep sea, so that the status is quite apart from the case in *Callistoctopus*. Thus, the emission of phosphorescent light in Octobrachiata is a new record.

HARVEY (1952, p. 296) says, "it is highly probable that no true octopus is luminous, although a few references occur," and quotes a statement in DARWIN's voyage of the "Beagle," and GARDINER & COOPER's record (1907) in the Indian Ocean; in

the latter is stated that "*Eledonella*..... giving a tiny spark of rather blue phosphorescent light." HARVEY adds that, "possibly the word 'phosphorescent' was used when 'iridescent' was meant." But ROBSON (1932, p. 7), quoting GARDINER and COOPER's statement, says that "In the *Eledonella* there are evidently definite organs" [of light]. The same author (1932, p. 164-165) describes, in the genus *Cirrothauma*, "Most of the suckers are modified, probably to carry light-organs. The suctorial chamber is obliterated, and the sucker is borne on a spindle-shaped stalk containing a light-organ(?)." Concerning this, CHUN (1911, p. 9) already said, "Eine grössere Wahrscheinlichkeit hat die Deutung dieser Bildungen als Leuchtorgan für sich." The eye is rudimentary in this genus, which is represented by monotypy, *C. murrayi* CHUN, but unfortunately nothing definite about the light-emission is known. However, quite recently AKIMUSHKIN (1963, p. 152-155, figs. 37-39) described *Tremoctopus lucifer*, n. sp. from the North-western Pacific, which is equipped with photophores in the distal portion of first arms of female. This is the first record of the luminous species in the Octobrachiata.

In the genus *Hapalochlaena* the surface is ornamented with numerous small conspicuous circles, which may be iridescent (ROBSON, 1929, p. 207) when stimulated. I formerly observed that in *Octopus ocellatus* GRAY the ocellar pattern becomes iridescent (a golden ring encircled with black ring, the centre of ring is a solid black patch; in ordinary state somewhat silvery ring with grey circle) when stimulated, and this is accompanied with the appearance of dark stripes on the mantle and arms, the mantle particularly narrowed and raised above, the web unusually expanded (TAKI 1944). As a whole, I think that the particular colour pattern in Octopodinae may serve to menace the enemy when attacked. There are several species in *Octopus* having ocellus pattern, but the colour change in the living state is scarcely known. In *C. magnocellatus* the ocellus pattern is the greatest I have seen, and this fact is duly related to the large size of this species, the species having ocellate pattern are generally small species. ROBSON (1929, p. 11) enumerated in his fig. 3 the following species having ocellus pattern, and I add the total length of each species.

(1) *Octopus herdmani* HOYLE (550 mm), (2) *bimaculatus* VERRILL (345 mm), (3) *bimaculoides* PICKFORD (smaller than the preceding species), (4) *ocellatus* GRAY (292 mm),<sup>1)</sup> (5) *areolatus* ORBIGNY (245 mm), (6) *robsoni* ADAM (210 mm),<sup>2)</sup> (7) *oculifer* HOYLE (52 mm), (8) *pulcher* BROCK (50 mm), (9) *membranaceus* QUOY et GAIMARD (50 mm).

In contrast to these species, *C. magnocellatus* measures 600 mm and therefore this species is the largest one having ocellus pattern in so far as I am aware.

The ocellus pattern or target marking is widely seen in the animal kingdom, for example in fishes, insects, crabs etc. and in insects, "the essential feature is a pair of gleaming eye-spots" (COTT 1957, p. 387), and these markings are particularly displayed in warning attitude. This device seems to "attract the attention of enemies to an apparently dangerous attribute of their prey," or at least, to intimidate and banish the enemies from its environment. In my experience on *Octopus ocellatus* GRAY above

1) TAKI 1936, p. 51.

2) ADAM 1959, p. 278, pl. 9, fig. 1.

stated, we may be able to find such ecological significance to the ocellus pattern.

With these matters in mind, the mechanism of menacing the enemy in the genus *Callistoctopus* may be thought to be the highest level in this group of animals, as the animal itself is large in size, quite different from the genus *Hapalochlaena* which comprises two species of smaller animals (ADAM 1954).

In the genus *Hapalochlaena* the ink-sac is much reduced in size (ROBSON 1929, p.207). As widely known in Octopodinae, the ink is ejected when attacked, but this is evidently a negative way of defence. However, if the positive way of defence, for example, menacing by the phosphorescent colour pattern all over the surface of body, accompanied with a pair of gleaming eye-spot markings, is developed, it is probable that the necessity of the ink-sac naturally decreases, which results in its reduction in size. In *Callistoctopus*, the ink-sac may have reduced with this reason.

This genus is named *Callistoctopus* (Gr. kallist- , most beautiful or exceedingly beautiful, + octopus) by its conspicuous colour pattern.

## VII Description of *Octopus marginatus* TAKI, n. sp.

Genus *Octopus* CUVIER 1797

Subgenus *Octopus* s. str.

Species-group of *O. aegina*

*Octopus marginatus* TAKI, n. sp. Pl. 5 ; Text-figs. 47-48

### Measurements (in mm)

Total length						
Mantle length (dorsal)					175	
" " (ventral)					43	
" width					38	
Head width					31	
					26	
		s	L	R	s	
Arm length	}	1	4.5 (mut.)	114	4.5	
		2	4.5	115	126	4.5
		3	4.5	123	129	4.5
		4	4.5	122	125	4.5
Web depth	}	A		12		
		B	18		18	
		C	26		28	
		D	33		36	
		E		30		

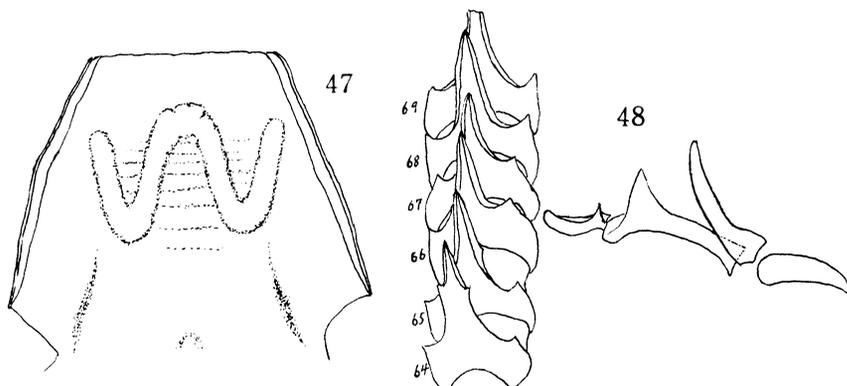
Locality: In the littoral near Kamae Town, Minami-Amabe County, Ôita Prefecture; forwarded to me by Mr. K. Y. ARAKAWA in Dec. 1962.

A small octopus, texture firm, surface granular and musculature well developed. Head rather broad but narrower than mantle, bordered by a weak constriction in front and behind, eye not prominent, interorbital area nearly flat; surface crowded with low, polygonal pustules, ca. 0.8 mm in diameter, which are sharply marked by narrow grooves. A low, ca. 3 mm long, ocular cirrus is found at the posterior corner of the

right eye.

Mantle ovoid, longer than broad, its length 24.6 % of total length and its width 72 % of mantle length, widest at the middle of its length and posterior margin rounded; surface evenly pustulose as in the dorsal surface of head, but here pustules are arranged longitudinally, and become much smaller toward both sides, in ventral side they disappear entirely and ventral surface smooth; interspace between pustules are wider than pustules themselves, its width 0.5 mm and become much wider toward lateral sides. Mantle aperture very wide (Stage C).

Arms subequal in length, its maximum length 73.7 % of total length and the order of length 3.2=4.1, squarish in cross-section; the surface is pustulose, each pustule is elongated, ca. 1 mm wide and 1.2 mm long, arranged in oblique, radiating rows, the interspace between pustules 0.5–1.0 mm, pustules are found up to the proximal half of the arm length and afterwards gradually fade away toward the extremity; pustules are also seen on the web and lateral side of arms; the surface of posterior half of the length of third and fourth arms are completely smooth, without any



Text-figs. 47–48. *Octopus marginatus* TAKI, n. sp. 47, Funnel cut open.  $\times 2.1$   
48, radula,  $\times 57$

pustules. Suckers of similar size in each arm, its diameter 10 % of mantle length.

Web rather firm to the touch, its depth 28 % of mantle length, its order of depth D.E.C.B.A., continued on the posterior side of each arm as contractile membrane, up to the proximal  $\frac{2}{3}$  of its length. The ventral surface of web smooth.

Radula (Text-fig. 48): rhachidian tooth tricuspid, showing  $B_4$ -seriation, very taller than broad, mesocone strong and long, acutely pointed, ectocone low and acute; first lateral very broad and axially narrow, its width about half as broad as the rhachidian tooth, its cusp moderately tall and acute; base of second lateral very broad and axially narrow, conspicuously arcuated, its cusp tall and broad, located at the proximal fourth the breadth of the base; third lateral rather long and broad, gently arcuated; marginal plate very long.

Funnel (Text-fig. 47) rather short, its length ca.  $\frac{1}{4}$  the ventral length of mantle, free portion about half of its length; funnel-organ rather inconspicuous, **W**-shaped, all limbs of moderate width.

Gill with 8 leaflets (inner demibranch) and 10 (outer demibranch) on both sides.

Alimentary canal. Posterior salivary gland 12 mm long and 8 mm wide; crop 6 mm wide and 15 mm long; stomach comparatively small, 6 mm long and 10 mm wide, spiral caecum very large, 11 mm wide and 7 mm long, roundly swollen; liver 23 mm long and 13 mm wide, roughly cylindrical; ink-sac 9 mm long and 6 mm wide, ovoid in shape; pancreas 4 mm long and 9 mm wide; intestine 3-4 mm wide, making a small looping.

Female genital organ. As a whole in immature state, ovary 5 mm long and 8 mm wide, oviducal ball 3 mm, and distal oviduct 1.5 mm in diameter and 25 mm long.

Colouration and pattern. The dorsal side of the animal Vernonia purple, in darker part purple drab, and this colour gradually becomes lighter towards ventral side, which is cameo pink. The suctorial surface of each sucker seashell pink.

The animal when alive, was sketched by Mr. K. Y. ARAKAWA, who kindly permitted to publish it here (Pl. 5, fig. 1). The dorsal surface is coloured mars brown (darker part) and hazel (lighter part), and the area around each eye (15 mm long) ecru, a narrow white line (ca. 1-2 mm in width) borders the arm from the side of suckers which are Corinthian pink. The animal, when at rest, stretches its first, second and third arms sideways and the fourth pair backwards, the tip of all arms rolled in. This seems to show the peculiarity of the habit of this species.

Comparison with related species: The specimen here described is single and an immature female, no male characters being known, it is fairly difficult to find the affinity to related species. This species is characterised by (1) developemnt of musculature of the animal as a whole, (2) epidermic sculpture composed of crowded low, minute pustules in the dorsal surface and entire smoothness in the ventral side, (3) development of arm suckers, (4) colouration of deep purplish brown, especially the animal when alive, is margined by a lighter colour around eye; these characters naturally lead to the assumption that it is an inhabitant of shallow rocky or gravelly bottom, as in *O. vulgaris*, *ocellatus* etc., though the habit of this species is not clearly known.

According to the subdivision of the subgenus *Octopus* by ROBSON (1929) this species seems to belong to the species group of *O. aegina*, in which *O. aegina* GRAY, *areolatus* ORBIGNY, *ocellatus* GRAY, *pulcher* BROCK, *hardwickei* GRAY are included. Among these species, the present species is somewhat allied to *aegina* GRAY, which was described in detail by ADAM (1954). This author did not give the total length of each specimen examined, so that here a comparison in a few characters will be made, using other value of measurements.

Species name	<i>aegina</i> GRAY		<i>marginatus</i> TAKI
Specimen	(a <sup>2</sup> )	(j)	
Mantle length (dorsal)	43 mm	45 mm	43 mm
Arm length	range	85-100 mm	90-100 mm
	order	4.2=3.1	2.4.1=3
Sucker index	8.2	7.8	10
Radula	A <sub>2-4</sub> -seriation		B <sub>1</sub> -seriation

Thus, the present species is well characterised in the species-group of *O. aegina*.

I name this species *marginatus*, by its particular light patch around eye, found in lifetime.

VIII Description of *Paroctopus araneoides* TAKI, n. sp.

Genus *Paroctopus* Naef 1923

*Paroctopus* NAEF 1923, p. 692; ROBSON 1929, p. 197; ADAM 1941, p. 11;

PICKFORD 1945, p. 702; AKIMUSHKIN 1963, p. 135.

*Pseudoctopus* GRIMPE 1925.

The status of this genus is by no means satisfactory, and ADAM (1941) and PICKFORD (1945) are sceptical about its generic distinction; especially PICKFORD (1963) seems to abandon this genus and assigned *dofleini* WÜLKER to *Octopus*. However, AKIMUSHKIN (1963) described a new species in *Paroctopus*. At present it is not easy to define this genus properly, but the following new species are described here, after ROBSON's definition.

*Paroctopus araneoides* TAKI, new species Pl. 4, fig. 3; Text-figs. 49-54

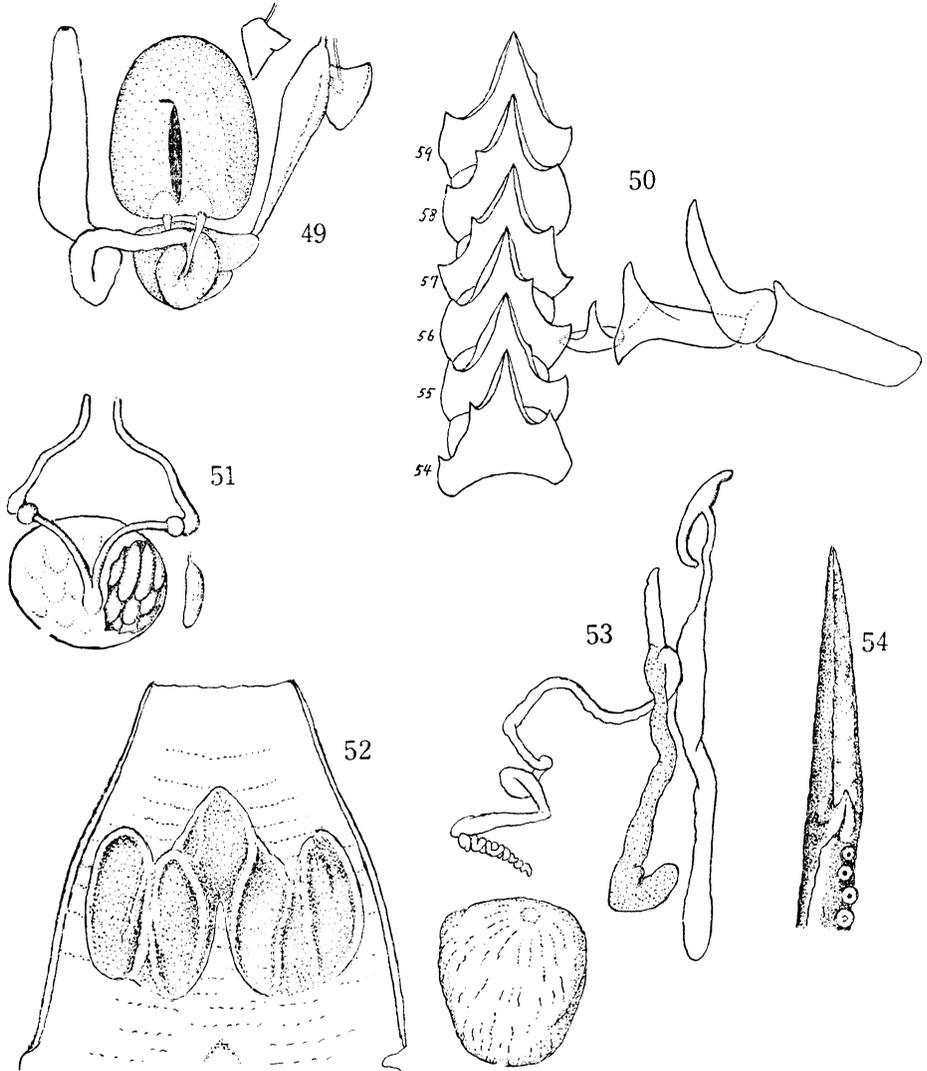
Measurements (in mm)

Sex	Type				Paratype				No.6♀				No. 5♀				
	♂				No.1♂												
Total length	345				375				320				315				
Mantle length (dorsal)	83				92				93				75				
" " (ventral)	72				83				83				72				
" width	55				42				40				50				
Head width	44				38				29				40				
Arm length	s	L	R	s	s	L	R	s	s	L	R	s	s	L	R	s	
	1	7.5	242	230	7.5	9.5	263	237	9.0	4.5	210	200	5.0	5.5	220	210	5.8
	2	6.5	243	220	6.5	7.5	227	220	7.0	4.5	185	190	4.5	5.0	198	170	5.0
	3	5.5	220	195	5.5	6.0	200	190	6.0	4.0	160	180	4.0	4.5	190	190	4.8
	4	5.0	210	202	5.0	5.5	195	192	5.5	4.0	178	180	4.0	4.2	170	180	4.2
Web depth	A 52				52				43				48				
	B		47	54	50		49	40		53	44		45				
	C		37	43	43		39	52		50	43		43				
	D		28	35	36		40	40		42	40		32				
	E		15		22		23		27								

Locality: 16 specimens (13♂♂, 3♀♀), caught with the shrimp dredge for the market off Kushiro City, Hokkaidô, all the year round, forwarded by the Kushiro Branch of the Hokkaidô Regional Fisheries Research Laboratory, in February, 1961.

A species of Octopodinae of moderate size, body and arms muscular; surface generally smooth, integument very thin and soft, in well-preserved specimens numerous small (0.5-1.5 mm in diameter), low pustules are scattered all over the surface, which are obliterated by a weak pressure.

Head broad, 41-53% of dorsal mantle length, a weak constriction in front and behind, orbit weakly raised and interorbital area smooth and flat; orbit large, its length ca. 1/5 of mantle length.



Text-figs. 49-54. *Paroctopus araneoides* TAKI, n. sp.  
 49. Alimentary canal,  $\times 0.7$   
 50. Radula,  $\times 50$       51. Female genital organ,  $\times 0.7$       52. Funnel cut open,  $\times 1.4$   
 53. Male genital organ,  $\times 0.7$       54. Hectocotylus,  $\times 1.7$

Mantle elongate ovoid or ellipsoid, longer than broad, widest at about the midway of its length, posterior margin rounded or very faintly pointed; mantle aperture very wide.

Arms subequal in length, the longest arm 65-70 % of total length, the order of length generally 1.2.3.4, the shortest arm 73-84 % of longest arm; rather slender, their width at base ca.  $\frac{1}{6}$  mantle length, roundish in cross-section; suckers larger in male than in female, their diameter greatest in the first arms of males, namely 9.0-9.8 % of mantle length in males and 5.4-7.7 % in females, the suctorial surface conspicuously expanded in males. In two other specimens at hand, the greatest

diameter measures 12 mm (first arm) and 11 mm (second arm).

Third right arm of males prominently hectocotylyzed (Text-fig. 54), its length 72-79 % of longest arm and 87-95 % of opposite mate, 45-49 pairs of suckers in the ordinary part of arm; ligula extremely long, its length 8-12 % of hectocotylyzed arm, roughly elongate conical, copulatory groove shallow; calamus short, its length ca.  $\frac{1}{8}$  of ligula.

Web depth unequal in each sector, the deepest one 20-25 % of longest arm, the order of depth A. B. C. D. E., the shallowest sector  $\frac{1}{2}$ - $\frac{1}{3}$  of deepest one; web is continued to the outer side of each arm as contractile membrane which can be traced to about the distal  $\frac{1}{3}$  of its length.

Radula (Text-fig. 50): rhachidian tooth pentacuspoid, showing B<sub>5</sub>-seriation, much taller than broad, mesocone slender and acutely pointed; inner ectocone rather low and narrow, outer ectocone wide; first lateral with a wide and narrow base, its cusp rather tall and acute; cusp of second lateral tall and rather acute; third lateral broad, moderately curved at the basal part, its cusp rather slender; marginal plate extremely large, very broad and oblong.

Funnel (Text-fig. 52): very long, its anterior edge attaining the anterior  $\frac{1}{5}$  the distance between the web (sector E) and mantle margin, width of its base  $\frac{1}{4}$  as wide as the mantle aperture; free portion about half of its length. Funnel organ W-shaped, very wide, occupying nearly the inner surface of the funnel, and also each limb extremely wide, attaching with each other; in paratype no. 1 the margin of each limb is raised up as a thin longitudinal film, the median limbs united in anterior half of its length and lies much forward than lateral limbs, also lateral limb united with median limb, so that the interior of the posterior half of tubular part of the funnel is encircled almost entirely by the funnel-organ, a feature at least not seen in any other Octopodid specimens in my experience.

Gill with 11 leaflets in each demibranch.

Alimentary canal (Text-fig. 49): posterior salivary gland rather small, 13 mm long, 7 mm wide, 3 mm thick, roughly trigonal; crop very large, its wall moderately thick; stomach large, 22 mm long, 13 mm wide, three portions can be discriminated by its exterior colouration; spiral caecum 18 mm long and 12 mm wide, as a whole showing one coil; liver ovoid, 38 mm long, 30 mm wide, 20 mm thick; ink-sac 18 mm long and 4 mm wide, fusiform; pancreas 8 mm long and 15 mm wide; intestine rather wide, 4-6 mm in diameter, turns to rectum after a coiling. In two specimens examined, numerous whitish dots are found in the wall of the intestine, from the beginning part to the anus, which seem to be due to the sporozoan infection.<sup>1)</sup>

Male genital organ (Text-fig. 53): testis ovoid, 36 mm long, 26 mm wide, 25 mm thick; vas deferens rather wide in diameter (1 mm), with several coilings; spermatophoric gland 1.5-2.0 mm wide, accessory spermatophoric gland 4-6 mm wide, 40 mm long; shunting duct 14 mm long and 2-5 mm wide; spermatophoric sac 3 mm wide and 40 mm long; penial duct slender, penis 13 mm long, 3 mm wide, gently arcuated, with a long (12 mm) diverticle which shows a coiling. Spermatophore very slender, 75 mm

1) Similar infection was observed in *Octopus minor variabilis* (SASAKI).

long by 0.8 mm wide.

Female genital organ (Text-fig. 51): ovary 24 mm long, 26 mm wide and 16 mm thick, containing large (13 × 5 mm) eggs; oviducal ball rather small, 5 mm in diameter; oviduct 2 mm in diameter.

Colouration: the ground colour of the animal is Hermosa pink and arms and web Vernonia purple, only faintly lighter in colour on the ventral side of the animal.

Comparison with related species: PICKFORD (1963) published an important paper on "*Octopus defleini*", by examining numerous specimens hitherto employed in description of this and other related species by previous authors. The present species, by its moderate size of the animal, differs fundamentally from *Paroctopus dofleini* (WÜLKER) which grows up to a gigantic size; also from *P. gilbertianus* (BERRY) which occurs in Alaska and Siberia by the order of arm length, arm length index, sucker index, order of web depth etc. (PICKFORD 1963, p. 58). AKIMUSHKIN (1963) referred the following two species of SASAKI to *Paroctopus* and compared with them, the present species differs from *conispadiceus* (SASAKI 1917), at first sight by its size (*conispadicus* attains as large as 900 mm in length, also caught near Kushiro for the market, one of the most important edible octopus in Hokkaidô), and by the feature that hectocotylized arm relatively long, ovarian egg larger, and moreover the fact that the funnel organ is VV-shaped in *conispadiceus*; from *P. yendoi* (SASAKI 1920), whose surface of whole body is covered with minute pustules, the mantle is shorter and funnel fused up to the orifice to the head, arms are bigger and hectocotylized arm relatively wider. AKIMUSHKIN's new species *P. asper* is, as the species name implies, equipped with small spinous processes on the dorsum of the animal, and the form of funnel-organ and penial diverticle is quite different from the present species.

This species is called "kumo-dako" (spider octopus) by the natives, so that the species is named *araneoides* (L. spider-like).

## IX Description of *Paroctopus megalops* TAKI, new species

Pl. 6, figs. 1-2; Text-figs. 55-57

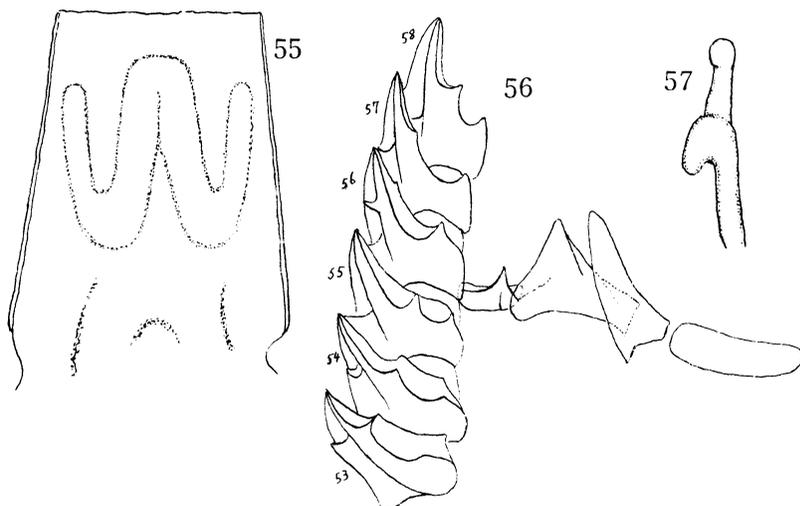
### Measurements (in mm)

		Type				Paratype No.1			
Sex		♂				♀			
Total length		380				380			
Mantle length (dorsal)		75				78			
" " (ventral)		55				57			
" width		48				57			
Head width		37				47			
		s L R s				s L R s			
Arm length	1	3.5	280	250	3.5	4.0	305	270	3.5
	2	3.5	275	240	3.5	4.0	255	270	4.0
	3	3.5	255	152	3.5	4.0	230	240	4.5
	4	3.5	230	220	3.5	3.5	240	240	4.0

Web depth	{	A	40	48
		B	67 50	55 43
		C	68 45	58 53
		D	69 55	50 58
		E	58	58

Locality: Tosa Bay, 100-200 *m* in depth, obtained on 4th April, 1960 by the author at the Mimase Market, Kôchi City, Kôchi Prefecture, Shikoku (5 ♂♂, 5 ♀♀). Enshû Nada, Pacific side of Central Japan, presented by Dr. Katsuzô KURONUMA, 2 juvenile ♀♀.

An Octopodine species of moderate size, with soft integument, with short body and moderately long arms. Musculature of the whole body weakly developed, mantle in ventral side 2.5 *mm* in thickness. Surface smooth throughout without any sculpture.



Text-figs. 55-57. *Paroctopus megalops* TAKI, n. sp.

55. Funnel cut open,  $\times 1.4$  56. Radula,  $\times 39$  57. Penis and diverticle,  $\times 2.8$

Head broad, its width 49-60 % of mantle length, demarcated in front from the base of arm by a weak constriction, and behind by a shallow groove from the mantle; orbit extraordinarily large, swollen ellipsoidally, its axial length about a third of mantle length, in juvenile specimens attaining nearly a half of mantle length; there is a small, 8 *mm* long and 6 *mm* high, trigonal, thin, fin-like ocular cirrus at the hind corner of the orbit, otherwise the surface is smooth.

Mantle bursiform, longer than wide, its width attaining 64-73 % of mantle length, widest at about the middle of its length, posterior margin rounded, surface smooth.

Arms subequal in length, roughly quadrangular in cross-section, but dorsal area roundly arcuated; the length attaining 74-80 % of total length, the order of length 1.2.3.4, the shortest arm about 75-79 % of longest arm. Suckers comparatively small and subequal in size in all arms, their diameter 5-6 % of mantle length, no particularly enlarged sucker present in males, though all male specimens at hand do not have attained their full maturity.

Third right arm in male hectocotylized, its length 54 % of longest arm and 60 % of opposite mate; ligula 8 mm long and 2.5 mm wide, its length 5.3 % of hectocotylized arm, elongate conical in shape, copulatory groove rather shallow; calamus 1 mm by 1 mm, short conical.

Web moderately well developed, its depth 19–25 % of longest arm, the order of depth D. C. B. E. A. or C. B. D. E. A., shallowest in sector A. Web is extended as contractile membrane to the outer side of each arm up to the distal  $\frac{1}{6}$  the length of the arm.

Radula (Text-fig. 56): rhachidian tooth pentacuspoid, showing B<sub>5</sub>-seriation, taller than broad, mesocone slender and acutely pointed, with a very broad, thin blade on each side; first lateral with an oblong base and its cusp rather low; second lateral axially long, with a trigonal moderately tall cusp, its inner side gently concave; third lateral very broad and gently curved; marginal plate very broad, very thin and oblong.

Funnel (Text-fig. 55) rather broad, its height more than a half of ventral mantle length; funnel-organ **W**-shaped, inner limb longer than outer limb and attaining a little anteriorly than the outer one.

Gill with 8–9 leaflets in each demibranch.

Alimentary canal: (dissection of paratype no. 1, male) posterior salivary gland rather small, 10 mm by 10 mm, 3.5 mm thick, trigonal; crop large, 30 mm long and 10 mm wide, containing pulverised prey (generally small Crustacean animals); stomach 13 mm long and 10 mm wide, spiral caecum particularly large, 17 mm long and 15 mm wide; liver short ovoid, 30 mm long, 26 mm wide, 15 mm thick; ink-sac at about the posterior one-third of its length, club-shaped, 7 mm wide; pancreas 10 mm long and 14 mm wide; intestine rather wide, 6 mm in diameter.

Male genital organ: as a whole in a juvenile state, contained in a long conical capsule, which is 22 mm long and its widest part 5 mm; penis (Text-fig. 57) slender cylindrical, 10 mm long and 1.5 mm wide, diverticle projecting at about the anterior third of its length.

Female genital organ: also in a juvenile state; ovary 8 mm wide and 4 mm long, oviduct 1 mm in width, oviducal ball 2.5 mm in diameter.

Colouration: uniformly *Hermosa* pink to *cameo* pink throughout, the ventral side somewhat lighter in colour; nowhere deeply coloured area is found.

Generic position: I assign this species to *Paroctopus*, by the soft and smooth integument and long ligula, but as all female specimens at hand are immature it is impossible to decide whether this species has a large egg or not, which is one of the diagnostic characters.

Comparison with related species: In the genus *Paroctopus* this species is allied to *P. araneoides* TAKI, described above, by the smooth integument, the radula and ligula, but fairly different from it by the form of funnel-organ, order of web depth and penis diverticle. Also the locality is widely distant in both species. *Polypus tenuicirrus* SASAKI (1929, p. 78–79, pl. 11, figs. 14–16, text-figs. 36–37) seems to be referable to *Paroctopus*, which was obtained in Chiba Prefecture (Province Awa). That species differs from the present species by the following characters:

Characters	<i>tenuicirrus</i> SASAKI	<i>megalops</i> TAKI
Consistency of animal	somewhat soft	very soft
Surface	polished, but beset with faint, ill-defined warts	entirely smooth
Ocular cirrus	2 cirri, of which posterior one longer	1 cirrus
Length of ligula	1/5 of hectocotylized arm (=20%)	5.3% of hectocotylized arm
Penis	short	long
No. filament in demibranch	11-12	8-9

Remarks on specific character: This species is quite unique in the Japanese known species of *Paroctopus*; it is characterized particularly by its large eye, by which I name this species *megalops* (Gr.). It is not clear to what extent the size of the eye is ecologically significant; it is needless to say that the eye is one of the ablest weapons in animals of shallow sea bottom; this species seems to be an inhabitant of the sea 100-200 *m* in depth, and the large eye may perhaps be a favourable organ for its life than animals of smaller eye, but the musculature of this species is so weak that this species may be a rather weak animal in the struggle for existence. On the other hand, in the genera *Opisthoteuthis* and *Grimpoteuthis* the eye is disproportionally large, which live in subabyssal bottom. Also a number of species of *Benthoctopus* have large eyes, and in littoral species of *Octopus* the eye is generally smaller than those above mentioned. Thus we can at present say only that, in Octobrachiata species having large eyes are inhabitants of rather deep sea and not shallow sea dweller. From this view-point this species has a tendency to the life of a deeper sea than actually obtained.

#### X Description of *Sasakinella eurycephala* TAKI, n. gen. et sp.

##### Genus *Sasakinella* TAKI, new genus

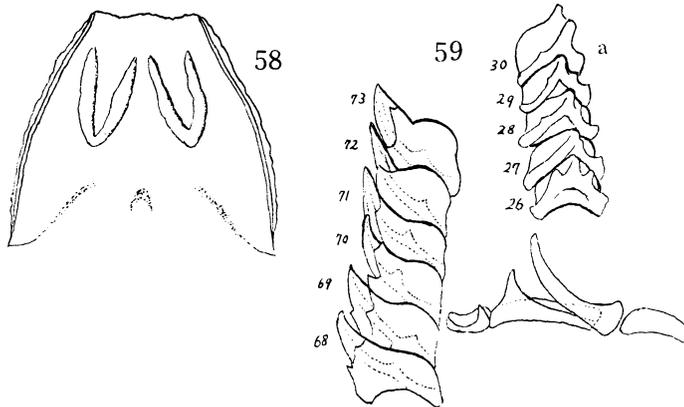
Diagnosis: An Octopodine genus of small animal, body and integument soft, surface smooth, mantle aperture wide, eye large, funnel free up to the distal one third of its length, with well-developed ink-sac, rhachidian tooth of radula tricuspid, intestine with a looping.

Type-species: *Sasakinella eurycephala* TAKI, n. sp.

This genus seems most akin to *Berrya*<sup>1)</sup> ADAM 1939, but can be distinguished as follows:

1) cf. TAKI 1963, p. 68-74, pl. 2, Text-figs. 15-19.

Characters	<i>Berrya</i>	<i>Sasakinella</i>
Surface of the animal	covered with small tubercles	entirely smooth
Mantle aperture	rather narrow (Stage B)	wide (Stage C)
Eye size	rather small	very large
Arm length	about twice as long as mantle (ca. 66 % of total length)	longer than twice as long as mantle (ca. 70-75 % of total length)
Funnel	completely fused to head	free up to the distal 1/3 of its length
Ink-sac	conspicuously reduced	of large size
Rhachidian tooth of radula	5-7 cuspid	tricuspid
Intestine	short, nearly straight, without turning or looping	long, with a slight turning



Text-figs. 58-59. *Sasakinella eurycephala* TAKI, n. gen. et sp.

58. Funnel cut open,  $\times 3.5$  59. Radula,  $\times 46$ . a, earlier portion.

*Sasakinella eurycephala* TAKI, new species Pl. 6, fig. 3; Text-figs. 58-59

A small Octopodine species, texture very soft and integument thin, very loose and somewhat gelatinous; musculature of a whole animal rather weakly developed; surface smooth throughout with many wrinkles which do not form particular sculpture.

Measurements (in mm)

	Type	Paratype No.1
Sex	♀	♀
Total length	107	105
Mantle length (dorsal)	25	26
" " (ventral)	23	25
" width	23	25
Head width	27	22

		s	L	R	s	s	L	R	s
Arm length	1	2.0	45	48	2.0	1.8	(mut.)	70	1.8
	2	2.0	75	70	2.0	1.8	73	75	1.8
	3	2.0	73	70	2.0	1.8	75	71	1.8
	4	2.0	70	70	2.0	1.8	75	79	1.8
Web depth	A			21				23	
	B		23		2 <sub>2</sub>		20		25
	C		26		23		24		24
	D		28		26		22		23
	E			18					23

Locality: Enshû Nada, 3 ♀♀, obtained at Mikawa-Isshiki Market, by Mr. Shôichirô HAYASHI, in May 1961. Exact location and depth of habitat unknown.

Head exceedingly broad, a little narrower than mantle or even wider than mantle, eye very large, ellipsoidally swollen, its axial length  $\frac{1}{2}$ .<sub>5</sub> or a half of the length of mantle, interorbital area very shallowly concave, a low, ca. 1 mm high, short conical ocular cirrus present on the posterior corner of each eye, a weak constriction in front and behind.

Mantle saccular, its length nearly as long as its width, side margin nearly straight and posterior margin roundish, mantle aperture wide.

Arms subequal in length, its length 70–75 % of longest arm, the order of length irregular and can not be determined (in the type specimen both the first arms are disproportionally short owing to regeneration after mutilation of distal one third, and in a smallest specimen paratype no.2, both right first and second arms are mutilated). Arm suckers small, its diameter 7–8 % of mantle length, rather low and soft.

Web soft, well developed, its depth subequal in each sector, the deepest one 27–32 % of longest arm, its order of depth rather irregular and can not expressed in ordinary way.

Radula (Text-fig. 59): Rhachidian tooth very thick, its distal cusps in duplex structure, tricuspid, showing B<sub>4</sub>-seriation, taller than broad, mesocone long and acutely pointed with a thin blade on each side, ectocone very small and low; first lateral moderately large, with an oblong base and its cusp narrow, sharp and tall; second lateral with a very wide and narrow base, its cusp rather narrow; third lateral long and acute, gently curved; marginal plate thin, narrow and long.

Funnel (Text-fig. 58) wide and rather short, its distal one third of its length free; funnel-organ **VV**-shaped, each limb rather narrow and anterior end of all limbs somewhat pointed.

Gill with 8–9 leaflets in each demibranch.

Alimentary canal. Posterior salivary gland 6.5 mm long and 5 mm wide; crop 15 mm long and 3 mm wide, stomach 8 mm long and 5 mm wide; spiral caecum roundish, 5 mm in diameter; liver approximately cylindrical, 18 mm long and 8 mm wide; ink-sac ellipsoid, 8 mm long and 4 mm wide, located at about the middle of the liver; pancreas located at the hind end of the liver, 5 mm long and 8 mm wide; intestine 2.5 mm in diameter, comparatively short, with a slight turning.

Female genital organ. The largest specimen (paratype no.1) is still immature, ovary 4 × 4 mm in size, oviduct 12 mm long and 1 mm in diameter, oviducal ball

1.8 mm in diameter.

Colouration: Vernonia purple throughout the surface, oral surface old rose in colour.

Remarks on the generic position: In the subfamily Octopodinae there are some inhabiting subabyssal and abyssal sea, showing characteristic features adapted for these modes of life. *Sasakinella* belongs evidently to one of this group, and the common features in *Berrya* and *Sasakinella* may be enumerated as follows:

- (1) The animal is small in size.
- (2) The animal as a whole very soft and somewhat gelatinous in consistency, the musculature is only weakly developed.
- (3) Mantle saccular and as long as broad, and head is very broad.
- (4) Arms are short and suckers small.
- (5) Web is deep and subequal in each sector.
- (6) Brachial membrane is broadly developed.
- (7) Funnel-organ is of **VV**-shaped type.
- (8) Ink-sac present.
- (9) Kidney, liver and pancreas are well developed.
- (10) Crop present.

These features seem to be transient to those of animals of abyssal life, e. g. *Benthoctopus*. Therefore, if viewed from the status of the ink-sac, the relative Octopodine group may be arranged in vertical distribution as follows:

Ink-sac	
Littoral group.....	<i>Octopus</i> , <i>Paroctopus</i> , etc....well developed
Subabyssal group...	<i>Sasakinella</i> ....., , <i>Berrya</i> .....reduced
Abyssal group.....	<i>Benthoctopus</i> ..... lost

Unfortunately, I can not describe the characters of male animals, which are missing at hand, so that relationship to other groups based on hectocotylus and male genital organ can not be elucidated.

As stated above, this genus seems to stand close to *Berrya*, which is dedicated to Dr. S. S. BERRY of California. I dedicate this genus to the late Prof. Dr. Madoka SASAKI (1883-1927), who has made an outstanding contribution to the Japanese teuthology and lived some period of time in common with Dr. BERRY. In the generic names of animals there are already *Sasakia* (Insecta: Lepidoptera-Nymphalidae), *Sasakina* (Mollusca: Pulmonata- Ariophantidae) and *Sasakiella* (Coelenterata: Stauromedusae-Kishinouyeidae), so that I am obliged to adopt this spelling for avoiding the homonymy. The species name is chosen for its head (Gr. broad head).

#### XI Description of *Benthoctopus fuscus* TAKI, new species

Pl. 7, fig. 1; Text-figs. 65-68

Measurements (in mm)	
Sex	♂
Total length	575

Mantle length (dorsal)		115				
Mantle length (ventral)		95				
" width		95				
Head width		70				
		┌───────────┐				
		s	L	R	g	
Arm length	{	1	6.5	460	(mut.)	6.5
		2	6.5	470	360	6.0
		3	6.5	410	283	6.5
		4	7.0	390	(mut.)	6.0
Web depth	{	A			74	
		B		83	85	
		C		92	98	
		D		78	78	
		E				42

Locality : Kashima Nada, depth of habitat unknown, obtained at Chôshi Market, by Mr. Satoshi HIRANO, June 1961.

An Octopodine species of large size, body muscular but rather soft in consistency, surface smooth throughout without any sculpture of integument, though in preserved specimen there are seen many slender wrinkles which are non-characteristic.

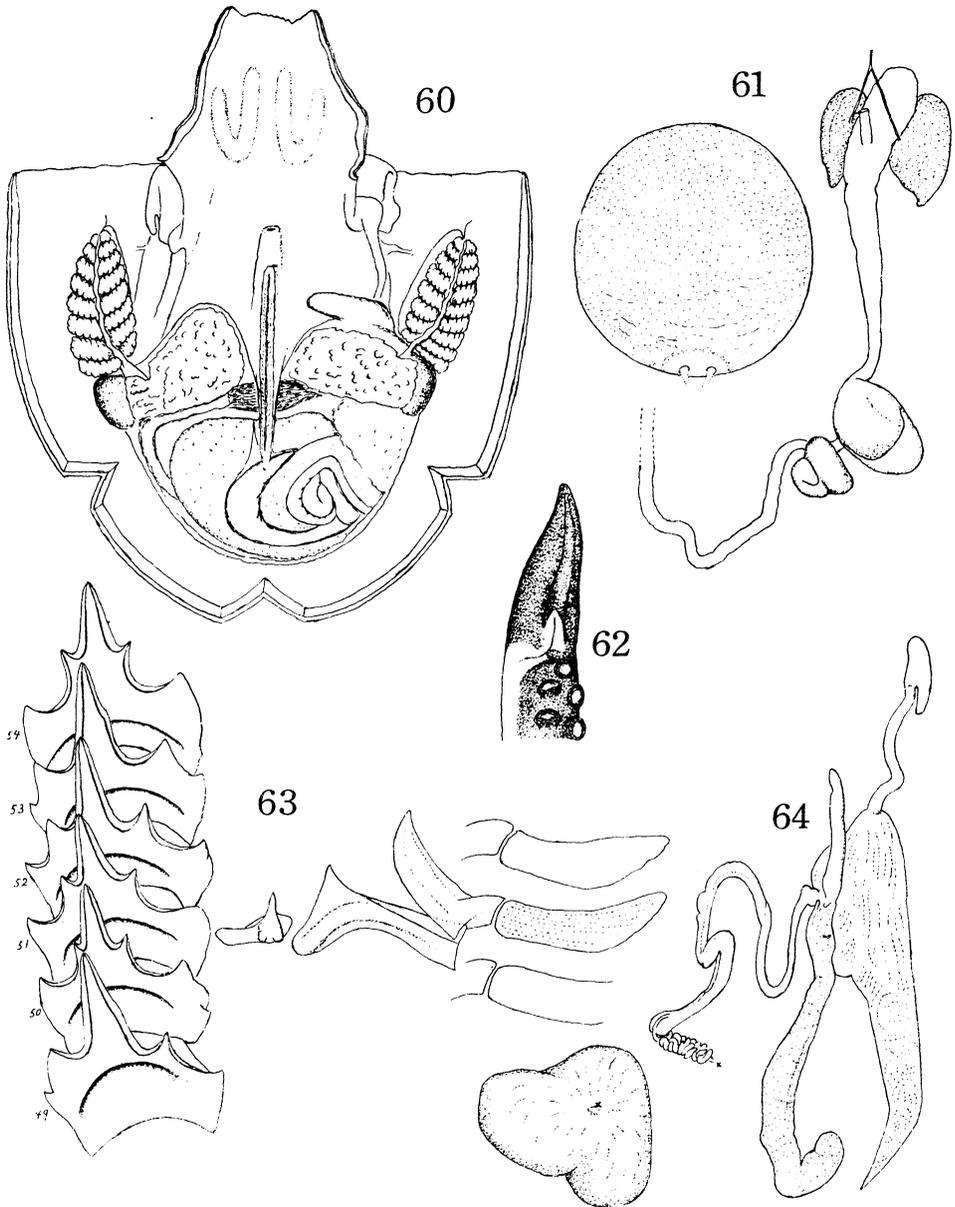
Head broad, 61 % of mantle length, evenly smooth, faintly constricted in front and behind; no ocular cirri; eye-orifice extremely large, 22 mm long which is 19 % of mantle length. Mantle broadly ovoid, its width 83 % of mantle length, widest at the halfway of its length, entirely smooth, mantle aperture very wide.

Arms nearly circular in section; slender and long, the longest arm 82 % of total length, the order of length 2. 1. 3. 4. on the left side. Arm suckers rather small, no particular enlarged suckers present, the diameter of largest one 6.1 % of mantle length.

Third right arm hectocotylized, its length 61 % of longest arm and 70 % of the opposite mate, 40 pairs of suckers in the ordinary part. Ligula (Text-fig. 62) 15 mm long (5.0 % of hectocotylized arm) and 6 mm wide at base, conical, the copulatory groove rather shallow and narrow, pigmented, no lamina copulatoria present, with faint rugosities on both ridges of copulatory groove; calamus pointed, whitish, 3.5 mm long and 2.5 mm wide; seminal channel very prominent by its entire lack of chromatophores, 2.5 mm wide near the calamus and 4.0 mm wide at the middle of the hectocotylized arm, flat, no groove is seen throughout the hectocotylized arm, perhaps due to the unfavourable state of preservation.

Web moderately developed, the deepest sector 20 % of longest arm, the order of depth C. B. D. A. E. on both sides.

Radula (Text-fig. 63): rhachidian tooth longer than broad, pentacuspoid, showing B<sub>5</sub>-seriation, mesocone acute, with a thin blade on each side, inner ectocone acute, but rather small, outer ectocone rather low and wide; first lateral very wide transversely, with a long, acute cusp; base of second lateral prominently arcuated, with a rather broad cusp; third lateral thin and broad, only slightly curved; marginal plate quite thin and transparent, longer than the third lateral, gently curved, with a number of longitudinal striations.



Text-figs. 60-64. *Benthoctopus fuscus* TAKI, n. sp. 60. Funnel and mantle cut open from ventral side,  $\times 0.6$  61. Alimentary canal,  $\times 0.6$  62. Hectocotylus,  $\times 1.4$  Unstippled part shows unpigmented area. 63. Radula,  $\times 33$  64. Male genital organ,  $\times 1.4$

Funnel (Text-fig. 60) rather tall, 45 mm long measured from the ventral mantle margin, 11 mm wide at its aperture, its wall 2.5 mm thick; funnel-organ **VV**-shaped, each **V** rather widely separated, and inner limb longer than the outer one, each limb 4 mm wide.

Gill with 7-11 leaflets in each demibranch.

Alimentary canal (Text-fig. 61): posterior salivary gland somewhat heart-shaped,

20 mm wide, 25 mm long, 6 mm thick, surface smooth; crop large, 13 mm wide and 45 mm long, forming a spacious caecum anteriorly; oesophagus short, 4 mm in diameter; stomach muscular, ovoid in shape, 25 mm long, 20 mm wide, 18 mm thick; spiral caecum rather small, 15 mm in diameter; liver disc-shaped, 58 mm wide, 60 mm long and 13 mm thick; ink-sac entirely absent; pancreas occupies a small portion at the hind end of the liver; the wall of the intestine is so thin and by the bad state of preservation the natural state is not observed.

Male genital organ (Text-fig. 64): testis large, 46 mm wide, 40 mm long, 15–20 mm thick; vas deferens ca. 1 mm in diameter, with numerous coils; spermatophoric gland 2–4 mm in diameter; accessory spermatophoric gland very thick, 5 mm in proximal part and 10 mm in distal part in diameter; shunting duct 20 mm long and 3 mm in diameter; spermatophoric sac very large, its proximal part enlarged (20 mm in diameter) and tapers distally, ca. 80 mm long, numberless spermatophores are contained compactly, penial duct rather long, 1.5–2.0 mm wide and 25 mm long; penis short, flat, 4 mm wide and 8 mm long, with a penis diverticle which protrudes backward 6 mm long; spermatophore 85 mm long, anteriorly 1.5 mm wide, with ca. 65 coils.

Colouration. The whole surface, both dorsal and ventral, is coloured uniformly Vernonia purple, dark part Cotinga purple. It is not certain that in the living state what part of the body was coloured dark, but in the specimen at hand the hind end of mantle, lateral sides of all arms and margin of web are coloured dark, and viewed from the oral surface the central area, including basal part of each arm and web, ca. 100 mm from the mouth, is light coloured. This unevenness of colour seems to be due to the state of preservation, perhaps different from the natural colouration.

It is a noticeable fact that the ventral side of the whole surface, including the web, lateral surface of the arms and suckers, is coloured similar to the dorsal surface, quite different from the case in littoral Octopods.

Comparison with related species. There have been 14 species in the genus *Benthoctopus* from various localities in the world (ROBSON 1932, p. 223). In 1954 ADAM reported 4 species of this genus from the Siboga Expedition, of which without giving the specific name respectively, he called them merely sp. A to D. According to him (p. 187), he found a specimen in the British Museum labelled by ROBSON as *B. pacificus* obtained by the "Arcturus" Expedition from the eastern Pacific, but description of that species has not yet been published and therefore not valid. Also DELL (1959) described *B. sp.*, but he says that "the viscera are so damaged that it is impossible to be certain that there is no ink sac" (p. 95). So that these are not taken in consideration here.

From Japanese waters 3 species have been known, namely *B. hokkaidensis* (BERRY 1921), *profundorum* ROBSON 1932, *abruptus* (SASAKI 1920) (SASAKI 1929, ROBSON 1932). As compared with these Japanese species, the present species can be decidedly distinguished by its large size of the animal, namely total length of *fuscus* measures 575 mm, while the largest species *abruptus* only 520 mm. Moreover by the form of the funnel organ, male gonoduct system, hectocotylus and colouration the present species can be easily separated from all of them.

From 4 species reported by ADAM (1954), which are as a whole quite smaller

than the present species (for example: dorsal mantle length of sp. A and B 60 mm, which are the largest of 4 species), a comparison of the numerical value of indices of mantle-width, head-width, arm-length, web-depth and diameter of sucker between them and the present species show the specific difference clearly (Table 2). Also ADAM remarks that *B. sp. D.* resembles *B. pacificus* ROBSON (MS.), but the present species is much larger than both these species, and also the web shallower, the eye smaller, the arms longer than these species.

Remarks on the colouration: This species is characterized by (1) the deep purplish colour and (2) homochromatism on the dorsal and ventral surfaces, though partly the ventral side is coloured lighter. This homochromatism seems to be a feature of this genus, and sometimes a reverse case is seen (ROBSON 1932, p. 229). For example in *B. berryi* "the general colour is a light purplish brown, and is deeper ventrally than dorsally (an unusual feature)." I have noticed that, in this species the colouration is based on the microscopical chromatophores (diameter ca. 0.05-0.1 mm), not the uniform pigmentation as in, for example, *Opisthoteuthis*. This particular colouration seems to be due to the depth of the habitat and also the moving habit of the animal. The actual depth of catch of this species is not known, but I surmise that the animal lives in the subabyssal bottom, a transient level between littoral and abyssal habitat. But the real reason of this homochromatism in this genus is not at present properly explained.

The features of this species seem to retain the characters of littoral animals rather abundantly, namely the animal is quite large for the genus (in so far as I am aware, the present specimen is the largest of all known species of this genus), the mandibles are very large, the mantle aperture is very wide, the musculature is fairly well developed.

Details in comparison with related species are shown in Table 2, together with the next species (p. 324).

This species is named *fuscus* (L. dark-coloured, dark, black) by its characteristic colouration.

## XII Description of *Benthoctopus violescens* TAKI, new species

Pl. 7, fig. 2; Text-figs. 65-68

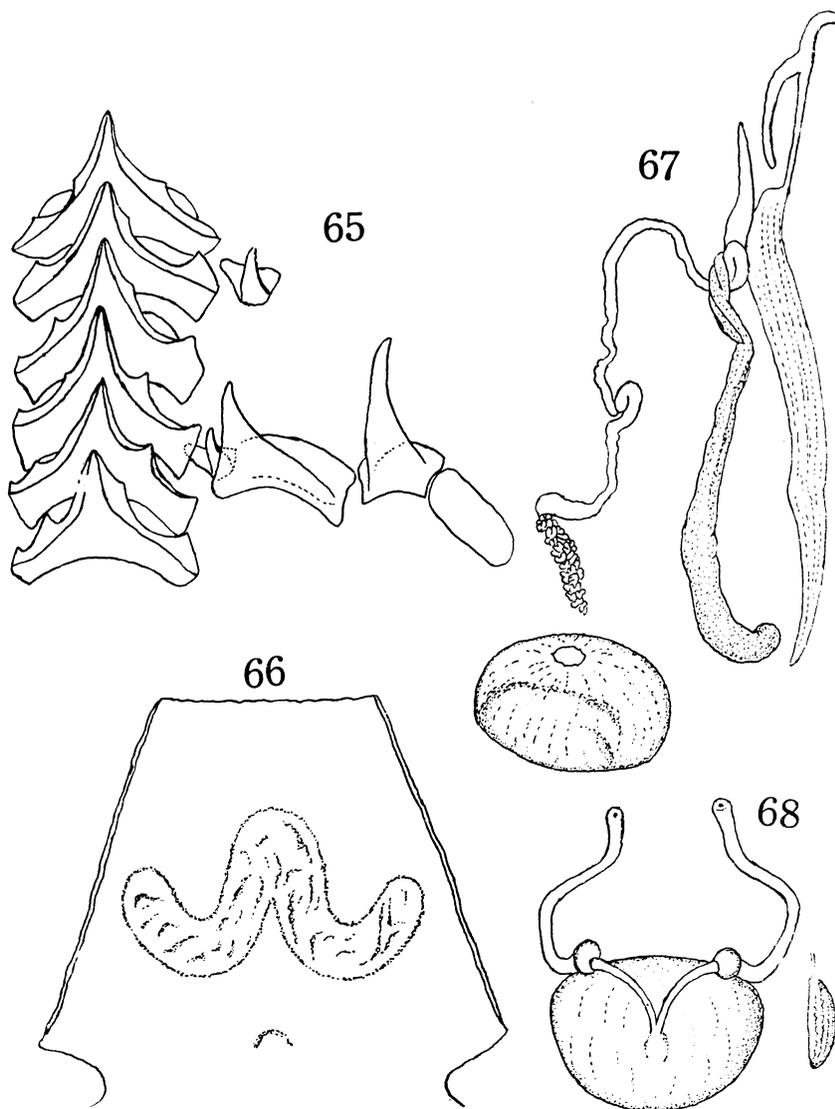
### Measurements (in mm)

Sex	Type					Paratype No.1			
	♀					♂			
Total length	350					280			
Mantle length (dorsal)	75					68			
" " (ventral)	58					57			
" width	60					35			
Head width	50					35			
Arm length		s	L	R	s	s	L	R	s
	1	6.0	225	260	5.5	5.0	210	175	5.0
	2	5.5	220	213	5.0	4.0	195	175	4.0
	3	4.5	195	218	4.0	3.5	170	165	3.5
	4	4.0	195	220	3.5	3.0	155	145	3.0

Web depth	{	A	43		37	
		B	48	53	32	37
		C	45	53	47	30
		D	40	42	35	44
		E		18		28

Locality: Kashima Nada, 6 specimens (3♂♂, 3♀♀), obtained at Chôshi Market, Chiba Prefecture, on 16th March, 1961, by the author. Exact location and depth of habitat unknown.

An Octopodine species of rather small size, with soft body, musculature rather



Text-figs. 65-68. *Benthoctopus violescens* TAKI, n. sp.  
 open,  $\times 2.1$

67. Male genital organ,  $\times 0.85$

65. Radula,  $\times 50$

66. Funnel cut

68. Female genital organ,  $\times 0.9$

weakly developed, the thickness of ventral side of mantle measures 2.5 *mm*; surface smooth throughout without any sculpture.

Head broad, only a little narrower than mantle, bordered by inconspicuous constriction in front and behind, orbit very large, its axial length about  $\frac{1}{2}$ – $\frac{1}{3}$  of dorsal mantle length, ellipsoidally swollen, the area between both orbits shallowly concave; no ocular cirrus found.

Mantle bursiform, a little longer than broad, its length 22–24 % of total length and its width 52–80 % of mantle length, posterior margin rounded, mantle aperture very wide.

Arms unequal in length, the order of length 1.2.3.=4. (type) and 1.2.3.4. (paratype no.1), the longest arm 69–75 % of total length, arm suckers comparatively small, 7–8 % of mantle length, no enlarged suckers present in matured male.

Third right arm in male hectocotylized, its length 79 % of longest arm and 97 % of length of opposite mate; ligula slenderly conical, 9 *mm* long, copulatory groove very narrow and shallow, calamus 1.5 *mm* long, conical.

Web moderately developed, its depth 20–21 % of longest arm, its order B.C.A. D.E. (type) and C.A.D.B.E. (paratype no.1), deepest in sector B or C and shallowest in E. Web is connected with a broad brachial membrane at the outer side of each arm.

Radula (Text-fig. 65): Rhachidian tooth about as tall as broad, pentacuspoid, showing B<sub>5</sub>-seriation, base narrow, mesocone slender and acute, ectocone very low; base of first lateral short, nearly quadrangular, cusp tall and weakly arcuated; base of second lateral narrow and gently arcuated, its cusp narrow and tall, acutely pointed; third lateral slender and nearly straight, its base roughly quadrangular; marginal plate slenderly oblong.

Funnel (Text-fig. 66) long and wide, its anterior edge nearly attains the margin of sector E of web, its free portion is about  $\frac{2}{3}$  of its length; funnel-organ **W**-shaped, each limb very wide, outer limb shorter than the inner limb.

Gill composed of 11–13 filaments in demibranchs.

Alimentary canal (dissection of paratype no.2, total length 250 *mm*). Posterior salivary gland small, 6 *mm* long and 5 *mm* wide, trigonal; crop 18 *mm* long and 6 *mm* wide; stomach small, 8 *mm* long and 12 *mm* wide, spiral caecum disproportionately large, 11 *mm* long, 13 *mm* wide, 8 *mm* thick; liver ovoid, 32 *mm* long, 20 *mm* wide, 18 *mm* thick, ink-sac absent; pancreas 8 *mm* long and 12 *mm* wide; intestine 3–5 *mm* in diameter.

Male genital organ (Text-fig. 67) (paratype no.2): Testis 25 *mm* long, 30 *mm* wide, 20 *mm* thick, vas deferens 1.5 *mm* in diameter, with numerous coils; spermatophoric gland 2–3 *mm* in diameter, 65 *mm* long, accessory spermatophoric gland 3–5 *mm* in diameter, terminal coil slight; shunting duct 18 *mm* long and 4 *mm* wide at base; spermatophoric sac 4–5 *mm* wide and 65 *mm* long; penial duct 1–2 *mm* in diameter and 18 *mm* long, penis gently arcuated, 1.5 *mm* in diameter and 12 *mm* long, diverticle very long, 1.5–2.0 *mm* wide and 12 *mm* long; spermatophore abundantly contained in the spermatophoric sac, 65 *mm* long by 1.0 *mm* wide at the distal part.

Female genital organ (Text-fig. 68): Ovary in matured state, 25 *mm* long, 30 *mm*

wide, 20 mm thick, containing matured ova, 13 mm long and 4.5 mm wide, with a short stalk; oviduct 2 mm in diameter, oviducal ball 5 mm in diameter, distal oviduct 5 mm in diameter, terminal portion weakly swollen.

Colouration: The animal as a whole coloured dark slate purple, not different in dorsal and ventral side, and dark madder violet in deeper colour which is found in web and contractile membrane of arm; lighter colour area is Laelia pink in some specimens.

Comparison of diagnostic characters in *Benthoctopus* which are needed for discriminating *B. fuscus* and *B. violescens* from related species is tabulated as follows (Table 2):

*B. sibiricus* LØYNING 1930 is reported from New Siberian Islands (ROBSON 1932, p. 230–231; AKIMUSHKIN 1963, p. 151–152), but ROBSON says, "It is very unfortunate that this interesting form is known only from a fragmentary specimen. It is not even certain that it is a *Benthoctopus*, though I think this is likely." Therefore this species is omitted from the table given here.

Table 2. Comparison of specific characters of selected species in *Benthoctopus*.

Species name	<i>hokkaidensis</i> BERRY 1921	<i>profundorum</i> ROBSON 1932	<i>abruptus</i> SASAKI 1920	<i>fuscus</i> TAKI 1964
Total length	245 mm	320 mm	520 mm	575 mm
Mantle aperture	rather narrow	very narrow	moderate	very wide
Arm length index	70 %	71-83 %	78-82 %	82 %
Sucker index	6.8-8.6 %	5.1-6.7 %	15 %	6 %
Web index	24-27 %	24-34 %	23-24 %	20 %
Funnel organ	<b>W</b>	<b>w</b>	<b>w</b>	<b>VV</b>
Rhachidian tooth of radula	—	pentacuspide	—	pentacuspide
No. filaments in demibranch	12	8-10	10-14	7-11
Ligula length index	4.5 %	6.9 %	7.3 %	5.0 %
Penis diverticle	long, S-shaped	moderately long	long	short, straight
Oviduct	thin and nearly straight	distal oviduct a bit crooked or even straight, oblique	distal oviduct straight, axial	—
Locality	Off Prov. Hidaka, Hokkaido; Off Kin-kasan; Suruga Bay	Off Yokohama; Bungo Channel; Off Prov. Kii; ? Andaman Sea; Aleutian Islands	Off Prov. Kii.	Kashima Nada

<i>violescens</i> TAKI 1964	(ADAM 1954)			
	sp. A	sp. B	sp. C	sp. D
350 mm	—	—	—	—
very wide	—	very wide	wide	—
69-75 %	75 %	75 %	75 %	76 %
7-8 %	8.3 %	5.8 %	8.3 %	7.9 %
20-21 %	38%	29 %	36 %	30 %
<b>W</b>	<b>W</b>	—	—	—
pentacuspид	pentacuspид; first lateral large	pentacuspид; first lateral very large	pentacuspид; first lateral very wide and cusp low	tricuspid; first lateral short and cusp very high
11-13	8-9	9	8-9	5-6
5.5 %	—	6.2 %	—	—
long, curved inside	—	—	—	—
S-shaped	—	—	—	—
Kashima Nada	South of Ceram (resembles <i>januarii</i> and <i>profundorum</i> ; if presence of ink- sac is confirmed, this species cannot be placed in this genus)	South Celebes	South of Celebes (resembles <i>levis</i> )	South Celebes (resembles <i>pacificus</i> )

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## 日本産頭足類11新種（内マダコ亜科の2新属を含む）について

瀧 巖

最近数年間に我国の諸地方の知友から及び私自身が得た頭足類を分類して次の新種を見出したので報告する。

## (1) ツメイカダマシ（新種・新称）

標本1個，土佐湾より豊後水道に至る間の水深120~230mより底曳網で採れたもの，黒原和男氏寄贈。套背長60mm，套幅18mm，腕はいずれも套長よりは短かく吸盤は2列に並び，吸盤の角質環は平滑で歯はない。触腕は長く，触腕頭は同腕の3.5分の1の長さで，鉤が2列あるが吸盤はない。体は淡紫色，本属の既知のどの種よりも大きく，又諸特徴がちがう。日本に産することは新記録である。

## (2) タラバホタルイカモドキ（新種・新称）

標本7個。日本海（福井県沖及び兵庫県沖）で採れたスケトウダラの胃中より得たもの。伊藤勝千代・西村三郎の2氏寄贈。套背長80mm，套幅24mmで，腕は亜等長で鉤と吸盤があり，吸盤は極めて微小（直径0.69mm又はそれ以下）で角質環には7本の幅広い歯がある。雄の右第4腕の先端部は交接腕化している。発光器は動物の腹面に散布しているが，外套腹面においては成体では散在する。しかし幼若個体では6縦列に列んでいる。又漏斗には4列，頭には5列，第4腕に3列，第3腕に1列，眼球上に1列ある。富山湾及び豊後水道から知られているホタルイカモドキと諸点で異っている。鱈の漁場に住むと考えられるのでこの和名を設けた。

## (3) ゴマファイカ（新種，新称）

標本3個，土佐湾及び駿河湾産。套背長46mm，套幅27mmで，胴は短円錐形，鱗は亜円形でその幅は套腹長にほぼ等しく，腕は胴より長く，吸盤の角質環には歯なく平滑で，左眼開口は右より大きい。触腕は套背長の2倍以上の長さで，触腕頭は僅かに膨らみ，大形吸盤の角質環には23個の歯がある。発光器は背面より腹面に多く散布し，大きさから3種に分けられるが，腹面にあるものは一般に大形であり，規則正しく配列している。全体淡紫褐色，我国にはこれまで *Calliteuthis japonica* (PFEFFER) と *C. dofeini* (PFEFFER) が知られていたが，本種は両種とも明らかに区別せられる。発光器の散布している状態からこの和名を設けた。

## (4) シマダコ（新属・新種・新称）

新属はマダコなどに似ているが，体軀大形で強壯な体格で，筋肉よく発達し皮膚は強靱で，歯舌の軸歯は3~7歯尖を有し，肝臓・鰓・鰓心臓など大形であるが墨汁嚢は退化している。体表には顕著な斑紋があり，シマダコでは斑紋の部分が弱い青白い燐光を発する。八腕類で従来発光すると考えられたものは少しあるが明確になったものはなかった。しかし最近ムラサキダコ属に発光器を有する *Tremoctopus lucifer* AKIMUSHKIN 1963 という新種が報告された。しかし燐光を発するものは本種が初めての記録である。

シマダコは標本2個，大分県南海部郡蒲江町附近（荒川好満氏寄贈）と三重県鳥羽市相差附近（鳥羽水族館所蔵）。体長870mm，套背長120mm，套幅80mmで，保存標本では皮膚に微小な小顆粒が一面にあり，胴は卵形で腕長は全長の81~84%に達し，強壯で，最大吸盤の直径は雄で套長の13%，雌で9%に当る。交接腕は反対側の腕の65%の長さで，舌状片は長円錐形で，その長さは交接腕の7.4%で，傘膜は厚い。歯舌も強壯で軸歯には5~7歯尖を有し，他の歯も大きい。漏斗器はW形。内臓器官で後唾腺・肝臓・鰓・鰓心臓などすべて大形であるが，墨汁嚢は体に比べて小さく細長い。体色（着色図版は保存標本を写生したものであるが，生時色とほとんど変っていない）は紫褐色で，淡紅色の帯状斑が体の背面に縦に並ぶ。属名は最も美しい，或は極めて美しいタコの意で，種名は荒川好満氏を記念したものである。

燐光皮膚の組織。シマダコの斑紋部・地色部及び外套腹面の皮膚を切片にして組織を検した。い

ずれも表皮細胞層は脱落していた。斑紋部では色素胞層の直下に特異な細胞の層があるが、それは燐光を発する細胞と考えられるので燐光細胞と呼び、その層を燐光細胞層と名付けよう。その細胞は長さ26~33 $\mu$ 、直径9~10 $\mu$ の円筒形のもので、エオシン嗜好性で、緻密で、極微の顆粒状で、中心部は稀薄で、核は実質内になく外にある。この細胞は密に並び、数個の集った層をしている。この層は虹彩細胞層と呼ばれたものに相当するであろうが、イカ類の発光器の組織とは全く異なる。それは本種のは燐光で真の発光とは違うから当然であろう。切片によると色素胞と燐光細胞の分布は斑紋部と地色部において根本的な差がない。僅かに地色部では燐光細胞の分布が少いという程度である。燐光の生ずる機構は明らかでないが、細胞の顆粒が発光すると考えることはできよう。尙、外套腹面の皮膚には色素胞も燐光細胞も見出されない。

(5) ワモンダコ (新属・新種・新称)

標本4個、愛媛県南宇和郡内海村家串附近産(荒川好満氏寄贈)。体は大形で最大のものは重量(保存標本)2820gあった。体格強壯で皮膚強靱である。全長約600mm、套背長147mm、套幅95mm、腕は重等長で全長の84~92%に当り、交接腕は反対側の腕の長さの90~96%で、舌状片は同腕の1.3%の長さで、歯舌の軸歯は3~5歯尖を有し、他の歯も幅広く太い。漏斗器はW形、内臓器官もシマダコに似て大形でよく発達し、墨汁嚢は比較的小さい。体は暗褐色で、第2~3腕の基部に大形の環状紋(最大のものの直径40mm)があり、腕の背面・側面には橙色の縦斑がその先端部まで存在する。もしこの橙色斑がシマダコのように燐光を発するものであるなら、生時、刺戟に対して、眼紋と共に著しい警戒色斑となると推定される。既知の眼紋を有するマダコ属の種と比べて、最も大形の眼紋を有するのでワモンダコの和名を付けた。

(6) メジロダコ (新種・新称)

標本雌1個、大分県南海部郡蒲江町附近産(荒川好満氏寄贈)。マダコ亜属の小形のタコで全長175mm、套背長43mm、套幅31mm、腕長は全長の74%、筋肉よく発達し、最大吸盤の直径は套背長の10%に当る。表面に微細な顆粒が密に存するが腹面はほとんど平滑で、歯舌の歯は一般に細く高く、軸歯は3歯尖を有する。漏斗器はW形で鰓葉は片側に8~10個、生時の体色はその写生図を提供された荒川氏の好意によって知ることができるが、全体暗灰褐色で眼の縁が淡褐色、腕の吸盤は淡紅色で吸盤の基部に沿って腕の全長にわたる白線があり、静止時に腕を側方及び後方に伸ばす特性がある。保存標本では一様に暗褐色となって白線は見られない。眼の縁が淡色であるのでこの和名を付けた。

(7) エゾクモダコ (新種・新称)

標本雌雄15個。*Paroctopus*属の特徴は必ずしも明確でなく PICKFORD氏のように *Octopus* と同一視する学者もあるが、ここでは ROBSON氏に従って別属として考え、その新種とした。全長375mm、套背長92mm、套幅42mmで、体表は平滑で、胴は長楕円形、腕はやや細くその長さは全長の65~70%、腕長式は1.2.3.4.、成熟雄の吸盤は特に拡大している。交接腕は長さが最長腕の72~79%で、舌状片は極めて細長く、交接腕長の8~12%、漏斗は細長く漏斗器はW形であるが各枝は極めて幅広い。全体は紫褐色、北海道釧路市沖で周年エビ桁網で漁獲され、クモダコと呼ばれている。種名はこの意をとって *araneoides* とし、和名は本州にもクモダコと俗称されるものがあるので区別するためエゾクモダコとした。

(8) オオメダコ (新種・新称)

前種と同属で、標本雌雄12個。全長380mm、套背長75mm、套幅48mm。体表は平滑で体質は柔軟である。眼は特に大きくその長さは套背長の1/3を占め、幼若のものは1/2にも及ぶのでこの和名を付けた。腕長は全長の74~80%で、腕長式は1.2.3.4.、吸盤は小形で、その最大のものは直径は套背長の5~6%である。交接腕の長さは最長腕の54%、舌状片は細長く、長さは交接腕長の5.3%、陰莖は管状で盲嚢は短かい。漏斗器はW形、体は淡灰紫色、土佐湾及び遠洲灘の底曳網で採れた。

## (9) セビロダコ (新属・新種・新称)

標本雌3個。 *Berrya* ヤワハダダコ属に似ているがこれとも区別しうるので新属 *Sasakinella* とした (故佐々木望博士に献名したが、 *Sasakia*, *Sasakina*, *Sasakiella* は既に動物の属名として用いられているので同綴りになるのを避けるためにこの綴りとした)。全長107mm, 套背長25mm, 套幅23mm, 体も皮膚も極めて柔軟で, 体表は平滑, 頭は特に幅広く, 外套開口は幅広く, 眼は大きく, 墨汁嚢はよく発達している。腕長は全長の70~75%で吸盤は小形である。漏斗は基部は融着し先端約 $\frac{1}{3}$ は体部と離れ, 漏斗器は **VV**形である。体は暗紫褐色, 遠洲灘で採れた (林奨一郎氏寄贈)。頭部, 従って背部が特に広いのでこの和名を付けた。

## (10) クロダコ (新種・新称)

標本雄1個, *Benthoctopus* チヒロダコ属の新種で既知種と比べてこれは最大である, 全長575mm, 套背長115mm, 套幅95mm。体表は平滑で体質はやや軟かい。頭は幅広く, 腕は細長く, 長さは全長の82%に及び, 吸盤は小形で最大吸盤の直径は套背長の6%。交接腕の長さは最長腕の長さの61%で, 舌状片は円錐形で, その長さは交接腕長の5%。漏斗器は **VV**形。肝臓は円盤状で墨汁嚢を全く欠いている。体は黒紫色で, 背面と腹面がほとんど同色であることは注意されることである。鹿島灘産 (平野敏氏寄贈)。和名はムラサキダコというのは *Tremoctopus violaceus* を指すのでこれと混同しないようにクロダコとした。

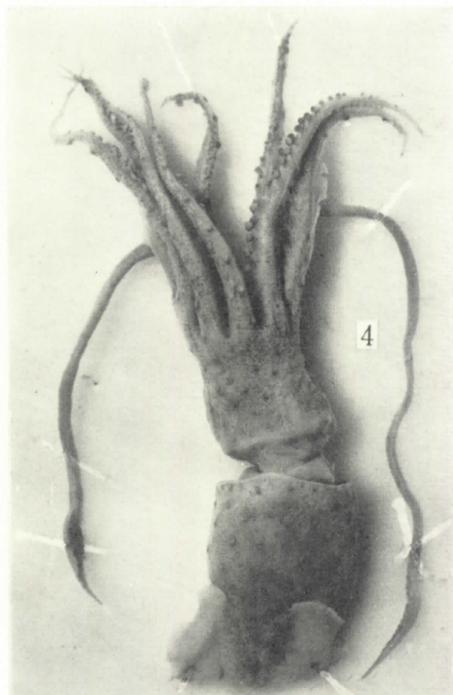
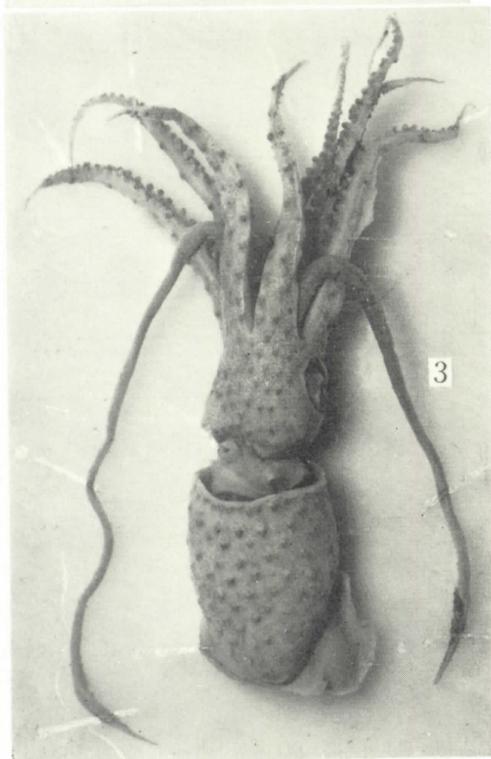
## (11) スミレダコ (新種・新称)

標本雌雄6個, 前種と似た点があるが同属の別種とした。全長350mm, 套背長75mm, 套幅60mmで, 体表は平滑で体質は甚だ柔軟である。腕長は全長の69~75%で腕長式は1.2.3.4。交接腕は長さ最長腕の79%で, 舌状片は細長く, その長さは交接腕長の5.5%, 漏斗器は **W**形であるが外枝は短かい。墨汁嚢を欠いている。体は紫灰色, 鹿島灘産, 前種と共に近縁の種との比較を表で示した。

## EXPLANATION OF PLATES

## Plate 1

1. *Onykia japonica* TAKI, n. sp. Holotype,  $\times 0.9$
2. *Enoploteuthis theragrae* TAKI, n. sp. Paratype, No.1  $\times 0.6$
- 3-4. *Calliteuthis inermis* TAKI, n. sp. Ventral and dorsal views. Holotype,  $\times 0.7$



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Plate 2

*Callistoctopus arakawai* TAKI, n. gen. et sp. Type, about  $\frac{1}{4}$  of size of living state, painted from the preserved specimen, but according to Mr. K. Y. ARAKAWA this colouration is nearly the same as the living state.

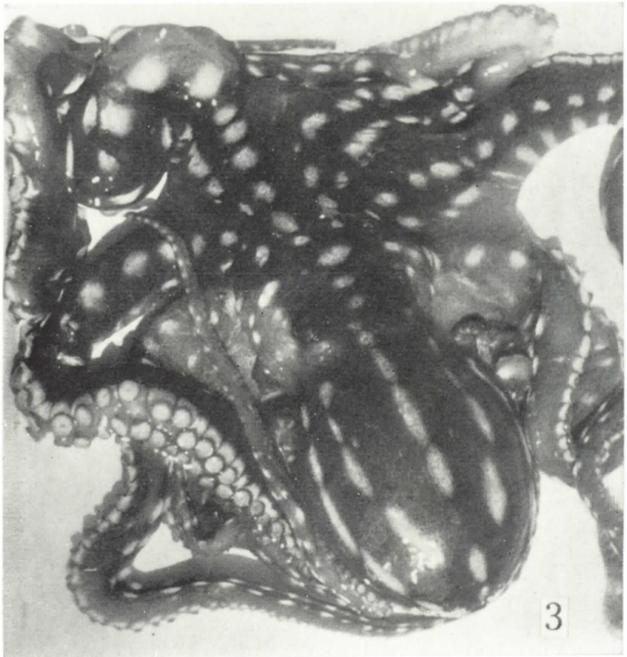
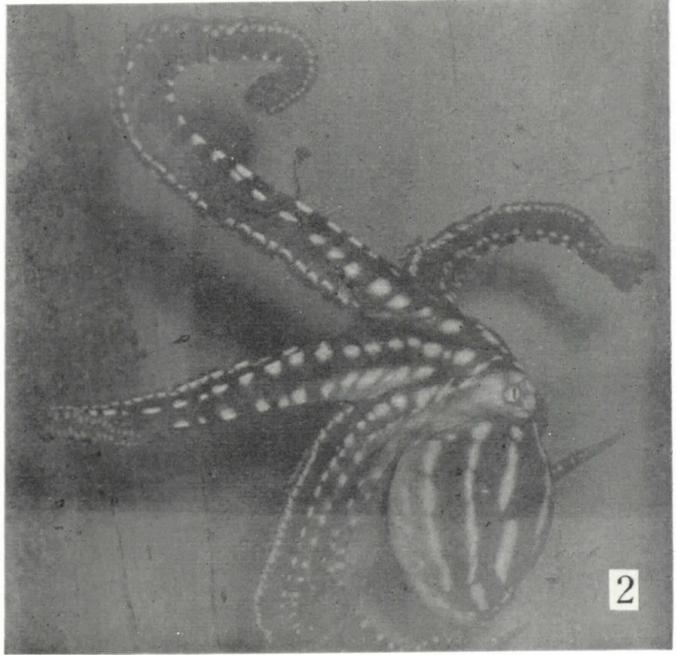
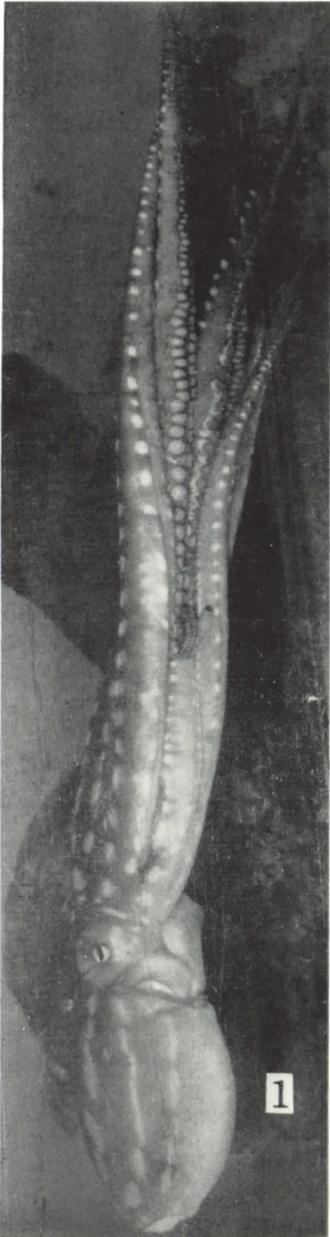


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Plate 3

*Callistoctopus arakawai* TAKI, n. gen. et sp.

1. Type, backward swimming state in the Miyajima Aquarium, seen from the right side. Note the distal part of hectocotylized arm (right third arm) which is rolled by one turn.
2. The same, seen from the left side. A weak phosphorescence is seen when the aquarium is somewhat dark. 1, 2, photo by Mr. K.Y. ARAKAWA.
3. Paratype, when alive in the Toba Aquarium. Photo by Mr. T. KATAOKA.



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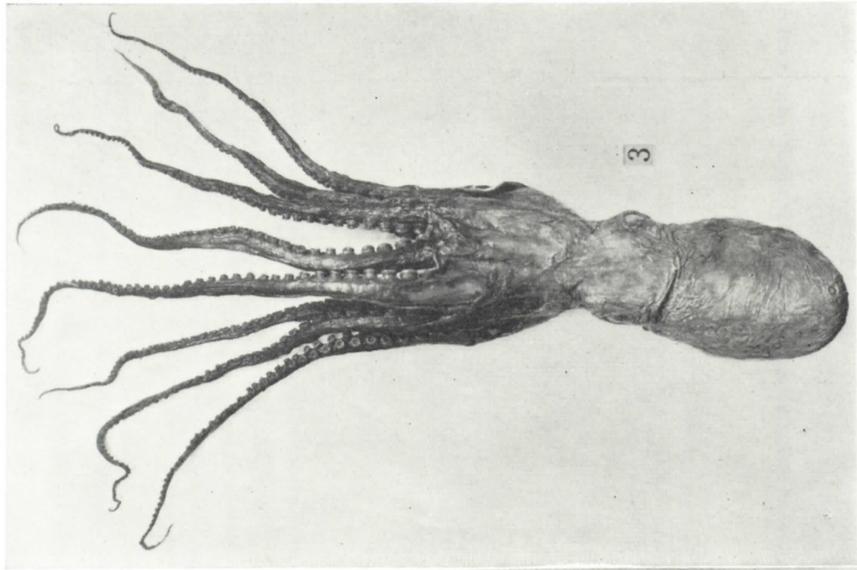
Plate 4

1-2. *Callistoctopus magnocellatus* TAKI, n. gen. et sp.

1. Dorsal view of type.  $\times$  ca.  $\frac{1}{5}$

2. Right side view of paratype,  $\times$  ca.  $\frac{1}{5}$  Note the ocellus pattern.

3. *Paroctopus araneoides* TAKI, n. sp.  $\times$   $\frac{1}{3}$

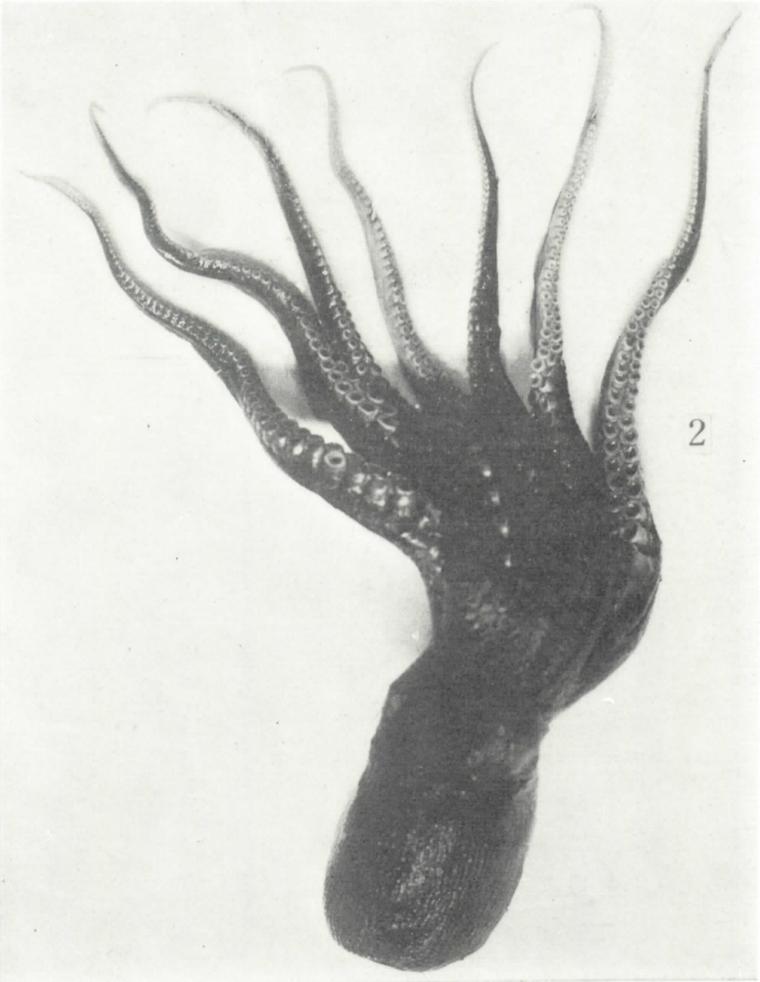
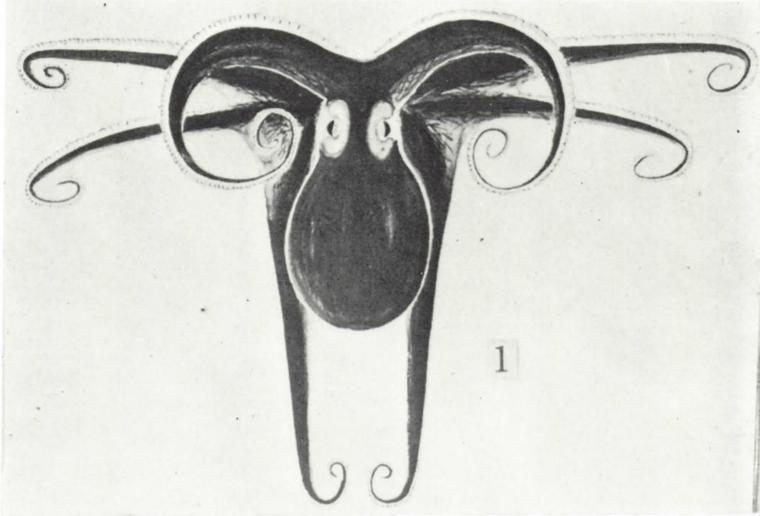


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Plate 5

*Octopus marginatus* TAKI, n. sp.

1. The animal at rest, sketched by Mr. K.Y. ARAKAWA, on Dec. 30, 1962.
2. The same specimen, in preserved state.  $\times \frac{3}{4}$



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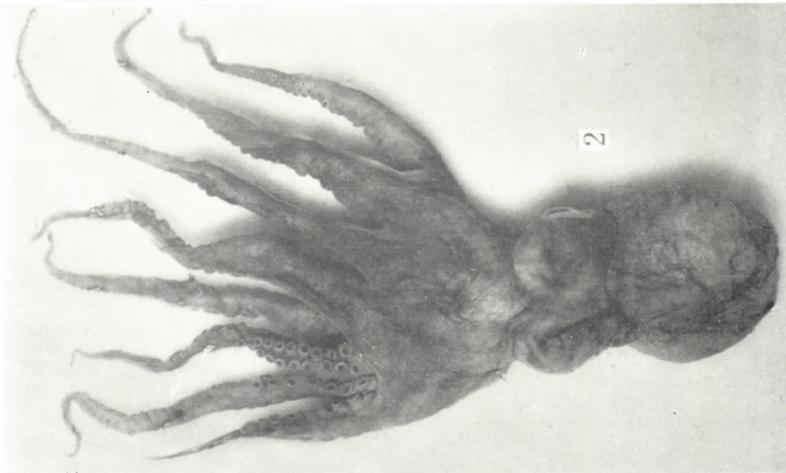
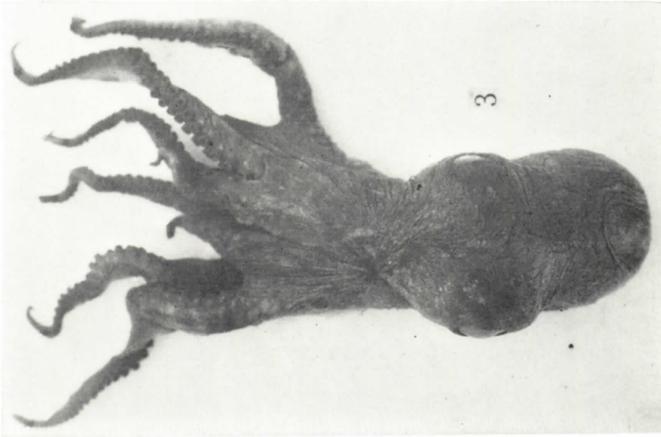
Plate 6

1-2. *Paroctopus megalops* TAKI, n. sp.

1. Paratype no. 1, total length 380 mm, ♀, from Tosa Bay. ×0.36

2. Paratype no. 11, total length 160 mm, from Enshū Nada. ×0.79

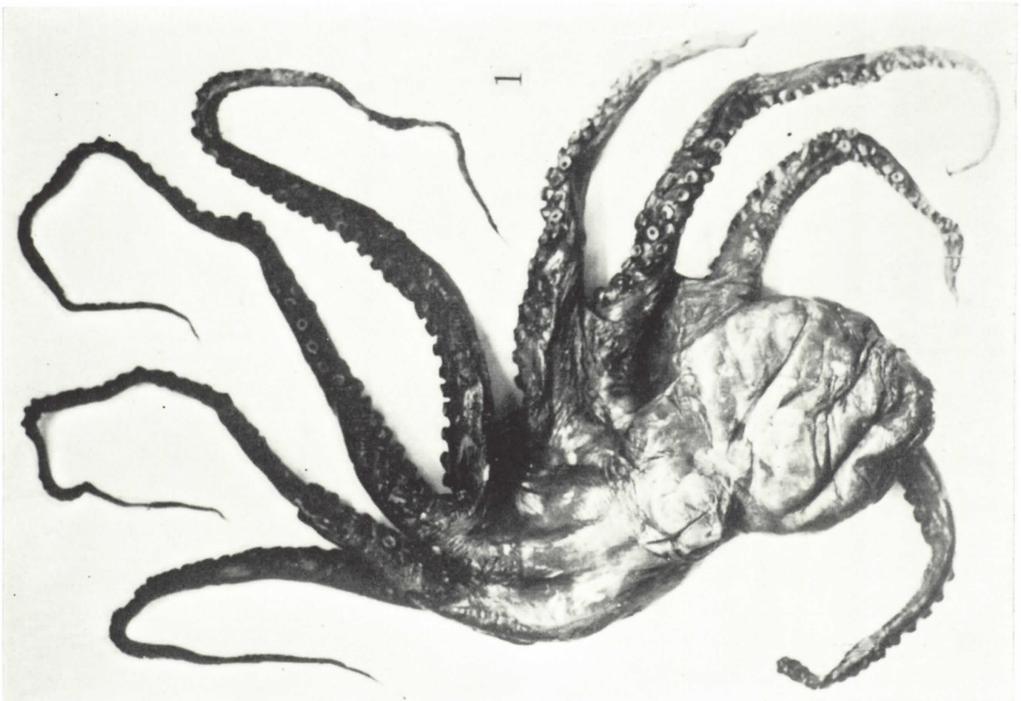
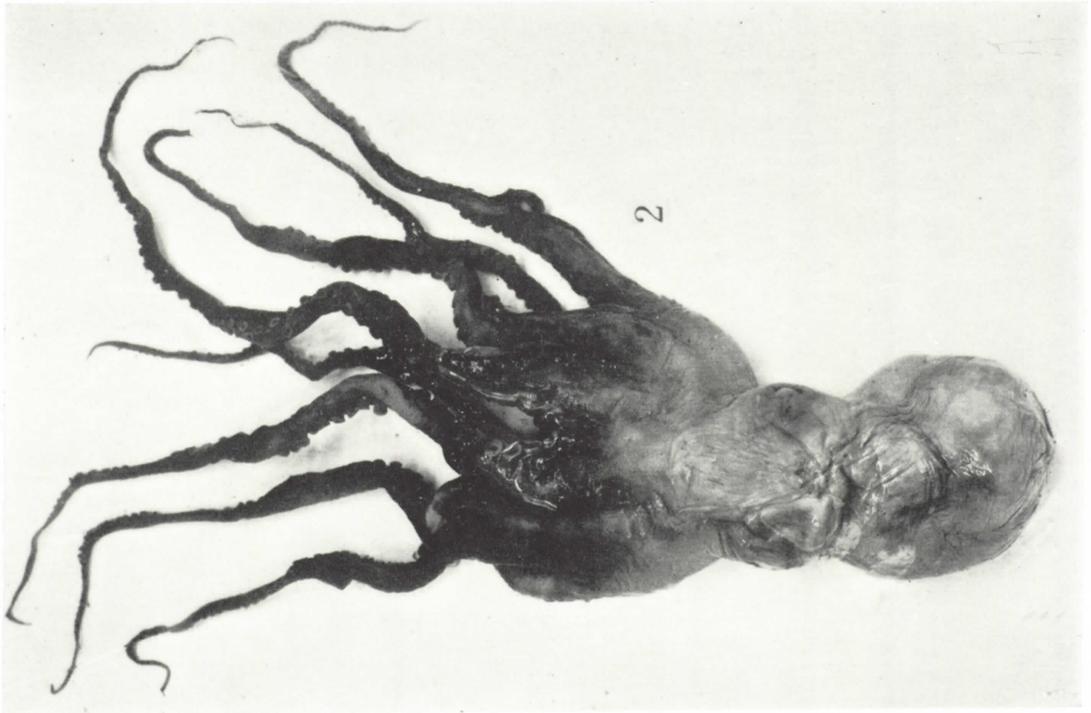
3. *Sasakinella eurycephala* TAKI, n. gen. et sp. Type, ×0.9



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Plate 7

1. *Benthoctopus fuscus* ТАКИ, n. sp.  
Type, ♂,  $\times \frac{1}{3}$
2. *Benthoctopus violescens* ТАКИ, n. sp.  
Type, ♀,  $\times \frac{1}{2}$



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