FOUR NEW SPECIES OF SQUID (OEGOPSIDA: *ENOPLOTEUTHIS*) FROM THE CENTRAL PACIFIC AND A DESCRIPTION OF ADULT *ENOPLOTEUTHIS RETICULATA*

LOURDES ALVINA BURGESS[1]

ABSTRACT

Four new species of *Enoploteuthis* (*E. obliqua*, *E. octolineata*, *E. jonesi*, and *E. higginsi*) are described, illustrated, and compared. Adults of *E. reticulata* Rancurel 1970 are described for the first time. A key for all the species is provided.

Cephalopods are important fisheries resources in the Pacific Ocean. Thus, clarification of cephalopod systematics, particularly from areas where they are not thoroughly known such as the central Pacific, is important. Because enoploteuthid squids are deepwater animals that are not easily accessible or profitable to fish, they are not at present generally exploited commercially. In Toyama Bay, Sea of Japan, however, the enoploteuthid squid *Watasenia scintillans* (Berry 1911) is fished regularly in the spring and early summer when swarms of this species migrate to the surface to spawn (Sasaki 1914).

Cephalopods also play important roles in marine food webs. They are the principal food of many marine mammals, fishes, and some birds. Reintjes and King (1953) found that 26% of the aggregate total volume of the stomach contents of yellowfin tuna, *Thunnus albacares*, captured in the central Pacific consisted of cephalopods. King and Ikehara (1956) showed that as much as 33% of the food of the bigeye tuna, *T. obesus*, were squids, including *Enoploteuthis* sp.

Berry (1914) reported on the cephalopods collected on board the U.S. Fish Commission steamer *Albatross* from the Hawaiian area; the collection included enoploteuthid squids but none of them of the genus *Enoploteuthis*. Species of *Enoploteuthis* from Hawaiian waters and the central Pacific are described here for the first time and compared with all the known species of *Enoploteuthis* in the world.

Four new species of pelagic squids belonging to the genus *Enoploteuthis*, together with some adults of *E. reticulata*, were identified during the examination of the large collection of cephalopods at the Honolulu Laboratory, Southwest Fisheries Center of the National Marine Fisheries Service (NMFS), Honolulu, Hawaii (formerly Bureau of Commercial Fisheries Biological Laboratory, Honolulu).

The squids were taken from various areas of the central Pacific on several research vessels operated by the Honolulu Laboratory from 1953 to 1970. The fishing gear was either a modified Cobb trawl, a 10-ft Isaacs-Kidd trawl, or a Nanaimo trawl. The depth of fishing generally was between 50 and 100 m; most of the fishing was done at night.

Details on the capture of the cephalopods reported on here, including all holotypes and paratypes, are available from the original cruise reports and logs on file at the Honolulu Laboratory.

Type specimens are deposited in the cephalopod collections of the Division of Mollusks, U.S. National Museum of Natural History (USNM), Smithsonian Institution.

The terminology of the anatomical parts, measurements, and indices conform to those generally used for squids and in particular to those listed and defined by Roper (1966): ML = mantle length, CH = club hooks, CS = club suckers, MWI = mantle width index, HWI = head width index, FLI = fin length index, FWI = fin width index, ALI = arm length index, and TLI = tentacle length index. As in Roper (1966) the arm length is measured from the first basal hook (or sucker) to the tip of the arm.

The ranges and means of indices given in the descriptions were computed from measurements of the male and female specimens listed in Tables 1 to 5. This is not applicable to indices in-

[1]Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, Honolulu, Hawaii; present address: T. F. H. Publications, Inc., 211 West Sylvania Avenue, Neptune, NJ 07753.

Manuscript accepted April 1982.
FISHERY BULLETIN: VOL. 80, NO. 4, 1982.

cluded in the remarks on immature individuals; not all their measurements are presented in the tables.

The following abbreviations which appear in the list of material refer to the research vessels: HMS = *Hugh M. Smith*, CHG = *Charles H. Gilbert*, and TC = *Townsend Cromwell*. A + sign after numbers in the text and tables indicates a missing mantle or arm tip, or lost suckers.

FAMILY ENOPLOTEUTHIDAE PFEFFER 1900

Genus *Enoploteuthis* Orbigny 1848

Diagnosis: Enoploteuthids with numerous light organs on mantle, head, and arms; single row of small light organs on ventral surface of eyeball; two rows of hooks on tentacular club; buccal connectives DDVD[2]; fins lateral; and mantle projecting posteriorly as free "tail."

Type species: *Loligo leptura* Leach 1817; Hoyle 1910:409, by elimination.

Enoploteuthis obliqua n. sp.
(Figs. 1, 2A; Table 1)

Enoploteuthis sp. (No. 2), Okutani 1974: figures 12c, d, f.

Holotype: Male, ML 55 mm, TC-48, Stn. 11, 11°47'N, 144°47'W, 31 March-1 April 1970, 50 m, USNM 729722.

Paratypes: 1 female, ML 50 mm, TC-46, Stn. 9, 11°49'N, 144°51'W, 14 October 1969, 50 m, USNM 577605. 1 male, ML 41 mm, TC-46, Stn. 9, 11°49'N, 144°51'W, 14 October 1969, 50 m, USNM 729713. 1 male, ML 58 mm, TC-48, Stn. 19, 11°34'N, 144°54'W, 3-4 April 1970, 50 m, USNM 729688.

Other material: 5 specimens, ML 12-17 mm, TC-43, Stn. 10, 12°03'N, 144°55'W, 8 May 1969, 50 m. 16 specimens, ML 5-18 mm, TC-43, Stn. 14, 11°56'N, 144°56'W, 10 May 1969, 50 m. 5 specimens, ML 12-17 mm, TC-43, Stn. 22, 07°41'N, 145°01'W, 13 May 1969, 50 m. 1 female (from *Alepisaurus* stomach contents), ML 50 mm, TC-44, equatorial central Pacific, July-August 1969, 10-100 m, USNM 729716. 2 specimens, ML 5 and 10 mm, TC-44, Stn. 16, 11°51'N, 144°41'W, 11 July 1969, surface. 1 specimen (from *Alepisaurus* stomach contents), ML 27 mm, TC-44, Stn. 17, 11°N, 144°W, 10 July 1969. 2 specimens, ML 12 and 17 mm, TC-44, Stn. 18, 11°53.2'N, 144°49.3'W, 11 July 1969, 100 m. 1 male, ML 37+ mm, 4 specimens, ML 12-20 mm, TC-44, Stn. 24, 07°32.9'N, 145°58'W, 13 July 1969, 50 m. 1 specimen, ML 13 mm, TC-44, Stn. 32, 07°31.5'N, 144°50.2'W, 17 July 1969, 50 m. 1 specimen, ML 12 mm, TC-44, Stn. 54, 00°01.8'N, 145°08.8'W, 28 July 1969, 50 m. 4 specimens, ML 6-11 mm, TC-47, Stn. 16, 12°02'N, 144°54'W, 23 January 1970, 50 m. 3 specimens, ML 7-10 mm, TC-48, Stn. 16, 11°45'N, 144°46'W, 2-3 April 1970, 20 m. 1 female, ML 40+ mm, TC-48, Stn. 19, 11°34'N, 144°54'W, 3-4 April 1970, 50 m.

Description: The mantle is muscular except for the thin-walled posterior end (tail) consisting of a gelatinous alveolar material. The mantle is widest (MWI 29.1-*32.4*-34.1) at the anterior edge and tapers into a blunt end. The anterior ventral margin is slightly excavated forming low, pointed lateral angles on each side. The dorsal margin is extended anteriorly into a median rounded lobe.

The fins are wider (FWI 62.1-*69.5*-73.2) than their lengths (FLI 52.0-*59.0*-64.0). They are attached anteriorly at about the midpoint of the mantle length. The anterior margin of each fin forms a rounded lobe. The lateral angles (72°) of the fins are rounded. The posterior margins are straight and are fused to the mantle separately, except for a point (difficult to see) near the tip of the mantle where they join.

The funnel is large, triangular, and has a broad base. The funnel-mantle locking cartilage is straight, the ends are rounded but the anterior end is slightly narrower; the median groove is shallow. The funnel organ of the holotype is large (9 mm long). The dorsal pad has an inverted V-shape with a slender papilla anteriorly and with prominent ridges on the limbs; each limb is about 2.5 mm wide. The ventral pads are oval and elongated (7 mm long, 3 mm wide).

The head is nearly square in cross section and narrower than the mantle (HWI 21.8-*26.0*-29.3). The funnel groove has a distinct edge on each side. The edges continue posteriorly to form the first pair of nuchal folds which bears the small olfactory papillae. The second and third nuchal folds are crescentlike membranes on each side

[2]D = dorsal; V = ventral.

TABLE 1.—Measurements (in millimeters) and counts of *Enoploteuthis obliqua*. TC = RV *Townsend Cromwell*; + = a missing mantle or arm tip, or lost suckers.

Cruise:	TC-48	TC-48	TC-46	TC-44	TC-46	TC-44	TC-44	TC-44
Station:	19	11 (Holotype)	9		9	24	24	18
Sex:	Male	Male	Female	Female[1]	Male	Male	?	?
Mantle length	58	55	50	50	41	37+	20	17
Mantle width	19	16	17	16	14	13	9	9
Head width	17	12	14	12	11	8	5.5	7
Fin length	34	32	31	32	21	17	7	8
Fin width	36	38	36	35	30	22	10	12
Arm length								
Right I	29	25+	25	26	20	17+	9	10
Right II	31+	24	26	27	21	17+	12	11
Right III	28+	26	24	30	20	21+	11	9+
Right IV	31	27+	25	31	20	20+	10	9+
Left IV	32	27	25	31	22	22	10	—
Arm hooks/suckers								
Right I	18/24	20/24	23/26	20/22	20/23	10/18	16/—	18/12
Right II	22/20	21/25	24/24	22/20	20/18	20/—	17/—	18/13
Right III	23/—	22/24	24/20	22/16	21/20	20/—	15/—	17/—
Right IV	28/16	30/21	32/15	31/15	30/14	28/—	18/—	26/—
Left IV	28/16	31/16	31/12	31/19	30/18	29/14	17/—	28/—
Tentacles right/left								
Tentacle length	—	47/53	32/—	45/41	29/30	31/—	12/—	14/—
Club length	—	9+/10	8.5/—	13/13	7/—	7/—	3.5/—	3.5/—
Club hooks								
Right (dorsal/ventral)-left (dorsal/ventral)	—	4/4-4/5	4/5-—	4/5-4/5	3/5-4/4	—	—	1/—
Club suckers right/left								
Distal suckers	—	—/13	17/—	14/14	11/—	11/—	—	—
Carpal suckers	—	5/3	5/—	5/5	5/5	4/4	3/4	5/—

[1]From stomach of *Alepisaurus*.

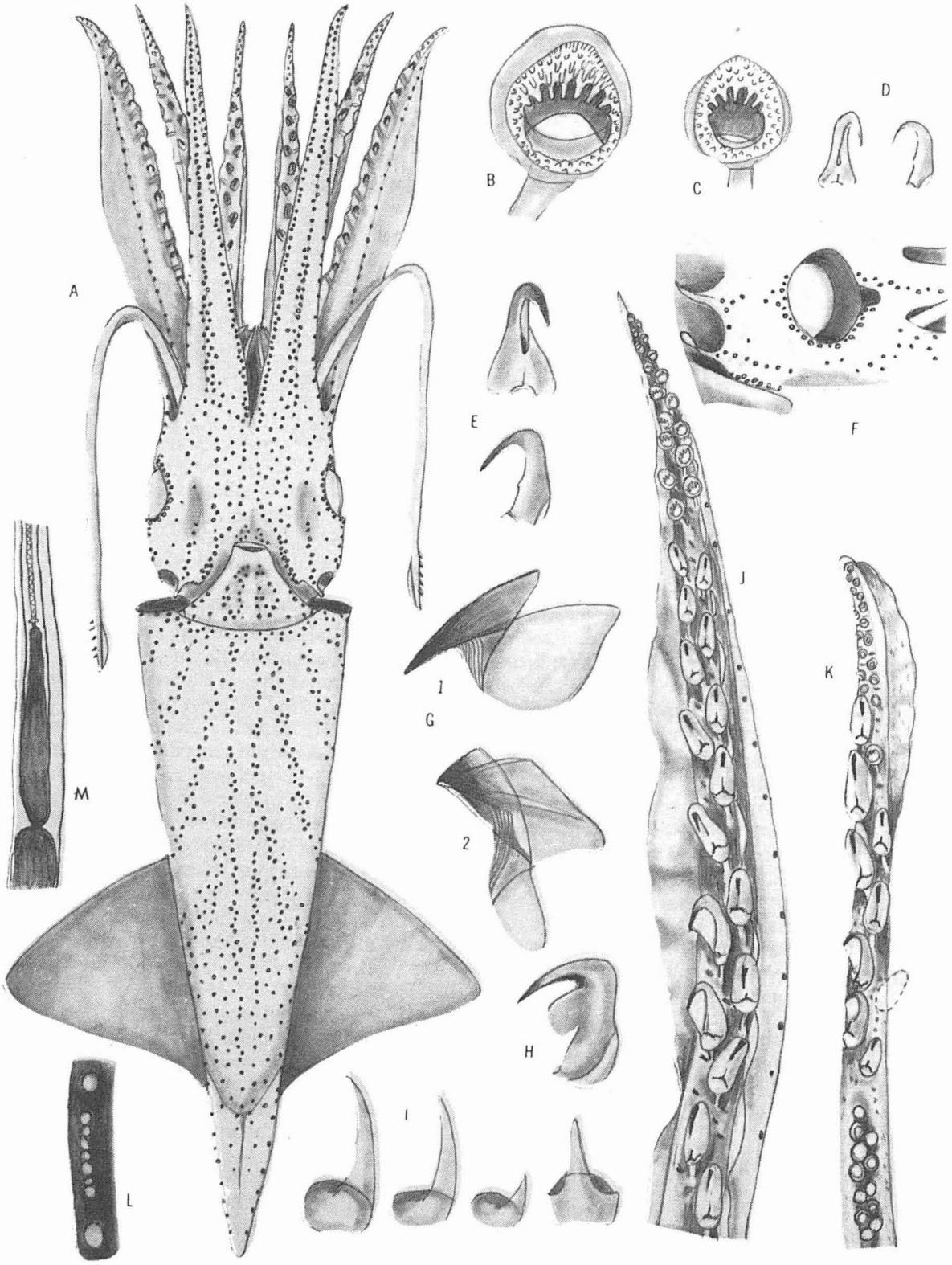
of the neck that are connected to each other posteriorly by a narrow membranous ridge. The third dorsal fold extends dorsally as a membranous ridge, but the ridge does not reach the midline of the head. Dorsal and ventral ocular "windows" are present and the latter easily allows a count of the nine eye photophores on the ventral side of the eyeball. The eye opening is a large, wide, transverse oval with a deep sinus (Fig. 1 F).

The buccal membrane completely hides the buccal mass and surrounding lips. Eight slender supports are joined by slender connectives to the arms in the order DDVD (i.e., all are attached to the dorsal side of the arms except the third pair which are attached to the ventral side of arm III). The inner surface of the buccal membrane is rugose, but without papillae; the lappets are delicate and pointed. The membrane is purple and does not appear much darker than most parts of the body. The chromatophores are small and are scattered evenly on both the supports and the membrane.

The arms are subequal, slender, and much shorter than the mantle length (ALI: I, 48.8-*50.2*-52.0; II, 43.6-*50.2*-54.0; III, 47.3-*51.0*-60.0; IV, 48.8-*53.2*-62.0). They taper gradually to slender tips. The swimming keels are low and poorly developed on the dorsal arms, and they are mainly confined to the distal third of these arms. The swimming keel of arm III is wider than the arm at its greatest width. The lateral membrane or tentacular sheath along arm IV is narrow; it is about half of the arm width proximally and it extends to the tip of the arm. Protective membranes are developed on the ventral side of all arms, but decrease in size in the following order: III, II, I, IV. The dorsal protective membranes on all the arms are low; on arm IV the trabeculae are not evident.

The right ventral arm of the male is hectocotylized. The protective membrane on the medial side of this arm (Fig. 1J) is expanded into an undulating membrane that extends from the eighth pair of hooks to the tip of the arm. The dorsal protective membrane is slightly developed. In the males small tubercles or conical papillae are present between the bases of the hooks and bases of all arms.

All the arms bear two rows of alternating strong hooks, each (Fig. 1E) completely enclosed in a membranous sheath. The distalmost hook is about half the length of the largest one. In both sexes, arm IV has the most hooks. The distal part of each arm is occupied by two rows of suckers with wide apertures and slender stalks. The inner sucker ring bears seven or eight prominent truncated teeth on the distal margin but the proximal margin is smooth (Fig. 1B). The outer ring has numerous pegs (Nixon and Dilly 1977).


A
B
C
D
E
F
G
1
2
H
I
J
K
L
M

The suckers decrease in diameter distally, become globular in shape, and have only three or four blunt teeth.

The tentacles are shorter than the mantle (TLI 62.1-*79.2*-96.4), very delicate and slender. The stalk is laterally compressed, about a third of the width of arm III. The club is not expanded (Fig. 1K). The carpus bears a series of four or five suckers and four, five, or seven pads, and the whole cluster is bordered by a very low ridge on each side. The manus includes a dorsal row of three or four sheathed hooks and a ventral row of four or five slightly larger similarly sheathed hooks (Fig. 1D). These two rows are very close to each other. Marginal suckers are absent. A medial sucker or two may be present in series with the hooks distally. The largest club hook is smaller than any of the arm hooks. The dactylus of the club is occupied by 11 to 17 suckers that are also arranged in two rows. They have long stalks and wide openings. The distal margin of the inner sucker ring bears six or seven slender blunt teeth and the outer sucker ring has numerous pegs (Fig. 1C). Protective membranes are absent. The aboral keel or dorsal membrane is narrow and, at most, about half the length of the club. The tip of the club is rounded and bears a short hoodlike membrane that conceals one or two of the suckers there.

There are two types of light organs on the integument: Large dark ones with pearly white centers and small white ones with very narrow outer pigmented rings. These photophores range in size from small (0.2 mm) to large (0.4 mm), and they are randomly interspersed with each other. The most distinctive feature of this species is the unique arrangement of the mantle photophores. Some of the rows are slanting or oblique (Fig. 1A), instead of the usual straight longitudinal rows described in most other *Enoploteuthis* species. Two median longitudinal rows (two to three photophores in width), separated by an intervening space lacking photophores, extend from the anterior edge of the mantle to the posterior tail. Photophores on the posterior part of the mantle are scattered, those on the anterolateral part are arranged in four oblique rows on each side of the median longitudinal rows. Except for the most posterior row, the oblique rows radiate from the anterior edge of the mantle. The edge of the mantle is lined by a transverse row in which the photophores are closer to each other ventrally than dorsally. A few isolated photophores are present on the dorsal surface of the mantle, none are present on the surface of the fins. The tail has a single row on each side; a few photophores occur on the ventral side, but none are present on the dorsal side.

Six groups of photophores occur on the funnel: Two broad rows separated by a narrow midline space on the ventral side; a short row of six or seven light organs on each lateral margin (one or two photophores are present in the space between these rows posteriorly); and a group of photophores on each side of the bridles on the dorsal side of the funnel.

There are two patches of light organs, separated by a narrow space, in the apical region of the funnel groove. Six rows are recognizable on the ventral surface of the head, three rows on each side of a narrow midline space devoid of photophores. A row (two or three closely set photophores in width) along the lateral edge of the funnel groove extends anteriorly with increased numbers of photophores medial to each eye. It then bifurcates into two branches: one branch extends along the ventral aboral border of arm IV to a point opposite the last arm hook, the other branch continues distally along the base of the tentacular sheath to the tip of arm IV. The next lateral row of the head photophores extends from near the first nuchal fold anteriorly, although a short gap occurs opposite the lens of the eye at the ventral window, along the head and onto the edge of the tentacular sheath where it continues to near the tip of arm IV. The lateralmost row of the head extends from between the second nuchal fold to the posterior margin of the eye; it continues as a single row of closely set photophores along the edge of the eyelid ventrally to the ventral edge of the optic sinus (Fig. 1F). The dorsal edge of the eyelid is devoid of light organs. From the dorsal edge of the optic sinus the row proceeds along the base of the swimming keel of arm II almost to the tip of the arm. Some small white photophores occur near

FIGURE 1.—*Enoploteuthis obliqua* (A-F, K, and L from female paratype, ML (mantle length) 50 mm; other body parts are from specimens as listed.) A, Ventral aspect; B, Dorsal arm sucker; C, Tentacular sucker; D, Tentacular hook, oral and lateral aspects; E, Dorsal arm hook, oral and lateral aspects; F, Eye and surrounding area; G, Mandibles: upper (1), lower (2), male, ML 37 mm; H, Dorsal arm sucker, ex-*Alepisaurus* female, ML 50 mm; I, Radular teeth, male, ML 37 mm; J, Hectocotylus, male, ML 41 mm; K, Tentacular club; L, Eye light organs; M, Section of spermatophore, male holotype, ML 55 mm.

the eye region between the median and lateralmost rows.

Nine light organs occur in a single row on the ventral side of the eyeball (Fig. 1L). The terminal photophores are larger and are separated by a wide space from a row of seven much smaller ones that lie adjacent to one another.

The teeth of the radula are long and slender (Fig. 1I); the rachidian has distinct cusps on each side. The first lateral teeth are the shortest.

The mandibles of a young male (ML 40 mm) have distinct growth lines on the wings. The rostrum is heavily pigmented; the edges are sharp and the tip of the upper mandible is very pointed (Fig. $1G_1$). The gular plate of the lower mandible is strengthened by three stout ribs (Fig. $1G_2$).

The gladius has a strong rachis which is rounded anteriorly and thickened medially. The thin vanes are widest at about the midpoint of the total length. The rounded posterior cone is shallow and thin.

A single spermatophore was found in the spermatophoric sac of the holotype (ML 55 mm), and its measurements are given below:

Spermatophore segment	*Length (mm)*
Entire spermatophore	11.5
Spiral filament	4.5
Cement body	1.5
Sperm reservoir	5.5

The spiral filament is slightly sculptured at the aboral end by some irregular ridges. The cement body has a small collar at the oral end (Fig. 1M). A few spiral turns are visible behind the spermatophore cap.

Young individuals: Small specimens (ML 6.0-20.0 mm) are easily separated from other species of *Enoploteuthis* by the unique oblique rows of photophores on the mantle. Early development of the oblique rows are shown in Figure 2Aa and b in specimens ML 7 and 9 mm, respectively. Arm hooks are formed early; six to nine hooks are already present in the arms at ML 6.0 mm. But tentacular hooks appear much later; a ML 17 mm specimen has one tentacular hook and another (ML 20 mm) has none at all. Only two rows of suckers are present on the club.

Remarks: A female specimen tentatively assigned to this species (from the stomach contents of an *Alepisaurus*) exhibits certain features not observed in other specimens of the same or nearly the same size. The arm and tentacular hooks have flattened processes (Fig. 1H). Furthermore, this specimen shows a slight variation in the arrangement of photophores: some photophores occur on the median space of the mantle.

The closest species to *E. obliqua* is *E. leptura* (Leach 1817) from the Atlantic. Both *obliqua* and *leptura* have slender tentacles and clubs. There are few suckers (<20) arranged in two rows on their clubs. However, *obliqua* has fewer tentacular hooks (at most 9) while *leptura* has more (6-12). The carpal cluster is elongate and without prominent ridges in both species. Their spermatophores show similar characteristics: very little sculpture in the spiral filament and one small collar on the cement body.

The specific name *obliqua* reflects the arrangement of the mantle photophores. The oblique arrangement of light organs on the mantle was described earlier by Okutani (1974). His three immature specimens (ML 23.8-25.8 mm) from the EASTROPAC collection and a fourth specimen from the invertebrate collection of the Scripps Institution of Oceanography are all referable to *E. obliqua*. His material was collected in the eastern Pacific.

Distribution: Equatorial regions of the central and eastern Pacific.

Enoploteuthis octolineata n. sp.
(Figs. 3, 2C; Table 2)

Holotype: Female, ML 71 mm, HMS-47, Stn. 58, 02°56'N, 150°03'W, 4 November 1958, 212 m, USNM 577607.

Paratypes: 1 female, ML 75 mm, TC-43, Stn. 52, 00°01'N, 145°03'W, 28 May 1969, 50 m, USNM 729721. 1 female, ML 56 mm, TC-46, Stn. 37, 03°23'N, 145°04'W, 26 October 1969, 50 m, USNM 729720. 1 male, ML 46 mm, TC-48, Stn. 50, 03°29'N, 144°58'W, 17-18 April 1970, 50 m, USNM 729708.

Other material: 1 specimen, ML 10 mm, HMS-47, Stn. 51, 00°44'S, 149°46'W, 2 November 1958, 576 m. 1 specimen, ML 25 mm, HMS-47, Stn. 58, 02°56'N, 150°03'W, 4 November 1958, 212 m. 1 specimen, ML 15 mm, CHG-89, Stn. 5, 02°40'N, 157°31'W, 28 July 1966, 120-240 m. 1 specimen, ML 15 mm, TC-43, Stn. 12, 12°11'N,

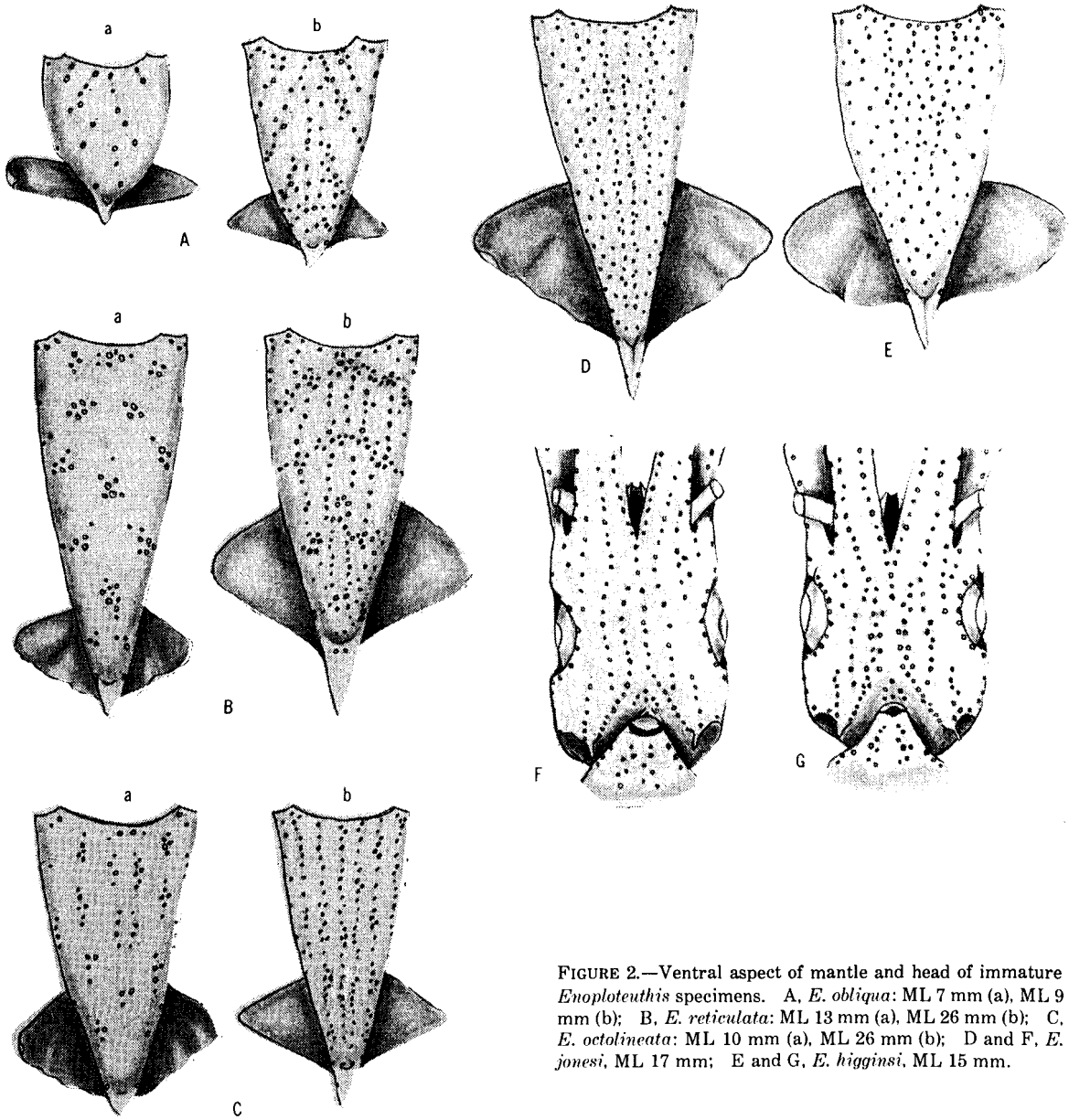


FIGURE 2.—Ventral aspect of mantle and head of immature *Enoploteuthis* specimens. A, *E. obliqua*: ML 7 mm (a), ML 9 mm (b); B, *E. reticulata*: ML 13 mm (a), ML 26 mm (b); C, *E. octolineata*: ML 10 mm (a), ML 26 mm (b); D and F, *E. jonesi*, ML 17 mm; E and G, *E. higginsi*, ML 15 mm.

145°11′W, 9 May 1969, 20 m. 1 specimen, ML 20 mm, TC-43, Stn. 26, 07°33′N, 144°50′W, 15 May 1969, 50 m. 3 specimens, ML 19-30 mm, TC-43, Stn. 38, 03°30′N, 145°06′W, 20 May 1969, 50 m. 2 specimens, ML 21 and 40 mm, TC-43, Stn. 42, 03°32′N, 144°59′W, 22 May 1969, 50 m. 1 specimen, ML 24 mm, TC-43, Stn. 48, 00°04′N, 145°07′W, 26 May 1969, 50 m. 2 specimens, ML 20 and 22 mm, TC-43, Stn. 52, 00°01′N, 145°03′W, 28 May 1969, 50 m. 1 specimen, ML 26 mm, TC-44, Stn. 26, 07°14.8′N, 144°58.8′W, 14 July 1969, 20 m. 1 specimen (from *Alepisaurus* stomach contents), ML 28 mm, TC-44, Stn. 44, 03°49.9′N, 145°18′W, 22 July 1969, 50 m. 1 specimen, ML 20 mm, TC-44, Stn. 56, 00°15.2′N, 144°43.9′W, 29 July 1969, 50 m. 1 specimen, ML 25 mm, TC-44, Stn. 68, 03°39′S, 144°54.5′W, 3 August 1969, 75 m. 1 specimen, ML 36 mm, TC-46, Stn. 41, 03°19′N, 145°03′W, 28 October 1969, 50 m. 2 specimens, ML 14 mm, TC-46,

TABLE 2.—Measurements (in millimeters) and counts of *Enoploteuthis octolineata*. HMS = RV *Hugh M. Smith*; TC = RV *Townsend Cromwell*; + = missing arm tips and lost suckers.

Cruise:	HMS-47	TC-43	TC-46	TC-48	TC-48	TC-44	HMS-47	TC-43
Station:	58	52	37	50	92	26	58	12
Sex:	(Holotype) Female	Female	Female	Male	?	?	?	?
Mantle length	71	75	56	46	33	26	25	15
Mantle width	26	27	21	18	13	11	13	6
Head width	24	21	16	14	10	10	12	5
Fin length	50	52	38	30	19	15	15	7
Fin width	54	56	42	32	23	20	20	8
Arm length								
Right I	43	49	28+	32	23	16	15	8
Right II	42	46	32	[1]32	24	16	18	8
Right III	42	50	31	38	25	18	17	7
Right IV	42	52	38	33	25	16	16	9
Left IV	45	54	35	31	25	18	16	—
Arm hooks/suckers								
Right I	21/36	23/26	20/23+	20/—	—	21/25	16/14	16/12
Right II	22/32	22/24	21/21	18/—	22/—	22/22	21/—	16/14
Right III	25/27	24/28	22/22	21/18	20/—	21/24	23/—	15/11
Right IV	29/25	34/38	32/25	29/23	28/10+	30/22	21/—	18/10
Left IV	30/30	32/34	31/26	29/20+	26/12	29/27	29/12	—
Tentacles right/left								
Tentacle length	75/80	70/70	53/—	43/44	39/37	15/16	25/—	13/—
Club length	19/18	—	14/15	12/13	10/9	5/5	5/—	4/—
Club hooks (Right (dorsal/ventral)-left (dorsal/ventral)	4/5-4/6	—-6/5	4/6-4/6	5/5-4/6	4/5-—	4/5-4/6	5/5-—	—
Club suckers right/left								
Distal suckers	16/17	—	14/14	14/16	10/—	—/19	—	—
Carpal suckers	3/5	6/4	6/5	5/6	4/—	6/4	3/—	—

[1]Length of left arm.

Stn. 45, 03°29'N, 144°54'W, 30 October 1969, 50 m. 1 female, ML 56 mm, TC-46, Stn. 47, 03°23'N, 145°04'W, 31 October 1969, 115 m. 2 specimens, ML 16 and 20 mm, TC-47, Stn. 45, 03°28'N, 144°59'W, 3-4 February 1970, 50 m. 1 specimen, ML 39 mm, TC-48, Stn. 35, 07°18'N, 144°47'W, 11-12 April 1970, 50 m. 1 female, ML 49 mm, TC-48, Stn. 50, 03°29'N, 144°58'W, 17-18 April 1970, 50 m. 1 specimen, ML 33 mm, TC-48, Stn. 92, 00°08'N, 145°00'W, 28 April 1970, 50 m.

Description: The mantle (MWI 36.0-*37.3*-39.1) is cylindrical and tapers gradually toward the end of the blunt tail. Ventrally the anterior edge of the mantle is only slightly excavated and the lateral angles are pointed and low. The anterior dorsal lobe is rounded and also low.

The fin lengths are more than half of the mantle length (FLI 65.2-*68.0*-70.4) and the combined width of both fins is less than the mantle length (FWI 69.6-*73.9*-76.1). The anterior margins project into rounded lobes near their anterior attachments. The lateral angle (about 70°) is rounded and the posterior margin is slightly convex.

The funnel is large; its length equals its width. The funnel-mantle locking cartilage is simple; its anterior end is slightly narrower and more pointed than the rounder posterior end. The funnel valve is a wide semilunar flap; its anterior edge reaches the edge of the funnel opening.

The head (HWI 28.0-*30.2*-33.8) is narrower than the mantle, almost square in cross section, slightly rounded on the top, and is deeply excavated on its posteroventral surface to form a large funnel groove. The dorsal and ventral ocular "windows" are distinct. The eye opening has a deep sinus (Fig. 3G). Three nuchal folds lie on each side of the head; the closest fold to the funnel bears at its posterior end the tonguelike olfactory papilla. These nuchal folds are united to each other by a narrow posterior membrane, although this membrane does not reach the dorsal midline.

The buccal membrane is purple and the eight supports are joined by connectives to the arms in the order DDVD. The membrane is pigmented more heavily than the supports. The lappets are delicately pointed, and the inner surface of the buccal funnel is very rugose but lacks papillae.

The arms are subequal and shorter than the mantle (ALI: I, 60.6-*65.2*-69.7; II, 57.1-*61.8*-69.6; III, 55.4-*66.0*-82.6; IV, 59.2-*66.7*-72.0). They are nearly square at their bases and taper into fine points. Arms I and II have very low keels; arm I is keeled to about half its length and arm II to

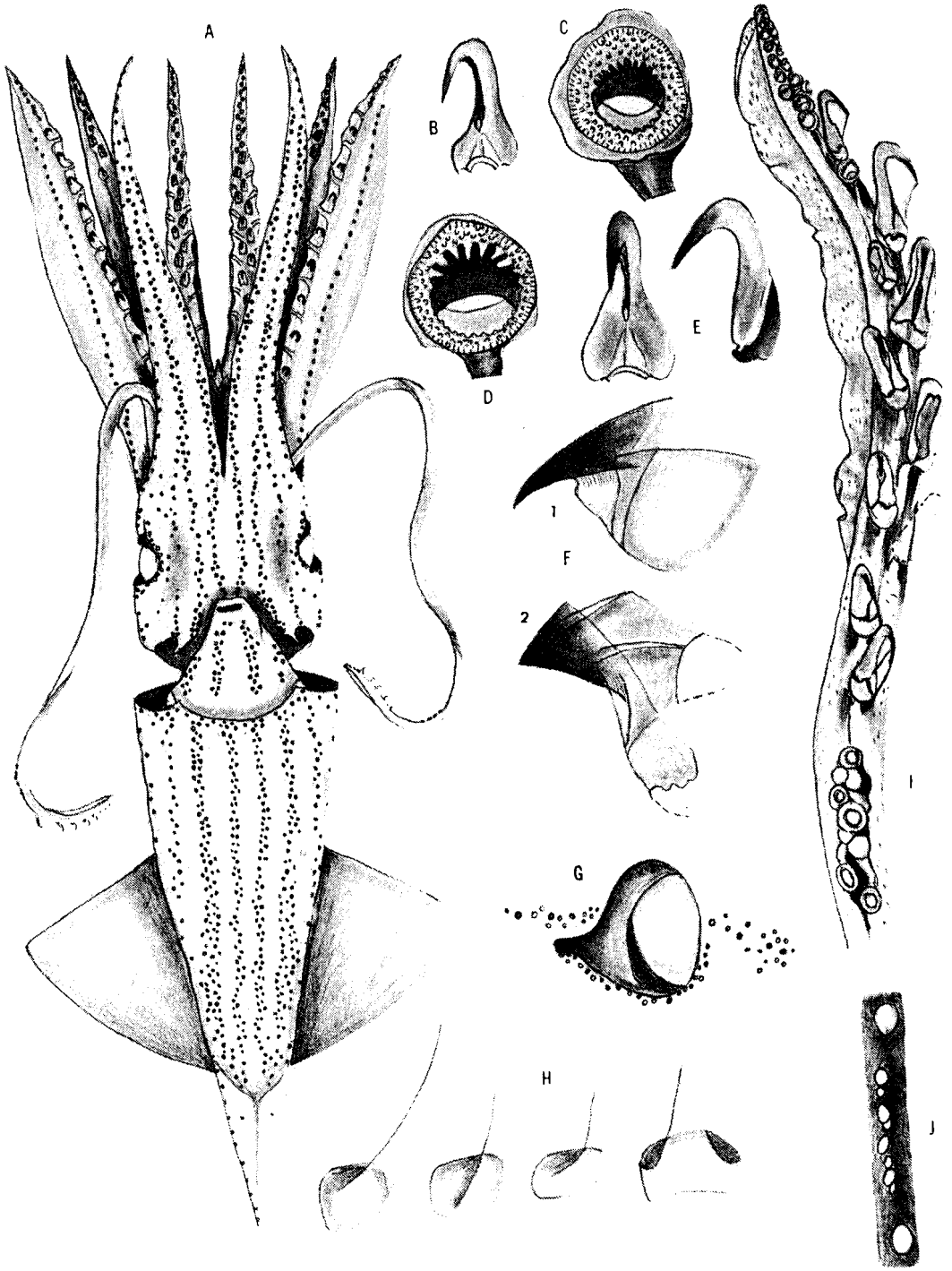


FIGURE 3.—*Enoploteuthis octolineata.* (A-E, G, I, and J from female paratype, ML (mantle length) 75 mm; other body parts are from specimens as listed.) A, Ventral aspect; B, Tentacular hook; C, Tentacular sucker; D, Dorsal arm sucker; E, Dorsal arm hook, oral and lateral aspects; F, Mandibles: upper (1), lower (2), male, ML 25 mm; G, Eye and surrounding area; H, Radular teeth, ML 25 mm; I, Tentacular club; J, Eye light organs.

about one-third. The swimming keel of arm III is about as wide as the arm. The tentacular sheath is narrow, about half the width of arm IV near the base. The dorsal and ventral protective membranes are developed on all the arms and extend to the arm tips. The ventral membranes are wider on arm III, although they do not reach the top of the hooks. The protective membranes of arm IV are very narrow, except those on the hectocotylus of the male.

The ventral protective membrane of right arm IV (hectocotylus) of the immature male paratype (ML 46 mm) is slightly enlarged into a narrow undulating membrane, about 1 mm wide, opposite the eighth and ninth pairs of hooks. The dorsal protective membrane is very narrow.

The arm hooks (Fig. 3E) are biserial and are completely covered by sheaths. Arm IV is slightly longer than the other arms, and has the greatest number of hooks. The suckers on the distal part of the arms can be separated into two types. The distalmost suckers are markedly reduced in size, are globular in shape with small apertures, and lack teeth. The proximal suckers have long stalks and wide openings. The inner rings of these suckers have eight to nine large pointed teeth distally, very irregular, smaller teeth proximally, and a wide shelf at the bottom half. The outer ring bears numerous pegs (Fig. 3D).

The tentacles are weakly developed, about as long as the mantle (TLI 93.3-*98.4*-112.7) and very narrow (only about one-third of the width of arm III). The cross section is almost triangular. The club is also narrow (Fig. 3I). The aboral keel extends from opposite the second hook to the tip of the club. Protective membranes are absent, but a short hoodlike membrane is present at the blunt tip. The carpal cluster is composed of a series of three to six smooth-ringed suckers and three to five rounded pads which are biserially arranged in an elongate patch. One of the paratypes (ML 75 mm) has two additional suckers on the stalk located a short distance from the right carpal cluster (such suckers not present in other specimens); corresponding pads, if any, were not seen on the opposite tentacle due to damage. The manus has a total of 9 to 11 sheathed hooks and an occasional sucker in the distal part. These alternating dorsal and ventral hooks are only slightly separated medially. Hooks on the dorsal row are smaller. The hooks (Fig. 3B) resemble the arm hooks in structure, except for the relatively narrower bases of club hooks and their relatively smaller size. The few (16 or 17) distal suckers on the dactylus are also biserial. They have long stalks and wide openings; the inner rings have about 10 sharp teeth distally, a series of smaller denticulations proximally, and an inner shelf at the proximal bottom part (Fig. 3C). The outer ring bears pegs.

There are two types of skin photophores: Very dark ones with whitish centers and white ones with very thin outer black rings (in preservation). The smallest is about half the size of the largest, but intermediate sizes occur. Both types appear randomly interspersed. On the ventral side of the mantle there are eight distinct rows separated by spaces wider than the rows themselves. A continuous midline space is present from the anterior of the mantle to the tail (Fig. 3A). Four parallel rows of varying widths lie on either side of this space. The first and second lateral rows extend from the excavated part of the mantle to the tail. The third row extends from opposite the lateral angle of the mantle to the tip of the mantle, occurring along the lateral margins of the tail as a single row of evenly spaced photophores. The photophores of these rows tend to disperse at the posterior end, particularly the second row, and the rows become slightly intermingled, but each row remains recognizable. The fourth or lateralmost row is composed of widely spaced light organs forming a single line that becomes somewhat irregular opposite the region of the fins. Small photophores are dispersed on the dorsal side of the mantle, but there are none on the fins or on most of the tail except for the lateral row mentioned above and a few very small ones ventrally. A transverse row that has fewer and more widely separated photophores dorsally runs along the edge of the mantle.

Four narrow rows of photophores separated by wide spaces are present on the ventral half of the funnel. There are two additional rows on the dorsal side, one on each side of the bridles.

There are eight separate rows of photophores on the ventral half of the head, four rows on each side of a wide median space. The first row lateral to the midline space originates anterior to the bridle within the apex of the funnel groove and continues directly to the ventral aboral side of arm IV and ends just beyond the distalmost arm hook. The second lateral row begins at the posterior end of the funnel groove and runs along the edge of the groove, over the ventral part of the head, and proceeds anteriorly along the base of

the tentacular sheath to the tip of arm IV. The third row extends anteriorly from the base of the first nuchal fold but is interrupted by the window of the eye, and subsequently divides. One branch unites with the second row at a short distance from the base of the ventral arm. The other branch continues laterally along the edge of the tentacular sheath to the tip of arm IV. The fourth row begins opposite the second nuchal fold and proceeds to the posterior margin of the eye opening and runs along the edge of the eyelid ventrally to the optic sinus (Fig. 3G). The dorsal half of the eyelid has no light organs. From the upper edge of the optic sinus the fourth row continues along the base of the swimming keel of arm III to almost opposite the last arm hook. An additional short arc-shaped row of very small white photophores, set far apart, lies between the third and fourth rows on the posteroventral eye region. This short row is inconspicuous and can easily escape detection.

The light organs on the eyeball vary from 9 to 10. The large terminal photophores are separated by a space from a series of eight or seven adjacent round to oval smaller light organs (Fig. 3J) of varying dimensions.

The radula has seven long, slender, slightly curved teeth in each transverse row. The rachidian tooth has pointed cusps, one on each side. The lateralmost teeth are longest (Fig. 3H).

The mandibles are strong and heavily pigmented. The rostrum of the upper mandible is very pointed and the edges are sharp (Fig. $3F_1$). The lower mandible has three distinct ridges (Fig. $3F_2$). In a specimen ML 25 mm the wings of both halves are transparent.

The gladius is featherlike and the rachis is thickened into a rounded ridge dorsally. The vanes are fragile and narrow. The cone is thin and narrow, but rounded posteriorly. The thickened edge of the vanes described by Roper (1966, fig. 14) in *E. anapsis* is only slightly indicated here.

There are no spermatophores in the largest male paratype (ML 46 mm). The hectocotylus is not fully developed; the lappet is only 1 mm wide and there are no tubercles on the inner surface of the arms. Numerous sperm reservoirs are present in one of the females (ML 75 mm). These are about 6 mm long and are attached in two areas: on the inner wall of the mantle (opposite the midpart of each funnel retractor muscle) and in the concave inner wall of the retractor muscles themselves. The same female is gravid; the diameter of an egg taken from the ovary is slightly <1 mm.

Young individuals: Immature specimens (ML 10-30 mm) have six to eight rows of light organs on the mantle. These rows first appear as a series of elongate patches of large photophores separated by spaces which later develop smaller photophores (Figs. 2Ca, b). At ML 10 mm, all the arms have hooks. The club has two rows of suckers and no hooks. Five of the suckers are set apart proximally and presumably become carpal suckers. At ML 15 mm there are three hooks on the club; by ML 20 mm the club has eight hooks. The tentacles of these immature individuals are shorter than the mantle (TLI 50.0-*68.4*-86.7). The light organs of the eye do not develop simultaneously: some of the smaller individuals have only seven or eight (the two terminal photophores and five or six inner ones).

Remarks: The most distinctive feature of this species is the eight well-defined rows of photophores, separated by wide spaces, on the mantle. In some respects this species resembles *E. leptura* in the shape of the fins and the structure of the clubs and tentacles. However, the latter species has only seven rows of photophores on the mantle, one of which arises from either of the most median pair of rows and does not reach the mantle. This feature is also found in juveniles. The arrangement of the photophores on the head also differs. The third lateral row is unbranched in *E. leptura*.

Distribution: Central Pacific, equatorial waters. Based on sampling for the present collection, *E. octolineata* does not seem to occur in the Hawaiian area.

Enoploteuthis jonesi n. sp.
(Figs. 4, 2D, F; Table 3)

Holotype: Male, ML 47 mm, TC-7, Stn. 12, off Milolii, Hawaii, 16 August 1964, 9-13 m, USNM 729717.

Paratypes: 1 male, ML 35 mm, CHG-89, Stn. 24, 14°55.1'S, 164°02'W, 10 February 1966, 90-130 m, USNM 729699. 1 female, ML 82 mm, TC-7, Stn. 12, off Milolii, Hawaii, 16 August 1964, 9-13 m, USNM 577608. 1 female, ML 40 mm, TC-32, Stn. 28, 20°58.6'N, 158°33.7'W, 25 July 1967, 92-122 m, USNM 729707.

Other material: 1 male, ML 27 mm, CHG-89, Stn. 14, 06°06.9'S, 157°44.2'W, 3 February 1966, 70-80 m. 1 specimen, ML 22 mm, CHG-89, Stn. 29, 04°05'S, 167°51'W, 14 February 1966, 120-135 m. 1 specimen, ML 17 mm, CHG-89, Stn. 31, 01°01'S, 168°06'W, 15 February 1966, 90-150 m. 1 specimen, ML 11 mm, TC-32, Stn. 37, 20°59.1'N, 158°12.7'W, 15 August 1967, 55-123 m. 1 female, ML 30 mm, TC-32, Stn. 39, 20°59.6'N, 158°29.3'W, 15 August 1967, 63-101 m. 1 female, ML 35 mm, TC-32, Stn. 46, 20°57.6'N, 158°28.7'W, 18 August 1967, 77-118 m.

Description: The mantle is long, cylindrical, and narrow (MWI 24.4-*34.3*-40.7). The width at the edge is only slightly greater than that at the middle and the sides taper into a blunt tail. The mantle is muscular except for the tail which is thin-walled and translucent, yet very firm. The ventral anterior excavation of the mantle is shallow and the lateral angles and middorsal projection are low and blunt.

Each fin is triangular and their combined width is about three-fifths to four-fifths of the mantle length (FWI 65.9-*74.0*-80.0). The fins are shorter than their combined width (FLI 62.9-*67.5*-70.0). The anterior margin is rounded and the posterior margin is slightly concave. The lateral angles are sharp, about 75°.

The funnel is triangular with a broad base. The funnel-mantle locking cartilage is simple and typical of the genus. The groove is shallow and it spreads out toward the more rounded posterior end of the cartilage. The funnel organ is large; the dorsal pad has a papilla and well-developed ridges; the ventral pads are oval with pointed anterior ends. The semilunar funnel valve is wide and its anteriormost edge does not reach the edge of the funnel opening.

The head is nearly square in cross section, as long as it is wide, and nearly as broad as the mantle (HWI 25.6-*30.9*-37.5). Both dorsal and ventral ocular "windows" are distinct. The eye opening is a wide oval (triangular when constricted) and has a moderately deep sinus. The three crescentic nuchal folds are prominent. The olfactory papilla is tonguelike and arises from the nuchal fold nearest to the funnel. The funnel groove is moderately deep and the sides of this excavation are steep.

The buccal funnel has eight stout supports connected to the arms in the order DDVD. The lappets are pointed; the inner wall of the buccal membrane is very rugose and carries papillae. Both membrane and supports are covered with small fine chromatophores, but the membrane appears darker.

The arms are of moderate length (ALI: I, 40.0-*45.4*-50.0; II, 43.9-*48.8*-51.9; III, 47.6-*51.3*-59.2;

TABLE 3.—Measurements (in millimeters) and counts of *Enoploteuthis jonesi*. TC = RV *Townsend Cromwell*; CHG = RV *Charles H. Gilbert*; + = lost suckers.

Cruise:	TC-7	TC-7	TC-32	CHG-89	TC-32	CHG-89	CHG-89	CHG-89
Station:	12	12	28	24	39	14	29	31
Sex:	Female	(Holotype) Male	Female	Male	Female	Male	?	?
Mantle length	82	47	40	35	30	27	22	17
Mantle width	20	14	15	13	11	11	10	9
Head width	21	13	15	11	9	9	8	6.5
Fin length	56	32	28	23	21	17	14	10.5
Fin width	54	34	32	25	24	20	18	14
Arm length								
Right I	35	23	16	15	15	13	[1]9	8
Right II	36	24	19	17	15	14	11.5	9
Right III	39	23	20	17	16	16	12	10
Right IV	46	28	22	20	15	15	13	11
Left IV	46	28	21	19	15	15	—	—
Arm hooks/suckers								
Right I	26/41	20/48	21/—	19/30	17/22	14/18	[1]15/16	11/19
Right II	27/32	23/38	22/—	16/20	18/18	18/18	17/18	14/14
Right III	28/36	21/28	22/—	22/22	17/15	20/18	18/16	14/21
Right IV	31/15	21/10	23/—	25/9	21/15	21/21	19/—	22/20
Left IV	31/22	28/38	25/—	26/16	21/18	21/12+	19/—	—
Tentacles right/left								
Tentacle length	—/86	61/—	65/68	43/—	51/46	48/51	42/42	23/27
Club length	—/20	15/—	15/15	12/—	11/11	11/11	9/9	7/7
Club hooks								
Right (dorsal/ventral)-left (dorsal/ventral)	—-7/7	7/7-—	6/7-6/7	7/6-—	7/7-6/7	—-7/6	7/7-—	6/6-5/7
Club suckers right/left								
Distal suckers	—/68	64/—	72/52+	70	64/72	—/64	72/—	68/64
Carpal suckers	—/4	4/—	3/4	4/—	3/4	—/4	3/—	4/4

[1]Length or count of left arm.

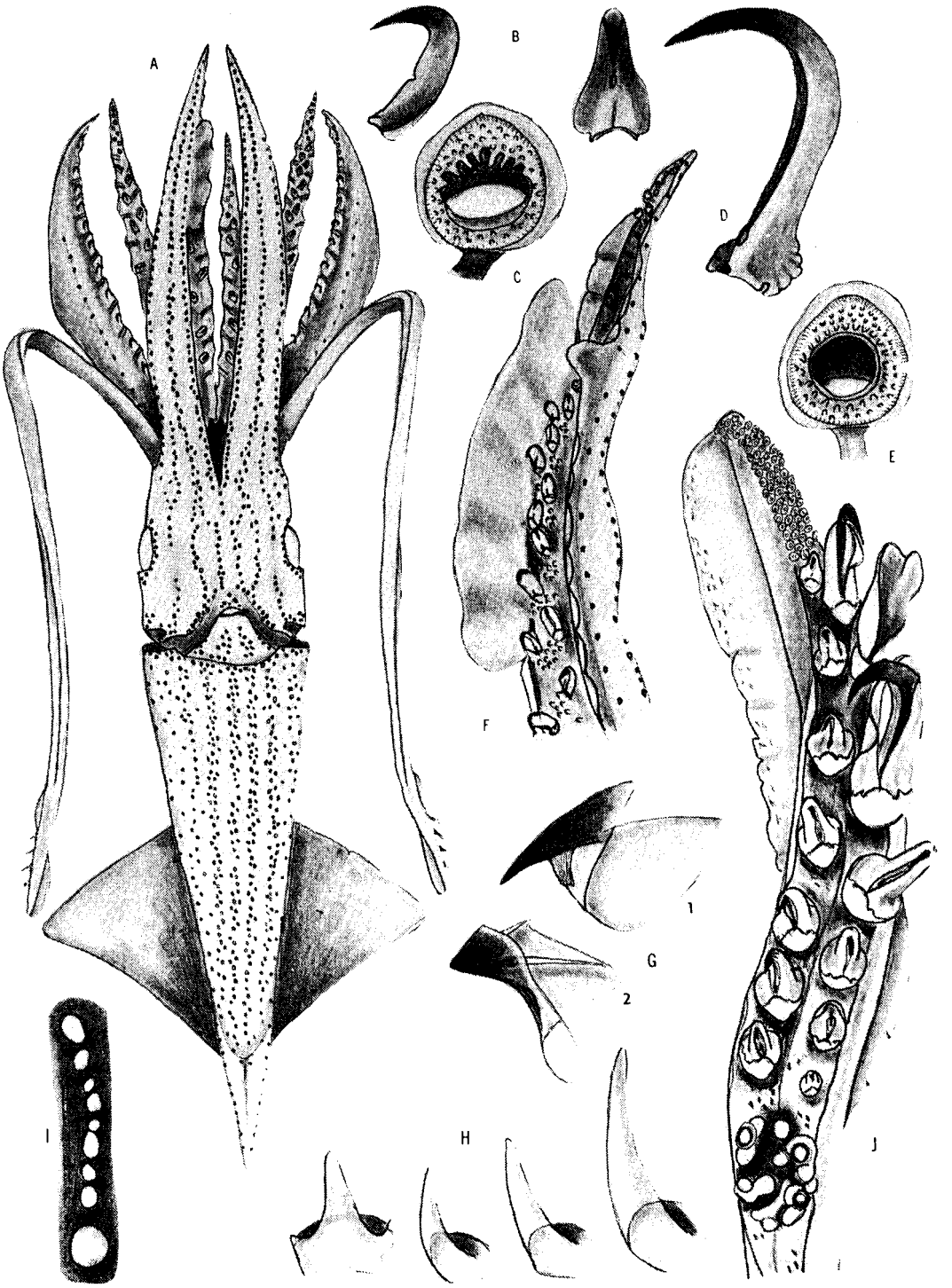


FIGURE 4.—*Enoploteuthis jonesi.* (A-F, I, and J from male holotype, ML (mantle length) 47 m; other body parts are from specimens as listed.) A, Ventral aspect; B, Dorsal arm hook, oral and lateral aspects; C, Dorsal arm sucker; D, Tentacular hook; E, Tentacular sucker; F, Hectocotylus; G, Mandibles: upper (1), lower (2), ML 27 mm; H, Radular teeth, ML 27 mm; I, Eye light organs; J, Tentacular club.

IV, 50.0-*55.0*-59.6). Arm IV is longest in both sexes. The arms are nearly square in cross section and they taper distally into fine delicate tips. The keels of arms I and II are confined mainly to the distal halves of the arms. The swimming keel of arm III is as wide as the arm at its midpoint. The lateral membrane (or tentacular sheath) of arm IV is moderately wide and extends to the tip of the arm. Dorsal and ventral protective membranes are present in all the arms. The ventral membrane is more developed than the dorsal, particularly on arm III.

In the males the right arm IV is hectocotylized. The ventral protective membrane on this arm forms a very wide lappet that extends from about the middle half, opposite the sixth pair of hooks, to about four-fifths of the arm length. Distally the membrane is much narrower and tapers to the arm tip (Fig. 4F). The dorsal protective membrane is slightly modified: a small tongue-like flap is developed opposite the distal end of the larger medial lappet. In addition, the males have numerous conical tubercles at the bases of the oral surface of all the arms and between the bases of all the hooks.

The biserial and regularly arranged hooks are completely sheathed by membranes (Fig. 4B). The distal arm suckers have long stalks. Each inner ring has eight teeth on its distal half and none on the smooth proximal half (Fig. 4C). The outer rings bear pegs all around. The suckers are progressively smaller distally; the distal suckers assume a globular shape, have small apertures, no teeth, and no outer rings.

The tentacles are longer than the mantle (TLI 104.9-*153.3*-188.9) and are about twice the length of the longest arm. The stalk is oblong in cross section near the base, very muscular, and almost as thick as arm III. The proximal part of the club is as narrow as the stalk or only slightly expanded. The club becomes unusually narrow in the distal one-third (Fig. 4J). The tip is blunt. The aboral keel is about one-half of the club length. A semilunar membrane is present on the ventral or oral side; it extends between the carpal area and the fourth pair of hooks. Protective membranes are developed on the ventral side but are rudimentary dorsally. Protective membranes are absent on the dactylus. The carpal cluster consists of three or four smooth-ringed suckers and several rounded pads in a compact round cluster together with some irregular grooves and ridges. There are 13 or 14 robust hooks in two rows on the club. The ventral row includes a series of greatly enlarged hooks. The hooks (Fig. 4D) are enclosed by membranes but the tips are exposed. These hooks have very broad bases and are set in rounded shallow excavations. Marginal suckers are absent. Twelve to 18 transverse rows of 4 small suckers per row occupy the narrow dactylus. About 12 of these suckers at the tip are slightly larger than the immediately preceding transverse row, thus forming a cluster at the tip of the club. All the club suckers have smooth inner rings (Fig. 4E). The pegs on the outer ring are moderately long and may hide the smooth edge of the inner ring from view.

The integumentary photophores occur in different sizes ranging from about 0.2 to 0.4 mm. A photophore may appear dark or very pale, depending on the extent of pigmentation. Many of the larger photophores are heavily pigmented, except for a small central area. Most of the smaller photophores are pale because pigmentation is confined to the periphery in the form of a very thin dark ring. Intermediate conditions between these extremes occur. At first glance the photophores on the mantle appear scattered at random, but on closer examination one can recognize four multiserial, ill-defined rows: two rows on each side of a very narrow midline space that extends from the anterior opening of the mantle to the tail and bounded laterally by a broad zone of photophores (Fig. 4A). Each row consists of large and small photophores set near each other; smaller and whiter ones occupy the central part of the row, while the larger and more conspicuously darker ones are located mostly on the outer area of the row. These rows become more difficult to distinguish posteriorly. A single row of evenly spaced photophores extends along the lateral margins of the tail. Numerous photophores occupy the ventrolateral surface and some single photophores, generally small ones, are scattered on the dorsal surface of the mantle, except near the midline. The edge of the mantle is lined by a single row of photophores; the photophores are spaced progressively farther apart toward the dorsal midline.

The funnel has six groups of photophores: Two rows separated by a midline space on the ventral side; a short row on each lateral side; and two dorsal rows, one on each side of the bridle.

A small triangular cluster of photophores is situated in the apex of the funnel groove. A space in the ventral midline of the head is broken by a

short row of two or three photophores that bifurcates at the fork of the ventral arms; each branch continues along the ventral aboral side of arm IV to almost the tip. A row of closely set photophores runs along the edge of the funnel groove and divides near the apex of the groove into two branches, each with photophores in single file. The branches reunite near the base of arm IV. The row continues distally along the base of the tentacular sheath to the tip of the arm. The third lateral row on the head begins anterior to the first nuchal fold, has a gap at the window of the eye, and then continues and splits into two branches: A medial branch that continues anteriorly and ends near the base of arm IV at the midline of the tentacular sheath and a lateral branch that extends along the edge of the tentacular sheath and terminates about the level of the last hook on arm IV. The lateralmost row on the head also starts at the first nuchal fold, continues along the nuchal crest, and turns toward the posterior eyelid where it runs along the ventral edge to the optic sinus. The row begins again on the dorsal edge of the optic sinus, continues along the base of the swimming keel of arm III, and stops at about three-fifths of the arm length. The dorsal eyelid lacks photophores.

There are nine irregularly spaced photophores on the ventral part of the eyeball (Fig. 4I). The posteriormost light organ is larger than the anteriormost which in turn is larger than the remaining seven light organs. The latter are slightly different from each other in size and shape.

The teeth of the radula are long (lateralmost teeth are longest), blunt, and slightly curved (Fig. 4H). Of the seven teeth only the rachidian tooth has small lateral cusps.

The upper mandible of a small specimen (ML 30 mm) has distinct growth lines on the wings (Fig. $4G_1$). The riblike ridges on the gular plate of the lower mandible are well developed (Fig. $4G_2$).

The gladius is feather-shaped. The rachis is blunt anteriorly and forms a strong ridge dorsally through its length. The vanes are narrow, widest at about a third of the length of the gladius. The posterior end is curved inward ending in the cone.

The largest female (ML 82 mm) is gravid; the ovaries are distended and extend to the posterior part of the mantle cavity. The eggs are opaque and about 1 mm in diameter.

None of the males have spermatophores.

Young individuals: Immature individuals (ML 11-22 mm) have relatively wider mantles (MWI 45.5-*57.0*-72.7) than adults. At ML 11 mm the arms have the following armature: 1 to 3 suckers proximally, 7 to 12 hooks, and 15 to 20 suckers distally. The tentacles are distinctly longer than the mantle (TLI 172.7). The club has three hooks along with nine biserial suckers on the manus. Two of the suckers are slightly set apart (future carpal suckers). Four rows of minute suckers are located on the dactylus. At ML 17 mm the arms have no proximal suckers, 12 to 18 hooks, and 19 to 21 distal suckers. The club resembles that of the adult, except that two marginal suckers are present on the dorsal distal side of the manus and although there are already four carpal suckers, the carpus is still not completely developed. The photophores on the mantle are not distinctly arranged into rows, except for two medialmost rows which are separated by a narrow space (Fig. 2D). The rows on the head are each composed of photophores in single file (Fig. 2F). The number and position of the rows agree with those of the adult.

Remarks: Adults of this species resemble superficially *E. chuni* Ishikawa 1914 from Japan, but they are easily distinguished by the photophore pattern of the head and arms. *Enoploteuthis chuni* has seven rows of photophores on the head (including the rows passing along the ventral eyelids) (pl. XX, fig. 1, Sasaki 1920), whereas *jonesi* has six rows. There is a distinct midventral multiserial row on the head of *chuni*, whereas the ventral midline of *jonesi* is a clear space, except for two or three single photophores near the fork of the ventral arms anteriorly. Some rows of photophores on the head divide and reunite in *jonesi*, a condition absent in *chuni*. The row of photophores at the base of the swimming keel of arm III reaches the tip of the arm in *chuni*, but in *jonesi*, the same row ends slightly beyond one-half to three-fifths of the arm length. These observations were confirmed by T. Okutani of the Tokai Regional Research Laboratory (presently with the National Science Museum, Tokyo) who kindly examined specimens of *E. chuni* from Suruga Bay and compared them with illustrations of *E. jonesi* sent to him. In addition, there are more distal club suckers in *chuni* (90) than in *jonesi* (64-72) and these suckers are toothed in *chuni* and smooth in *jonesi*.

The counts and measurement of *E. jonesi*

overlap those of *E. anapsis* Roper, 1964 from the tropical Atlantic and Caribbean. These species exhibit the following differences: 1) The midline space on the mantle in *jonesi* continues uninterrupted to the tail, but this space in *anapsis* has some scattered photophores near the tail; 2) the row that traverses the window on the ventral side of the head is bifurcate in *jonesi* whereas it is single in *anapsis*. The tentacles and clubs of *anapsis* are relatively longer than those of *jonesi*. The distal club suckers are more numerous in *jonesi* (64-72) than in *anapsis* (40-50).

This species is named after Everet C. Jones, former fishery biologist at the Honolulu Laboratory. It was under the supervision of E. C. Jones that the specimens collected during some of the cruises reached me in good condition.

Distribution: Central Pacific, Hawaiian waters, and equatorial region.

Enoploteuthis higginisi n. sp.
(Figs. 5, 2E, G; Table 4)

Enoploteuthis species B, Young 1978: figure 9B.

Holotype: Male, ML 37 mm, *Teritu*, Stn. 6 off Waianae, Oahu, September 1969, 110 m, USNM 729710.

Paratypes: 1 male, ML 35 mm, CHG-89, Stn. 11, 06°04.9'S, 157°36.9'W, 2 February 1966, 140-200 m, USNM 729714. 1 female, ML 53 mm, TC-32, Stn. 22, 21°02'N, 158°29.7'W, 21 July 1967, 67-117 m, USNM 729723. 1 female, ML 45 mm, TC-32, Stn. 56, 21°22.4'N, 158° 14.6'W, 23 August 1967, 97-179 m, USNM 577609.

Other material: 1 specimen, ML 27 mm, HMS-47, Stn. 51, 00°44'S, 149°46'W, 2 November 1958, 576 m. 1 specimen, ML 12 mm, CHG-51, Stn. 164, 16°44'N, 169°16'W, 14 February 1961, 100 m. 1 specimen, ML 12 mm, CHG-51, Stn. 172, 19°21'N, 169°20'W, 15 February 1961, 0-100 m. 1 specimen, ML 16 mm, CHG-89, Stn. 29, 04°05'S, 167°51'W, 14 February 1966, 120-135 m. 1 specimen, ML 11 mm, CHG-89, Stn. 30, 02°59'S, 167°51'W, 15 February 1966, 100-125 m. 1 male, ML 46 mm, TC-32, Stn. 23, 21°00.2'N, 158°30.1'W, 22 July 1967, 17-25 m. 1 female, ML 60+ mm, TC-32, Stn. 28, 20°58.6'N, 158°33.7'W, 25 July 1967, 8-60 m. 1 female, ML 30 mm, 2 specimens, ML 12 and 19 mm, TC-32, Stn. 33, 20°58.8'N, 158° 28.4'W, 13 August 1967, 83-99 m. 1 female, ML 32 mm, 1 specimen, ML 22 mm, TC-32, Stn. 37, 20°59.1'N, 158°12.7'W, 15 August 1967, 55-123 m. 1 male, ML 30 mm, 2 females, 37 and 40 mm, TC-32, Stn. 38, 20°58.7'N, 158°27.9'W, 15

TABLE 4.—Measurements (in millimeters) and counts of *Enoploteuthis higginsi*. TC = RV *Townsend Cromwell*; CHG = RV *Charles H. Gilbert*; + = missing mantle tip and lost suckers.

Cruise:	TC-32	TC-32	TC-32	TC-32	*Teritu*	CHG-89	TC-32	CHG-51
Station:	28	22	23	56	6	11	56	172
Sex:	Female	Female	Male	Female	(Holotype) Male	Male	Female	?
Mantle length	60+	53	46	45	37	35	29	22
Mantle width	24	20	18	14	14	13	13	11
Head width	20	17	13	14	15	12	11	10
Fin length	—	39	30	34	27	23	20	15
Fin width	58	42	38	34	30	30	24	21
Arm length								
Right I	42	32	25	26	20	20	[1]13	15
Right II	24	36	27	25	20	21	[1]15	12
Right III	48	33	28	28	21	20	[1]15	12
Right IV	51	37	28	31	23	23	19	11
Left IV	53	34	32	33	23	—	17	13
Arm hooks/suckers								
Right I	26/22	25/34	19/—	25/22	20/16	24/16	16/19	16/20
Right II	29/27	26/34	22/—	25/20	22/16	23/20	17/20	18/20
Right III	32/28	28/33	22/—	25/22	22/20	22/20	18/23	16/21
Right IV	28/28	26/21	25/—	29/20	22/2+	26/14+	22/23	18/6
Left IV	28/26	27/20	27/—	29/22	26/16	—	20/23	20/7
Tentacles right/left								
Tentacle length	—	108/117	110/—	—/92	41/41	60/—	—/48	34/27
Club length	—	17/17	16/—	—/16	11/11	11.5/—	—/9	—
Club hooks								
Right (dorsal/ventral)-								
left (dorsal/ventral)	—	5/6-5/6	4/6—	—6/6	5/6-5/6	5/6—	—4/6	—
Club suckers right/left								
Distal suckers	—	68/68	—	—/60	60/60	72/—	—/64	—
Carpal suckers	—	3/3	3/—	—/3	3/2	3/—	—/3	—

[1]Length or count of left arm.

August 1967, 8-25 m. 1 male, ML 46 mm, TC-32, Stn. 41, 20°58.9'N, 158°29.1'W, 16 August 1967, 59-122 m. 1 female, ML 37 mm, TC-32, Stn. 44, 21°00.1'N, 158°29.1'W, 18 August 1967, 72-118 m. 1 female, ML 47 mm, TC-32, Stn. 45, 20°58.1'N, 158°28.7'W, 18 August 1967, 12-31 m. 2 specimens, ML 27 and 28 mm, TC-32, Stn. 46, 20°57.6'N, 158°28.7'W, 18 August 1967, 77-118 m. 1 female, ML 35 mm, TC-32, Stn. 48, 20°59.7'N, 158°27.7'W, 19 August 1967, 60-104 m. 1 female, ML 29 mm, TC-32, Stn. 56, 21°22.4'N, 158°14.6'W, 23 August 1967, 97-179 m.

Description: The muscular mantle is slender (MWI 31.1-*37.9*-44.8) and conical; the translucent tail is slender and ends bluntly. The ventral anterior edge of the mantle is not deeply excavated and the lateral angles are pointed, but low. The dorsal anterior lobe is low.

The fins are triangular, wide (FWI 75.6-*81.2*-85.7), and long (FLI 65.2-*70.4*-75.6). The anterior margin near its attachment is a rounded lobe, but more laterally it appears straight. The lateral angles (about 75°) are rounded at the tip. The slightly concave posterior margins join the mantle independently, but the union of both fins (close to the tip of the mantle) is indistinct.

The funnel is triangular and wide at the base. The funnel valve is a wide semicircular flap. The funnel organ is large; an anterior papilla and thick lateral ridges are present. The funnel-mantle locking cartilage is simple with a shallow groove. The anterior part of the cartilage is slightly narrower than the posterior end.

The head is as wide as the mantle (HWI 28.3-*34.0*-40.5). The eye opening is a wide oval with a deep anterior sinus. The funnel groove is moderately deep and the lateral sides continue posteriorly as sharp ridges. The ventral ocular "windows" are translucent. The three nuchal folds are very prominent. The tongue-shaped olfactory organ is attached to the first fold closest to the funnel. The second and third folds are united to each other posteriorly and the third fold on each side continues as a much reduced fold toward the dorsal midline.

The buccal membrane has a DDVD attachment to the arms. Numerous folds and broad tonguelike papillae occur on the inner surface of the membrane. The external surface is densely supplied with small purplish chromatophores so that it is darker than most parts of the body.

The arms are slender but muscular, nearly square in cross section at the base and finely pointed at their tips. The arms are moderate in length (ALI: I, 44.8-*54.8*-60.4; II, 51.7-*58.0*-67.9; III, 51.7-*58.5*-62.3; IV, 58.6-*65.5*-73.3). Arm IV is longest in both sexes. The swimming keels are developed to about one-half of arm I distally, two-thirds of arm II distally, and complete in arm III where they are as wide as the arm at the mid-section. The lateral membrane (tentacular sheath) of arm IV is wide and reaches to the tip of the arm. Dorsal and ventral protective membranes are developed on all the arms of both sexes. They are widest on arm III and least developed on arm IV, except on the hectocotylized arm of the male.

The right ventral arm of the male is hectocotylized. The protective membranes of this arm are modified. At about the middle half of the arm opposite the sixth pair of hooks, the ventral protective membrane becomes enlarged into a wide undulating flap that is reduced abruptly about three-fourths of the arm length and continues distally to the tip of the arm as a much narrower membrane. The dorsal protective membrane, on the contrary, is only slightly modified. A short semilunar flap is present opposite the distal end of the larger ventral flap (Fig. 5F). Numerous conical papillae are scattered on the oral surface of the arms of males between the bases of the hooks and on the bases of the arms.

The arms have biserial hooks proximally and biserial suckers distally. The hooks (Fig. 5E) are strongly attached and completely enclosed by sheaths. About half of the suckers at the tips of the arms have long stalks and wide openings. The distal half of the inner rim of the sucker has seven to eight teeth; the two middle teeth are narrower than the lateral teeth; a shelf is visible on the proximal half (Fig. 5B). The outer ring bears numerous pegs. The remaining suckers gradually become smaller distally, assuming a globular shape with smaller openings that lack teeth and outer rings.

The robust tentacles are much longer than the mantle (TLI 110.8-*190.3*-239.1). The stalk near the base is almost square in cross section and as stout as arm III. The carpus and manus of the club are wide but the dactylus is quite narrow (Fig. 5G). The carpal cluster is compact and it includes three smooth-ringed suckers (very rarely two suckers) and several rounded pads and some elongate ridges and grooves; these are arranged in an oval cluster. Ten to 12 very robust, sheathed hooks are present in two rows

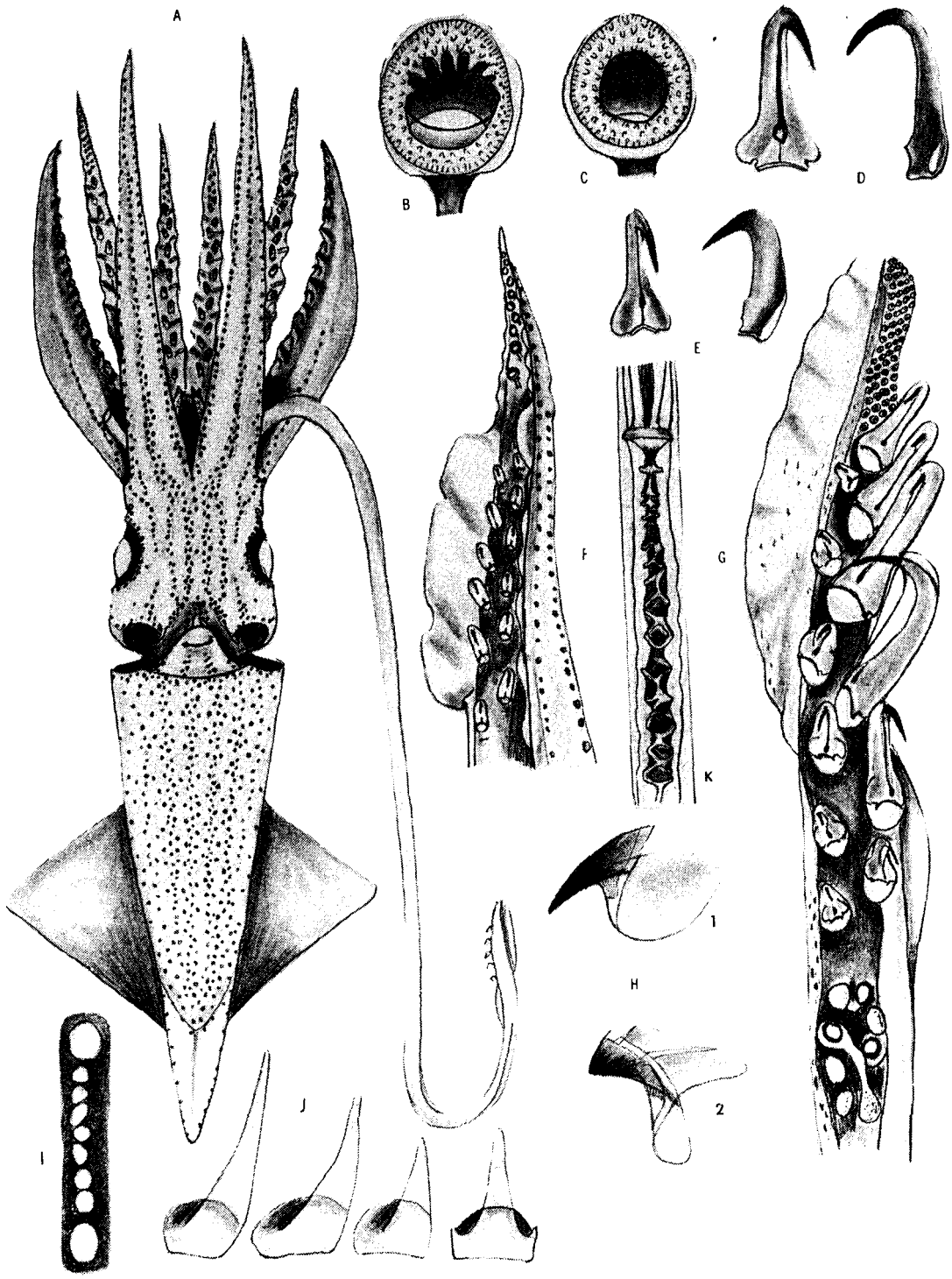


FIGURE 5.—*Enoploteuthis higginsi.* (A-E, G, and I from female paratype, ML (mantle length) 45 mm; other body parts are from specimens as listed.) A, Ventral aspect; B, Dorsal arm sucker; C, Tentacular sucker; D, Tentacular hook, oral and lateral aspects; E, Dorsal arm hook, oral and lateral aspects; F, Hectocotylus, male holotype, ML 37 mm; G, Tentacular club; H, Mandibles: upper (1), lower (2), female, ML 37 mm; I, Eye light organs; J, Radular teeth, female, ML 37 mm; K, Section of spermatophore, male, ML 46 mm.

on the manus. The ventral row includes a few large curved hooks, the largest hook is about one-fifth larger than the largest arm hook. The hooks have broad bases (Fig. 5D) and fit into shallow depressions on the club. The distal club suckers are arranged in four longitudinal rows (between 15 and 18 suckers in each row). The inner rings of these suckers are smooth but are surrounded by an outer ring with broad pegs that can be mistaken for teeth of the inner ring (Fig. 5C). A few suckers in the distal part of the dactylus are slightly enlarged and form a cluster there at the blunt end of the club. The dorsal or aboral keel is well developed and extends from opposite the third dorsal hook to the blunt end. A smaller semilunar membrane lies on the oral or ventral side of the club. It extends from opposite the distal half of the carpal cluster to opposite the second or third ventral hook. Protective membranes are poorly developed but recognizable.

The integumentary photophores range in size from about 0.2 mm to about 0.4 mm with varying degrees of pigmentation. Some are very dark with small pearl gray centers, others are lighter with varying widths of peripheral pigmentation. Those with very thin dark rings appear palest or almost white. The photophores on the ventral surface of the mantle appear to be distributed at random (Fig. 5A). They are concentrated on the ventral surface except at the tail and gradually become widely scattered toward the dorsal surface. A single row extends along each lateral margin of the tail. The free edge of the mantle opening is lined by a transverse row where the photophores are farther separated dorsally. There are no photophores on the fins, or on most of the ventral area of the tail.

Two rows of photophores separated by a median space are present on the ventral surface of the funnel. A shorter row or patch occurs on each of the lateral margins and a wider strip is found on each of the dorsolateral surfaces of the funnel.

The distribution of the photophores on the head is rather intricate. A small cluster lies in the apical region of the funnel groove. The ventral midline of the head is not totally clear of light organs, as a few isolated ones may be present. A very short row of three to four photophores in single file on the ventral midline (near the bases of arm IV) splits into two at the fork of the arms; each branch then continues along the ventral aboral edge of arm IV, ending a short distance from the distal tip of the arm. A row of photophores begins near the first nuchal fold, follows the curve of the funnel groove, and at a point near the apex of the funnel groove it splits into a wider medial branch and a narrower lateral branch. These branches reunite near the base of arm IV and the combined row proceeds anteriorly along the base of the tentacular sheath to the tip of arm IV. The next lateral row begins anterior to the first nuchal fold, is interrupted by a gap at the window of the eye, continues for a short distance, and divides into two short branches; each branch then extends to the edge of the tentacular sheath independently. A row of single photophores runs along the edge of the tentacular sheath and stops a short distance from the tip of arm IV. The lateralmost row on the head extends from the first nuchal fold along the nuchal crest, then anteriorly to and along the ventral margin of the eyelid, and ends at the ventral edge of the optic sinus. The row begins again on the dorsal edge of the optic sinus, continues along the base of the swimming keel of arm III, and terminates at about one-half the length of the arm. Two or three isolated small photophores occur in the area surrounding the ventral part of the eye opening; one photophore is usually located directly lateral to the window.

There are nine light organs on the ventral part of the eyeball. The terminal organs are much larger and slightly separated from seven smaller, closely set, light organs (Fig. 5I).

The radular teeth (seven teeth in a series) are long and slender. The outermost lateral teeth are longest while the innermost lateral teeth are shortest. The rachidian tooth has cusps. The three median teeth are almost straight while the two outermost lateral teeth are slightly curved (Fig. 5J).

The upper mandible (Fig. $5H_1$) has a pointed rostrum with very sharp edges and the lower mandible (Fig. $5H_2$) has three well-developed ribs on the gular plate.

The gladius is feather shaped and the midrib is low and rounded. The cone is narrow and rounded at the extreme end. The vanes start to broaden at about one-third of the length and reach their greatest width at about half of the length. The lateral edges of the gladius appear slightly thickened when held against a strong light.

Spermatophores from a male (ML 46 mm) are about 14 mm in total length. The cement body is slightly greater than half the length of the sperm reservoir and has two collars at the oral end (Fig.

5K), the anterior much smaller than the posterior. The aboral part of the spiral filament is supplied with numerous intricate diamond-shaped depressions separated by thickened ridges. Two to four turns are present behind the cap. A spermatophore examined has the following measurements:

Spermatophore segment	*Length (mm)*
Entire spermatophore	13.8
Sperm reservoir	5
Cement body	2.8
Spiral filament	6.0

Some eggs taken from the ovary of the female paratype (ML 53 mm) measured about 1.2 mm each.

Young individuals: Small individuals (ML 11-16 mm) have relatively wider mantles (MWI 56.3-*59.4*-63.6) and the photophores on the mantle are scattered (Fig. 2E) as they are in the adult. At ML 15 mm all the rows of photophores on the head correspond to those of the adult with respect to number and position (Fig. 2G). The most medial row consists of several photophores set close to each other as in the adult. All other rows are composed of a single line of photophores. At ML 12 mm the tentacles are robust and longer than the mantle (TLI 108.3), more than the length of the arm. The club has two carpal suckers, four hooks on the ventral side of the manus among a group of 16 suckers (presumably future hooks), some marginal suckers, and numerous quadriserially arranged suckers on the dactylus. The aboral keel is also developed. The arms bear between 12 and 14 hooks and a sucker at the base of one of the dorsal arms. Thirteen or 14 suckers occupy the distal part of arms I, II, and III, and 24 suckers on arm IV. At ML 16 mm there are still 4 club hooks and 2 carpal suckers, but the arm hooks have increased (18 on arm IV) as have the distal suckers. At ML 19 mm, 16 to 19 hooks are observed on the arms and 6 to 7 on the club along with an increased number of distal arm suckers and club suckers. At this stage three carpal suckers are present as in the adult.

Remarks: The species can be easily confused with *E. jonesi*; counts and measurements overlap and both species can be found in the same trawl hauls. However, a close examination of the material reveals a series of minor but consistent characteristics that separate one from the other even at a small size (ML 10 mm). At comparable sizes the tentacles and clubs are similar in structure, but *jonesi* has 13 or 14 club hooks and usually 4 carpal suckers while *higginsi* has 11 or 12 club hooks and usually 3 carpal suckers. Both have long tentacles, but they are relatively longer in *higginsi*.

Discrete longitudinal arrangement of photophores on the mantle is wanting in *higginsi* while a median space and identifiable rows are found in *jonesi*. The arrangement of photophores on the head also shows some differences: 1) The row closest to the midline is multiserial in *higginsi* whereas it is simple in *jonesi*; 2) isolated photophores occur in the midline area of the head and in the space near the eye in *higginsi* but are absent in *jonesi*; 3) the row directly anterior to the window is bifurcate in both species but in *higginsi* both branches extend to the tentacular sheath whereas in *jonesi* only the lateral branch does; and 4) the row of photophores on arm III is incomplete in both species, but in *higginsi* the row rarely extends more than 50% of the arm length (45-52% of arm length, 11 specimens) and in *jonesi* the row is more than half the arm length (56-85% of arm length, 18 specimens).

Enoploteuthis higginsi, like *E. jonesi*, shares many characteristics with *E. chuni* and *E. anapsis* (see remarks section of *E. jonesi*), but the scattered distribution of photophores on the mantle is distinctive of *higginsi*. Rows do not occur on the mantle in any stage of development in *higginsi*. At ML 10 mm, or smaller, the rows are already evident in *anapsis* (Roper 1966, figs. 22, 23).

Specimens captured in Hawaiian waters which were labeled *Enoploteuthis* sp. B and reported in Young (1978) also belong to this species (R. E. Young[3]).

This enoploteuthid squid is named after Bruce E. Higgins, former fishery biologist at the Honolulu Laboratory under whose leadership most of the material was collected during cruise 32 of the RV *Townsend Cromwell* in Hawaiian waters.

Distribution: Central Pacific, Hawaiian, and equatorial regions.

[3]R. E. Young, Department of Oceanography, University of Hawaii, Honolulu, HI 96822, pers. commun. 3 March 1980.

Enoploteuthis reticulata Rancurel 1970
(Figs. 6, 2B; Table 5)

Enoploteuthis reticulata Rancurel 1970: figures 31-37 (incorrect spelling *reticula* in figures 31-33).
Enoploteuthis sp. (No. 1), Okutani, 1974: figures 12a, b, e.
Enoploteuthis sp. A, Young 1978: figures 9B, 10A.

Material examined: 1 male, ML 130 mm (regurgitated by a porpoise) CHG-7, 20°42.7'N, 157°50'W, 3 February 1953, USNM 729718. 1 male, ML 117 mm, HMS-30, Stn. 3, 28°38.5'N, 161°20.3'W, 16 July 1955, 100 m. 1 specimen, ML 26 mm, TC-7, Stn. 5, off Waianae, Oahu, 12 August 1964, 60-100 m. 1 female, ML 35 mm, TC-32, Stn. 3, 21°22.5'N, 158°13.5'W, 13 July 1967, 15-25 m. 1 specimen, ML 13 mm, TC-32, Stn. 4, 21°20.9'N, 158°13.1'W, 13 July 1967, 75-107 m. 1 specimen, ML 18 mm, TC-32, Stn. 6, 21°21.7'N, 158°13.3'W, 14 July 1967, 83-124 m. 1 female, ML 45 mm, TC-32, Stn. 9, 21°21.5'N, 158°13.5'W, 15 July 1967, 17-25 M. 2 females, ML 39 and 62 mm, TC-32, Stn. 15, 21°20.3'N, 158°12.2'W, 17 July 1967, 16-30 m, USNM 729691. 1 specimen, ML 30 mm, TC-32, Stn. 28, 20°58.6'N, 158°33.7'W, 25 July 1967, 92-122 m. 1 male, ML 46 mm, TC-32, Stn. 29, 20°59.5'N, 158°31.5'W, 26 July 1967, 8-60 m. 1 male, ML 71 mm, TC-32, Stn. 31, 20°59.6'N, 158°29.3'W, 13 August 1967, 80-121 m, USNM 577606. 1 specimen, ML 32 mm, TC-32, Stn. 46, 20°57.6'N, 158°28.7'W, 18 August 1967, 77-118 m. 1 male, ML 50 mm, TC-32, Stn. 48, 20°59.7'N, 158°27.7'W, 19 August 1967, 60-104 m.

Description: The mantle is almost circular in cross section and is very muscular; the tail is thin and translucent. The mantle is widest at the opening (MWI 27.4-*32.3*-37.1) and the sides converge gradually toward the saccate tail. The anterior ventral margin is very slightly excavated and the lateral angles are pointed, but low. The dorsal evagination of the mantle is a rounded and low lobe.

The fins are about three-fifths of the mantle length (FLI 62.4-*64.7*-67.7) and are moderately wide (FWI 59.8-*69.3*-82.6). They arise at about the anterior third of the mantle length. The anterior margin projects as a rounded lobe near its attachment and then extends laterally, and together with the almost straight posterior margin, a rounded angle (about 72°) is formed. The posterior margins are each joined to the mantle separately leaving a small gap between them.

The funnel is triangular and almost as wide as

TABLE 5.—Measurements (in millimeters) and counts of *Enoploteuthis reticulata*. CHG = RV *Charles H. Gilbert*; HMS = RV *Hugh M. Smith*; TC = RV *Townsend Cromwell*; + = missing arm tips and lost suckers.

Cruise:	CHG-7	HMS-30	TC-32	TC-32	TC-32	TC-32	TC-7	TC-32
Station:		3	31	15	29	28	5	6
Sex:	Male	Male	Male	Female	Male	?	?	?
Mantle length	130	117	71	62	46	30	26	18
Mantle width	38	32	22	23	17	12	11	10
Head width	31	30	19	17	13	12	8	8
Fin length	88	73	43	42	30	16	15	9
Fin width	85	70	48	44	38	20	18	14
Arm length								
Right I	65	58	[1]45	35	28	17	15	12
Right II	65	65	[1]46	43+	30	19	15	13
Right III	70	[1]60	[1]47	34+	30	18	16	12
Right IV	69	65	45	38	33	18	17	13
Left IV	72	66	48	40	31	19	17	13
Arm hooks/suckers								
Right I	26/—	24/8+	[1]21/24	21/20	20/15	20/11	21/14	21/14
Right II	24/—	24/19	[1]23/24	26/16	20/18	18/10	21/12	20/15
Right III	24/—	24/22+	[1]24/15	24/14	22/13	20/11	22/11	21/14
Right IV	32/—	34/17	33/20	28/11	29/9	27/12	30/9	30/10
Left IV	31/—	33/19	33/35	31/12	26/13	27/12	28/10	30/9
Tentacles right/left								
Tentacle length	120/126	93/115	76/68	80/60	47/49	22/28	20/20	—/16
Club length	20/20	21/21	16/16	—/14	14/14	8/8	6/6.5	—/5
Club hooks								
Right (dorsal/ventral)-left (dorsal/ventral)	5/5-4/5	5/6-5/6	6/6-7/5	5/5-5/5	5/6-4/5	5/5-5/5	4/5-5/5	—-3/5
Club suckers right/left								
Distal suckers	—	10/8	10/8	—	11/8	8/—	10/9	—/8+
Carpal suckers	5/4	4/6	6/6	5/5	5/5	4/6	5/7	—/6

[1]Length or count of left arm.

it is long. The funnel-mantle locking cartilage is simple. The anterior end is slightly pointed and narrower than the posterior end. The groove is shallow and wider posteriorly. The funnel organ has a papilla on the anterior end of the dorsal component (inverted V-shape), is small, and has wide ridges on the lateral limbs. The ventral components are oval but have pointed anterior ends. The funnel valve is broad and its rounded anterior edge reaches the level of the funnel opening.

The head is almost square in cross section, slightly rounded at the top, and narrower than the mantle (HWI 23.8-*26.4*-28.3). The ventral excavation is moderately deep and well marked by sharp lateral edges. The three nuchal folds on each side of the head are very prominent. The first nuchal fold bears a tonguelike olfactory papilla at its posterior end. The second and third folds are crescentic folds with broad anterior ends and are united to each other posteriorly by a narrow membrane. From the posterior end of the third fold a narrow membranous ridge extends toward the dorsal midline but does not quite reach it. In large specimens the nuchal crest connects the three folds to each other and to the midline, so that three oval areas are formed on each side of the head posteriorly. The eye opening is wide and has a deep sinus. Both dorsal and ventral ocular "windows" are easy to recognize, particularly in specimens that have been preserved longer.

The buccal membrane has eight stout supports with connectives attached to the arms in the order DDVD. The lappets are pointed and the inner surface of the buccal membrane is rugose and lacks papillae. The membrane is darker than the supports; small chromatophores are present in both structures.

The arms are moderate in length; the ventral arms, which are longest, are shorter than the mantle length (ALI: I, 49.7-*56.1*-63.4; II, 50.0-*58.9*-65.2; III, 51.3-*59.1*-66.2; IV, 53.1-*61.7*-71.7). Weak keels extend along the distal third of arm I, along the distal half of arm II, and from the base to the tip of arm III. In the largest specimen the swimming keel of arm III is slightly wider than the arm width. The tentacular sheath along arm IV is narrow, about half of the arm width near the base, and reaches the tips of the arms. The protective membranes are developed on borders of all arms, but are more strongly developed on the ventral borders. This is particularly so on arm III, although the ventral membrane is never wider than the height of the hooks. The trabeculae and the membranes are very distinct even at the tips of the arms.

The right ventral arm of the male is hectocotylized (Fig. 6B). The ventral protective membrane on this arm is enlarged into an undulating lappet, which extends from near the 9th or 10th pair of hooks to the arm tip, although it becomes progressively reduced in width distally. The membrane is deeply notched at about two-thirds of its length so that two semilunar flaps of unequal lengths are formed. The dorsal protective membrane is less developed than the ventral protective membrane even in the area opposite the enlarged lappet. In addition, the males have numerous conical tubercles distributed on the oral surface, at the bases of all the arms, and on the areas between the bases of the hooks.

The arm hooks are large (Fig. 6E), arranged in two alternate rows, and enclosed by sheaths. The ventral arms of both sexes bear the most hooks. None of the hooks are unusually enlarged or reduced in either sex. The distal part of each arm has two rows of suckers. The proximal suckers in this region have long stalks and the inner rings of these suckers have seven or eight large blunt teeth (middle two teeth broadest) distally and smooth proximally (Fig. 6C). The outer ring has long pegs. The most distal pairs of suckers (with about three teeth) are much reduced in size, carried on short stalks, and have small openings.

The tentacles are generally about the length of the mantle (TLI 79.5-*100.4*-129.0). The stalk is slender, only about one-third of the width of arm III. The sides are compressed and the cross section is almost triangular. The club is narrow (Fig. 6I). The carpus includes between four and seven smooth-ringed suckers and corresponding pads arranged in an elongated series which is limited on both sides by a narrow ridge. The manus includes a dorsal row of four to seven sheathed hooks and a ventral row of five or six slightly larger hooks. The hooks (Fig. 6F) have narrow bases. The largest hooks are not bigger than any of the largest arm hooks. Marginal suckers are absent and any sucker present along the rows of hooks in young specimens certainly represents an undeveloped hook. The dactylus has 8 to 11 suckers arranged in two rows. They have long stalks and wide openings. The sucker rings bear teeth; six or seven short teeth distally and six or seven very blunt teeth proximally (Fig. 6D). The outer ring has many short pegs. The tip of the club is blunt with a short over-

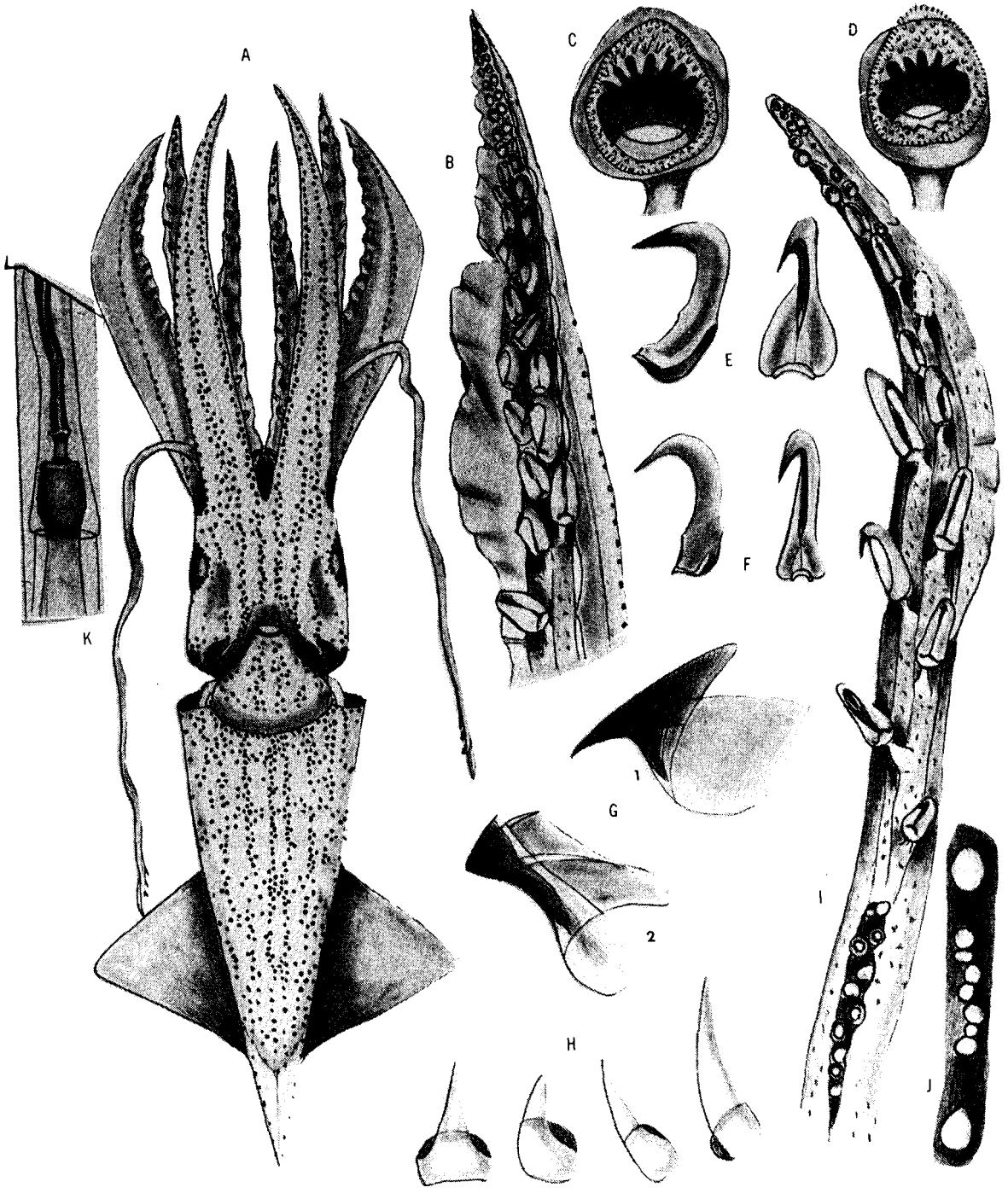


FIGURE 6.—*Enoploteuthis reticulata* Rancurel. (A, C-F, and J from female, ML (mantle length) 62 mm; other body parts are from specimens as listed.) A, Ventral aspect; B, Hectocotylus, male, ML 71 mm; C, Dorsal arm sucker; D, Tentacular sucker; E, Dorsal arm hook, oral and lateral aspects; F, Tentacular hook, oral and lateral aspects; G, Mandibles: upper (1), lower (2), male, ML 50 mm; H, Radular teeth, male, ML 50 mm; I, Tentacular club, male, ML 117 mm; J, Eye light organs; K, Section of spermatophore, male, ML 117 mm.

lapping hood which conceals a few of the suckers at the tip. The aboral keel is also narrow and extends from opposite the second hook to the lateral side of the hooded tip. Protective membranes are not developed on either side.

The photophores range in size from 0.2 to 0.4 mm. The dark or light appearance of each photophore is caused by the extent of pigmentation. The majority of the small ones are white owing to pigmentation confined only to the periphery of the photophores. The photophore pattern of the mantle is distinctive. It can be described briefly as the combined effect of about six ill-defined longitudinal rows and four oblique rows to produce a netlike or reticulated pattern (Fig. 6A). The photophores are scattered irregularly in the posterior region of the mantle, except on the tail where a single row extends on each side to the tip of the tail. The ventral area of the saccate tail lacks photophores. A single transverse row in which the photophores are farther apart dorsally lies along the anterior edge of the mantle. A few small photophores are distributed on the dorsal surface of the mantle. The fins lack photophores.

Two longitudinal rows, separated by a midline space, occur on the ventral surface of the funnel. A short row (connected to the ventral row posteriorly) is located on each side of the funnel and a long row of photophores is found on the dorsolateral side, close to each bridle.

The photophore pattern on the ventral side of the head is observed best in smaller specimens. Two clusters, separated by a narrow midline space, lie in the apex of the funnel groove. A clear space occupies the ventral midline of the head. Eight main rows of photophores (four rows on each side of the midline space) are present. The first or most medial row begins at the posterior end of the funnel groove, extends anteriorly to the ventral aboral side of arm IV, and reaches almost to the tip of this arm. The second row branches out from the first row near the apex of the funnel groove, extends parallel to the first row and joins it at a point near the base of arm IV, at about the same level as the anterior margin of the eye. At the base of arm IV the width of the second row is increased by additional photophores, and as the row continues along the base of the tentacular sheath distally it is gradually reduced to a single series of photophores which reaches the tip of the arm. A very short row or cluster of photophores occurs between the first and second rows at a short distance beyond the base of arm IV, but in older individuals this short row tends to lie closer to the second row and may be difficult to distinguish. The third lateral row extends from opposite the first nuchal fold anteriorly (interrupted by a gap at the window of the eye) to the base of arm IV where it merges with the second row. A branch continues further along the edge of the tentacular sheath almost to the tip of arm IV. The fourth or most lateral row extends from the second nuchal fold to the posterior margin of the eye and passes along the edge of the ventral eyelid to the ventral edge of the optic sinus. The row begins again on the dorsal edge of the optic sinus and continues along the base of the swimming keel of arm III to a short distance from the tip. An arclike row of small white photophores, spaced widely, lies along the ventral region of the eye between the third and fourth rows of photophores.

Nine light organs, arranged in a single row, are present on the ventral side of the eyeball. The terminal organs are much larger than the seven, closely spaced, interior light organs and are set apart from them. The interior organs are not of uniform size (Fig. 6J).

The seven radular teeth are blunt and slightly curved. The rachidian has low lateral cusps (Fig. 6H).

The mandibles are strong; the rostrum of the upper mandible is pointed and the edges are sharp (Fig. $6G_1$). The gular plate of the lower mandible is reinforced by three stout ribs (Fig. $6G_2$). At ML 45 mm the wings of both halves are already well pigmented.

The gladius is thin with a low rounded midrib. The vanes are narrow and widest at about the middle. The cone is thin-walled and as wide and rounded as the anterior end of the gladius.

The spermatophores are large. The cement gland has a large swelling at the aboral end (Fig. 6K). The aboral end of the spiral filament, anterior to the cement gland, is plain except for some longitudinal ridges. Two or three spiral turns behind the cap are present. Measurements from two specimens are given below:

	Length (mm)	
Spermatophore segment	*ML 130 mm specimen*	*ML 71 mm specimen*
Entire spermatophore	28	14
Spiral filament	12	6.2
Cement gland	3	1.8
Sperm reservoir	13	6

Young individuals: At ML 13 mm the photophores on the mantle are arranged as small clusters of large photophores distributed in a definite pattern (Fig. 2Ba). There are a few small and large photophores on the head, arms, and funnel, and they are aligned in areas that correspond to the adult pattern. At this stage there are 17 to 21 arm hooks and 7 to 11 distal arm suckers. The tentacles are shorter than the mantle (TLI 84.6) and weak. On the club a single hook, along with 16 suckers in two rows, is developed; however, the carpal area is not yet differentiated. At ML 18 mm, 20 or 21 hooks and 14 or 15 distal suckers are present on each of arms I, II, and III, and 30 hooks and 9 distal suckers are present on arm IV. On the club, 6 carpal suckers are set apart from 8 hooks (biserial) on the manus and about 13 suckers on the dactylus. At ML 26 mm the photophore pattern of the mantle appears more complex. First, additional photophores develop between the clusters whereby four oblique rows are present; and second, six longitudinal rows of indistinct small white photophores are present (Fig. 2Bb). This pattern, although not as complicated, resembles that of the adult. At this stage the clubs have 9 or 10 hooks, 9 or 10 distal suckers (biserial), and 5 to 7 carpal suckers. A ML 45 mm female has an oviducal gland 2.0 mm long, and at ML 46 mm the right ventral arm of the male is already hectocotylized, although the lappet is still very narrow and the tubercles on the arm bases are minute. There is no indication of spermatophores in the still undeveloped genital system. However, a ML 50 mm specimen has spermatophores.

Remarks: The present material can be assigned with confidence to *E. reticulata* (Rancurel 1970). The photophore patterns of the mantle, head, and arms, and characteristics of the tentacles and clubs are very close, and hook counts (arms and clubs) overlap. Differences in measurements are not considered to be significant.

Okutani (1974; 51, fig. 12a, b, e) described and illustrated a specimen, labeled n. sp. (No. 1) in his paper on the cephalopods collected at lat. 17°53′S, long. 126°18′W during the EASTROPAC Expedition, 1967-68; I have examined this particular specimen deposited in the U.S. National Museum; it is *E. reticulata.*

Enoploteuthis sp. A of Young (1978) belongs to *E. reticulata* described here (R. E. Young footnote 3).

The reticulated pattern is not unique. A similar pattern has been described for *E. galaxias* Berry, 1918. However, these two species differ in a number of basic features. Except for the mantle photophores, the pattern of the light organs in *galaxias* is unlike that of *reticulata*; there is a median row present in the head of *galaxias* flanked by three lateral rows, or a total of seven rows. A median row is absent in *reticulata.* I have examined the type of *E. galaxias* deposited at the Australian Museum, Sydney, Australia. Unfortunately, the specimen has darkened considerably and the photophore pattern is no longer recognizable with an ordinary microscope. The tentacles and clubs are very different. The tentacular stalk in *galaxias* is as stout as the arms, but in *reticulata* the stalk is only a third of the arm width. The club of *galaxias* has an expanded carpus, whereas in *reticulata* the carpus is very slender. The carpal suckers and pads in *galaxias* are arranged in a compact oval area, but in *reticulata* they are biserially arranged lengthwise in a narrow area. The suckers of the dactylus in *galaxias* are quadriserially arranged and quite numerous (38-43), whereas they are biserially arranged and very few (8-11) in *reticulata.* Lastly, the rachidian tooth of *galaxias* has no cusps, but that of *reticulata* does.

The present collection data and those from the literature show that *E. reticulata* occurs over a wide area of the Pacific, Hawaiian waters included, from lat. 28°38.5′N to 22°58′S and from long. 164°04′E to 126°18′W.

GENERAL DISCUSSION

Since the description of *Loligo leptura* by Leach (1817) and the subsequent designation of this species as the type of the genus *Enoploteuthis* Orbigny, 1848 by Pfeffer (1900), only five other valid species have been described: *E. chuni* Ishikawa 1914; *E. galaxias* Berry 1918; *E. anapsis* Roper 1964; *E. theragrae* Taki 1964; and *E. reticulata* Rancurel 1970. (See summary of history, synonymy, and generic diagnosis in Roper 1966.)

Enoploteuthis dubia Adam 1960 was described from a single specimen captured in the Gulf of Aqaba, Red Sea. However, Adam in his remarks was not certain that it was an *Enoploteuthis.* With more material and information several years later, he removed the species from *Enoploteuthis* (Adam 1973).

Enoploteuthis theragrae was described from seven specimens found in the stomach contents of two codfish, *Theragra chalcogramma*, captured in 1957 and 1962 from two localities in the Japan Sea. These specimens probably are allied to *E. chuni*. Except for the mantle photophores (six in rows for *theragrae* and eight in rows for *chuni*) all other diagnostic characters are shared by both species (M. Okiyama[4]).

GEOGRAPHIC DISTRIBUTION

Enoploteuthis anapsis and *E. leptura* are widely distributed in the Atlantic. *Enoploteuthis leptura* is known from the Gulf of Guinea (type locality), Madeira, Cape Verde Islands, the southern Straits of Florida (Roper 1966), and east of Bermuda (Roper 1977). *Enoploteuthis anapsis* is recorded from parts of the western Atlantic in the Gulf of Mexico and Caribbean Sea, from the mid-Atlantic, Madeira, St. Helena, and South Equatorial Current (Roper 1966), and east of Bermuda (Roper 1977).

Enoploteuthis chuni was first described from Toyama Bay, Sea of Japan, and Sasaki (1920) reported it later, again from Toyama Bay and farther south from Bungo Strait. Shimomura and Fukataki (1957) recorded it again from the sea of Japan together with *Watasenia scintillans* in the stomach contents of Alaskan pollock. Okutani (1967) listed an adult specimen from Sagami Bay on the Pacific side of Japan and some larval stages later (1968), also from the Pacific side of Japan. The first and only record of *E. theragrae* is from the Sea of Japan in 1964.

Enoploteuthis galaxias is known only from the type locality, off Gabo Island to Everard Grounds, Victoria, Australia.

Enoploteuthis reticulata was described from specimens taken by midwater trawl and from stomach contents of *Alepisaurus ferox* caught in areas of the southwest Pacific, approximately between lat. 22° and 18°S and long. 164°E and 133°W. The present material extends the distribution to lat. 21°N in the Hawaiian area and Okutani's specimen (1974, *Enoploteuthis* sp. No. 1) to the southeast Pacific at lat. 17°S, long. 126°W.

The genus *Enoploteuthis* was first reported from the central Pacific by King and Ikehara (1956) in their study of the food and feeding habits of the yellowfin tuna and bigeye tuna. They found a total of 36 specimens of *Enoploteuthis* in the stomach contents of these fishes. There are no other previous records of the genus from the central Pacific. The station data of the present material show that *E. obliqua* ranges approximately from lat. 11°N to 5°S and long. 81° to 144°W; *E. octolineata* from lat. 7°N to 3°S and long. 144° to 157°W; *E. jonesi* from lat. 20°N to 14°S and long. 157° to 168°W; and *E. higginsi* from lat. 21°N to 4°S and long. 149° to 169°W. Of the five species found in the central Pacific, namely, *obliqua*, *octolineata*, *jonesi*, *higginsi*, and *reticulata*, the last three species range to areas close to the Hawaiian Islands whereas *obliqua* and *octolineata* do not (Fig. 7). Based on available records, *reticulata* has the widest range; it is found in the southwest Pacific, Hawaiian area, and southeast Pacific. Collections made between September 1969 and November 1974 by the University of Hawaii include specimens of *E. reticulata* and *E. higginsi* (Young 1978).

BATHYMETRIC DISTRIBUTION

The genus *Enoploteuthis* is rare in collections, and, except for *E. anapsis* (Roper 1966), *E. higginsi*, and *E. reticulata* (Young 1978), few depth records are available.

Useful depth data are available for only two specimens of *E. leptura* studied by Roper (1966). These specimens were taken from depths between 0 and 170-300 m. *Enoploteuthis anapsis* is represented by 25 specimens taken from depths between 33 and 600 m at night and a single specimen from very deep waters, 2,000 m, during the day. Roper and Young (1975) mentioned the capture of an *E. anapsis* specimen in a closing net at 90 m, off Bermuda at night.

Depth records are not included in the original description of *E. chuni*; however, the *Albatross* specimens reported by Sasaki (1920) came from the stomach of a fish captured from deep water, about 857 m. Okutani (1967, 1968) reported an adult from a depth of 700 m and two larval stages from the surface.

The only known specimens of *E. galaxias* (four specimens) were captured at depths between 288 and 450 m.

The present material, except for that from two tows at 240 and 576 m, came from depths between the surface and 179 m. Depth data and other pertinent records are listed in Table 6 for 131 specimens of *obliqua*, *octolineata*, *jonesi*,

[4]M. Okiyama, Tokyo University, Tokyo, Japan, pers. commun. 26 November 1970.

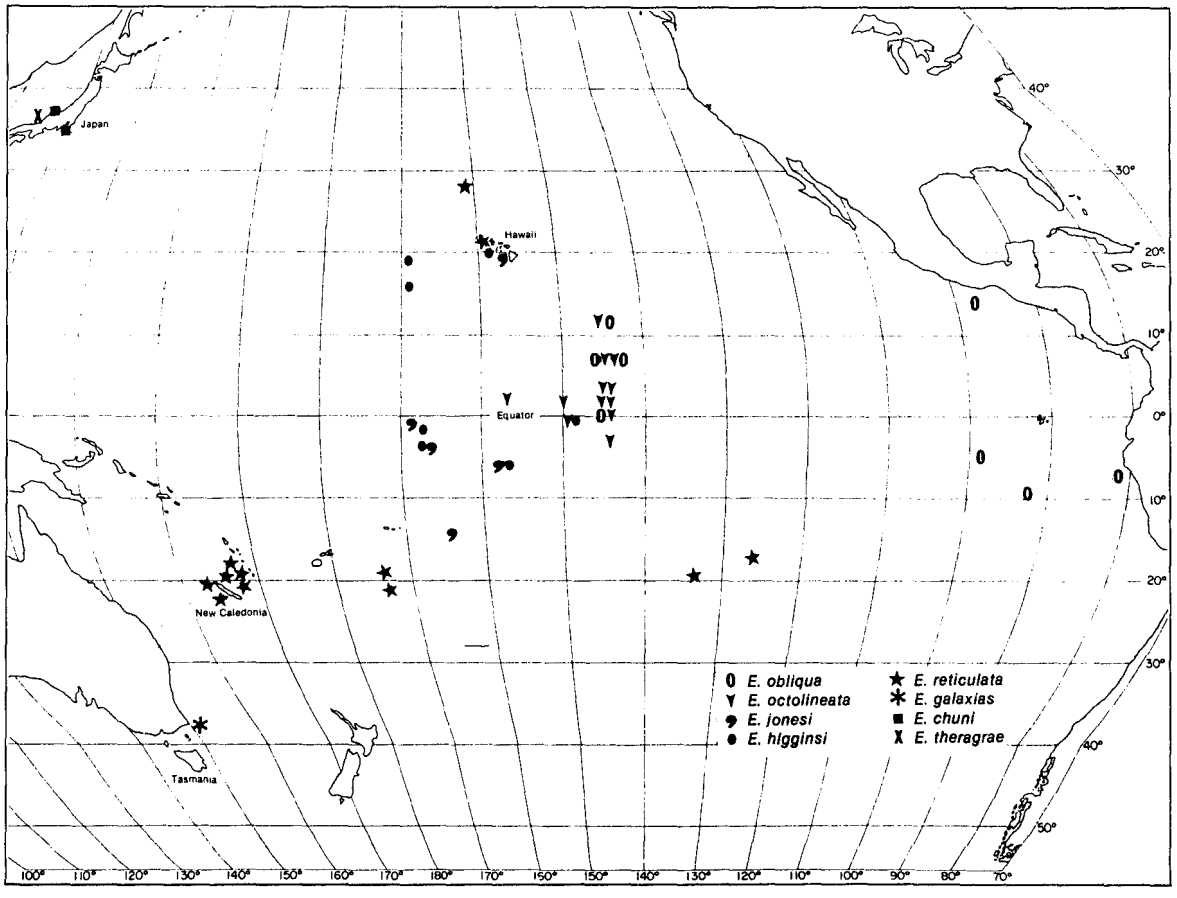


FIGURE 7.—Distribution of *Enoploteuthis* species in the Pacific.

higginsi, and *reticulata*. Most of the specimens (93.1%) were taken between the surface and 150 m, and the greatest number of these (48.1%) came from a depth of 50 m. A majority of the specimens (70.2%) were collected at night between 1900 and 0400. A limited number of specimens (8.4%) came from the few tows made during the day. *Enoploteuthis higginsi* and *E. reticulata* captured off Oahu, Hawaii, were taken close to the surface (50-100 m) at night and much deeper (500-600 m) during the day (Young 1978).

Species of *Enoploteuthis* are undoubtedly mesopelagic forms (200-1,000 m day habitat) that make diel vertical migrations as has been demonstrated for *E. anapsis* by Roper (1966) and for two other *Enoploteuthis* by Young (1978).

RELATIONSHIPS

The Pacific species of *Enoploteuthis* fall into two natural groups allied either to *E. anapsis* or *E. leptura* along the same characters that separate these two Atlantic species (see Roper 1966). Apparently, there are two species complexes within the genus: Species that tend toward the development of larger clubs and long and muscular tentacles, and those species that exhibit the opposite trends.

Additional features of the former complex are: many suckers in four rows on the clubs, large hooks, and oval to round carpal apparatus. These are features common to *galaxias*, *chuni*, *theragrae*, *anapsis*, *jonesi*, and *higginsi*. Within this group, *anapsis*, *jonesi*, and *higginsi* all have the semilunar membrane on the club while *galaxias* and *theragae* are illustrated in the literature without it. Both Berry (1918) and Taki (1964) do not mention the semilunar membrane in their species descriptions. I have seen the holotype of *galaxias*, but I could not verify the presence of the membrane because of the poor

TABLE 6.—Bathymetric data of *Enoploteuthis* species: *obliqua, octolineata, jonesi, higginsi,* and *reticulata.* TC = RV *Townsend Cromwell;* HMS = RV *Hugh M. Smith;* CHG = RV *Charles H. Gilbert.*

Cruise no.	Station no.	No. of specimens	Mantle length (mm)	Sex	Depth (m)	Time 24 h	Month
Enoploteuthis obliqua							
TC-48	19	1	58	M	50	—	April
TC-48	11	1	55	M	50	—	March
TC-46	9	1	50	F	50	1945-0230	October
TC-44		[1]1	50	F	—	—	July-August
TC-46	9	1	41	M	50	1945-0230	October
TC-48	19	1	40+	F	50	—	April
TC-44	24	1	37+	M	50	1933-0245	July
TC-44	17	[1]1	27	—	—	—	July
TC-44	24	4	12-20	—	50	1933-0245	July
TC-43	14	16	5-18	—	50	1945-0235	May
TC-43	22	5	12-17	—	50	2017-0237	May
TC-43	10	5	12-17	—	50	1943-0239	May
TC-44	18	2	12-17	—	100	1947-0253	July
TC-44	32	1	13	—	50	1937-0303	July
TC-44	54	1	12	—	50	1932-0238	July
TC-47	16	4	6-11	—	50	1930-0250	January
TC-48	16	3	7-10	—	20	—	April
TC-44	16	2	55-10	—	0	1059-0129	July
Enoploteuthis octolineata							
TC-43	52	1	75	F	50	1940-0244	May
HMS-47	58	1	71	F	212	2013-2153	November
TC-46	47	1	56	F	115	1939-0240	October
TC-46	37	1	56	F	50	1934-0236	October
TC-48	50	1	49	F	50	—	April
TC-48	52	1	46	M	50	—	April
TC-43	42	2	21-40	—	50	1942-0235	May
TC-48	35	1	39	—	50	—	April
TC-46	41	1	36	—	50	1935-0230	October
TC-48	92	1	33	—	50	—	April
TC-43	38	3	19-30	—	50	1944-0240	May
TC-44	44	[1]1	28	—	—	1935-0237	July
TC-44	26	1	26	—	20	1934-0243	July
TC-44	68	1	25	—	75	1932-0235	August
HMS-47	58	1	25	—	212	2013-2153	August
TC-43	48	1	24	—	50	1943-0240	May
TC-43	52	2	20-22	—	50	1940-0244	May
TC-43	26	1	20	—	50	1945-0235	May
TC-44	56	1	20	—	50	1933-0235	July
TC-47	45	2	16-20	—	50	2000-0200	February
TC-43	12	1	15	—	20	1945-0226	May
CHG-89	5	1	15	—	120-240	2058-2332	July
TC-46	45	2	14	—	50	1934-0234	October
HMS-47	51	1	10	—	576	2013-2158	November
Enoploteuthis jonesi							
TC-7	12	1	82	F	9-13	1926-2056	August
TC-7	12	1	47	M	9-13	1926-2056	August
TC-32	28	1	40	F	92-122	1952-0152	July
CHG-89	24	1	35	M	90-130	2053-2246	February
TC-32	46	1	35	F	77-118	1951-0151	August
TC-32	39	1	30	F	63-101	1053-0153	August
CHG-89	14	1	27	M	70-80	0258-0445	February
CHG-89	29	1	22	—	120-135	2038-2231	February
CHG-89	31	1	17	—	90-150	2040-2233	February
TC-32	37	1	11	—	55-123	0354-0954	August
Enoploteuthis higginsi							
TC-32	28	1	60+	F	8-60	1952-0152	July
TC-32	22	1	53	F	67-117	1952-0152	July
TC-32	45	1	47	F	12-31	1143-1743	August
TC-32	41	1	46	M	59-122	1151-1751	August
TC-32	23	1	46	M	17-25	0403-1003	July
TC-32	56	1	45	F	97-179	1952-0152	August
TC-32	38	2	37-40	F	8-25	1144-1744	August
TC-32	44	1	37	F	72-118	0353-0953	August
Teritu	6	1	37	M	110	—	September
TC-32	48	1	35	F	60-104	1155-1755	August
CHG-89	11	1	35	M	100-200	0254-0445	February
TC-32	37	1	32	F	55-123	0354-0954	August
TC-32	38	1	30	M	8-25	1144-1744	August
TC-32	33	1	30	F	83-99	1950-0150	August
TC-32	56	1	29	F	97-179	1952-0152	August
TC-32	46	2	27-28	—	77-118	1951-0151	August
HMS-47	51	1	27	—	576	2013-2153	November
TC-32	37	1	22	—	55-123	0354-0954	August
TC-32	33	2	12-19	—	83-99	1950-0150	August
CHG-89	29	1	16	—	120-135	2038-2231	February
CHG-51	164	1	12	—	0-100	2105-2323	February

TABLE 6.—*Continued.*

Cruise no.	Station no.	No. of specimens	Mantle length (mm)	Sex	Depth (m)	Time 24 h	Month
CHG-51	172	1	12	—	0-100	2100-2250	February
CHG-89	30	1	11	—	100-125	0603-0745	February
Enoploteuthis reticulata							
CHG-7		[2]1	130	M	—	daylight	February
HMS-30	3	1	117	M	100	2105-2315	July
TC-32	31	1	71	M	30-121	0354-0954	August
TC-32	15	1	62	F	16-30	0352-0952	July
TC-32	48	1	50	M	60-104	1155-1755	August
TC-32	29	1	46	M	8-60	0343-0755	July
TC-32	9	1	45	F	17-25	0354-0954	July
TC-32	15	1	39	F	16-30	0352-0952	July
TC-32	3	1	35	F	12-15	0355-0955	July
TC-32	46	1	32	—	77-118	1951-0151	August
TC-32	28	1	30	—	92-122	1952-0152	July
TC-7	5	1	26	—	60-100	2023-2156	August
TC-32	6	1	18	—	83-124	0354-0954	July
TC-32	4	1	13	—	75-107	1146-1747	July

[1]From stomach of *Alepisaurus*.
[2]Regurgitated by a porpoise.

condition of the specimen. *Enoploteuthis galaxias, chuni,* and *theragrae* have a midventral row of photophores on the head flanked by two lateral rows which extend (without branching) to the ventral arms. These three species are found in the western Pacific: *chuni* and *theragrae* from Japan and *galaxias* from Australia. The remaining species of this complex, *anapsis, jonesi,* and *higginsi,* are very similar: All have distal club sucker rings without teeth; all have an incomplete midventral row of photophores on the head (represented by a short anterior segment near the base of the ventral arms and by a triangular patch of photophores in the apex of the funnel groove); the first lateral row of photophores on the head is divided and reunited before extending to the ventral arms; and all have an incomplete photophore row on arm III. The longitudinal rows of photophores on the mantle are easily recognized in *anapsis* and *jonesi,* but not in *higginsi.*

Enoploteuthis leptura, octolineata, obliqua, and *reticulata* comprise the other species complex. They all have thin, slender, and short tentacles, clubs without semilunar membranes, few club suckers that lie in two rows, and a continuous midventral space on the head. *Enoploteuthis octolineata* and *E. leptura* are similar in that both have distinctly separated first and second lateral rows of photophores on the head, and lack a triangular patch of photophores in the apex of the funnel groove although each of the first lateral rows continues into the groove. Both species also have distinct and well-spaced mantle and funnel photophores. *Enoploteuthis reticulata* and *E. obliqua* also show similarities. The photophore pattern on the head, arms, and funnel have basically the same arrangement: Two small clusters of photophores, separated by a narrow space, are present in the apex of the funnel groove and, except for the continuous midventral space, single photophores are present posteriorly in the spaces between the funnel photophore rows. Thus, the rows are not completely separated. However, the mantle photophore pattern of each species is distinct: oblique in one and reticulate in the other. *Enoploteuthis reticulata* and *E. galaxias* have similar patterns of mantle photophores, but their head photophore patterns and some features of the clubs differ. The reticulate pattern on the mantle is probably an independently developed trait.

The spermatophores of *E. higginsi* and *E. anapsis* are both intricately sculptured, while those of *E. leptura, E. obliqua,* and *E. reticulata* are simple. Since the spermatophores of the other species are undescribed, it remains to be seen if the sculptured type are only associated with the first species complex and the simple type with the second complex. The important characters (except photophore pattern) of these two complexes are listed in Table 7.

KEY TO THE SPECIES OF *ENOPLOTEUTHIS* (ADULTS, WORLDWIDE)

1. Tentacular stalk and club narrow, suckers on dactylus few and in two rows; carpal cluster elongate; semilunar membrane absent 2

TABLE 7.—Some comparative features of *Enoploteuthis anapsis* and *E. leptura* complexes. ML = mantle length.

Species	Maximum ML (mm) Female	Maximum ML (mm) Male	Tentacle length index	Club length index	Carpal suckers	Shape of carpus	Club hooks No.	Club suckers No.	Club suckers arrangement	Club sucker ring teeth No.	Semi-lunar membrane
anapsis complex											
chuni	87	63	119.0-147.0	21.6-25.4	4-6	polygonal, oval	9	90	quadriserial	5-8	present
galaxias	87	73	102.6-108.3	25.6-26.4	4-6	round, oval	11	38-43	quadriserial	undescribed	absent
theragrae	80	60	83.3-91.3	25.0	5	ellipsoid	10	many, minute	quadriserial	undescribed	absent
anapsis	76.9	54	163.0-275.7	29.1-47.1	3-4	rectangular	12-13	40-50	quadriserial	absent	present
jonesi	82	47	104.9-188.9	24.4-40.7	3-4	round	13-14	60-72	quadriserial	absent	present
higginsi	60+	46	110.8-239.1	29.7-36.1	2-3	oval	10-12	60-72	quadriserial	absent	present
leptura complex											
leptura	44.5	79	89.0-96.0	17.9-20.6	5-6	elongate	6-12	10-15	biserial	7	absent
obliqua	50	58	62.1-96.4	17.0-26.0	4-5	elongate	8-9	11-17	biserial	6-7	absent
reticulata	62	130	79.5-129.0	15.4-30.4	4-7	elongate	8-12	8-11	biserial	6-7	absent
octolineata	75	46	93.3-112.7	25.0-28.3	3-6	elongate	9-11	16-17	biserial	10	absent

1. Tentacular stalk and club robust, suckers on dactylus many and in four rows; carpal cluster round to oval; semilunar membrane present or absent 5

2. Mantle photophores in longitudinal rows only 3
2. Mantle photophores in longitudinal and/or oblique rows 4

3. Eight well-spaced mantle rows, all reaching anterior mantle edge; eight photophore rows on head, second and third lateral rows united posteriorly .... *octolineata*
3. Seven well-spaced mantle photophore rows, only six reaching anterior mantle edge; eight photophore rows on head, none united .... *leptura*

4. Two photophore rows on median part of mantle, oblique photophore rows on sides .... *obliqua*
4. Longitudinal rows and intersecting oblique rows of photophores on mantle (reticulate pattern)............. *reticulata*

5. Midventral photophore rows on head complete; first and second lateral photophore rows unbranched; photophore row on arm III complete 6
5. Midventral photophore row on head incomplete; first lateral photophore row on head divided and reunited; photophore row on arm III incomplete............. 8

6. Eight photophore rows on mantle, distinct for one-third of mantle length; semilunar club membrane present .... *chuni*
6. Six photophore rows on mantle or no rows, photophores scattered; semilunar club membrane absent 7

7. Six photophore rows on mantle, photophores scattered on posterior half of mantle.......................... *theragrae*
7. No photophore rows on mantle, mantle photophores scattered; some areas devoid of photophores .... *galaxias*

8. Mantle photophores not in rows, photophores scattered .... *higginsi*
8. Six longitudinal photophore rows separated by narrow space................ 9

9. Midventral space not extending to tail, this space occupied by scattered photophores near tail ..... *anapsis*
9. Midventral mantle space narrow, extending to tail..... *jonesi*

ACKNOWLEDGMENTS

I am indebted to J. C. Marr and B. J. Rothschild, past directors, and R. S. Shomura, present director, Honolulu Laboratory of the National Marine Fisheries Service (formerly the Biological Laboratory of the Bureau of Commercial Fisheries) at Honolulu, Hawaii, for extending me the use of the facilities of the laboratory, library, and office space during my extended stay in Honolulu. I thank Hazel S. Nishimura, Librarian, for her help and patience in locating cephalopod literature. I also appreciate the hospitality and assistance of the scientific and clerical staff of the laboratory. I give special thanks to E. C. Jones for his efforts to retrieve all the squid material collected in net tows made on the various cruises of the vessels operated by the Honolulu Laboratory between 1967 and 1970 and for ensuring that the material reached me in good condition.

I extend my deepest gratitude to C. F. E. Roper of the Mollusk Division of the U.S. National Museum of Natural History, Washington, D.C., and R. E. Young of the Department of Oceanography, University of Hawaii, Honolulu, Hawaii, both of whom unselfishly gave much attention and expert advice on the systematics of squids and on the preparation of this paper; and to G. L. Voss of the Rosenstiel School of Marine and Atmospheric Science, Miami, Fla., who initially suggested the investigation of the Pacific cephalopod material at the Honolulu Laboratory and who reviewed the manuscript prior to publication—his constructive criticism is greatly appreciated. R. E. Young donated the holotype of *Enoploteuthis higginsi*.

Finally, I sincerely thank T. Okutani of the National Science Museum (Natural History Institute), Tokyo, Japan, and M. Okiyama, University of Tokyo, for examining *E. chuni* specimens and offering their opinions and observations on Japanese *Enoploteuthis*; and W. F. Ponder of the Australian Museum, Sydney, Australia, for allowing me to examine the holotype of *E. galaxias* during my visit to that museum.

LITERATURE CITED

ADAM, W.
1960. Cephalopoda from the Gulf of Aqaba. Sea Fish. Res. Stn., Haifa, Bull. 26:1-26.
1973. Cephalopoda from the Red Sea. Bull.Sea Fish. Res. Stn., Israel, 60:9-47.

BERRY, S. S.
1911. Note on a new *Abraliopsis* from Japan (*A. scintillans*, n. sp.). Nautilus 25:93-94.
1914. The Cephalopoda of the Hawaiian Islands. U.S. Bur. Fish., Bull. 32:255-362.
1918. Report on the Cephalopoda obtained by the F.I.S. "Endeavor" in the Great Australian Bight and other southern Australian localities. Biol. Results Fish. Exper. "Endeavor," 1909-1914, 4:203-298.

HOYLE, W. E.
1910. A list of the generic names of dibranchiate Cephalopoda with their type species. Abh. Senckenb. Naturforsch. Ges. 32:407-413.

ISHIKAWA, C.
1914. Uber eine neue Art von Enoploteuthis, *Enoploteuthis chunii* spec. nov., aus Uwodu, Japanische Meer. J. Coll. Agric. Univ. Tokyo 4:401-413.

KING, J. E., AND I. I. IKEHARA.
1956. Comparative study of food of bigeye and yellowfin tuna in the central Pacific. U.S. Fish Wildl. Serv., Fish. Bull. 57:61-85.

LEACH, W.
1817. Synopsis of the orders, families, and genera of the class Cephalopoda. Zool. Misc. 3:137-141.

NIXON, M., AND P. N. DILLY.
1977. Sucker surfaces and prey capture. *In* M. Nixon and J. B. Messenger (editors), The biology of cephalopods, p. 447-551. Symp. Zool. Soc. Lond., no. 38., Acad. Press, Lond.

OKUTANI, T.
1967. Preliminary catalogue of the decapodan mollusca from Japanese waters. Bull. Tokai Reg. Fish. Res. Lab. 50:1-16.
1968. Studies on early life history of decapodan mollusca.—III. Systematics and distribution of larvae of decapod cephalopods collected from the sea surface on the Pacific coast of Japan, 1960-1965. Bull. Tokai Reg. Fish. Res. Lab. 55:9-57.
1974. Epipelagic decapod cephalopods collected by micronekton tows during the EASTROPAC Expeditions, 1967-1968 (systematic part). Bull. Tokai Reg. Fish. Res. Lab. 80:29-118.

PFEFFER, G.
1900. Synopsis der oegopsiden Cephalopoden. Mitt. Naturhist. Mus. Hamburg 17:145-198.

RANCUREL, P.
1970. Les contenus stomacaux d'*Alepisaurus ferox* dans le sud-ouest Pacifique (Céphalopodes). [In Fr., Engl. summ.] Cah. O.R.S.T.O.M., Ser. Oceanogr. 8(4):3-87.

REINTJES, W. J., AND J. E. KING.
1953. Food of yellowfin tuna in the central Pacific. U.S. Fish Wildl. Serv., Fish. Bull. 54:91-110.

ROPER, C. F. E.
1964. *Enoploteuthis anapsis*, a new species of enoploteuthid squid (Cephalopoda, Oegopsida) from the Atlantic Ocean. Bull. Mar. Sci. Gulf Caribb. 14:140-148.
1966. A study of the genus *Enoploteuthis* (Cephalopoda: Oegopsida) in the Atlantic Ocean with a redescription of the type series, *E. leptura* (Leach, 1817). Dana Rep.

Carlsberg Found. 66, 46 p.
1977. Comparative captures of pelagic cephalopods by midwater trawls. Symp. Zool. Soc. Lond. 38:61-67.

ROPER, C. F. E., AND R. E. YOUNG.
1975. Vertical distribution of pelagic cephalopods. Smithson. Contrib. Zool. 209, 51 p.

SASAKI, M.
1914. Observations on Hotaru-ika *Watasenia scintillans*. J. Coll. Agric. Tohoku Imp. Univ. 6:75-107.
1920. Report on the cephalopods collected during 1906 by the United States Bureau of Fisheries steamer "Albatross" in the northwestern Pacific. Proc. U.S. Natl. Mus. 57:163-203.

SHIMOMURA, T., AND H. FUKATAKI.
1957. On the year round occurrence and ecology of eggs and larvae of the principal fishes in the Japan Sea—I. Bull. Jpn. Sea Reg. Fish. Res. Lab. 6:155-290.

TAKI, I.
1964. On eleven new species of the Cephalopoda from Japan, including two new genera of Octopodinae. J. Fac. Fish. Anim. Husb., Hiroshima Univ. 5:277-330.

YOUNG, R. E.
1978. Vertical distribution and photosensitive vesicles of pelagic cephalopods from Hawaiian waters. Fish. Bull., U.S. 76:583-615.