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THE MAGNAPINNIDAE, A NEWLY DISCOVERED FAMILY OF OCEANIC SQUID (CEPHALOPODA: OEGOPSIDA)

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A peculiar squid paralarva from Hawaiian waters was described by Young (1991, *Bull. mar. Sci*. **49**(1–2): 162–185), but it could not be assigned to any known family. Two larger juvenile specimens have now been obtained, one collected near the surface in the eastern Pacific Ocean and the other rehydrated from a dried specimen originally recovered from the stomach of an *Alepisaurus*. A photograph of the latter specimen before dehydration was found among the unpublished notes of S. S. Berry. The squid are characterized by very large fins that dwarf the rest of the animal. The fins are terminal in position, mostly posterior to the mantle muscle. The tentacles are similar to the arms in general form, but are much more robust. Tentacle suckers are in eight series, whereas the crowded arm suckers constitute more than two series on some arm pairs. The distal portions of the arms and tentacles taper abruptly to thin vermiform filaments. The funnel cartilage of the net-collected juvenile is oval and the buccal connectives to Arms IV are ventral. Although some characters indicate a likely relationship with the chiroteuthid/mastigoteuthid group of families, the brachial crown differs from that found in any known family. Based upon these three specimens and the photograph, it is concluded that the squid represent a family not previously recognized by science. This family is named Magnapinnidae, with the type species *Magnapinna pacifica* n. gen., n. sp., the holotype of which is the net-collected juvenile. Although all three specimens are included in the family and genus, the possibility exists that the paralarva and the rehydrated specimen are not conspecific with the holotype. Therefore, paratypes are not designated.

In a review of the paralarval development of chiroteuthid and related squid from Hawaiian waters, Young (1991) described an unusual squid paralarva from a single specimen captured during an extensive survey of cephalopods in Hawaiian waters. Although it had characteristics that indicated a relationship with the chiroteuthid group of families (Chiroteuthididae, Mastigoteuthididae, Joubiniteuthididae, Batoteuthididae, Promachoteuthididae; see Young 1991), it was clearly distinct from the paralarvae known from those families. Young called the paralarva "bigfin" and proposed that it might represent an unknown family. The specimen is archived in the Santa Barbara Museum of Natural History (SBMNH).

A second, larger, specimen of "bigfin" subsequently was identified from among a small collection of midwater squid taken in the eastern Pacific Ocean by the National Marine Fisheries Service (NMFS) and sent to the NMFS Systematics Laboratory.

Additionally, Mr M. J. Sweeney, at the U.S. National Museum of Natural History (NMNH; USNM in catalogue records), discovered among the unpublished files donated to that museum by the late S. S. Berry, a photograph of a squid that appeared to be a "bigfin". The photograph had neither annotation nor associated notes to indicate the source of the specimen. A thorough search of the preserved squid in the Berry collection at NMNH failed to locate this animal. However, the Berry collection contained, when donated, a large number of jars in which the alcohol had evaporated, leaving the specimens dehydrated. Rather than discard those normally unusable specimens, Sweeney and Dr C. F. E. Roper (Smithsonian Institution) retained any that had labels with associated collection data. A search of the dried collections revealed several candidates for the squid in the Berry photograph. Rehydration of these in Aerosol™ solution allowed identification of one squid as the bigfin in the photograph.

The three specimens and the photograph of one allow description of a new genus and species and the conclusion that the specimens do indeed represent a family previously unknown to science. Because of questions about the conspecific status of the three specimens attributable to differences in size and condition, only one is used as the basis of the new species. Observations on all three, however, contributed to the generic and familial diagnoses below.

In the descriptions below, dorsal mantle length (*DML*) is measured from the dorsal anterior mantle edge to the posterior junction of the fins, rather than to the posterior end of the muscular mantle. Also, because of confusion in the use of "rows" to describe sucker arrangement (longitudinal v. transverse v. oblique), the term "series" is here used to denote the

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Table I: Basic morphometrics of two juvenile bigfin squid

Parameter	Measurement (mm)	
	Magnapinna pacifica (holotype)	*Magnapinna* sp. (Berry specimen)
Mantle length	51	49
Muscular mantle length	16	17
Gladius length*	53	52
Fin length	39	40
Fin width	34	41
Head length	5	4
Head width	7	5
Eye diameter	4	3

*Gladius tip broken and missing in both specimens

approximate number of sucker lines that run lengthwise along the arm or tentacle. This is determined by the number of suckers counted perpendicular to the long axis of the arm or tentacle in a particular region (e.g. near the proximal base of the arm).

SYSTEMATIC ACCOUNT

Magnapinnidae n. fam.

DIAGNOSIS

Oegopsid decapod cephalopods, with relatively small mantle that is thinly muscled. Fins very large and heart-shaped; fin length equals or exceeds squid length from posterior tip of muscular mantle to tips of tentacles; width approximates length. Tentacles short, thick, robust, with fleshy trabecular membranes, but without keels or locking apparatus. Tentacular suckers small and in approximately eight series, except near tentacle bases, where sucker series are fewer. Arms with suckers crowded in 3–4 series at bases. Distal tips of arms and tentacles vermiform. Monogeneric.

Table II: *Magnapinna pacifica* gen. & sp. nov. (Holotype, 51 mm *DML*, USNM 885786). Arm and tentacle measurements of holotype

Parameter	Measurement (mm)			
	Length to terminal sucker		Terminal filament length	
	Left	Right	Left	Right
Arm I	2.3	2.4	2+	1.3+
Arm II	3.9	3.5	2+	2.6
Arm III	2.9	2.7	2.6+	2.9
Tentacle	7.1	7.4	2.2	Undet.
Arm IV	4.8	4.8	2.0	1.3+

Magnapinna n. gen.

DIAGNOSIS

As in family. Currently monotypic, although variability in size and characters among the specimens described below suggests the possibility of more than one species in the genus.

Magnapinna pacifica n. sp.

DESCRIPTION

Holotype

Juvenile, sex undetermined, 51 mm *DML*, NOAA Ship *David Starr Jordan* Cruise 9505, Station 24, 23 April 1995, 17:45, Bongo sampler, Depth 0 – 200 m, 33°49′N, 121°51′W. USNM 885786 (Figs 1, 2, Tables I, II).

EXTERNAL ANATOMY

Owing to the small size of the squid and concern that it may be damaged, especially the vermiform tips of its arms and tentacles, measurements were difficult to make, so they are not very accurate.

Mantle thin-walled, free from head in nuchal region; large nuchal cartilage present. Mantle musculature terminates just posterior (6 mm) to the anterior fin insertion; length from free margin to anterior fin insertion 10 mm. Length of muscular mantle much less than *DML* as usually measured (Roper and Voss 1983). *Gladius* not extracted; elongate, apparently with elongate secondary conus between fins. Gladius extends slightly beyond the posterior edge of fins as short tail; tip broken.

Fins terminal in position; very large, length greater than that of rest of squid, slightly longer than wide but nearly circular in outline and with large, convex anterior lobes. Fins separate throughout length; insert on narrow gladius visible both dorsally and ventrally through skin.

Funnel large; extends anteriorly to level of midpoint of eyes. Funnel free from head dorsally except for funnel adductors that form broad midline band; individual muscles not visible through covering integument; no anterior depression or pit separates muscles. *Funnel cartilage* oval (Fig. 2f), deeply excavated anteriorly, without tragus or antitragus. Mantle cartilage knob-like, near but somewhat posterior to mantle edge (Fig. 2a). Funnel valve present.

Head wider than long; without brachial pillar. Gelatinous ridge present on posteroventral-lateral surface of head (only indication of nuchal crest and folds); adjacent olfactory bulb prominent, white (Fig. 2b). Vesicular

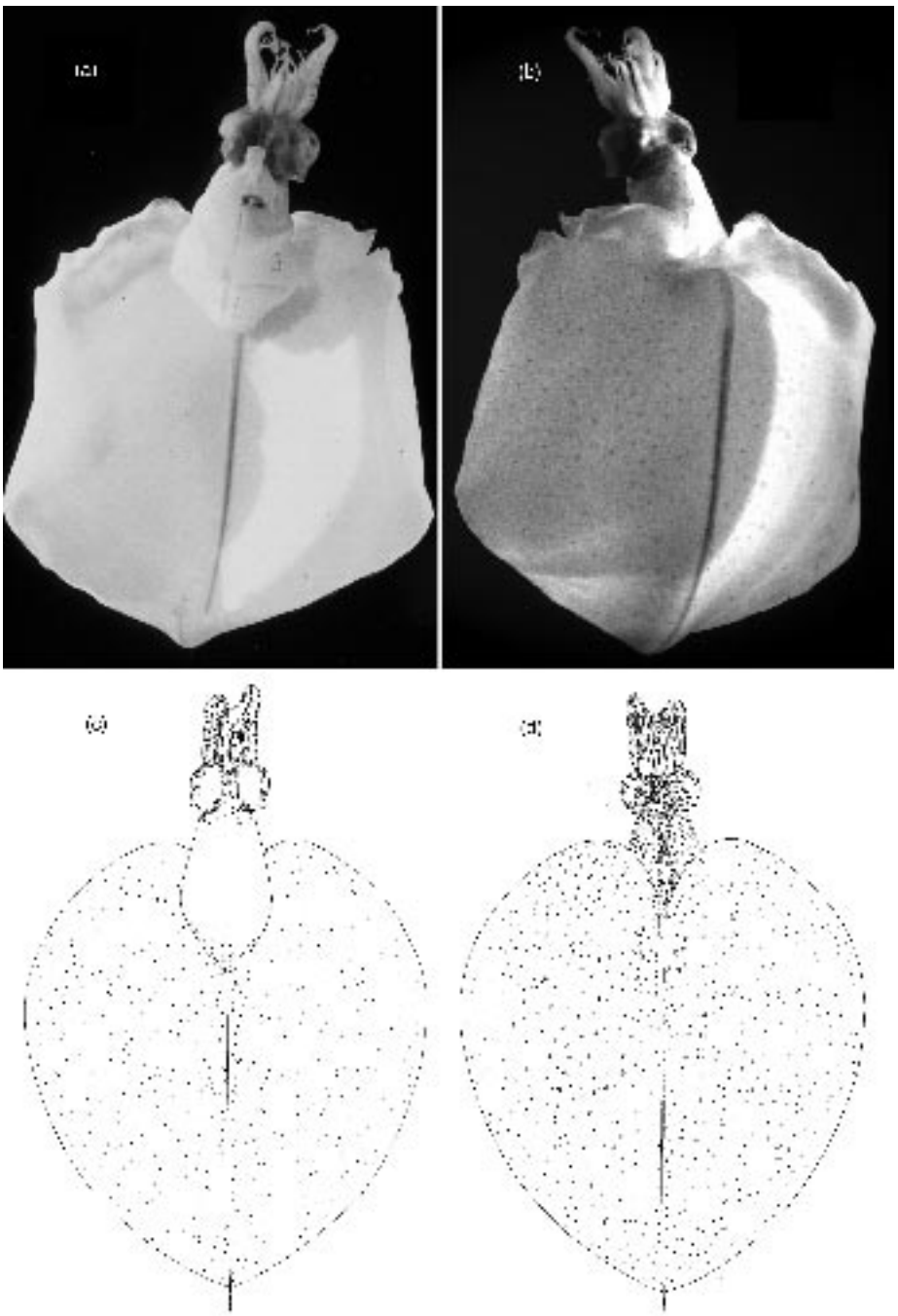

Fig. 1: *Magnapinna pacifica* gen. & sp. nov. (Holotype, 51 mm *DML*, USNM 885786). Photograph of preserved specimen – (a) ventral, (b) dorsal. Drawing of same specimen – (c) ventral, (d) dorsal

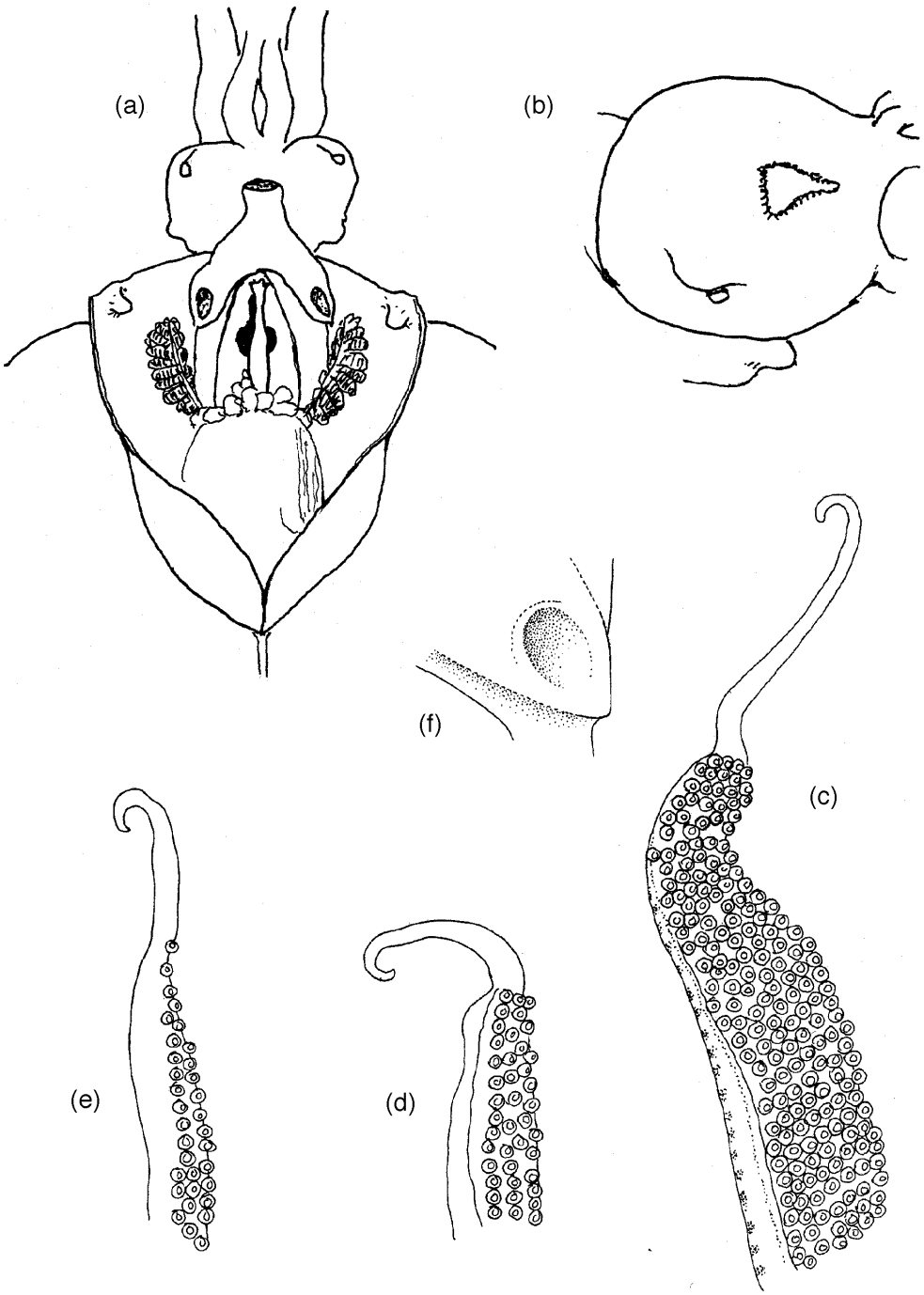

Fig. 2: *Magnapinna pacifica* gen. & sp. nov. (Holotype, 51 mm *DML*, USNM 885786) – (a) internal anatomy, (b) lateral view of head, (c) left tentacle, (d) left Arm III, (e) left Arm II, (f) funnel component of funnel-mantle-locking cartilage

tissue (similar to that in chiroteuthids) absent from head and not apparent elsewhere. *Eyes* large (lens diameter c. 1.7 mm), occupy entire side of head; eyelids with distinct optic sinus. Reflective tissue present on iris of each eye and traces on eyelid and eyeball.

Arms with unique distal filament that is vermiform and devoid of suckers and membranes (Fig. 2d, e). Transition to vermiform filament marked by noticeable decrease in arm thickness and abrupt termination of suckers; transition point not a region of budding suckers. Filament lengths from 30 to 100% of length of the sucker-bearing portion of arms, shortest on Arms IV. Filaments maintain a nearly constant width over much of length. Arm formula, without vermiform filaments, apparently IV>II>III>I. Each Arm IV with a well developed lateral membrane that crosses base of adjacent tentacle. Arm suckers biserial distally, but crowded into 3–4 series proximally on all arms. Suckers slightly larger towards arm bases, with largest about 0.2 mm in diameter, apparently slightly larger than largest tentacular suckers. Outer rings with knobs, no obvious dentition on inner ring can be seen with dissecting microscope. Details of suckers difficult to determine because of minute size. Arms with low, thick, barely recognizable trabeculate, protective membranes.

Tentacles with terminal vermiform filaments (as in arms), otherwise each tentacle essentially all club. Tentacle appearance similar to thick arm, with flat oral surface that bears up to eight irregular series of suckers along much of length. Fleshy trabeculate protective membranes and small suckers extend from base of each tentacle to filament base although suckers are more scattered proximally; at tentacle base, scattered suckers present in roughly two series; sucker series increase to 6–8 at one-third of tentacle length from its base (minus filament). Transition to vermiform filament marked by abrupt decrease in tentacle width (more pronounced than in arms); transition area not a growth zone. Tentacles lack keels, terminal pads and division into dactylus, manus and carpus (Fig. 2c).

Buccal crown ventral connectives attach to ventral margins of Arms IV. Buccal supports low; number uncertain. Buccal mass large, positioned dorsally; protrudes from the midpoint of the brachial crown.

Pigmentation in form of chromatophores scattered over head, funnel, dorsal mantle, dorsal and ventral surfaces of fins, and aboral surfaces of arms and tentacles (Fig. 1). Ventral mantle lacks chromatophores, except near posterior end and anterior margin. Pigmentation absent from buccal crown and lips. Chromatophores densest on dorsal surface of head and dorsal surface of muscular mantle anterior to fins. Chromatophores brown and apparently normal (i.e. functional); no epithelial pigmentation apparent. *Photophores* apparently absent.

INTERNAL ANATOMY (Fig. 2a).

Viscera situated well anteriorly within confines of muscular mantle. *Branchial hearts* located in anterior one-third of mantle cavity. *Gills* with branchial canals. *Funnel- and head-retractor muscles* fused into single thin sheet on each side, S-shaped in cross-section, closely enveloping digestive gland.

Digestive gland short, broad; abuts cephalic cartilage. Digestive-gland-duct appendages large and vesicular. *Intestine* anterodorsal and left of anteriormost nephridial appendages. (In other families, this generally indicates position of vena cava, which is not visible.) *Anal flaps* very small. *Ink sac* small, with patch of reflective tissue present on ventral surface.

Visceropericardial *coelomic sac* occupies posterior two-thirds of mantle cavity. Sex undetermined. Beak and radula not removed.

ETYMOLOGY

Young (1991) named the paralarva “bigfin”; the Latin *Magna* (Big) *pinna* (fin) has been adopted as the generic name. The specific name refers to the oceanic distribution of the species.

COMMON NAME

Bigfin.

Paralarva

19.1 mm *DML*. Collected off Oahu, Hawaiian Islands. SBMNH 144791 (Fig. 3). The description below, abbreviated from that of Young (1991, p. 180), is included for comparison with larger specimens.

EXTERNAL ANATOMY

Mantle wall thin. *Fins* terminal. Posterior mantle overlaps anterior fins by 15% of fin length. Fin length equals width (10.9 mm). Anterior fin margins rounded, lobes lacking. Posterior margins concave on each side, forming tail with gladius. *Gladius* extends posteriorly well beyond fins. *Head* with large eyes that protrude ventrally. *Eyes* abut arm bases. Small knob on posterolateral surface of each eye. *Tentacles* short and broad, width nearly 50% of length; trabecular membranes present, but dorsal keels absent. Tentacular suckers in two series at base, then grading to 7–8 series with numerous buds near tips. All *arms* shorter than tentacles, arm lengths: I=II>IV>III. Arm suckers in two series on Arms I and II, but 3–4 series on Arms III and IV. Tips of all arms and tentacles bare and attenuate.

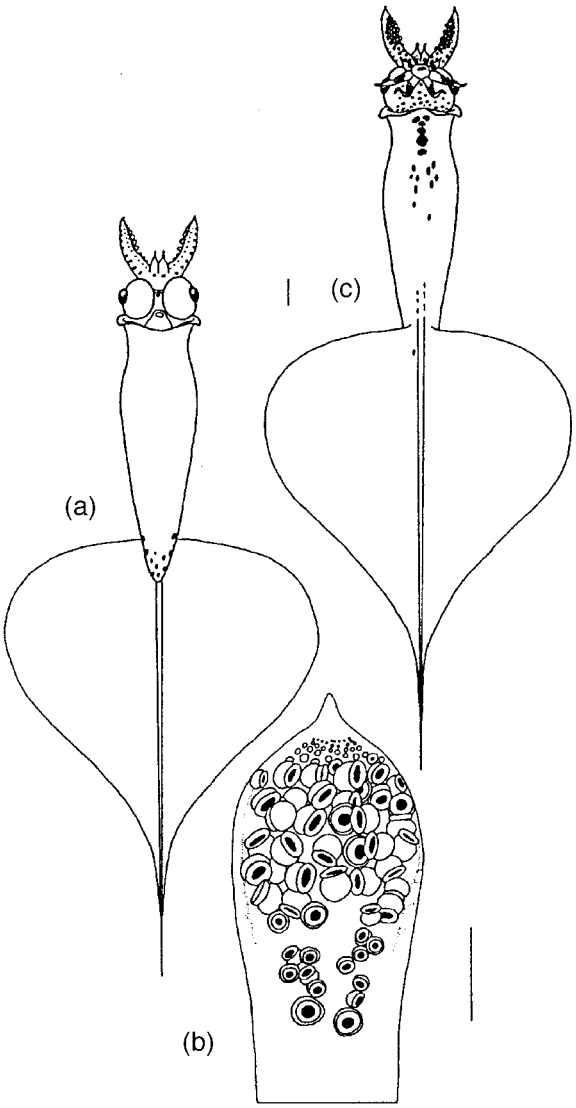

Fig. 3: *Magnapinna* sp. paralarva (19 mm *DML*, SBMNH 144791) from Hawaiian waters (after Young 1991) – (a) ventral, (b) tentacle, (c) dorsal

Connectives of *buccal membrane* to ventral arms not determined. *Pigmentation* in three series of chromatophores on aboral surface of tentacles; few chromatophores scattered near base on oral surface. One chromatophore at base of each Arm III and IV and one on ventral midline of head. Patch of chromatophores on posterior end of ventral mantle. Dorsal surfaces of head and mantle with scattered chromatophores.

INTERNAL ANATOMY

Funnel cartilage not well defined, but with broad, shallow, straight depression. Funnel adductors fused. *Digestive gland* broadly rounded, but spindle-shaped and orientated obliquely to body axis.

Juvenile

Sex undetermined, 49 mm *DML*, from stomach of an *Alepisaurus* caught at 30º22′N, 129º45′W on 18 March 1954 by J. E. Fitch, USNM 885787 (Fig. 4, Table I).

Although no longer hard, the rehydrated specimen is still stiff and brittle. The arm filaments, etc., broke when they were manipulated for measurement. The photograph, taken of the squid in ventral aspect before it was dehydrated, therefore forms the primary basis for the description below. The rehydrated specimen matches the photograph in the following aspects: tail bent laterally, holes in fins, vermiform arm tips, and general proportions. It differs from the holotype in two respects not obvious from the photograph:

(i) demarkation between arm bases and filaments is not as pronounced;
(ii) arm filaments possess very tiny suckers, although tentacle filaments do not.

EXTERNAL ANATOMY

Mantle small; weakly muscled. *Fins* very large, terminal, overlap posterior one-third of mantle; with large anterior lobes. Fin length approximately equals mantle, head and tentacle length together; width slightly greater than length; heart-shaped, although edges torn. *Gladius* visible between fins; forms small tail (bent laterally) posterior to fins. *Funnel* large, extends anteriorly to level of midpoint of eyes. *Head* elongate; slightly wider than mantle, somewhat longer than wide. *Eyes* large, anterolateral on head. *Arms* and *tentacles* vermiform distally. Tentacles robust, longer than arms. Large keel present on Arms IV. Keels appear absent on tentacles. Obvious *photophores* lacking.

DISCUSSION

Similar species

These squid are somewhat similar in overall appearance to another species with a very large fin, *Chiroteuthopsis talismani* Fischer and Joubin, 1906. The latter species is known only from the holotype, which

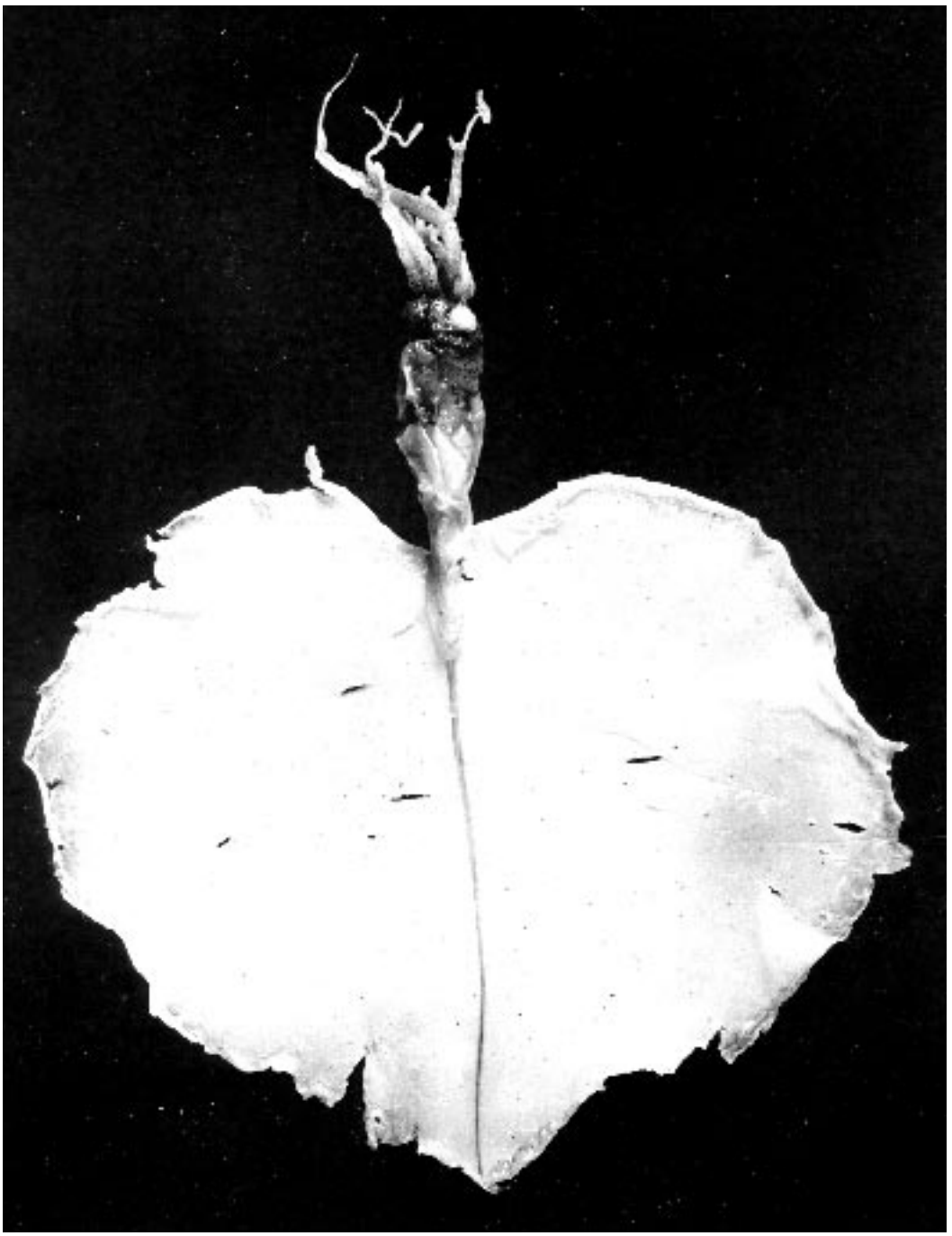

Fig. 4: *Magnapinna* sp. juvenile (49 mm *DML*, USNM 885787). Photograph from the archives of S. S. Berry of ventral view of specimen from the stomach of an *Alepisaurus*

has been examined by the present authors. Although the general proportions of the fins and mantle are similar to those of *Magnapinna*, the brachial crown differs substantially. Tentacle diameter on *C. talismani* is much less than that of the arms. Arm suckers are many times the diameter of the tentacle suckers, which are extremely minute and not crowded on the tentacles. The tips of all arms and tentacles are missing, so it is impossible to determine whether vermiform filaments were present. It is not clear to what family *C. talismani* properly belongs, but it is not congeneric and probably not confamilial with *M. pacifica*.

Comparison of specimens

Although the mantle lengths of the two juveniles are similar, the effects of digestive processes and dehydration/rehydration on the size of Berry's specimen are unknown. Because of differences in proportions (e.g. the relative sizes of eyes, head and anterior fin lobes) and the development of suckers on the arm filaments, it is suspected that Berry's specimen was somewhat more advanced in development than the NMFS specimen. Possibly, though, the specimens are not conspecific, but they are certainly congeneric.

The holotype differs most markedly from the paralarva in the following respects:

(i) shorter mantle relative to the fin length;
(ii) the presence of anterior fin lobes;
(iii) the shorter tail;
(iv) the form of the funnel-locking apparatus;
(v) the greater development of the vermiform filaments.

These differences, presumably, are attributable to ontogenetic changes. Because of these differences, however, combined with the lack of specific features such as sucker dentition, it is not possible to be certain that the Californian and Hawaiian specimens belong to the same species.

Familial relationships

This squid shares three important features with the "chiroteuthid families" (i.e. Chiroteuthididae, Mastigoteuthididae, Joubiniteuthididae, Promachoteuthididae, Batoteuthididae):

(i) the ventral attachment of the buccal connectives to Arms IV;
(ii) gladius with an apparently elongate secondary conus (except Promachoteuthididae);
(iii) the absence of the "teuthoid" tentacular club.

Some characters are especially similar to those of mastigoteuthids and chiroteuthids. These latter two families have large terminal fins which extend well beyond the posterior end of the mantle (a character also shared with lepidoteuthids), and they have oval funnel-locking cartilages, but usually with protrusions (tragus and antitragus) that are lacking in the new family. However, the brachial crown of this new species is very different from that of either family. In particular, the robust tentacles and vermiform tips of the arms and tentacles are unique. The fins of *Magnapinna* are much larger, relative to the mantle length, than those of any known mastigoteuthid. Young (1991) showed numerous differences in paralarval morphology between this species and those known of the families of the chiroteuthid group.

One of the most peculiar features of *Magnapinna* is the presence of long vermiform filaments on the arms and tentacles. These are somewhat similar to the bare arm tips of some planktonic hatchling octopodids (Hochberg *et al*. 1992) and the elongate arm tips of the fossil "teuthoid" *Mastigophora* (Vecchione *et al*. in prep.). The function of the filaments is unknown in all cases and, for now, a credible one is not proposed for this new family.

The paralarva was caught off Hawaii, the holotype off California, and Berry's specimen between those two locations. If they are all the same species, it can be defined as a widespread species that is rarely collected. The Bongo sampler that collected the holotype was towed obliquely through the upper 200 m of the water column (D. Woodbury, NMFS, Tiburon, California, pers. comm.). The lancetfish *Alepisaurus ferox* commonly feeds on mesopelagic squid (e.g. Rancurel 1970, Okutani and Tsukada 1988). Midwater cephalopods have been extensively sampled in these areas (e.g. Okutani and McGowan 1969, Young 1972, 1978, 1995, Okutani 1974). The dearth of *Magnapinna* specimens in previous collections indicates that they are either very rare, very good at avoiding samplers or stray from a rarely sampled habitat (e.g. near bottom in deep water).

ACKNOWLEDGEMENTS

We thank Mr D. Woodbury who collected the NMFS specimen, Mr M. J. Sweeney for finding the photograph and, together with Dr C. F. E. Roper, for the foresight of saving the dehydrated lots, Ms M. Ryan (Smithsonian Institution) for restoring and reproducing Berry's photograph, and Ms K. Hiratsuka Moore (NMFS Systematics Laboratory, Washington, D.C.) for executing the detailed artwork of Figs 1c, d and 2c-f. Dr C. C. Lu (National Chung Hsing University, Taiwan)

suggested that we examine *Chiroteuthopsis talismani*, and Dr R. Boucher-Rodoni (Museum National Histoire Naturelle, Paris) arranged the loan of the specimen. Drs C. F. E Roper and D. Khromov (ICF/EKO, Moscow) and an anonymous reviewer provided helpful comments on earlier drafts of this paper.

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