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Cephalopods
of the
Philippine Islands

GILBERT L. VOSS

SMITHSONIAN INSTITUTION
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This work forms number 234 of the *Bulletin* series.

FRANK A. TAYLOR,
Director, United States National Museum.



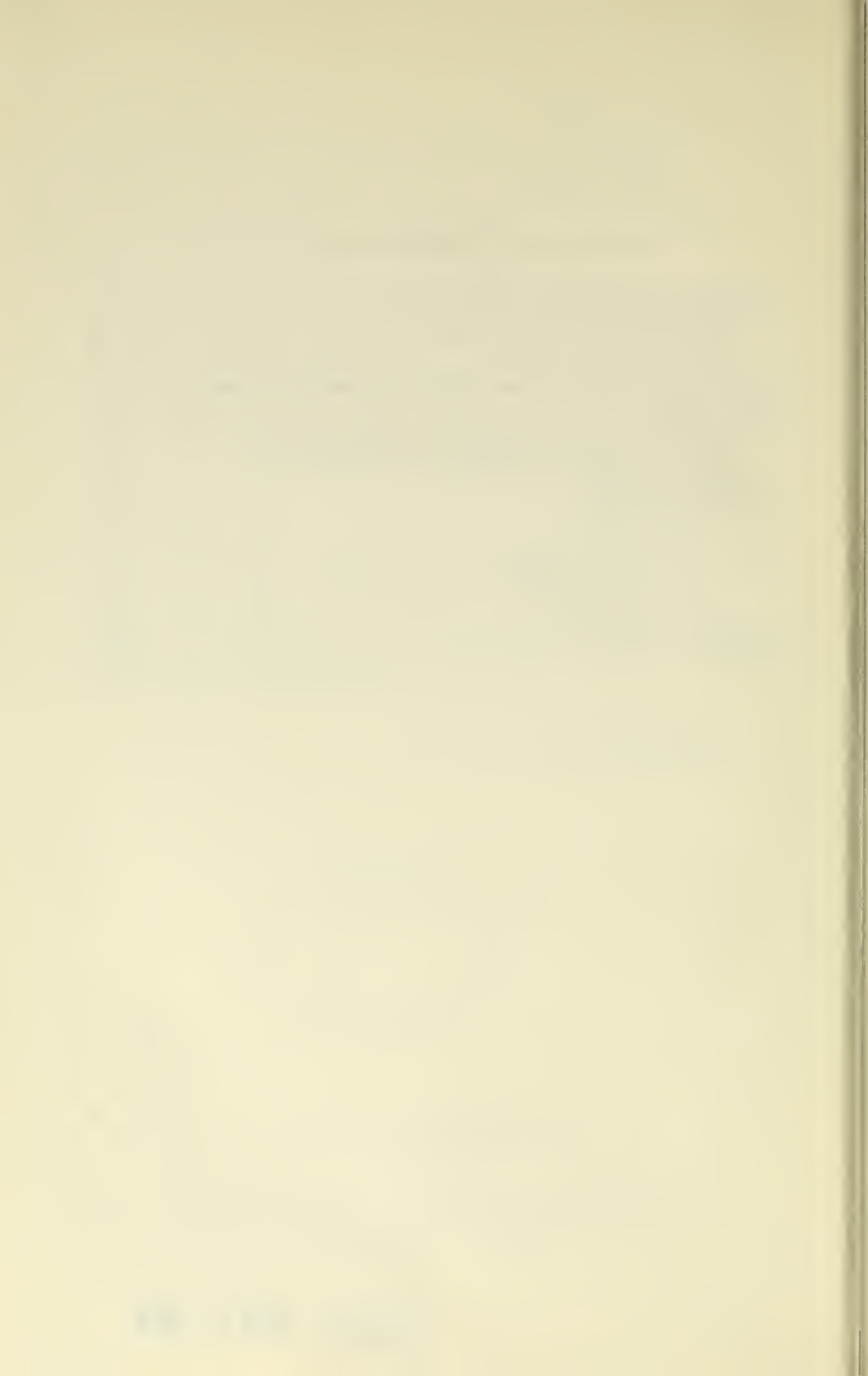
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Cephalopods of the Philippine Islands

Introduction

This report is based mostly on the extensive collections of cephalopods made by the United States Fisheries steamer *Albatross* between December 1907 and September 1909 in the Philippine Islands and adjacent seas, and deposited in the United States National Museum.

The Philippine cruise was under the direction of Dr. Hugh M. Smith, then Deputy Commissioner of Fisheries. The late Dr. Paul Bartsch, formerly Curator of Mollusks, U.S. National Museum, made many of the cephalopod collections and I am greatly indebted to him and his assistants for the accurate labeling of the collections and the numerous supplementary notes which have proved invaluable during this study.

Collections of cephalopods taken at numerous trawling and dredging stations were extensively supplemented by shore collections made both by hand and by shore seines. In addition several valuable specimens were obtained from local fish markets.

Dr. Bartsch made frequent night use of a submarine electric light. This light, now in the possession of the U.S. National Museum, was enclosed in a heavy waterproof brass-bound glass casing. According to Dr. Bartsch, the light was lowered several hundred feet below the surface and then gradually hauled upward, bringing with it many species not easily taken at the surface. The efficacy of this type of collecting, now in use on most oceanographic vessels, is well demonstrated by the large number of specimens bearing the legend "electric light."

Forty-six species of cephalopods were collected during this cruise, from northern Luzon to Mindanao, the southern Sulu Archipelago, and Balabac, south of Palawan.¹ Of these, eight are species new to

¹ Geographic place names given in this report were taken from pin labels and some are no longer current; a few obvious misspellings and inconsistencies were corrected.

science and two represent new subspecies. Records are given also of all species of cephalopods reliably reported in the literature as occurring in the Philippine Islands. This brings the total number of species now known to occur in this region to 54, an increase of 43 species resulting from the present study.

During the course of this study I also drew freely on the collections of the U.S. National Museum for comparative material, material consisting in the main of the collection of cephalopods from the Japanese Islands made by the *Albatross* and reported on by Madoka Sasaki. Direct comparison of this material with the Philippine specimens has greatly facilitated the conclusions given. For certain other supplementary material, I am indebted to Mr. Inuncio Ronquillo of the Bureau of Fisheries, Manila.

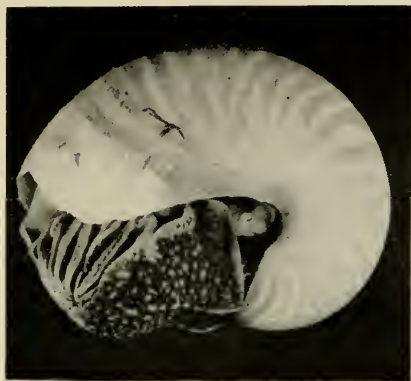
A short period of research in the British Museum in London permitted me to examine several types whose relations to the Philippine species were in doubt. For permission to examine these collections I wish to thank the authorities of the British Museum, Mr. Ian Galbraith, presently in charge of the mollusk collections, and especially Dr. W. J. Rees, formerly in charge of the cephalopod collections, who gave valuable assistance and advice and made available several rare volumes for reference.

I am especially indebted to Dr. Harald A. Rehder, Curator of Mollusks, U.S. National Museum, for pointing out the need for this work, for placing the collections at my disposal, and for affording working room in his department during my study at that institution. He also offered many suggestions and has critically read the manuscript. My colleague, Dr. C. Richard Robins, Curator of Fishes, Marine Museum, The Marine Laboratory, made valuable suggestions on nomenclatural problems.

To my wife, Nancy A. Voss, must go special thanks for the illustrations accompanying this work. Their accuracy is such that comparative measurements may be taken directly from the drawings, and details have been faithfully executed. Many minor discrepancies were noted by her while drawing, and the descriptions of the specimens are more accurate and exact owing to her marginal notes on the working sheets. Her constant encouragement is gratefully acknowledged.

The excellent photographs are the work of Mr. Walter R. Courtenay, of The Marine Laboratory.

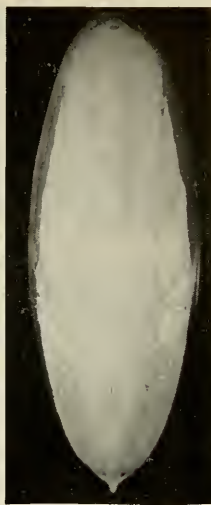
Dr. Grace E. Pickford, of the Bingham Oceanographic Laboratory, Yale University, placed at my disposal a copy of her unpublished manuscript revision of the octopods of the Indo-Malayan region based on the collections of the British Museum. This work has been of invaluable assistance in the identification of the octopods in the collections.



a



b



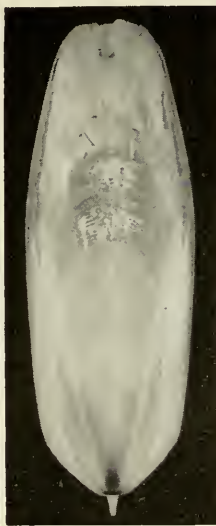
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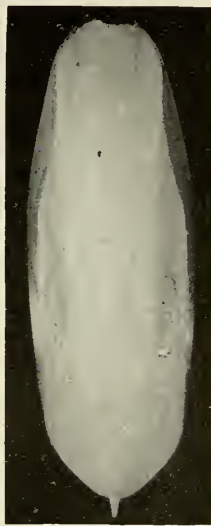
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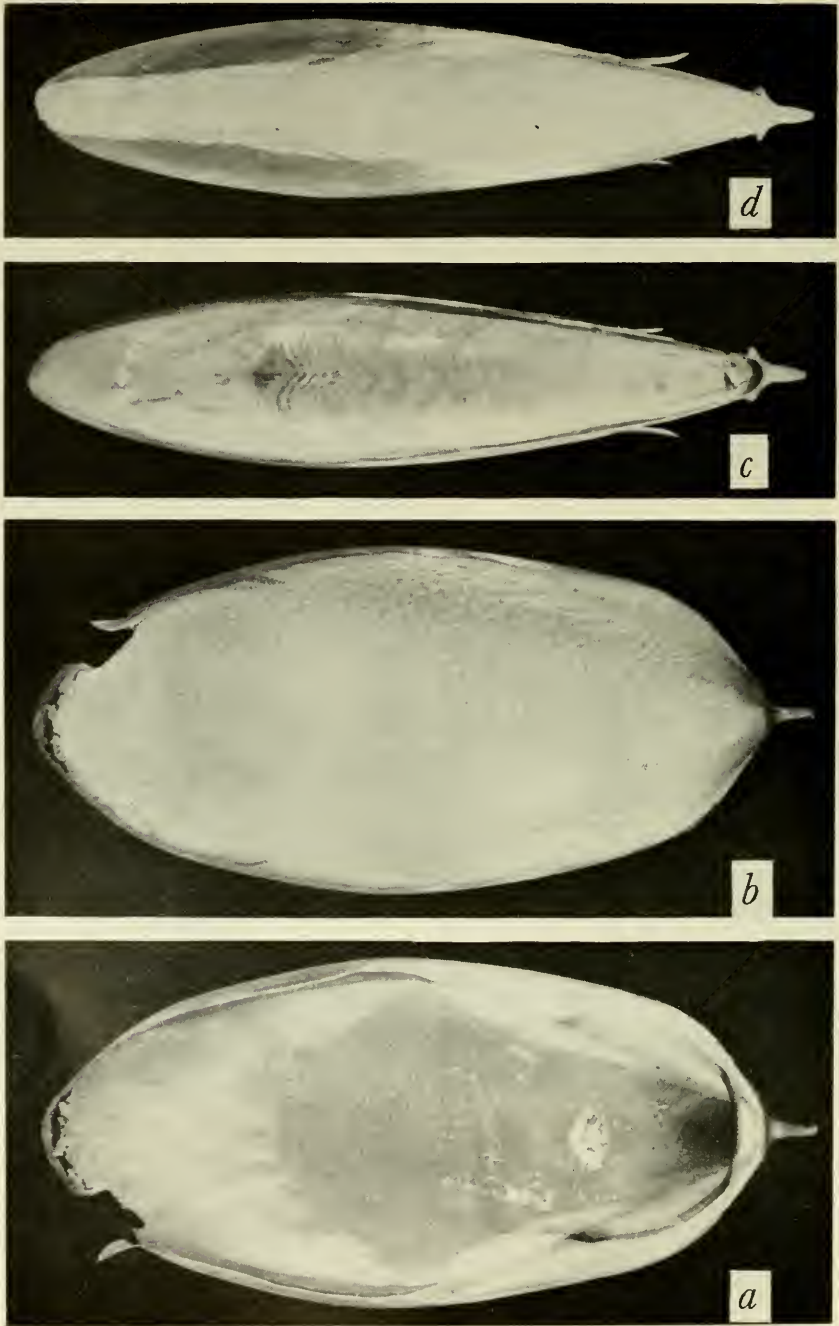


f



g

a, *Nautilus pompilius* Linnaeus, lateral view. b, c, *Sepia pharaonis* Ehrenberg: b, ventral view of shell, length 110.0 mm.; c, dorsal view. d, e, *Sepia latimanus* Quoy and Gaimard: d, ventral view of shell, length 81.0 mm.; e, dorsal view. f, g, *Sepia prionota*, Voss; f, ventral view of shell, length 60.0 mm.; g, dorsal view.

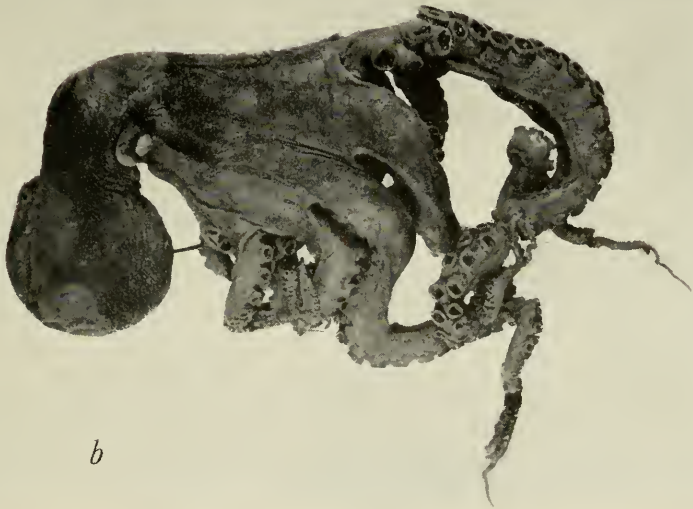


SPECIES OF SEPIA

a, b, Sepia esculenta Hoyle: *a*, ventral view of shell, length 58.0 mm.; *b*, dorsal view. *c, d, Sepia andreana* Steenstrup: *c*, ventral view of shell, length 50.0 mm.; *d*, dorsal view



a



b

SPECIES OF OCTOPUS

a, *Octopus horridus* d'Orbigny, dorsal view of female, mantle length 50.0 mm. b, *Octopus macropus* Risso, dorsal view of male, mantle length 90.0 mm., showing ligula.



OCTOPUS TEUTHOIDES ROBSON

Mantle length 14.3-17.0 mm.

Finally, I wish to thank the National Science Foundation for a 2-year grant (G-2901) in support of this study and for the assistance which permitted the visit to the British Museum in 1958 in conjunction with the 15th International Congress of Zoology. This paper constitutes a technical report to the National Science Foundation.

Historical Summary

The cephalopods of the Philippine Islands have been largely ignored by previous workers. There are no papers dealing specifically with Philippine cephalopods with the exception of the description of *Uroteuthis bartschi* by Rehder. A time-consuming survey of the cephalopod literature yielded few records though undoubtedly some have escaped the writer's notice.

The first mention of Philippine cephalopods apparently, upon the authority of d'Orbigny, was *Rossia subalata* described by Gervais and Van Beneden (1838) from Manila. Ferussac and d'Orbigny, in their classic monograph (1834-48) added only two more, *Octopus rugosus* and *Octopus aculeatus*.

Tryon (1879) listed *Octopus aculeatus* and *Loligo subalata* (= *Rossia subalata*) from Manila, both described by Ferussac and d'Orbigny.

In 1881, Steenstrup listed the pygmy squid, *Idiosepius pygmaeus* from Zamboanga.

Although the *Challenger* Expedition passed through the Philippine Islands, Hoyle (1886) reported only two species from those waters: *Octopus granulatus* from Manila and the type of *Loligo galathea* from off the island of Panay.

In 1896, Castro de Elera published a systematic catalog of the fauna of the Philippines in which are listed thirty-one species of cephalopods. According to Hidalgo (1905, pp. 4-5), de Elera was not a naturalist and had at his disposal only Tryon's "Manual of conchology," Paetel's "Catalogue," Semper, some of Hidalgo's works, Möllendorff, and Boettger. De Elera's work is quite defective and he did not cite sources for localities and identifications; it has been ignored for systematic purposes by later workers. The de Elera species are:

<i>Octopus pusillus</i>	<i>L. duvaucelii</i>
<i>O. aculeatus</i>	<i>L. hardwickei</i>
<i>O. membranaceus</i>	<i>L. chinensis</i>
<i>Tremoctopus dubius</i>	<i>L. sumatrensis</i>
<i>Argonauta hians</i>	<i>Sepioteuthis lessoniana</i>
<i>A. kochiana</i>	<i>S. blainvilleana</i>
<i>A. argo</i>	<i>Sepiola penares</i>
<i>A. nodosa</i>	<i>S. bursa</i>
<i>Loligo galatena</i> [sic]	<i>Loligopsis cyclura</i>
<i>L. subalata</i>	<i>L. ocellata</i>

<i>Abralia armata</i>	<i>S. pagenstecheri</i>
<i>Onychoteuthis banksi</i>	<i>S. sinope</i>
<i>Sepia dabryi</i>	<i>S. inermis</i>
<i>S. elongata</i>	<i>S. tuberculata</i>
<i>S. latimanus</i>	<i>Nautilus pompilius</i>
<i>S. lycidas</i>	

Although a number of the species in the above list have been recorded from the Philippines in this report, the museum of the Universidad de Santo Tomas de Manila was burned by the Japanese and the collections destroyed, so that no check can be made of de Elera's species.

Joubin (1902) in his revision of the Sepiolidae mentioned only *Inioteuthis rossiaeformis* from the general area of the Philippines.

In 1905 Hidalgo published his "Catalogo de los Moluscos de las Islas Filipinas, Joló, y Marianas." Besides criticizing de Elera's list, he gave the following list of Philippine species:

<i>Argonauta boettgeri</i>	<i>A. oweni</i>
<i>A. compressa</i>	<i>A. tuberculata</i>
<i>A. gondola</i>	<i>Spirula peronii</i>
<i>A. hians</i>	<i>Nautilus pompilius</i>

Faustino (1928) published a list of Philippine marine and fresh-water mollusks in which he stated that 12 cephalopods were known from the islands, of which he listed 8 shell-bearing species:

<i>Nautilus pompilius</i>	<i>A. oweni</i>
<i>Argonauta boettgeri</i>	<i>A. tuberculata</i>
<i>A. compressa</i>	<i>A. hians</i>
<i>A. gondola</i>	<i>Spirula peronii</i>

Sasaki (1929) in his monograph on the cephalopods of Japan included species from the island of Formosa, but despite its proximity to the Philippine Archipelago only two species, *Euprymna berryi* and *Sepia torosa*, were recorded from our area. In the same year Robson published his monographic study of the octopods in which *Octopus niveus* was listed from the Philippines. In the second volume published in 1932 he reported *Argonauta hians*, *A. boettgeri*, and *A. nodosa*.

According to Boone (1938), the Vanderbilt expedition took specimens of *Loligo indica* from Cebu and *Onychoteuthis banksi* from Mindanao, and in 1939 Adam, in his revision of the Sepiidae, noted *Sepia torosa* and *Sepia papuensis*, the latter on the authority of Joubin.

To complete our survey we have only to mention the description of *Uroteuthis bartschi* by Rehder, published in 1945.

In considering the known species of Philippine cephalopods, de Elera's list is omitted from our discussion inasmuch as the identities are in doubt and we are unable to verify them because no distinguishing characters were given. The names of species as given by the various authors previously mentioned (including de Elera) are listed below, together with their modern equivalents.

Name by previous author	Modern equivalent
<i>Nautilus pompilius</i>	<i>Nautilus pompilius</i>
<i>Spirula peronii</i>	<i>Spirula spirula</i>
<i>Sepia torosa</i>	<i>Sepia pharaonis</i>
<i>S. papuensis</i>	<i>S. papuensis</i>
<i>Inioleuthis rossiaeformis</i>	? <i>Inioleuthis rossiaeformis</i>
<i>Euprymna berryi</i>	? <i>Euprymna berryi</i>
<i>Idiosepius pygmaeus</i>	<i>Idiosepius pygmaeus</i>
<i>Rossia subalata</i>	? <i>Loligo sumatrensis</i>
<i>Loligo galatheae</i>	<i>L. duvauceli</i>
<i>L. indica</i>	? <i>L. etheridgei</i>
<i>Uroteuthis bartschi</i>	<i>Uroteuthis bartschi</i>
<i>Onychoteuthis banksi</i>	<i>Onychoteuthis banksi</i>
<i>Octopus niveus</i>	<i>Octopus niveus</i>
<i>O. aculeatus</i>	<i>O. niveus</i>
<i>O. rugosus</i>	? <i>O. vulgaris</i>
<i>O. granulatus</i>	? <i>Octopus</i> sp.
<i>Argonauta boettgeri</i>	<i>Argonauta boettgeri</i>
<i>A. oweni</i>	<i>A. boettgeri</i>
<i>A. compressa</i>	<i>A. argo</i>
<i>A. gondola</i>	<i>A. hians</i>
<i>A. hians</i>	<i>A. hians</i>

Certain species in this corrected list seem in doubt because of the uncertainty of the identifications or the brevity of the descriptions. Among those that appear to me to be unworthy of inclusion are *Spirula spirula*, based on shells alone, *Euprymna berryi* whose identity can easily be confused with other closely related species, and *Inioleuthis rossiaeformis* which I consider on present knowledge to be an uncertain species. *Rossia subalata* (= ?*Loligo sumatrensis*) has never been verified and could be anything, while *Loligo etheridgei*, from the standpoint of the discussion in the systematic section of this paper, may be *L. edulis*. The identity of *Octopus granulatus* is problematical. In summary, only 11 species can be said to be known with certainty from the Philippine area prior to this report.

Relationships of the Philippine Fauna

The Philippine cephalopod fauna is very diversified and contains elements from most of the areas of the Indo-Pacific. Little of a definitive nature can be given without a great deal more study. There are no endemic families or genera, and little reliance can be placed

upon the few endemic species because in all likelihood extensive collecting in the Indo-Malayan region will show that the present endemic species have a wide range.

The endemic species and subspecies from the Philippines are:

<i>Sepia prionota</i>	<i>Sepiolo trirostrata</i>
<i>Sepiadarium gracilis</i>	<i>Loligo</i> sp. A
<i>Euprymna phenax</i>	<i>Doryleuthis reesi</i>
<i>E. albatrossae</i>	<i>Calliteuthis celetaria pacifica</i>
	<i>Nototodarus sloani philippinensis</i>

Before 1954, when Adam published his final *Siboga* report, *Uroteuthis bartschi* would have been added to the list, but he showed that it also occurs in Indonesia. As to be expected, the endemic species are mainly Sepioidea, whose species, with the exception of those of the genus *Sepia*, tend toward localization. *Idiosepius pygmaeus* also shows a tendency towards local variation, but on the basis of this study the Philippine forms do not warrant nomenclatural separation. *Calliteuthis celetaria* is a widely distributed bathypelagic species. The form named from the Philippines undoubtedly represents the Indo-Pacific branch, distinct from the Atlantic form. *Nototodarus sloani philippinensis* I consider to be the Indo-Malayan form of this widely distributed species.

Of the remaining 43 species, the 13 listed below are worldwide in distribution in warm and temperate seas:

<i>Onychoteuthis banksi</i>	<i>Japetella diaphana</i>
<i>Octopoteuthis sicula</i>	<i>Eledonella pygmaea</i>
<i>Calliteuthis meleagroteuthis</i>	<i>Octopus macropus</i>
<i>Cranchia scabra</i>	<i>O. vulgaris</i>
<i>Liocranchia reinhardti</i>	<i>Argonauta argo</i>
<i>Taonius pavo</i>	<i>A. hians</i>
<i>Bathothauma lyromma</i>	

These forms are either pelagic or bathypelagic as adults or, like *Octopus vulgaris* and *O. macropus*, they have planktonic larvae.

Seventeen species may be considered to belong to the Indo-Pacific fauna although in some cases their presence on the East African coast has not been demonstrated:

<i>Nautilus pompilius</i>	<i>Chiroteuthis imperator</i>
<i>Sepia pharaonis</i>	<i>Symplectoteuthis oualaniensis</i>
<i>S. latimanus</i>	<i>Mastigoteuthis cordiformis</i>
<i>Euprymna stenodactyla</i>	<i>Octopus membranaceus</i>
<i>E. morsei</i>	<i>O. horridus</i>
<i>Loligo duvauceli</i>	<i>O. teuthoides</i>
<i>Sepioteuthis lessoniana</i>	<i>Argonauta nodosa</i>
<i>Abralia andamanica</i>	<i>A. böttgeri</i>
<i>A. spärcki</i>	

The following distinctive species, according to our present knowledge, are members of the Indo-Malayan province:

<i>Sepia papuensis</i>	<i>Uroteuthis bartschi</i>
<i>S. recurvirostris</i>	<i>Doryteuthis singhalensis</i>
<i>Iniotheuthis maculosa</i>	<i>Abralia armata</i>
<i>Idiosepius pygmaeus</i>	<i>Cistopus indicus</i>

Abralia armata probably will be found over much of the Indo-Pacific area when more thorough collecting has been done, but the others, belonging to the Sepioidea and the myopsid teuthoids, again tend to be more restricted in distribution.

If to these Indo-Malayan species we add the endemic species, whose closest relations are with the Indo-Malayan species, it is apparent that the cephalopods of the Philippines have strong affinities with the Indo-Malayan faunal province, and most workers have agreed that the archipelago is part of this province. Certainly the cephalopod fauna shows strong Indo-Malayan affinities but at the same time it shares five species exclusively with Japan:

<i>Sepia esculenta</i>	<i>Sepiolina nipponensis</i>
<i>S. andreana</i>	<i>Loligo edulis</i>
<i>Rossia bipapillata</i>	

Adam (1954) discussed the possibility that *Loligo edulis* may be the end of a cline with *L. etheridgei* Berry from Australia at the other end. At present, for reasons given in the systematic section (p. 70), I prefer to keep them separate. *Rossia bipapillata* is a questionable species that may be a geographical variant of Chun's *R. mastigophora* which has a wide distribution. *Sepia esculenta*, *S. andreana* and *Sepiolina nipponensis* appear to be restricted to Japan and the Philippines.

Much more collecting is needed in the Philippine Islands before the zoogeographical picture can be completed. Differences and distribution within the archipelago can only be worked out with intensive collecting and statistical treatment of large series of specimens.

Fisheries

The people of the Philippine Islands have long eaten octopus, squid, and cuttlefish, and these animals are found in fish markets in Manila and in the other towns and villages of the archipelago. Bartsch (1917), who accompanied the *Albatross* on the Philippine expedition, has given the interesting account of an octopus hunt by torchlight quoted below.

The simplest method, probably, is that used by the Filipinos. Well do I recall my first octopus hunt with them in the southern islands. It was a dark night. The good ship *Albatross* lay peacefully at anchor some half mile off a Moro village, whose dim outline was faintly silhouetted against the sky. We had just finished

our dinner, returned to the deck to take up submarine light fishing, when we noticed a torchlight procession proceeding from the village down the sand spit that fringed a reef. The orderliness of the procedure soon changed to what at our distance might have [been] considered some wild ceremonial dance.

Our curiosity being thoroughly aroused, we lowered a boat and soon joined the party of men and boys, who were clad in the conventional G-string costume, each provided with a torch varying from about 4 to 6 inches in diameter and probably 10 to 12 feet in length, made of slender segments of dried, split bamboo, carried on the left shoulder, held by the left hand, and lighted in front. The right hand was reserved for the ever-present bolo or a spear. The light of these torches would show through the shallow water and thus reveal the luckless devil fish, which seemed to have forsaken the secure caverns of the reef and to have gone a-hunting on the shallow flats within. They are curious creatures, and their humped up attitude and large eyes render them rather mirth provoking at such times. But there is little time given to contemplating, for a native bolo or spear brings him in and he is promptly strung on a rattan string, where he may continue to squirm with his fellow captives until dead.

Thelma Jutare, a graduate student in marine biology from Estancia, Panay, stated that this method of octopus fishing is still customary. The best time is during a low tide when the octopus is seized by hand by the light of a palm frond torch and placed alive in a basket. She was not familiar with the custom of "turning the cap" practiced in many countries. According to Jutare another method of capturing octopus is the use of the juice of the plant called *tubli* in the Visayan dialect. The plant is macerated and the juice squeezed into an octopus hole. The octopus immediately deserts its home and is grasped by the fisherman. Octopus are usually cooked fresh. The industry is small and local in nature.

Squid and cuttlefish are widely eaten in the Philippines and are in great demand, both fresh and dried. Dried squid bring the highest prices, about three pesos per kilogram, and fresh squid about two pesos. The supply of Philippine dried squid has never equalled the demand and they are imported from other countries. Immediately after World War II, dried *Loligo opalescens* was imported from Monterey, Calif. Since then, dried *Todarodes pacificus* from Japan has helped to fill the market.

Jutare states that most of the squid and cuttlefish are caught by shore seines, but that they are usually incidental to and included with the fish catch. Squid and cuttlefish are also caught at night from boats, dipped by net under night lights or caught along with fish in the purse seines.

The large cuttlefish, *Sepia pharaonis* and *S. latimanus*, are split open, the cuttlebone removed along with the viscera, and the mantle, head, and arms dried in the sun without salt. Smaller squids do not have the viscera removed and squids of 3 to 5 inches in length are preferred. Dried squid and cuttlefish are more highly prized and demand higher prices.

Through the courtesy of Dr. Heraclio R. Montalban, Director of Fisheries, Bureau of Fisheries, Republic of the Philippines, I have been able to include the following squid-catch statistics. The figures represent only the catch of licensed fishing vessels of 3 tons gross and over registered with the Bureau of Fisheries; the total catch from all sources would be much higher.

Year	Catch, in kilograms
1952	16, 143
1953	22, 758
1954	35, 760
1955	139, 890
1956	138, 195
1957	153, 654

I had hoped to follow, in the systematic section, the precedent set by Sasaki (1929) and give under each species the local name. Jutare (personal communication) stated, however, that the various species are not distinguished in the islands. The following common names from the Tagalog, Visayan, and Ilocano dialects have been compiled from information given by Montalban and Jutare.

	Tagalog	Visayan	Ilocano
Squid	Pusit, Tsoko	Locus	Bomagto
Cuttlefish	-----	Bagolan	-----
Cuttlebone	-----	Bagol	-----
Octopus	Puguita	Cogeta	Curita
Little octopus	-----	Tamala	-----
Dried squid	-----	Uga nga locus	-----

Octopus and squid are prepared in many ways in the islands. Fresh squid may be broiled or prepared in other ways. Jutare gave the following common Visayan recipes for squid or octopus, with the Visayan names:

Squid adobo (adobo nga locus): The squid are washed and cleaned, then boiled in vinegar, crushed garlic, and salt. Spices may be added if desired. When the water is about cooked down, oil is added. Squid is turned occasionally and removed from fire after about 5 minutes.

Squid tinola (stew) (tinola nga locus): Boil squid in water, green onions, tomatoes, and salt for about 10 minutes or less. Use about 2 cups of water for a pound of squid. Vegetables may be added.

Explanation of Tables, Abbreviations, Measurements, and Counts

The identification and evaluation of cephalopods has been greatly facilitated through the use of precise measurements and the almost universal use of proportional indices in the comparison of closely related species. Verrill (1881) was one of the first teuthologists to use ratios, comparing the length of various parts of *Loligo pealei* to the mantle length as a standard. Pfeffer (1912), however, was the

first worker to elaborate upon this system. He expressed the relative size of various parts as a percentage of either the mantle length or other parts. The preciseness and ease of expression of such proportions facilitated their use in the comparison of age groups and species. Robson (1929) introduced percentages in the comparison of the poorly defined octopodan species and Pickford (1945) elaborated upon this by precisely defining her indices and the method of measurement. Since then Rees, Adam, and Voss in various papers have used similar indices or have presented additional ones as the need arose.

Some malacologists have criticized teuthologists for being slaves to measurement and detailed description, but it must be remembered that cephalopods are soft-bodied animals subject to great change in shape due to different methods and degree of preservation and except in a few forms no hard skeletal parts are present to preserve original shape. Pfeffer (1912) has discussed many of the problems of proportional growth and the value of proportional characters in cephalopodan systematics. I do not intend to review Pfeffer's work here, but in my work I have placed, with due caution, considerable reliance upon proportional measurements in comparing like samples of closely related specimens.

Few meristic characters in squids are of value. I have not used the number of suckers on the arms although this has been used by some workers. Numbers of teeth on the arm and club suckers have been considered, although owing to alteration with use, the shape of such teeth varies considerably with age. The number of gill lamellae is useful in octopods, but in squids, because of the high number and wide range, it seems of dubious value.

The radula has proved of good systematic value in the mollusks in general, but I agree with Hoyle that, except in some groups, it is of little reliability in the cephalopods. The differences of this structure as well as of the beaks do not seem to be great enough to be significant.

Primary reliance has been placed upon the numbers, position, and form of the light organs, although in some species, as in *Abralia spärcki*, these characters may show some variability. Likewise, great weight has been given to the relative size and structure of the hectocotylized or nuptial arm, as well as to other sexual characters such as size of the specially enlarged arm suckers in males of *Euprymna* and others. The spermatophores have been investigated where possible and give apparently sound characters for specific differentiation in the males. Sucker arrangement on the tentacular clubs has proved valuable in some species, and striking differences can be seen in some species of *Sepia* and *Loligo*. Other characters used in special cases are mentioned in the systematic section.

Where the data warranted, I have given the basic indices of all specimens in good condition. Definitions of these indices are given below, together with a description of the method in which the measurement was made. Raw data are not given but are on file at the Marine Museum, The Marine Laboratory, University of Miami.

1. BODY PROPORTIONS:

- ML, mantle length: dorsal length of mantle in mm. In decapods, measured from the anteriormost point of the mantle to the apex of the mantle or to the tip of the united fin, whichever is longest. In octopods, measured from the apex to midpoint between eyes.
- VML, ventral mantle length in mm. In decapods and octopods measured from the anteroventral border of the mantle in the midline, to the apex of the mantle or the tip of the united fins, whichever is longest.
- MWI, mantle width index: greatest width of mantle as a percentage of mantle length.
- HWI, head width index: greatest width of head across eyes as a percentage of mantle length.
- FWI, fin width index: greatest width across both fins as a percentage of mantle length.
- FWIs, fin width index single: greatest width across single fin from center line of mantle as a percentage of mantle length.
- FLI, fin length index: greatest length of fins as a percentage of mantle length.
- Gills, number of primary lamellae on either side of the main axis of the gill, not including the terminal lamellae. Used primarily for the octopods.
- LO, light organs.
- TbI, tubercular ridge index: length of tubercular ridge as a percentage of mantle length.
- E, diameter of eye measured across bulbus.
- NCI, nuchal commissure index: width of nuchal commissure as a percentage of mantle length.

2. PROPORTIONS OF ARMS, WEB, AND TENTACLES:

- Arm formula, comparative lengths of arms expressed numerically, 3.4.2.1, in decreasing order.
- I, II, III, IV, length of dorsal, dorsolateral, ventrolateral and ventral arms, measured on the right side, as a percentage of the mantle length when used in the tables. In decapods, arm length is measured from first basal sucker to tip of arm, in octopods from the mouth to the tip of the arm. When used in the text, the numbers refer only to the particular arm.
- ALI, arm length index: in octopods, length of longest arm as a percentage of total length.
- MAI, mantle arm index: in octopods, mantle length as a percentage of length of longest arm.
- AWI, arm width index: in octopods, width of stoutest arm as a percentage of mantle length.
- WDI, web depth index: in octopods, depth of deepest sector as a percentage of length of longest arm.

Web formula, the depth of each web sector given in decreasing order and expressed alphabetically, A.B.C.D.E.

TLI, tentacle length index: total length of tentacle and club as a percentage of mantle length.

CLI, club length index: length of club as a percentage of mantle length. Club length is measured from base of carpal cluster to tip, or, in those species having no distinct carpal cluster, from first basal true club sucker. In octopods, CLI is calamus length index.

3. SUCKERS:

SIs, sucker index (sessile): diameter of largest arm sucker as a percentage of mantle length.

SIt, sucker index (tentacular): diameter of largest tentacular sucker as a percentage of mantle length.

SIn, sucker index (normal): in octopods, the diameter of largest normal sucker as a percentage of mantle length.

SIe, sucker index (enlarged): in octopod males, the diameter of largest "special" sucker as a percentage of mantle length.

4. HECTOCOTYLUS AND PENIS:

HcAI, hectocotylized arm index: length of hectocotylized arm as a percentage of mantle length.

HcLI, hectocotylus length index: length of modified portion of arm measured from first modified sucker to tip as a percentage of length of hectocotylized arm.

CLI, in octopods, calamus length index: length of calamus, measured from last sucker to tip of spout as a percentage of ligula length.

LLI, in octopods, ligula length index: length of ligula measured from last sucker to tip of arm expressed as a percentage of length of hectocotylized arm.

PLI, in octopods, penis length index: length of penis and diverticulum as a percentage of mantle length.

5. GLADIUS AND SHELL PROPORTIONS:

GL, gladius length.

GLI, gladius length index: length of gladius as a percentage of mantle length.

GWI, gladius width index: greatest width of gladius as a percentage of gladius length.

ShL, in *Sepia*, total length of shell (sepion) including spine.

ShWI, shell width index: greatest width of shell as a percentage of shell length.

LocLI, loculus length index: length of loculus as a percentage of shell length.

SnLI, spine length index: length of spine as a percentage of shell length.

6. SPERMATOPHORE PROPORTIONS:

SpL, spermatophore length: total length of spermatophore.

SpLI, spermatophore length index: total length of spermatophore as a percentage of mantle length.

SpRI, sperm reservoir index: length of sperm reservoir as a percentage of the spermatophore length.

SpWI, spermatophore width index: width of spermatophore as a percentage of the spermatophore length.

Species Treated

Synopsis

Subclass Nautiloidea

Family Nautilidae

Genus *Nautilus* Linnaeus, 1758*Nautilus pompilius* Linnaeus, 1758

Subclass Coleoidea

Order Sepioidea

Family Spirulidae

Genus *Spirula* Lamarck, 1801*Spirula spirula* (Linnaeus, 1758)

Family Sepiidae

Genus *Sepia* Linnaeus, 1758*Sepia pharaonis* Ehrenberg, 1831*Sepia prionota* Voss, 1962*Sepia latimanus* Quoy and Gaimard, 1832*Sepia esculenta* Hoyle, 1885*Sepia andreana* Steenstrup, 1875*Sepia papuensis* Hoyle, 1885*Sepia recurvirostris* Steenstrup, 1875

Family Sepiariidae

Genus *Sepiadium* Steenstrup, 1881*Sepiadium gracilis* Voss, 1962

Family Sepiolidae

Subfamily Rossiinae

Genus *Rossia* Owen, 1834*Rossia bipapillata* Sasaki, 1920

Subfamily Heteroteuthinae

Genus *Sepiolina* Naef, 1912*Sepiolina nipponensis* (Berry, 1911)

Subfamily Sepiolinae

Genus *Euprymna* Steenstrup, 1887*Euprymna phenax* Voss, 1962*Euprymna albatrossae* Voss, 1962*Euprymna stenodactyla* (Grant, 1833)*Euprymna morsei* (Verrill, 1881)Genus *Sepiola* Leach, 1817*Sepiola trirostrata* Voss, 1962Genus *Iniotheuthis* Verrill, 1881*Iniotheuthis maculosa* Goodrich, 1896

Family Idiosepiidae

Genus *Idiosepius* Steenstrup, 1881*Idiosepius pygmaeus* Steenstrup, 1881

Order Teuthoidea

Suborder Myopsida

Family Loliginidae

Genus *Loligo* Lamarck, 1798*Loligo edulis* Hoyle, 1885*Loligo duvauceli* d'Orbigny, 1835*Loligo* species A, Voss, 1962

- Genus *Sepioteuthis* Blainville, 1824
Sepioteuthis lessoniana Lesson, 1830
- Genus *Doryteuthis* Naef, 1912
Doryteuthis singhalensis (Ortman, 1891)
Doryteuthis reesi Voss, 1962
- Genus *Uroteuthis* Rehder, 1945
Uroteuthis bartschi Rehder, 1945
- Suborder Oegopsida
- Family Enoploteuthidae
- Subfamily Abraliinae
- Genus *Abralia* Gray, 1849
Abralia armata (Quoy and Gaimard, 1832)
Abralia andamanica Goodrich, 1896
Abralia lucens, new species
Abralia spärcki Grimpe, 1931
- Family Octopodoteuthidae
- Genus *Octopoteuthis* Rüppel, 1844
Octopoteuthis sicula Rüppel, 1844
- Family Onychoteuthidae
- Genus *Onychoteuthis* Lichtenstein, 1818
Onychoteuthis banksi Leach, 1817
- Family Histioteuthidae
- Genus *Calliteuthis* Verrill, 1880
Calliteuthis celetaria pacifica Voss, 1962
Calliteuthis meleagroteuthis Chun, 1910
- Family Ommastrephidae
- Subfamily Todarodinae
- Genus *Nototodarus* Pfeffer, 1912
Nototodarus sloani philippinensis Voss, 1962
- Subfamily Ommastrephinae
- Genus *Symplectoteuthis* Pfeffer, 1900
Symplectoteuthis oualaniensis (Lesson, 1930)
- Family Chiroteuthidae
- Subfamily Chiroteuthinae
- Genus *Chiroteuthis* d'Orbigny, 1839
Chiroteuthis imperator Chun, 1910
- Subfamily Mastigoteuthinae
- Genus *Mastigoteuthis* Verrill, 1881
Mastigoteuthis cordiformis Chun, 1908
- Family Cranchiidae
- Subfamily Cranchiinae
- Genus *Cranchia* Leach, 1817
Cranchia scabra Leach, 1817
- Genus *Liocranchia* Pfeffer, 1884
Liocranchia reinhardti (Steenstrup, 1856)
- Subfamily Taoniinae
- Genus *Taonius* Steenstrup, 1861
Taonius pavo (LeSueur, 1821)
- Genus *Bathothauma* Chun, 1906
Bathothauma lyromma Chun, 1906
- Order Octopoda
- Suborder Incirrata
- Family Bolitaenidae

- Genus *Japetella* Hoyle, 1885
 - Japetella diaphana* Hoyle, 1885
- Genus *Eledonella* Verrill, 1884
 - Eledonella pygmaea* Verrill, 1884

Family Octopodidae

- Genus *Octopus* Cuvier, 1797
 - Octopus membranaceus* Quoy and Gaimard, 1832
 - Octopus horridus* d'Orbigny, 1826
 - Octopus teuthoides* Robson, 1929
 - Octopus macropus* Risso, 1826
 - Octopus vulgaris* Cuvier, 1797
- Genus *Cistopus* Gray, 1849
 - Cistopus indicus* (d'Orbigny, 1840)

Family Argonautidae

- Genus *Argonauta* Linnaeus, 1758
 - Argonauta argo* Linnaeus, 1758
 - Argonauta hians* Solander, 1786
 - Argonauta nodosa* Solander, 1786
 - Argonauta böttgeri* Maltzan, 1881

Artificial Key to Cephalopods of the Philippine Islands

1. Shell external, coiled, and chambered; tentacles numerous and without suckers. Subclass NAUTILOIDEA *Nautilus pompilius* (p. 19)
- Shell internal or lacking; circumoral appendages 8 or 10 and bearing suckers. Subclass COLEOIDEA 2
2. Circumoral appendages eight, the suckers without horny rings. Order OCTOPODA 41
- Circumoral appendages consisting of 8 arms and 2 tentacles, the suckers equipped with horny rings 3
3. Shell internal, chalky or coiled and chambered, or reduced, thin, or lacking. Fins either marginal and narrow or large and paddle-shaped; eyes covered by skin of head, not widely perforate. Order SEPIOIDEA 4
- Shell internal, usually a thin, well-developed gladius; fins terminal or nearly so, often rhombic or triangular (marginal in *Sepioteuthis*), not paddlelike (except in Cranchiidae); eyes open, perforate except in the Myopsida. Order TEUTHOIDEA 19
4. Shell internal, coiled and chambered; fins inserted transversely; bathypelagic. *Spirula spirula* (p. 20)
- Shell straight, thick, and chalky, thin and vestigial, or lacking 5
5. Shell chalky; fins marginal, narrow 6
- Shell reduced and thin, or lacking; fins usually paddle-shaped 10
6. Body rather long and slender; shell very slender; end of body projects as a sharp point beyond fins *Sepia andreaana* (p. 31)²
- Body broad; shell moderately wide; end of body not projecting beyond fins 7
7. Suckers of tentacular club in about 10 rows, all small with no enlarged median suckers *Sepia esculenta* (p. 28)
- Suckers of tentacular club in about 4 or 5 rows, some suckers of inner rows much larger than marginals 8

² In the key to the *Sepia*, *S. papuensis* and *S. recurvirostris* are not included. Specimens were not seen and the descriptions are insufficient for obtaining key characters.

8. Dorsal and ventral lateral membranes of club not approaching at base of club, but becoming parallel along stalk *Sepia pharaonis* (p. 20)
Dorsal and ventral lateral membranes of club closely approaching or united at base of club 9
9. Lateral membranes of club nearly or completely united at base of club; one saw-toothed ridge or keel on three dorsal pairs of arms.
Sepia prionota (p. 24)
Lateral membranes of club completely united at base of club; no sawlike keel on three dorsal pairs of arms *Sepia latimanus* (p. 26)
10. Tentacular stalk contained within both an oral and an aboral membrane which form a sheath about the stalk; body longer than wide, fins small; suckers in two rows throughout *Sepiadarium gracilis* (p. 37)
Tentacular stalks not contained within a sheath 11
11. One or both dorsal arms hectocotylized in male; fins lateral 12
Both ventral arms hectocotylized in male; fins terminal or nearly so.
Idiosepius pygmaeus (p. 63)
12. Mantle free from head in dorsal region; a papilla on each side of rectum below anus *Rossia bipapillata* (p. 40)
Mantle united with head in dorsal region 13
13. Two dorsal pairs of arms united by a web for half their length or more; both dorsal arms in male hectocotylized by a reduction in size of suckers.
Sepiolina nipponensis (p. 42)
Arms not deeply involved in the web; only left dorsal arm hectocotylized in males 14
14. All arms normal in females; left dorsal arm hectocotylized by suckers of both rows on distal third or half with apertures nearly closed, slitlike; suckers stalked, crowded together, palisaded 15
Third arms of males and females curled inward; left dorsal arm hectocotylized in males by modification of the suckers in basal portion of arm . . 18
15. Two rows of suckers on arms; left dorsal arm with only a few terminal suckers slitlike in male; no specially enlarged suckers in male.
Euprymna phenax (p. 46)
Four rows of suckers on arms 16
16. Suckers of ventral row in males enlarged, a few greatly so.
Euprymna morsei (p. 56)
Suckers of outer rows enlarged in males 17
17. Suckers of outer rows much larger than those of median rows on left I, II, and IV. Suckers of III small throughout.
Euprymna albatrossae (p. 49)
Suckers of outer rows slightly larger on left I and II; three or four suckers of ventral rows greatly enlarged; suckers of outer rows of IV much larger than those of median rows *Euprymna stenodactyla* (p. 52)
18. Left dorsal arm of male hectocotylized by a large pocket in basal part of arm; ventral suckers of I, II, and IV greatly enlarged.
Inioteuthis maculosa (p. 59)
Left dorsal arm of male hectocotylized by reduction in size of suckers on distal two-thirds of arm and placement upon long pedicels, all with a 45° turn to right; basally, two long and one short pointed papillae on ventral edge. Arms III much enlarged basally and strongly curled inward *Sepiola trirostrata* (p. 57)
19. Eyes covered by continuous skin of head, only a minute pore anteriorly; sucker rings toothed or smooth but never developed into hooks; shell a broad thin well-developed gladius. Suborder MYOPSIDA 20

- Eyes open, perforate, eyeball not covered by skin of head; sucker rings smooth, toothed, or modified into hooks; shell well developed, slender, or occasionally absent. Suborder OEGOPSIDA 26
20. Mantle stout to slender; fins terminal (marginal in *Sepioteuthis*); body bluntly pointed 21
 Mantle slender; fins subterminal, body drawn out into a long slender point or tail. *Uroteuthis bartschi* (p. 89)
21. Gladius broad, with rounded borders, not thickened near edge 22
 Gladius narrow, with straight edges, borders thickened and darkened 25
22. Fins terminal, rhombic, occupying about half the mantle length 23
 Fins marginal, occupying nearly 90 percent of mantle length.
Sepioteuthis lessoniana (p. 77)
23. Left ventral arm hectocotylyzed in male for about two-thirds of its length; about 7 to 10 long truncate teeth on distal half of arm suckers; teeth of large suckers of club sharp and slender, irregular in size.
Loligo edulis (p. 67)
 About half or less of left ventral arm hectocotylyzed in the male 24
24. More than half the length of left ventral arm hectocotylyzed in males; arm suckers with large blunt teeth nearly all around ring; large suckers of club with a few sharp teeth; suckers of median rows of club not more than twice the diameter of marginal suckers. *Loligo duvauceli* (p. 71)
 Less than half the length of left ventral arm hectocotylyzed in males; arm suckers with short truncate teeth on distal half; large suckers of club with about 15 low pointed teeth of which about 2 to 4 on the distal border are on a raised base and are very long and clawlike; suckers of median rows of club about twice the diameter of marginal suckers.
Loligo species A (p. 74)
25. Left ventral arm of male hectocotylyzed; large club suckers with 20 to 22 sharp curved teeth; two to eight suckers on lobe of buccal membrane; large species *Doryteuthis singhalensis* (p. 81)
 Both ventral arms of male hectocotylyzed, the left longer and broader than the right; tips of both ventral arms devoid of suckers, smooth; large club suckers with 11 or 12 sharp slender teeth, longer and separated on distal side; one to six suckers on lobe of buccal membrane; small species.
Doryteuthis rcesi (p. 84)
26. Mantle articulates with head in neck region and on each side of funnel by means of grooves and ridges 27
 Mantle is permanently fused with head and funnel 37
27. Hooks present on both arms and tentacles 28
 Hooks present on arms or tentacles but not on both, or absent 31
28. Light organs on ventral surface of head forming five distinct rows 29
 Light organs on ventral surface of head forming about nine distinct rows.
Abralia andamanica (p. 99)
29. An indistinct light organ on ink sac; fin width index 89-92-100; mantle width index 33-47; right ventral arm hectocotylyzed in male; suckers in two rows on end of arms *Abralia armata* (p. 92)
 No light organ on ink sac; left(?) ventral arm hectocotylyzed in male; suckers in four rows on end of arms; species medium size 30
30. Three distinct rows of photophores on ventral arms with no, or only one or two supplementary photophores between the rows near base of arms. No solitary large white photophores within funnel groove near base of first nuchal fold. *Abralia lucens* (p. 105)

Three distinct rows of photophores on ventral arms and in addition a row of 4 to 9 light organs between ventral and median row and 1 or 2 scattered organs between median and dorsal row. A solitary large white photophore within funnel groove at base of first nuchal fold.

Abralia spärcki (p. 112)

- 31. Hooks present on arms; fins not united posteriorly, but with end of mantle projecting beyond fins; tentacles absent in juveniles and adults.

Octopoteuthis sicula (p. 116)

Hooks absent on arms; fins united posteriorly; tentacles present in juveniles and adults 32

- 32. Mantle-funnel locking apparatus well developed, forming a distinct \perp ; animals muscular, active 36

Mantle-locking apparatus straight or ear-shaped; if ear-shaped, animals soft, choroidal; bathypelagic 33

- 33. Mantle-funnel locking apparatus a simple groove and corresponding ridge . 34
- Mantle-funnel locking apparatus ear-shaped 37

- 34. Animal strong, muscular; fins terminal, rhombic; a double row of prominent large hooks on tentacular club; no light organs on surface of head, mantle, and arms *Onychoteuthis banksi* (p. 117)

Animal choroidal, soft, flabby; fins terminal, round; no hooks on tentacular club; numerous light organs on mantle, head, and arms 35

- 35. Light organs on mantle, head, and arms numerous but scattered; three rows of light organs on IV, two rows on I, II, and III.

Calliteuthis celetaria pacifica (p. 119)

Light organs on mantle, head, and arms very numerous, closely set; eight or nine rows of light organs on IV; three or four rows on arms I, II, and III *Calliteuthis meleagroteuthis* (p. 123)

- 36. Mantle-funnel locking apparatus articulating by grooves and ridges.

Nototodarus sloani philippinensis (p. 128)

Mantle-funnel locking apparatus fused on one or both sides, but strong grooves and ridges present . . *Symplectoteuthis oualaniensis* (p. 134)

- 37. Tentacular club with four rows of suckers on hand part.

Chiroteuthis imperator (p. 136)

Tentacular club with about 20 rows of suckers.

Mastigoteuthis cordiformis (p. 140)

- 38. A line of cartilage-bearing tubercles in dorsal midline, and a \wedge -shaped line on each side of funnel at point of fusion with mantle 39

No line of cartilage-bearing tubercles, either dorsally or ventrally 40

- 39. Mantle inflated, barrel-shaped; surface of mantle and fins covered with numerous close-set cartilaginous tubercles . . *Cranchia scabra* (p. 142)

Mantle elongate; no tubercles on surface of mantle or fins.

Liocranchia reinhardti (p. 145)

- 40. Mantle and fins drawn out into a long narrow tail; eyes sessile, not on stalks; head sessile *Taonius pavo* (p. 150)

Mantle rounded posteriorly with small, paddlelike fins; eyes stalked; head stalked; transparent *Bathothauma lyromma* (p. 153)

- 41. Animals small, gelatinous, semitransparent; bathypelagic 42

Animals small to large, muscular; surface or bottom dwelling 43

- 42. Optic nerve short; eyes lateral; male without a hectocotylus; suckers in contact and crowded *Eledonella pygmaea* (p. 158)

Optic nerve long; eyes lateral; male with a hectocotylus; suckers small, urn-shaped, widely spread, one or two sucker diameters apart.

Japetella diaphana (p. 156)

amination revealed nothing of particular interest. The species has been described by Owen (1832), Willey (1902), and Griffen (1900), and its ecology, food, capture, and economic importance have been discussed by Dean (1901). The umbilicus of the shell, except in young specimens, is completely covered by the callus. The red markings on the shells are conspicuous. The hood or foot is dark brown and is liberally covered with white or cream-colored spots.

TYPE.—British Museum (Natural History).

TYPE LOCALITY.—“Habitat in India.”

DISTRIBUTION.—Australia to Philippines; Polynesia; Indian Ocean. (Shells widely distributed outside the range of the living animal.)

Subclass Coleoidea: Order Sepioidea

Family Spirulidae

Spirula spirula (Linnaeus, 1758)

Nautilus spirula Linnaeus, 1758, p. 710.

Spirula peronii, Hidalgo, 1905, p. 10.

No specimens of this species were found in the National Museum collections. Shells of the species are found on beaches throughout the world and Hidalgo's record (1905) is probably based on such shells. Bruun (1943) has reported on the biology of the species.

TYPE.—Linnean Collection, Linnean Society of London.

TYPE LOCALITY.—“America.”

DISTRIBUTION.—Widely distributed in various seas at depths from 200–1500 m.

Family Sepiidae

Sepia pharaonis Ehrenberg, 1831

FIGURE 1, *f,g*; PLATE 1, *b,c*

Sepia pharaonis Ehrenberg, 1831, sign. a, pl.—Adam, 1941, p. 5.

Sepia rouxii d'Orbigny, 1841, p. 271.—Adam, 1939b, p. 56.

MATERIAL.—1 ♀, ML 111.0 mm., from mouth of Santiago River, Balayan Bay, western Luzon, seine, Feb. 20, 1909; USNM 575352. 1 ♀, ML 92.0 mm., from Cavite, Manila, June 14, 1908; USNM 575354. 3 mutilated specimens from Stn. D5461 off Caringo Id., eastern Luzon, in 20 m., June 14, 1908; USNM 575355. 2 ♀♀, ML 43.0–74.0 mm., from Port Benanga, Subig Bay, southern Luzon, Jan. 8, 1908; USNM 575353.

DESCRIPTION.—A small series of specimens undoubtedly referable to this species is in the National Museum collections. The species is widely distributed in the Indo-Malayan region.

The mantle is short and stout, oval in outline, and widest at about the midpoint. It is slightly pointed posteriorly and strongly flattened dorsoventrally. The anterior margin is produced as a broad, round triangular projection; ventrally it is slightly emarginated below the funnel.

The fins originate just posterior to the anterior margin of the mantle and form an anterior lobe which projects beyond the margin. They border the mantle on either side and are about one-fifth of the mantle width. Posteriorly, they are separated by the end of the body.

The funnel is large and stout and extends to the interbrachial area of IV. The locking apparatus consists of a short curved teardrop-shaped groove, rounded anteriorly and pointed posteriorly, and a short ridge on the mantle which is highest in the middle. The funnel organ is normal. The valve is large, rounded, and triangular.

The head is large and somewhat flattened dorsoventrally. It bears large eyes with conspicuous lower lids. The buccal membrane is seven-pointed, each lappet bearing one or two small suckers. Spermatophore pads were not seen.

The arms are subequal, in the order 4.3.2.1 or 4.2.3.1. They are stout at the base, I and II rounded, III slightly and IV strongly flattened, and taper evenly to an attenuate point. All the arms are keeled for their entire length and IV has a broad conspicuous swimming membrane. There is a low interbrachial web between all arms except IV. The suckers are in four rows throughout, and are bordered on each side by a low protective membrane. The arm suckers have horny rings whose sides are vertical, the upper part formed by numerous fused flattened teeth which give the margin a scalloped, palisaded effect.

The tentacles are long with stout stalks which bear expanded clubs, bent somewhat upward. The club is bordered by a dorsal web which originates at about the level of the proximal sucker. The suckers are arranged in about six to eight rows; those of the two middle rows are greatly enlarged for about seven series, those of the ventral median row being larger than those of the dorsal row. The sucker rings are formed in the same manner as those of the arms, the edge appearing serrate. The suckers are bordered on each side by a low protective membrane which, however, does not unite basally.

The shell is slenderly elliptical, slightly pointed at each end but blunter posteriorly. The outer cone is well developed and is bordered by a thin chitinous rim. The breadth of the shell is greater than a third of the length. The dorsal surface is convex posteriorly, flattened

anteriorly. There is a low median ridge bordered by a shallow groove, with a slightly angled ridge on each side. The calcareous section is bordered by a clear area. The papillated ridges are concentrically arranged. The ventral side of the shell is concave posteriorly, convex from the midpoint anteriorly. The striated area extends to slightly beyond the midpoint and is V-shaped with the apex rounded. The hindmost section has almost straight sides and is well rounded posteriorly. The inner cone originates just posterior to the middle of the shell, with very narrow limbs, but posteriorly becomes greatly thickened, forming a rounded callosity of some size. The spine is small.

No males were available.

The sculpture is very noticeable in one specimen, consisting of a series of short high ridges along the bases of the fins, scattered large papillae on the dorsum of the mantle, and a few papillae behind the eyes.

The color, in preservation, is dark reddish brown dorsally with fins lighter and a generally yellowish hue ventrally.

Measurements and indices of four females of *Sepia pharaonis* Ehrenberg are:

	♀	♀	♀	♀
ML	111.0	92.0	74.0	43.5
MWI	47.2	54.4	54.0	53.0
HWI	30.9	39.2	41.9	42.5
FLI	92.6	98.6	100.0	85.0
FWI	13.6	14.1	13.5	13.8
I	30.0	44.0	35.1	29.0
II	32.7	47.8	33.8	28.7
III	36.3	41.3	33.8	34.4
IV	41.8	47.8	41.9	41.4
SIs	1.82	----	----	----
SIt	1.85	----	----	----
CLI	-----	27.2	21.6	----
ShLl	110.0	91.0	70.0	----
ShWI	36.4	38.5	38.9	----
LocLI	59.2	37.4	44.3	----
SnLI	2.5	----	----	----

TYPE.—Zoologisches Museum, Berlin.

TYPE LOCALITY.—Egypt, Red Sea.

DISCUSSION.—This species was apparently first recorded from the Philippines by Sasaki (1929) as *S. torosa*; he confused three species, *S. torosa*, *S. formosana*, and *S. tigris*, listing them from Japan and Formosa. Adam (1939b) placed all three under the synonymy of *S. rouxii* d'Orbigny; in a later paper (1941), he demonstrated that *S. rouxii* is identical with *S. pharaonis* Ehrenberg, 1831, which has priority. This species may easily be recognized by the small suckers on the lobes of the buccal membrane and the enlarged median suckers of the tentacular club. The callosity of the inner cone alone is distinctive.

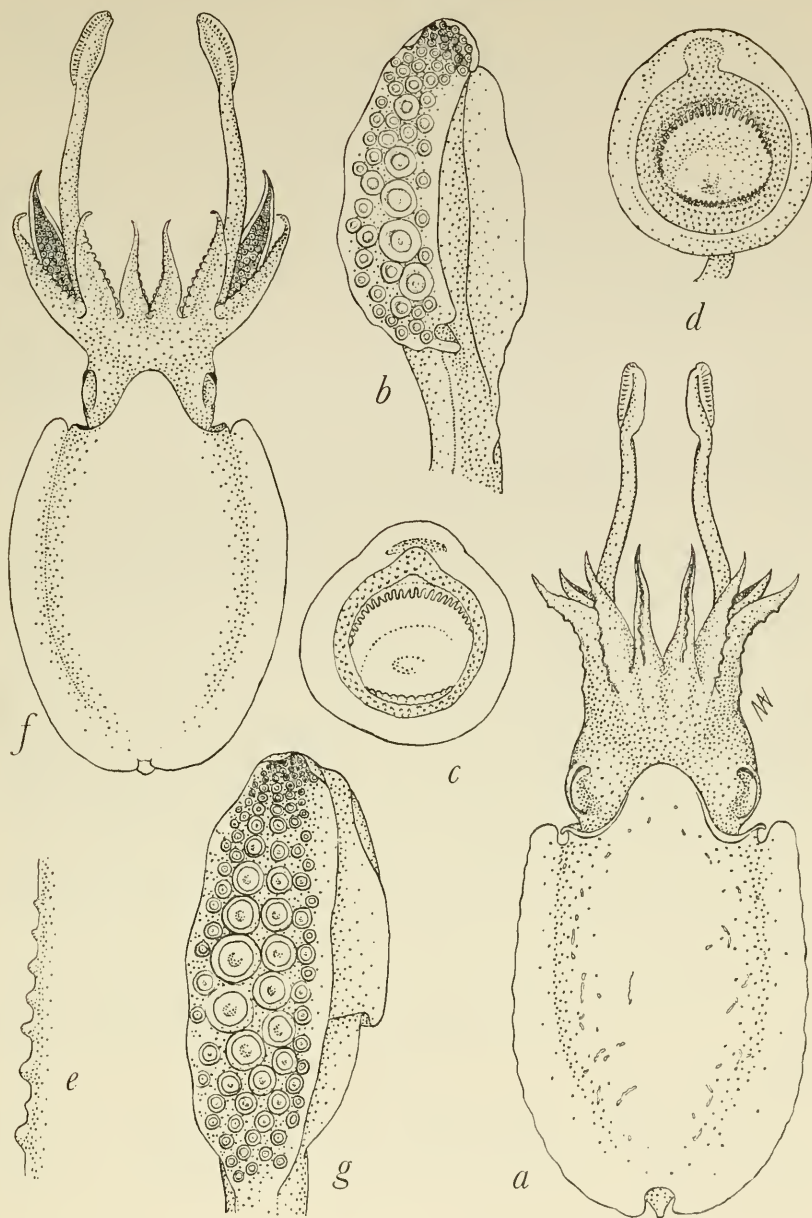


FIGURE 1.—*a-e*, *Sepia prionota* Voss: *a*, dorsal view of holotype; *b*, right tentacular club; *c*, sucker from 8th row of right dorso-lateral arm; *d*, largest tentacular sucker from left club; *e*, lappets from dorsum of right dorsal arm. *f*, *g*, *Sepia pharaonis* Ehrenberg: *f*, dorsal view of female, mantle length 111.0 mm.; *g*, right tentacular club of female.

DISTRIBUTION.—East Africa; Red Sea; India; Malay Straits; Dutch East Indies; northern Australia; Philippines; Formosa; southern Japan.

Sepia prionota Voss, 1962

FIGURE 1, *a-e*; PLATE 1, *f,g*

Sepia prionota Voss, 1962, p. 169.

HOLOTYPE.—1 ♀, ML 61.0 mm., Sta. D5151, from off Sirun Id., Sulu Archipelago, Tawi Tawi group, in 44 m., coral sand and shell, Feb. 18, 1908; USNM 575326.

PARATYPES.—3 ♀♀, ML 26.0–36.2 mm., from Sta. D5151, from off Sirun Id., Sulu Archipelago, Tawi Tawi group, in 44 m., coral sand and shell, Feb. 18, 1908; USNM 575327.

OTHER MATERIAL.—1 ♀, ML 45.0 mm., from Sta. 5165, off Observation Id., Sulu Archipelago, Tawi Tawi group, 16.5 m., coral, Feb. 24, 1908.

DIAGNOSIS.—Keels of arms I–III equipped with widely spaced, rounded erect lappets; arm and tentacular sucker rings armed with long slender truncate teeth; numerous papillae on body, arms, and head below eyes; shell concave throughout.

DESCRIPTION.—The mantle is rather slender, about half as wide as long. Dorsally there is a broad rounded lobe in the midline, the anterior mantle margin somewhat emarginate on each side. Ventrally the mantle margin is straight, with a shallow squarish emargination beneath the funnel without bordering lappets. Posteriorly the mantle ends in a distinct fleshy point.

The fins are long and narrow, originating 1 to 2 mm. posterior to the margin but with distinct anterior lobes projecting slightly beyond the margin and posteriorly separated with free lobes. The fins are widest in the posterior third and are ruffled.

The funnel is short and stout, with short but strong locking cartilages. The funnel projects nearly to the interbrachial area of IV. The funnel organ could not be distinguished. There is a triangular valve.

The head is large, broad, slightly flattened; it bears large eyes with strong ventral lids. The ventral surface is only slightly excavated for the funnel. The buccal membrane has seven points with no suckers.

The arms are in the order 4.1=2=3, with IV 34–40 percent of the mantle length; all are strongly compressed, rather thick at the base and tapering to sharp points, not attenuate; all are keeled on the aboral surface but in a manner quite different from that observed in other species. The keels on arms I–III are formed of a single series of distinct, erect semicircular or elongate lappets, thick and fleshy,

united along their bases by a low fleshy ridge. The lappets originate at the base of the arms and extend outward to near the tip; there are about eight on the dorsal arms of the holotype and six on each of the other arms, with a few of those on III fused together. All five specimens are distinctly so formed, though varying slightly in the number of lappets. IV possesses the typical broad, well-developed smooth ventral keel. The suckers are in four rows on all arms and are bordered by well-developed protective membranes. The sucker rings are toothed on the whole margin, the teeth being very numerous and square-tipped; those on distal half are long, slender, and crowded, those of the proximal half are almost minute, the two groups gradually blending into each other on the sides. There is a broad band of papillations around the ring.

The tentacles are of moderate length and stoutness, compressed but with a flat oral surface bearing a small groove. The clubs are small, expanded, and bordered dorsally by a broad keel which originates well proximal to the basal suckers and extends to the tip. The sucker pad or basal plate lies somewhat free posteriorly on the club and is bordered by dorsal and ventral protective membranes. The dorsal membrane extends downward on the stalk; the ventral membrane nearly unites with the dorsal one but terminates immediately on the stalk. The suckers are in about six rows and vary in size, about four of those of the second dorsal row being greatly enlarged. The horny rings of the large suckers bear long narrow square-tipped teeth which are greatly crowded and are larger on the distal half. A narrow band of papillations of the usual type surrounds the rings.

The color of the animals, so long preserved in alcohol, is yellowish superimposed by numerous very fine purplish chromatophores.

The sculpture consists of the aforesaid row of lappets on the arms and scattered rugae and papillae along the dorsum of the mantle, the base of the fins, the sides of the ventral surface of the mantle, and a patch of papillae below and in front of each eye. There are a few papillae on the sides of the arms, especially on IV.

The shell is rather narrow, rounded both anteriorly and posteriorly, and with a short stout spine. Dorsally there is a median ridge which is narrow posteriorly but broadens anteriorly, bordered by a narrow flat area. On each side of this flat area, the shell is angled by a broad concave slope which again flattens out to form the edge of the shell. Ventrally the shell is concave both anteriorly and posteriorly. The locus is only moderately thickened, concave medially. The striated area forms a straight narrow V with an arched anterior contour. The outer cone is deeply spoon-shaped posteriorly with deepened sides. The inner cone is thin but widened posteriorly and is fused throughout to the outer cone.

The measurements and indices of four females of *Sepia prionota*, Voss, 1962, (those of the holotype being given first) are:

	♀	♀	♀	♀
ML	61.0	36.2	29.2	26.0
MWI	45.0	51.4	51.7	53.0
HWI	42.6	50.0	45.5	53.2
FLI	86.0	90.3	94.3	88.5
FWI	13.1	12.7	10.9	9.6
I	32.8	36.0	26.7	30.3
II	32.8	36.0	26.7	30.3
III	32.8	36.0	26.7	30.3
IV	35.7	40.0	34.3	40.1
SIs	1.65	----	----	----
SIt	1.47	----	----	----
CLI	13.1	13.3	----	----
ShL	60.0	35.0	----	----
ShwI	34.2	42.0	----	----
LLI	38.3	35.1	----	----
SnLI	3.5	5.4	----	----

TYPE.—USNM 575326.

TYPE LOCALITY.—Off Sirun Id., Sulu Archipelago, Tawi Tawi group, Sta. D5151.

DISCUSSION.—This species seems to be distinct from any of the other species of *Sepia* so far recorded from the Indo-Malayan area. It does not seem referable to any of the species mentioned by Adam (1939b) in his monographic treatment of the species, nor does it conform to any of the Japanese species given by Sasaki (1929). The presence of the sawlike keels on the arms alone seems sufficient to separate this species from all others presently known from the Indo-Malayan region.

Sepia latimanus Quoy and Gaimard, 1832

FIGURES 2,d; 3,b; PLATE 1,d,e

Sepia latimanus Quoy and Gaimard, 1832, p. 68, pl. 2—Adam, 1939 b, p. 41.

MATERIAL.—6 ♀ ♀, ML 26.0–82.0 mm., from Canmahala Bay, Ragay Gulf, Luzon, dynamited from coral reef in 55 m., Mar. 11, 1909; USNM 575351.

DESCRIPTION.—The mantle is somewhat slender, forming an oval outline. The anterior margin is produced as a broad triangular lobe in the midline, rounded at the apex, the margin scooped out on each side of the lobe. Ventrally the margin is slightly excavated beneath the funnel and straight, the sides curving downward. The posterior end is bluntly pointed. The mantle is widest at about the midpoint.

The fins are very narrow, widest at the posterior third. They originate almost at the anterior margin and terminate on either side of the end of the mantle. They are not strongly lobed but are free at each end.

The funnel is short and stout, united to the ventral surface of the head for most of its length, and has an oval opening. It does not reach to the base of arms IV. The locking apparatus is stout, consisting of a raised lappetlike mantle member and a semicircular deep funnel groove. The funnel organ is well developed: a dorsal V-shaped member with stout ventral pads. The valve is large and triangular.

The head is large, round, and compact, and bears large protruding eyes with conspicuous ventral lids; it is constricted between the eyes and the bases of the arms. There is a single olfactory papilla below each eye. The buccal membrane is seven-pointed and bears no suckers on the points.

The arms are short and stout, in the order $4.3=2=1$. All the arms are strongly compressed on the distal half, forming a keel towards the ends. Arm IV is extremely stout and broad at the base and bears a keel for its entire length. There is a well-developed web between the arms except for the ventrals. The arms are thick and stout at their bases but rapidly come to a sharp point. The suckers are in four rows, regularly arranged and of equal size. The horny rings are toothed on the entire margin, the teeth thin and crowded, longest distally, rather minute proximally; in many rings the teeth appear fused, forming a paper-thin margin.

The tentacles are short and stout, slightly squarish in cross-section. The clubs are large, expanded, especially on the ventral side. Dorsally a broad stout web originates at the oral face of the club at a considerable distance from the sucker-bearing portion and extends to the tip of the club, separated from the suckers by a broad expanse of smooth skin. The sucker-bearing portion of the club is mostly borne on a somewhat elongate semicircular expansion of the club which ventrally and aborally is continuous with the club. However, dorsally this section is separated from the club by a deep cleft beneath the sucker bases and becomes deeper proximally so that the sucker-bearing section proximally is a loose flap, united to the stalk only by a thin membrane, the entire posterior half loose and movable. This section is bordered by protective membranes which unite in a point proximally and do not continue onto the stalk. The tentacular suckers are in six or seven rows. Four or five suckers of the second and third rows from the dorsal edge are greatly enlarged; their horny rings bear numerous very small sharp teeth. Distally the club is rounded and there are a few small terminal suckers.

The specimens before me are mostly smooth except for a few small papillae on the dorsum of the head. Dorsally the color in preservative is a closely mottled purplish black; ventrally it is yellowish.

The measurements and indices of six females of *Sepia latimanus* Quoy and Gaimard are:

	♀	♀	♀	♀	♀	♀
ML	82.0	67.3	57.2	39.0	43.0	26.0
MWI	48.8	47.5	47.2	52.6	51.2	50.8
HWI	39.1	41.0	40.2	48.8	46.5	57.7
FLI	88.4	70.0	89.1	89.8	89.5	112.2
FWI	5.1	12.6	13.6	12.8	14.4	15.4
I	25.6	26.8	29.7	28.2	25.6	----
II	26.9	25.3	29.7	28.2	25.6	----
III	25.6	27.8	29.7	28.2	25.6	----
IV	31.7	35.7	37.0	36.2	37.2	----
SIs	1.7	1.3	1.4	1.5	1.4	1.5
SI _t	2.1	2.5	2.8	3.1	3.0	3.0
CLI	14.9	13.4	16.5	----	----	----
ShL	81.0	----	----	----	----	----
ShWI	35.9	----	----	----	----	----
LLI	38.9	----	----	----	----	----
SnLI	4.9	----	----	----	----	----

The shell forms a slender oval, rounded anteriorly and a little more pointed posteriorly. Dorsally the shell is nearly flat anteriorly but strongly convex in the posterior half, the calcareous portion wide with only a narrow chitinous border. Ventrally the anterior half is convex, the loculus with a median groove. The striated area is narrow, short, pointed anteriorly and strongly concave. The outer cone is somewhat spoon shaped, flaring at the sides. The inner cone has narrow arms, adheres to the outer cone and is thickened and raised posteriorly, forming a very small excavation. The spine is small but stout.

TYPE.—(?)Museum d'Histoire Naturelle, Paris.

TYPE LOCALITY.—Port Dorey, New Guinea (Quoy and Gaimard).

DISCUSSION.—This is apparently the first record of this species from the Philippines, although it has been recorded from Japan by Sasaki (1929). It seems to be easily recognizable by the union of the protective membranes at the base of the tentacular club and by the character of the shell. In addition, the arms are very short and stout with deep interbrachial webs.

DISTRIBUTION.—According to Adam (1939b, p. 46), this species is confined to Australia, the eastern part of the Indo-Malayan region, and Japan. It has been recorded from Australia, New South Wales, Torres Strait, New Guinea, Celebes, Tasmania, Palaus, Kei Islands, Java, Japan, and the Philippines!

Sepia esculenta Hoyle, 1885

FIGURE 2,a,b; PLATE 2,a,b

Sepia esculenta Hoyle, 1885, p. 188.—Sasaki, 1929, p. 175.—Adam, 1939b, p. 73.

MATERIAL.—1 ♀, ML 91.0 mm., Sta. D5304, China Sea near Hong Kong, blue mud, 62.2 m., August 9, 1908; USNM 575347. ?5 ♀♀,

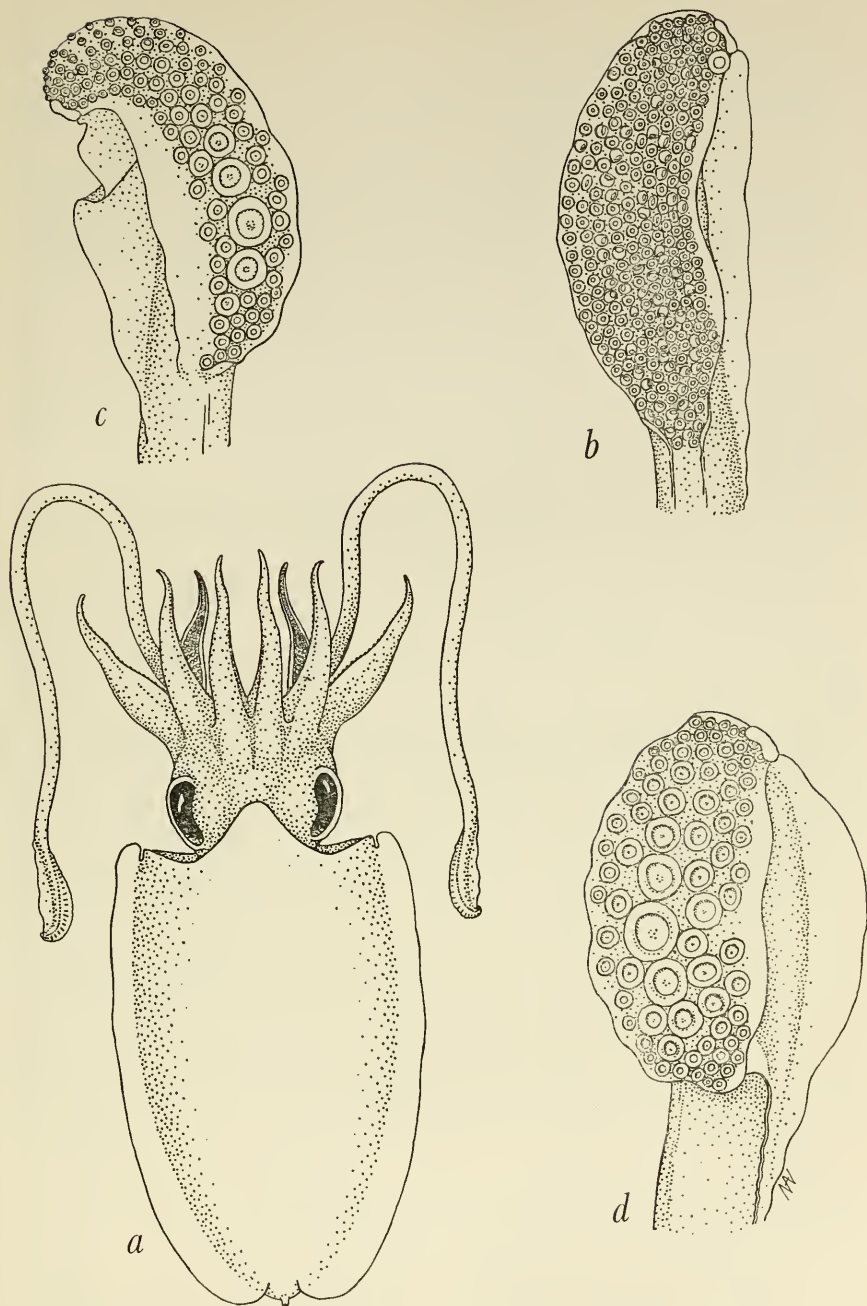


FIGURE 2.—*a, b*, *Sepia esculenta* Hoyle: *a*, dorsal view of female; *b*, right tentacular club of same. *c*, *Sepia andreana* Steenstrup, left tentacular club. *d*, *Sepia latimanus* Quoy and Gaimard, right tentacular club.

ML 54.0-26.0 mm., Sta. D5442 off San Fernando Point, west coast of Luzon, coral sand in 77 m., May 10, 1909 (all but one are in poor condition); USNM 575348.

DESCRIPTION.—This species is represented in the collections by one female with a mantle length of 91.0 mm. and by five specimens, in rather poor condition, which are tentatively referred to this species.

The mantle is roughly oval, dorsoventrally flattened and bluntly pointed posteriorly. The anterior margin is produced dorsally as a rounded triangular lobe and ventrally is nearly straight.

The funnel is stout and long and projects slightly beyond the bases of the ventral arms. The mantle locking apparatus is stout. No funnel organ could be distinguished, but there is a triangular valve.

The fins are long and narrow. They originate only 1 to 2 mm. from the margin and have free lobes posteriorly. They are very narrow.

The head is large, stout, with large eyes and conspicuous lower lids. The buccal membrane is seven-pointed and free of suckers. No spermatophoric pad could be seen.

The arms are in the order 4.3.2.1 or 4.3.1.2 and are short and stout. There is a low interbrachial web, missing in E, low in A and B, and deepest in C and D sectors. The arms are broad basally but with narrow to slender tips. I and II are rounded aborally, but III is slightly compressed with a low ventral keel and IV is strongly compressed with a prominent keel extending along its entire length. The suckers are quadriserial with a low protective membrane on each side. The suckers are very finely serrated on their horny rings.

The tentacles are long, slender, and slightly compressed, and bear small curved clubs. There is a narrow web on the dorsal side originating below the most proximal sucker and extending almost to the tip. The suckers are bounded on both sides by low protective membranes which do not unite basally but continue along the stalk as two parallel low ridges. The suckers are minute, about 0.3 mm. in diameter, and uniform in size except for two enlarged suckers in the anterodorsal corner of the club. The exact number of rows of suckers in the flaccid club is difficult to determine, but probably more than 10 rows are involved. The horny rings are finely toothed.

The shell is broad, elliptical, with both ends about equal and slightly pointed. Dorsally, the shell is convex posteriorly but nearly flat anteriorly with a low median ridge and shallow parallel grooves. There is a narrow chitinous border; the rest of the dorsal surface is calcified and marked by somewhat pointed concentric lines of rugose papillae. Ventrally, the shell is convex in the anterior half and strongly concave in the posterior half. The outer cone is thin posteriorly, and flared out and up. The striated area occupies a little more than half of the

shell, the anterior edge forming a rounded shallow V of which the apex is anterior. It has straight sides bordered by the thin sides of the inner cone which broadens posteriorly and adheres to the outer cone, forming a narrow ventral shelf. There is a long slender posterior spine.

Sculpture and color could not be determined because of the poor condition of the specimens.

The measurements and indices of two females of *Sepia esculenta* Hoyle, 1885, are:

	♀	♀
ML	91.0	54.0
MWI	46.2	65.0
HWI	32.9	46.4
FLI	83.5	84.2
FWI	11.0	----
I	26.4	38.9
II	32.9	35.2
III	34.1	40.7
IV	39.6	42.5
SIs	.77	1.39
Slt	.34	----
CLI	14.6	----
ShL	90.0	53.0
ShWI	41.2	49.0
LLI	34.6	26.2
SnLI	3.9	----

TYPE.—British Museum.

TYPE LOCALITY.—Yokohama market, Japan (*Challenger*).

DISCUSSION.—This is apparently the first record from the Philippine Islands. With the exception of one report from Queensland and one from Singapore, all records of this species have been from Japan. As discussed by Adam (1939b, p. 73-75) *esculenta* is closely related to *aculeata* Orbigny. It may be distinguished from this, however, by the much smaller club (CLI 24.0-37.0 in *aculeata*, 10-14 in *esculenta*) and by the groove on the inner face of the shell. The presence of one or two enlarged suckers on the tip of the club as found in our specimens has apparently not been noted before. *S. esculenta* may also be separated from *aculeata* by the absence of suckers on the points of the buccal membrane.

DISTRIBUTION.—Japan, Philippines, off Hong Kong; (?)Queensland, Australia; (?)Singapore.

Sepia andreana Steenstrup, 1875

FIGURES 2,c; 3,a; PLATE 2,c,d

Sepia andreana Steenstrup, 1875, p. 474.—Sasaki, 1929, p. 196.

MATERIAL.—1 ♀, ML 52.5 mm., from Sta. D5312, China Sea near Hong Kong, sand and small shells in 257 m., Nov. 4, 1908; USNM 575349.

DESCRIPTION.—A single specimen of this species was collected on the voyage to Hong Kong. The mantle is slender, roughly elliptical in outline, and is broadest near the anterior margin. It is strongly dorsoventrally flattened. The margin is produced in the dorsomedian region, the lobe having the two sides of an equilateral triangle, rounded slightly at the apex. Posteriorly, the mantle is sharply pointed between the fins. Ventrally, the anterior margin forms a rounded lappet on each side of the funnel, bordering the shallow funnel excavation.

The fins originate 3 to 5 mm. posterior to the margin of the mantle and border it but are separate at the posterior end. The fins are very narrow and attain their greatest width slightly anterior to the midpoint.

The funnel is small and stout. It extends about to the level of the eyes but does not reach to the interbrachial area of IV. The locking apparatus is very short and stout. The funnel organ could not be distinguished but there is a small triangular valve.

The head is large and somewhat flattened, with large eyes with prominent ventral lids. The buccal membrane is seven-pointed and without suckers.

The arms are in the order 4.2.1=3; they are short and stout, tapering to rather sharp points, except for I which has the tip slightly expanded. There is a low web between the arms which is deepest in sectors C and D but lacking in E. I, II, and III are in general rounded on the aboral surface but IV is strongly flattened with a prominent keel over its entire length. The suckers are quadriserial and are bordered on each side by a low non-trabeculate protective membrane. The sucker rings are smooth but are surrounded by a narrow papillated band.

The tentacles are long and slender, extending to the posterior end of the body. The stalks are laterally compressed and flattened orally. The club is small and lunate, with a strong dorsal membrane which originates proximal to the carpal area and extends to the tip. The suckers are bordered on each side by low protective membranes which, however, do not unite proximally. The suckers appear to be arranged in about six rows but the exact number is difficult to discern. Four or five of the suckers of the second row from the dorsal side are about twice as large as the others of the hand region. The horny rings of all the club suckers bear numerous minute teeth and are surrounded by a narrow band of papillations.

The surface is mostly smooth, but the mantle bears a few scattered low ridgelike knobs. The color is yellowish but sprinkled with many minute purplish chromatophores on mantle, fins, head, and arms.

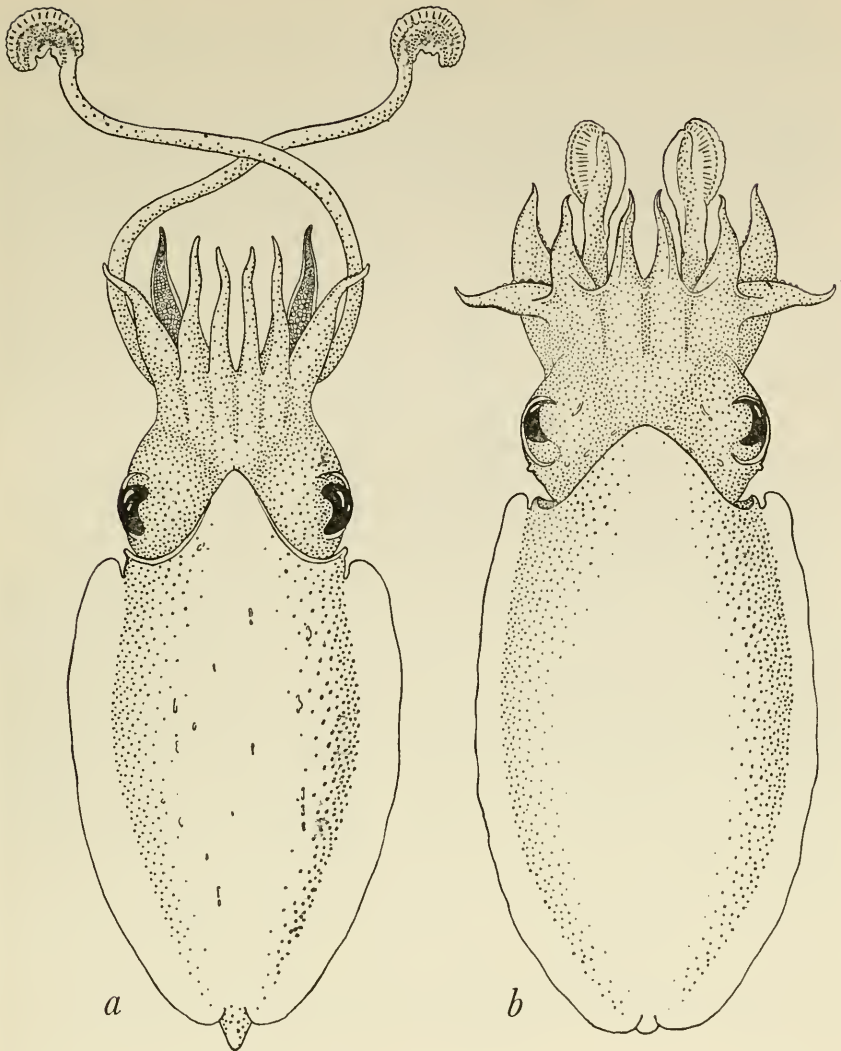


FIGURE 3.—*a*, *Sepia andreana* Steenstrup, female, 52.5 mm. mantle length. *b*, *Sepietta latimanus* Quoy and Gaimard, female, dorsal view.

The shell is very long and slender, about a fourth as wide as long. It is sharply pointed posteriorly and somewhat less so anteriorly, the posterior end terminating in a small discoidal outer cone bearing a small spine. The posterior two-thirds of the shell has straight edges which form a very narrow V. The sides are strongly angled a third the distance from the anterior end, and thence the sides are more curved. Dorsally, the shell has a straight median ridge, slightly grooved on either side. The chitinous areas on each side are

wide so that only about a fourth to a third of the central portion is calcified. Ventrally, the striated area occupies about two-thirds of the shell. The margins are straight and the boundary line between striated and smooth areas is an inverse rounded W. The longitudinal groove is faint but easily seen. The inner cone is poorly developed with a very narrow V-shaped inner cone with a more prominent posterior section. It encloses a narrow but deep cavity.

Measurements and indices of a female *Sepia andreana* Steenstrup are:

	♀		♀
ML	52.5	SIs	1.23
MWI	42.2		
HWI	36.2	SI _t	1.14
FLI	82.0	CLI	11.4
FWI	5.65	ShL	52.0
I	28.6	ShWI	23.5
II	30.3	LLI	33.7
III	28.6		
IV	33.4		

TYPE.—Zoologiske Museum, Copenhagen.

TYPE LOCALITY.—Japan.

DISCUSSION.—I have referred this specimen to *S. andreana* with some hesitation. Firstly, it is a female and hence lacks the diagnostic characters found in the male. Secondly, if it is *andreana*, it is somewhat out of its range because that species is a northern one, unreported outside of the Japanese waters, whereas *andreanooides* Hoyle, 1885, is the tropical species. With our small knowledge of these animals, however, this geographical anomaly may prove to be of no consequence. I have decided to place the specimen in *andreana* because (a) the shell is narrow and strongly angled on the sides as Sasaki stated is true for that species (this character does not show in Steenstrup's figure which is of a male) although he also showed this condition for *S. kubiensis* var. *toyamensis* (= *andreanooides*) in a lesser degree, (b) the disparity in size between some of the suckers of the club (Sasaki stated that this disparity also occurs in a lesser degree for certain variations of *kubiensis*), and (c) the expansions of the tips of arms I.

Having specimens identified by Sasaki of *andreana* and *kubiensis* (= *andreanooides*) in my possession, I have compared my specimen with them. It is referable as much to one as to the other. Sasaki's *kubiensis* has a slight expansion of I, but it is far narrower in general build; his *andreana* has no expansion of the arm tip, but it is about the same shape otherwise. Despite the irregularities, my specimen comes closer to corresponding to *S. andreana* and is so listed here.

Grimpe (1922, p. 44) created a new genus, *Andreasepia*, for these elongate forms, but this division does not seem warranted.

DISTRIBUTION.—Japanese islands; China Sea.

Sepia papuensis Hoyle, 1885

Sepia papuensis Hoyle, 1885a, p. 197.—Joubin, 1897, p. 102.—Adam, 1939b, p. 85.

DESCRIPTION.—No material has been available to me of this species, which has been reported from the Philippines by Joubin (1897). Therefore I have depended upon Hoyle's (1886, pp. 126–128) description, which is quoted below:

The *body* is elongated, broadest about one-third back, pointed behind: the *fins* extend the whole length of the body and are one-third of its breadth, a little wider behind; they extend to within 1 mm of the anterior margin but are separated by about 5 mm posteriorly: the *mantle-margin* projects far over the head dorsally, and is slightly emarginated ventrally. The *siphon* is conical, reaching two-thirds up to the gap between the ventral arms.

The *head* is short and broad; the *eyes* prominent.

The *arms* are subequal, their order of length being 4,3,1,2; they are about one-fourth as long as the body and taper to fine points: the dorsal are conical with a very slight ridge up the outer aspect, the third pair have a similar ridge; the ventral are flattened and bear a distinct crest. The *suckers* are in four series throughout and of moderate size, set obliquely on short peduncles, with meridional grooves on the outside: the *horny ring* bears twenty to twenty-five long, square-cut, irregular teeth on its distal semicircumference, and outside it is an area covered with closely set papillae. The *hectocotylus* was not observed, both the specimens being females. The *umbrella* is slight, reaching only as high as the sixth row of suckers between the third and fourth arms, where it is widest; as usual it is entirely absent between the two ventral arms. The *buccal membrane* has the usual seven points. The *spermatid pad* is not developed; the *outer lip* is smooth, except for a few ridges due to contraction; the *inner* bears numerous small papillae.

The *tentacles* are about as long as the body, the *stem* being three-sided: the *club* is short and flattened, and expanded, with a protective membrane on either side and a broad web down the back, reaching along the stem for a distance equal to half the length of the club; it bears six large *suckers* in the central row, a series of smaller ones on either side, and some very minute ones along each margin: at the top are fifteen to twenty in four series. The *horny ring* of the large suckers has twenty-five to thirty teeth in its distal semicircle; those of the smaller about ten.

The *surface* is smooth, except for a few irregular inconstant papillae on one side of the ventral surface and below the eye.

The *colour* is a pale yellowish grey, darker above.

The *jaws* are as shown in figs. 16, 17 [not shown here].

The *shell* is oval in *outline*, broadest anteriorly to the middle, tapering somewhat rapidly and ending in a semicircle in front; posteriorly it tapers gently, and then rounding off, ends in two almost straight lines, which meet at a right angle at the base of the spine. The *chitinous margin* is but slightly uncovered on the *dorsal surface*, which shows two grooves diverging as they pass forwards, separating three ribs, and is covered with rounded papillae arranged in curves parallel to the anterior margin. The *ventral surface* has a rather broad and deep median groove: the *last locus* has an index of 34, and is bounded posteriorly by a wavy line with three curves; the *striated area* is hollowed, so that this part of the shell is thin; the *inner cone* commences by two limbs, which arise halfway along the

striated area, curve outwards, and are united below the posterior apex by a broad, chitinous band passing from one side of the shell to the other and forming a rather deep *outer cone*: the *spine* is short (but has broken off); it bends slightly upwards and has a narrow longitudinal keel on its ventral surface.

Dimensions

Length, total	90 mm.
End of body to mantle-margin	64
End of body to eye	60
Breadth of body	28
Breadth of head	26
Eye to edge of umbrella	12
Breadth of fin	7
Diameter of largest sucker on sessile arm	75
Length of shell	64
Breadth of shell	22
	<i>Right</i> <i>Left</i>
Length of first arm	20 19 mm.
Length of second arm	20 18
Length of third arm	20 21
Length of fourth arm	23 22
Length of tentacle	50

This species agrees very closely with *Sepia singaporensis* Pfeffer, as regards the soft parts, but the shell is broader at the anterior extremity and the spine cannot be said to be "zurück gebogen," although it slopes gently upwards; it also is near to *Sepia plangon* Gray, which seems, however, to be still nearer to Dr. Pfeffer's species.

It corresponds with an unnamed shell in the Copenhagen Museum.

The smaller specimen has the curve bounding the loculi even, not wavy, and the keel upon the spine is more distinct than in the other specimen.

TYPE.—British Museum (Natural History).

TYPE LOCALITY.—*Challenger* Sta. 188, in the Arafura Sea, south of Papua, Sept. 10, 1874.

Sepia recurvirostris (?) Steenstrup, 1875

Sepia recurvirostris Steenstrup, 1875, p. 475.—Hoyle, 1886, p. 137.

This species was taken off Tablas Island, Philippines. It represents the only record of sepiids from the Philippines in the *Challenger* collections. Hoyle is quoted directly:

A much mutilated shell was brought up in the trawl at the above locality; unfortunately the posterior extremity, which furnishes the most striking character of Professor Steenstrup's species, was wanting, but still the general form of the body of the shell and the curvature of the lines in the striated area resemble the type more than any other known to me, and as the locality is corroborative of this view I refer it with a query to that species.

TYPE.—Zoologiske Museum, Copenhagen.

TYPE LOCALITY.—South China Sea.

Family Sepiadariidae

Sepiadarium gracilis Voss, 1962

FIGURE 4, a, b

Sepiadarium gracilis Voss, 1962, p. 170.

HOLOTYPE.—1 ♀, ML 16.0 mm., preserved in alcohol, Sta. D5290; USNM 575325.

TYPE LOCALITY.—Varadero Harbor, northern Mindoro, July 22, 1908. At ship's side with electric light, 11:30 p.m. to 12:30 a.m.

DESCRIPTION.—A single female was taken alongside the ship under the electric light at Varadero Harbor. It was in an excellent state of preservation and the following description and illustrations are based upon the unique specimen.

The mantle is nearly twice as long as wide (MWI 59.3), bluntly rounded posteriorly, and joined to the head in the nuchal region by a commissure which is less than one-third the mantle length (NCI 28.1). Laterally, the margins project forward to shield the eyes as two broad-angled lappets. Ventrally, the mantle margin projects slightly forward beneath the funnel and is sinuous.

The fins are small, less than half the mantle length (FLI 43.7) and longitudinally ovate, united to the mantle by most of the base and only slightly auriculate anteriorly.

The funnel is long, extending beyond the level of the eyes, is tubular, and is free for most of its length, with a narrow aperture. The mantle is undetachably fused to the base of the funnel on each side, the fusion long and narrow, extending outward onto the ventral surface of the funnel adductor muscle. The funnel organ consists of a small inverted V-shaped dorsal member and two oval ventral pads. The valve is subterminal and narrow with a sharp point and strongly concave sides.

The head is prominent, large, wider than the mantle (HWI 64.4), and bears large eyes with distinct ventral lids. No olfactory tubercle was evident.

The arms are in the order 3.1.2.4, rather fat, and muscular. They are united at their bases by a web which is subequal in sectors A and B, moderate in C, and deep in D (WDI 38.9). The web in sector D completely envelopes the basal section of the tentacle, forming a rather unusual sheath about it. There is no web between the ventral arms. The suckers are in two rows throughout, with about 40 pairs on III of which the largest has a diameter of 0.6 mm. They are borne on short pedicels. The horny rings appear to be smooth but are encircled by a papillate area.

The tentacles are short (TLI 50.0), stout, as large as the arms, and are rounded aborally and flattened orally. They bear short clubs (CLI 25.0) which are slightly expanded. There is a single broad web on the dorsal margin which originates just proximad of the club and extends nearly to the distal tip. The suckers of the club are arranged in six distinct rows and are very small (0.2 mm. in diameter) with round apertures.

The color in alcohol is yellowish.

There is no gladius.

Measurements and indices of the holotype of *Sepiadarium gracilis* Voss, 1962, are:

	<i>Holotype</i>		<i>Holotype</i>
ML	16.0	SIs	3.75
MWI	59.3	SIt	1.27
HWI	64.4	TLI	50.0
FLI	48.7	CLI	25.0
FWI	87.5	WDI	38.9
I	50.0	MAI	56.2
II	46.2	NCI	28.1
III	56.2		
IV	43.7		

DISCUSSION.—The genus *Sepiadarium* was founded by Steenstrup in 1881 to contain a single species, *S. kochii*, from Deep Water Bay, Hong Kong. Subsequent to that date, four other species were recorded: *auritum* Robson, 1914; *austrinum* Berry, 1921; *nipponianum* Berry, 1932; and *malayense* Robson, 1932. Berry discussed the affinities and distribution of the first three species (1921) and later (1932a) showed that the species *S. kochii* of authors was composed of two species, *kochii* Steenstrup and *nipponianum* Berry. Robson's (1932a) brief description of *malayense* has never been amplified and the species has not been taken since. Robson's species was described the same year that Berry described *nipponianum* and redefined *kochii*, neither being aware of the other's paper. I have examined the type of *malayense* in the British Museum (BM 1938.5.9.42) but although now well curated, it had formerly dried up (perhaps at the Raffles Museum or in transit to London) and nothing of value could be derived from it. *S. kochii*, as redefined by Berry, seems to be directly comparable to *malayense*, which was very briefly and inadequately described and figured by Robson. The only major differences between the two seem to be in the arm order and the arm length. The differences in lengths from which the arm order is compiled are trivial. The MAI is smaller for *kochii* because of shorter arms; it may be due to flaccidity in *malayense* but the condition of the type prohibits a check. The description of the hectocotylized arm fits one as well as the other and in the light of these considerations I consider that *malayense* should be placed in the synonymy of *S. kochii*.

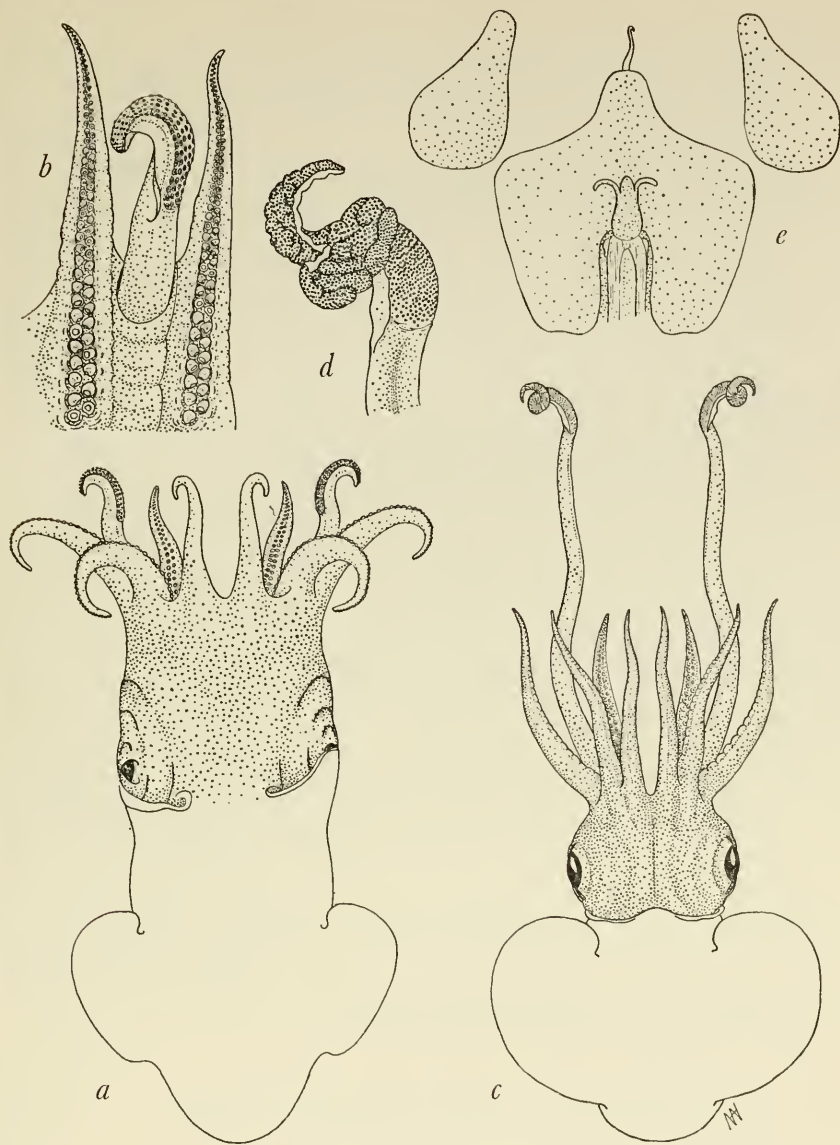


FIGURE 4.—*a, b*, *Sepiadarium gracilis* Voss: *a*, dorsal view of holotype, mantle length 16.0 mm.; *b*, left ventrolateral arm, tentacle and club and left ventral arm. *c-e*, *Rossia bipapillata* Sasaki: *c*, dorsal view of female, mantle length 39.0 mm.; *d*, left tentacular club; *e*, funnel organ and rectum, showing papillae.

Much work remains to be done on this group, but the species seem to be distinct; they may be separated from one another by means of the following key:

Key to the Species of *Sepiadarium*

1. Fins narrow; nearly four-fifths (FLI 78.0) as long as mantle; mantle width greater than the length (MWI 111.2); arm formula 3.1=4.2; mantle and head covered dorsally by small round patches of pale red or brown and fine black or dark brown spots *S. auritum* Robson, 1914.
Fins narrow; about one-half mantle length; mantle width variable; arm formula not as above; no pigment present 2
2. Mantle width about one-half mantle length (MWI 59.3); fins less than half mantle length; arm suckers in two rows; tentacular club suckers in six distinct rows; tentacular stalk as thick as arms and shorter than III; arm formula 3.1.2.4 *S. gracilis* Voss, 1962
Mantle width much more than half mantle length, nearly equal to latter; fins about half mantle length; arm suckers partly in four rows; tentacular club suckers in six to eight rows; arm formula variable 3
3. Mantle width greater than length (MWI 101.5); fins less than half mantle length; arm suckers in four rows on at least part of arm; hectocotylyzed arm of male armed with series of conical lamellae on distal portion, not bounded by distinct folds or continuous membranes.

S. austrinum Berry, 1921

Mantle width less than length; fins less than half length of mantle; arm suckers in four rows on at least part of arm; hectocotylyzed arm of male armed distally with a series of grooved transverse padlike lamellae bounded on the ventral side by a wide fleshy crenulated vertical membrane . . . 4

4. Arm formula usually 3.1=2.4 or 3.1.2=4; females with a distinct space free of suckers down middle of median portion of arm; hectocotylyzed portion of arm formed of about 18-20 low transverse ridges, bounded on the ventral side by a wide fleshy crenulated vertical membrane.

S. kochii Steenstrup, 1881

Arm formula usually 3.2.1.4; females with only an incipient opening between the suckers; transverse ridges on hectocotylyzed arm of male more conical, more papillose, more elevated, and more numerous, with about 24 transverse ridges *S. nipponianum* Berry, 1932

Berry (1932) gave a résumé of the differences between *nipponianum* and *kochii* and considered them of sufficient value to constitute specific differences, but the differences are of a minor nature (mostly in degree) and apparently are not constant; *nipponianum* may eventually be found to be only a subspecies of *kochii*.

Family Sepiolidae: Subfamily Rossiinae

Rossia bipapillata Sasaki, 1920

FIGURE 4, c-e

Rossia bipapillata Sasaki, 1920, p. 190, pl. 25, fig. 3; 1929, p. 160, pl. 16, figs. 18, 19; text figs. 98-99.

MATERIAL.—1 ♀, ML 39.0 mm., Sta. D5412, off Lauis Point, between Cebu and Bohol in 113 m., temp. 54.8° F, Mar. 23, 1909.

DESCRIPTION.—The species was first described by Sasaki (1920) on the basis of a single immature female of 19 mm. ML, from 131 fms. in Suruga Bay, Japan (*Albatross*). The present specimen is apparently a mature female although not bearing fully developed eggs.

The mantle is longer than broad, somewhat tubular, with a rounded posterior end. The dorsal mantle margin is slightly produced and the ventral margin is hollowed out.

The fins are large, four-fifths of the mantle length, with the anterior lobes free. The anterior fin margin almost reaches the anterior mantle margin. The fins are about half as wide, individually, as they are long.

The head is large, broader than the mantle, with prominent large eyes which have crescentic lower lids. The web is low and poorly developed, and is lacking entirely between arms IV.

The funnel is of moderate length, conical, projecting only slightly beyond the ventral margin of the mantle. The funnel organ is not clearly discernible in this specimen but enough can be seen to determine the general outline. The dorsal pad is pointed anteriorly and has a long slender papilla at the apex. The sides are rounded and strongly shouldered. The ventral pads are oval with an anterior point. The valve is situated near the mouth of the funnel. The funnel cartilage is about twice as long as broad, deep, with thickened borders. The anterior end is rolled inward slightly. The lateral adductors are strongly developed.

The arms are long, differentiated, in the order 3.2.1.4. The longest is about four-fifths the dorsal mantle length. The arms are all somewhat damaged, and all the suckers are missing except for a few at the base of the arms. The basal suckers are large, round, and have very small apertures. The dorsal and lateroventral arms bear low but distinct keels.

The tentacles are of moderate length, somewhat compressed, and grooved on the oral surface. The club is only slightly expanded, rather long, and so coiled upon itself that all measurements are impossible. A low dorsal membrane originates in the carpal region and extends along the full length of the club. The club itself is so folded that it gives the impression of being round. The suckers are very minute with small apertures. The exact number of suckers in a row across the club was exceedingly difficult to ascertain. Sasaki gives 24 rows but the present specimen appears to have about 30. The nature of the chitinous ring of the aperture was not discernable.

A pair of large papilliform organs of unknown function, one on each side of the rectum, is located just posterior to the opening. The pair

lies somewhat further posterior than that figured by Sasaki and appears to be larger.

The surface of the animal is smooth without papillations.

Measurements and indices of two females of *Rossia bipapillata* Sasaki are:

	<i>Holotype</i>	<i>Philippine specimen</i>
ML	19.0	39.0
MWI	84.0	66.7
HWI	100.0	69.3
HLI	79.0	51.3
FLI	84.0	71.8
FWI (single)	58.0	41.1
FWI	----	136.0
I	79.0	81.5
II	89.5	95.0
III	105.0	100.0
IV	68.5	79.5
TLI	289.0	256.0
CLI	47.3	77.0
SIs	4.2	----
St	----	0.38

TYPE.—U.S. National Museum.

TYPE LOCALITY.—Suruga Bay, 131 fms. (*Albatross*).

DISCUSSION.—The exact position of *R. bipapillata* is not known. As Sasaki stated, it stands very close to *R. mastigophora* Chun. Even though Sasaki gave the number of rows of suckers on the tentacular club as 24 in contrast to the latter species' 30, he did not consider this character to be of specific value and in the present specimen it is different. The funnel organ is quite similar to that described by Sasaki and differs from that of Chun's species. However, inasmuch as the male is unknown, the two species may be identical and if so, Chun's name would have priority. Most of the differences between the present specimen and that described and figured by Sasaki may be explained on ontogenetic grounds.

DISTRIBUTION.—Suruga Bay, Japan (Sasaki); Philippines!

Subfamily Heteroteuthinae

Sepiolina nipponensis (Berry, 1911)

FIGURE 5

Stoloteuthis nipponensis Berry, 1911, p. 39, fig. 1.

Sepiolina nipponensis, Naef, 1912, p. 248.—Sasaki, 1929, p. 149.

MATERIAL.—2 ♂♂, ML 14.0–15.5 mm., 3 ♀♀, ML 16.0–25.0 mm., Sta. D5516 off Point Tagolo light, Mindanao in 320 m., globigerina ooze, bottom temp. 54.3° F, Aug. 9, 1909. 1 ♂, ML 15.0 mm., 2

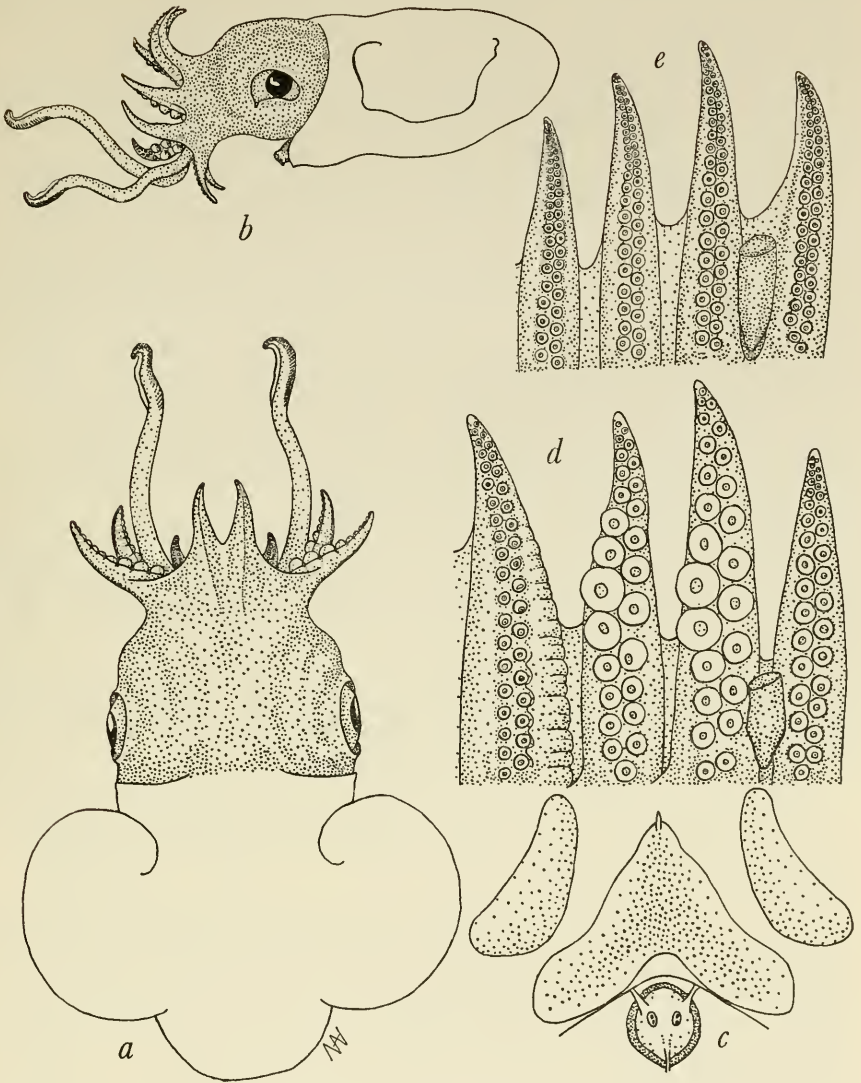


FIGURE 5.—*Sepiolina nipponensis* (Berry): *a*, dorsal view of male, mantle length 24.0 mm.; *b*, lateral view of female, mantle length 18.0 mm.; *c*, funnel organ with ink sac and light organ; *d*, arms of left side of male; *e*, arms of left side of female.

♀♀, ML 12.0–14.0 mm., Sta. D5412, off Lauis Point, between Cebu and Bohol in 297 m., green mud, bottom temp. 54.8° F, Mar. 23, 1909; USNM 575346. 2 ♂♂, ML 16.0–23.5 mm, 2 ♀♀, ML 16.0–17.0 mm, Sta. D5523, off Point Tagolo Light, northern Mindanao, Aug. 10, 1909; USNM 575345.

DESCRIPTION.—Twelve specimens of this species were found in the collections. Hitherto known only from the Japanese Islands and their vicinity, the present record extends their range southward.

The mantle is short, saccular, and bluntly rounded posteriorly. In cross-section it appears square due to dorsoventral flattening. The mantle is united to the head in the nuchal region by a narrow band, but in most of the specimens a slight fold or crease obscured the attachment and gave instead the appearance of a free mantle. Ventrally the mantle is longer, reaching almost beyond the eyes on each side but slightly emarginated immediately below the funnel. The entire ventral surface forms a shelf or shield below, the mantle here being thicker and pigmented. It has a glistening or iridescent purple sheen which contrasts strongly, except in poorly preserved specimens, with the color of the remaining area.

The funnel is almost entirely covered by the ventral shield and only the extreme end or orifice projects beyond the mantle. The funnel organ is broadly V-shaped with a slender terminal papilla. The ventral pads are slightly arcuate, narrow anteriorly but wide posteriorly.

The fins are large, originate in the middle of the mantle, and do not project beyond the margin; they are semicircular, with a large free anterior lobe. Apparently they are unpigmented.

The head is broad, compact, with prominent eyes. The eyelids are well developed dorsally and ventrally and there is even a pseudo-sinus in the anteroventral border. There is a small rather prominent olfactory papilla posterior to each eye.

The arms are short and have the average order of 3.2.1.4, but they are nearly subequal; variation in the order of the arms is so great that it cannot be used as a diagnostic character. The web is subequal in the females and extends about a third up the arms. In the males the web is much deeper in sector A between the dorsal arms, covering 50 percent or more of the arms. The arms are all without keels except III which is keeled for the distal two-thirds. There are no protective membranes. The suckers are biserial and are nearly spherical with small apertures bearing smooth rings. In the females, about 22 pairs of small suckers extend over the entire arm, largest in the middle but decreasing gradually in either direction. In the male, the dorsal pair of arms is hectocotylyzed by being somewhat enlarged and swollen and equipped with about 19 pairs of small suckers deeply set in the

fleshy oral surface. The suckers of the other arms are in about 12 pairs, those of the midsection of II and III greatly enlarged, a little more than twice as large as the suckers of I. The middle 3 or 4 pairs are greatly and almost abruptly enlarged.

The tentacles are long and slender, flattened on the oral surface and bear small, slightly expanded clubs. The clubs are bordered on each side by a low web which extends the full length. The ventral one is low and indistinct, but the dorsal web is broad. There is no carpal cluster. The suckers of the club are arranged in about 12 rows of minute round suckers with small apertures.

There is a small round photogenic organ on the ventral surface of the ink sac. It is round and has two raised pores in the surface.

The spermatophores have been well figured by Sasaki (1929). Two of the present males were ripe.

Measurements and indices of 12 specimens of *Sepiolina nipponensis* (Berry) are:

	D5516					D5412			D5523			
	♂	♂	♀	♀	♀	♂	♀	♀	♂	♂	♀	♀
ML	14.0	15.5	16.0	15.0	12.5	15.0	12.0	14.0	23.5	16.0	17.0	16.0
VML	15.0	19.0	16.0	17.0	14.0	18.0	14.0	16.0	25.0	18.0	20.0	17.5
MWI	93.0	84.0	62.5	80.0	96.0	76.8	91.9	85.8	68.0	75.0	82.4	68.8
HWI	100.0	87.1	----	86.8	96.0	76.8	75.0	78.5	78.7	93.8	94.2	81.3
FLI	93.0	77.4	62.5	73.5	80.0	80.0	75.0	78.5	68.0	78.1	82.4	68.8
FWs	64.2	51.6	46.8	53.3	52.0	63.3	58.3	50.0	43.8	50.0	59.0	43.8
FWI	200.0	161.0	131.0	147.0	176.0	173.0	158.0	157.0	144.0	144.0	182.0	144.0
I	57.2	58.0	34.4	60.0	36.0	66.7	50.0	50.0	48.8	51.2	41.2	43.8
II	64.2	59.2	43.7	60.0	52.0	80.0	54.0	53.5	48.8	56.2	44.0	50.0
III	60.6	64.6	50.0	60.0	56.0	73.0	62.4	57.0	48.8	63.6	64.8	56.2
IV	60.6	46.5	50.0	63.3	48.0	73.4	50.0	46.4	33.3	50.0	47.0	50.0
TLI	128.0	187.0	175.0	140.0	168.0	220.0	167.0	178.0	98.0	131.0	94.2	150.0
CLI	35.7	25.8	21.9	33.3	28.0	50.0	30.8	28.6	21.3	21.9	23.5	25.0
SIs	5.0	4.5	3.1	2.6	4.0	4.6	4.1	4.2	4.6	8.1	4.1	3.7

TYPE.—Stanford Natural History Museum.

TYPE LOCALITY.—Suruga Bay, Japan.

DISCUSSION.—There are certain small discrepancies between these specimens and those described by Sasaki from Japan: (a) The arm formula is different but it is also highly variable, (b) the suckers of the lateral arms in the male are 12 or 13, not 15, (c) the 5th and 6th pairs of suckers in the male are largest, not the 7th to 9th, and (d) there are 22 pairs in the female instead of 25. The present specimens agree with Sasaki's and differ from Berry's by (a) the broader web between dorsal arms of male and (b) the fins, which do not reach the border of the mantle. My largest specimen is only slightly larger than Sasaki's, but the smallest is 2 mm. shorter.

DISTRIBUTION.—Suruga Bay, 124–131 fms. (Berry); near Goto Island, Kyushu, 139 fms. (*Albatross*); Kagoshima (Sasaki); Van Dieman Strait, Kyushu, 115–119 fms. (*Albatross*); Cebu, Luzon to Mindanao, Philippines!

Subfamily Sepiolinae

Euprymna phenax Voss, 1962

FIGURES 6,a,b; 7,a

Euprymna phenax Voss, 1962, p. 171.

HOLOTYPE.—1 ♂, ML 11.0 mm., taken at ship's side by electric light, Nogas Point, Panay, Feb. 3, 1908; USNM 575328.

DESCRIPTION.—Only a single specimen of this interesting species was found in the collections. It was preserved in excellent condition and permits a detailed description.

The mantle is saccular, bluntly rounded posteriorly, and connected to the head in the nuchal region by a broad commissure about three-fourths the width of the mantle. In preservation the mantle margin is folded down on each side of the nuchal commissure, but in life this margin probably extended forwards, partly shielding the eyes. Ventrally, the mantle margin is extended forward, the lobes on each side of the funnel reaching beyond the eyes, but there is a deep V-shaped notch beneath the funnel.

The fins are small, about 43.0 percent of the mantle length. They are circular in outline with a deep anterior cleft, and are united to the mantle by a narrow base. Together their width is 127.0 percent of the mantle length.

The head is large, a little wider than the mantle (HWI 91.0), with large eyes. There is a distinct ventral lid.

The funnel is long, tubular, and rather stout, extending well beyond the level of the eyes. The locking apparatus is stout and straight. The funnel organ is composed of a small inverted V-shaped dorsal member and small compact ventral pads. There is no valve.

The arms are in the order 3=2.4.1. They are without protective membranes. The suckers are biserial. In the holotype, they are apparently of equal size in both rows and there are apparently no specially enlarged suckers present, although, inasmuch as most of the suckers are absent, one cannot overlook the possibility that one or more may be enlarged in a complete specimen. The suckers are obliquely inserted and have small apertures with smooth rings.

The left dorsal arm is hectocotylized in the following manner: Basally, there are 10 pairs of normal suckers covering about two-thirds of the length of the arm. The 3d pair in the ventral row is modified into an enlarged fleshy papilla with a degenerate sucker at the tip. The distal third of the arm bears about 10 pairs on enlarged fleshy pedicels. They are crowded, their bases forming a palisade on either side of the arm with the suckers of each row facing outward.

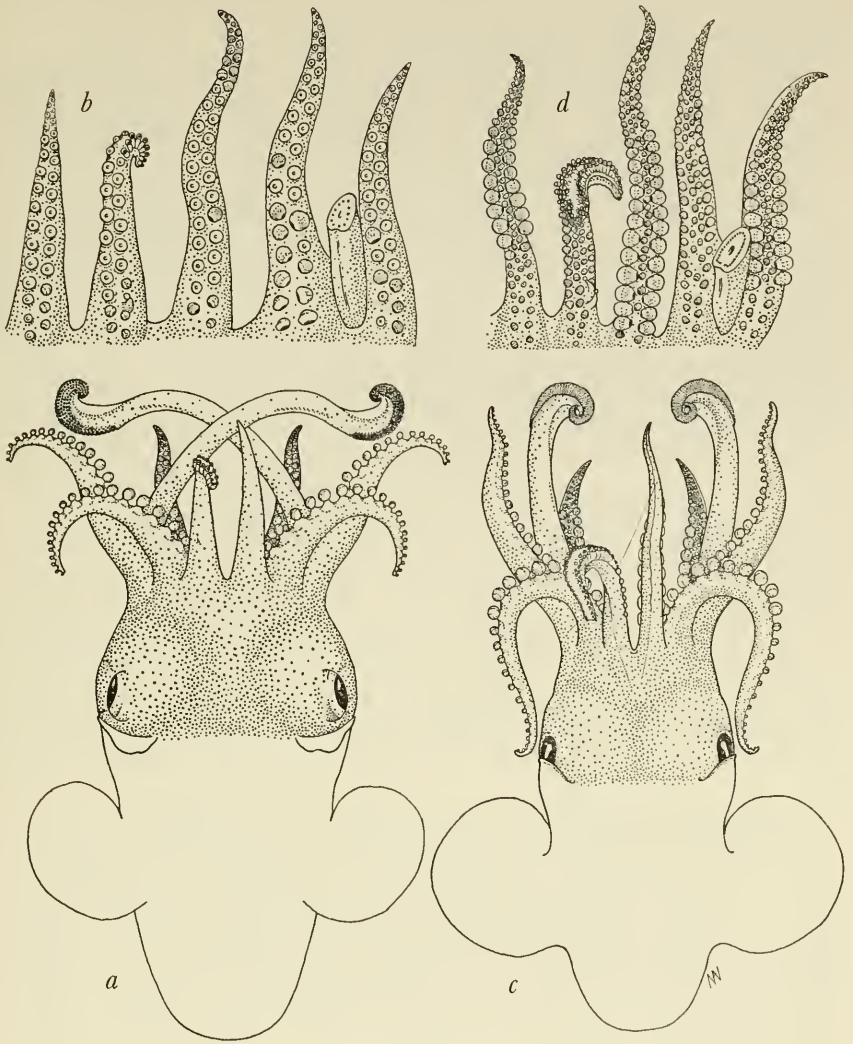


FIGURE 6.—*a, b*, *Euprymna phenax* Voss (holotype): *a*, holotype, male, mantle length 11.0 mm.; *b*, arms of holotype (right I, left I, II, III and IV) showing sucker arrangement of male and hectocotylus. *c, d*, *Euprymna albatrossae* Voss (holotype): *c*, dorsal view of holotype, mantle length 24.0 mm.; *d*, arms of holotype (right I, left I, II, III and IV) showing sucker arrangement of male and hectocotylus.

The tentacles are long and slender, flattened on the oral surface, and bear short, strongly curled clubs. A broad membrane on the dorsal surface originates proximal of the club and extends to the tip. The club bears about 12 to 14 rows of small suckers whose presence or absence of dentition could not be discerned.

The male holotype bore a number of spermatophores. One of these (fig. 7) is long and slender, with a very small and tightly coiled reservoir; it does not correspond to any of the spermatophores known from other species of *Euprymna*.

The color in alcohol is yellowish brown. Dorsally the head and mantle bear few but large dark-brown chromatophores; ventrally the chromatophores are more numerous and smaller. The aboral surface of all the arms bear large pigment spots, a single row on I, II, and III but liberally scattered over the surface of IV. Several large chromatophores on the aboral surface give the arms a barred effect.

Measurements and indices of the holotype of *Euprymna phenax* Voss, 1962 are:

	<i>Holotype</i>		<i>Holotype</i>
ML	11.0	TLI	109.0
MWI	81.7	CLI	27.1
HWI	91.0	SlS	6.3
FLI	43.6	SpL	19.5
FWI	127.0	SpLI	172.0
I	54.5	SpRI	19.8
II	2.77		
III	72.7		
IV	59.0		

There is no gladius.

There is a well-developed saddle-shaped luminous organ on the ink sac.

DISCUSSION.—This unique specimen must be considered, because of its several peculiarities, to represent a new species of *Euprymna*. This decision was arrived at after a great deal of deliberation inasmuch as our knowledge of the various nominal species of this genus is scanty and the species poorly defined. It is axiomatic that only the males of the genus show any real specific differences, and according to Adam (1954) even these differences are apparently not consistent. However, all the other species possess four rows of suckers on the mid-portion of the arms in contrast to only two in the present species, and all have at least some of the suckers abruptly enlarged in the males whereas this one does not.

In summary, *E. phenax* may be immediately separated from *morsei*, *berryi*, *scolopes*, and *stenodactyla* by the presence of biserial suckers, the more simplified hectocotylus and apparent lack of any enlarged suckers on the arms. It may also be separated by the structure of the spermatophore.

Euprymna albatrossae Voss, 1962

FIGURES 6,c,d; 7,b,c

Euprymna albatrossae Voss, 1962, p. 171.

HOLOTYPE.—1 ♂, ML 24.0 mm., from Cubagao Anchorage, Catanduanes Id., off southeast coast of Luzon, June 9, 1909; electric light; USNM 575331.

PARATYPES.—2 ♂♂, ML 22.0–20.5 mm., 3 ♀♀ ML 20.0, 15.0, and 12.5 mm., from Cubagao Anchorage, Catanduanes Id., off southeast coast of Luzon, June 9, 1909; electric light; USNM 575332.

DESCRIPTION.—The mantle is saccular, bluntly rounded posteriorly, and joined to the head dorsally by a broad nuchal commissure. The lateral margins nearly cover the eyes and ventrally it is produced, leaving only the tip of the funnel exposed. The ventral margin is sinuous.

The fins are large, nearly two-thirds the length of the mantle and united to the body a little in front of the middle of the mantle. They are subcircular with broad strong bases and auriculate anteriorly with a broad free anterior lobe.

The funnel is stout, tubular with a narrow aperture, and free for over half of its length. The funnel adductors are strongly developed. The funnel organ is clearly seen, the dorsal member stout and V-shaped, the surface heavily wrinkled. The ventral pads are also wrinkled, stout, pointed anteriorly. The valve is triangular.

The head is large, as wide as the mantle. The eyes are prominent, with small eyelids, and there is a large pore posterior to and slightly ventral of the pupil. The head is flattened and grooved ventrally for the funnel.

The arms are in the order 2.3.4.1 or 2.3.4=1, about as long as the mantle and rather stout, strongly keeled for most of their length. In the females, the suckers are nearly equal in size between the outer and inner rows and all the arms are the same (SIs 2.5–3.3). In the males, I right has three pairs of suckers basally, followed by about three sets of four suckers. Beyond this the suckers of the inner rows are small with round apertures, but about eight of the median suckers of the outer rows are greatly enlarged, about 3 to 4 times as wide as those of the inner rows, the suckers of the dorsal and ventral rows equal. The apertures of all the enlarged suckers on all the arms are smooth but in two sections, a broad straight "lower lip" and an arched upper border, the union between the two incomplete. Distally, the suckers abruptly decrease in size. On II, the suckers of the inner rows are small, but those of the outer rows are greatly enlarged (in the holotype about the first 14 in each outer row are enlarged, the others decreasing in size somewhat abruptly). On III, there are a few basal

pairs of suckers; the other suckers are in four rows, the marginal rows bearing suckers almost imperceptibly larger than those of the inner rows. The most notable feature of this species is the small, nearly equal suckers on III which are so strikingly different from those of the other arms. On IV, the suckers of the inner rows are nearly minute, but the outer rows bear about eight greatly enlarged suckers about three or four times the size of the inner ones. Distally there is an abrupt decrease in size, but even distally the suckers of the outer rows are larger than those of the inner ones. The enlarged suckers on all the arms are about the same diameter and have a SIs of 5.3-5.9 in contrast to a SIs of 2.5-3.3 in the females.

In the male the left dorsal arm is hectocotylyzed by the modification of the suckers of the distal half. Basally there are about 35 normal suckers of which two, located a quarter of the length of the arm from the base in the ventral row, are modified into long fleshy papillae. Beyond this proximal half, the suckers are modified into short fleshy papillae surmounted at the extremity by a slitlike aperture, with fleshy lips. These modified suckers are in four rows, the two pairs of rows being turned outward. In the larger male there is a broad expanse between the two sets of rows, but in the smaller ones this clear area is reduced or absent. Ventrally, the papillae form a closely packed palisade, less so dorsally. There are about 68 papillae crowded into the distal section. Aborally a broad keel is highly developed over the modified section.

Measurements and indices of six specimens of *Euprymna albatrossae* Voss, 1962, from Catanduanes Island are:

	Holotype	♂	♂	♀	♀	♀
ML	24.0	22.0	20.5	20.0	15.0	12.5
MWI	75.0	72.8	83.0	75.0	93.5	96.0
HWI	71.0	70.5	75.5	71.0	86.6	88.0
FLI	62.5	56.8	66.0	62.5	66.6	72.0
FWI	146.0	145.0	151.0	156.0	163.0	168.0
I	83.0	75.0	83.0	70.0	76.8	80.0
II	100.0	86.4	95.0	95.0	86.6	96.1
III	96.0	82.0	92.7	90.0	85.5	88.0
IV	83.3	81.0	85.0	75.0	80.0	80.0
TLI	131.0	----	----	----	----	----
OLI	33.3	----	----	----	----	----
SIs	5.8	5.9	5.8	2.5	3.3	3.2

The tentacles are short and stout, flattened orally, angled on the dorsal side. The clubs are small, only slightly expanded and bear about 20 rows of very minute suckers. There is a broad stout dorsal web.

The color is yellowish with numerous large purplish-brown chromatophores, which are numerous both dorsally and ventrally on the head, mantle, and arms. The fins are heavily pigmented over most of the dorsal surface and bear a large central patch of spots on the

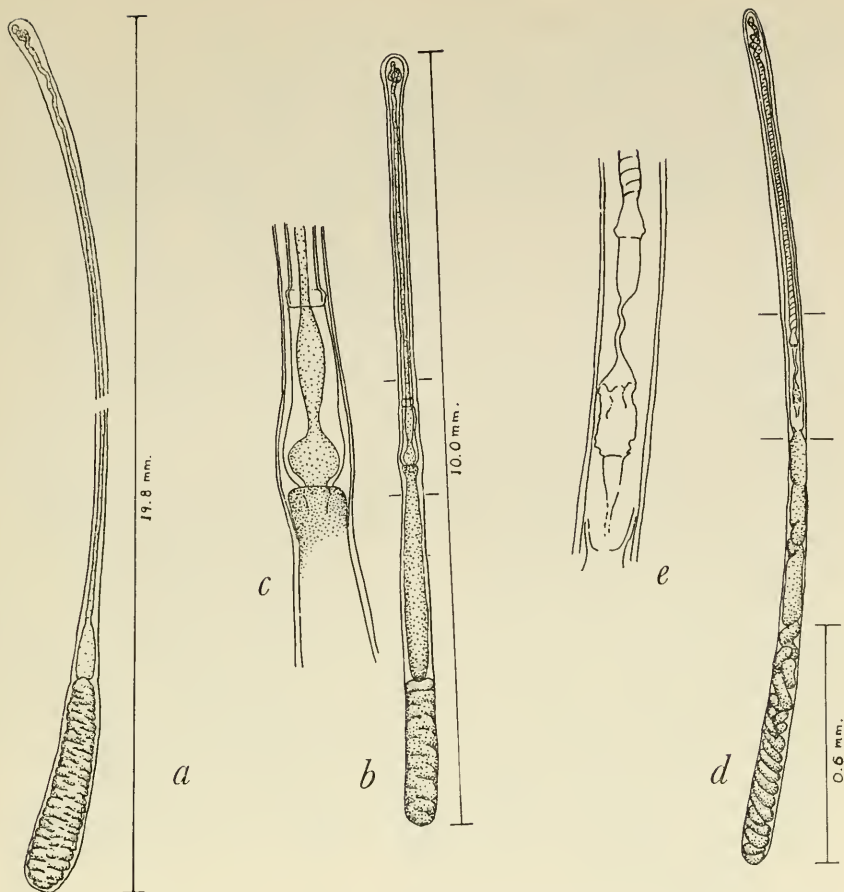


FIGURE 7.—Spermatophores: a, spermatophore of *Euprymna phenax* Voss; b, spermatophore of *Euprymna albatrossae* Voss; c, middle part of same enlarged; d, spermatophore of *Sepiolo trirostrata* Voss; e, middle part of same enlarged.

ventral surface. The oral face of the arms, especially II, are strongly pigmented with purple from chromatophores at the base of the pedicels and crossing the oral surface.

Spermatophores were present in the paratype of 22.0 mm. mantle length. The spermatophore is 10.0 mm. in length and closely resembles those of *E. berryi* as figured by Sasaki except in the details of the midportion in which there is a distinct round posterior section.

DISCUSSION.—This is a large species of *Euprymna* which in many ways approaches *E. berryi* Sasaki, but the enlarged suckers on the dorsal arms, no very moderately enlarged suckers on III, and the numerous enlarged suckers on I, II, and IV are quite different from anything that Sasaki or others have described. Furthermore, no

other species of *Euprymna* known to me has such prominent keeling of I, II, and III.

REMARKS.—A note within the jar, evidently in Dr. Bartsch's handwriting, states "Sepiola?, 2 kinds, 1 smooth, 1 papillose." No differences, however, could be found among the six specimens in the jar, and evidently the character was transient and lost in preservation.

Euprymna stenodactyla (Grant, 1833)

FIGURE 8, a, b

Sepiola stenodactyla Grant, 1833, p. 42.

Euprymna stenodactyla, Steenstrup, 1887, p. 66.—Hoyle, 1904, p. 24.

MATERIAL.—13 ♂♂, ML 18.5–11.2 mm., 3 ♀♀, ML 18.0–9.2 mm., Tumindao Island Anchorage, Feb. 25, 1908; electric light; USNM 575335. 1 ♀, ML 12.0 mm., Panabutan Bay, Sulu Sea, Mindanao, Feb. 5, 1908; electric light; USNM 575337. 1 ♂, ML 11.0 mm., from Ulugan Bay, Palawan I., near mouth of Baheli River, seine, Dec. 28, 1908; USNM 575336.

DESCRIPTION.—The mantle is saccular, a little narrower than long and united with the head in the nuchal region by a broad commissure. The anterior margin projects forward, almost covering the pupil of the eye on the sides. The ventral margin is strongly advanced, nearly covering the long funnel, sinuous, slightly scalloped beneath the funnel. Posteriorly the mantle is blunt and broadly rounded.

The fins are semicircular in outline, meeting the mantle smoothly behind. Anteriorly they are strongly auriculate, the inner margin of the lobe lying adjacent to the mantle. They are attached at about the middle of the mantle.

The funnel is long, tapered, tubular, with narrow aperture. It is free for most of its length. The funnel organ is composed of a broad, compact, inverted V-shaped dorsal member and two oval ventral pads which are pointed anteriorly. There is a very small, sharply triangular valve.

The head is compact, broad, with small eyes with small, nearly round eyelids. A distinct raised olfactory pore lies well posterior to the eye and slightly ventral. The head is decidedly flattened with a shallow excavation for the funnel. All the arms are united by a web except IV. The web is deep in sectors A and B, deepest in D, shallow in C, and missing in E.

The arms are comparatively long, and are about subequal, with II the longest and IV the shortest, although they vary considerable. All the arms are keeled, sometimes prominently, for the basal three-fourths of the length. In a few specimens there was little or no trace of the keel, but in others I and III were strongly keeled, II

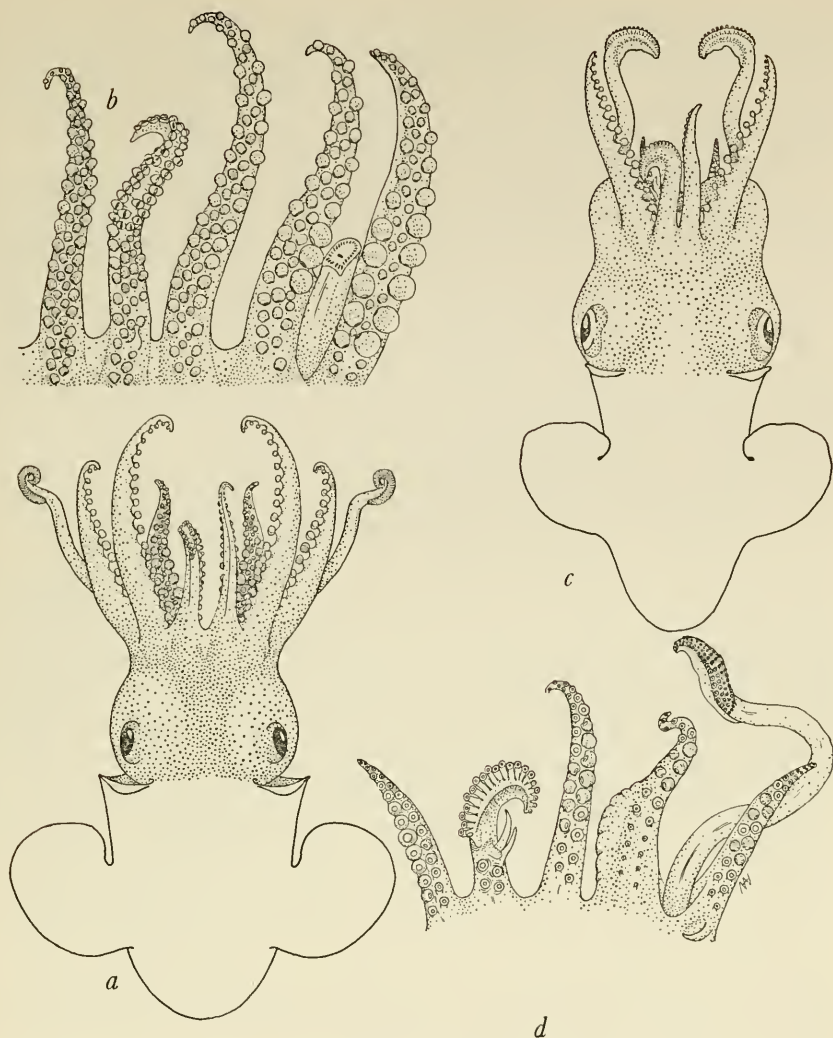


FIGURE 8.—*a,b*, *Euprymna stenodactyla* (Grant): *a*, dorsal view of male, mantle length 18.0 mm.; *b*, arm arrangement (right I, left I, II, III, IV) showing sucker pattern and hectocotylus of male. *c, d*, *Sepiolo ttrirostrata* Voss: *c*, dorsal view of male paratype, mantle length 11.5 mm.; *d*, arm arrangement of same (right I, left I, II, III and IV) showing details of hectocotylus.

slightly, and IV only upon the dorsal edge as is commonly found in most decapods. Protective membranes appear to be absent.

The arm suckers are in four rows on all arms. They are round or slightly barrel-shaped, inserted laterally on small pedicels with stout bases. As a result they are very easily lost and except in perfectly preserved specimens many of the suckers are missing.

In the females the suckers are in two rows basally for about three pairs after which they become four-rowed, remaining so to the distal tip. The suckers of both the inner rows are of equal size, no discernable or measurable differences being found. The sucker apertures are smooth, untoothed.

In the males the suckers are irregularly biserially arranged at the base for about three pairs after which they are found in four rows. On the right dorsal arm the suckers of the outer rows are about equal, both ventral and dorsal, and about a third to a half larger than the suckers of the two median rows. On II the suckers of the outer rows are still not strikingly larger, but the suckers of the ventral row are slightly larger than those of the dorsal row and about a half larger than the median ones. On III the suckers of the median row are slightly smaller than those of the outer rows, but about three or four of the median suckers of the ventral row are much larger than the remaining ones of that row or the dorsal. These three or four enlarged suckers are about three or four times larger than those of the median row. About half the males available to me have three enlarged suckers on III, the others four. On IV the suckers of the median rows are smaller than those of I, II, and III and again the outer rows are similar to those of the other arms except that three or four of the median suckers of the dorsal row are greatly enlarged and four or five of those of the ventral row are abruptly enlarged. This order seems to be consistent in all the males studied.

The left dorsal arm of the male is hectocotylized. Basally there are 20 to 25 suckers in four rows of nearly equal size. Near the middle of this area in the ventral row are one, rarely three, prominent, usually suckerless nipplelike papillae. Distal to the normal suckers are 35 to 40 closely palisaded papillae terminating in a slitlike aperture containing a small sucker. The palisade effect is only visible on the ventral side of the arm. The arm is stouter than its right counterpart and may be slightly shorter but this shortness is probably due to the strongly outward curling of the arm.

The tentacles are short, round, flattened on the oral surface, with the edges of the flat area angled, the dorsal edge forming a low web which at the base of the club becomes broader, extending to the tip of the club. The club is short, curled, and rounded with numerous rows of very minute suckers.

The color in alcohol is yellowish with numerous large purplish-brown chromatophores distributed over the dorsum of the mantle, head, and arms. Ventrally the pigment spots are just as numerous. The fins are completely devoid of pigment except for a small portion on the base. The arms are banded, with large rectangular or oval

chromatophores on the aboral surface giving a barred effect. There are additional pigment spots on the arms on each side near the base of the outer row of suckers.

There is no gladius.

There is a prominent saddle-shaped luminous organ on the ventral surface of the ink sac.

Measurements and indices of eight specimens of *Euprymna stenodactyla* Grant are:

	♂	♂	♂	♂	♂	♀	♀	♀
ML	18.5	16.0	16.0	17.0	16.0	18.0	9.2	12.0
MWI	89.3	87.5	90.5	94.2	83.6	77.8	103.0	91.6
HWI	75.7	84.3	75.0	76.4	81.3	72.2	95.6	84.0
FLI	54.2	65.6	62.5	63.7	62.5	55.5	65.2	62.5
FWI	151.0	163.0	153.0	154.0	166.0	153.0	174.0	150.0
I	70.3	81.2	90.5	67.5	81.3	77.8	----	----
II	97.2	93.7	112.5	88.2	100.0	89.0	----	----
III	81.0	81.2	100.0	76.4	87.4	80.5	----	----
IV	78.3	75.0	87.4	76.4	81.3	72.3	----	----
TLI	97.2	----	109.0	----	----	----	----	----
CLI	21.6	----	----	----	----	----	----	----
NCI	49.7	50.0	59.4	53.0	53.7	50.0	----	----

TYPE.—Not traced.

TYPE LOCALITY.—Mauritius.

DISCUSSION.—In the present study I have disregarded the structure of the suckers of the tentacular club, which Adam (1954, p. 127–128) discussed briefly, because I do not think that such highly modifiable structures are of any real value when the object itself is so minute and the organs subject to change in shape from strong crowding. If one disregards these structures and centers upon the size and arrangement of the arm suckers, some cohesion becomes apparent. I have examined specimens of *E. morsei* and *berryi* from Japan, and find that they consistently conform to the illustration and description given by Sasaki (1929, p. 144).

A paratype of Berry's *scolopes*, also available for direct comparison, does not approach these specimens. Hoyle's description of *stenodactyla* Grant corresponds very closely and differs only in the lack of keels in the Arno Atoll specimens (probably due to preservation). Hoyle gives the arm order as 3.2.1=4. Grant said that they were equal, but his figure distinctly shows III to be the longest. In 1954, I published on some *Euprymna* from the Marshall Islands, calling them *stenodactyla*. One of these is available to me for direct comparison and again close agreement is found. The Marshall Island specimen differs from the present material only in having two or three enlarged suckers on the ventral row of III (4 in present specimens) and one or two enlarged suckers on the dorsal row of IV. This slight variance may easily be geographical and varies in the same degree from those

described by Hoyle (1904) from Arno Atoll, Marshall Islands. In view of this I have consigned the present specimens to Grant's species. However, since Adam (1954) found species referable to *morsei* and *berryi* to the southward in Indonesia, these latter two species almost certainly will also be found to occur in the Philippines. The 18 specimens available to me are remarkably consistent in their characters and show little variation. If we accept the arrangement of the sessile suckers of the male as diagnostic, they may be easily distinguished from all other species.

DISTRIBUTION.—Mauritius (Grant). Rangiroa, Tuamotus; Funafuti, Ellice Islands; Tarawa, Gilbert Islands, Arno Atoll, Marshall Islands (all Hoyle). Bikini Atoll, Marshall Islands (Voss). Philippine Islands!

?Euprymna morsei (Verrill, 1881)

Inioteuthis morsei Verrill, 1881, p. 417.

Euprymna similis Sasaki, 1913, p. 249.

Euprymna morsei, Sasaki, 1929, p. 146.—Adam, 1954, p. 125.

MATERIAL.—1 ♂, ML 15.5 mm., from Cebu market, Mar. 20, 1909; USNM 575333. 1 ♂, ML 14.0 mm., 1 ♀, ML 12.5 mm., Sta. D5159, off Tinakta Id., coral sand, 18 m., Feb. 21, 1908; USNM 575334.

The three specimens listed above appear to belong to this well-known species, but they are in a poor state of preservation, with most of their suckers absent, and are badly distorted. However, from the size of the sucker bases on the ventral rows of all the arms and the occasional greatly enlarged suckers still present on the ventral rows, they have been tentatively placed in this species.

TYPE.—Yale University.

TYPE LOCALITY.—Yeddo Bay, Japan.

DISTRIBUTION.—Japan (numerous records by Sasaki); Indonesia, Makassar, Amboina (all Adam); Philippine Islands!

Unidentified *Euprymna*

MATERIAL: 1 ♂ ML 19.0 mm. (formerly dried up), from Port Dupon, Leyte, Mar. 17, 1909. 1 ♀ ML 29.0 mm. (all suckers missing, tentacular clubs round and coiled, broad dorsal web, suckers very minute), Jolo, Sept. 16, 1909, taken by electric light. 1 ♀ ML 13.0 mm. (badly crushed), Endeavour Straits, electric light, Dec., 1908. 1 ♀ ML 28.0 mm. (suckers in two rows for the basal half of the arms), from market, Ilo Ilo, Panay, June 1, 1908. 1 ♀ ML 20.0 mm. (formerly dried up), Sta. D5165, from off Observation Id., Sulu Archipelago, 9 m., coral, Feb. 24, 1908. 1 ♀ ML 25.0 mm. (in good shape but all suckers missing), river at Port Dupon, Leyte, Mar. 17, 1909. Bartsch. 2 ♀♀, ML 24.0–25.0 mm., Sta. D5360, from off

Corregidor Light, Manila Bay, 18 m., hard bottom, Feb. 7, 1909. 1 ♀? ML 9.0 mm., from off Teomabal Id., surface, Sept. 18, 1909. 1 juv., ML 5.5 mm., 1 ♂ ML 9.0 mm. (some enlarged suckers on ventral arm), San Miguel Bay, Ticao Id., Apr. 21, 1908; electric light. 1 ♂ ML 12.0 mm. (most suckers missing), Bolinao, May 9, 1909; electric light.

Sepiola tirostrata Voss, 1962

FIGURES 7,d,e; 8,c,d

Sepiola tirostrata Voss, 1962, p. 172

HOLOTYPE.—Male, ML 12.0 mm., taken by electric light at ship's side, Nogas Pt., Panay, Feb. 3, 1908; USNM 575329.

PARATYPES.—2 ♂♂, ML 10.0–11.5 mm., 2 ♀♀, ML 11.0–12.3 mm., taken by electric light at ship's side, Nogas Pt., Panay, Feb. 3, 1908; USNM 575330.

DESCRIPTION.—The mantle is short and saclike, broadest anteriorly and tapering in a cone-shaped fashion to the posterior end. In the females the end is blunt and broadly rounded, in the males it is pointed. In the nuchal region, the mantle is connected to the head by a broad commissure which is half the breadth of the mantle. Ventrally the mantle margin is sinuous with a broad lobe on each side of the funnel and a shallow excavation beneath it.

The fins are small (about 40 percent of the dorsal mantle length) and semicircular, with a deep, free anterior lobe. The fin width is slightly greater than the mantle length.

The funnel is long and slender, tubular, tapering to a narrow aperture. The locking apparatus consists of a small straight groove on the funnel and a long slender ridge on the mantle. The funnel organ is composed of a small inverted V-shaped dorsal organ with a fused double center portion and two large oval ventral pads which have an elongate and rounded lobe anteriorly. The funnel valve is a slender organ with slightly diverging straight sides ending in a triangular point.

The head is large with rather enormous eyes which have distinct ventral lids. There is a small round olfactory pore just posterior to and slightly ventral of the eyelid.

The arms vary between the sexes but have a formula of $2=3.4=1$ in most cases. However, in both sexes III is stouter than the others and generally strongly curved inward. In the males, III is enormously stout, more than twice as broad as the other arms. None of the arms are equipped with protective membranes and there are no keels except a broad ridge on the dorsal surface of IV which basally connects with III.

In the female, III is only slightly larger than the others, only slightly turned inward, and with a tapering point. The suckers are biserial on all arms and with the exception of III are of normal size, smaller basally and gradually increasing to the midpoint and then decreasing slowly distad. On III, the first three or four pairs of suckers are very small basally; others abruptly increase in size, comparably to the midsuckers of the other arms.

In the males, the suckers of I and II are unequal, those of the ventral row about a third larger than those of the dorsal row; IV is normal. In III, the arm is about twice as stout as the others apparently permanently strongly incurved with the tip again turned outward in an S-shape. Basally, about the first four pairs of suckers are minute; the others become greatly enlarged on the ventral row, moderately so dorsally. The left dorsal arm is hectocotylized in the following manner: Basally there are two pairs of normal suckers, equal in size. Distad of these, in the ventral row there is a large swollen fleshy papilla turned downward and outward, and attached to the inner surface of the arm except for a small portion at the tip. From the outer side of the arm beneath this swollen papilla arise two other papillae. In the largest male, both of these are long and slender, curving outward and forward, the anterior one about twice as long as the posterior one and twice as thick, 1.5 mm. in length. In the smaller males, the posterior papilla is much smaller. Distad of this group of papillae there is an open smooth area. Beyond this area the arm has the appearance in ventral view of being twisted 45° to the right. Basally, there is a small conical papilla on the oral surface, marking the origin of a heavy pronounced fold or ridge which follows the arm to the distal tip with an intervening clear space between the ridge and the crowded suckers. Dorsally, there are two rows of crowded elongate papillae bearing distal apertures, alternating in such a manner as to appear to be one row. There is a palisaded effect on each side. External to the fleshy ridge a short compact membrane coils the distal part of the arm into almost a complete circle.

The tentacles are long and slender, round in cross-section, but slightly flattened on the oral surface. The clubs are short and expanded, and bear four rows of small suckers, of which those of the dorsal row are about twice the diameter of those of the ventral row, decreasing in an orderly fashion. There are two membranes on the club, a broad dorsal one originating some distance proximal to the basal suckers and a ventral narrow one originating at the basal suckers. Both extend to the tip, the dorsal membrane contracted and hence coiling the club.

Measurement and indices of five specimens of *Sepiola trirostrata* Voss are:

	<i>Holotype</i>	♂	♂	♀	♀
ML	12.0	10.0	11.5	12.3	11.0
MWI	66.6	80.0	65.3	72.3	81.7
HWI	83.3	80.0	69.6	73.0	77.2
FLI	41.6	40.0	39.1	44.6	45.4
FWI	116.0	120.0	109.0	114.0	109.0
I	50.0	45.0	39.1	48.8	45.4
II	66.6	65.0	63.6	48.8	54.5
III	83.2	60.0	47.8	52.8	54.5
IV	50.0	45.0	43.5	40.6	36.4
TLI	----	100.0	----	97.4	109.0
CLI	----	33.3	----	24.4	27.3

The color in alcohol is a brownish yellow. The mantle, especially ventrally, is liberally spotted with minute round dark brown or black chromatophores. These are larger on the ventral surface of the head. Arms III are tinted a deep rose or pink, paler in some specimens. The outer surface of I, II, and III has a single row of about eight large brownish chromatophores, whereas IV has a double row of small ones.

The ink sac appears to be shaped like two kidneys with an indefinitely defined light organ on each lobe.

The spermatophores are small, 2.2 mm. in length. Though resembling those of both *Sepiola parva* and *S. birostrata*, they are more slender than either, the coiled part of the sperm reservoir is shorter, the straight part longer, and the midorgan is somewhat differently constructed.

TYPE.—U.S. National Museum.

TYPE LOCALITY.—Off Nogas Point, Panay.

DISCUSSION.—The peculiar construction of the hectocotyized arm serves to separate this species from both of the other Indo-Pacific forms. The structure of the spermatophore also is distinctive.

DISTRIBUTION.—Known only from the type locality.

Inioteuthis maculosa Goodrich, 1896

FIGURE 9

Inioteuthis maculosa Goodrich, 1896, p. 2.—Massy, 1916, p. 216.—Adam, 1954, p. 128.

MATERIAL.—26 ♂♂, ML 11.2–12.0 mm., 14 ♀♀, ML 10.0–12.5 mm., from Cubugao Anchorage, Catanduanes Id., June 9, 1909; USNM 575338. 1 ♂, ML 11.2 mm., 1 ♀, ML 11.2 mm., from Ragay Bay, Ragay Gulf, Luzon, March 9, 1909; electric light; USNM 575339.

DESCRIPTION.—The mantle is saccular, bluntly rounded posteriorly and slightly flattened. It is united to the head by a narrow nuchal commissure. Laterally, the anterior margin projects forward, partly

shielding the eyes. Ventrally, the margin is produced, nearly covering the funnel and is not, or is only slightly, sinuous. In the males, the mantle is distinctly widest at the margin which flares outward bell-like. In the females, the sides are straighter, the margin is not flared, and there is a widening posteriorly.

The fins are small, nearly circular, and strongly auriculate anteriorly, not at all so posteriorly, with narrow bases. They originate at about the midpoint of the mantle.

The funnel is small, stout basally, with a slender anterior section which is free for most of its length. In the female examined, the funnel organ differs somewhat from that of the male in that the dorsal member is V-shaped in the female but U-shaped in the male, the ventral pads broad in the female, rather narrow and compact in the male. The mantle-funnel locking apparatus is somewhat peculiarly formed. The funnel member is a short deep groove bluntly rounded at each end. The mantle member is a long slender ridge, slightly curved, and partially divided in the middle. The posterior half fits within the funnel groove, whereas the anterior half projects forward and appears to lie against the funnel adductor.

The head is small and compact, almost as wide as the mantle. It bears large eyes with small pupils and with small but distinct eyelids. There is a small pore posterior to and ventral to the eye. The head is flattened ventrally and shallowly excavated to include the funnel.

The arms are in the general order $3=2.4.1$ or $3=2.1.4$. The arms are rather long, rounded aborally and with the exception of IV have narrow but well-defined aboral keels extending over the greater length of the arms. The suckers are biserial, on short pedicels, and are not equipped with protective membranes. In the females there are about 18 pairs of round suckers on II and III. The suckers of the arms are barrel-shaped, laterally inserted, with round apertures without teeth. In the male the suckers are small and evenly distributed. Arm III is slightly stouter than the others and curves slightly inward.

In the males the suckers are in general all larger than in the female but in addition on I, II, and III the suckers of the ventral row for most of its length are greatly enlarged and about a half larger than those of the dorsal row. On IV the suckers of both rows are somewhat enlarged, the ventral ones a little larger than the dorsal ones. The suckers of III are not so enlarged as on the other arms. In the males, III is much stouter than the others and strongly turned inward.

The left dorsal arm is hectocotylized in the males by a tremendous broadening of the basal half of the arm containing a deep excavation, the sides of the excavation inrolled along the edges. The dorsal edge is entire but the ventral one is deeply cut in, the proximal and distal sections forming lobes. The proximal edge terminates at the

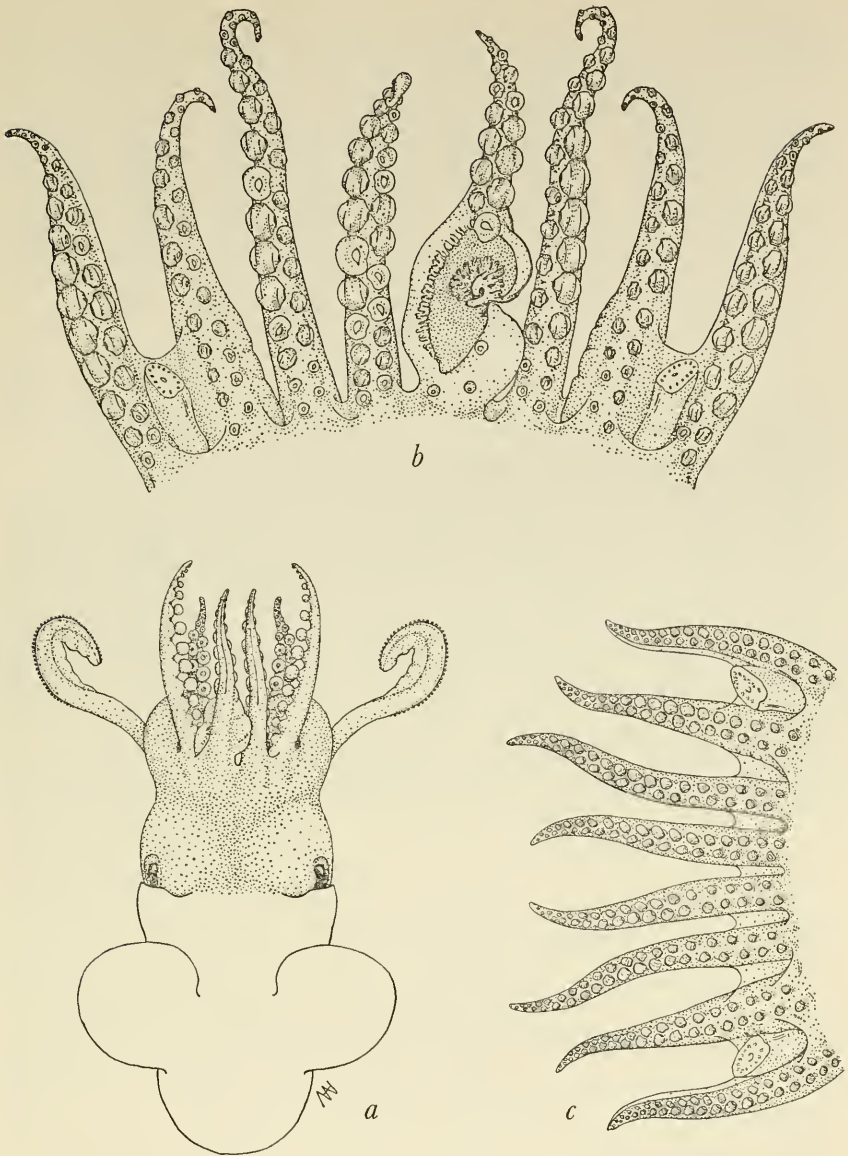


FIGURE 9.—*Iniotewthis maculosa* Goodrich: *a*, dorsal view of male, mantle length 12.0 mm.; *b*, arm pattern of male showing arrangement of suckers and details of hectocotylus; *c*, arm pattern of female showing arrangement of suckers.

interruption in a sharp angle which is less than 90° and forms two sharp lobes lying one on top of the other. Viewed from the oral surface, the edge here turns inward and dorsal to meet the floor of the excavation. The inward turning of the edge forms a deep proxi-

mal pocket. The inward-turning margin becomes a low ridge terminating in the middle of the excavation in a mound which bears a raised internal lobe cleft in the proximal border. From the outer or ventral side of the cleft, the margin turns outward to become the outer distal edge of the main excavation and forms an excavation again containing a deep anterior pocket. Proximal of the excavation there are two or three small suckers, the third one when present placed on the ventral margin. Distad of the excavation are eight pairs of suckers similar in size and arrangement to those of the normal right dorsal arm, that is, those of the ventral row enlarged.

The tentacles are long and slender, flattened on the oral surface, and bear clubs which are somewhat expanded. Ventrally the club has a low protective membrane, but dorsally there is a wide web originating basal to the club and extending to the tip. The suckers are small, toothed on the margin, and in about 8 to 10 rows.

There appears to be no gladius.

The color in preserved specimens is yellowish with numerous purplish-brown chromatophores which are minute to large, crowded on the dorsum of the head, arms, and mantle, scattered ventrally. On the arms, the chromatophores provide a banded effect as they do on the aboral distal half of the tentacles. Chromatophores extend over most of the dorsal surface of the fins but are absent on their ventral surface.

There are no light organs in the mantle cavity or elsewhere.

Measurements and indices of 10 specimens of *Iniotoothis maculosa* Goodrich are:

	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
ML	11.2	11.5	11.2	11.7	12.0	12.6	12.0	12.5	11.8	10.0
MWI	84.7	82.5	71.5	77.0	79.0	71.4	71.6	72.0	80.5	80.0
HWI	73.2	76.5	71.5	75.0	72.5	75.3	75.0	73.5	76.2	80.0
FLI	46.3	49.1	51.8	45.3	50.0	47.6	52.5	52.0	46.5	55.0
FWI	125.0	133.0	134.0	124.0	125.0	125.5	133.0	132.0	135.0	130.0
I	71.5	78.0	75.8	72.6	71.0	55.5	54.0	48.0	59.3	60.0
II	80.3	87.0	80.3	87.0	83.4	72.2	66.6	64.0	67.8	75.0
III	84.7	87.0	80.3	----	19.7	64.2	63.3	64.0	63.5	60.0
IV	71.5	82.5	75.8	64.1	75.0	55.5	58.3	52.0	59.2	60.0
TLI	80.3	78.2	----	----	----	135.0	150.0	176.0	102.0	130.0
CLI	----	----	----	----	----	----	----	----	----	----
SIs	6.7	6.5	6.2	7.7	7.1	3.8	3.7	3.2	3.3	4.5
SIt	----	----	----	----	----	----	----	----	----	----
NCI	37.5	39.2	35.7	35.8	37.5	35.6	41.7	40.0	46.6	45.0

TYPE.—Indian Museum, Calcutta.

TYPE LOCALITY.—Andaman Ids. (specimen first mentioned).

DISCUSSION.—This small species is closely related to *Iniotoothis japonica* Verrill which it resembles in most particulars except for the details of the hectocotylized left dorsal arm. The details of this arm, described above, leave no doubt as to the validity of the

species, and I have made direct comparison with the nuptial arm of one of Sasaki's specimens from the Japanese islands. I do not understand Adam's reference (1954, p. 128) to Massy's description of the hectocotylization of the specimen in the Indian Museum inasmuch as she only makes a brief quote from Joubin's 1897 paper.

DISTRIBUTION.—Andaman Islands; Persian Gulf (both Goodrich). Indonesia (Adam); Philippines!

Family Idiosepiidae

Idiosepius pygmaeus Steenstrup, 1881

FIGURE 10, a-g

Idiosepius pygmaeus Steenstrup, 1881, p. 219.—Berry, 1921, p. 357; 1932, p. 46.—Grimpe, 1931, p. 165-174.

MATERIAL: 1 ♂, ML 8.0 mm., 5 ♀♀, ML 11.8-14.0 mm., Jolo Harbor, Feb. 7-8, 1908; electric light. 1 ♀, ML 13.5 mm., Mansalay, Mindoro, June 3, 1908; electric light. 2 ♂♂, ML 6.8-7.2 mm., 2 ♀♀, ML 7.1-7.4 mm., Busin Harbor, Burias Id., Apr. 22, 1908; electric light. 1 ♀, ML 6.9 mm., Cebu, Mar. 18, 1909; electric light. 25 ♂♂, ML 5.0-7.18 mm., 56 ♀♀, from Masbate Bay, Masbate Id., Apr. 20, 1908; electric light in anchorage. 6 ♂♂, ML 6.2-8.0 mm., 3 ♀♀, ML 10.0-12.0 mm., Nato River, Lagonoy Gulf, east coast of Luzon, June 18, 1909; electric light. 2 ♂♂, ML 12.0-12.0 mm., 3 ♀♀, ML 14.0-15.0 mm., Macabalan Point, Mindanao, Aug. 4, 1909. 1 ♂, ML 9.0 mm., 1 ♀, ML 9.0 mm., Panabutan Bay, Mindoro, Feb. 5, 1909; electric light. 1 ♀, ML 6.0 mm., San Pascual, in tide pool, Mar. 8, 1909. 1 ♀, ML 13.0 mm., Atulayan Bay, Luzon, June 17, 1909; beach seine.

DESCRIPTION.—The numerous specimens obtained by the *Albatross* permit a detailed description of this species and some considerations of the range of variation in some of the important characters.

The mantle is elongate oval, widest about in the middle and bluntly pointed posteriorly. The dorsal margin is nearly straight, sometimes slightly indented in the midline. The ventral margin is shallowly excavated. On the dorsal surface beginning at the midpoint and extending posteriorly to between the fins is a prominent oval rugose area which is an adhering organ utilized by the squid to attach to the underside of sea weeds and grasses. The mantle is free, articulating at the neck and on each side of the funnel by the usual cartilaginous processes. The posterior end is turned strongly downward.

The fins are small, separate, and are attached at an angle to the body by means of narrow bases. The individual fins are elongate oval, the long axis paralleling the body, with free anterior and posterior

lobes. The posterior ends of the fins extend past the blunt end of the body.

The funnel is small and compact, free for only a small part at the end. In most of the specimens, the aperture is turned strongly ventrad and even slightly posteriorly. There is a subterminal valve. The dorsal member of the funnel organ is an inverted V-shape with broad arms which end bluntly. There is a small sharp anterior point and the posterior margin is roundly concave. The ventral pads are oval, either rounded or sometimes slightly pointed. The mantle locking apparatus consists of a flattened nose-shaped plug and a deep oval socket, deepest posteriorly. The resulting articulation is rather strong.

The head is small and compact, its width less than that of the mantle. A noticeable neck region extends beyond the mantle margin in the males, but in the females it is shorter. The eyes are small and deeply set, with a minute anterior pore. There is a small olfactory pit posterior to each eye and beneath the mantle margin.

The arms are short and stout, with blunt points, and in the order of 2.3.1.4. They are slightly compressed and without keels. There is a low web between III and IV which partly encloses the tentacles. The suckers are biserial, round, and with small apparently smooth apertures. There are about 16 pairs on the lateral arms. In the males, the arm suckers on I, II, III, and IV appear somewhat larger than in the females.

In the males, both ventral arms are hectocotylized. Both arms are devoid of suckers except at the base where may be found, in the Philippine specimens, one to three small round suckers. Usually the number is the same on each arm, but it may vary from 3-3, 3-2, 3-1, 2-2, 2-1, to 1-1, showing a tendency towards greater reduction on the right arm. When there are three on left IV, two are in the ventral row and one is in the dorsal row. In well-preserved specimens, there are a number of transverse rugae, thick and gelatinous, on the oral surface above the suckers and extending towards the tip. The right arm is always much stouter than the left, and somewhat triangular. On each side of the arm is a thin transparent or whitish keel which is rolled back aborally to form a broad smooth groove from the base to the tip, the latter being inrolled towards the mouth. The left ventral arm is slim, nearly round in cross-section, and about equal in length with the right, but in a few males it is shorter. The tip is flattened into a small lamina which lies in an oral-aboral plane. Just below the flattened tip is another small, semicircular or quadrate flap, partly curled about the arm. The function of the various parts is not known.

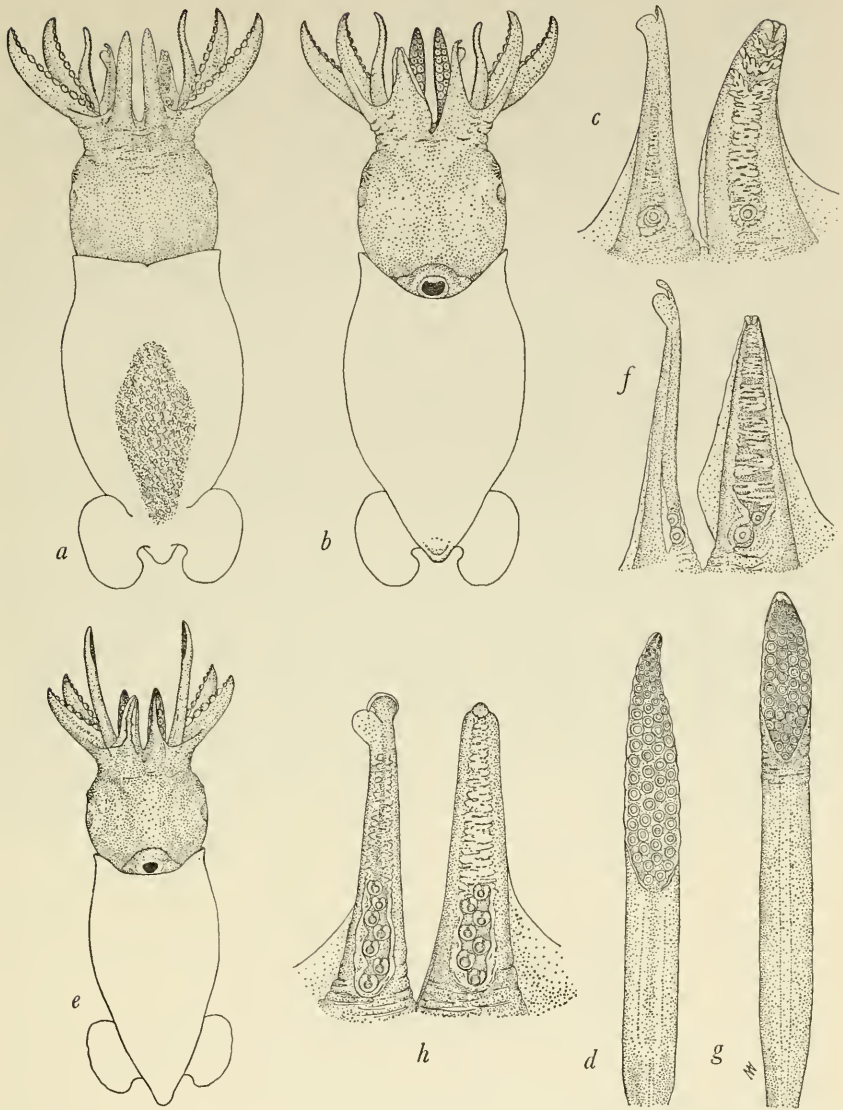


FIGURE 10.—a-g, *Idiosepius pygmaeus* Steenstrup: a, dorsal view of male, mantle length 18.0 mm.; b, ventral view of same; c, oral view of ventral arms, same specimen; d, right tentacular club of female, mantle length 10.0 mm.; e, ventral view of male, mantle length 13.0 mm.; f, oral view of ventral arms, same specimen; g, right tentacular club, same; h, oral view of ventral arms of *Idiosepius paradoxus* Ortmann.

The tentacles are short and slender, nearly equal to or much less than the diameter of the sessile arms. They are usually so retracted that only the clubs project from the pockets. The stalks are roundish in cross section, and bear clubs which are greatly variable in length, ranging from very small and compact ones to elongate clubs which occupy about half of the stalk. The suckers are quadriserial, in about 16 transverse rows, and are nearly uniform in size, only gradually reducing in diameter towards the tips.

The radula was not examined.

Spermatophores were numerous in the males and are small and slender. Their condition did not permit detailed description. Several females bore spermatophores attached to their skin at various points. In one they were attached as a fringe on the base of the ventral arms; in another they formed a broad patch on the midventral region of the head and on one they were attached to the right side of the mantle near the anterior margin.

In all the lots examined, the males were considerably smaller in total length and mantle length than the females, and because of the long neck, the males have a relatively smaller mantle.

The coloration in alcohol consisted of a general yellowish hue upon which were superimposed numerous reddish-brown pigment spots. On the dorsum of the mantle, head, and arms, these chromatophores are large and often crowded, on the arms yielding a barred effect. On the sides and ventrally the pigment spots are small to minute and more scattered. The whole area of the adhering organ has a purplish cast. Within the mantle cavity the viscera are covered by a thin membrane containing a few large reddish-purple spots.

Measurements and indices of 10 males of *Idiosepius pygmaeus* Steenstrup, 1881, are:

	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂
ML	6.5	6.5	7.3	7.0	7.3	7.0	6.0	6.5	7.8	5.0
MWI	58.5	61.5	54.7	56.0	----	----	----	----	----	----
HWI	48.7	46.2	48.0	44.3	----	----	----	----	----	----
FLI	----	30.7	31.5	32.9	----	----	----	----	----	----
FWI	----	61.5	61.5	60.0	----	----	----	----	----	----
TL	12.0	11.8	13.0	12.0	12.1	----	----	----	----	----
CLI	33.9	23.1	27.4	27.0	27.4	25.7	23.3	26.2	20.5	20.0
S (IIV)	3	3	3	3	2	3	2	3	2	1
S (rIV)	2	2	2	2	2	3	3	1	1	1

TYPE.—Zoological Museum, Copenhagen.

TYPE LOCALITY.—4°20' N., 107°20' E. (South China Sea).

DISCUSSION.—Four nominal species of *Idiosepius* have been described. Steenstrup described *pygmaeus* from two specimens in the museum at Copenhagen in 1881. The second was described by Ortmann from Japan in 1888, as *I. paradoxus*, and in 1894 Joubin

described *I. picteti* from Amboina. In 1921, Berry described a new species, *I. notooides* from Goolwa, southern Australia.

In 1931, Grimpe described specimens of *Idiosepius* from the island of Lombok, considering them as a subspecies, *hebereri*, of *I. pygmaeus*. He reexamined Steenstrup's original specimens and also *paradoxus* from Japan and concluded that *pygmaeus* is divisible into three subspecies: *I.p. hebereri* in the south, *I.p. pygmaeus*, and *I.p. paradoxus* in the north. The distinction between *pygmaeus* and *hebereri* is very small: a slight difference in means and ranges of total and mantle length, a thickening or callous on the dorsal edge of IV, and in the disposition of the suckers of left IV, two in the dorsal row and one in the ventral row, the opposite being true in typical *pygmaeus*. Some of the other differences are not real. The smooth surface of arms IV above the suckers as shown in Grimpe's figure is also found in the present specimens when the rugae have been rubbed off. Certainly *paradoxus* is much closer to *pygmaeus* than the other nominal species (*picteti* and *notooides*), but it is strictly a matter of opinion whether *paradoxus* should be so placed. With our present knowledge I prefer to keep it as a distinct species. Data concerning *hebereri* is not clear enough to warrant an opinion at the present time. Considerable variation is shown in the Philippine material, and the mean size, especially of the males, varies considerably from area to area. Presently available material indicates that *pygmaeus* may attain a much larger size than either Grimpe or Steenstrup have shown.

DISTRIBUTION.—4°20' N., 107°20' E.; Zamboanga (both Steenstrup); Banda Sea (Appellöf); Ternate (Appellöf); Borneo and Sumatra (Grimpe); Philippines!

Order Teuthoidea: Suborder Myopsida

Family Loliginidae

Loligo edulis Hoyle, 1885

FIGURE 11, a-e

Loligo edulis Hoyle, 1885, p. 186.—Sasaki, 1929, p. 107.

MATERIAL.—2 ♂♂, ML 72.5–78.0, 2 ♀♀, ML 46.0–89.0 mm, Sta. D5302, China Sea in vicinity of Hong Kong, 21°42' N., 114 50' E., soft grey mud, 69 m., Aug. 9, 1908; USNM 575341. 1 ♀, ML 75.0 mm., 2 juv., ML 27.3–26.0 mm., Sta. D5304, China Sea in vicinity of Hong Kong, 21°46' N., 114°47' E., blue mud, 62 m., surface temp. 84° F, Aug. 9, 1908; USNM 575342. 4 ♂♂, ML 32.0–53.0 mm., 3 ♀♀, ML 42.0–64.0 mm., Sta. D5376 off Tayabas Id.,

Marinduque, grey mud and sand, in 165 m., Mar. 2, 1909; USNM 575343.

DESCRIPTION.—The mantle is cylindrical, moderately stout, tapering in its posterior half to a blunt point. The dorsomedian area of the anterior margin is produced as a small lobe. Ventrally the margin is emarginated below the funnel, with pointed angles on each side.

The fins are large, rhombic in outline, with straight anterior margins sharply rounded laterally, and with concave posterior margins. The fins are about half the mantle length, slightly larger in the females.

The funnel is stout, reaching beyond the line of the eyes. The locking apparatus is normal, the funnel member slightly curved, pointed anteriorly and rounded posteriorly. The funnel organ is of the usual type and large. The valve is large, semicircular, and subterminal.

The head is large, with prominent eyes. It is dorsoventrally flattened. There is a prominent olfactory crest below and behind the eye and a small pore between the eye and the arms near the base of the 3rd arm.

The arms are of moderate length, in the order 3.4.2.1. I is compressed and keeled along its entire length. II is squarish with a prominent ridge on its outer ventral margin. III is flattened, broad, with a broad swimming membrane on its outer surface, widest about in the middle. IV is again squarish, with a tentacular sheath membrane dorsally and a keel ventrally. The suckers of all arms are biserial and bordered on both sides by trabeculate protective membranes. The arm suckers are of medium size, a little larger on the lateral arms in the males. The horny rings bear on the distal border about six to eight, usually seven, long square-cut teeth, the lateral one or two on each side often as much as twice as broad as the median ones. Proximally, the ring is smooth on the edge, but in a few cases the edge may be irregular, but there is always an abrupt change from the smooth proximal half to the toothed distal half. The aperture is nearly one-half closed off by the broad platelike extension of the inner margin of the horny ring in the proximal half. The suckers of the ventral arms are much smaller than those of the other arms.

In the males, the left ventral arm is hectocotylized for over two thirds of its length. Basally there are about eight pairs of normal suckers followed by 33 to 36 pairs of large fleshy pedicels, cone-shaped, surmounted by tiny ringless suckers. The pedicels of the ventral row are much longer than those of the dorsal row.

The tentacles are long and slender, their stalks compressed, and they bear large expanded clubs. The stalk is slightly keeled aborally and flattened orally. There is a broad swimming keel on the aboral

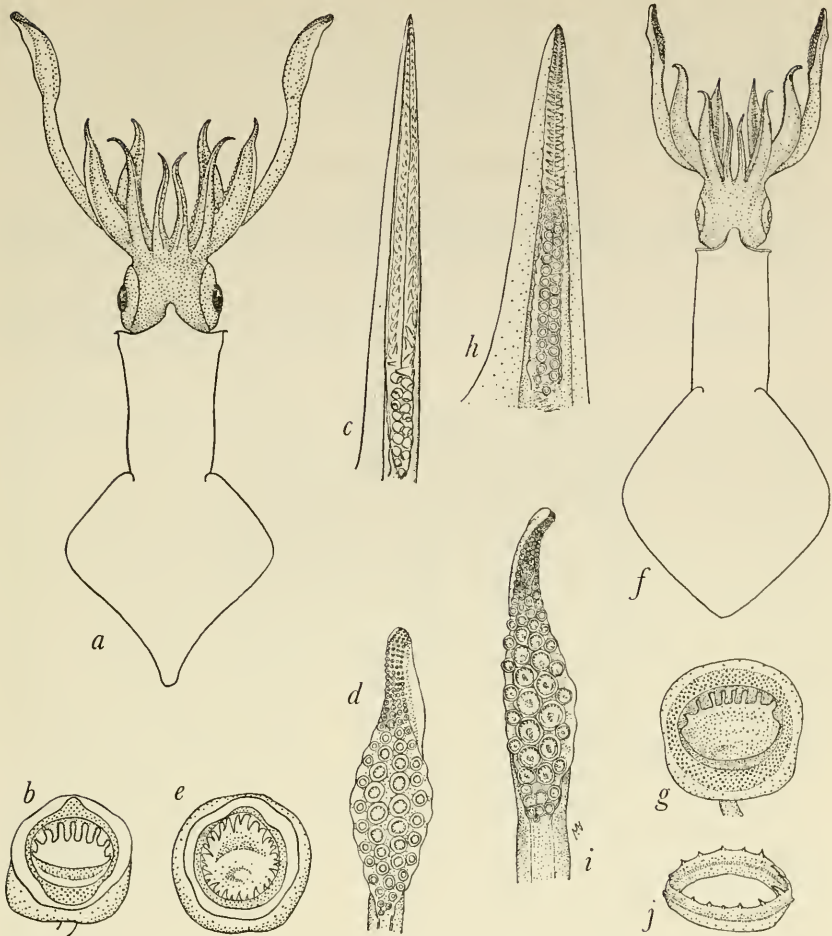


FIGURE 11.—*a-e*, *Loligo edulis* Hoyle: *a*, dorsal view, female, mantle length 84.0 mm.; *b*, same, sucker from 8th row of arm III; *c*, left ventral arm of male, mantle length 78.0 mm.; *d*, tentacular club of female, mantle length 89.0 mm.; *e*, largest sucker of tentacular club of female. *f-j*, *Loligo* sp. A: *f*, dorsal view of male, mantle length 136.0 mm.; *g*, sucker of 9th row of arm III; *h*, left ventral arm; *i*, tentacular club; *j*, largest tentacular club sucker.

surface of the club, originating at about the 5th sucker series. The suckers, which are quadriserial, are bordered on each side by a broad trabeculate protective membrane. The suckers of the median rows are much larger than those of the lateral rows and are toothed around the entire border of the horny ring by 21 to 24, occasionally as many as 30, long sharp teeth which alternate in size irregularly, those of the distal margin being somewhat longer. The lateral suckers have the

teeth more uniform in size, the largest being on the outer margin, and the distal suckers bear 18 to 20 teeth largest distally but uniform in regularity.

The buccal membrane is seven-pointed, and each point bears two to six small suckers.

The gladius has a broad rhachis; the vane is large, oval, with rounded margins.

The color, in alcohol, is yellowish brown with indistinct reddish-purple chromatophores scattered about over the mantle, head, and arms.

Measurements and indices of five specimens of *Loligo edulis* Hoyle are:

	<i>D5302</i>				<i>D5304</i>
	♂	♂	♀	♀	♀
ML	72.5	78.0	89.0	46.0	75.0
MWI	27.6	28.2	25.9	30.5	26.7
HWI	24.9	----	23.6	37.2	----
FLI	49.7	52.6	57.3	55.5	56.0
FWI	57.3	57.7	57.8	65.0	53.3
I	34.5	37.2	27.0	24.0	26.0
II	42.7	43.0	33.7	37.0	32.0
III	46.3	49.4	36.0	50.0	38.0
IV	39.0	37.8	32.6	49.0	31.0
HeLI	71.0	68.7	----	----	----
CLI	23.5	26.3	26.4	39.2	26.0
SIs	2.3	2.2	1.7	3.7	----
Slr	2.7	1.9	1.9	3.7	----

TYPE.—British Museum.

TYPE LOCALITY.—Yokohama market.

DISCUSSION.—I have carefully compared the present specimens with well-preserved males and females of *L. etheridgei* Berry (1918) from Moreton Bay, South Queensland. There are many differences in *etheridgei*, most noticeable of which are: (a) the more numerous and more slender, often pointed, teeth on the arm suckers which gradually reduce in size, (b) the minute teeth on the proximal border of the arm suckers, (c) the more irregular teeth on the tentacular suckers, and (d) the short modified area of the hectocotylyzed arm. I also had four specimens of *Loligo* from the fish market, Pusan, Korea, sent me by a former student, Mr. Won Tak Yang, which conform exactly to Sasaki's *L. edulis* forma *nagasakiensis*. The present material conforms closely to the material from Korea, varying only in size and in the reduction in length of the dorsal row of papillae on the left ventral arm as described for *nagasakiensis*. Sasaki's material came from Nagasaki which lies on the east side of the Korea Strait and below Pusan. After careful study of all the available material, I consider *L. edulis* to be distinct from *L. etheridgei*, at least until such time as additional material shows otherwise. The specimens in the lot from Sta. D5376 were labelled *Loligo edulis* in what I presume to be Dr.

Paul Bartsch's handwriting. This, I believe, was his only attempt to identify any of the cephalopods taken by the *Albatross*.

DISTRIBUTION.—Japan (Hoyle, Sasaki); Formosa (Sasaki); Philippines!

Loligo duvauceli d'Orbigny, 1835

FIGURE 12

Loligo duvaucelii d'Orbigny, 1835, p. 318 (illustrated).—Adam, 1954, p. 132-136, figs. 5-6.

Loligo indica Pfeffer, 1884, p. 64, figs. 3, 3a.

Loligo galatheae Hoyle, 1885, p. 183.

?*Loligo oshimai* Sasaki, 1929, p. 123.

MATERIAL.—11 ♂♂, ML 65.0-91.0 mm., 3 ♀♀, ML 83.0-92.0 mm., from Balalo Bay, Dec. 20, 1908; USNM 575380. 2 ♂♂, ML 75.0-80.0 mm., 13 ♀♀, ML 70.0-106.0 mm., from Kowloon, China, electric light, Aug. 22, 1908; USNM 575379. 1 ♀, ML 89.0 mm., Subig Bay, Jan. 6, 1908, dipnet and night light; USNM 575378. 2 ♂♂, ML 91.0-101.0 mm., Ragay Bay, Ragay Gulf, Luzon, Mar. 10, 1909; electric light; USNM 575383. 4 ♀♀, ML 41.0-103.0 mm., Tacloban market, Leyte, Apr. 12, 1908; USNM 575382. 4 ♀♀, ML 58.0-67.0 mm., Sandakan, Borneo, electric light, Feb. 29, 1908. 6 ♀♀, ML 58.0-72.0 mm., Manila Bay, Dec. 9, 1907; USNM 575385. 1 ♀, ML 78.0 mm., beach below fishing village, Sandakan, Borneo, Mar. 2, 1904(?); USNM 575384.

DESCRIPTION.—A large series of this species was available to me in the course of this study. The mantle is moderately long and slender, tubular, with parallel sides for about three-fifths of its length, the last two-fifths conical, ending in a blunt point. The anterior margin is produced dorsally in the midline with a small rounded lobe; ventrally it is emarginated beneath the funnel with low angles on each side.

The fins are small and short, occupying about half the mantle length. They are broad rhombic, round on the outer angles, and with small free lobes anteriorly. The anterior margin is slightly convex, the posterior margins slightly concave. They are united around the end of the mantle by a low ridge.

The funnel is short and stout and reaches to the level of the pupil of the eyes. The locking apparatus is of the usual type, simple and straight. The funnel organ is normal and there is a large terminal semicircular valve.

The head is large, wide, and flattened dorsoventrally. It bears large eyes. There is a small olfactory crest posterior to the eye and a small pore between the eye and the base of the second arms. The ventral surface of the head is deeply excavated for the funnel.

The arms are long and in the order 3.2.4.1. Arm I is slender and strongly compressed and bears a keel for its entire length. II is

squarish in cross-section, somewhat rounded on the dorsal angle, but slightly keeled on the ventral edge. III is compressed and bears a broad keel, widest at about the middle of the keel. IV has a natatory membrane dorsally and a low keel ventrally. The suckers are biserial and are bordered on each side by a trabeculate protective membrane. There is a strong sexual dimorphism in the suckers of the males and females. In the females the suckers of all arms are similar in their dentition and not strikingly different in size. The larger suckers of III have rings which are smooth on the proximal half but bear about seven teeth on the distal half, the central one broad and pointed, the marginal ones broad and square ended. In the males the suckers of I and IV are similar to those of the females but bear usually only six teeth on the distal half. The suckers of II and III are greatly enlarged, however, larger than the largest suckers of the tentacular clubs. The first two or three pairs basally have normal dentition, followed by the enlarged suckers. In these there is a low, broad truncate tooth proximally, all that is left of the broad proximal smooth area in the normal suckers, followed by 11 long square truncate teeth around the entire ring, the central one slightly more slender and pointed or rounded.

The left ventral arm is hectocotylyzed in the male. Less than half of the arm length, basally, is equipped with normal suckers. Beyond this the suckers abruptly give way to a double row of papillae, fat basally, attenuate distally, many of them with minute ringless suckers on their tips. The papillae of the ventral row are nearly twice as large as those of the dorsal row, the two rows spread outward and separated by a low median ridge.

The tentacles are long and stout, flattened, with a low keel on the aboral surface which becomes expanded along the outer surface of the club. Orally the stalk is ridged basally, but in the distal half becomes flattened along a narrow strip, the sides of which form the trabeculate protective membrane on each side of the club. The suckers of the club are quadriserial, those of the hand portion large, those of the slender distal portion small. On the hand the suckers of the inner rows are about 1.5 times larger in diameter than those of the outer rows. The large suckers bear 14 to 17 short sharp teeth on the circumference of the horny ring.

The buccal membrane is seven-pointed, each point bearing two to five small suckers crowded at the tip. In the female there were numerous spermatophores attached to the spermatic pad on the ventral surface of the buccal membrane below the mouth.

The ink sac bears a large oval light organ buried on each side. Ventrally it appears as a fleshy bulge; there is a small round organ within the sac.

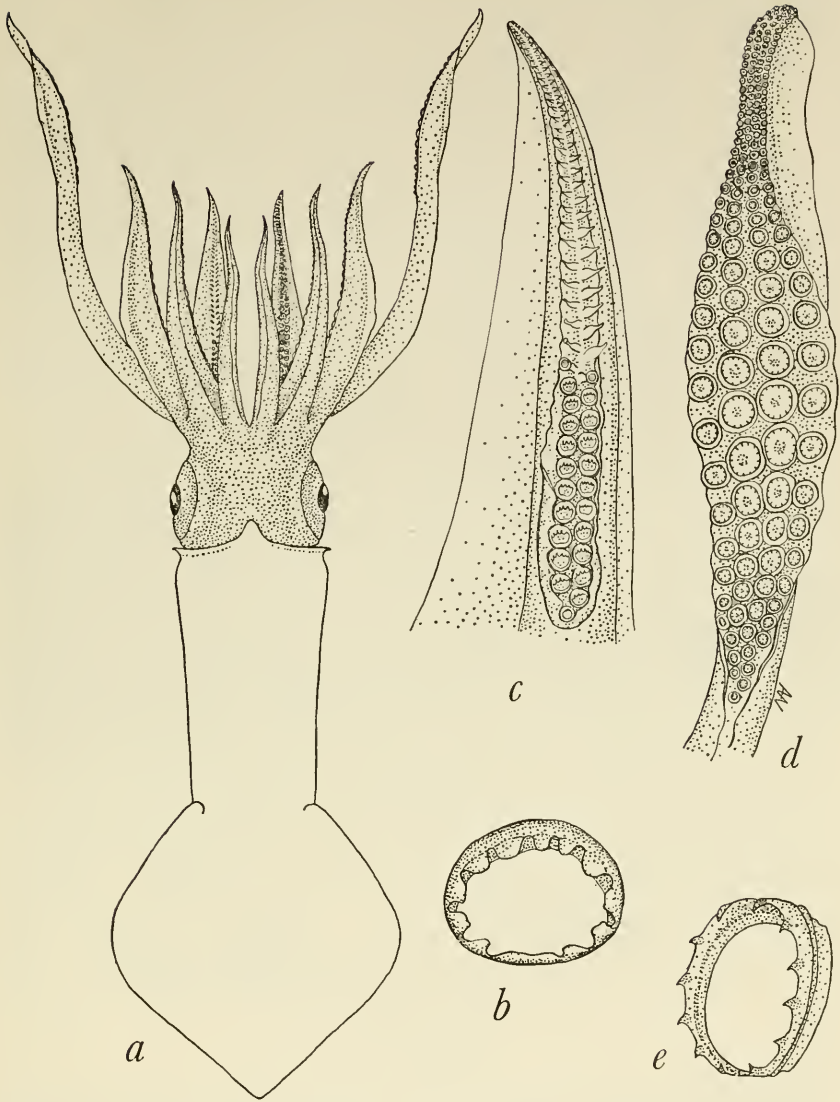


FIGURE 12.—*Loligo duvaucelli* d'Orbigny: *a*, dorsal view, male, mantle length 93.0 mm.; *b*, arm sucker, 9th row of arm III; *c*, left ventral arm, male, mantle length 86.0 mm.; *d*, right tentacular club, female; *e*, largest sucker of right tentacular club.

The gladius was not examined.

The color, in alcohol, is a muddy, yellowish brown with numerous small purplish-red chromatophores on mantle, head, and arms.

Measurements and indices of 10 specimens of *Loligo duvauceli* d'Orbigny are:

	♀	♀	♀	♂	♂	♂	♂	♂	♂	♂
ML	92.0	83.0	83.0	86.0	91.0	65.0	80.0	84.0	85.5	85.0
MW1	22.8	26.5	24.7	22.4	24.1	24.0	25.0	25.0	24.0	24.6
HWI	23.9	25.3	24.7	24.2	23.0	26.2	25.0	25.0	24.5	24.6
FLI	52.2	49.4	50.6	50.0	50.5	47.7	48.8	51.2	49.7	51.7
FWI	51.4	49.4	50.6	47.6	49.0	43.8	49.4	48.8	48.0	46.2
I	25.0	27.7	27.7	39.5	36.5	32.3	35.8	39.4	32.4	34.0
II	37.0	37.9	39.7	42.3	44.0	37.0	45.0	44.0	35.9	40.0
III	42.3	41.6	44.5	46.0	47.3	40.7	47.8	48.8	39.5	43.5
IV	38.0	37.4	36.1	38.4	37.6	35.4	40.0	42.3	35.5	36.7
HeLI	----	----	----	57.5	57.6	56.5	61.0	59.0	57.0	54.5
CLI	35.9	35.0	33.8	31.4	34.4	26.2	32.5	31.0	27.5	30.6
SIs	1.6	1.8	1.8	2.7	2.5	2.6	2.6	2.6	2.6	2.5
SIt	2.2	2.4	3.6	2.3	2.1	1.8	2.1	2.4	2.1	2.3

TYPE.—Museum National d'Histoire Naturelle, Paris.

TYPE LOCALITY.—Not given.

DISCUSSION.—Adam (1954) discussed the affinities of this species with the others of the Indo-Pacific region; he gave a complete synonymy and discussed the reasons for placing the various species together. Only one discrepancy in his discussion merits notice. He stated that Massy's *Loligo indica* is the same as the present species; however, Massy (1916, p. 220) stated "there is no trace of a hectocotylus," although she had several males before her for examination. *L. duvaucelii* has a well-developed hectocotylus and it seems hardly conceivable that Massy would have missed it in her analysis. A reexamination of her specimens would settle this matter.

L. oshimai as described by Sasaki has two light organs buried in the ink sac. These were present in my specimens but I can find no reference to such organs in the literature on *L. duvaucelii*. Perhaps it has not been investigated.

DISTRIBUTION.—Inhabits the Indian and Pacific Oceans, from South Africa to Formosa. A common Indo-Malayan species.

Loligo species A

FIGURE 11, f-j

MATERIAL: 1 ♂, ML 136.0 mm., from Port Langcan, Dumaran Id., eastern Palawan, Apr. 7, 1909. 1 ♀, ML 114.0 mm., from Catbalogan, Samar, Apr. 14-16, 1908. 6 ♂♂, ML 79.0-53.0 mm., 2 ♀♀, ML 53.0, 72.0 mm., from Port Uson, west of Piñas Id., Dec. 17, 1908. ?1 ♂, ML 137.0 mm., from Manila Harbor, Nov. 2, 1908.

DESCRIPTION.—The mantle is long and slender, especially in the males. It is cylindrical with nearly parallel sides for half the mantle

length, thence tapering into a blunt point posteriorly. The anterior margin is produced into a narrow rounded lobe in the dorsomedian region. Ventrally, it is shallowly excavated beneath the funnel. There is a longitudinal ridge on the ventral surface of the male.

The fins are rhombic in outline, widest at the midpoint and united by a ridge around the end of the body. Both the anterior and posterior margins are nearly straight, the angle rounded. There is a very small, anterior free lobe.

The funnel is stout and broad, reaching beyond the eyes. The locking mechanism is straight and simple. The funnel organ consists of a V-shaped dorsal member and long oval ventral pads. The valve is large and conspicuous, filling the end of the funnel.

The head is small and compact with large eyes. It is slightly flattened and excavated ventrally for the funnel. There is a large olfactory crest below and posterior to the eye and a large pore between the eyes and the base of the arms.

The arms are moderately long, in the order 3.4.2.1. All the arms are distinctly keeled for their entire length and are strongly compressed, especially I and III. The keel on III is broad and forms a swimming membrane; IV has both a dorsal and ventral keel, of which the ventral is more conspicuous in the males.

The suckers are biserial, bordered on each side by a trabeculate protective membrane. The suckers have wide apertures, the horny ring smooth on the proximal half and toothed on the distal half, the ring surrounded by a papillated band. The teeth on the distal half are 7 to 11 in number, long, broad, and flat with square ends. On the proximal half of the sucker ring is a series of rudimentary teeth.

The left ventral arm is hectocotyized in the male. More than half of the basal section of the arm has normal suckers; a little past the middle of the arm two or three of the suckers are greatly reduced in size. Immediately thereafter the pedicels of both rows become very elongate, large, and fleshy. The first few terminate in small suckers without horny rings but distally even these are lost. There is a low ridge medially between the rows of suckers.

The tentacles are compressed, keeled aborally, the keel expanded on the hand and extending to the tip of the club. The oral surface is rounded, but midway from the base to the club it becomes flattened, the flat portion roughened and terminating proximally in a slender point. This flattened portion is broad in the carpal region and its borders extend around the club as wide trabeculate protective membranes. The suckers are quadriserial. On the hand the suckers of the inner rows are about twice as large as those of the marginal rows; distally the suckers become uniformly small in the attenuate portion of the club. The large suckers of the hand have about 15

low pointed teeth unevenly spaced about the rim of the horny rings but widely separated from each other, and of which two to four on the distal outer margin are united or raised on a common base. They are much larger and sharper, having the appearance of a small cluster of claws. No other species in the area has suckers so formed, to my knowledge. On some of the larger specimens the rings appear almost smooth except for one or two low triangular teeth on the distal border. This may be a variation or may be due to changes with age. The distal suckers have large teeth on the distal side, smaller proximally but without any minute teeth in between.

The buccal membrane is seven-pointed, with seven stout supports. Each lappet bears two to four small round suckers at the tip.

The color in the male is yellowish brown with closely set oval reddish-brown chromatophores distributed over the mantle, head, fins, arms, and tentacles. In this specimen the chromatophores form a sort of scaling over the skin.

A gladius that was removed from one of the specimens had the typical *Loligo* form.

Measurements and indices of two males and one female of *Loligo* sp. A are:

	♂	♂	♀
ML	137.0	136.0	114.0
MWI	21.9	19.8	21.1
HWI	16.4	17.3	18.8
FLI	61.3	61.0	56.1
FWI	50.1	52.0	51.7
I	22.6	16.9	21.9
II	30.2	21.3	25.4
III	35.0	27.6	33.4
IV	34.3	23.9	30.3
HcLI	16.8	55.5	----
CLI	28.5	19.1	23.7
SIs	1.2	1.0	1.0
SIt	2.2	1.5	1.3

DISCUSSION.—I am not at all certain that the specimen of 137.0 ML from Manila is the same species. The teeth on the tentacular suckers are broadly triangular, of moderate size, widely spaced with two or three on the distal side enlarged. In the others approaching the size of this specimen, the ring would appear smooth or nearly so except for the distal pad.

The status of the present specimens seems so uncertain that it seems wiser to leave them unnamed rather than add another name to the systematic confusion already existing or to identify them tentatively with another already existing species. It is hoped that as the Philippine fauna becomes better known that larger and better series of these will come to hand.

DISTRIBUTION.—Piñas Island; Palawan Island; Samar; Manila.

Sepioteuthis lessoniana Lesson, 1830

FIGURE 13

Sepioteuthis lessoniana Ferussac, 1826; p. 155 (nomen nudum).—Lesson, 1830; p. 244.—Sasaki, 1929; p. 127.—Adam, 1939a, p. 21 (complete synonymy and descriptions).—Voss, 1954; p. 365.

MATERIAL.—1 ♀, ML 178.0 mm., Cebu market, Mar. 27, 1909; USNM 575172. 1 ♂, ML 109.0 mm., 2 ♀♀, ML 97.0, 132.0 mm., Malcochin Harbor, Linapacan Id., Dec. 18, 1908. 9 ♂♂, ML 83.0–150.0 mm., 5 ♀♀, ML 54.0–77.0 mm., Surigao (beach near Bilou Bilou) Mindanao, 150-foot seine, May 8, 1908; USNM 575166. 1 ♂, ML 104.0 mm., 1 ♀, ML 48.0 mm., San Roque market, Luzon, June 27, 1908; USNM 575183. 1 ♂, ML 62.0 mm., 2 ♀♀, ML 74.0, 80.0 mm., beach near anchorage off Daet, Luzon, seine, June 15, 1909. 1 ♂, ML 93.0 mm., 1 ♀, ML 98.0 mm., beach below fishing village, Sandakan, Borneo, Mar. 2, 1909; USNM 575191. 1 ♂, ML 52.0 mm., 1 ♀, ML 50.0 mm., Bolalo Bay, seine, Dec. 21, 1908; USNM 575187. 3 ♂♂, ML 130.0–160.0 mm., 1 ♀, ML 152.0 mm., Port Caltom, Busananga Id., 130-foot seine, Dec. 15, 1908; USNM 575167. 1 ♂, ML 26.5 mm., ship's side, Masbate Bay, Masbate, Apr. 20, 1908; USNM 575176. 1 ♀, ML 36.0 mm., Busin Harbor, Burias Id., Apr. 22, 1908; USNM 575175. 1 juv., ML 20.5 mm., Cebu, Mar. 18, 1909. 1 ♀, ML 25.0 mm., Looc Bay, Lubang Id., southern Luzon, electric light, July 18, 1908. 2 juv., ML 24.0–27.0 mm., Teomabal Id., Mindanao, Sept. 17, 1909; USNM 575179. 1 ♀, ML 24.0 mm., Cabrigas Anchorage, Catanduanes Id., east coast of Luzon, June 9, 1909; USNM 575180. 24 juv., ML 7.0–39.0 mm., 16 ♀♀, ship's side with submarine light and dipnet, off Jolo Light, Jolo Id., Feb. 7–8, 1908; USNM 575184. 1 ♀, ML 85.0 mm., mouth of Santiago River, Balayan Bay, Luzon, Feb. 20, 1909; USNM 575188. 2 ♂♂, ML 76.0–77.0 mm., Manila Bay, Dec. 9, 1907; USNM 575185. 1 ♂, ML 83.0 mm., 4 ♀♀, ML 37.0–97.0 mm., Mantaquin Bay, Palawan Id., Apr. 1, 1909, 130-foot seine; USNM 575190. 2 ♀♀, ML 39.5–46.0 mm., Pandanon Id., between Cebu and Bohol, seine, Mar. 24, 1909; USNM 575182. 1 juv., 5 ♀♀, ML 11.5–42.0 mm., Batan Id., east coast of Luzon, June 22, 1909; electric light; USNM 575181. 3 ♀♀, ML 34.5–72.0 mm., Port San Miguel, Ticao Id., between Burias and Luzon, seine, Apr. 21, 1908; USNM 575186. 1 ♂, ML 116.0 mm., 16 ♀♀, ML 27.0–138.0 mm., Atulayan Bay, Laganay Gulf, Luzon, June 17, 1909, 130-foot seine; USNM 575171. 1 ♀, ML 142.0 mm., Cavite, Manila, June 14, 1908; USNM 575193. 2 ♂♂, ML 114.0–141.0 mm., 4 ♀♀, ML 78.0–159.0 mm., beach at village near Chase Head, Endeavor Straits, Malam Paya Sound, Palawan Id., seine, Dec. 22, 1908;

USNM 575170. 6 ♀♀, ML 55.0–175.0 mm., 9 ♂♂, ML 73.0–97.0 mm., Surigao, east coast of Mindanao, 150-foot seine, May 8, 1908; USNM 575166. 40 juv., ML 26.0–41.0 mm., 3 ♂♂, ML 56.0–68.0 mm., 20 ♀♀, ML 43.0–148.0 mm., Mansalay, southeastern Mindanao, 150-foot seine, June 4, 1908; USNM 575167. 4 ♂♂, ML 82.0–99.0 mm., 10 ♀♀, ML 64.0–107.0 mm., Hinunangan Bay Beach, Leyte, July 30, 1909; seine; USNM 575169.

DESCRIPTION.—This species is perhaps the most distinctive of all the Philippine cephalopods and is known from Australia to Japan and the Hawaiian Islands.

The mantle is long and tubular, bluntly rounded posteriorly. Anteriorly the margin is produced on the dorsal midline and slightly excavated beneath the funnel with sharp lappets on either side.

The fins are large, extending from 1 to 2 mm. from the anterior lateral margin of the mantle to the posterior end. The fins are united posteriorly around the end of the mantle by a fleshy ridge. Together they form a broad oval outline, which is broadest about one-third of the length of the mantle from the posterior end.

The funnel is long and set deeply into the ventral surface of the head. The funnel locking apparatus is strong, straight, and firmly connected by a deep groove on the funnel and a straight ridge on the mantle. The funnel valve is exceptionally well developed and prominent.

The head is broad and stout, wider than the mantle, with prominent eyes. There is a small olfactory crest below and ventral to the eyes.

The arms are in the order 3.4.2.1, I being much smaller and more slender than the rest. All the arms are somewhat flattened and keeled for at least part of their length. Arms I are small, slender, flattened with slender tips, equipped with a keel for the distal half or two-thirds. Arms II are slightly squarish in cross-section with a low keel on the ventral border extending from the base to the tip of the arm. Arms III are strongly flattened and equipped with a keel or swimming membrane extending the entire length. This keel is deepest at the midpoint of the arm. Arm IV is subequal in length to III, the dorsal edge thin and with a web connecting with III at the base for the protection of the tentacle. The ventral edge is also keeled for the entire length.

The sessile suckers are bordered on either side on all arms by protective membranes with stout supports, the membrane being largest and deepest on III where the dorsal membrane is much wider than the ventral one. The suckers are closely set, round, with stout peduncles. The horny ring of the suckers of the midportion of III bears 18 to 20 sharp, pointed triangular teeth.

In the male the left ventral arm is hectocotylized by a modification of the distal third of the arm. Basally there are about 23 normal

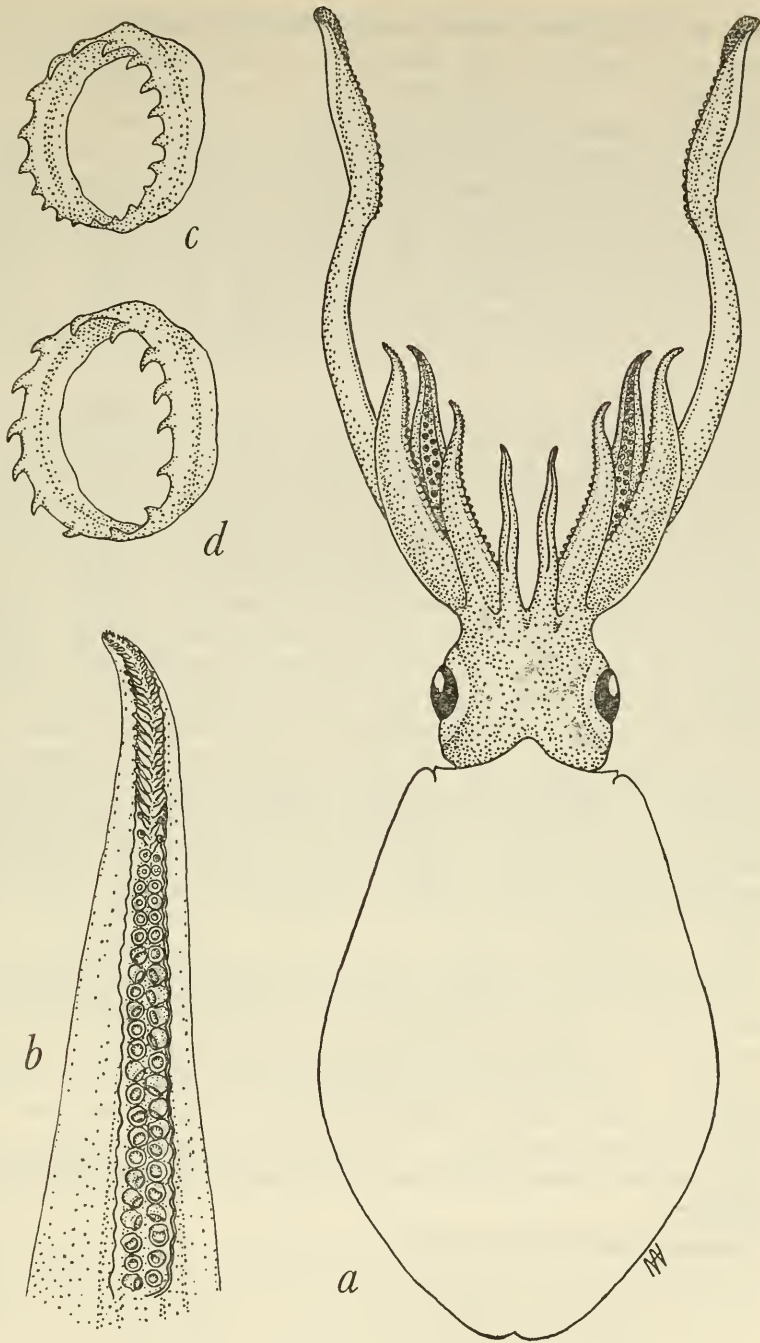


FIGURE 13.—*Sepioteuthis lessoniana* Lesson: *a*, dorsal view, female, mantle length 134.0 mm.; *b*, left ventral arm of male; *c*, arm sucker, 7th row of arm III; *d*, largest sucker of tentacular club.

suckers with chitinous toothed rings. The 24th and 25th pairs of suckers are abruptly much smaller than the others with smooth chitinous rings. Beyond the 25th sucker the suckers of the dorsal row become minute, without a chitinous ring and placed on the tip of a large fleshy triangular peduncle whose base crosses the oral surface of the arm as a low ridge, but separated from a similar construction of the ventral row. Beyond this are about 14 large triangular pedicels decreasing in size to the tip. The ventral row of suckers is similarly modified but is lower and not as conspicuous. The ridge between the dorsal and ventral pedicels is longitudinally grooved to give the appearance of a weblike structure. The suckers of the right ventral arm are normal.

The tentacles are of medium length and stout, the stalks laterally compressed. The club is only slightly expanded, bordered on either side by a strong and well-developed protective membrane with prominent supports. The aboral surface of the club bears a strong keel for almost the full length. The tentacular suckers are in four rows. There is an indistinct carpal cluster followed by 10 pairs of large suckers whose horny rings bear 14 to 16 small sharp, widely spaced triangular teeth. The suckers of the dorsal and ventral marginal rows are two-thirds the size of the median suckers and are equipped with eight or nine large long slender curved sharp teeth on the outer margin and about the same number of tiny sharp triangular teeth on the inner margin. The distal section of the club bears about four rows of small toothed suckers, terminating in an expanded flattened tip which bears a cirlet of suckers composed of two rows of flattened smooth-ringed suckers closely spaced and surrounding a clear open section in the center. There are 14 suckers in the outer ring and 9 in the inner ring.

The spermatophores are well described by Sasaki (1929).

The color is very variable, both when specimens are alive and in preservation. The chromatophores are large and very numerous dorsally in the mantle, fins, head, and arms, but are small or absent ventrally. The mantle and fins may have numerous transverse markings or there may be a series of about 10 round dark spots in a single series along the fins.

TYPE.—Not traced (Museum National d'Histoire Naturelle, Paris(?)).

TYPE LOCALITY.—Not traced.

Measurements and indices of 10 males and 10 females of *Sepioteuthis lessoniana* Lesson are:

	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂
ML	75.0	83.0	88.0	87.0	89.0	108.0	105.0	145.0	150.0	109.0
MWI	39.6	28.9	27.3	29.7	28.1	27.8	27.6	27.6	28.0	29.3
HWI	----	31.3	----	----	31.5	----	30.5	29.0	28.6	29.8
FLI	93.2	94.0	91.9	94.2	93.2	92.6	93.2	92.4	94.0	92.6
FWI	62.6	62.6	59.2	65.5	65.2	63.0	61.0	66.8	62.5	58.7
I	22.7	20.3	22.7	24.1	23.6	25.9	23.9	24.8	26.0	27.5
II	30.6	28.9	31.8	32.2	34.9	36.1	33.3	33.8	32.0	30.7
III	40.0	39.7	42.0	42.6	45.0	41.7	43.8	43.5	39.3	45.0
IV	38.7	36.1	35.2	40.2	41.6	39.7	42.8	39.3	41.3	41.3
TLI	----	70.0	----	67.7	71.8	----	----	----	68.0	107.0
CLI	34.6	33.7	33.0	37.9	37.1	36.1	35.2	32.4	32.6	38.5
SIs	----	----	----	----	----	----	----	----	1.5	1.8
SIt	----	----	----	----	----	----	----	----	2.0	2.3
HcLI	24.1	26.6	29.0	27.1	27.0	23.2	25.5	28.1	25.8	33.3

	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
ML	178.0	97.0	132.0	54.0	54.0	58.0	71.0	77.0	74.0	80.0
MWI	29.9	36.1	29.6	33.4	33.4	31.1	38.1	29.7	32.4	30.0
HWI	25.3	27.8	30.6	----	----	36.2	----	33.7	32.4	31.2
FLI	91.0	94.8	94.9	90.6	92.7	94.8	93.0	94.7	93.2	91.2
FWI	64.6	69.2	63.6	66.6	64.8	84.3	63.3	65.0	69.0	63.7
I	34.3	24.7	29.8	22.2	20.2	22.4	23.9	24.6	24.3	25.0
II	50.5	34.0	34.0	33.3	33.3	31.1	33.8	32.5	35.1	30.0
III	55.6	44.3	41.7	42.6	42.6	43.2	43.7	42.8	46.0	40.0
IV	48.3	42.3	39.4	40.7	40.7	37.9	38.0	40.2	32.4	40.0
TLI	----	89.6	100.0	----	----	----	69.0	71.3	----	----
CLI	----	39.2	34.9	37.0	37.0	34.5	35.2	35.0	35.1	33.7
SIs	1.7	1.8	1.5	----	----	----	----	----	----	----
SIt	----	2.0	2.5	----	----	----	----	----	----	----

DISCUSSION.—This is one of the most widely distributed loliginids in the Indo-Pacific; it shows considerable variability, especially in color, from area to area. Our specimens coincide well with those described by Adam (1939a) and workers desiring information on their morphology, sex differences and ratios, and variability should consult this work.

DISTRIBUTION.—From the Japanese Islands to Australia and New Zealand and from Hawaii to the eastern Indian Ocean.

Doryteuthis singhalensis (Ortmann, 1891)

FIGURES 14; 15a

Loligo singhalensis Ortmann, 1891, p. 676, pl. 46, fig. 3.

Doryteuthis singhalensis, Naef, 1912, p. 742.—Adam, 1939a, p. 70; 1954, p. 144, figs. 13-14.

MATERIAL.—1 ♂, ML 162.0 mm., Balamban, Negros, sand in 22 m., April 2, 1908. 2 ♀♀, ML 132.0-133.0 mm., from Batangas market, June 7, 1908. 1 ♂, ML 84.0 mm., from Cebu, Aug. 30, 1909. 2 ♂♂, ML 106-93.0 mm., Onol, Mindanao, Aug. 4, 1909.

DESCRIPTION.—The mantle is long and slender, about one-sixth to one-seventh as wide as long, tubular, and tapering posteriorly to a slender point. The anterior margin is produced dorsally into a distinct lobe, the ventral portion emarginated with lateral projections on either side of the funnel.

The fins are large, occupying nearly two-thirds of the mantle length and widest anterior to the midpoint with slightly convex anterior margins and strongly concave posterior margins.

The head is small, compact, with large eyes. The ventral surface is deeply excavated for the funnel.

The funnel is stout, strong, and reaches about to the midpoint between the eyes. The funnel organ is indistinct.

The arms are short, in the order 3.4.2.1, I distinctly the shortest, strongly keeled for the entire length, and strongly compressed. II is not keeled but is angled on the dorsal surface and equipped with a broad swimming membrane ventrally. III is stout, longer than the others, compressed and bears a swimming membrane on the aboral surface. The protective membranes on III are much deeper than on the others and exceed the depth of the suckers. IV is bordered by a membrane on the dorsal edge and has a slight keel on the ventral edge. The sessile suckers are biserial. The suckers are somewhat barrel-shaped, the pedicels inserted obliquely. The apertures are slightly pointed distally. The horny ring is smooth on the proximal half but bears seven to nine long slender teeth on the distal side, the anterior ones being longest and reducing in size gradually towards the smooth portion of the border.

The left ventral arm is hectocotylyzed by the modification of the distal half of the sucker-bearing portion of the arm. Proximally there are 15 pairs of normal suckers of the same size as those of the right ventral arm, but much smaller than those of I-III. Beyond the 15th pair of suckers, the pedicels are greatly enlarged and elongated, especially those of the ventral row and bear at their tip a small fleshy sucker without a horny toothed ring. There are about 33 of these pedicels of which the distalmost seven or eight are extremely minute and without suckers.

The tentacles are long and somewhat slender, compressed, with a slight groove on the distal oral surface. The club is short, only slightly expanded, with a trabeculate protective membrane bordering each side. Aborally there is a keel extending the length of the club. The tentacular suckers are quadriserially arranged, the median two rows of the hand about a fourth larger than those of the lateral rows. The horny rings are surrounded by a narrow papillated area. The rings of the large rhachial suckers bear 20 to 22 sharp curved teeth

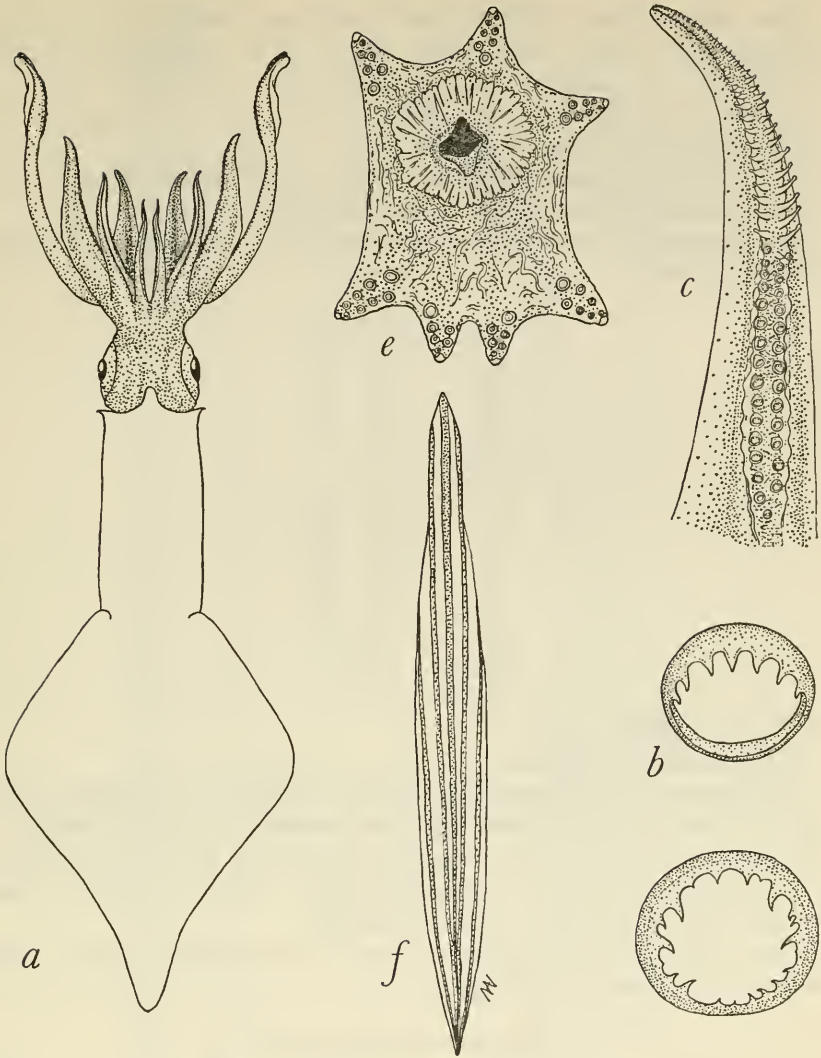


FIGURE 14.—*Doryteuthis singhalensis* (Ortmann): *a*, dorsal view of male, mantle length 162.0 mm.; *b*, arm sucker, 8th row, arm III; *c*, left ventral arm; *d*, largest sucker of tentacular club; *e*, buccal membrane; *f*, gladius.

of which a few are small and placed alternately between the larger ones. The horny rings of the outer suckers bear about 18 teeth; those on the inner margin are minute but those of the outer margin are large and sharply pointed. Distal of the hand part, the small suckers are crowded into four regular rows, decreasing in size to the rounded tip of the club.

The penis is long, straight, and tubular and contained about six spermatophores which were 6.1 mm. by 0.3 mm. Details of structure are shown in the accompanying illustration.

The buccal membrane is seven-pointed, smooth, and bears two to eight suckers on the tip of each lappet.

The gladius is narrow (GWI 10.3) with almost straight margins, the lateral portion of the vane thickened and darkly colored.

Measurements and indices of two males of *Doryteuthis singhalensis* (Ortmann) are:

	♂	♂
ML	162.0	84.0
MWI	14.8	19.1
HLI	16.0	16.7
HWI	14.2	16.7
FLI	63.0	63.2
FWI	44.5	51.2
GLI	96.4	----
GWI	10.2	----
I	14.8	15.5
II	18.5	25.0
III	24.7	27.4
IV	19.8	23.8
TLI	57.3	62.0
CLI	14.2	19.1
SIs	.8	.8
SIt	1.15	1.5
SpLI	3.8	----
SpWI	4.9	----

TYPE.—Not traced.

TYPE LOCALITY.—Ceylon.

DISCUSSION.—Adam (1954) has given a detailed description of this species from the East Indies and has discussed briefly the status of *D. spectrum*, and *D. arabica*, which he considers may represent geographical races along with *D. singhalensis*. Much more work must be done before their status can be decided.

GEOGRAPHICAL DISTRIBUTION.—Ceylon (Ortmann). India; East Indies (both Adam). Philippines!

Doryteuthis reesi Voss, 1962

FIGURES 15,b; 16

Doryteuthis reesi Voss, 1962, p. 173.

HOLOTYPE.—1 ♂, ML 70.0 mm., from Port Maricaban, southern Luzon, July 20, 1908; electric light; USNM 575323.

PARATYPES.—43 ♂♂, ML 43.0–66.0 mm., 13 ♀♀, ML 51.5–62.0 mm. from Port Maricaban, southern Luzon, July 20, 1908; USNM 575324.

OTHER MATERIAL.—1 ♀, ML 63.5 mm., Varadero Harbor, Varadero Bay, northern Mindoro, July 23, 1908.

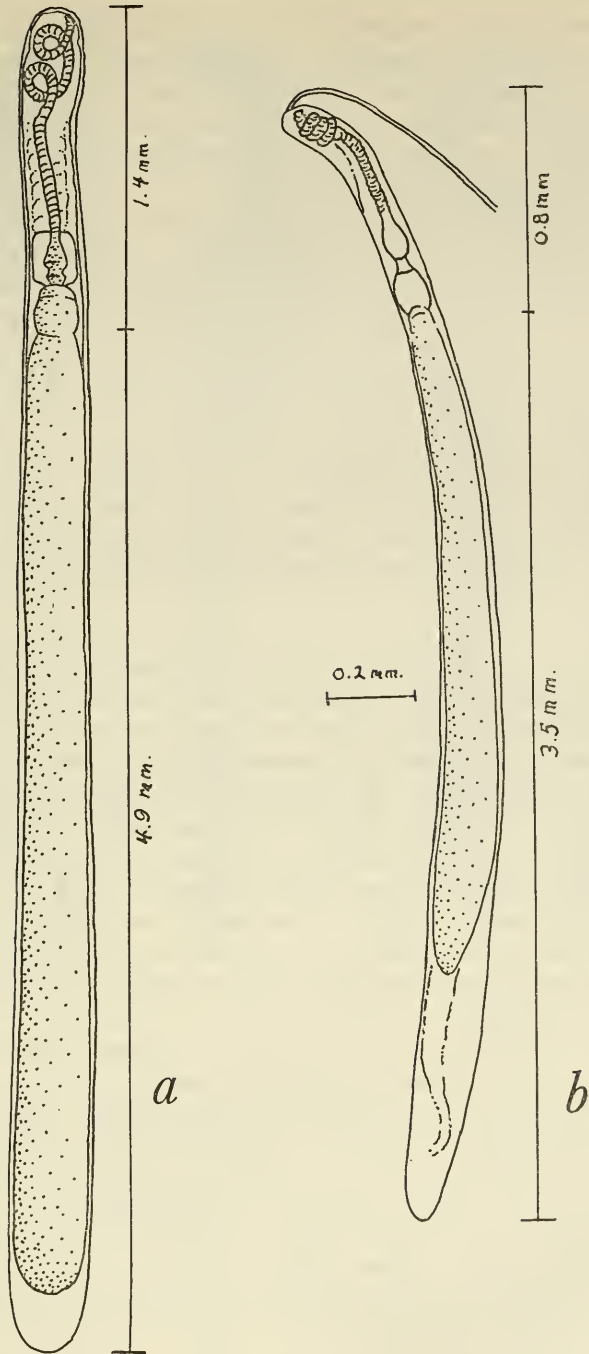


FIGURE 15.—Spermatophores: *a*, spermatophore of *Doryteuthis singhalensis* Ortmann; *b*, spermatophore of *Doryteuthis reesi* Voss.

DESCRIPTION.—The mantle is long and slender, about a fifth as wide as long, ending posteriorly in a sharp point. There is a small lappet in the dorsomedian line anteriorly and a shallow excavation beneath the funnel with sharp angles on each side. In the males there is a ventromedian ridge on the anterior three-fourths of the mantle; the females are smooth.

The funnel is small, stout, nearly covered by the mantle. The locking apparatus is straight and simple. The funnel organ is of the usual type and there is a large subterminal semicircular valve.

The fins are small, about 50 percent of the mantle length in the males, less in the females. They have very small anterior lobes, straight anterior edges, rounded angles, and concave posterior edges. They are united just dorsal of the posterior end of the mantle.

The head is small, slightly wider than the mantle, with large eyes and a slight constriction at the base of the arms. There is also a small straight-edged groove in the median dorsal surface. There is a large crest posteriorly and a small anterior pore near the base of arm III. The head is flattened and is deeply and distinctly excavated ventrally for the funnel.

The arms are short, about 25 percent of the mantle length, in the order 3.4.2.1, although in the males the left ventral arm may be the longest, especially in the larger specimens. Arm I is very flattened, short, and provided with a high keel along its entire length. II is squarish with a sharp keel or low membrane on both outer corners, the ventral the deepest. III is flattened and equipped with a broad swimming membrane, or keel. IV is also square in cross-section with a pronounced keel dorsally and ventrally. The arm suckers are in two rows bordered on each side by a trabeculate protective membrane which, except in IV, is deepest on the ventral side. The suckers in both sexes have the horny ring smooth on the proximal margin and armed with about seven long narrow square-tipped teeth on the distal margin.

In the males both ventral arms are hectocotylized. The left ventral arm is longer than the right and broader, because of the wide ventral and dorsal keels which do not taper to a point distally. Basally, in the holotype, there are 19 suckers of the normal type, becoming smaller towards the last pair; beyond this, for more than half the length of the arm there are about 22 pairs of long round papillae or pedicels each terminating in a minute ringless sucker. Pairs 2 to 7 of these are much longer than the remaining pedicels. Beyond the terminal pedicels, the tip of the arm projects as a smooth round cone. The right ventral arm is shorter than its fellow. The suckers are normal basally, but pairs 8 through 15 diminish rapidly in size; beyond pair 15 the suckers disappear and only a double row of minute pedicels is

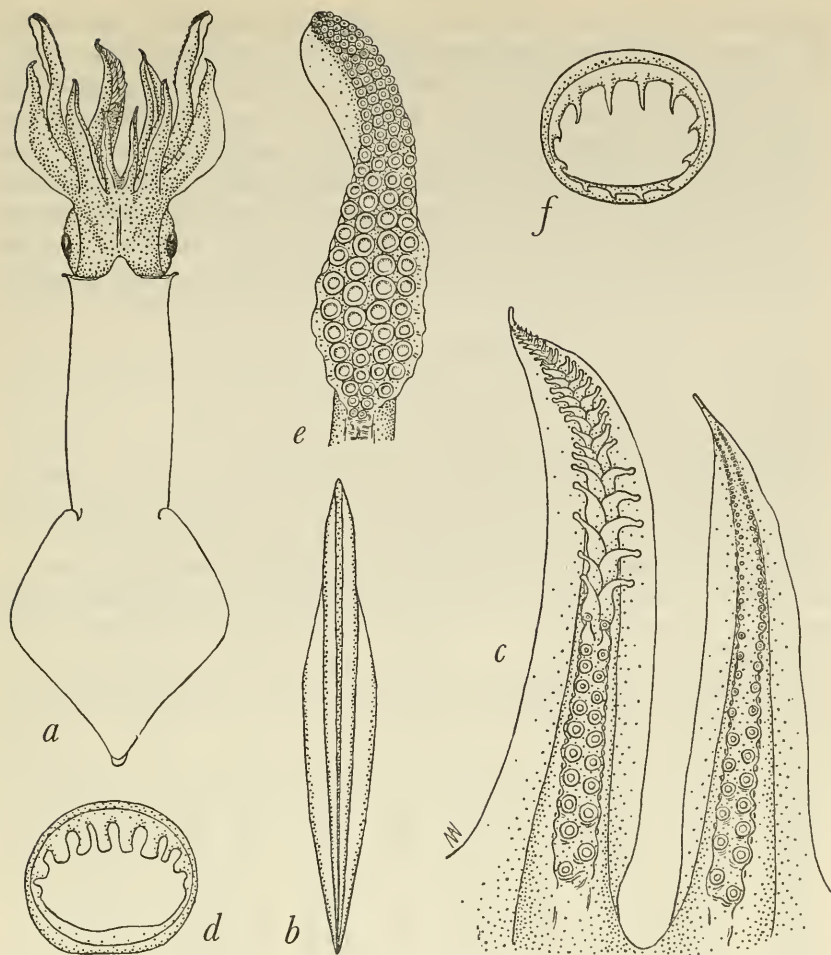


FIGURE 16.—*Doryteuthis reesi* Voss: *a*, dorsal view of holotype, mantle length 70.0 mm.; *b*, gladius; *c*, ventral arms; *d*, arm sucker, 9th row of arm III; *e*, left tentacular club; *f*, largest sucker of tentacular club.

present. There are about 17 pairs of the minute pedicels, barely discernible, beyond which the end of the arm is long, slender, and smooth. In the distal part, the protective membrane is absent but the trabeculae remain, somewhat longer than the pedicels. The ventral keel terminates prior to the dorsal keel, and abruptly.

The tentacles are short, only a little longer than the longest arm, compressed, with an aboral keel which originates near the base of the stalk. At about the level of the 5th proximal row of suckers, the keel is superseded by a broad swimming membrane on the aboral surface of the club, which extends to the tip. On the oral surface there is a

slight flattening of the stalk which at the midpoint gradually widens. The edges of this form the broad trabeculate membrane on each side of the club. The suckers are quadriserial, those of the hand much larger than the terminal group. There is not much disparity of size in the median suckers which are only slightly larger than those of the outer rows. The large suckers bear 11 or 12 sharp slender teeth on their horny rings. The three or four teeth of the distal side are much longer than the remaining proximal teeth and they are farther apart.

The buccal membrane has seven points, each of which may bear from one to six small suckers.

The gladius is long and slender, the rhachis pointed anteriorly and strong, the vane slender, little widened, broadest at the anterior end and thence tapering with straight sides to a fine point. The lateral margins are thickened and more heavily colored.

The color in alcohol is uniform yellowish brown with numerous small reddish-purple chromatophores on the dorsum, particularly along the midline, on the head, and on the arms.

Many of the males contained large numbers of spermatophores in the penis. They are very small, only about 6.7 percent of the mantle length, and very slender. A spermatophore from a specimen ML 52.0 mm. is shown.

Measurements and indices of 10 males and of 10 females of *Doryteuthis reesi* Voss, 1962, are:

	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂ (holo- type)
ML	46.2	47.0	47.0	50.0	50.2	51.0	51.2	62.0	65.0	72.0
MWI	22.1	23.4	22.3	22.0	21.9	22.5	21.5	21.8	20.4	19.4
HWI	23.8	23.4	23.4	23.2	23.9	23.5	21.9	22.1	21.6	20.8
FLI	45.5	45.0	43.7	47.2	43.9	46.5	46.5	47.3	49.0	48.6
FWI	43.3	42.6	40.4	41.2	43.4	42.2	41.0	45.1	47.0	44.5
I	19.5	18.7	19.2	19.6	19.9	19.6	17.6	17.7	16.2	13.9
II	24.2	21.3	23.4	24.0	23.9	23.5	22.1	22.5	20.0	20.3
III	26.0	27.6	26.0	28.0	28.9	28.4	25.8	26.1	25.4	23.8
IV	27.3	28.7	27.6	28.0	29.5	28.4	29.3	25.3	24.0	23.8
HcAI	28.1	29.1	27.6	28.0	31.5	28.8	29.3	30.5	29.3	26.8
HcLI	58.5	58.5	62.0	60.6	57.0	55.7	60.0	55.2	63.0	59.5
CLI	17.3	15.3	17.4	16.6	17.9	17.6	17.8	17.7	----	15.7
SIs	1.3	1.3	1.1	1.2	1.0	1.2	1.2	1.1	----	1.0
SIt	1.1	1.1	1.1	1.0	1.0	1.2	1.2	1.0	----	1.0

	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
ML	55.0	55.5	56.0	57.0	58.0	58.0	58.0	60.0	62.0	62.6
MWI	23.6	23.4	23.2	24.5	23.3	24.5	23.3	25.0	24.2	22.3
HWI	22.2	23.4	21.4	24.5	23.1	22.6	23.2	22.8	21.1	22.3
FLI	47.2	47.0	43.4	44.7	44.8	45.7	44.0	46.6	44.4	47.8
FWI	41.8	42.4	42.8	43.8	41.0	41.4	46.6	46.6	45.5	38.6
I	18.2	18.9	18.0	18.1	17.3	18.0	19.0	19.2	19.4	17.1
II	22.0	24.5	21.8	24.0	22.4	23.3	25.0	25.3	22.8	20.7
III	25.4	29.2	26.8	28.1	27.6	27.6	29.3	30.0	29.0	25.5
IV	23.8	27.4	23.2	26.3	25.8	25.0	26.7	25.7	26.0	23.9
CLI	16.9	19.8	16.1	16.8	17.1	17.3	17.2	20.0	17.8	17.5
SIs	1.1	1.1	1.3	1.1	1.0	1.0	1.2	1.0	1.1	1.0
SIt	1.1	1.1	1.1	1.2	1.0	1.0	1.2	1.3	1.1	1.1

TYPE.—U.S. National Museum.

TYPE LOCALITY.—Off Port Maricaban, southern Luzon.

DISCUSSION.—This is the third species of small *Doryteuthis* to be recorded; it has much in common with Adam's (1954) two species from the Indo-Malayan region, *D. sibogae* and *pickfordae* (emended from *pickfordi*). This species may easily be distinguished from the others by the hectocotylization of both ventral arms and the elongation of the left and by the smooth terminal ventral arm tips.

DISTRIBUTION.—Known only from Port Maricaban, southern Luzon, and Varadero Bay, northern Mindoro, Philippines.

Uroteuthis bartschi Rehder, 1945

FIGURE 17

Uroteuthis bartschi Rehder, 1945, p. 22, figs. 1-2.—Adam, 1954, p. 140, figs. 10-12.

HOLOTYPE.—1 ♂ ML 199.0 mm., from Jolo Harbor, Jolo, Feb. 8, 1908; USNM 573515.

PARATYPES.—1 ♀, Jolo Harbor, Jolo, Feb. 8, 1908; USNM 573512. 16 ♂♂, ML 181.0-223.0 mm., Jolo Harbor, Jolo, Feb. 8, 1908; USNM 573513. 5 ♀♀, ML 120.0-131.0 mm., Jolo Harbor, Jolo, Feb. 8, 1908; USNM 573514.

DESCRIPTION.—The mantle is long, slender, and cylindrical and tapers gradually to a long attenuated taillike point, which is very long and slender in the male but less so in the female. Dorsally the mantle margin is produced in a distal lobe in the midline but ventrally it is emarginated beneath the funnel with sharp pointed lappets beneath each eye. In the male a prominent raised ridge on the ventral surface of the mantle in the midline extends from the anterior margin to the tip of the tail. The ventral surface of the female is smooth.

The fins are short and slender if they are not considered to extend to the tip of the tail, but they are long and slender if the ridge, slight as it may be, running from the fins to the tip is considered to be a connecting ridge between the two fins. This latter view has been taken here. The anterior edge is nearly straight, only slightly convex, the posterior border concave, the fins at about the midpoint tapering to a low indistinct ridge.

The funnel is small and compact, reaching to about the level of the pupil of the eye, and deeply set into the head. The funnel organ is an inverted V with oval ventral pads. The valve is large, semi-circular, and just within the aperture.

The head is small and compact with large eyes covered by the outer skin of the head and with a minute pore anterior and ventral to the eye. There are two small lappets forming the olfactory crest at each corner of the funnel excavation, the inner lappet about half the size of the outer one.

The arms are in the order 4.3.2.1, in the female in the order 3.2.4.1. All the arms are keeled but in a different manner. I is short, slender, flattened laterally with a sharp, strong, dorsal keel extending from the base to the tip. II is keeled on both the dorsal and ventral borders but not on the aboral surface. III is keeled prominently from the base to the tip, the keel broadest in the posterior third. IV is keeled only on the inner border. The suckers are biserial on all the arms. The horny rings are armed with about five long square truncate teeth on the distal margin and are entire proximally.

The left ventral arm is hectocotylized by a modification of the suckers on the distal half. The proximal suckers are normal. At about the middle of the arm, the suckers abruptly are transformed into long stout pedicels, those of each row turned strongly outward and becoming smaller towards the tip of the arm. Only the first one or two pedicels are equipped with tiny fleshy suckers. The right ventral arm appears normal.

The tentacles are short, flattened, with a sharp ridge on either side. The club is short, little expanded. On the ventral surface a low protective membrane extends to the tip of the club. On the dorsal surface a low trabeculate membrane originates at the carpal region and extends along the hand part only. The low dorsal keel of the stalk expands near the carpal region and extends as a wide membrane or web along the length of the club to the distal extremity. The suckers are in four rows, the ring bearing about 15 short truncate teeth, largest on the distal border.

The buccal membrane is seven-pointed, each lappet bearing five to seven small suckers near the tip.

The gladius has been described by Rehder (1945). It is very narrow with no prominent expansion. A strong central ridge runs the length of the pen, and a lateral ridge occurs on each side just below the anterior point. About a third of the distance from the anterior end, a slight broadening occurs with a marginal border formed outside of the lateral ridge. Posteriorly the pen narrows with the margins turned inward to form a narrow groove.

The color in alcohol is yellowish brown with large reddish-brown chromatophores densely packed in the midline and scattered laterally. The stripe is narrower and denser in the males than in the females. The dorsal surface of the head also is heavily pigmented.

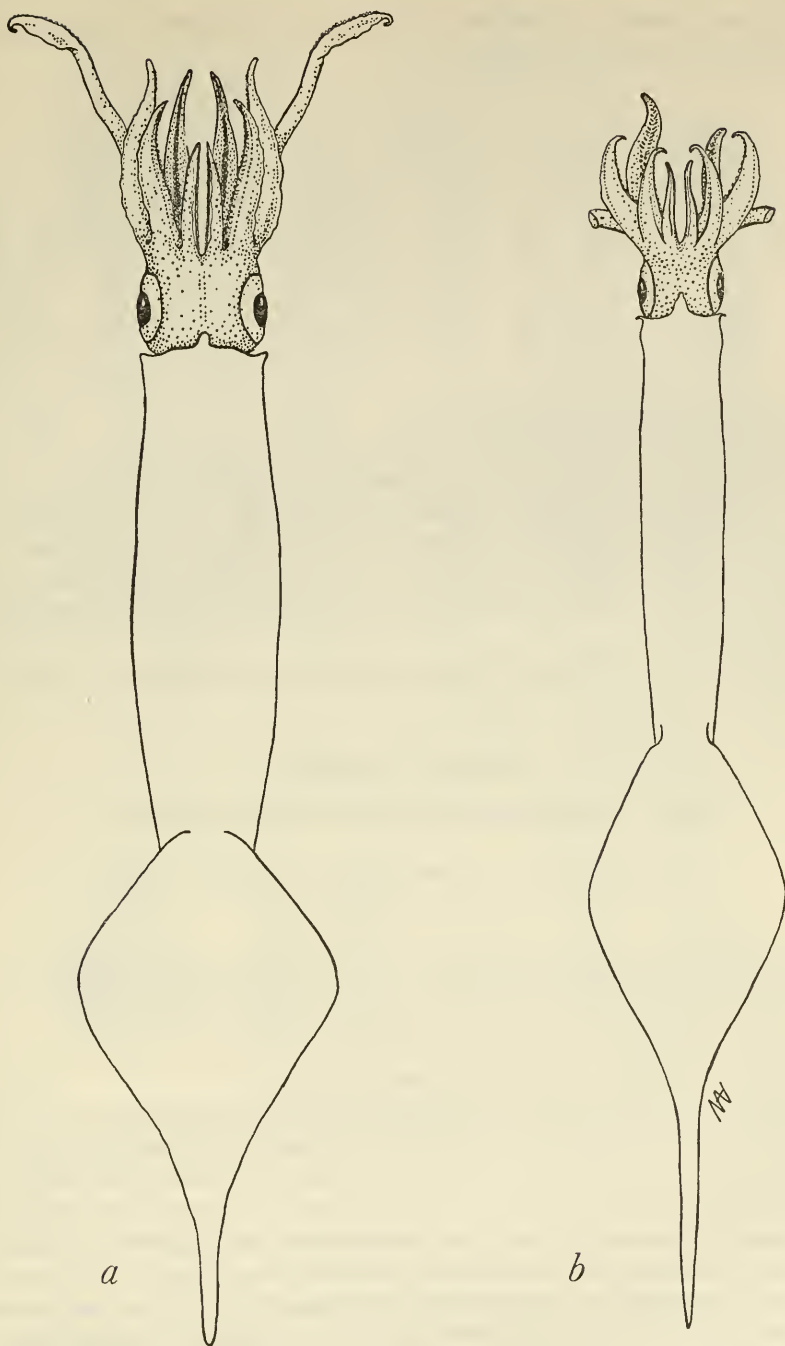


FIGURE 17.—*Uroteuthis bartschi* Rehder: *a*, dorsal view of female; *b*, dorsal view of male, mantle length 182.0 mm.

Measurements and indices of one male and seven females of *Uroteuthis bartschi* Rehder are:

	♂	♀	♀	♀	♀	♀	♀	♀
ML	182.0	150.0	128.0	128.0	132.0	120.0	100.0	110.0
MWI	8.2	11.3	12.5	12.5	11.3	14.2	15.0	12.7
HWI	7.7	10.6	10.9	10.5	11.3	12.5	12.5	10.9
FLI	56.6	52.0	50.0	52.4	50.5	50.0	43.0	50.0
FWI	20.9	25.4	25.8	24.2	22.7	25.8	27.0	21.8
I	7.7	10.6	10.1	10.9	10.6	10.8	10.5	11.8
II	9.9	13.3	13.3	14.1	13.3	15.8	16.0	15.9
III	12.1	14.6	14.8	16.4	15.9	17.5	16.0	16.3
IV	9.9	13.3	12.5	13.3	14.8	13.3	15.5	----
HcAI	12.9	----	----	----	----	----	----	----
TLI	18.7	24.0	23.4	23.4	20.4	25.0	26.0	22.7
CLI	6.6	9.3	9.8	9.4	9.1	10.4	11.0	10.9

TYPE.—U.S. National Museum.

TYPE LOCALITY.—Jolo Harbor, Jolo, Philippines.

DISCUSSION.—Rehder (1945) described this species in full and proposed the generic name *Uroteuthis* to distinguish it from the species pertaining to *Alloteuthis* which occur in the Mediterranean and eastern Atlantic. Adam (1954) discussed the problem of the relationships of this species and, no new material being present, I feel that I can add nothing here.

DISTRIBUTION.—Flores Straits (Adam); Jolo, Philippines (Rehder).

Suborder Oegopsida

Family Enoploteuthidae: Subfamily Abraliinae

Abralia (Abralia) armata (Quoy and Gaimard, 1832)

FIGURES 18 AND 19

Onychoteuthis armata Quoy and Gaimard, 1832, p. 84, pl. 5, figs. 14–22.

Enoploteuthis armata, d'Orbigny, 1848, p. 340, pl. 9, figs. 2–6, pl. 14, figs. 11–14.

Abralia armata, Gray, 1849, p. 50.—Pfeffer, 1908, p. 290; 1912, p. 167, 763.

MATERIAL: 2 ♂♂, ML 27.0–29.0 mm., 8 ♀♀, ML 21.0–29.5 from "Ostasien, Suenson, leg. Grimpe determ. 1931."

This interesting and taxonomically important species has not been recorded in the literature since Quoy and Gaimard originally described and illustrated it from the voyage of the *Astrolabe*. The original description is very brief and does not deal with the presently recognized taxonomic characters and the illustrations are apparently rather crudely executed. Taxonomically, the two most important features were (a) the absence of terminal light organs on the 4th arms, hence setting it apart from *Abraliopsis* and (b) the suckers of the hand part of the tentacular club in a single row at the base of the six hooks. This latter character has been the cause of much subsequent discus-

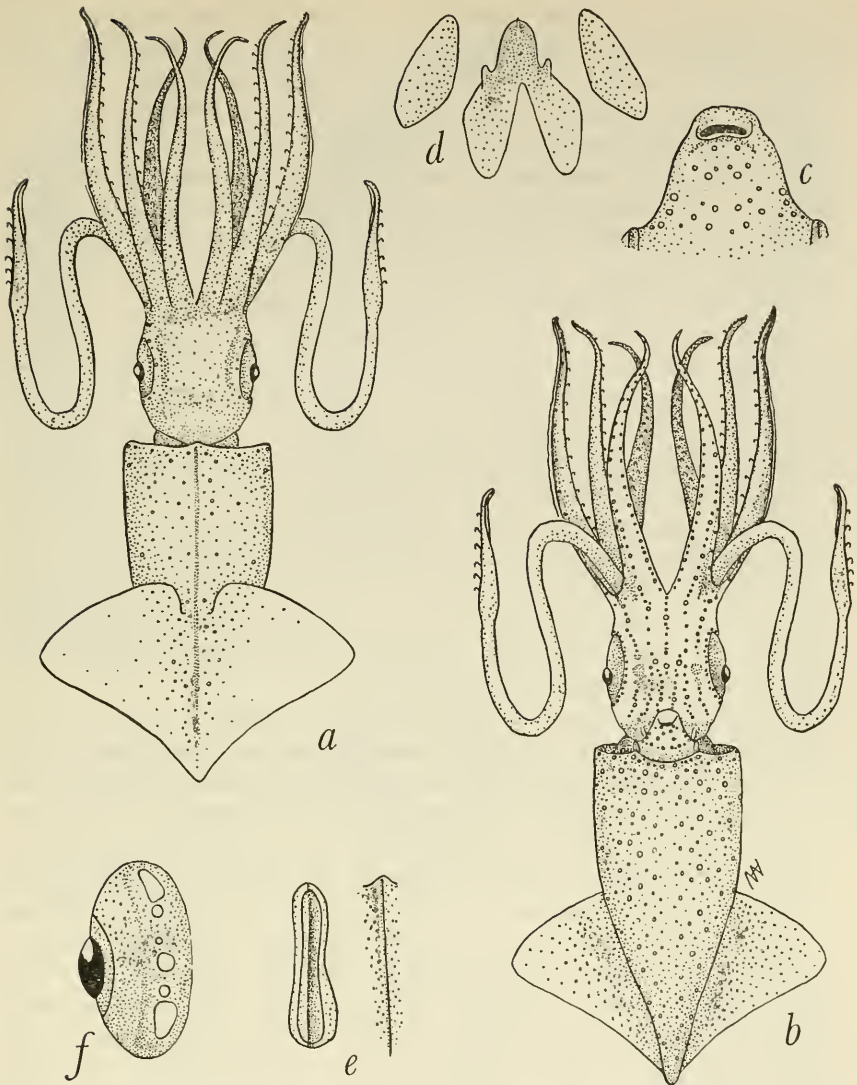


FIGURE 18.—*Abralia armata* Quoy and Gaimard: *a*, dorsal view; *b*, ventral view; *c*, funnel; *d*, funnel organ; *e*, funnel mantle locking apparatus; *f*, ventral view of right eyeball with photophores.

sion. Later workers have considered either that Quoy and Gaimard's figure was an immature specimen in which only one row of suckers had developed, or that the illustration was in error. Pfeffer (1912) in the appendix to his monograph stated that he had finally examined the type in Paris and that it was definitely an *Abralia* but that other parts were missing and the exact definition must remain in question. In

1931, Grimpe stated that there were a number of *A. armata* in the Zoological Museum in Copenhagen and that they would be described later. Unfortunately he died before the paper was written.

In 1957 the author, through the kindness of Dr. Gunnar Thorson, received the specimens of *Abralia* identified as *armata* by Grimpe; after a thorough examination and comparison with the original description and illustrations, he agrees with Grimpe as to their identity. As a result, more detailed illustrations and the following redescription are given to clear up this problem. As the description indicates, this species is still a very perplexing one.

DESCRIPTION.—This is a small species, now known from 11 specimens, the type and the present collection from "Ostasien." The mantle is rather short and conical, the anterior half with nearly parallel sides, the posterior half cone-shaped. The antero-dorsal margin is slightly produced in the midsection, ventrally it is emarginated beneath the funnel and sharply produced at each side of the funnel. In small specimens the posterior end is bluntly pointed, but in the four large specimens it is produced into a slender point.

The fins are short (FLI 21.0–65.4) and wide (FWI 85.0–100.0), their anterior margins slightly convex, the posterior margins concave and roundly pointed laterally. Posteriorly they are united to the narrow point of the mantle.

The head is rather narrow (HWI 29.5–42.6) and rounded, with large but not prominent eyes. The eyelids are narrow and transversely open with a small median anterior sinus. The dorsal windows are obscure, perhaps due to the length of preservation, but the ventral windows are large and clear, permitting a clear view of the eyeball light organs.

The funnel is slender and tubular in the smaller specimens but shorter and wider in the larger ones. The mantle locking apparatus is simple, the funnel member a nearly straight groove slightly narrower anteriorly, somewhat rounded and expanded posteriorly. The mantle member is a straight narrow ridge. The funnel organ is well developed, the dorsal member an inverted V-shape, with marginal flaps anteriorly and with long arms; the ventral pads are narrowly oval and nearly straight.

The arms are long and slender with attenuated tips (MAI 61.3–79.4), in the order 2.3.4.1. Arms I, II and IV are not keeled, III is moderately keeled for most of its length. The greater part of each arm bears hooks in two rows, 12 to 16 on I, 12 to 16 on II, 14 to 16 on III, and 15 to 20 on IV. Beyond the hooks are 6 to 12 moderately large suckers, in two rows, with 4 to 6 teeth on the upper border and entire on the bottom; beyond the larger suckers are two rows of minute suckers reaching to the distal extremity. There are low

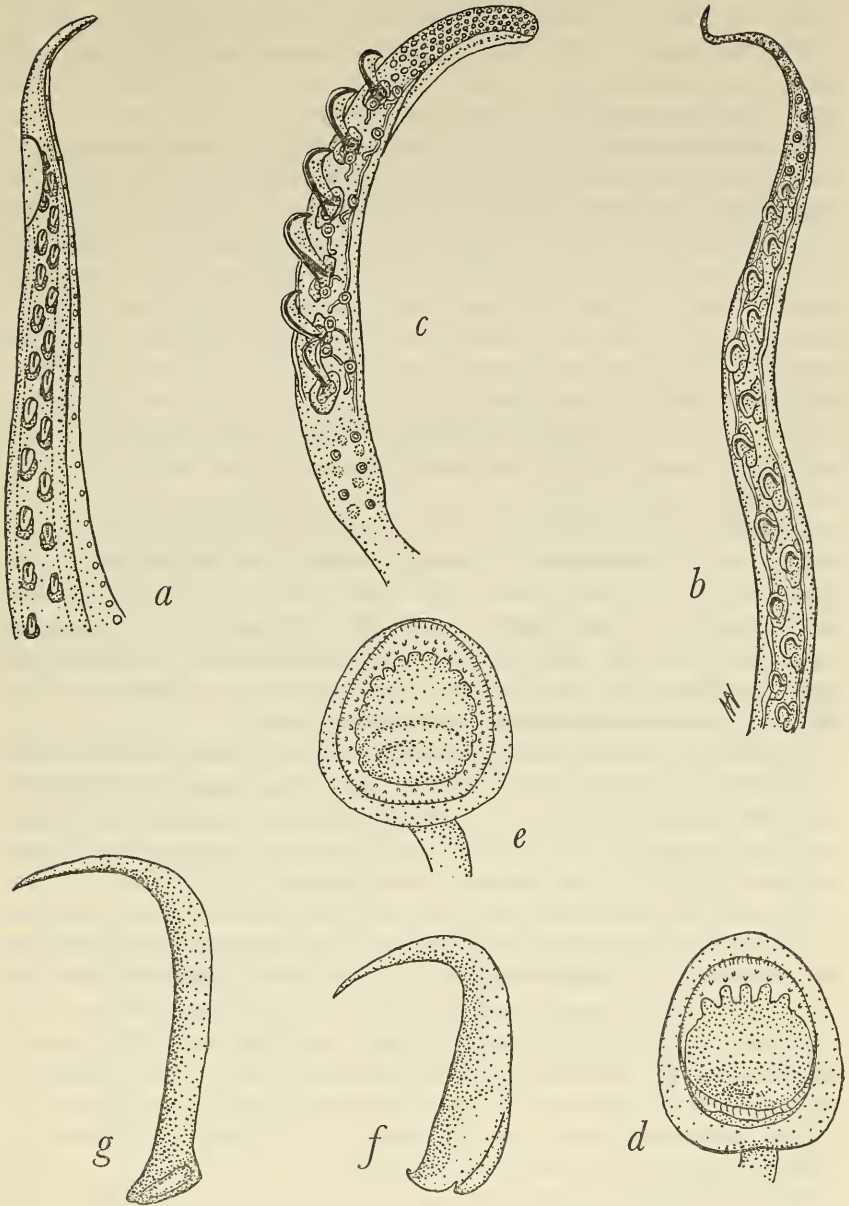


FIGURE 19.—*Abralia armata* Quoy and Gaimard: *a*, right ventral arm of male; *b*, dorso-lateral arm of female; *c*, right tentacular club of female; *d*, arm sucker, 1st sucker row of arm II of female; *e*, largest sucker, outer row, tentacular club near base of second hook; *f*, hook from 5th row of arm II; *g*, fourth hook from left tentacular club.

protective membranes bordering the hooks and suckers on either side. The arm hooks are small but widely curved and finely pointed.

The tentacles are long and oval in cross-section with long, only slightly expanded clubs. They are attached basally in the same manner as is described for *A. lucens* (p. 108).

The tentacular club is only slightly expanded, the tentacular hooks and their associated suckers occupying about four-fifths of the club. Proximally there is a carpal cluster which consists of about five small cups and five buttons. Distal of the carpal cluster are six long, widely open, slender hooks; the proximal and the distal hooks are smaller than the other four, which are subequal. Dorsal to the hooks is a distinct double row of small suckers, one pair to each hook but, because the club is so elongate, they give the illusion of lying in a single row along the dorsal border of the club as in Quoy and Gaimard's figure. In the smaller specimens the suckers actually lie in a single row, their exact position and relation to each other being difficult to ascertain.

Distad of the hooks lie four rows of small suckers which extend to the distal extremity. Dorsally a protective membrane which borders the suckers of the hand part originates opposite the first hook and terminates at the distal-most hook. Ventrally a low indistinct membrane borders the proximal half of the club. On the outer surface a swimming membrane or keel originates opposite the third hook and extends outward to the tip of the club.

The light organs are numerous and probably conspicuous in fresh specimens. They are of three sizes, large, medium, and small, are scattered profusely over the ventral mantle surface and the funnel, and are arranged in regular rows on the ventral surface of the head, on arms III and IV, and on the base of arms II.

The ventral surface of the mantle bears numerous light organs somewhat symmetrically arranged. On the midline there is a clear streak bordered on either side by a distinct row of photophores. On the sides of the mantle and dorsally the light organs decrease in number. Dorsally they are very few, but there are three pairs of photophores on the fins near the midline, the two anterior pairs somewhat widely spaced, the posterior pair quite close together.

On the ventral surface of the funnel are about 30 light organs symmetrically placed as shown in the figure.

The ventral surface of the head bears a circlet of light organs around each eye and five distinct rows of light organs lying between these. They are arranged as follows: thirty around the right eye, lacking near the sinus, numerous ventrally, and sparse dorsally. Around the left eye about 21, numerous ventrally, sparse dorsally,

none around the sinus and none dorsoposteriorly. In the midline of the head a single row of about 12 light organs originating between the bases of arms IV and terminating posteriorly at about the level of the eye pupils. On either side is a row of light organs originating as the middle row of arms IV and extending posteriorly as a single row to the level of the eye pupils. Here, demarcated on either side by a single large photophore, the row divides into two, the inner row leading directly posterior into the funnel groove and terminating beside the funnel supports, the outer branch turning slightly outward and terminating at the base of the olfactory crest. The outer row of light organs originates at the web between arms III and IV in a cluster of photophores partially composed of the lower light organs of arms III and IV. From there it partially encircles the eye ventrally as a semicircle, terminating posteriorly in a line drawn from the olfactory crest to the lower edge of the eyelid.

Upon the ventral arms are three rows of light organs, the ventral and middle rows extending nearly to the tip of the arm, the dorsal row merging with the middle row about a third of the length of the arm from the base. There are a few scattered light organs on arm III, both dorsally and ventrally but not extending to the tip, a single light organ dorsally on the base of the arms II, and a pair of closely set photophores in the midsection, one on each arm I.

The number and position or order of the light organs on the ventral periphery of the eyeball is confusing. In two specimens (ML 21.5 mm. and 29.5 mm.) they are in the order extra large, medium, small, medium, small, medium, large (seven in number); in a female 23.0 ML they are large, small, small, small, small, large; and in a female 21.0 ML they are large, medium, medium, small, large. In the remaining six, including two males, they are in the order large, medium, medium, small, medium, large, and are consistent on both sides. This order is somewhat the same as figured by Grimpe for *A. renschi*. The posterior large organ is somewhat half-moon shaped, the anterior one oval and often reduced.

In addition to the light organs, *A. armata* may be unique in having a large luminous organ on the ventral surface of the ink sac. The sac is broadly oval and black, but extending across the ventral surface and up the sides laterally is a distinctly demarcated bronze and pearly iridescent layer which appears to be similar to the luminous light organs found on the ink sac in some other groups. If there is a luminous organ, *armata* is unique among the *Abralia*, of which it is definitely a member, in having an internal photophore.

The two males (ML 27.0–29.0 mm.) had numerous spermatophores. An examination of the ventral arms of these two specimens showed

that the right ventral arms, rather than the left as is usual in *Abralia*, are hectocotylized by the presence of a short semicircular flap on the ventral margin of the arm originating at the 15th hook and bordering 4 hooks; the flap terminates just distad of the last hook. There are no suckers or hooks beyond the flap and no sign in either specimen of the customary dorsal flap.

The buccal membrane is very slightly pigmented, having sparsely set large chromatophores. The body of the animal in general is devoid of pigmentation but has sparsely distributed individual chromatophores over most of the surface of the head, mantle, and arms.

Measurements and indices of two males and seven females of *Abralia (Abralia) armata* Quoy and Gaimard, 1832, from "Ostasien" are:

	♂	♂	♀	♀	♀	♀	♀	♀	♀	Range	Mean
ML	27.0	29.0	21.0	21.5	22.0	23.0	26.0	26.5	29.5	21.0-29.5	25.5
MWI	33.3	41.4	47.6	41.8	40.0	43.5	40.3	41.5	37.3	33.3-47.6	40.7
HWI	42.6	38.0	38.1	37.2	29.5	39.1	38.5	34.0	30.3	29.5-42.6	36.3
FLI	55.5	62.0	47.6	51.2	50.0	50.0	65.4	21.0	54.2	21.0-65.4	50.7
FWI	85.0	93.0	92.7	97.7	81.8	91.4	100.0	98.0	90.0	89.0-100.0	92.2
I	59.5	65.5	59.5	53.5	54.5	60.8	65.3	68.0	67.8	53.5-68.0	61.6
II	77.8	79.4	71.4	74.5	61.3	69.6	76.9	78.2	78.0	61.3-79.4	74.1
III	77.8	76.0	64.3	74.5	59.1	65.2	76.9	71.7	78.0	59.1-78.0	71.5
IV	74.0	72.5	62.0	69.7	61.3	63.0	73.1	71.7	71.2	61.3-74.0	68.7
Arm hooks											
I	14	14	13	12	14	14	16	16	12	12-14	13.9
II	16	14	14	12	14	15	15	16	12	12-16	14.2
III	14	15	14	14	15	16	15	15	13	13-16	14.5
IV	17	16	15	15	18	20	16	18	16	15-20	16.7
Club hooks	6-6	6-6	5-6	6-6	6-6	6-6	6-6	6-6	6-6	5-6-6-6	6-6

TYPE.—Museum National d'Histoire Naturelle, Paris.

TYPE LOCALITY.—Molluccas, near Celbes.

This species is included here on the basis of a record in de Elera's (1896) systematic catalog of the mollusks of the Philippines. Though this is a doubtful record, it certainly is within the range and therefore should be included in the Philippine fauna.

As can be seen from the above description, this species poses a problem in the classification of the genus. All the known species have the left ventral arm hectocotylized rather than the right, and if the ink sac does bear a luminous organ, the two characters alone separate this species clearly. *A. armata* might be considered to belong to a separate genus from the others, but it seems more reasonable, in the present stage of our knowledge of the group, to place it in a separate subgenus alone, *Abralia (Abralia) armata*.

DISTRIBUTION.—Moluccas (Quoy and Gaimard); Balabac, Philippines (de Elera); Ostasien (Zoological Museum, Copenhagen).

Abralia (Asteroteuthis) andamanica Goodrich, 1896

FIGURES 20 AND 21

Abralia andamanica Goodrich, 1896, p. 9.

Asteroteuthis andamanica, Pfeffer, 1912, p. 92.

MATERIAL.—1 ♂, with spermatophores, ML 33.0 mm., 8 ♀♀, ML 39.0–46.0 mm., from Sta. D5396 off Panalangan Pt., Talajit Id., between Samar and Masbate Id., hard bottom, in 250 m., Mar. 15, 1909. 1 ♂ with spermatophores, ML 32.0 mm., from Sta. D5116 off Sombrero Id., Verde Island Passage, 368 m., bottom temperature 50.2° F, Jan. 20, 1908. 1 ♀, ML 40.0 mm., from Sta. D5269 off

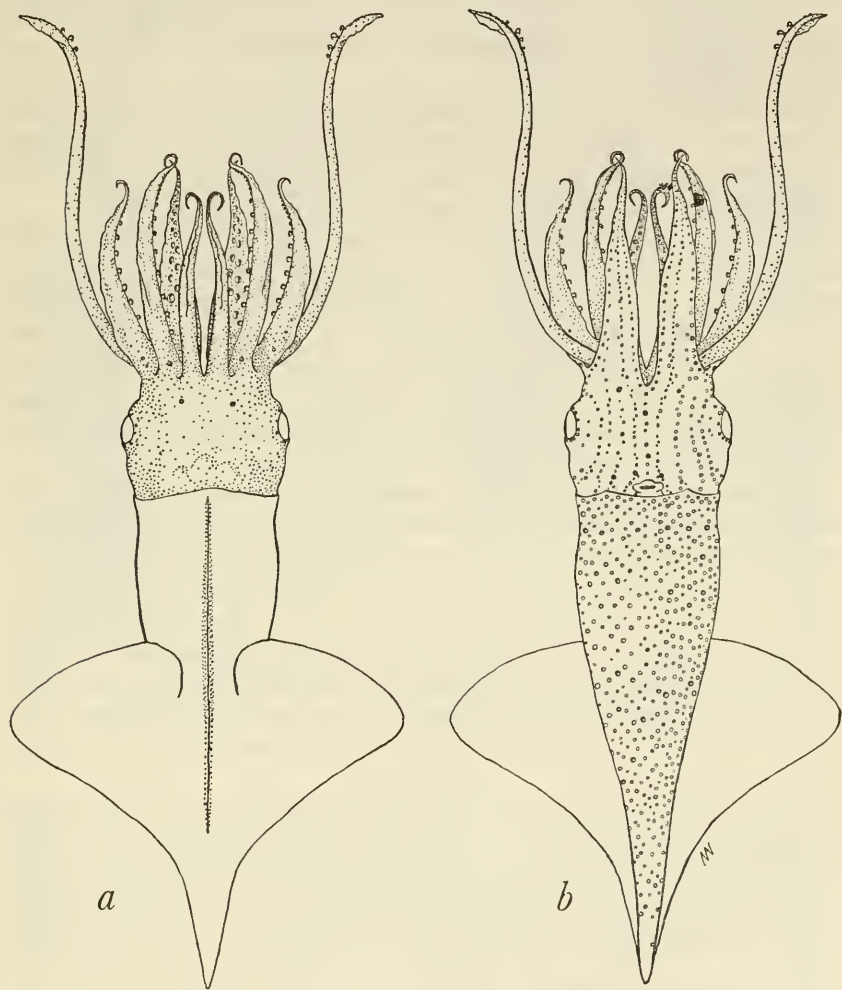


FIGURE 20.—*Abralia andamanica* Goodrich: a, dorsal view of female; b, ventral view of female.

Matocot Pt., Verde Island Passage, fine sand and pebble, in 421 m., June 8, 1908. 1 ♀ ML 50.0 mm., Sta. D5626, off Kayoa Id., gray mud and fine sand, in 485 m., Nov. 29, 1909. 1 ♀, ML 46.5 mm., Sta. D5184 off Lusaran Lt., between Panay and Negros, green mud, bottom temperature 49.8° F, in 1,032 m., Mar. 30, 1908. 1 ♀, ML 34.0 mm., Sta. D5444, off Atalaya Pt., Batag Id., east coast of Luzon, green mud, in 564 m., bottom temperature 45.3° F, June 3, 1909. 1 ♀, mangled, Sta. D5664 off Kapoposang Lt., Macassar Straits, hard bottom, in 732 m., Dec. 28, 1909. 1 ♂, ML 23.0 mm., 4 ♀♀, ML 38.0–44.0 mm., Sta. D5392 off Tubig Pt., Destacado Id., between Samar and Masbate, green mud and sand, in 297 m., Mar. 13, 1909. 1 ♂, ML 32.0 mm., 11 ♀♀, ML 31.0–44.0 mm., Sta. D5396 off Panalangan Pt., Talajit Id., between Samar and Masbate Id., hard bottom, in 250 m., Mar. 15, 1909.

DESCRIPTION.—Thirty-two specimens of this species are in the collections: 28 females and 4 males (ML 23.0–50.0 mm.), including gravid females and males with spermatophores. The means of all measurements and counts are given in the table on page 105.

The mantle is of medium length and slender, the width 28.5 to 32.3 percent of the length, widest at the anterior margin, and tapering gradually to a point posteriorly. The dorsal mantle margin is slightly produced in the midline, but ventrally it is emarginated beneath the funnel. It is muscular except for the posterior fourth which is nearly transparent. The posterior end tapers to a long point, the lateral margins confluent with the posterior end of the fins. The gladius shows through the mantle dorsally as a dark line.

The fins are large, about 66.0 percent of the mantle length, their width about 80.0 percent. The anterior margins are free, the anterior lobe projecting forward. The anterior margin of the fins is convex, the fins rather sharply pointed laterally, the posterior margin concave. Posteriorly they are united and drawn out into a long slender point.

The head is short and compact, about a fourth the mantle in length and about a third the mantle length in width. The eyes are large and prominent, although the eyelid may be almost completely closed in some specimens. The sinus is minute, indistinct, and somewhat closed.

The funnel is large but only the anterior extremity projects beyond the ventral mantle margin. The mantle locking apparatus is simple, consisting of a straight groove on the funnel and a corresponding ridge on the mantle. The funnel organ consists of a prominent inverted V-shaped dorsal pad with short broad arms, and stout oval ventral pads.

The arms are moderately long (MAI 37.8–48.5) in the order 2.4.3.1. The arms are squarish with the exception of III which is flattened

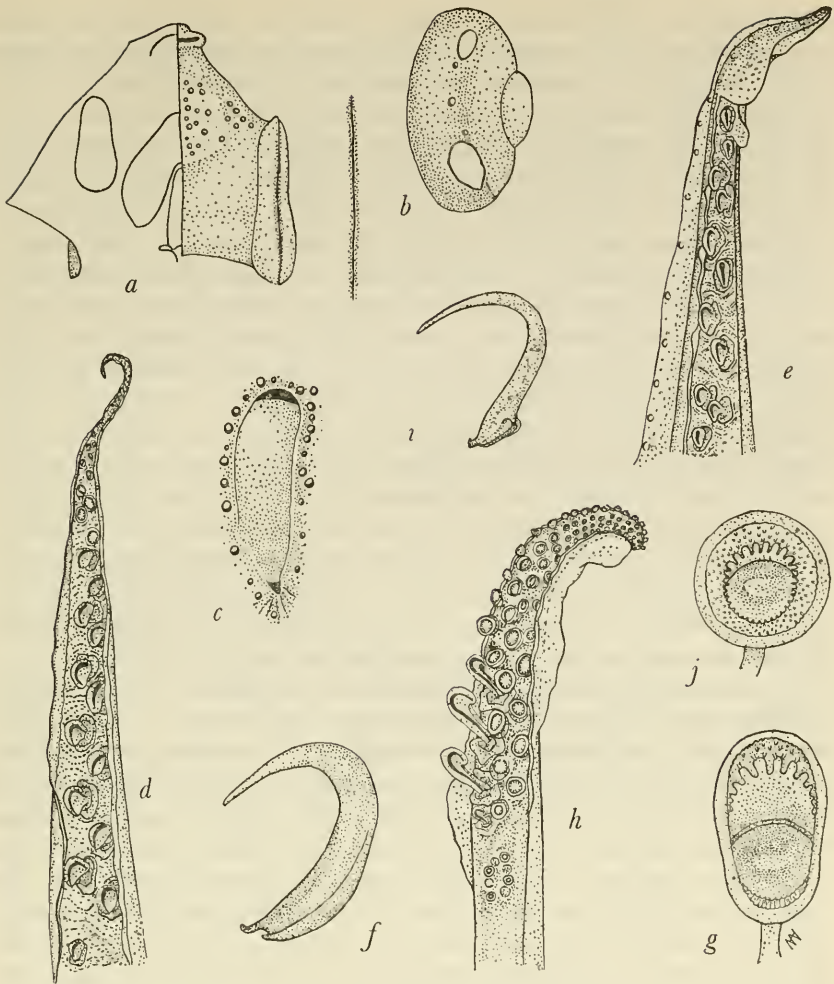


FIGURE 21.—*Abralia andamanica* Goodrich; a, funnel; b, ventral view of left eyeball; c, left eyelid; d, right arm II; e, left ventral arm; f, arm hook from middle of right arm II; g, arm sucker from right arm II; h, right tentacular club; i, second hook of right tentacular club; j, sucker from base of third hook of right tentacular club.

from side to side. Arms I, II, and III are prominently keeled, I and II on the distal two-thirds, III entirely. There is no keel on IV. The arms are stout and strong, but terminate in slender whiplike tips. The arms bear on their proximal two-thirds two rows of strong compact hooks, which in 32 specimens at my disposal occurred on the average as follows: I arm 13, II arm 15, III arm 13, IV arm 15 (♀): I arm 12, II arm 13, III arm 12, IV arm 13 (♂). Distally the hooks are followed by 12 to 14 small oval to round suckers that terminate in two rows of minute suckers. The suckers and hooks are bordered on

either side on I-III by a protective membrane of which the ventral part is deepest. IV has very low, rudimentary membranes but bears a well-developed swimming membrane on its dorsal surface.

The tentacles are long and slender, slightly flattened, about 100 percent of the mantle length, with a small, slightly expanded club. On the hand part of the club is a series of three or four long slender curved hooks. These may be 3-3, 3-4, or 4-3 but are usually 4-3, with four hooks on the right club and three on the left. The sizes of the hooks vary greatly. The proximal one may be very minute or nearly as large as the second or all may be approximately the same size. The variableness does not seem to be related to the size of the animal. Dorsal to the hooks are two irregular rows of suckers. Distal of the hand are four rows of small suckers. The suckers are bordered on either side by a protective membrane. Ventrally, this membrane originates at the middle of the carpal connectives and is at first broad and somewhat semicircular, but at the base of the second or third hook it becomes low and extends to the distal end. Dorsally the membrane originates more distally and is low throughout, although somewhat broader basally. On the outer surface of the club is a broad swimming membrane. The carpal cluster consists in almost all specimens of four small cups and four knobs or buttons.

In the male the left ventral arm is hectocotylized. In a specimen of 32.0 mm. ML from Sta. D5116 there are 13 hooks on the right ventral arm, 7 in the dorsal row and 6 in the ventral row; the arm ends with about 10 small suckers succeeded by a series of minute suckers extending to the tip. However, on the left ventral arm there are 11 hooks consisting of 5 dorsally and 6 ventrally. Distad of these, the arm is devoid of suckers with the oral surface smooth. On the ventral side, originating at the base of next to the last hook is a wide, somewhat circular flap which distally becomes low and extends to the tip of the arm. It slightly curls over the oral surface of the arm. On the dorsal surface the protective membrane continues as a low web to beyond the terminal hook where it suddenly and abruptly widens into a semicircular flap which curls over the arm distal of the ventral flap. Distally it narrows and extends to the tip.

The light organs, as in all *Abralia*, are numerous and conspicuous, characteristically arranged, and of the three usual types. Most diagnostic of the present species is their arrangement upon the ventral periphery of the eyeball. These are five in number, the anterior and posterior photophores large and conspicuous, the anterior one oval, slightly less than one-half the size of the posterior one and with both a dorsal and ventral sinus. The posterior one is large, oval, pointed posteriorly, occasionally with traces of a sinus dorsally. Between

these two large ones are three others, much smaller, round, and in long preserved specimens sometimes indistinct. The two end ones, nos. 2 and 4, are smaller than the middle one, no. 3, and placed very close to the adjoining terminal organs. The middle one is slightly larger than its companions and is placed about midway of the other organs. I find no variation in size or arrangement of these organs in any of the specimens.

The light organs in the skin show considerable variability in numbers and patterns. On the body, head, and arms the photophores are ventrally arranged, only a few on the dorsal surface of the arms, head, and mantle. There is one near the base of arm II, plus several smaller ones on the arm, and two on the head below the junction of I and II. On the ventral surface of the mantle the photophores are crowded, indistinctly arranged in longitudinal rows and in some specimens there appears to be a ventral clear midstripe devoid of light organs.

The ventral surface of the funnel bears numerous light organs in orderly arrangement.

The ventral surface of the head and arms bears numerous photophores. On the ventral surface of the head there are 9 or 10 indistinct rows of dark-type medium-size light organs. On the inner or ventral side of arms IV a single row of light organs extends from near the tip to the base of the arm; there the rows from the two arms unite and descend to near the base of the head as a midline. The midrow of each ventral arm extends from the tip to the base of the arms where they converge slightly toward the midline and thence descend into the funnel groove. The dorsal row of IV originates near the tip and descends along the dorsal edge to the base where it turns slightly dorsal and then sharply turns back upon itself to describe a semicircle around the ventral side of the eye, yet separated from the eyelid circle. Between this dorsal row and the midarm row lie two short rows on the head, originating slightly upon the arm and descending to near the base of the head. On the ventral surface of the head are 10 large white photophores arranged in a regular pattern: two in the midline, one on each side of the funnel and three on each side of the head in a single row. There are also two on the dorsal surface of the head and one near the base of each dorsolateral arm and of each ventrolateral arm. There are 29 light organs encircling the eye on the right side of the male and twelve posteriorly on the eyelid on a female examined.

Measurements and indices of 27 females and 4 males of *Abratia andamanica* Goodrich, 1896, with stations where collected, are as follows:

	5392				5397					
	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
ML	41.0	44.0	38.0	44.0	39.0	43.0	42.0	41.0	39.0	42.0
MWI	29.3	28.4	31.6	25.0	30.7	25.6	28.5	29.3	20.8	28.6
HWI	39.2	29.6	----	----	----	25.6	----	29.3	32.0	32.1
FLI	68.3	66.0	71.0	63.6	66.7	65.1	64.3	67.1	64.0	64.3
FWI	75.6	72.8	81.6	86.4	84.7	69.8	73.8	78.0	84.6	81.0
I	36.6	37.3	32.9	----	36.0	30.1	28.8	29.3	25.6	28.6
II	39.0	41.0	39.5	----	43.6	34.9	31.0	39.0	33.3	36.0
III	34.1	31.8	39.5	----	33.3	31.5	33.3	31.7	28.2	38.1
IV	41.5	34.1	42.2	----	51.3	31.4	33.3	31.7	35.9	35.7
TLI	111.3	----	----	134.0	----	79.1	85.7	87.8	113.0	83.4
CLI	----	----	----	----	----	17.6	18.0	16.7	13.6	15.7
Arm hooks										
I	11	13	13	----	14	13	13	12	13	12
II	15	15	14	----	12	14	14	15	15	11
III	14	13	13	----	12	13	13	12	13	13
IV	1	14	14	----	13	14	14	14	13	13
Club hooks	..3	----	..3	3-4	----	3-3	3-4	3-4	..4	3-3
Carpal cluster	----	----	----	----	----	4,2	4,4	4,4	4,7	4,4

	5397				5398					
	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
ML	44.0	40.0	42.0	40.0	31.0	44.0	39.0	44.0	46.0	44.0
MWI	25.0	28.8	26.2	30.0	32.2	28.4	30.7	27.3	26.1	28.4
HWI	----	----	----	----	----	31.8	38.5	31.8	34.8	34.1
FLI	70.5	62.5	64.3	62.5	67.7	66.0	74.3	66.0	63.0	68.1
FWI	70.5	82.5	81.0	72.5	83.8	82.0	89.5	72.7	76.0	77.2
I	38.7	30.0	28.6	28.8	----	31.8	30.8	29.5	26.1	29.5
II	43.2	35.0	33.3	33.8	----	34.1	38.5	34.1	34.8	38.6
III	47.8	30.0	26.2	35.0	----	30.7	38.5	31.8	30.5	27.3
IV	47.8	35.0	27.4	32.5	----	31.8	38.5	29.5	32.5	34.1
TLI	115.0	110.0	81.0	127.0	----	75.0	18.0	95.4	78.2	93.0
CLI	----	----	----	----	----	16.7	13.0	15.9	16.7	17.1
Arm hooks										
I	13	14	14	14	13	14	15	13	13	13
II	14	15	15	15	15	16	15	13	14	14
III	13	14	13	14	12	14	15	12	12	12
IV	13	15	15	15	13	15	16	13	14	14
Club hooks	4-3	3-3	3-4	..3	3-4	3-4	4-3	..4	..4	4-4
Carpal cluster	4,4	4,4	4,4	5,0	----	4,5	5,5	4, ..	4, ..	3,4

	5396			5299	5296	5184	5444	5116	5396	5397	5398
	♀	♀	♀	♀	♀	♀	♀	♂	♂	♂	♂
ML	44.0	41.0	41.0	40.0	50.0	46.5	34.0	32.0	33.0	32.0	28.0
MWI	28.4	29.3	26.8	30.0	28.0	29.0	29.4	34.3	31.8	28.1	34.8
HWI	31.8	36.6	32.7	47.5	36.0	34.4	38.3	37.5	30.3	----	----
FLI	68.1	70.7	70.7	65.0	68.0	68.8	67.7	68.7	66.6	65.7	65.2
FWI	75.0	78.1	80.5	95.0	80.0	90.1	85.3	86.0	75.7	81.2	82.6
I	29.5	26.8	31.7	31.2	36.0	36.6	32.3	31.2	36.4	31.2	----
II	31.8	31.7	36.6	37.5	40.0	43.0	38.3	40.6	41.0	40.6	----
III	29.5	29.3	33.0	35.0	34.0	36.5	32.3	62.5	42.5	34.4	----
IV	31.8	34.1	34.1	42.5	36.0	38.7	33.9	34.4	36.4	34.4	----
TLI	----	80.5	85.4	105.0	92.0	98.8	79.5	115.0	----	----	104.0
CLI	----	18.2	----	16.7	18.4	21.5	18.5	16.2	----	----	----
Arm hooks											
I	15	13	11	13	16	15	13	11	13	11	12
II	16	14	13	15	16	16	15	12	14	13	13
III	14	13	12	13	14	14	13	11	13	12	12
IV	17	14	15	16	16	17	14	12	14	12	10-12
Club hooks	4-3	3-4	..4	3, ..	3,4	4-4	3-3	3-4	..3	----
Carpal cluster	4,4	3,4	4,5	4,4	4,5	5,5	4,4	4,5	----	4, ..	----

Ranges and means of measurements given above are:

	Females			Males		
	No. of measurements	Range	Mean	No. of measurements	Range	Mean
ML	27	31.0- 50.0	41.3	4	23.0- 33.0	30.0
MWI	27	25.0- 32.2	28.6	4	28.1- 34.8	32.2
HWI	18	25.9- 47.5	34.3	2	30.3- 37.5	33.9
FLI	27	62.5- 74.3	66.9	4	65.2- 68.7	66.5
FWI	27	69.8- 95.0	80.0	4	75.7- 86.0	81.3
I	25	25.6- 38.7	31.3	3	31.2- 36.4	32.7
II	25	31.0- 43.6	36.8	3	40.6- 41.0	40.4
III	25	26.2- 47.8	33.1	3	34.4- 62.5	46.0
IV	25	27.4- 51.3	35.9	3	34.4- 36.4	34.7
TLI	22	75.0-134.0	96.9	2	104.0-115.0	109.0
CLI	15	13.0- 21.5	17.0	1	16.2	16.2
Arm hooks						
I	26	11-15	13.6	4	11-13	11.7
II	26	11-16	14.5	4	12-14	13.0
III	26	12-15	13.2	4	11-13	12.0
IV	26	13-17	14.5	4	12-14	12.5
Club hooks						
left	17	3-4	3.3	2	3-3	3
right	26	3-4	3.54	3	3-4	3.3

TYPE.—Calcutta Museum.

TYPE LOCALITY.—Andaman Sea.

DISCUSSION.—I have referred the present specimens to *Abralia andamanica* Goodrich. Comparison with Goodrich's description and figures convinces me that they are conspecific. The few comparable measurements which Goodrich gave also are within the range of the present series. It appears that *andamanica* may be separable into several subspecies throughout its range, with one form occurring in Japan and another in the Hawaiian Islands.

DISTRIBUTION.—Andaman Sea (Goodrich); Japan (Sasaki); Hawaiian Islands; Philippines!

Abralia (Stenabralia) lucens, new species

FIGURES 22 and 23

HOLOTYPE.—Female, gravid, in alcohol, ML 62.0 mm., from Port Dupan, Leyte, April 6, 1908; USNM 575449.

PARATYPES.—♀, ML 44.0 mm., Fanning Id., Line Islands, May 8, 1937; W. B. Gray and L. Smith, G. Vanderbilt Exped.; ANSP. 1♀, ML 43.0 mm., Christmas Id., Line Islands, May 6, 1937; W. B. Gray and L. Smith, G. Vanderbilt Exped.; ANSP. 2♀♀, ML 47.0-48.2 mm., Fanning Id., with light, 2030-2230, June 5, 1951; John McGowan, leg.

DESCRIPTION.—The mantle is long, slender, and tubular. The sides of the mantle are straight, slightly flaring at the anterior margin.

Posteriorly the sides commence converging at the anterior margin of the fins demarcated by a distinct angle, and thence the mantle tapers cone-shaped to a blunt point which is partly free from the fins. The anterior margin is only slightly produced in the dorsomedian line but is emarginate below the funnel.

The fins are short (49.0-39.6) and fairly narrow, their anterior margins convex with anterior lobes free, the posterior margin slightly concave. Posteriorly they unite to form a narrow drawn-out point.

The funnel is strong, compact, and deeply set into the ventral surface of the head. The mantle locking apparatus is straight and simple. The funnel member is narrow anteriorly, expanding posteriorly, and terminates in a rounded tip. The ventral margin of the groove is straight, the dorsal edge slightly bowed, the groove deeper in the midportion. The mantle member is straight and narrow. The funnel organ is an inverted V with broad lateral members: the ventral pads are elongate-oval and angled. The funnel valve is large and strong.

The head is wider than the mantle, with small eyes which project slightly. The eyelids are very narrow, transversely open with a small but distinct anterior sinus. It is interesting to note that in this specimen the dorsal windows over the eyes are very distinct and nearly round. There are four nuchal folds on either side of the funnel, widely spaced, with the ventral fold immediately adjacent to the funnel. No olfactory crest is observable. The buccal membrane is eight-lobed and has eight supports.

The arms are long and comparatively slender, in the order 3.4.2.1, 4.3.2.1, or 2=4.1.3. The dorsal arms are shortest, smooth at their bases but keeled for about two-thirds of their length by a low sharp ridge. The right arm bears eight pairs of hooks, the left arm nine, arranged in two rows terminating distally in two rows of about six pairs of small suckers, beyond which the tip bears four rows of minute suckers. The hooks and suckers are bordered on each side by a protective membrane, the ventral one the deepest, and the supports alternate with the hooks.

The dorsolateral arms bear a ridge on the distal half of the arm and each bears nine pairs of hooks followed by about five pairs of suckers terminating in four rows of minute suckers on the distal tip. A protective membrane borders the hooks and suckers, the larger on the ventral side.

The ventrolateral arms are connected with the dorsolateral arms by a vestigial external web at their bases and with the ventrals by the normal thin membrane which aids in sheathing the tentacular stalk. A broad swimming membrane originates at the base of the arms and extends to the distal tip. Both arms bear nine pairs of

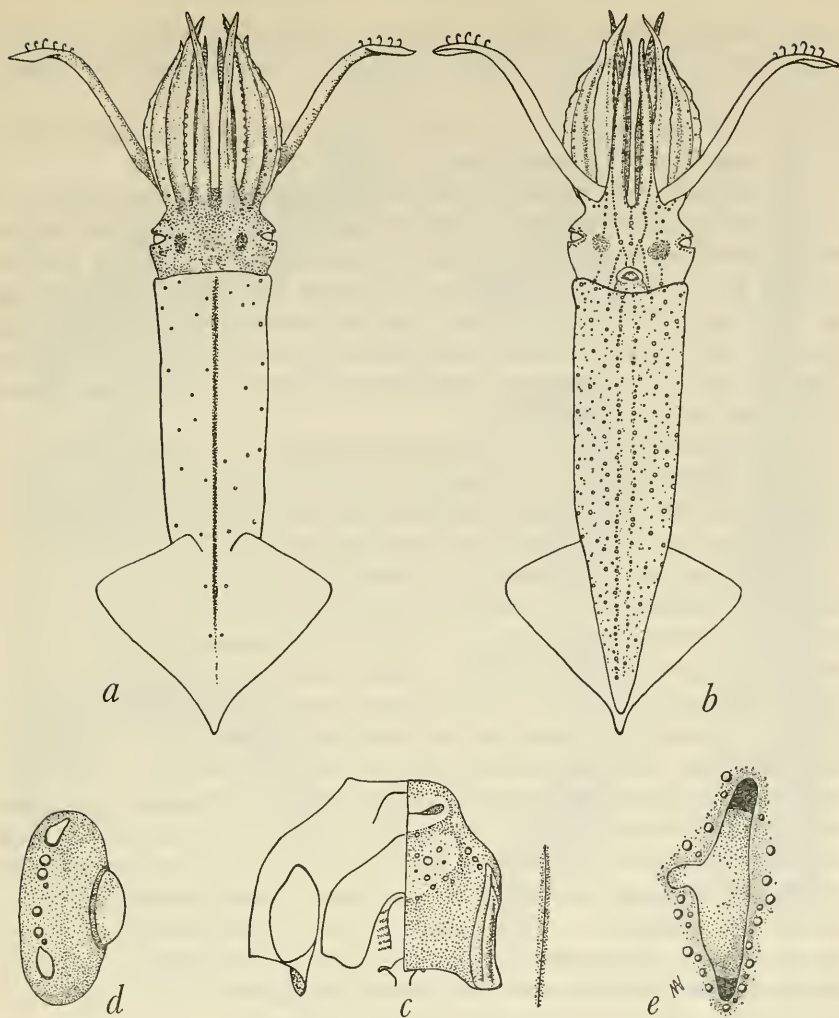


FIGURE 22.—*Abralia lucens*, new species: a, dorsal view of holotype, mantle length 62.0 mm.; b, ventral view of same; c, ventral view of funnel, partly opened to show organ; d, ventral view of left eyeball; e, left eyelid.

hooks, followed by six or seven pairs of small suckers, and terminate in four rows of minute suckers. The ventral protective membrane is very deep, half again as wide as the depth of the largest hooks.

The ventral arms are without keels, strongly angled on their ventromedian sides, and bear 10 pairs of hooks on the dorsal row and nine hooks on the ventral row. Beyond these are about five pairs of suckers in two rows terminating in the usual four rows of minute suckers. On the dorsal margin of the outer edge of the arms is a broad thin membrane which partially encloses the tentacle stalk

when the arms are brought together. The hooks and suckers are bordered on either side by a low membrane of about equal depth with short but stout supports.

The hooks of the arms are large, narrow, and strongly arched with long, narrow, curved distal tips.

The tentacles are short. The stalks are flattened, rectangular in cross-section with strongly angled corners. The inner ventral angle is composed of a strong muscle at the base which, in the pocket formed by III and IV, separates and passes downward and attaches at the base of IV as part of the brachial crown base. In the space between this muscle and the stalk another muscle originates near the base of arm IV and, passing dorsally, attaches to the brachial crown near the base of arm III.

The tentacular club is moderately expanded, broad in the proximal part but rapidly tapers to a narrow tip which curls ventrally. Proximally there is a carpal cluster which in the left club has four cups and four(?) buttons, but in the right there are five cups and four buttons. Distad of the carpal cluster is a minute hook on the ventral edge of the club, followed by five others on the left club of which the 2nd, 3rd, and 4th increase in size, the latter the largest of all, the 5th and 6th decreasing somewhat. Each hook has a pair of large, minutely toothed suckers at its base, representing apparently the two dorsal rows, the inner ventral row having been lost. Distad of the hooks the club terminates in an area bearing four rows of minute suckers. On the dorsal border the club bears a protective membrane which originates opposite the 1st hook just above the carpal pad and terminates opposite the base of the 6th hook. On the outer surface of the club opposite the base of the 3rd hook a strong broad swimming membrane originates. This membrane lies adjacent to the base of the protective membrane, borders the distal section of the club, and encircles the distal suckers. The right tentacular club bears only five hooks, the 6th apparently being missing.

The light organs, as in other *Abralia*, are numerous and conspicuous. They are found both dorsally and ventrally upon the mantle, sparsely on the funnel, and in distinct rows on the ventral surface of the head, the ventral periphery of the eyeball, and the ventral and ventrolateral arms. Although the specimen is in an excellent state of preservation, some of the features of the light organs are no longer discernable but, by their size, they appear to be of three kinds, minute, small, and large. They are arranged as follows on the body:

On the ventral surface of the mantle they are placed thickly, the large light organs numerous and conspicuous and arranged somewhat in rows, longitudinally. There is a clear stripe on the midventral line which is followed on either side by a row of all three types of

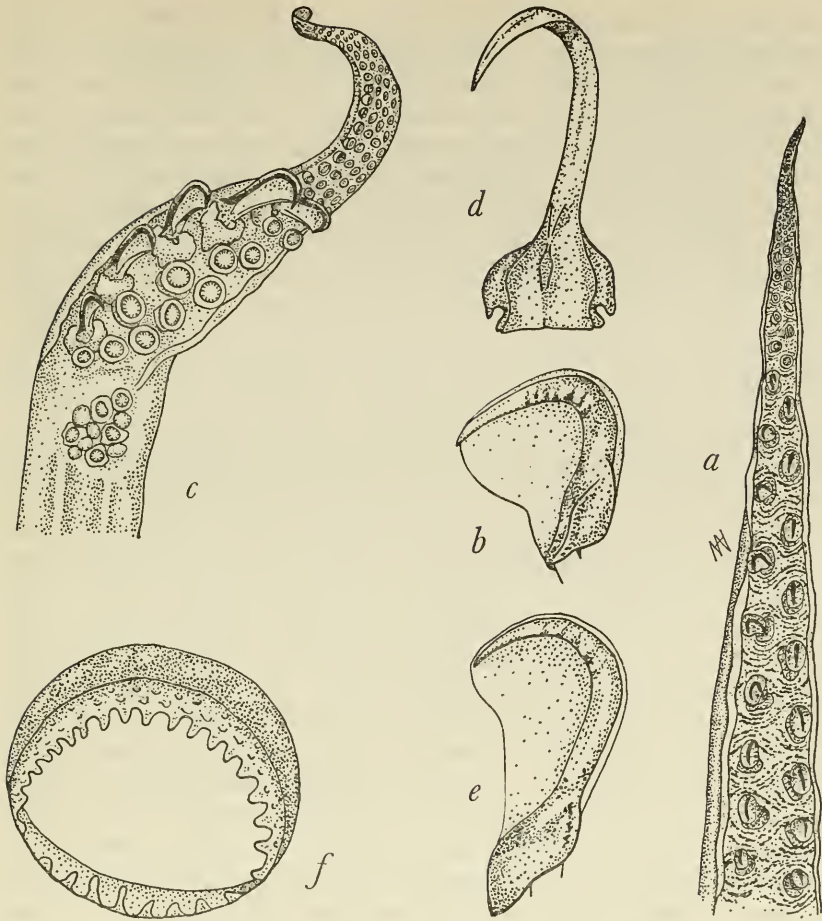


FIGURE 23.—*Abralia lucens*, new species: *a*, right arm II; *b*, hook from right arm II; *c*, right tentacular club; *d*, large tentacular hook; *e*, same; *f*, sucker from base of fourth sucker of tentacular club.

light organs, then by a somewhat clear stripe, and last by indistinct rows of photophores with scattered ones between. Dorsally the photophores become very scarce and scattered, the large ones not extending to the dorsal surface. Along the midline there are indications of pairing of photophores on either side of the gladius rather far apart, but these may be coincidental since some are singly placed. Just anterior of the fin and between the free lobes is a pair of photophores on the mantle. About a fourth of the way posterior on the fins is a single pair of photophores, moderately far apart and deeply sunken in the skin. A short distance posteriorly lies another pair, closer together.

On the ventral surface of the funnel are 26 light organs somewhat symmetrically arranged. Most conspicuous of these are (a) a single pair of large light organs arranged transversely slightly above the level of the anterior edge of the funnel member of the locking apparatus, and (b) a set of three light organs decreasing in size posteriorly and arranged in an oblique row just mediad of the funnel member of the locking apparatus and directed towards the funnel opening.

The ventral surface of the head bears five longitudinal series of photophores arranged in distinct lines which cause the surface of the head to appear ridged. The light organs extend onto the arms and their arrangement is as follows: In the midline of the head the median row originates at the edge of the funnel groove and extends forward to the base of the ventral arms. In the midline it consists of two large light organs and eight smaller ones. At the base of the arms this row divides and extends along the angle of the inner edge of the ventral arm to the distal tip. It is composed of irregularly arranged large and small photophores. On each side of the midrow of the head lies a row of mixed photophores which upon the ventral surface of the head is single, but posteriorly it branches in an inverted Y, the inner branch descending deeply into the funnel groove on either side of the bridle, the outer row following the edge of the funnel groove to the origin of the ventral neck fold beside the funnel. Anteriorly, after these two branches unite, the row takes a slight dorsal turn at the base of the ventral arms and extends distally along the median line of the arm to the end. Between the ventrolateral row of photophores and the eye lies another row of photophores. Posteriorly it originates at the base of the neck fold anterior to the mantle lock-apparatus. Five or six light organs lie anterior of the neck fold but the row is interrupted, the photophores lacking in the area of clear transparent skin forming the ventral window of the eyeball. Anterior of the window, the row is resumed and extends by means of scattered photophores onto the ventral arm where a distinct and orderly row of organs somewhat widely spaced extend anteriorly on the dorsal membrane to within one-sixth of the length of the arm from the tip.

The lateral row of light organs appears to divide somewhat at the base of the ventral arms; it furnishes a band which extends onto the ventral side of the ventrolateral arms as a few scattered, deeply sunken organs which extend over about three-fourths of the arm. On the dorsal surface of the arms III are three minute, widely spaced photophores. A single small light organ is located at the base of each of the dorsolateral arms, slightly dorsad.

Around each eyelid is a cirlet of photophores which are crowded ventrally but scattered dorsally. There are 24 around the left eyelid and 27 around the right.

The eyeball bears a row of light organs on its ventral periphery. These are arranged in a row of eight photophores, as follows: Proceeding posteriorly, No. 1 is large, oval, white, slightly pointed posteriorly. Posterior to 1, lie 2, 3, 4, and 5, all of which are small, round, yellowish, and of about equal size. The posterior-most is no. 6 which is similar to 1 but pointed anteriorly. Midway between photophores 1 and 2 lies a minute round yellowish photophore, No. 7, which is somewhat dorsally located. Similarly, between 3 and 4 is 8, again a minute, dorsally situated round organ. The arrangement is the same on both eyes.

The specimen is a gravid female and the posterior half of the mantle cavity is filled with eggs, the largest about 0.8 by 0.6 mm. The above description is based on the holotype.

Measurements (in mm.) of five females of *Abralia lucens*, new species, are as follows:

	Holotype	Paratypes				
	♀	♀	♀	♀	♀	
ML	62.0	43.0	44.0	47.0	48.2	
MW	14.2	11.5	12.0	13.8	14.8	
HW	15.2	11.3	12.0	11.2	13.0	
FL	24.5	18.0	21.0	23.2	23.5	
FW	33.5	26.2	31.5	20.0	31.0	
I	16.2	16.9	18.0	18.5	19.0	
II	18.0	22.0	21.9	20.2	20.0	
III	16.0	19.4	20.4	23.0	21.0	
IV	18.0	21.7	20.8	22.0	21.5	
Arm hooks						
I	18	17	15	16	16	
II	18	19	17	16	16	
III	18	19	18	19	18	
IV	21	21	20	20	20	
TL	37.0	39.0	35.2	35.0	29.5	
CL	8.0	8.0	9.3	8.0	7.5	
Club hook	6-5	6-6	6-5	5-5	6-5	

TYPE.—U.S. National Museum 575449.

TYPE LOCALITY.—Port Dupan, Leyte.

DISCUSSION. —This new species of *Abralia* is closely allied to *steindachneri*, *renschii* and *spärcki* but can be distinguished from *steindachneri* by the smaller number of club hooks and the larger number of ocular light organs. It may be separated from *renschii* by the beautifully regular striping of the mantle photophores in the latter and finally from *spärcki* by the presence of only three rows of light organs on the ventral arms and the lack of a large white photophore within the funnel groove near the base of the first nuchal fold.

It appears to be, on the basis of its present distribution, a more oceanic species than the other known species of the subgenus. The name *lucens* is from the Latin *lucens* meaning bright or shining.

DISTRIBUTION.—Line Islands, Oceania! Philippines!

Abralia (Stenabralia) spärcki Grimpe, 1931

FIGURES 24 AND 25

Abralia spärcki Grimpe, 1931, p. 150.

MATERIAL.—Holotype, ♀, ML 47.0 mm., from "Amboina Bugten, Kysten von Sawrude, de danske Exped. til Kei Ørne 1922. Grimpe determ. Legit Dr. Th. Mortensen. 2, 1922." 1♀, ML 48.0 mm. Bagacay Bay, Escarpada Id., Naranjon between Samar and Masbate; U.S. Fish Comm. steamer *Albatross*, electric light, March 12, 1909.

DESCRIPTION.—A single specimen of this interesting and poorly known species was found in the National Museum collections. A scrutiny of the literature indicated that it might be conspecific with Grimpe's insufficiently described species. Thanks to the kindness of Prof. Gunnar Thorson of the Zoological Museum, Copenhagen, the type was loaned to the author and the two specimens were found to be in close agreement.

The mantle is long and cylindrical, tapering in the posterior half to a small blunt point. The anterior margin is very slightly advanced in the dorsal middle region and excavated ventrally beneath the funnel with marginal acute angles.

The fins are small and short with sharp lateral angles. The anterior margins are slightly convex with free anterior lobes. The posterior margins are concave and are drawn out posteriorly to the mantle point.

The funnel is small, compact and deeply set into the head. The funnel locking apparatus is simple, and enoploteuthid in structure. The funnel organ is an inverted V shape with a low ridge on each side near the apex. The ventral pads are small, oval and compact.

The head is small and compact, about as wide as the mantle and equipped with large eyes. The eyelids are transversely oval, straight bordered posteriorly with small, distinct anterior sinuses. There are four nuchal folds. The inner is a simple small semicircular flap. The first lateral is small, distinct and bears the olfactory organ. The third and fourth are prominent raised ridges which unite posteriorly but do not form a semicircular outline.

The gladius was not dissected out but shows as a broad dark ridge beneath the skin.

The buccal membrane is eight lobed with eight supports. The outer surface is pale in color with a few scattered reddish brown chromatophores.

The arms are short, slender and in the order 3.4.2.1. All of the arms are bordered on each side by trabeculate protective membranes which are deepest ventrally. I is keeled on the distal two thirds, II on the distal half, and III for the entire length. IV has a broad

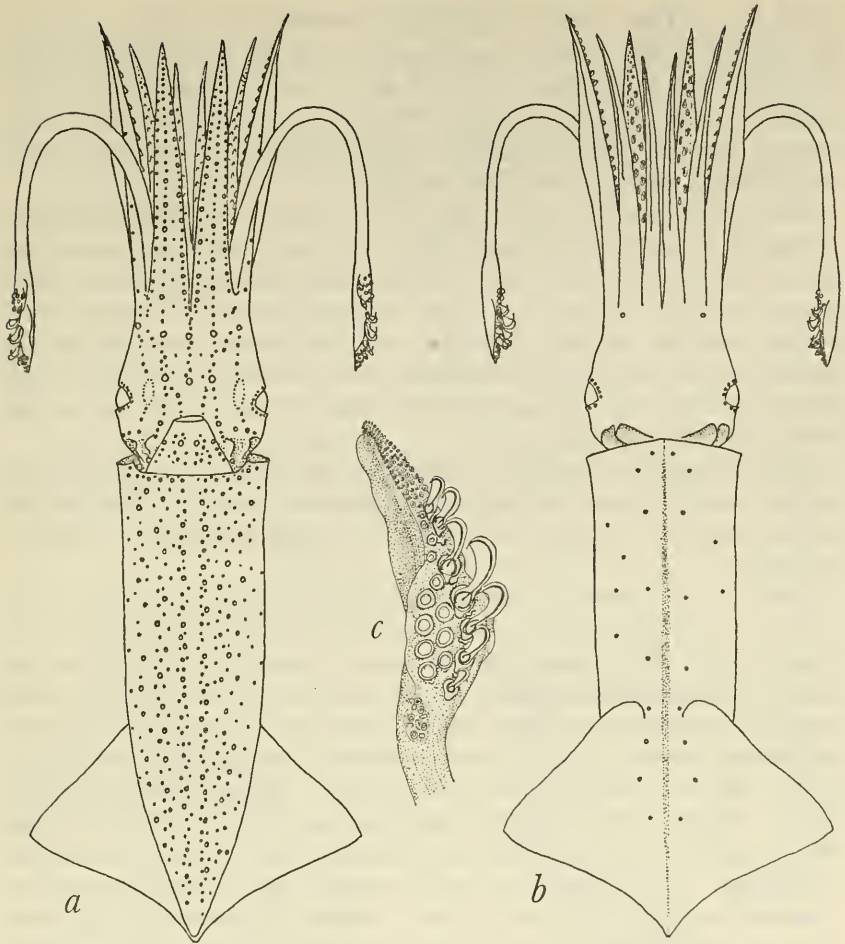


FIGURE 24.—*Abralia spärcki* Grimpe: *a*, ventral view of holotype, mantle length 47.0 mm.; *b*, dorsal view of same; *c*, left tentacular club of Philippine specimen.

membrane along the dorsal edge which encloses the tentacular stalk. All of the arms are equipped with a series of biserial compact hooks originating near the base and extending over most of the arm. The hooks are followed distally by about ten pairs of small toothed suckers. The arm tips terminate in three to four rows of minute suckers.

The tentacles are long, squarish in cross-section but with a concave oral surface. The club is only moderately expanded and long. It is bordered on each side by a protective membrane of which the dorsal one is low and indistinct. It originates at the carpus and terminates at the base of the last hook. The ventral membrane is wide and large originating at the distal end of the carpus and terminating at the base of the third hook. There is a prominent aboral keel on the distal half

of the club. The hand is equipped on the ventral margin with six long slender hooks of which the terminal ones are small and the third from the base the largest. Each hook is accompanied dorsally by two large, finely toothed suckers. The terminal portion of each club is short, less than one-fourth of the total club length and bears four rows of small nearly equal-sized suckers.

The light organs are numerous and are found distributed over the animal in three different sizes. Those on the ventral surface of the mantle are numerous and are not arranged in any semblance of rows except medially where two indistinct rows border a narrow clear median zone or stripe. Elsewhere on the ventral mantle surface minute, small, and large photophores are numerous, closely set but becoming fewer and minute on the dorsal surface where only a few widely spaced pairs are found.

On the funnel are about 28 organs in four patches on the ventral surface, with a line of four large photophores across the funnel in the middle area. The dorsal bridles are equipped with light organs on each side.

There are five distinct rows of light organs on the ventral surface of the head. The median row originates slightly anterior to the funnel groove with a large photophore and extends forward with about eleven organs, ending at the base of arms IV where it divides, each branch forming a ventral row along the arms. The inner lateral row originates posteriorly from two branches, one within the funnel groove, the other on the inner nuchal fold. These unite at a large organ on the posterior surface of the head and lead forward as a single row to arm IV where it forms the middle row of the arms. The outer lateral row originates on the second nuchal fold and leads forward in a shallow arc with a break at the ventral "windows" of the eyes. This row terminates between the bases of arms IV and III. Within the funnel groove there is a single large white photophore posterior to and slightly medial to the inner nuchal fold. There is a circlet of about 30 light organs around each eyelid.

The ventral arms bear three distinct rows of light organs. Of these the ventral row extends to near the tip, the middle row extends to the tip, and the dorsal row on the keel extends only to near the tip. On the basal quarter of IV there are a few photophores, varying between four and nine in a scattered row between the ventral and median rows and one or two scattered organs near the base between the median and the dorsal row. Arm III has a few widely spaced photophores along the base of the keel on the ventral side and a few scattered along the dorsal side. Arm II bears only a single basal organ.

The eyeball bears six photophores on the ventral periphery. The

terminal organs are slender, ridged and pointed. Nos. 2, 4, and 5 are large, round and dark red, No. 3 is smaller but similar. In addition there may be 0 to 3 minute supplementary photophores which vary in position. One may be found adjacent to or touching Nos. 2, 3, 4, and 5 but not the large terminal organs.

Measurements (in mm.) of two females of *Abralia spärcki* Grimpe are as follows:

	<i>Holotype</i>	<i>Philippine</i>
ML	47.0	48.0
MW	13.0	13.0
HW	13.0	13.2
FL	23.0	25.0
FW	30.0	32.0
I	22.0	18.0
II	24.0	21.0
III	28.0	21.0
IV	25.0	19.0
Arm hooks:		
I	15	16
II	17	16
III	17	18
IV	19	20
TL	52.0	44.0
CL	15.0	13.1
Club hooks	6, 6	6, 7

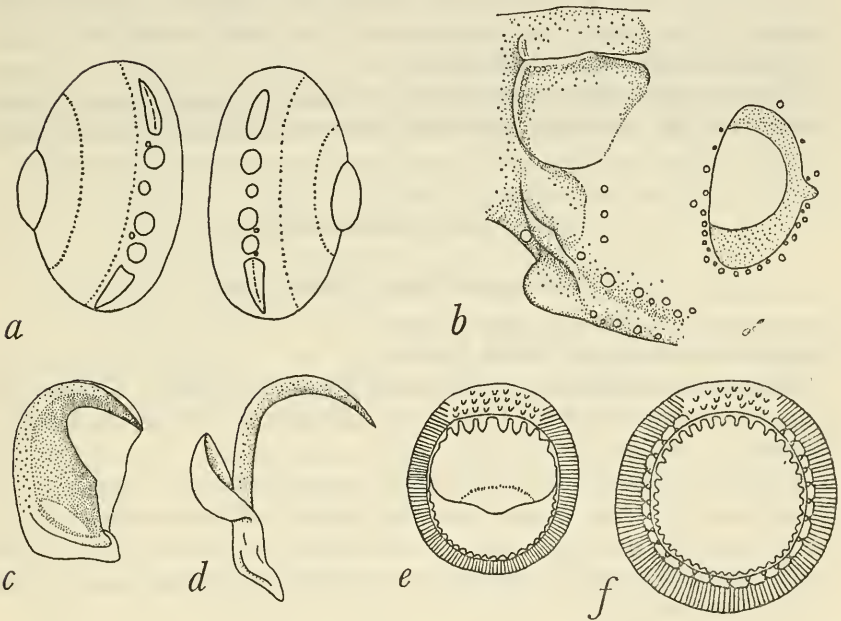


FIGURE 25.—*Abralia spärcki* Grimpe: *a*, eyes of holotype showing numbers and arrangement of light organs; *b*, lateral view of head; *c*, large hook from right arm III; *d*, large hook from tentacular club; *e*, large sucker from end of right arm III; *f*, large sucker from tentacular club.

TYPE.—Zoological Museum, Copenhagen.

TYPE LOCALITY.—Amboina Bay, coast of Sawrude.

DISCUSSION.—This interesting species has been entirely neglected since Grimpe mentioned it in 1931. It is closely related to *A. steindachneri* from the Red Sea and *A. lucens* described above. It is, however, easily distinguished from these by the accessory rows of light organs on the base of arm IV and other features mentioned above.

The validity of the name *spärcki* needs some explanation. It is given by Grimpe (1931, footnote, p. 150) in his paper describing *Abralia renschi*. It is there listed with the three members of his "typischen Species des Gattung (*Abralia* J. E. Gray s. str.; hierher: *A. armata* Quoy and Gaimard, 1832 [Stücke des Mus. Kopenhagen!], *A. multihamata* Sasaki, 1929, *A. spärcki* mihi in edit.)"; *spärcki* is characterized, according to Grimpe, by the possession of five or six hooks on the club and by the general shape of the body. Though this description in itself is probably not sufficient, I believe that it does satisfy the requirements for availability. Fortunately, the type was carefully labeled and was maintained in the collections of the Zoological Museum in Copenhagen. It gives me great pleasure to be able to describe in detail this species erected by Grimpe, whose detailed studies of this group have contributed to a fuller understanding of their morphology and relationships.

DISTRIBUTION.—Sawrude Island, Amboina (Grimpe); Bagacay Bay, Escarpada Id., Naranjon, between Samar and Masbate, Philippines!

Family Octopodoteuthidae

Octopoteuthis sicula Rüppell, 1844

Octopoteuthis sicula Rüppell, 1844, p. 135.

Octopodoteuthis sicula Sasaki, 1929, p. 256.

MATERIAL.—1 specimen, macerated, from Sta. D5405, off Ponson Id., near Leyte, in 500 m., hard bottom, Mar. 17, 1909; USNM 574882.

A single specimen of this species was contained in the National Museum collections; it was identified by the author some years ago when working over part of the collections in Washington. The specimen is now completely macerated and descriptions based on it are impossible.

This is a well-known species; students of Philippine cephalopods will find a description in several works, including Sasaki's monograph (1929, p. 256, pl. 21, figs. 17-19; text fig. 125).

TYPE.—Not traced.

TYPE LOCALITY.—Messina.

DISTRIBUTION.—Worldwide in warm and temperate seas. Philippines!

Family Onychoteuthidae

Onychoteuthis banksi (Leach, 1817)

FIGURE 27,d

Loligo banksii Leach, 1817, p. 141.

Onychoteuthis banksii, d'Orbigny, 1826, p. 161.—Pfeffer, 1912, p. 70.

MATERIAL.—1 ♀, ML 60.0 mm., from 6.4 mi. off Buka Buka Id., Sta. D5611, Nov. 19, 1909. Gulf of Tomini, Celebes, at surface; USNM 574889.

DESCRIPTION.—A single juvenile female of this cosmopolitan species was obtained by the *Albatross* in the Celebes. The description is based entirely upon this individual.

The mantle is tubular, flared at the anterior margin, and from thence nearly straight-sided to the origin of the fins where the mantle becomes abruptly much narrower, tapering with concave sides to a blunt point. A ridge or keel which is rather characteristic of the genus is on the ventral surface of the point. The anterior mantle margin is slightly dorsally produced in the midline but ventrally is strongly emarginated beneath the funnel with sharp lateral lappets. The gladius is seen as a narrow dark line along the dorsal midline.

The large fins in this specimen, amounting to about half the length of the mantle, their width two-thirds of the mantle length, are partly a juvenile character. The anterior lappet is free, the outer angle sharp, the posterior borders forming about a 90° angle.

The funnel is small and compact, deeply set into the ventral surface of the head. The locking apparatus consists of a slightly sinuous cartilaginous groove on the funnel and a very long, narrow ridge on the mantle. The funnel organ is an inverted V with oval ventral pads.

The head is compact, as wide as the mantle, with prominent eyes. The eyelids are semicircular, round in front, truncate posteriorly, with a deep sinus in the anteroventral margin. There are transparent, unpigmented "windows" above and beneath the eyes. There are 11 nuchal folds on each side of the funnel of which the ventralmost 3 are the largest, the one just posterior to the eyes the largest of all.

The arms are long, in the order 2=4.3.1. I is keeled on its distal half, II is without an aboral keel but has a well-developed membrane along the ventral side, III is keeled along its entire length, the keel broadest on the distal half. IV has a sharp angle ventrally and a broad membrane on the dorsal edge. The suckers on all the arms are biserial and are bordered on each side by a trabeculate protective

membrane. The suckers are small, closely set, with round apertures slightly pointed distally, and the sucker rings are smooth.

The tentacles are short, stout, square in cross-section. The outer ventral corner is rounded, the others are sharply angled and the outer dorsal is keeled, the keel terminating distally just distal to the carpal cluster. The club is slightly expanded; there are no protective membranes, but a keel or web is found on the dorsal border originating near the base of the second club hook and extending to the tip. There is also a small thin web originating at the carpal cluster and extending outward and upward, terminating at the base of the fifth hook of the ventral row. The carpal cluster forms a distinct circular patch surrounded by a fleshy ridge. On the left tentacle, the cluster consists of 10 small suckers and 9 pads; on the right tentacle there are 10 suckers and 10 pads. On the club proper there are no suckers, their place being taken by 2 rows of hooks, 10 ventral and 10 dorsal on the left club and 11 dorsal and 10 ventral on the right club. The hooks of the dorsal row are all small and compact whereas on the ventral row, hooks 4-10 are enlarged, the middle ones long and slender. There is a small patch of about 13 minute suckers at the distal extremity of the club.

The color in alcohol is a uniform yellowish brown in which a few brown chromatophores may be seen, although there are a few on either side of the gladius.

The buccal membrane has seven supports and seven lappets.

There are two round *light organs* within the mantle cavity; one located on the ventral surface of the ink sac, the smaller one embedded just above the anus and slightly proximal to the opening.

Measurements and indices of an immature female *Onychoteuthis banksi* (Leach) are:

	♀		♀
ML	60.0	TLI	71.6
MWI	28.3	CLI	37.2
HWI	28.3	SIs	1.5
FLI	53.3	Hook length	3.1
FWI	76.6		
I	31.6		
II	46.7		
III	43.4		
IV	46.7		

TYPE.—British Museum (Natural History).

TYPE LOCALITY.—Not traced.

DISCUSSION.—Pfeffer (1912) has given a thorough treatment of this species and nothing can be added here. This is the most truly cosmopolitan of all of the squids; it dwells in the upper layers of the sea.

DISTRIBUTION.—Cosmopolitan in warm and temperate seas. It has been recorded from as far north as Hammerfest, Norway, and as far

south as Cape Horn. Sasaki represented it from Japan and Castro de Elera recorded it from Luzon and Cebu, Philippines. Celebes!

Family Histioteuthidae

Calliteuthis celetaria pacifica Voss, 1962

FIGURE 26

Calliteuthis celetaria pacifica Voss, 1962, p. 174.

HOLOTYPE.—1 ♀, ML 74.0 mm., Sta. D5564, Dammi Id. between Jolo and Tawi Tawi, 432 m., 52.3° F, Sept. 21, 1909; USNM 575453.

PARATYPES.—2 ♀♀, ML 52.0–33.0 mm., Sta. D5589, Mabul Id., Borneo, 494 m., 45.7° F, Sept. 29, 1901; USNM 575457. 1 ♀, ML

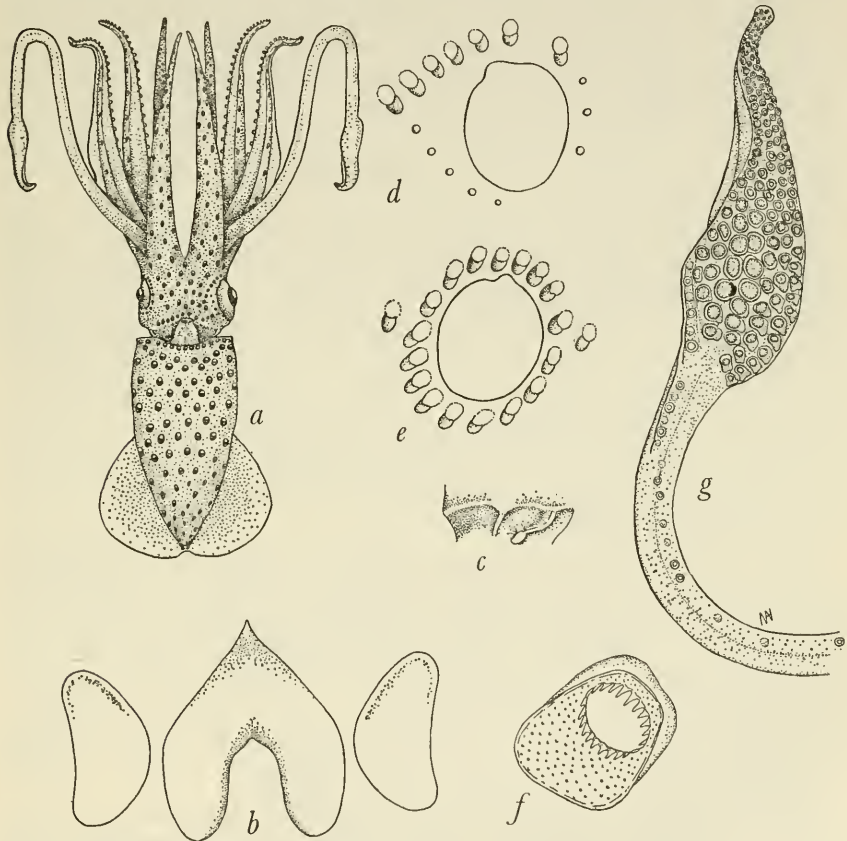


FIGURE 26.—*Calliteuthis celetaria pacifica* Voss: a, ventral view of holotype, mantle length 74.0 mm.; b, funnel organ; c, olfactory papilla and ridge; d, left eyelid with photophores; e, right eyelid with photophores; f, fourth sucker of ventral row of tentacular club; g, left tentacular club.

51.0 mm., Sta. D5118, Sombrero Id., 13°48'45" N., 120°41'51" E., 292 m., dark green mud, Jan. 21, 1908; USNM 575454. 1 ♀, ML 58.0 mm., Sta. D5221, San Andreas Id., between Marinduque and Luzon, 354 m., green sand, Apr. 24, 1908. 1 ♀, ML 28.0 mm., Sta. D5268, Matacot Point, Verde Island Passage, 310 m., sand and pebbles, June 8, 1908; USNM 575455.

DESCRIPTION.—The six specimens available to me from the *Albatross* collections are all remarkably constant in the observed characters; the description of one fits almost exactly all the remaining five. The specimens are very close to the newly described *Calliteuthis celetaria* Voss, 1960, from off Bermuda, but vary from that species consistently in certain minor characters so that it seems advisable to consider them as members of an Indo-Pacific subspecies of the Atlantic species.

The mantle is thick, soft, and more elongate than in most of the other species of the genus. In general the greatest width is about one-third of the distance from the anterior border, with the sides somewhat parallel. The width is about 40 percent of the mantle length. Dorsally the anterior margin is only slightly produced whereas it is slightly excavated beneath the funnel. In the posterior third of the mantle the sides are slightly concave but the posterior end is blunt.

The head is about as wide as the mantle width, sharply angled at the neck and with parallel sides. The head is about half as long as the mantle, measured from the base of arm I to the edge of the neck cartilage. The head is somewhat flattened above and rounded below; from the dorsal view it appears squarish. The eyes are distinctly different in size, the left eye about twice as large as the right eye, the pupil also posterior to the right pupil. Slightly ventral and posterior to each eye is a crescent-shaped olfactory crest terminating posteriorly in an olfactory bulb. Dorsal to the olfactory crest is a single nuchal fold.

The funnel is small but strong and without a groove. The locking apparatus is simple. The funnel cartilage is broad, the length less than twice the width, tapered anteriorly and deeply excavated. The mantle member is straight, crescent-shaped in side view, the ridge highest and broadest posteriorly and low and narrow anteriorly. The funnel organ is inverted V-shaped, smooth, pointed anteriorly, with oval ventral pads. There is a distinct and well-developed dorsal flap or valve just within the funnel opening.

The fins are large, their length 50 to 55 percent of the mantle length, their width about 70 percent. Individually, the fins are semicircular, the anterior border free. In total view, they are considerably wider than long, forming a transversely oval figure with a distinct notch in the median posterior border. They are dorsally inserted

on the mantle, the anterior borders separated but united posteriorly. On the average, the posterior median border slightly overreaches the end of the mantle. In the smaller specimens they overreach the mantle end by about a fourth of their length; in the largest ones the mantle end and the posterior border of the fins are of equal length.

The arms are long, somewhat subequal, II and III about equal in length, I and IV shortest. Arms I and II are rounded aborally, with a low keel on the distal third, III with a well-developed and deep swimming membrane originating a quarter of the length from the base and extending as a high membrane to about the midpoint of the arm where it becomes a low membrane and extends outward as almost unnoticeable to the tip. All the arms are equipped with dorsal and ventral protective membranes which however are very undeveloped and inconspicuous. The suckers are in two rows, round, laterally inserted on short delicate pedicels and with lateral openings. The apertures of the large suckers, extending over more than two-thirds of the length of the arms are completely smooth and round. Distally the small terminal suckers have five to eight small blunt teeth on the distal border.

The tentacles are long, slender, strongly compressed, and bear small, broadly expanded clubs which are attenuate on their distal half. The club is bordered on either side by a protective membrane originating at the carpus and extending distad to the tip. On the aboral surface of the attenuated half is a low swimming membrane, about half the length of the club. There is no cleft on the aboral surface of the club.

The carpal connectives originate about a club length below the carpus as a single sucker on the ventral side. Following this is a single row of alternating pairs or single pads and suckers which cross to the dorsal side and, with a break at the base of the club, extend as a straight row of alternating pads and suckers along the dorsobasal line of the club.

The suckers of the hand portion of the club are in six to seven longitudinal series distinctly larger than those of the attenuate half. The suckers of the four median rows are larger than the marginals but not so abruptly larger as in *C. reversa* Verrill. The large median suckers bear 28 to 32 sharp pointed teeth on the horny ring. These teeth are usually smaller and straight on the anterior half of the ring, heavier, longer, and curved inward on the posterior half. The suckers of the two ventral rows and a few of the proximal suckers of the median rows have the papillated collar surrounding the horny ring curiously broadened and elongated on the ventral side, forming a shelf or plate. In those of the ventral row the shelf may be broader than the actual aperture of the sucker.

The buccal membrane bears seven lappets and seven supports. The web between the arms is insignificantly developed and very low.

The photophores are numerous and large on the ventral surface of the mantle, head, and ventral arms. They are scattered over the ventral surface and sides with a close-set single row along the anteroventral margin of the mantle. The ventral mantle light organs are of nearly uniform size and are evenly spaced to the posterior tip of the mantle. Only posteriorly near the tip is there a noticeable decrease in size. Dorsally the anterior marginal row of photophores approaches the median line.

On the ventral surface of the head the light organs are in diagonal rows with a closely set row along the posterior margin of the head. Excluding the organs of the marginal row, there are three photophores in a line down the midventral row of the head. Around the right eyelid there is a close-set row of 17 large light organs. The left eyelid has a series of about seven large light organs around the anteroventral margin and about eight small light organs in two series partially enclosing the remaining portion.

On arms I, II and III, there appear to be two rows of photophores, those of the dorsal small, those of the ventral large. On IV there are three rows of photophores, only the middle one extending to the tip of the arm. The ventral one extends to the last fifth and the dorsal row on the membrane extends for about two-thirds of the length of the arm in large specimens with five to seven large light organs comprising the row.

Measurements and indices of six females of *Calliteuthis celetaria pacifica* Voss, 1962, are:

	♀	♀	♀	♀	♀	♀
ML	52.0	33.0	51.0	58.0	74.0	28.0
MWI	38.5	48.5	44.2	43.1	43.3	50.0
HLI	50.0	53.0	41.2	44.9	35.1	46.5
HWI	40.4	45.5	39.3	41.4	37.9	57.2
FLI	55.8	56.1	59.0	51.7	55.4	57.2
FWI	77.0	69.7	77.5	67.3	73.0	75.0
I	112.0	91.0	114.0	103.0	104.0	86.0
II	121.0	109.0	129.0	112.0	111.0	96.5
III	123.0	106.0	121.0	108.0	111.0	96.5
IV	102.0	100.0	106.0	84.5	105.0	82.0
TLI	188.0	----	212.0	176.0	223.0	171.0
CLI	38.0	----	16.6	29.3	29.7	26.8
Fin past end	2.0	3.0	1.0	3.0	.0	2.5

TYPE.—U.S. National Museum.

TYPE LOCALITY.—Sta. D5564, 432 m. off Dammi Island, between Jolo and Tawi Tawi, bottom temperature 52.3° F, Sept. 21, 1909.

DISCUSSION.—The six specimens in the collections show a remarkable uniformity in all characters examined. It is for this reason that I consider the slight differences between the Atlantic *C. celetaria* and

the Philippine specimens to be of subspecific value and not individual variation. The Atlantic *C. celetaria celetaria* and *C. celetaria pacifica* vary as follows:

C. celetaria celetaria

1. Swimming membrane of III originates near base of arm and is less than half the arm length.
2. Tentacular suckers toothed only on distal margin.
3. Seven large, four small light organs around left eye.

C. celetaria pacifica

1. Swimming membrane of III originates at a fourth the arm length and extends to tip of arm.
2. Tentacular suckers toothed on entire margin.
3. Seven large, eight or nine small light organs around left eye.

Besides these differences, the carpal arrangement of suckers and pads is slightly different. The Philippine specimens lack any pigmentation but the Atlantic subspecies is a rich wine red.

REMARKS.—The subspecific name *pacifica* is given to distinguish this group from its Atlantic counterpart. Inasmuch as the species of *Calliteuthis* are all widespread bathypelagic forms, *C. celetaria pacifica* will undoubtedly be found throughout the Pacific region. It resembles no other Indo-Pacific form.

Calliteuthis meleagroteuthis Chun, 1910

FIGURE 27, a-c

Meleagroteuthis Hoylei Pfeffer, 1900, p. 170 (nomen nudum); 1908, p. 292; 1912, p. 291.—Joubin, 1924, p. 63 [not Berry, 1912b, p. 305 (= *C. heteropsis* Berry, 1913)].

Calliteuthis meleagroteuthis Chun, 1910, p. 170.

?*Meleagroteuthis separata* Sasaki, 1915, p. 131; 1929, p. 262.—Akimushkin, 1957, p. 130.

MATERIAL.—1 ♀, ML 65.0 mm., Sta. D5444, June 3, 1909, off Atalaya Pt., Batag I., east coast of Luzon in 695 m., bottom temperature 45.3° F.

DESCRIPTION.—The mantle is roundly conical and fleshy, the wall thick. The width is slightly more than half the length and greatest just posterior to the anterior border. Dorsally the anterior margin is sharply produced, but ventrally it is truncate. Posteriorly the mantle ends in a blunt point. The midline of the mantle dorsally has a row of about 17 small tubercles occupying a raised ridge on the anterior two-thirds of the mantle.

The head is large, about half as long as the mantle and nearly or quite as wide. The eyes are very disproportionate; the left eye is about twice as large as the right eye and lies considerably posterior to it.

The funnel is small with a narrow opening and is equipped with two strong supports or bridles. There is no apparent funnel groove in the

head. The locking apparatus is simple, the funnel member consisting of an elongate oval groove, narrow anteriorly, the mantle member a short cartilaginous ridge crescentic in side view. The funnel organ is an inverted V-shape with curved ventral pads. The valve is small but well developed.

The fins are large, less than half the mantle length, separate anteriorly but united posteriorly. Each fin is a half circle; united they form a transverse oval outline with a notched posterior border. The end of the body does not reach to the posterior border of the fins.

The arms are subequal, III the largest, in the order 3.2.1.4. There is a low web connecting the first three pairs of arms. The arms are stout at their bases and taper gradually to a fine point distally. All the arms bear two rows of small globular suckers on delicate peduncles. The suckers of all the arms are bordered on either side by a low, weakly supported protective membrane. There is no swimming membrane on III as Sasaki (1929) reported for *Meleagroteuthis separata*. This web also occurs in *M. hoylei*; its absence in this specimen is probably due to the extensive damage of the skin on both arms. The suckers are arranged basally and distally on the arms in two distinct rows which are widely separated basally; in the midportion of arms I-III the suckers are missing, but the peduncles remain and here the suckers appear to have been in three to four rows. The apertures are laterally placed and the chitinous rings are nearly smooth on the proximal half but bear 8 to 11 low round teeth on the distal half of the margin. The suckers of the ventral arms are noticeably smaller than those of the others. On the aboral surface of the first three pairs of arms is a row of tubercles extending from the base of the arm outward for about half the arm's length. The rows of the dorsal pair originate proximal to the base. These rows are composed of cone-shaped tubercles topped by small round knobs. On I there are 26 tubercles, on II there are 21, and on III there are 12. These tubercles are similar to the row on the dorsum of the mantle described above.

The tentacles are long and slender, strongly flattened, with small, abruptly widened but distally attenuated clubs which are bordered on either side by narrow protective membranes. Proximally there is a series of about seven small connective suckers originating on the ventral surface of the stalk and passing across the oral surface to the dorsal side, ending about one-third up the hand. There are four small pads or buttons on the left tentacle. On the hand are six or seven rows of large suckers with short pedicels and large apertures. The chitinous ring bears 25 to 30 small but long, square-tipped teeth inside of a narrow bordering papillated area. Distally the suckers become smaller and more regular and in seven distinct rows. There

is a well-developed swimming membrane or keel on the aboral surface occupying the distal half of the club.

The buccal membrane has seven lappets and seven supports. The supports are fastened as follows: the dorsal one to the dorsal surface

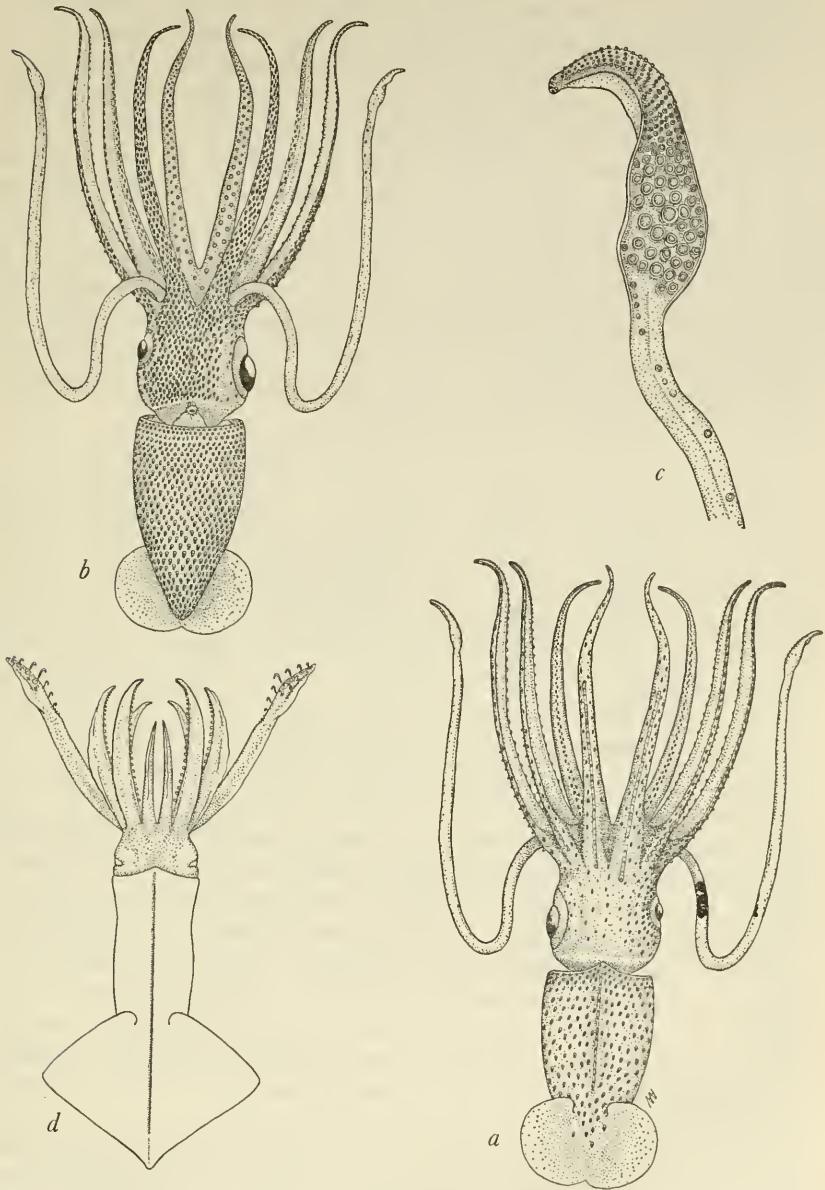


FIGURE 27.—*a-c*, *Calliteuthis meleagroteuthis* Chun: *a*, dorsal view, female, mantle length 65.0 mm.; *b*, ventral view of same; *c*, left tentacular club; *d*, *Onychoteuthis banksi* (Leach), dorsal view of female, mantle length 60.0 mm.

of arm I, the second to the ventral surface of arm I and the dorsal side of arm II, the third to the ventral side of arm III, and the fourth to the dorsal side of arm IV.

The photophores are very numerous on the ventral surface of the mantle, head, and ventral arms. They are spaced about a photophore length apart, but become slightly more scattered laterally and very sparse dorsally. On the arms the photophores have been mostly rubbed off so that their order cannot be ascertained. The three upper pairs in places have light organs. Pfeffer (1912, p. 295) stated that this species has one dorsal row and two ventral rows on I and II. Arms III have two dorsal and two ventral. Pfeffer stated that the ventral arms have eight rows, but this is true only of the proximal fourth of the arm, the rows rapidly decreasing until there are only about four rows on the distal fourth of the arm. At the base of the arms the exact number of rows is difficult to determine and may be eight or nine.

Measurements and indices of a female specimen of *Calliteuthis meleagroteuthis* Chun from Sta. D5444:

	♀		♀
ML	65.0	TL	200.0
MWI	55.4	TLI	112.8
HWI	47.7	CLI ¹	21.3
HLI	49.2	Diam. right eye	8.0
FLI	37.0	Diam. left eye	13.0
FWI	54.0	Length tubercle row,	41.0
I	143.0	midline	
II	152.0	I	63.0
III	163.0	II	58.0
IV	147.0	III	39.0

TYPE.—Hamburg Museum (no longer extant).

TYPE LOCALITY.—Fonseca Bay, west coast of Honduras, Central America.

DISCUSSION.—The specimen at hand is undoubtedly conspecific with *Meleagroteuthis hoylei* Pfeffer, 1900, from the west coast of Central America. I have compared it with specimens from the Atlantic in the *Dana* collections and find no differences. These latter specimens have been identified by Joubin. Pfeffer was incorrect in stating that there are 30 tubercles in the cartilaginous row on the mantle. Actually in both the present specimen and those from the Atlantic there are 17 to 20; hence, this character should be expanded for this species to read "17 to 30 tubercles in the median mantle row."

The problem of the nomenclature of the histioteuthids is formidable as has been stated by numerous authors (Chun, 1910; Pfeffer, 1912; Joubin, 1924; Dell, 1952; Voss, 1956). In 1900, Pfeffer split the genus *Calliteuthis* into three: *Calliteuthis*, *Stigmatoteuthis* and *Melea-*

groteuthis. These genera are well differentiated from *Histioteuthis* which has a six-lobed buccal membrane, complete interbrachial web, elongate light organs on the dorsal arms and other features. *Calliteuthis*, *Stigmatoteuthis*, and *Meleagroteuthis* share in common a seven-lobed buccal membrane, but show a great diversity in the arrangement of light organs and in the degree of webbing between the arms.

Calliteuthis and *Stigmatoteuthis* are definitely synonymous. The sole distinction of any value is the reported smooth tentacular sucker rings in *C. reversa*. Studies of large series of young and adult *Calliteuthis* clearly demonstrate that the tentacular suckers are finely toothed in the young, but that in the smooth-ringed species (presumably *C. meneghinii*, not *C. reversa*) from the Mediterranean these teeth eventually fuse into smooth rings with increasing age. I am indebted to Dr. Morales of the laboratory at Blanes, Spain, for a specimen of the Mediterranean form for direct comparison. This character is clearly only of specific rank as was proposed by Chun (1910).

The name *Meleagroteuthis* was proposed by Pfeffer in 1900 for what seemed to be a very well characterized genus. The eight or nine rows of light organs on the ventral arms, the cartilaginous tubercle rows on the six upper arms and the tubercle row on the mantle, and the very closely set light organs on the ventral surface of the mantle and head all seemed to be very good criteria. However, in 1913 Berry named a new species from California, *C. (M.) heteropsis* which had no tubercle rows on arms or mantle, and in 1918 he named another, *C. miranda* from Australia which had tubercle rows but had only four rows of light organs on the ventral arms and in which the light organs are only sparsely located on mantle and head. To make matters worse, Dell (1951) described a species, *cookiana*, which he placed in the genus *Histioteuthis* for lack of a better place, even though it had seven buccal membrane lobes instead of six. This species also had four rows of light organs on the bases of the ventral arms but had no cartilaginous tubercle rows on either arms or mantle. Inasmuch as Dell had both males and females, his description disposes of the point raised by Joubin (1924) that the presence or absence of tubercle rows may be sex linked.

These examples should suffice to show that, as Dell (1951) remarked, there is no consistency to the generic characters used in the histioteuthids and especially so, as far as I can see, in those used for *Meleagroteuthis*. There seems to be no recourse other than to place this genus in the direct synonymy of *Calliteuthis* which has priority by many years. It is even possible that future study may show that all should be united under the genus *Histioteuthis*, but this step does not

seem advisable at present. Whether *Meleagroteuthis* is considered a synonym of *Calliteuthis* or a subgenus, several changes must take place. The only one pertinent to this study, however, is the specific name *hoylei*, which was first used by Goodrich for his species *Histiopsis hoylei* Goodrich, 1896. Pfeffer (1900) has shown that this species is *Stigmatoteuthis hoylei* (now *Calliteuthis hoylei*). In the erection of the genus *Meleagroteuthis* he designated (by monotypy) the type of his new genus as *hoylei*. Chun, however, in 1910 had renamed this *Calliteuthis* (*Meleagroteuthis*) *meleagroteuthis* because of the submersion of both *Stigmatoteuthis* and *Meleagroteuthis* as subgenera. Chun's nomenclature must now stand, and unfortunately the well-known *Meleagroteuthis hoylei* is ground into oblivion by the slow but irresistible wheels of biological progress. As much as I deplore it, it now seems unavoidable that we call this species by the name *Calliteuthis meleagroteuthis*, and all the remaining species of the family Histioteuthidae now must be placed in the genus *Calliteuthis* Verrill, 1880, with the exception of *Histioteuthis bonelli*, still well characterized by several distinctive criteria.

The remaining problem is the identity of Sasaki's (1915) species, *Meleagroteuthis separata*. The only real difference between this species and the present specimen is in the shape and arrangement of the tentacular clubs. Until additional specimens are forthcoming with complete clubs, showing that this difference is real, I must consider this species as synonymous with *meleagroteuthis*, or at most as subspecific. The clubs in Sasaki's specimen I believe to be either deformed or mutilated with subsequent regeneration. A critical examination of plate 22, figure 7, in his work will bear out this diagnosis.

DISTRIBUTION.—Fonseca Bay, west coast of Central America (Pfeffer); Japan (as *separata*, Sasaki); eastern coast of Russia (as *separata*, Akimushkin); eastern Atlantic (Joubin); Philippines!

Family Ommastrephidae: Subfamily Todarodinae

Nototodarus sloani philippinensis Voss, 1962

FIGURE 28

Nototodarus sloani philippinensis Voss, 1962, p. 175.

HOLOTYPE.—1 ♀, ML 180.0 mm., Sta. D5444, off Atalaya Pt., Batag Id., east coast of Luzon, green mud in bottom, temp. 45.3° F, 565 m., June 3, 1909; USNM 575451.

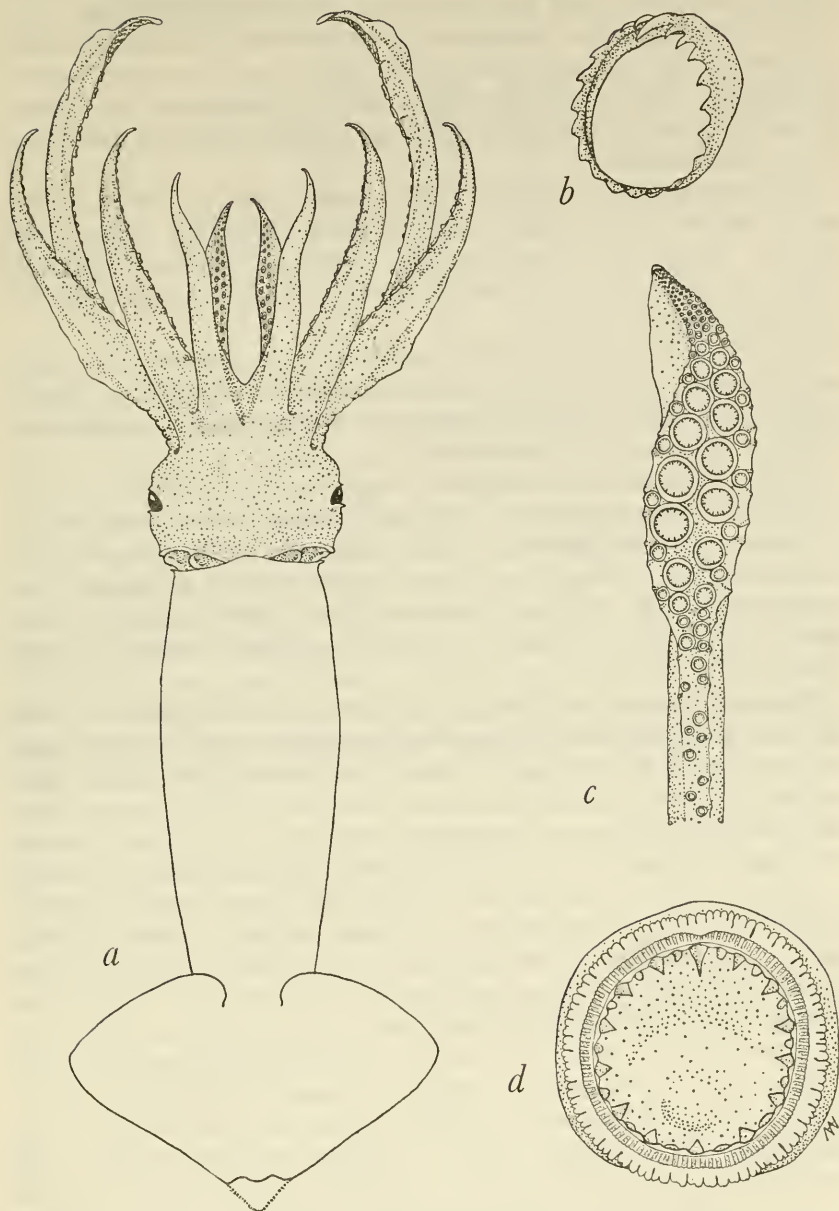


FIGURE 28.—*Nototodarus sloani philippinensis* Voss: a, dorsal view of holotype, mantle length 180.0 mm.; b, arm sucker from 6th row of right arm III; c, left tentacular club; d, largest sucker of tentacular club.

PARATYPE.—1 ♀, ML 101.0 mm., Sta. 5135, 11 miles off Jolo Light, Jolo Id., fine coral sand, 294 m., Feb. 7, 1908; USNM 575452.

DESCRIPTION.—Two females of an ommastrephid squid, considerably varying in size, were found in the collections, but no males were obtainable. The specimens have certain characters not shared *in toto* by other known species; they are placed with some hesitation in a new subspecies.

The mantle is heavy, thick, and muscular, with a sinuous margin, somewhat pointed dorsally and shallowly excavated beneath the funnel. The anterior two-thirds is cylindrical and nearly straight sided, but at about the level of the fins it tapers with concave sides to a narrow posterior point.

The fins are small, wider than long, convex on the anterior margin and concave on the posterior margin, the anterior lobes free. In the large female, the posterior part of the fin was cut away at some time, leaving a symmetrical indentation.

The funnel is stout and compact, deeply set into the funnel groove. The locking apparatus is an inverted T-shape, with a deep median pit and longitudinal groove. The mantle member is composed of a prominent longitudinal ridge which is club shaped posteriorly and narrow anteriorly, with the transverse ridge somewhat pointed posteriorly. The funnel organ is a sharply inverted V-shape with oval ventral pads.

The head is stout, as broad as the mantle, and deeply excavated ventrally for the funnel. The posterior margin of the head is clearly delimited by a sharp ridge. Dorsally, in the midline, this ridge is shallowly V-shaped with an angle of about 120°. There are three large olfactory crests, one dorsal, one lateral, and one ventral, of which the dorsalmost is the largest. The eyelid is large and bears a deep distinct sinus on the anteroventral border. The funnel groove is sharply defined by a distinct border. Anteriorly it has a small foveola, halfmoon-shaped, which bears a number of longitudinal folds. There are no side pockets. The nuchal cartilage is long and slender posteriorly but broadly expanded anteriorly. The double parallel ridges are surrounded by a narrow round border in the swollen anterior end.

The arms are of medium length, unequal, in the order 2.3.1.4. Arms II, III, and IV are keeled, III with a deep triangular swimming membrane. I is keeled only on the basal section, all the keels being on the outer ventral border rather than on the middle of the arms. The suckers are biserially arranged, the dentition varying in shape and number of teeth from base to tip.

Measurements and indices of two females of *Nototodarus sloani philippinensis* Voss, 1962, are:

	♀	♀
ML	101.0	180.0
MWI	18.8	25.0
HWI	19.8	28.3
HLI	18.8	23.9
FLI	32.7	35.5
FWI	44.5	55.0
I	27.7	33.3
II	34.7	33.9
III	34.7	41.2
IV	25.8	31.1
SI _t	2.18	3.3
SI _s	1.18	1.6
TLI	49.5	66.6
CLI	30.7	46.6

In the specimen of 180.0 mm. ML, two types of arm suckers, differentiated on the basis of their dentition, are present. The first type, characterized by a single large median tooth on the outer or distal margin which is long and sharp, often upturned, is found basally for the first seven or eight pairs of suckers. On either side of the giant median tooth are noticeably smaller teeth graduating downward in size but continuing proximally entirely around the sucker ring in those of pairs 4 to 8, the teeth amounting to about 20. The first few pairs have smooth rings basally. The basal portion of the ring of the first pairs is composed of broad shallow flat teeth; the teeth of the last five or six pairs become broadly triangular but low. Beyond the basal eight pairs the suckers are distinctly changed, the proximal border flattened, entirely smooth. The distal border has six or seven long slender teeth. The first few suckers have the median tooth much larger than the others, but within two or three pairs they become equal and continue so to the tip of the arms. In none of the series are there any intermediate smaller teeth.

In the smaller specimen there is not such a sharp distinction between the two series, but at about the 9th pair the proximal border becomes less rounded, the aperture somewhat semi-circular, and the distal teeth even and six or seven in number. There is no indication of an enlarged median sucker.

The tentacles are short and stout, the stalk somewhat triangular and keeled on its outer surface, and with an enlarged and broadened club. The club is surrounded by a broad protective membrane with supports. The sucker-bearing portion of the tentacle is about three-fourths of the total length, the carpal section indistinct. There are about 11 suckers differentiated by their dentition which may compose

the carpal cluster. Five of these are not in regular order; a proximal pair, followed by three others in an irregular row. Beyond these the next four are also irregular. The suckers of the hand portion are in four rows, the suckers of the median rows being three to four times the size of the small marginal ones. The suckers of the carpal area are typical distal arm suckers with a flattened smooth proximal border and about seven teeth distally of which the center one is larger than the others. Beyond the first 11 suckers all are toothed on their entire margins. The large suckers of the hand region have 14 to 18 large sharp teeth, the outer one the largest, alternating with broadly triangular or rounded teeth which are much smaller. Distally the smaller suckers have numerous sharp slender teeth separated by smaller ones in between.

The smaller specimen has about the same general plan except that there are 18 to 20 pointed teeth alternating with smaller rounded ones.

TYPE.—U.S. National Museum.

TYPE LOCALITY.—Off Atalaya Pt., Batag Id., east coast of Luzon.

DISCUSSION.—The present specimens may, if my interpretation is correct, partly explain the perplexing question of the variations in the ommastrephids of the Pacific.

In 1849, Gray described a new species of ommastrephid squid from New Zealand, *Ommastrephes sloanii*; Gould in 1852 described a species from the Fiji Islands which he called *O. insignis*. In 1888, McCoy named *O. gouldii* from Australia and in the same year Steenstrup described *Todarodes pacificus* from Japan. In 1898, Rochebrune and Mabile described a species from Cape Horn which they called *Martialia hyadesi*, and in 1912 Berry described *O. hawaiiensis* from the Hawaiian Islands.

Pfeffer (1912) treated the ommastrephids of the Pacific in some detail. On the basis of the double hectocotylization of the ventral arms in *insignis* from Akaroa, New Zealand, he established a new genus, *Nototodarus*, for this species. But as Dell (1952) has pointed out, only a single species, *N. sloani*, occurs in New Zealand; hence Pfeffer's (1912) type species is based on the characters of *N. sloani* and not on *N. insignis* which may or may not be conspecific. In the same work (1912), he reduced *O. gouldii* to the synonymy of *O. sloani*; *O. hawaiiensis* was as yet undescribed. *Martialia hyadesi* he placed in the genus *Ommastrephes*. Thus, according to Pfeffer there were in the Pacific the following species: *N. insignis* (= *O. sloani*), *O. sloani sloani*, *O.* (= *Todarodes*) *sloani pacificus*. In addition there are the true *insignis*, Berry's *hawaiiensis*, and *O. hyadesi* from off South America.

Berry (1918) in his report on the *Endeavour* cephalopods, gave a detailed analysis of *gouldi* (placed in *sloani sloani* by Pfeffer) and maintained it as a separate species, placing it in the genus *Nototodarus*, type *O. insignis* (actually *O. sloani*). He remarked that its closest relative was *N. insignis* of Pfeffer from New Zealand and *O. hawaiiensis*, which, known only from females, he considered also to be in the genus *Nototodarus*.

Dell (1952) has well characterized the species from New Zealand and has shown that only one species, *N. sloani sloani*, occurs in those waters. He distinguished it from the Australian forms which he called *N. sloani gouldi*. Sasaki (1929) gave a detailed account of *Ommastrephes sloani pacificus* (which Dell apparently was ignorant of) and showed that only a single ventral arm was hectocotylized. This removes it from *Nototodarus* and places it as an independent species in the genus *Todarodes*. The history of this name will be noted below.

The present specimen, especially the larger one, presents certain differences from all the others. It is most closely related to *N. sloani hawaiiensis* and appears to lie intermediate to it and *N. sloani gouldi*. It is quite different from *Todarodes pacificus* of Japan.

Both from the geographical standpoint and because of the remarked differences, *Martialia hyadesi* should remain distinct.

There appears to be a distinct cline within the species *N. sloani*, following a curve from New Zealand through Australia, the Philippines, and Hawaii. Along this curve are *sloani sloani* in New Zealand, *sloani gouldi* in Australia, *sloani philippinensis* in the Philippines and *sloani hawaiiensis* in the Central Pacific and Hawaii.

Todarodes pacificus Steenstrup poses a nomenclatural problem. Steenstrup (1880) originally placed this in the genus *Todarodes*, recognizing its affinity with *T. sagittatus* from Europe. Hoyle also used the genus *Todarodes* but in his later works reversed himself and used the genus *Ommastrephes*. Adam (1939c) discussed the whole problem of the use of *Ommastrephes* versus *Todarodes* for the species *sagittatus*, and there appears to be no question that *Ommastrephes* has priority over *Sthenoteuthis* Verrill and is properly applied to *O. bartrami* and *O. pteropus* and that *sagittatus* is the type species of *Todarodes*. As a result, at the present status of our knowledge, *pacificus* is united with *sagittatus* in the genus *Todarodes*. *T. pacificus* is generically distinct from *Nototodarus sloani* and its subspecies. The name *Ommastrephes sloani pacificus* is presently in wide use in Japan but is incorrect both biologically and nomenclaturally and its continued use is to be deplored.

DISTRIBUTION.—Luzon, Jolo Island, Philippines.

Subfamily Ommastrephinae

Symplectoteuthis oualaniensis (Lesson, 1830)

FIGURE 29

Loligo oualaniensis Lesson, 1830, p. 240.

Ommastrephes oualaniensis, d'Orbigny, 1835, p. 351.

Ommatostrephes oualaniensis, Steenstrup, 1880, p. 76.

Symplectoteuthis oualaniensis, Pfeffer, 1900, p. 180; 1912, p. 502.—Sasaki, 1929, p. 296.—Adam, 1954, p. 157.—Voss, 1954, p. 365.

Material.—50 juv., ML 14.0–71.0 mm., from Taal Anchorage, Balayan Bay, Luzon, evening with electric light; USNM 575399. 9 juv., ML 21.0–36.0 mm., Varadero Harbor, Mindoro, July 23, 1908. 0030–0145, with electric light at ship's side.

DESCRIPTION.—All the specimens available are very small juveniles with the single exception of the young specimen of 71.0 mm. ML. The following description is based upon this single individual.

The mantle is long, slender, and cylindrical, with parallel sides. The dorsal mantle margin is shallowly produced in the median line, but the margin is slightly excavated below the funnel. The mantle tapers rapidly at the level of the fins and ends in a sharp point.

The fins are small and terminal with straight margins and acute pointed lateral angles. The anterior lobes are free.

The funnel is small and compact, deeply set into the ventral side of the head. The groove is sharply set off from the head by a ridge; it bears in its anterior portions a halfmoon-shaped foveola with eight longitudinal ridges and with three pockets on each side. There is a very large terminal valve. The funnel organ is of the usual ommastrephid type. The locking apparatus is an inverted T-type but at the junction of the grooves the mantle and funnel are fused together so that they cannot be detached.

The head is small, compact, and sharply set off from the neck by a transverse ridge. There are three nuchal folds on each side of the head. The eyes are small and the eyelids form a rounded triangle, truncated behind and with a sharp narrow sinus in the anterior border.

The arms are short, in the order 3.2.4.1. They are squarish in cross-section with a sharp ridge in the lower angle of II and III and the upper angle of IV. III is strongly keeled. The arm suckers are biserial and are protected on either side by a deep trabeculate membrane. The arm suckers are round and the horny ring bears about 12 sharp teeth laterally and distally, of which the median is largest. In the 71.0 m. specimen, the horny ring is smooth basally. There is a narrow papillated band.

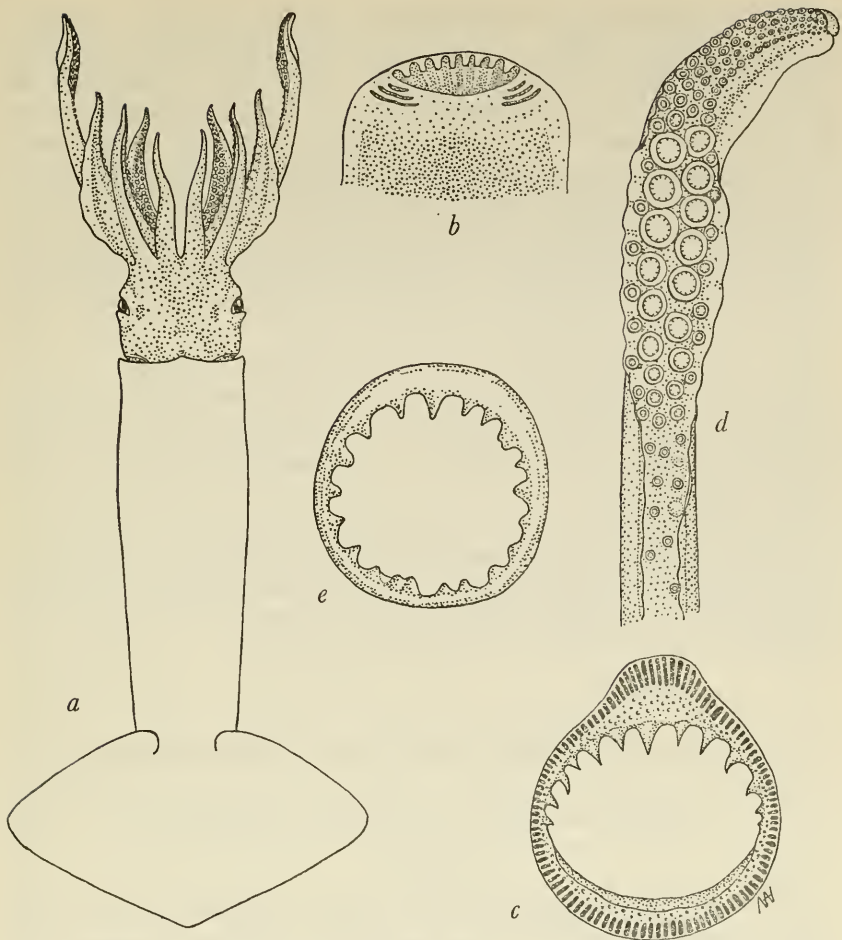


FIGURE 29.—*Symplectoteuthis oualaniensis* (Lesson): *a*, dorsal view of female, mantle length 71.0 mm.; *b*, funnel groove; *c*, arm sucker of 5th pair of right arm II; *d*, right tentacular club; *e*, largest sucker of tentacular club.

Measurements and indices of a young female *Symplectoteuthis oualaniensis* (Lesson) from Taal Anchorage are:

ML	71.0	TL	53.6
MWI	19.7	CL	16.9
HWI	19.7	SIs	1.4
FLI	31.7	SI _t	1.3
FWI	60.6		
I	22.5		
II	26.7		
III	26.7		
IV	24.0		

The tentacles are short, stout, laterally compressed, and bear short, slightly expanded clubs. The clubs are bordered by trabeculate membranes and there is an aboral keel. The suckers on the club are quadriserial throughout, uniformly small distally but with the sucker of the two inner rows 2 to 3 times as large as those of the outer rows. The arrangement of the carpal suckers is exactly as shown in the figure. The large hand suckers bear about 20 sharp teeth of which one in each quadrant, especially in the adults, is enlarged and very sharp.

The color in the specimens preserved in alcohol is yellowish brown with a broad band of reddish purple in the dorsal midline.

TYPE.—Museum d'Histoire Naturelle, Paris.

TYPE LOCALITY.—Oualan (=Kusaie, Caroline Islands).

DISCUSSION.—This small specimen differs somewhat from Sasaki's description, especially in relation to the dentition of the arm and tentacular suckers. These differences are undoubtedly due to the difference in size.

DISTRIBUTION.—This is an Indo-Pacific species distributed from the eastern Pacific, Cocos Island (Hoyle), to the Cape of Good Hope. In the Pacific it is recorded from Japan (Sasaki); Okinawa (Pfeffer, Sasaki); Formosa (Sasaki); Philippines; throughout the South Seas; and the west coast of South and Central America.

Family Chiroteuthidae: Subfamily Chiroteuthinae

Chiroteuthis (Chirothauma) imperator Chun, 1910

FIGURE 30,*a*

Chiroteuthis (Chirothauma) imperator Chun, 1910, p. 240.—Sasaki, 1929, p. 305

MATERIAL.—1 ♂, ML 164.0 mm., Sta. D5289, Matacot Pt., southern Luzon in 315 m., broken shell and sand, July 22, 1908; USNM 574901. 1 ♂, ML 160.0 mm., Sta. D5281, Malavatuan Id., southern Luzon 368 m., July 18, 1908; USNM 574900. 1 ♂, ML 144.0 mm., 1(?), ML 145.0 mm., Sta. D5280, off Malavatuan Id., southern Luzon 353 m., July 17, 1908; USNM 574899. 2 ♀♀, ML 73.0, 101.0 mm., Sta. D5269 off Matacot Point, southern Luzon 403 m., June 8, 1908; USNM 574898. 1 ♀, ML 83.0 mm., Sta. D5388, off Bagatao Id. between Burias and Luzon in 414 m., Mar. 11, 1909; USNM 574903. 1 ♀, ML 60.0 mm., Sta. D5276, off Matacot Point, southern Luzon 311 m., June 8, 1908; USNM 574897. 1 ♀, ML 75.0 mm., Sta. D5216, Anima Sola Id. between Burias and Luzon in 393 m., Apr. 22, 1908; USNM 574896.

DESCRIPTION.—The mantle is thick, choroidal, and soft. Anteriorly the margin is sharply produced in the dorsal section and emarginated

ventrally. For slightly less than half its length the mantle is cylindrical and nearly straight sided. Near the anterior margin of the fins the mantle becomes abruptly narrower and tubular and continues so, with straight sides, to some distance posterior to the fins. The gladius is not visible for most of its length.

The fins are thick and fleshy. In the larger specimens they are longer than wide, but in the smaller specimen available to me they are nearly round. They occupy more than 50 percent of the mantle length and are joined together dorsally. Along the sides of the narrow portion of the mantle extending beyond the fins are long thin bordering membranes.

The funnel is inconspicuous except at its extremity which is free. The funnel member of the mantle locking apparatus is oval, with a groove. Sasaki's description of the mantle member as shaped like a human nose is most descriptive. The funnel organ is composed of two oval ventral pads and a broad V-shaped dorsal member.

The head is long and narrow, less than one-third of the mantle length, with large but deeply set eyes. The eyelids are oval. The head is deeply convex ventrally, so that the depth of the head exceeds the width. There is no funnel excavation, and the neck is long and slender.

The arms are very unequal, with IV always the longest, in the order 4.3.2.1. IV is a little longer than the mantle length. All the arms are somewhat squarish in cross-section, concave on their oral surfaces, convex on the aboral, and slightly excavated on either side near the sucker rows. All the arms except IV have protective membranes with supports both dorsally and ventrally. III is also equipped with a low thick fleshy keel. The arms are bordered on the dorsal side by a low thick fleshy web which extends the entire length of the arms.

The suckers are biserial, subglobular, gradually becoming smaller distally, and are smaller throughout on the ventral arms. The apertures are small and are on the lateral aspect of the suckers which are raised on small slender peduncles. The horny ring is entire on the proximal half and toothed on the distal half, the teeth between being deeply cleft, squarish, and 9 to 16 in number.

The tentacles are about twice as long as the mantle, and have long slender stalks which are round in cross-section. The club is less than one-third the length of the tentacle; the stalk becomes much more slender and finally attenuate so that the club is very narrow. The club, however, is bordered for its entire length on either side by a broad protective membrane with numerous supports. The tentacular suckers are somewhat cone-shaped and supported on their broad base by long peduncles; the aperture of the sucker is on the proximal side of the cone. The suckers are arranged in four rows, gradually de-

creasing in size distally. In the outer rows the peduncles are long, broad at the base, but slender distally, with a bordering membrane on the outer side for about four-fifths the length of the peduncle, squarely truncated distally. Sasaki is in error (1929, p. 307) in stating that the peduncle is 2 to 3 times as thick as the diameter of the suckers, as can be seen by observing his figure (pl. 24, fig. 9). The inner rows of suckers are mounted on slender peduncles without membranes. The apertures are large, truncate proximally, and sharply oval distally. The proximal part is entire, the distal portion bearing about 10 teeth of which the median one is very large and talonlike. Distally the club ends in a fleshy spoon-shaped area devoid of suckers and with an oral papilla. Aborally there is a large oval light organ. The entire spoon-shaped area is dark purple except for the light organ. In addition there are about 26 round photophores on the aboral surface of the tentacular stalk (Sasaki said 38 to 45, but this is more than I have observed.)

The buccal membrane has seven lappets and seven connectives. The connectives are fastened to the dorsal surface of the first two pairs of arm and the ventral surface of the last two pairs.

Besides the photophores on the tentacular stalks and at the end of the club, the eyeballs also bear three series of light organs, each series arranged in a narrow strip of differentiated tissue. The outer strip contains 7 or 8 light organs, the second series along the periphery of the bulbous 9 or 10 and the inner series about 6. There is also a single row of photophores extending along the dorsal side of the oral surface and regularly alternating with the suckers of the distal row. In large specimens, according to Sasaki, these may number 55 to 60, but in the specimens available to me they number about 40.

Measurements and indices of nine specimens of *Chiroteuthis imperator* Chun from the Philippine Islands are:

	♂	♂	♂	♀	♀	♀	♀	♀	♀
ML	164.0	160.0	144.0	73.0	101.0	145.0	83.0	60.0	75.0
MWI	14.6	13.2	13.9	16.4	----	15.2	----	14.2	16.0
HLI	31.1	20.0	27.0	33.4	39.8	27.8	49.4	43.3	41.4
HWI	11.0	13.1	12.5	16.4	12.4	13.1	10.8	16.7	14.7
FLI (fin only)	47.0	43.7	43.6	48.0	47.5	47.0	44.0	48.3	45.3
FLI (plus tip)	68.2	59.4	61.8	58.9	58.5	61.3	57.8	63.3	65.3
FWI	43.9	43.8	43.0	50.6	42.5	47.0	48.8	48.2	49.3
I	55.5	54.3	52.8	56.2	60.5	57.2	51.7	41.7	42.7
II	66.5	64.3	68.8	69.9	75.0	70.3	74.6	55.0	60.0
III	69.0	63.7	74.3	82.1	65.0	76.5	80.6	58.4	66.7
IV	109.0	107.0	110.0	144.0	147.5	132.0	141.0	115.0	129.0
TLI	195.0	210.0	213.0	----	267.0	237.0	----	227.0	----
CLI	26.6	53.0	53.4	----	76.3	56.5	----	65.0	----

TYPE.—Zoologische Museum, Berlin.

TYPE LOCALITY.—Sumatra.

DISCUSSION.—*Chiroteuthis imperator* is closely related to *C. picteti*

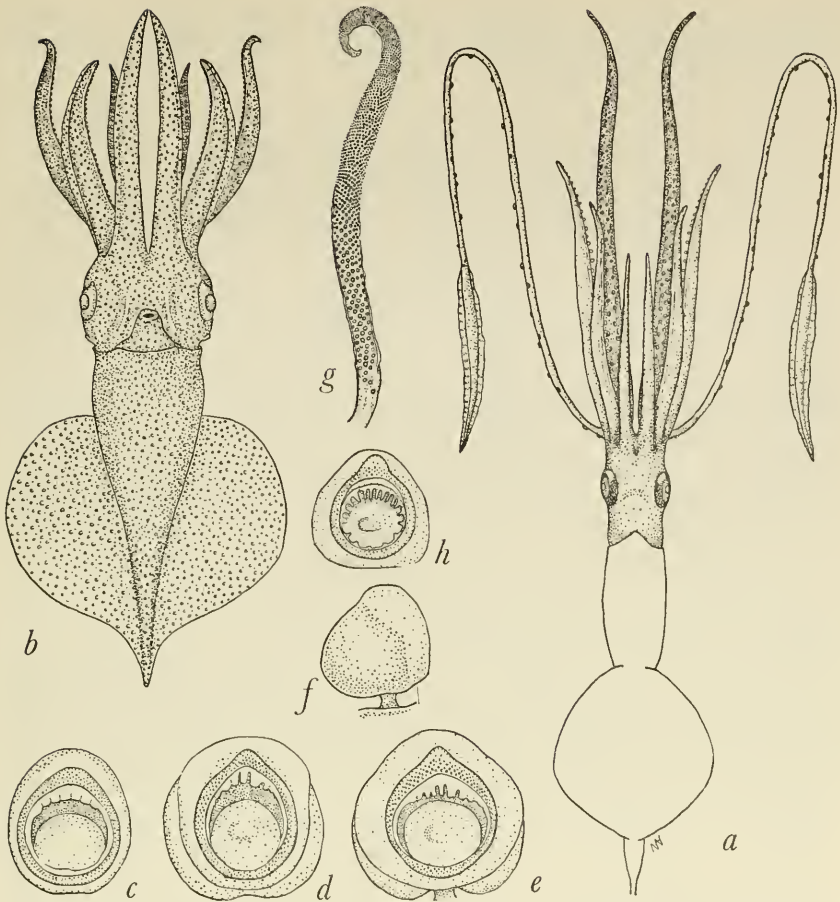


FIGURE 30.—*a*, *Chiroteuthis imperator* Chun, dorsal view, *b-h*, *Mastigoteuthis cordiformis* Chun: *b*, ventral view; *c*, arm sucker, 4th row, right arm III; *d*, arm sucker, 7th row, right arm III; *e*, arm sucker, 11th row, right arm III; *f*, side view of sucker from 11th row; *g*, left tentacular club; *h*, largest sucker of left tentacular club.

Joubin, 1894, and *C. macrosoma* Goodrich, 1896. In 1924, Joubin (p. 86) discussed rather vehemently the relationships of these species in an attempt to establish the priority of his species. A close examination of the illustrations by all three authors and a study of the original descriptions lends much credence to his statements. I, also, believe that there is a strong possibility that *imperator* and *macrosoma* are synonyms of *picteti*, but because I have had no opportunity to examine any of the types, a definite statement cannot be made at this time. If the three species are synonymous, the distribution given below would be amended to include records from the Atlantic Ocean.

DISTRIBUTION.—At present this species is known from Japan

(Sasaki, Nishikawa, *Albatross*), Sumatra (Chun), Bay of Bengal, Gulf of Oman, and the Arabian Sea (Massy). It is now first recorded from the Philippine Islands!

Subfamily Mastigoteuthinae

Mastigoteuthis cordiformis Chun, 1908

FIGURE 30, b-h

Mastigoteuthis cordiformis Chun 1908, p. 88; 1910, p. 222.—Pfeffer, 1912, p. 613.—Sasaki, 1920, p. 200; 1929, p. 310.—Adam, 1954, p. 159.

MATERIAL.—1 ♀, ML 92.0 mm., Sta. D5114 off Sombrero Id., Balayan Bay, Luzon, in 623 m., Jan. 20, 1908; USNM 574891. 1 ♀, ML 72.0 mm., Sta. D5378 off Mompog Id., in 720 m., Mar. 4, 1909; USNM 574895. 1 ♂, ML 60.0 mm., indet. sex, ML 36.0 mm., from Sta. D5283, off Malavatuan Id. off southern Luzon, 513 m., July 18, 1908; USNM 574892. 1 (?), ML 41.0 mm., Sta. D5296, Matacot Point, southern Luzon, in 384 m., July 23, 1908; USNM 574894. 1 ♀, ML 48 mm., Sta. D5122 off Malabrigo Light, east coast of Mindoro, in 404 m., Feb. 2, 1908; USNM 574893.

DESCRIPTION.—The mantle is soft and flabby as is characteristic of most deepwater cephalopods. The mantle is broad near the anterior end, convex anteriorly, but tapers quickly with concave sides to a narrow slender extremity. The dorsal margin is slightly produced in the midline but excavated beneath the funnel. In most of the specimens the skin is closely set, especially in the mouth, head, and bases of the arms, with small round tubercles as shown in the figure.

The fins are large, 70 to 80 percent of the mantle in length and 65 to 85 percent in width. They are slightly transversely oval in the midportion, with convex anterior and posterior borders, but near the posterior end the fins narrow and become drawn out in a sharp point.

The funnel is large, free for about half of its length, and bears a small subterminal valve. The dorsal member of the funnel organ is inverted V-shaped, with rounded arms and a prominent papilla anteriorly. The ventral members are stout, oval, with semitruncate anterior ends. The locking organ is ear-shaped and oval on the funnel, with a prominent ventral flap. The mantle member is a deep raised ridge resembling, as Sasaki stated, a human nose.

The head is large, its width 25 to 35 percent of the mantle length and slightly greater than the mantle width. In general appearance it is round, slightly flattened dorso-ventrally, and sharply demarcated by a narrow neck region. A small but distinct stalked olfactory papilla is located below and posterior to each eye. The eyes are relatively

enormous. The eyelids are triangular with rounded corners, truncate posteriorly, and tapered anteriorly with a distinct small sinus in the anterior border.

The arms are long, especially so in the larger specimens in the order 4.2.3.1, IV attaining as much as 90 percent of the mantle length. The arms are squarish in cross-section, rounded aborally, and flattened both orally and laterally. Arm III is keeled along most of its length. The suckers are biserial and bordered on either side by a narrow trabeculate protective membrane; they are small, round, and laterally inserted, rather crowded. On III and IV, the basal five or six suckers are in a single row, the others biserial. Near the base of the arms, the sucker rings are nearly smooth, with about seven low square teeth. At the 7th row there is a single slender median tooth and several blunt laterals; at the 11th row there are eight or nine teeth of which several are slender and square cut. These may be compared with Sasaki's illustrations of suckers from the same positions. All the suckers are bordered by a narrow papillated ring which becomes pointed on the distal margin.

The tentacles are long and slender, round in cross-sections and narrower than the arms. The club is little expanded and is 38.3 percent of the mantle length and about half the length of the tentacle. The tentacular suckers are very small and numerous and appear to form about 20 rows across the midpart of the club. The suckers are slightly oval, somewhat pointed distally and have the horny ring armed with teeth all around the circumference. The teeth are slender and square tipped, short proximally, but long and slender distally. The ring is surrounded by a band which bears large papillae in several rows.

The color, in alcohol, is yellowish, but the body is liberally covered with small reddish-brown chromatophores.

The gladius was not examined.

Measurements and indices of six specimens of *Mastigoteuthis cordiformis* Chun, 1908, are:

	♀	♀	♂	♀	♀	♀
ML	92.0	72.0	60.0	36.0	41.0	43.0
MWI	27.4	25.0	26.7	----	36.5	25.0
HWI	31.5	25.7	33.3	----	29.3	35.4
FLI	77.2	80.5	78.3	80.5	68.3	73.0
FWI	84.7	73.6	66.6	66.7	68.3	73.0
I	65.3	50.0	41.7	----	36.5	29.1
II	77.2	58.3	45.0	----	61.0	50.0
III	68.5	51.3	48.3	----	51.3	35.4
IV	90.2	73.6	70.0	----	78.0	60.4
TL	----	----	96.7	----	----	----
OLI	----	----	38.3	----	----	----
SIs	1.4	1.2	1.0	----	1.2	1.2
Stt	----	----	0.2	----	----	----

TYPE.—Zoologisches Museum, Berlin.

TYPE LOCALITY.—South of Pulo Nias, Sumatra.

DISCUSSION.—As far as shown by records available to me, only nine specimens of this species are known, of which six are in the *Albatross* collections from the Philippines and one, reported by Sasaki from Japan, was also taken by the *Albatross* on her Japanese cruise. The Japanese specimen came from 360 m. depth and the deepest from 720 m. off Mompog Island, Philippines. It would thus appear that this is a typical mesopelagic species.

There are few differences between the present specimens and those described by Chun (1910), Sasaki (1929), and Adam (1954), and the differences are minor.

DISTRIBUTION.—South of Pulo Nias, Sumatra (Chun); Java Sea (Adam); Suruga Bay, Japan (Sasaki); Philippines!

Family Cranchiidae: Subfamily Cranchiinae

Cranchia scabra Leach, 1817

FIGURE 31

Cranchia scabra Leach, 1817, p. 140.

MATERIAL.—1 ♀, ML 82.0 mm., Sta. D5283, Malavatuan Id., southern Luzon, 513 m., July 18, 1908; USNM 574888.

DESCRIPTION.—The mantle is barrel-shaped, about half as wide as long, broadly indented on the dorsal margin and on either side of the funnel at the points of attachment with the head. The posterior end is bluntly pointed. The entire mantle surface is closely set with large cartilaginous tubercles which often are square or triangular on their upper surface, each corner armed with a triangular point. The gladius is visible in the dorsal midline and bears a row of tubercles along most of its length, the broadened lanceolate area densely covered. Ventrally there are two short inverted V-shaped hyaline streaks, one on either side of the funnel, the streaks bearing a row of tubercles.

The fins are small and round, separate anteriorly but united posteriorly, their general shape a transverse oval but indented on the posterior margin. The fins project past the end of the mantle for about a third of their length. They are closely covered by tubercles similar to those on the mantle, only their borders being clear in a narrow band.

The head in the present specimen has been badly damaged and both eyes are missing. However, the head in a complete specimen is small, compact, often withdrawn inside the mantle, and bears promi-

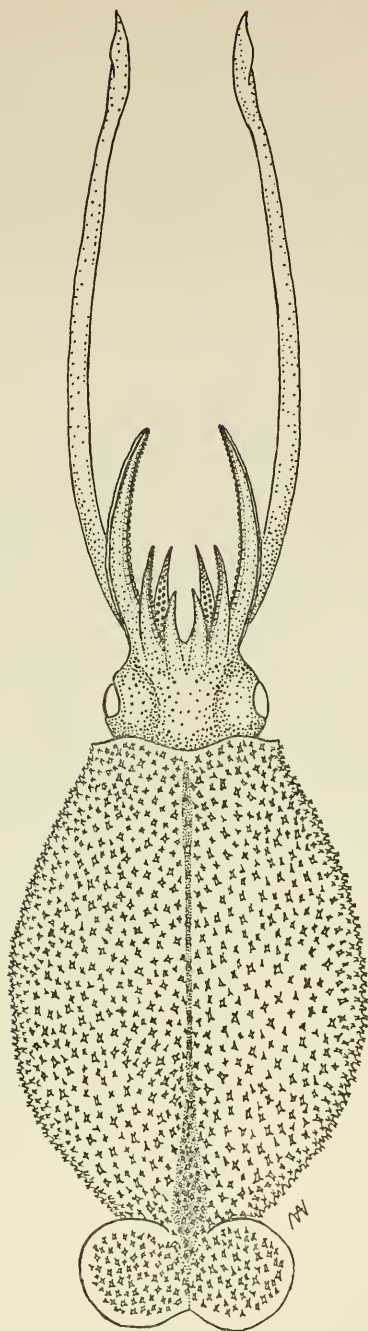


FIGURE 31.—*Cranchia scabra* Leach, dorsal view of female, mantle length 82.0 mm.

ment eyes. The dorsal surface of the head also bears scattered tubercles which are denser on the ventral surface. The eyes normally bear 13 or 14 round photophores on the ventral surface of the bulbous and around the iris, somewhat in the arrangement found in *Liocranchia reinhardti*.

The funnel is large and well developed and reaches to the level of the midpoint of the eyes. The funnel organ is indistinguishable in the present specimens, but according to Sasaki (1929) the dorsal member is inverted V-shaped, with one large central lamella and one on the middle section of each branch. The ventral pads are figured as short, half-moon members.

The arms are short, in the order 3.4=2.1, I very short. All the arms possess dorsal and ventral protective membranes. The suckers are globular, in two rows, with small smooth apertures.

The tentacles are short, rounded in cross-section, stout at the base, and tapering distally to the small, slightly expanded club. The tentacle stalk bears small smooth-ringed suckers, somewhat widely spaced and alternating on the distal half of the stalk. The club has two protective membranes, one on each side, originating at the carpus and extending to the tip. On the outer surface of the club a strong swimming membrane originates at the middle of the club and extends to the tip, expanded on the dorsal side. The tentacular suckers, arranged in four rows, are small in the carpal region, large in the mid-part of the hand, abruptly changing to small suckers in the distal portion of the club, and terminating in a distinct group of four large suckers on a circular pad. The hand suckers are round, those of the median rows are about equal in size to those of the marginal rows and bear about 20 sharp separated teeth on the circumference of the horny ring.

The buccal membrane has seven supports and seven lappets.

Measurements and indices of a female of *Cranchia scabra* Leach from off southern Luzon are:

ML	82.0	I	13.4
MWI	52.4	II	21.9
HWI	----	III	41.5
FLI	19.5	IV	21.9
FWI	33.0	TLI	102.0
		CLI	17.1

TYPE.—British Museum (Natural History).

TYPE LOCALITY.—Off the Congo, Africa.

DISCUSSION.—Despite the many hauls made by the *Albatross*, this is the only specimen obtained by the expedition. This species is among the commonest of all cranchiid squids.

DISTRIBUTION.—Cosmopolitan in all warm and temperate seas, apparently living mainly in the upper layers of the sea.

Liocranchia reinhardti (Steenstrup, 1856)

FIGURE 32

- Leachia reinhardti* Steenstrup, 1856, p. 200.
Loligopsis (Perotis) reinhardti, Tryon, 1879, p. 165.
Cranchia reinhardti, Brock, 1882, p. 605.
Perotheris reinhardti, Rochebrune, 1884, p. 25.
Liocranchia brockii Pfeffer, 1884, p. 25.
Liocranchia cf. *reinhardti*, Pfeffer, 1884, p. 29.
Liocranchia reinhardti, Pfeffer, 1900, p. 194.

MATERIAL.—1 ♂, ML 130.0 mm., Sta. D5563, off Dammai Id. between Jolo and Tawi Tawi in 410 m., Sept. 21, 1909; USNM 574883. 1 ♂, ML 102.0 mm., Sta. D5282, off Malavatuan Id. southern Luzon, in 455 m., July 18, 1908; USNM 574876. 2 ♂♂, ML 146.0 and 157.0 mm., Sta. D5177, off Escarceo Light, Verde Island Passage in 472 m., Mar. 24, 1908; USNM 574874. 2 ♂♂, ML 84.0 and 100.0 mm., Sta. D5216, off Anima Sola Id. between Burius and Luzon in 394 m., Apr. 22, 1908; USNM 574875. 1 ♂, approx. 98.0 mm. ML, Sta. D5289, off Matocot Point, southern Luzon, in 315 m., July 22, 1908; USNM 574877. 2 ♀♀, ML 77.0 and 107.0 mm.; 8 ♂♂, ML 83.0–112.0 mm., Sta. D5122, off Malabrigo Light, eastern Mindoro, in 518 m., Feb. 2, 1908; USNM 574873. 2 ♂♂, ML 83.0 and 79.0 mm., Sta. D5564, off Dammi Id. between Jolo and Tawi Tawi, in 433 m., Sept. 21, 1909; USNM 574884. 2 ♂♂, ML 77.0 and 105.0 mm., Sta. D5567, off Dammi Id. between Jolo and Tawi Tawi, in 491 m., Sept. 21, 1909; USNM 574886. 5 ♂♂, ML 62.0, 68.0, 69.0, 69.0, and 96.0 mm., Sta. D5374 off Tayabas Light, Marinduque Id., 348 m., Mar. 2, 1909; USNM 574878. 3 ♀♀, ML 63.0–69.0 mm., 5 ♂♂, ML 98.0–119.0 mm., Sta. D5365, off Cape Santiago Light, Balayan Bay, Luzon, in 392 m.; USNM 574872.

DESCRIPTION.—The Philippine specimens are the largest of this species yet to be recorded in the literature. If the specimen of 77.0 mm. mantle length recorded by Sasaki is the largest in the records, then the 157.0 mm. specimen from the *Albatross* is surely a giant amongst otherwise small specimens. In such large specimens, certain of the characters differ from those previously given and these will be found in the following account.

The mantle is long and somewhat slender, especially in the larger specimens (MWI 19.0–29.0), the greatest width commonly occurring about a third from the anterior mantle border. The anterior border is broadly indented dorsally at the point of attachment with the neck and again on both sides of the funnel at the ventral attachments. The posterior end of the body is slender and pointed, terminating in the posterior two-thirds of the fins. Dorsally, the gladius is visible through the integument, slightly broadened anteriorly, then narrowing

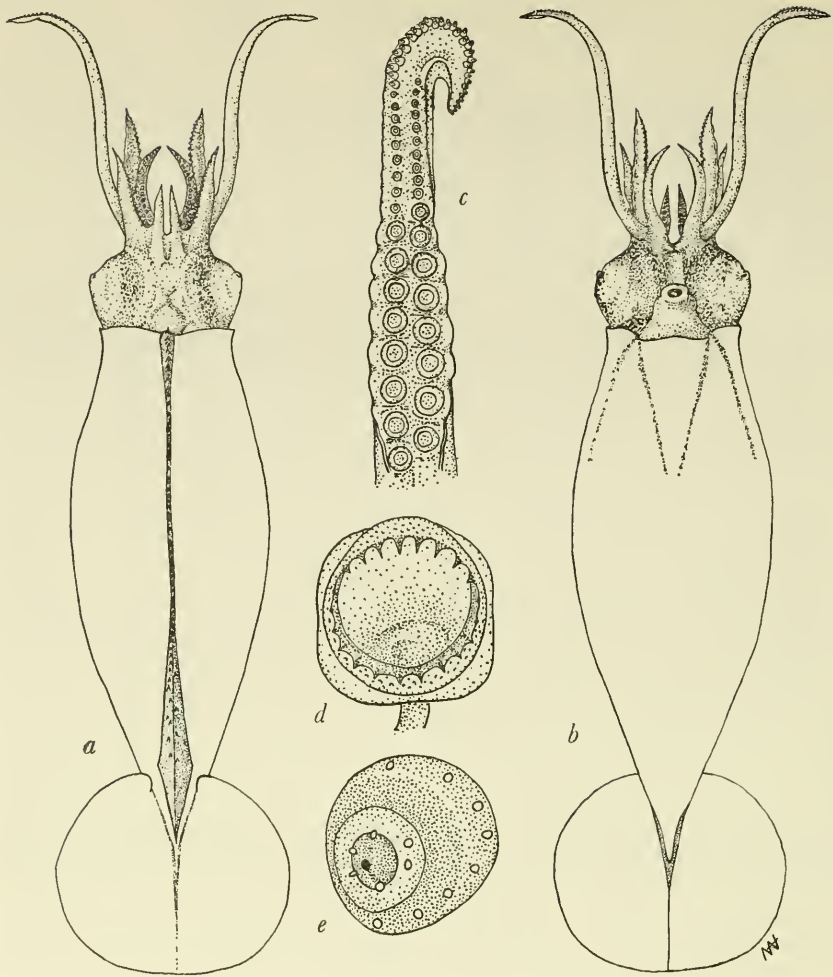


FIGURE 32.—*Liocranchia reinhardii* (Steenstrup): *a*, dorsal view; *b*, ventral view; *c*, right ventral arm of male, mantle length 157.0 mm.; *d*, large tentacular sucker of 7th transverse row of male, mantle length 157.0 mm.; *e*, ventral view of right eye.

for about half of the mantle length. Posteriorly the gladius is narrowly lanceolate. Along the midline of the gladius is a row of small tubercles, originating at the anterior end and terminating just anterior to the fins. Ventrally, on either side of the funnel originating at the point of attachment is an inverted V-shaped hyaline streak. The inner branch of the hyaline streak is slightly longer than the outer and constitutes 18.0 to 26.0 percent of the mantle length. Both branches bear a row of scattered tubercles, single on all but the anterior portion of the inner branch, where they are irregularly biserial.

Measurements and indices of 10 male and 3 female specimens of *Liocranchia reinhardtii* (Steenstrup) are:

	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♀	♀	♀
	79.0	83.0	84.0	100	102	112	130	146	157	83	77	77	105
ML	----	----	----	23.0	24.7	22.3	22.3	21.9	19.1	28.9	19.5	----	822.8
MWI	20.3	----	19.1	21.0	18.6	19.6	17.7	18.5	19.7	18.1	19.5	18.2	20.0
FLI	26.6	28.3	28.8	29.0	32.6	28.6	28.5	30.8	31.7	28.9	24.7	26.0	26.7
FWI	30.4	33.1	33.4	34.0	36.6	32.1	33.0	40.0	33.7	30.1	31.1	29.8	30.3
LO	15	14	----	----	----	14	14	14	14	14	----	----	14
TbLI	25.3	18.7	22.6	21.0	25.7	20.9	20.7	19.8	19.1	20.5	19.5	26.0	19.0
I	5.5	6.0	7.1	7.5	6.3	7.6	7.3	10.6	10.2	6.6	5.2	7.8	7.6
II	11.4	12.0	11.9	10.0	15.2	13.4	14.2	15.8	16.5	10.2	10.4	8.4	12.4
III	16.5	18.1	17.9	11.0	20.3	19.6	20.0	22.6	22.9	16.3	15.6	16.9	17.1
IV	12.7	10.8	9.5	15.0	16.7	17.0	14.6	17.8	17.2	12.0	11.7	13.0	14.3
TLI	43.0	52.4	46.4	39.0	43.6	52.6	43.4	44.5	35.6	47.0	43.0	66.3	34.3
CLI	20.6	19.5	29.2	19.2	24.9	15.2	18.6	17.6	24.1	20.5	19.7	14.7	25.0

The head is broad and compact with large and prominent eyes. The eyelids are very small, round, and puckered, with a small anterior sinus.

The fins are large and terminal, their outline describing a transverse oval, their combined width 30.0 to 40.0 percent of the mantle length, the FLI 25.0 to 33.0. Posteriorly there is a slight indentation in the midline.

The funnel is large, free only in the anterior third of its length, and reaches to the anterior margin of the eyeballs. The funnel organ is composed of a triangular dorsal pad, with a central and two lateral lamellae as figured by Sasaki (1929, pl. 26, fig. 2) and with two ventral pads which are lunate but have the posterior horns widened on the dorsal edge.

The arms are short (MAI 15.0-23.0), unequal, in the order 3.4.2.1, the first arms much the shortest and united for over half of their length by a web which also connects the next two pairs. A small inconspicuous protective membrane borders the suckers of all the arms. In addition, the third arms are somewhat compressed, keeled, and equipped with a low swimming membrane. The fourth arms also have a low swimming membrane on their outer border. The arm suckers are biserial throughout in the female and fairly large, the suckers covering nearly the entire length of the arm. In the male the distal fourth of the third arms bears abruptly much smaller suckers arranged in four to eight rows. As a result, the tip of the third arm in the males tends to curl over. In the larger specimens available to me the arm sucker rings appear to be entire with occasional slight indentations. In the largest specimens, there is no trace of the surrounding papillated area described and figured by Sasaki.

In the males the right or left ventral arms are hectocotylized. Previous authors have all stated that the left ventral arm alone is strongly modified; Chun gives this modification as one of the key

characters of the genus. In about half of the specimens available to me from the Philippines the right ventral arm is hectocotylized, in the remainder the left ventral arm. Neither Lönnberg's nor Sasaki's description of the modification fits the present specimens. In the largest specimen, of 157.0 mm. mantle length, both ventral arms are of equal length. On the right arm the suckers are in two rows proximally and of normal size for the first eight pairs. Distal to these at about the midpoint of the arm the suckers abruptly decrease in size and are only about a third the size of the larger ones. Distal of this point the small suckers are arranged in two rows, which are slightly diverging, to the distal quarter of the arm where the outer row turns outward to the margin of the arm and terminate. Immediately opposite the end of the outer row the suckers of the inner row become roundly triangular, fat, and fleshy, and the small aperture is located in the ventral or marginal part of the sucker. From there to the point of the arm, the suckers are crowded upon each other, giving at times the appearance of two crowded rows along the ventral border of the arm. Contrary to Sasaki's description, the protective membranes persist on the distal portion, at least ventrally, and the swimming membrane on the dorsal side is well developed and in the preserved specimens pulls the tip upward so that it curls along the distal quarter of the arm. In those specimens in which the left ventral arm is hectocotylized the appearance and structure is an identical mirror image. Its fellow is always normal in all respects that could be seen.

The tentacles are short (TLI 34.0-66.0) and rounded in cross-section, flattened in the oral aspect, with a small median groove. The clubs are only slightly expanded and constitute 14.0 to 25.0 percent of the tentacles. In the largest specimen the tentacular stalk bears 13 pairs of small suckers alternating with about the same number of small round pads or buttons. There are four rows of suckers on the clubs, those of the hand part about 4 times the diameter of the smaller distal suckers. On both borders of the club are protective membranes which originate at the carpus and extent to the tip. On the aboral surface of the club a swimming membrane originates at the midpoint and extends to the tip as a low raised ridge.

There are no photophores on the body or in the mantle cavity, but 14 small round light organs are arranged in a regular pattern on the eyeball. Around the iris proper are six light organs, two small ones above the iris, one on either side, and two larger ones below it. On the inner surface of the periphery of the eyeball are eight larger photophores, the row beginning and ending near the iris but lying on on the inner surface of the eyeball in the ventral portion.

The color in alcohol is brownish yellow but probably the specimens were transparent when alive, with only large scattered chromatophores on the mantle, head, and funnel.

TYPE.—Zoological Museum, Copenhagen.

TYPE LOCALITY.—Azores.

DISCUSSION.—Certain discrepancies occur between these specimens and the published accounts of this species. Most important of these is the nature of the hectocotylus. Undoubtedly the differences in this organ are due to growth; however, Lönnberg stated that there are two rows of minute suckers to the end of the arm. Sasaki's description is also at variance, even though his largest specimen should have shown all the structures found on the present specimens of a similar size. Perhaps there is in this species a certain amount of variation in the structure. Certainly it is noteworthy that either the left or right ventral arms may be hectocotylized, and that this character is at variance with all the published descriptions. It may be noted further that the terminal minute suckers have well-developed apertures with smooth rings and are not mere pads or peduncles minus the suckers, as Pfeffer suggested.

The number of photophores on the eyeball also seems to vary, probably with age. Both Chun and Pfeffer stated that there are four light organs on the eyeball in this species. Naef suggested four but his illustration indicates two rows and more than that number of organs. Sasaki stated that there are 15 photophores arranged irregularly around the eye. In the specimens from the *Albatross* all but one have 14 organs around the eyeball, 6 around the iris, and 8 on the periphery of the bulbous. Only in poorly preserved specimens is there any irregularity of arrangement. Apparently these light organs are fewer in number in smaller specimens, although an examination of small specimens from the Florida Current and from the *Dana* collections shows 14 light organs on all specimens.

In the armature of the tentacular suckers there are also dissimilarities. Sasaki illustrated the sucker ring of one of the large hand suckers, which shows strong curved round teeth and a narrowed aperture. In the present specimens the hand suckers have small, sharply pointed triangular teeth, slightly larger on the distal borders, all of about the same size, about 22 in number, and not at all corresponding to those on the hand suckers of Sasaki's figure.

REMARKS.—The present specimens all came from two general areas rather widely separated. Those from Dammal are from the inner or Sulu Sea side of the Sulu Archipelago in from 224 to 268 fathoms while those of the other group are from the area of the Verde Island Passage along the southern coast of Luzon from the South China

Sea almost to the Pacific. The latter group came from depths of from 172 to 283 fathoms. The structure and shape of the larger specimens suggests that they belong in life to the bathypelagic fauna and are excellent swimmers as adults, probably leaving the more passive planktonic stage at 50 to 60 mm. in mantle length. Although a number of adults were at hand, no spermatophores were observed.

DISTRIBUTION.—Cosmopolitan in tropical and temperate seas.

Subfamily Taoniinae

Taonius pavo (LeSueur, 1821)

FIGURE 33

Loligo pavo LeSueur, 1821, p. 96.

Taonius pavo, Steenstrup, 1861, p. 83.

MATERIAL.—1 ♀, ML 119.0 mm., Sta. D5511, Camp Overton Light, Iligan Bay, northern Mindoro 750 m., Aug. 7, 1909; USNM 574887.

DESCRIPTION.—This species is represented in the collection by a single mutilated specimen from which the head is detached. However, it was possible to obtain nearly complete measurements and an adequate description.

The mantle is long and slender, widest slightly behind the anterior margin. The mantle is slightly produced in the middorsal region and emarginated below, between the points of permanent attachment on either side of the funnel. Posteriorly the mantle is greatly elongate and tapering, ending in an attenuate point. The gladius rib shows through the mantle prominently.

The fins are slender, occupying nearly 50 percent of the mantle length. They have free anterior margins or lobes and gradually expand to a moderate width, widest about a third of their length and thence tapering with concave posterior borders to the attenuate tip.

The funnel is prominent, permanently attached to the mantle on either side, the fusion marked by a small slender oval hyaline band. Unlike that of most squids, the funnel opening is not round but strongly transverse. The funnel organ is composed of a small prominent inverted V-shaped dorsal membrane with a round papilla at the apex and two ventral pads.

The head is large, a little wider than the mantle, and bears two large, laterally projecting eyes. The head is strongly constricted both above and below the eyes, and the latter have small eyelids. Sasaki stated that there is a strong olfactory tubercle present on the ventral part of each eye prominence, but these also are missing.

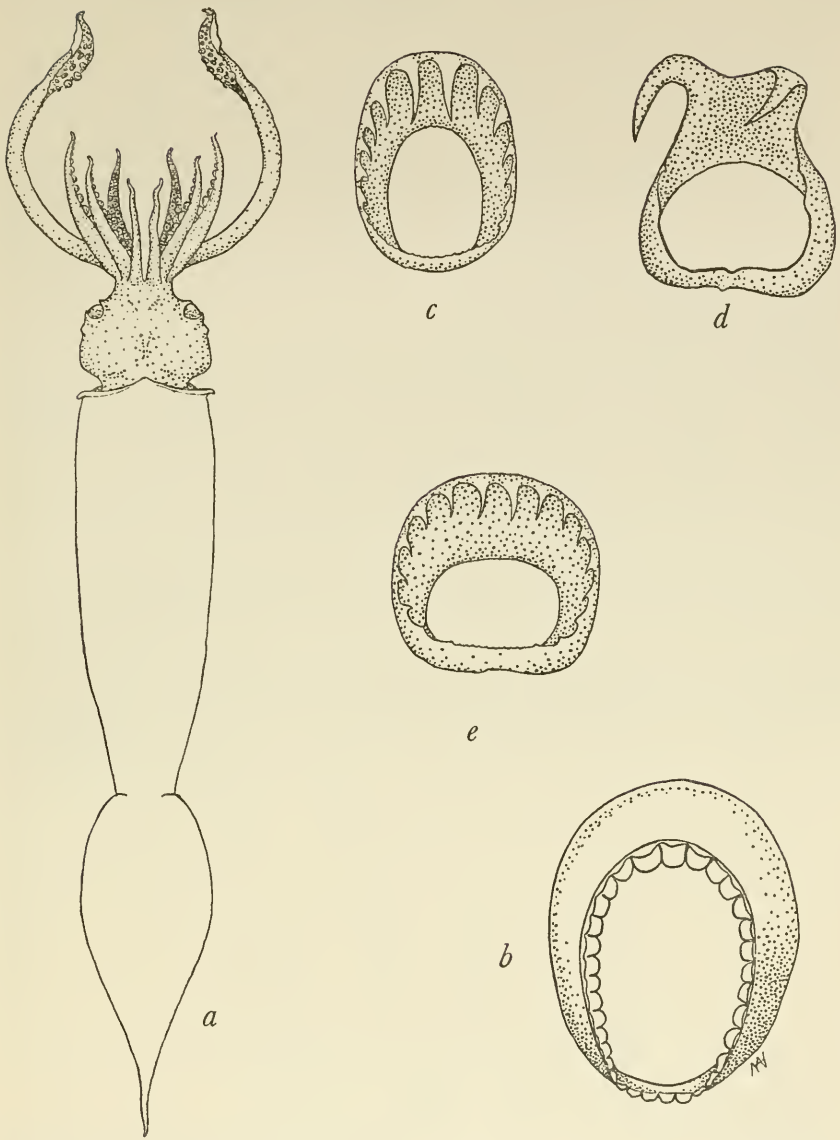


FIGURE 33.—*Taonius pavo* (LeSueur): *a*, dorsal view of female, mantle length 119.0 mm.; horny ring from sucker of 10th row of right arm III; *c*, marginal sucker of tentacular club; *d*, ring of large sucker of tentacular club; *e*, ring of distal sucker of tentacular club.

The arms are short, in the order 3.4.2.1, the longest about 12.0 percent of the mantle length. The arms are roundish in cross-section, mostly smooth, but III is equipped with a weak keel. All the arms are bordered by dorsal and ventral protective membranes which are narrow except basally. Here they are united to form, as Sasaki (1929) stated, an internal membrane. The arm suckers are biserial with one or more minute suckers basally after which they increase in size to the 8th pair after which they decrease to the extremity. Basal suckers are entire, with a sinuate edge; the larger midportion suckers bear 20 to 30 broad and closely set teeth, the distal ones entire proximally but toothed distally with 6 to 8 small rounded teeth (see Sasaki (1929), p. 320, figs. 146a-b).

The tentacles are short, little larger in diameter than the arms; they bear small, expanded clubs which taper rapidly distally. There is a protective membrane on each side and a small dorsal web distally. There is no distinct carpal cluster but there are eight or nine pairs of minute suckers separated by about the same number of minute pads evenly spaced along the oral surface of the stalk. The tentacular suckers are in four rows, often crowded, and are probably unique in structure. The marginal suckers of the hand are compressed laterally, the small proximal portion with low serrations, but the sides are equipped with about six teeth each and terminate in a distal pair of widely spaced sharp incurved hooks. The large rhachial suckers of the middle rows are strongly modified, the ring being compressed and smooth with the exception of two large hooks distally which give the suckers a bicuspid appearance. The distal suckers are smaller, toothed on the greater part of the ring (8-15 teeth, of which the distal two are much the largest).

Measurements and indices of a female specimen of *Taonius pavo* (Le Sueur) are:

	♀		♀
ML	119.0	CLI	23.2
MWI	11.8	I	6.7
HWI	12.6	II	10.5
FLI	43.7	III	11.8
FWI	10.9	IV	10.9
TLI	20.5		

TYPE.—Academy of Natural Sciences of Philadelphia.

TYPE LOCALITY.—Sandy Bay, Mass.

DISCUSSION.—Because of the condition of the animal, no further details external or internal were observable. No comparisons can be drawn with the Japanese specimens or those from elsewhere; the value of the specimen lies probably entirely in its being a new record for the Philippine Islands.

DISTRIBUTION.—Near Kashiki Island, Kiushiu, 369 fms., (*Albatross*), Sandy Bay (LeSueur), Gulf Stream (Verrill), Madeira (Joubin),

from stomach of *Diomedea fuliginosa* caught at 58°52' S., 43° E. (Chun), northern Mindoro, Philippines!

Bathothauma lyromma Chun, 1906

FIGURE 34

Bathothauma lyromma Chun, 1906, p. 86.

MATERIAL.—1 ♂(?), ML 114.0 mm., Sta. D5238, Point Lambajon, eastern Mindanao, 695 m., bottom temperature 43° F., May 12, 1908; USNM 575344.

DESCRIPTION.—The mantle is long and cylindrical, apparently straight sided, truncated anteriorly, and bluntly rounded posteriorly. The mantle is thin and almost membranous in consistency. The anterior margin has the appearance of being puckered at the normal points of attachment. Dorsally the long gladius is visible through the skin; anteriorly it is blunt, slightly expanded, and plainly visible. About a fourth of the mantle length posteriorly, the gladius becomes very narrow and is hardly discernible but widens rather abruptly about 10.0 mm. from the posterior end and here joins the base of the two broadly separated fins. Ventrally there are no cartilaginous lines or tubercles at the point of attachment on either side of the funnel.

The fins are small, widely separated, and almost terminal, paddle-shaped in outline, with narrow bases only 6.0 mm. wide. The individual fins are 12.5 mm. long and 14.0 mm. wide at the distal fanlike end. The total breadth across the two fins is 37.0 mm.

The funnel is large, weakly developed, and reaches almost to the base of the eye stalks. Although it perhaps may have been torn, it has a symmetrically arranged pair of elongate flaps on either side and a median notch in the upper margin of the funnel opening. The funnel organ cannot be accurately determined in the single specimen but it has the appearance of four facing oval pads, two dorsal and two ventral. In addition, just below the funnel opening on the dorsal side are two dark oval spots with a central round fleshy center with a porelike opening. The nature of the latter object is not known.

The head is long and slender, stalklike, 25.0 mm. from the anterior mantle margin to the base of the arms, cylindrical, with narrow eye-stalks originating at about the middle of the head. Above the eye-stalks the head is somewhat narrower than below them. The width across the eyes is 34.0 mm. The eyestalks are slender and support a bulbus 14.0 mm. long by 10.0 mm. wide; the iris is on the anterior border near the middle of the bulbus. Although difficult to determine, there apparently is a moderately produced rostrum. On the ventral surface of the bulbus is a long narrow lunar light organ.

In the right eye this organ appears to have a generally round shape; it covers half of the lower surface of the eyeball; the lunar strip is raised and prominent, an indistinct line running from one horn to the other outward and enclosing an expanse of skin with a slightly lighter color than that of the rest of the bulbus. No other light organs are evident. On the dorsal surface of the eyestalk in a patch at the base of the bulbus a small patch of dark chromatophores extends as a line down the stalk and back up the head part way to the arms.

The buccal membrane appears to have six points and seven supports, attached ventrally on arms III and IV and dorsally on I and II.

The arms are short and slender, arranged in a prominent brachial crown, in the order 3.1.2.4. All the arms are nearly round in cross-section and equipped with both dorsal and ventral protective membranes with supports, but no swimming membranes. All the arms with the exception of I are equipped with two rows of globular, moderately large suckers with small apertures somewhat oval in outline, the chitinous rings with smooth entire margins. The arms I are especially slender and attenuated, and bear two rows of suckers of normal size for the first pairs, or about a fourth of their length. Beyond the fifth pair, the suckers become abruptly much smaller, about a third of the diameter of the proximal ones, and lie in three or four rows to the tips of the arms. The apertures are very minute.

The tentacles are long and slender, round in cross-section, with a prominent deep groove on the oral aspect. The club is only slightly expanded and about 33.0 mm. in length. About 10.0 mm. from the base of the arms a series of minute suckers appear in what seems to be a single row but which actually are alternate, and each successive sucker is placed on opposite sides of the groove. At the seventh, the suckers appear in pairs, minute, on stalks originating from prominent bases, and directly opposite each other and in close contact. No buttons are visible. At the 25th pair of stalk suckers, the club originates without a distinct carpal area. The slightly expanded clubs are bordered on either side by a delicate protective membrane with supports which run the full length of the club. The suckers are of moderate size, in four rows, large on the hand part and gradually decreasing distally. They are somewhat oval in shape, raised on long peduncles, and have semioval apertures which are truncate proximally and rounded distally. They are equipped with eight or nine long sharp curved teeth on the distal border and entire on the proximal border.

The viscera were laid bare and are shown in the figure. The gills are small, located in the midpoint of the mantle, and are transverse in position. The esophagus is dorsal, runs down to the area of the gills, and turns back anteriorly, with a small semicircular caecum at the

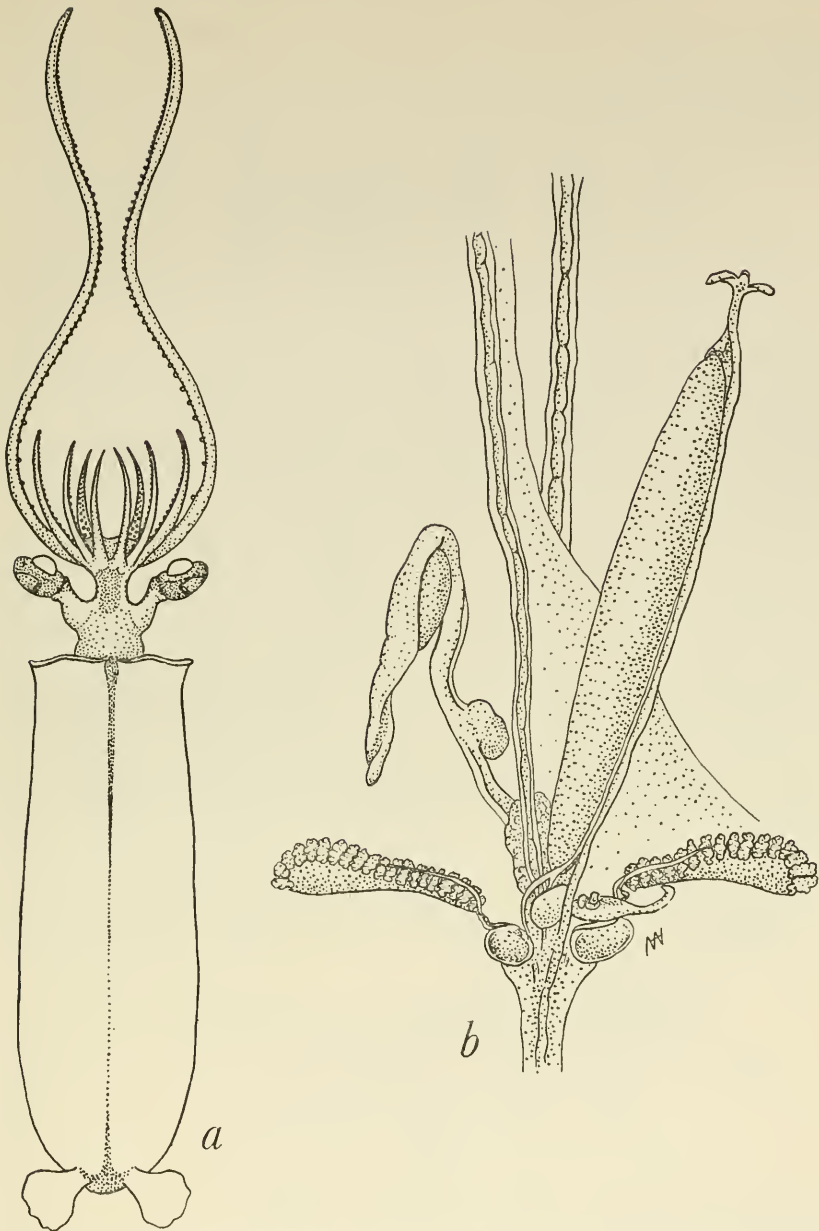


FIGURE 34.—*Bathothauma lyromma* Chun: *a*, dorsal view of male, mantle length 114.0 mm.; *b*, arrangement of viscera.

midpoint. The pancreas is folded back along the stomach. The liver is attached at the level of the gills and is 29.0 mm. long by 3.0 mm. wide, cigar-shaped, the ventral surface traversed by the intestine.

A small semicoiled, sharply pointed penis is on the left side at the base of the gills.

Measurements and indices of a male specimen of *Bathothauma lyromma* Chun are:

ML	114.0	I	23.6
MWI	28.1	II	21.9
HWI	29.8	III	25.5
FLI	13.1	IV	19.3
FWI	35.5	TLI	117.0
		CLI	24.8

TYPE.—Zoologisches Museum, Berlin.

TYPE LOCALITY.—West of Cape Verde, west Africa.

DISCUSSION.—This curious specimen is placed, with some hesitation, in Chun's *Bathothauma lyromma* inasmuch as it appears to share a number of characters with that species. Unfortunately, Chun gave no description of his species with the exception of a detailed comparison of the eyes; the only description available is that of Pfeffer which he took from Chun's excellent illustrations. Chun's specimen was, according to the illustration, about 65.0 mm. in mantle length and came from off Cape Verde. Hoyle examined another specimen taken by the *Albatross* in the eastern Pacific, but this was even smaller. The most distinguishing features of this species seem to be the rounded mantle end with the separate small fins, the peculiar shape of the mantle, and the eyes and their stalks. Even these may change with growth and, inasmuch as the present specimen is nearly twice as long as the largest previously known specimen, it is considered that the discrepancies noted are due to growth and maturity.

DISTRIBUTION.—West of Cape Verde 0–3000 m. (Chun); 36°05'30'' N., 9°30'' W., 0–3660 m. (Joubin); off Bermuda (Voss); eastern Pacific (Hoyle); Philippines.

Order Octopoda: Suborder Incirrata

Family Bolitaenidae

Japetella diaphana Hoyle, 1885

FIGURE 35

Japetella diaphana Hoyle, 1885b, p. 232.—Thore, 1949, p. 4.

Eledonella diaphana, Hoyle, 1886, p. 107.

Bolitaena diaphana, Chun, 1911, p. 15.

Chunella diaphana, Sasaki, 1920, p. 171; 1929, p. 14.

MATERIAL.—1 ♀, ML 35.0 mm., Sta. D5184, 11.25 miles off Lusaran Light, 1,034 m., Mar. 30, 1908. 1 ♀, ML 48.0 mm., Sta.

D5350, 43 miles off Point Tabonan, Palawan Passage, 942 m., Dec. 27, 1908.

DESCRIPTION.—This species has been so well described by Thore (1949) that nothing can be added from examination of the present material. The specimens are in such poor condition that the description has been supplemented from Thore's paper.

The mantle is oblong, slightly pointed at the posterior end, and gelatinous. In fresh material the viscera may easily be studied *in situ*, but in the present specimens the mantle is yellowish and opaque. In well-preserved specimens an outer jellylike coating bears minute bristles.

The head is nearly as wide as the mantle and bears rather large eyes which face lateral and are about 20 percent of the mantle length.

The arms are short, with the exception of III which in older specimens reaches a considerable size, and they are in the order 3.4.2.1.

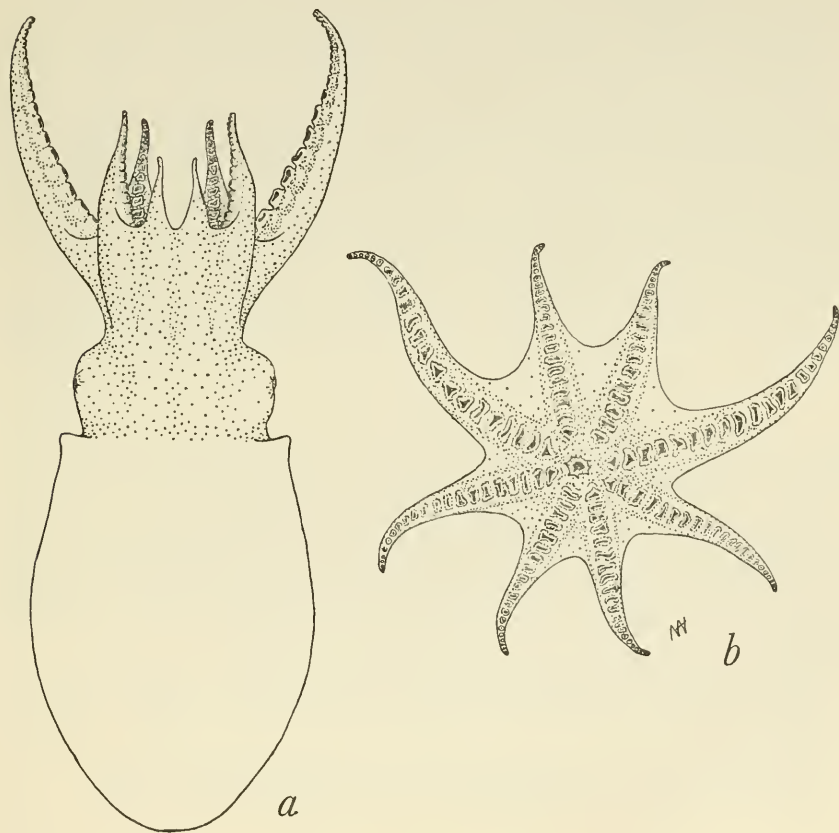


FIGURE 35.—*Jetetella diaphana* Hoyle *a*, dorsal view of female, mantle length 35.0 mm.; *b*, oral view showing sucker arrangement.

The suckers are crowded on all the arms except in large specimens and are in a single series. They are deeply embedded in the gelatinous coating. According to Thore, they have an average index of 5.9 but those of the female have an index of 4.3. The web is well developed and is especially prominent between the dorsal and the ventral arms. In the smaller of the two, sector E was deepest, with an index of 38.4.

The funnel is large and extends past the eyes. The funnel organ is distally placed and distinct. It is inverted V-shaped, with fat oval lateral members, and narrowly united at the apex.

Measurements and indices of a female *Japetella diaphana* Hoyle, 1885, are:

	♀		♀
ML	35.0	MAI	135.0
EI	20.0	WDI	38.4
ALI	41.3	SIn	4.3

TYPE.—British Museum (Natural History).

TYPE LOCALITY.—North of Papua, 147° E., 42' S., 1100 fms., Globigerina ooze.

DISCUSSION.—This species has been revised by Thore (1949) and nothing can be added here. According to this author the young live at about 200 m., just below the discontinuity layer. Later, they migrate downward, adults of more than 40 mm. living below 333 m. and concentrated at two levels, one at 1750 m. and the other at 2500 m.

DISTRIBUTION.—Cosmopolitan in deep water in the tropical and warm temperate seas. It has been previously reported from the Philippines (*see* Thore, 1949).

Eledonella pygmaea Verrill, 1884

Eledonella pygmaea Verrill, 1884, p. 145.—Thore, 1949, p. 39.

No specimens of this bathypelagic octopod were taken by the *Albatross*. It is listed here on the authority of Thore (1949) who recorded it from several localities in the Philippine Islands. Details of external morphology, anatomy, and distribution are available in Thore.

TYPE.—U.S. National Museum.

TYPE LOCALITY.—37°12'20'' N., 69°39' W., in 2949 fathoms (Verrill).

DISTRIBUTION.—Cosmopolitan in warm and temperate seas.

Family Octopodidae

Octopus membranaceus Quoy and Gaimard, 1832

FIGURE 36

Octopus membranaceus Quoy and Gaimard, 1832, p. 89.

MATERIAL.—1 ♀, ML 20.0 mm., from Sta. D5360, off Corregidor Light, Manila in 22 m., Feb. 7, 1909.

DESCRIPTION.—This small specimen is probably immature. The mantle is squat and globular, nearly as wide as long, bluntly rounded posteriorly, and with a constriction between the mantle and the rather small head. The funnel is long and tubular and the funnel organ is conspicuous, located mostly on the dorsal side, and forming a W with slender limbs. The head is small, compact, with only slightly projecting eyes. There are two ocular cirri above the eye, a large warty posterior one and a small inconspicuous anterior one.

The arms are long and slender, attenuate distally. The suckers are biserial and rather widely spaced. The arm formula is 3.4.2.1. The web is only moderately deep with the formula C.D.B.E.A., with a low thin extension along the ventral side of each arm.

The gills are large and short, rather low in number, with seven or eight lamellae per demibranch.

The oviduct is rather large and very long, the oviducal gland small, very posterior, and striated.

The sculpture consists of closely set small papillae, there are a few scattered larger papillae on the dorsum of the head and mantle, and numerous, moderately large papillae scattered on the aboral surface of the arms. The two supraocular cirri are located as described above.

The color is grayish or brownish with dark-purplish bands on the head, mantle, and arms. A single large brownish ocellus is on each side of the head about midway between the eyes and the edge of the web. The ocellus is solid with no indication of a ring or center. On the mantle there are four broad bands, the lateral ones crossing the eyes. The middle two converge in the middle of the head. Each arm is bordered dorsally by a narrow distinct, nearly black line from the base to near the tip. The dorsal arms may also have a less distinct band ventrally. At least in the dorsal arms the aboral surface is crossed by a few widely spaced dark bars.

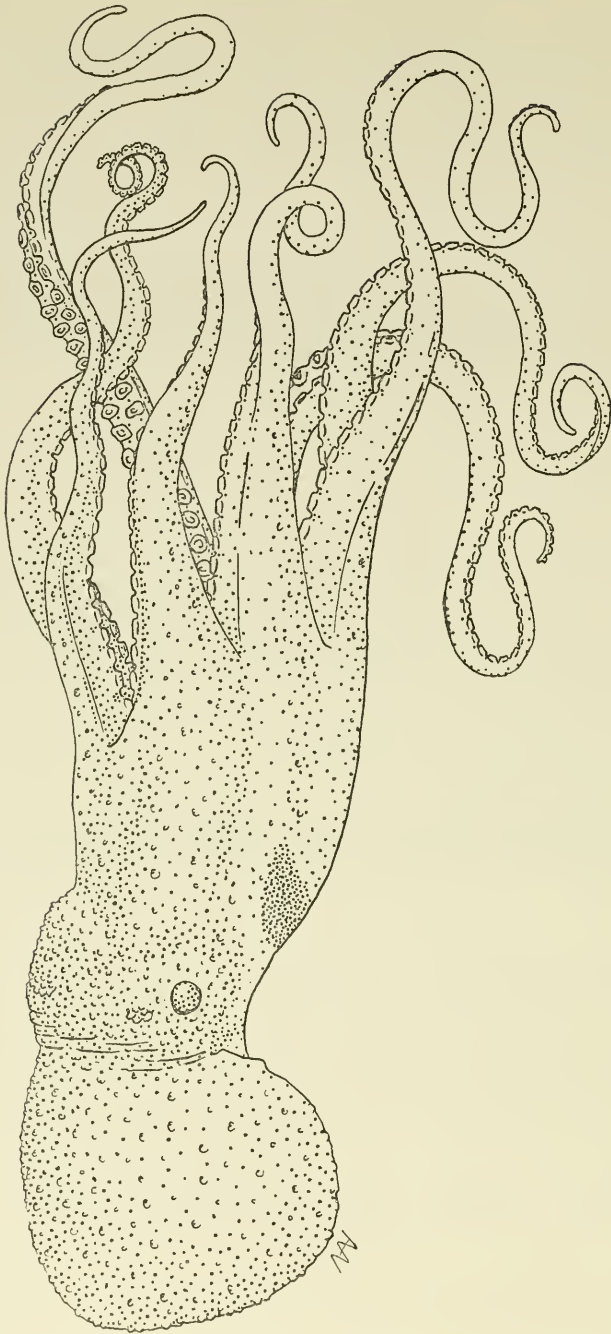


FIGURE 36.—*Octopus membranaceus* Quoy and Gaimard, lateral view.

Measurements and indices of a female *Octopus membranaceus* Quoy and Gaimard are:

	♀		♀
ML	20.0	MAI	22.5
MWI	85.0	WDI	21.0
HWI	65.0	A	7.0
Gills	8	B	12.0
I	51.0	C	13.0
II	54.0	D	12.5
III	62.0	E	11.0
IV	60.0	Sl _n	6.0
ALI	69.7		

TYPE.—Museum National d’Histoire Naturelle, Paris.

TYPE LOCALITY.—New Guinea.

DISCUSSION.—It is with some doubt that I place this specimen in the above species. A survey of the species in Robson (1929) reveals nothing which fits the present female. Sasaki (1929) is also of little help except for the description of *O. ovulum* which approaches this species rather closely in some respects. The specimen illustrated (Sasaki, 1929, pl. 11) is somewhat similar except in the structure of the ocellus. Experience with ocelli, however, makes me disregard this difference because they are very variable and often change according to the preservative and especially with the length of preservation. Perusal of Pickford’s magnificent study of the Indo-Malayan octopods (see p. 2) leads me to the conclusion that, despite certain differences, the specimen belongs to *O. membranaceus*, of which *O. ovulum* is tentatively considered by Pickford to be a synonym.

DISTRIBUTION.—New Guinea; Japan (Sasaki); Amboina; Red Sea (Adam); east Africa; central Pacific; Philippines!

Octopus horridus d’Orbigny, 1826

PLATE 3,a

Octopus horridus d’Orbigny, 1826, p. 144.—Robson, 1929, p. 21.

MATERIAL.—1 ♀, ML 50.0 mm., 2 ♂♂, ML 22.0 mm., from reef at Port Tilig, Lubang Id., July 15, 1908. 1 ♂, ML 35.0 mm., from tide pool at Canimo Id; near Daet Point, eastern Luzon, June 15, 1909.

DESCRIPTION.—The four specimens listed above were placed in this species with some hesitation. As noted in “Discussion” below, they present some features differing from those of previous specimens.

The mantle is globular, very blunt posteriorly, and widest in the posterior third (MWI 60–82). The head is narrow (HWI 50–68) and is set off from the body by a narrow constriction. The eyes are prominent.

The funnel is narrow and tubular, free for most of its length, and bears a broad W-shaped organ.

The arms are long (MAI 18-24), with the first arm always the shortest and either the third or fourth longest (3.4.2.1, 2.4.3.1, 4.2.3.1). The arms bear biserial suckers which are raised well above the arms in some specimens, in others rather deeply set. The SIn is 2.5-4.0. In the males, one or two of the suckers on the second and third arms are especially enlarged with indices of 4.0-6.0.

The third right arm is hectocotylized in the males and is somewhat shorter than its fellows. The ligula is very small, with an index of only 1.3-3.0. The sides are inrolled with faint traces of transverse ridges. The calamus is minute.

The web is shallow (WDI 10.5-20), with all sectors nearly equal although sector A is usually shallowest, the formula for the specimens being C.B.D.E.A. for the female, B.C.A.D.E. and E.B.A.C.D. for the two young males and D.B.E.A.C. for the older male. The web extends along the ventral surface of the arms in most cases.

The penis is small, tubular, and slightly tapered, with a small diverticulum at right angles to the remainder. The PLI is 19-20, measured from the anterior end to the angle made by diverticulum.

The radula was not examined.

The sculpture consists of numerous small flat tubercles over the dorsum of the mantle, head, and arms. Superimposed on these were a number of large multifid cirri. There are three or four large and several smaller branched cirri over each eye and several series of four or five cirri on the dorsum of the mantle. Large branched warts extend out along the aboral surface of the first two pairs of arms.

The color in alcohol is a dark brownish black, slightly mottled on the mantle and head. Along the outer surface of the arms there are occasional lighter spots or blotches. The ventral surface of the head and mantle bears numerous small reddish-brown chromatophores, closely placed. The oral surface of the arms and web are a light yellowish brown.

The gills are large and stout, with six to nine filaments per demi-branch.

Measurements and indices of one female and three males of *Octopus horridus* d'Orbigny, 1826, are:

	♀	♂	♂	♂
ML	50.0	22.0	22.0	35.0
MWI	60.0	82.0	73.0	74.0
HWI	52.0	54.0	68.0	50.0
Gills	9	7	6	7
ALI	80.0	80.0	79.0	85.0
MAI	23.0	23.0	24.0	18.0
WDI	19.5	13.2	20.0	10.5
SIn	7.0	11.4	16.0	11.4
SIe	----	18.2	22.7	17.1
LLI	----	1.7	----	1.6
PLI	----	20.2	19	19.8

TYPE.—Senckenbergisches Institut, Frankfurt am Main.

TYPE LOCALITY.—Red Sea.

DISCUSSION.—Pickford's unpublished monograph (see p. 2) contains a full and detailed consideration of the relationships of *O. horridus* with *O. filamentosus* and *O. niveus*; Dr. Pickford places the two latter in synonymy. The material at hand does not permit an evaluation of this problem, but the writer has accepted *horridus* as the valid name. The two small males, however, show little or no indication of the typical *horridus* coloration and apparently are more rugose and with far more prominent cirri than I have found in the literature. Subsequent study may show that these specimens belong to another species but for the time being they seem better referred to *horridus*.

DISTRIBUTION.—From the east coast of Africa through the Indian Ocean and the Pacific region. They are here first recorded from the Philippines.

Octopus teuthoides Robson, 1929

PLATE 4

Octopus teuthoides Robson, 1929, p. 133.—Adam, 1934, p. 22.

MATERIAL.—5 specimens, ML 14.3–17.0 mm., taken in Panabutan Bay, Mindanao, Feb. 5, 1908, electric light; USNM 575448.

DESCRIPTION.—The five specimens before me have been placed in this species until such time as the status of *teuthoides* is cleared up.

The mantle is spindle-shaped, its width about 35 per cent of its length. It is widest in the anterior third and tapers to a sharp point. The small head, about 30 per cent of the mantle length in width, is narrow and bears small eyes. The head is separated from the mantle by a constricted neck region.

The arms are relatively short, a little more than 50 percent of the total length, and slender, in the order 1.2.3.4. The suckers are biserial, small, but distinct and uncrowded. The web is shallow, (WDI 18–19) and in the order B=C=D.A.E. or B=C=D.E.A.

The funnel is small, free for about one-third of its length, and has a well-developed locking apparatus, especially prominent in the mantle where a deep sharp pit is found. The funnel organ consists of a narrow, sharply angled W. There is a well-developed adductor *pallii medialis*. The gills are long and there are 10 to 12 lamellae per demibranch.

The skin is smooth, and in the preserved specimens there were no observable chromatophores.

One specimen, ML 15.0 mm., does not appear to be conspecific. The mantle is slender and pointed, but the head is much wider and the arms shorter and heavier. In addition, there was a distinct circlet

of minute suckers around the mouth and then three or four uniserial suckers at the base of each arm. In the other four specimens there was no distinct circle and no uniserial suckers.

TYPE.—British Museum (Natural History).

TYPE LOCALITY.—Walla Id., New Hebrides.

DISCUSSION.—In the present status of our knowledge of the octopods of the Indo-Pacific, these specimens present a problem. Robson (1929) recognized that these were juvenile forms and suspected a relationship with *O. fusiformis*. Adam (1945), on the other hand, thought that they were the young of *macropus*. Pickford, in her manuscript of the Indo-Malayan octopods, considers, despite no evidence of water pores, that they are the young of *Cistopus indicus*.

I concur with Pickford that they only superficially resemble the young of *O. macropus*, which at the same size has much shorter arms by comparison with western Atlantic specimens. The final disposition of the five specimens is still in doubt.

DISTRIBUTION.—New Hebrides (Robson); Manokwari, New Guinea (Adam); Philippines.

Octopus macropus Risso, 1826

PLATE 3, b

Octopus macropus Risso, 1826, p. 3.—Robson, 1929, p. 101.—Adam, 1954, p. 172.

MATERIAL.—6 ♂♂, ML 28.0–52.0 mm., 10 ♀♀, ML 30.0–44.0 mm., from Mansalay, Mindoro, June 3, 1908. Caught by natives with their hands by torchlight.

DESCRIPTION.—The sixteen specimens listed above are small, in a very poor state of preservation, and are not suitable for detailed description. In the present material the mantle is sacular, the head small with small to rather prominent eyes. The arms are long, 1 much longer than the others. In the males the third right arm is hectocotylized, bearing a small but well-developed ligula with inward curled edges and transverse rugae. In most of the males the penis was undeveloped, but when present was long and slender with a small, compact diverticulum. No spermatophores were present in any of the males. There are no especially enlarged suckers in the males.

TYPE.—Museum d'Histoire Naturelle de Nice (not present when searched for in 1961).

TYPE LOCALITY.—Mediterranean.

DISCUSSION.—According to Pickford (see p. 2), three known octopods in the Indo-Malayan region, of which the Philippines faunally are a part, have long first arms. These are: *Octopus microphthalmus*, *Cistopus indicus*, and *Octopus macropus*.

Because of the very small eyes in some of the young specimens, they were at first considered to belong to *O. microphthalmus*. However, the sucker index of the Mansalay specimens ran slightly in excess of 10 (average 11) while that of *microphthalmus* is less than 10, and the gill count was 10 to 11, against 7 to 9 in the latter species.

No water pores could be demonstrated in the sixteen specimens available, despite repeated detailed examination. With the added evidence of the well-developed ligula, the specimens cannot be included in *Cistopus indicus*.

Whether the specimens are *macropus* is another matter. In general, the bodies are too round and sacular and the ligulas too small, in comparison with western Atlantic specimens.

Several species of octopus in Japanese waters have long first arms (Sasaki, 1929). I have not considered these because Sasaki described no species very comparable to the present and because data in the present volume show that the Philippines have in general the same benthic and shallow-water fauna as Indo-Malaya, but not the same as Japan. As a result I have identified the present specimens as *Octopus macropus*.

DISTRIBUTION.—In tropical and warm temperate seas throughout the world. Philippines!

Octopus vulgaris Cuvier, 1797

Octopus vulgaris Cuvier, 1797, p. 380.—d'Orbigny, 1839, p. 46 (as *rugosus*).

No specimens from the Philippines are available to me. Robson (1929) listed under his *rugosus* a record of Hoyle (1885a, p. 80) of *granulatus*, but Hoyle was merely quoting d'Orbigny. D'Orbigny stated that M. Perottet found *granulatus* in abundance at Manila, but whether they were actually *vulgaris* must remain in doubt.

TYPE.—Not traced.

TYPE LOCALITY.—Not traced.

DISTRIBUTION.—Cosmopolitan in all but cold seas.

Cistopus indicus (Orbigny, 1840)

Octopus indicus Orbigny, 1840, p. 24, pl. 26.

Cistopus indicus, Gray, 1849, p. 20.—Robson, 1929, p. 182.

MATERIAL.—2♀♀, ML 54.0–88.0 mm., Cavite market, June 14, 1908 (specimens in poor condition, partly macerated). ? 1♀, ML 90.0 mm., from fishermen at Mahinog, Camiguin Id., Aug. 3, 1909. ? 5♂♂, ML 22.0–80.0 mm., 4♀♀, ML 24.0–38.0 mm., Mahinog, Camiguin Id., Aug. 3, 1909.

DESCRIPTION.—Of the twelve specimens noted above, only the two

females from Cavite market can definitely be assigned to this species. The remaining specimens, now no longer available to me, most probably belong to *C. indicus* and their measurements are given below. The small males from Mahinog Island had small, undifferentiated ligulas, but water pores could not be seen.

The visceral sac is narrow in the males, wider in the females. There is a distinct neck region and the head is small.

The arms are long and slender with attenuate tips. The arm order in general is 1.2.3.4, with the first arms the longest and the stoutest. The sucker index is larger for the suckers of the first arms than for those of the other arms, and the males usually have specially enlarged suckers on the first and second arms. The most characteristic feature of the species, and upon which the genus was erected, is the water pores located in the interbrachial region near the base of the arms. These pores communicate with small oval pouches on the oral surface of the web and are very difficult to find in preserved animals.

The third right arm is hectocotylized in the males. The ligula however is small and poorly developed and often is nothing more than a smooth area on the end of the arms. The indices ranged from 1.37 to 2.46.

The gills ranged in number from 10 to 11, not counting the terminal filaments.

The sculpture is from smooth to slightly rugose on the dorsum of the mantle and head. The color in alcohol is reddish brown but mottled or spotted with lighter colors on the dorsum.

Measurements and indices of five males and four females of ?*Cistopus indicus* (Orbigny) from Mahinog, Camiguin Islands, are:

	♂	♂	♂	♂	♂	♀	♀	♀	♀
ML	80.0	29.0	31.0	22.0	22.5	38.0	27.0	26.0	24.0
MWI	66.3	76.0	77.5	86.5	98.0	84.3	89.0	77.0	92.0
HWI	47.5	58.6	58.0	63.7	57.8	60.5	63.0	61.5	62.5
Gills	10	10	11	10	10	11	11	10	----
MAI	20.3	17.9	20.5	21.4	15.5	18.3	16.4	18.6	16.3
WDI	18.7	17.9	17.2	18.8	18.0	18.3	17.1	15.7	15.0
SIn	13.8	17.2	12.9	18.2	17.8	13.2	14.8	15.3	----
LLI	4.37	2.46	1.75	1.64	1.37	----	----	----	----
PLI	12.5	----	----	----	----	----	----	----	----

TYPE.—Museum d'Histoire Naturelle, Paris.

TYPE LOCALITY.—Celebes.

DISCUSSION.—The two females from Cavite market are definitely assignable to *Cistopus indicus*. The water pores are clearly visible. These specimens constitute the first record of this species from the Philippines. *C. indicus*, according to Pickford (MS) is a common and commercially important Indo-Malayan species.

DISTRIBUTION.—Indo-Malayan region, Philippines:

Family Argonautidae

Argonauta argo Linnaeus, 1758

Argonauta argo Linnaeus, 1758, p. 708.

MATERIAL.—1 shell, Sta. D5423, Cagayan Id., Mar. 31, 1909; USNM 238403. 1 shell, Sta. D5188, Pescadero Id., Apr. 1, 1908. 1 shell, Sta. D5601, Limbe Id., Celebes, Nov. 13, 1909.

Only empty shells of this species were obtained at the above stations, so no observations on the animal can be made at present. Sasaki (1929, p. 23), because of the difference in the radula, doubted that the Japanese form referred to this species is identical with the Mediterranean. The shells are compressed, with a narrow keel and rather narrow aperture. The sides of the shells bear numerous simple and bifurcate ribs, most of which extend from the columella to the carinal knobs, but a few outer ones are separate, forming secondary ribs. The keel bears two rows of low but rather sharp, numerous, and closely spaced tubercles. The color is a shiny white except for the keels which may be black or brownish (sepia). The sides of the shell form a low outward-turning projection on each side, termed the "ear," but these are not prominent nor turned widely outward.

TYPE.—British Museum (Natural History).

TYPE LOCALITY.—"Habitat in pelago, M. Indico, Mediterraneo."

DISTRIBUTION.—Cosmopolitan in warm and temperate seas.

Argonauta hians Solander, 1786

Argonauta hians Solander, 1786, p. 44.

MATERIAL.—1 shell, Sta. D5207 off Badian Id., Samar, Apr. 14, 1908; USNM 234833. 1 shell, Sta. D5397 off Talajit, between Samar and Masbate, Mar. 15, 1909; USNM 234177. 1 shell, Sta. D5419 off Tubigan Id., Bohol, Mar. 25, 1909; USNM 229186. 1 shell, Sta. D5404 off Dupon Bay, Leyte, Mar. 17, 1909; USNM 229380. 1 shell, Sta. D5374 off Tayabas Bay, Luzon, Mar. 2, 1909; USNM 238272. 4 shells, Sta. D5407, Ponson Id., Dupon Bay, Leyte, Mar. 17, 1909; USNM 238272. 1 shell, Sta. D5405, Ponson Id., Dupon Bay, Leyte, Mar. 17, 1909; USNM 238262.

Empty shells were dredged up at the stations listed. The shells are small, with a wide keel which bears 15–23 large, widely spaced, very prominent carinal knobs. The ribs are less numerous than in *A. argo*, with less bifurcation and with rather regularly spaced secondary ribs. The "ears" are usually very pronounced, large, and turned strongly outward, the aperture much wider than in *argo*. The

carinal knobs are deep brown, and each angle of the keel may be brownish with white between. The general color of the shells is whitish.

TYPE.—Not traced.

TYPE LOCALITY.—Not known.

DISTRIBUTION.—Cosmopolitan in warm and temperate seas. (Recorded from the Philippines by Hidalgo and Robson.)

Argonauta nodosa Solander, 1786

Argonauta nodosa Solander, 1786, p. 96.—de Elera, 1896, p. 3.—Hidalgo, 1905, p. 9 (as *tuberculata*).

No material of this species has been available for comparison. The records from the Philippines are by de Elera (from Boac) and Hidalgo (from Mindanao). The species is listed here for completeness; for a description the reader is referred to Robson (1932b, p. 198).

TYPE.—Not traced.

DISTRIBUTION.—Tasmania, New Zealand, northern Australia (all Robson); Mozambique, Cape of Good Hope (d'Orbigny); Moluccas (Rumphius); South Australia (Verco and Cotton); Chile (Gray); (?)Brazil (Robson); Philippines (Hidalgo, de Elera).

Argonauta böttgeri Maltzan, 1881

Argonauta böttgeri Maltzan, 1881, p. 163.—Hidalgo, 1905, p. 9.—Robson, 1932b, p. 195.

No specimens of this species were found in the collections. Hidalgo's record from Masbate, quoted from Cuming, is doubtful. Robson had three specimens from Masbate, however, apparently from the same source. Inasmuch as no specimens of this species have been seen and Robson (1932ab, p. 195) considers the possibility that *böttgeri* is a form of *hians*, I do not feel that a description based upon the literature is warranted.

TYPE.—Not traced.

TYPE LOCALITY.—Not traced.

DISTRIBUTION.—Australia; Albay, Luzon, and Masbate, Philippines; Mauritius; China Seas; Chagos Id.; between Honolulu and Laysan Id., on surface (Berry); New Zealand (Massy); Japan (Denker, Sasaki, Ikeda); Andaman Id. (Massy).

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