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Four species of Pacific Ocean Holothurians allied to *Cucumaria frondosa* (Gunner).

By

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With Plate 19.

In a previous paper (1907), *Cucumaria frondosa* (GUNNER) was recorded from the north Pacific coast of North America. A more extended study of the large collections of the United States National Museum seems to show that *Cucumaria frondosa* does not occur in the Pacific Ocean, but that 4 species closely allied to it are found in this region. Professor LENZ, Director of the Lübeck Natural History Museum, has permitted me to examine the type specimens of *Cucumaria fallax* LUDWIG from Alaska. Professor N. NASSONOV, Director of the Zoological Museum of the Imperial Academy of Sciences of St. Petersburg, has lent me a specimen collected by W. BRASHNIKOW in 1899—1902 in the Gulf of Sachalin, Okotsk Sea, and identified by BRITTEN, 1906, as *Cucumaria miniata* BRANDT. Reinforced by the study of these specimens I have identified the species represented in the collections of the United States National Museum as *Cucumaria californica* SEMPER, 1868, *Cucumaria japonica* SEMPER, 1868, *Cucumaria fallax* LUDWIG, 1874, and *Cucumaria miniata* BRANDT, 1835.

The miserable condition of LUDWIG's type-specimens precluded any study of the internal anatomy and hence this author, 1881, is in error in placing his *Cucumaria fallax* in the synonymy of *Cucu-*

maria miniata. The spicules of the two forms are distinctly different and since the spicules of LUDWIG's type-specimens of *Cucumaria fallax* agree perfectly with those of the species I had differentiated as new, I shall assume that the internal anatomy also agrees and restore the name. BRITTEN, 1906, fails to discern these differences and hence incorrectly identifies the BRASHNIKOW specimens as *Cucumaria miniata*. CLARK, 1901, does not give the number of stone-canals and if his "scattered pedicels on the interambulacra" means on ventral, as well as dorsal, interambulacra, then he erroneously identifies his specimens as *Cucumaria miniata*. With more complete information on the above points the identity of CLARK's form may be determined. The opinion of LUDWIG, 1881, that SELENKA's *Cucumaria albida* is a young example of *Cucumaria miniata* is undoubtedly correct. On the other hand the specimens with "only 1 Polian vessel and 1 stone-canal" which CLARK, 1901, refers to *Cucumaria albida* SELENKA are possibly *Cucumaria californica* SEMPER.

Following LAMPERT, 1885, both CLARK, 1902, and EDWARDS, 1907, incorrectly identify specimens as *Cucumaria japonica* SEMPER, which should be known as *Cucumaria miniata*. These decided conclusions are the result of a prolonged study of a fairly large series of specimens and it is my belief that the status of these members of the *Cucumaria frondosa* species-cycle is now more clearly established.

For the opportunity to investigate the rich collections of the United States National Museum I would express my especial thanks to Prof. RICHARD RATHBUN, Assistant Secretary of the Smithsonian Institution. Also I desire to thank Directors LENZ, of the Lübeck Museum, and NASSONOV, of the Zoological Museum of the Academy of Sciences of St. Petersburg, for courtesies extended to me.

Cucumaria frondosa (GUNNER), 1767.

- 1767. *Holothuria frondosa* GUNNER.
- 1776. *Holothuria pentactes* O. F. MÜLLER, not LINNAEUS.
- 1830. *Cuvieria frondosa* BLAINVILLE.
- 1833. *Pentacta frondosa* JÄGER.
- 1839. *Holothuria grandis* FORBES et GOODSIR.
- 1839. *Holothuria fucicola* FORBES et GOODSIR.
- 1841. *Holothuria (Cladodactyla) pentactes* GOULD.
- 1841. *Cucumaria frondosa* (FORBES).
- 1841. *Cucumaria fucicola* FORBES.
- 1852. *Botryodactyla grandis* AYRES.
- 1852. *Botryodactyla affinis* AYRES.

In another paper (1910) I have presented a detailed revised description of *Cucumaria frondosa* together with an analysis of the literature pertaining to this form, giving now a description sufficient to serve as a basis for comparison with the other species discussed.

Form. — The subcylindrical body is somewhat flattened dorsally. In alcohol it is generally much contracted, ovoid, with deeply wrinkled, leathery skin.

Size in centimeters. — In 43 fixed adults with the introvert retracted the contracted body has a mean length of 8.7, with a range from 6 to 16.2, and a mean dorso-ventral diameter of 4, with a range from 2.6 to 8.6. The introvert has a mean length of 1.5 which should be added to the above mean length of the body to obtain the mean total length of specimens with introvert extended. The living holothurids may attain a length of from 60–100.

Color. — The alcoholic specimens are liver-brown to vinaceous-cinnamon, darker dorsally. In life the holothurid is greenish brown, or dark purple above, and pale brown below, some specimens however being of a uniform bright yellow. The colors are lighter in the young.

Tentacles. — Ten, large and equal.

Pedicels. — The pedicels are very retractile and arranged in 2 rows in each radius, running zig-zag from side to side of the radial canal and in addition they are scattered over the 3 dorsal interradial, the ratio of dorsal to ventral pedicels being 3:5. In certain cases some of the mid-body pedicels grow beyond the 2 typical primary rows thus constituting irregular partial secondary rows.

Genital papilla. — As described in previous papers (1909, 1910), in the female the genital papilla is usually simple and conical but sometimes it is subdivided into 2, or a very few lobes, while in the male it is always subdivided into from 4 to 22 parts, with an average of 10, each branch having a terminal pore. In a few cases one division is quite separated from the main portion of the papilla (Pl. 19, Fig. 1).

Spicules. — The spicules of the body-wall are irregularly square, rounded, or more or less elongated perforated plates, either smooth, or spinose and often ridged (Fig. 2). They are of 2 mean sizes, the small plates averaging $220 \times 110 \mu$ with from 25 to 30 holes. The plates may project from the surface so that the skin

feels rough. Sometimes the spicules of the cloacal region of the body-wall occur in heaps which are not so compact, or made of such large plates as the similarly located spicules of *Cucumaria japonica*. In the deepest layers formless calcareous deposits are often found.

The spicules of the pedicels (Pl. 19, Fig. 3), are somewhat elongated perforated plates with one end rounded or with several prongs, and the other spinose and projecting from the surface. The end-plates are sometimes simple in the young but in the adult they are always multiple, being made up of from several to many rods, rosettes, or simple plates, in one case of 65 such elements.

The spicules of the tentacles (Fig. 4), are elongated, knobbed, straight or curved rods and plates, being smaller distally. In some cases the spicules have been absorbed leaving clearly evident spaces in the tissues. THÉEL, 1886, claims that in small individuals the plates are common dorsally, while rare or totally absent ventrally. As described in my earlier papers (1909, 1910), there are 5 small radial vestigial anal teeth.

Calcareous ring. — The calcareous ring is not always perfectly preserved. All of the 5 radialia and the 5 interradialia have anterior prolongations and are notched posteriorly, the radialia being somewhat larger.

Polian vesicle. — There is one prominent Polian vesicle arising from the ring-canal in the left dorsal interradius. In 6% of the specimens there is in addition an extra vesicle from another interradius.

Stone-canal. — The single stone-canal has a mean length of 5 mm. The spherical madreporite is greatly convoluted and has a mean diameter of 1 mm.

Gonads. — The gonads are in two tufts, one to the right and one to the left of the median dorsal enteric mesentery.

Respiratory trees. — The right and left respiratory trees diverge from a common base at the anterior end of the cloaca. Each tree consists of a major, primary stem, in a lateral dorsal interradius, and of a minor, secondary stem, in a lateral ventral interradius.

Muscles. — The radial muscle bands and the introvert retractors are simple but thinner along the median line, where in some cases the introvert retractors may split into paired bands. The circular muscles and cloaca extensors are also well developed.

Enteric canal. — The third loop of the enteric canal is attached to the left of, and near to the mid-ventral radial muscle.

Habitat. — This species is two-thirds circum-polar, extending south to Britain in the eastern Atlantic Ocean and to the neighborhood of Nantucket Island, Massachusetts in the western Atlantic. POURTALES, 1869, reports it off Florida in 118 fathoms. LUDWIG, 1900, gives a very complete account of the geographical distribution.

Localities of the 123 specimens in the United States National Museum. — 40° 19' 30" north latitude, 69° 29' 10" west longitude, depth 41 fathoms. 40° 34' 30" north latitude, 69° 50' 45" west longitude, depth 32 fathoms. 42° 01' north latitude, 68° 00' 30" west longitude, depth 86 fathoms. 42° 10.5' north latitude, 70° 29' west longitude, depth 26 fathoms. 42° 23' north latitude, 66° 23' west longitude, depth 141 fathoms. 42° 31' north latitude, 70° 32' west longitude, depth 35 fathoms. 42° 33' north latitude, 70° 31' west longitude, depth 40 fathoms. 42° 41' 30" north latitude, 70° 24' 30" west longitude, depth 26 fathoms. Gloucester Harbor, depth 7—110 fathoms. Coast of Maine. Banks of Newfoundland, depth 26—180 fathoms. Anticosti Island, Canada. Off Newfoundland, from 43° 08' north latitude, 50° 40' west longitude to 45° 33' north latitude, 49° 43' west longitude, depth 36—65 fathoms. Labrador's reef, Ungava. Greenland. Bergen, Norway.

Cucumaria californica SEMPER.

1868. *Cucumaria californica* SEMPER.

1855. *Pentacta frondosa* AYRES.

1907. *Cucumaria frondosa* EDWARDS.

Of the cycle of the Pacific Ocean species similar to *Cucumaria frondosa*, this form most nearly resembles it. In fact, in my paper of 1907, specimens were placed under *Cucumaria frondosa* but the study of this larger series of individuals shows differences in the spicules that make these holothurids agree with *Cucumaria californica* SEMPER. It is probable that the *Pentacta frondosa* of AYRES, 1855, and STIMPSON, 1857, belongs to this species, as SEMPER, 1868, thinks likely. *Cucumaria californica* more or less closely resembles *Cucumaria frondosa* in all characters except the spicules. In addition to SEMPER's description the following facts are noted.

Size in centimeters. — The contracted body in the 31 fixed adults measured has a mean length of 10.6, with a range from

4.4—17 and a mean dorso-ventral diameter of 5.7 with a range from 2.2—8.5. The mean length of the introvert is 2.

Genital papilla. — In the female the genital papilla is usually simple while in the male it is subdivided as in *Cucumaria frondosa*.

Spicules. — Of the 132 spicules of the body-wall seriated from 6 specimens, 64% are more or less irregular perforated plates (Pl. 19, Figs. 5 and 6) having a mean length of 82.4 μ with a range from 63—180 μ ; a mean diameter of 61.7 μ with a range from 31.5—148.5 μ ; and a mean number of holes of 4.4 with a range from 1—12. The remaining 36% are elongated, slender rod-like spicules (Figs. 7—10), having a mean length of 120.6 μ with a range from 58.5 μ to 198 μ ; a mean diameter of 40.5 μ , with a range from 22.5—72 μ ; and a mean number of holes of 3.2 with a range from 0—7. Most of the spicules present a more or less rod-like appearance, for even the irregular plates are one-fourth longer than broad. In the pedicels the supporting plates are heavier (Fig. 11), and often have a 2 or 3 pronged base with a spinose and knobbed outer portion projecting from the surface. The end-plates are multiple being made up of from several to many rods, rosettes, and plates (Fig. 12). The tentacular spicules are mostly straight (Fig. 13), or slightly curved, supporting rods, but there are some plates with as many as 20 holes. Knobs, or spines, or both are present in 72% of the spicules. In some of the holothurids the spicules show degenerative changes and 4 individuals have no spicules. In certain cases small round, or conglomerate calcareous particles (Fig. 14) occur in the body-wall.

Habitat. — The geographical distribution is from Captain's Bay, Unalaska and Bering Island, in the north Pacific Ocean to the Galapagos Islands. Also Mazatlan, Gulf of California, SEMPER, 1868.

Localities of the 46 specimens in the United States National Museum. — 0° 29' south latitude, 89° 54' 30" west longitude. Galapagos Islands, depth, 392 fathoms. Captain's Bay, Unalaska. Afognak Bay, Afognak Island, Point Lipsett, S. 15° E., 1.7 miles, depth 12—17 fathoms. Alitak Bay, Kadiak Island, Cape Alitak S. 41° W., 7.1 miles, depth 36—44 fathoms. Chiniak Bay, Kadiak Island, depth 25—50 fathoms. 54° 52' north latitude, 159° 46' west longitude, depth 21 fathoms. Unalaska Beach. 54° 15' north latitude, 165° 06' west longitude, depth 34 fathoms. 54° 42' 15" north latitude, 164° 49' 15" west longitude, depth 27 fathoms. 54° 49' 30"

north latitude, 164° 49' 15" west longitude, depth 43 fathoms. 55° 44' 20" north latitude, 162° 17' 30" west longitude, depth 22 fathoms. 56° 28' north latitude, 161° 16' 30" west longitude, depth 39 fathoms. 56° 33' 30" north latitude, 164° 31' 40" west longitude, depth 43 fathoms. 56° 44' 30" north latitude, 159° 16' west longitude, depth 16 fathoms. 57° 04' north latitude, 170° 24' west longitude, depth 26 fathoms. 57° 05' north latitude, 170° 35' west longitude, depth 40 fathoms. 57° 05' north latitude, 170° 41' west longitude, depth 48 fathoms. 57° 45' 45" north latitude, 160° 12' 15" west longitude, depth 30 fathoms. Bering Island.

Cucumaria japonica SEMPER.

1868. *Cucumaria japonica* SEMPER.

In the original description of SEMPER, *Cucumaria japonica* is considered as scarcely to be distinguished from *Cucumaria frondosa* and is characterized as having (1) only a rudiment of the calcareous ring in the form of two small pieces of spongy calcareous matter in the connective tissue of each piece, (2) small, elongated perforated plates in the body-wall, pedicels and tentacles and (3) very large radially placed calcareous plates in the cloacal region of the body-wall. In the general part of his monograph SEMPER illustrates from this species the histology of the wall of the body and of the enteric canal, the central and radial nervous system, the muscles, water vascular and other related parts.

This species agrees with *Cucumaria frondosa* in most characters as form, size, color, number and size of tentacles, arrangement and distribution of pedicels, single Polian vesicle, single stone-canal with spherical madreporite, respiratory trees, muscles, and the attachment of the mesentery of the enteric canal. I do not find the calcareous ring so rudimentary as SEMPER describes it but more nearly as given in the excellent account of the species by BRITTEN, 1906. The spicules are characteristic and differentiate the form.

Spicules. — A majority of the perforated plates of the body-wall (Fig. 15), are elongated, knobbed, and spinose but some are irregularly rounded, or triangular. The plates have a mean length of 182 μ with a range from 70—300 μ , a mean width of 81 μ with a range from 45—160 μ and a mean number of holes of 14 with a range from 8—47. In the pedicels and tentacles the spicules are generally of the same type, but often smaller and more slender

varying to the form of supporting rods. The spicules are more or less crowded and usually placed at right angles to the surface of the body.

The large perforated plates described by SEMPER as located in the body-wall of the cloacal region occupy an annular space varying from 2,2—5,4 mm in length and from 1,6—3,4 mm in width. These plates (Fig. 16), are fan-shaped, or irregularly round, with several hundred larger and smaller holes. The mean size of the plates is $425 \times 380 \mu$ with a range from the size of the ordinary body-wall plates to that of Fig. 16 with 1059 holes, and an area of $1350 \times 950 \mu$. Usually the plates are smooth with occasional over-arching bars and are more or less interlocked into a general mass throughout the body-wall surrounding the cloacal region. BRITTEN, 1906, does, not find the large perforated plates of the cloacal region in his specimens. Vestigial anal teeth are found in some individuals and not in others.

Habitat. — Japan, SEMPER, 1868; MITSUKURI, 1896; Sachalin and Wladiwostock, BRITTEN, 1906; Molucca, SLUITER, 1895.

Localities of the 8 specimens in the United States National Museum. Off Japan, Hakodate Bay, depth from 11,5 to 15,5 fathoms.

Cucumaria miniata (BRANDT).

1835. *Cladodactyla* (subgen. *Polyclados*) *miniata*.

1857. *Pentacta miniata* STIMPSON.

1867. *Cucumaria albida* SELENKA.

1885. *Cucumaria japonica* LAMPERT.

The specimen from the Stuttgart Museum described by LAMPERT, 1885, and those by CLARK, 1902, and by EDWARDS, 1907, as *Cucumaria japonica*, are essentially different from SEMPER's species and agree with the holothurids of this collection which in accord with the excellent description of LUDWIG, 1881, are identified as *Cucumaria miniata* BRANDT. I agree with LUDWIG that the *Cucumaria albida* described by SELENKA, 1867, in which there are many (to 60) small stone-canals and with small end-plates in the pedicels, is synonymous with this species.

Form. — In general the body is similar to *Cucumaria frondosa* but the introvert is more slender and from one-half to one-third of the length of the body may be retracted.

Size in centimeters. — The contracted body of the adult

has a mean length of 10.6 with a range from 4—20, and a mean dorso-ventral diameter of 3.8, with a range from 1.4—6.3.

Color. — The alcoholic specimens agree with *Cucumaria frondosa*.

Tentacles. — Ten, large and equal.

Pedicels. — The pedicels agree in arrangement with those of *Cucumaria frondosa* but are more prominent, especially upon the introvert where they are often found almost to the bases of the tentacles.

Genital papilla. — As in *Cucumaria frondosa* sex differentiation is shown in the usually simple conical genital papilla of the female and the subdivided papilla of the male.

Spicules. — The prevalent type of spicule in the body-wall is an elongated, rather thick knobbed perforated plate (Fig. 17) with a mean size of $130 \times 43 \mu$. The length is often 5 or 6 times the breadth thus giving such plates a rod-like form. About 30% of the plates are irregularly rounded (Fig. 18) and in these the mean number of holes is 4, with a range from 1—13, or more. In addition, especially in the young, there is a second class of larger, heavier irregular plates (Fig. 19) with a mean size of $144 \times 102 \mu$. Their holes are comparatively large, the mean diameter being 25μ and the mean number, 6. The spicules are often numerous and crowded. In most specimens there are no masses of large plates in the body-wall of the cloacal region as in *Cucumaria japonica* but 5 small rudimentary anal teeth are noted by LUDWIG, 1881.

The pedicel spicules are similar to the general class of elongated plates found in the body-wall and there are multiple end-plates, as LUDWIG, 1881, describes. In the tentacles the supporting structures are mostly rod-like (Fig. 20), with fewer perforations.

Polian vesicle. — There is considerable variation in the location and number of the Polian vesicles but nothing at all homologous to the indefinite number and distribution of these organs in the genus *Holothuria* (cf. EDWARDS, 1908). Of the 33 specimens examined, 29 (88%), have at least 1 vesicle arising from the ring-canal in the left dorsal interradius. This may be called the primary Polian vesicle and taken to represent the modal state as in *Cucumaria frondosa* albeit there are 16 (50%) with more than 1 vesicle. Of these, 6 have 2 vesicles, 4 have 3 vesicles (like the two specimens of LUDWIG, 1881), 5 have 4 vesicles and 1 has 5 vesicles. The extra vesicles may be termed accessory Polian vesicles. Of the 6 with

2 vesicles, 3 specimens have besides the primary vesicle, 1 accessory vesicle in the left ventral interradius; 1 specimen has the primary and 1 accessory in the right dorsal interradius; another has the 2 vesicles in the left and right ventral interradii, and the last has 1 in the right dorsal interradius and 1 from the base of the left ventral radial canal. Three of the 4 specimens with 3 vesicles have besides the primary vesicle, 1 accessory vesicle in both the left and right ventral interradii while the fourth specimen has 1 accessory vesicle in both the left and right dorsal interradii. Each of the 5 specimens with 4 vesicles has in addition to the primary vesicle, one in both the left and right ventral interradii and the fourth accessory vesicle in the right dorsal interradius while the holothurid with 5 vesicles has them similarly located but with 2 in the last named region. One specimen has the origin of the primary Polian vesicle spreading over the neighboring radial regions. Another holothurid has no primary Polian vesicle but instead 60 little sacs from 0,2—1,2 cm long arising from the ring-canal and the bases of the radial canals. Each little vesicle has 1 or more round white cysts about 1 mm in diameter and filled with some micrococcus. Such cysts occur also in other specimens.

The mean length of the primary Polian vesicle in the adults with 1 vesicle is 19 cm with a range from 9—36 cm. When there are several Polian vesicles some, if not all, are shorter than the above mean. In the young holothurids (with the body under 3—4 cm long), the mean length of the Polian vesicle is 2,6 cm and thus it is evident that in this species the size of the Polian vesicle is correlated with age, while the variation in number is not.

Stone-canal. — As noted by LUDWIG, 1881, LAMPERT, 1885, CLARK, 1902, and EDWARDS, 1907, there are numerous stone-canals which in accord with LAMPERT can be divided into 2 classes. These I will call the principal and accessory stone-canals. The principal stone-canal has a mean length of 4,9 mm with a range from 6—12 mm and the usual median dorsal location. The accessory stone-canals have a mean number of 66, with a range from 4—140, and a mean length of 2,1 mm with a range from 1 mm or less to 6 mm. As my earlier paper (1907) shows, some of these stone-canals are bifid and some, trifid.

The madreporite of the principal stone-canal is spherical in form in a majority of cases but frequently it is either irregular, elongated, or lens-shaped, and has a mean diameter of 1,2 mm with

a range from 0,4—3 mm. In the very young the madreporite is composed of 2 or 3 simple lobes (Fig. 21). The madreporites of the accessory stone-canals are almost constantly spherical in form having a mean diameter of 0,6 mm with a range from 0,4—1,1 mm. One exceptional madreporite is elongated and 5 mm in length.

In the gonads, respiratory trees, muscles and enteric canal this species agrees with *Cucumaria frondosa*.

Habitat. — Pacific coast of North America from Southern California to Cedar Island, Alaska.

Localities of the 35 specimens in the United States National Museum. — 33° 38' 45" north latitude, 118° 13' 45" west longitude, depth 20 fathoms. Sand Point, Humboldt Bay, California. 48° 8' 10" north latitude, 122° 41' 48" west longitude, depth 15—26 fathoms. Port Townsend Bay, Washington. Neah Bay, Washington. Puget Sound, under rocks, low tide. Straits of Fuca. Ottar Bay, Pender Island. 54° 13' north latitude, 163° 06' west longitude, off Unimak, south of Alaska Peninsula, depth 38 fathoms. Cedar Island, Loring, Alaska. Off Shakan, Summer Strait, S. E. Alaska, depth 169—212 fathoms.

Cucumaria fallax LUDWIG.

1874. *Cucumaria fallax* LUDWIG.

1881. *Cucumaria miniata* LUDWIG.

1906. *Cucumaria miniata* BRITTEN.

In most of its characters this holothurian closely resembles *Cucumaria frondosa* but it is differentiated from that species by the size, spicules (including forked anal teeth) and Polian vesicle and from *Cucumaria miniata* besides especially by the presence of only one stone-canal. I have examined the specimens placed by BRITTEN, 1906, under *Cucumaria miniata* and am convinced of their identity with *Cucumaria fallax*.

Size in centimeters. — The 39 specimens seriated have a mean body-length of 5, with a range from 2,4—8,6 and a mean dorso-ventral diameter of 2,1, with a range from 1—3. The anterior part of the body introverted has a mean length of 1,2.

Tentacles. — Ten, large and equal. One variate has 11, the extra tentacle being a second to the left from the mid-ventral radial canal.

Genital papilla. — In the female the genital papilla is

usually simple while in the male it is subdivided, as in *Cucumaria frondosa*.

Spicules. — The characteristic perforated plate of the body-wall is somewhat elongated, smooth or knobbed, and pointed at one end (Fig. 22), or sometimes at both ends. Rounded and irregular plates are also often found but the presence of spines, or knobs (Fig. 23), is infrequent. The mean length is $162,9\ \mu$, with a range from $90\text{--}270\ \mu$, the mean diameter $88,6\ \mu$, with a range from $63\text{--}135\ \mu$ and the mean number of holes $14,4$, with a range from $2\text{--}35$. There are heaps of spicules in the cloacal wall similar to those found in *Cucumaria frondosa*. Around the anus, as BRITTEN, 1906, relates there are 5 forked teeth, or processes, which however I find with difficulty in the contracted specimens. When treated with potash these teeth are shown as composed of closely matted, branched and interwoven calcareous rods. The supporting plates of the pedicels (Fig. 24), are more delicate. In accord with LUDWIG, 1874, I find rudimentary end-plates and not that they are lacking as BRITTEN, 1906, states. In the tentacles the supporting rods (Fig. 25), are straight or curved, often with larger holes.

Polian vesicle. — In 36 of the 39 specimens examined there are at least 2 Polian vesicles, one arising from the ring-canal in the left dorsal, and the other, in the right dorsal, interradius. In 30 specimens (77%), there are only 2 vesicles, and in only 2 of these is there a variation from the above modal condition in that while 1 vesicle is as usual in the left dorsal interradius, the second is in the left ventral interradius. There are 3 specimens having 3 Polian vesicles, the extra vesicle being in the left ventral interradius in 2, and in the right ventral interradius in the third. Six specimens have 4 Polian vesicles, 5 with 2 extra vesicles in the left and right ventral interradii, and 1 with 1 extra vesicle in the right ventral interradius and 1 from the mid-ventral radial canal. One specimen has 5 Polian vesicles with 1 extra vesicle in each of the left and right ventral and the mid-dorsal interradii.

Stone-canal. — The stone-canal is single, having a mean length of $3,1\text{ cm}$, with a range from $1\text{--}6\text{ cm}$. In each of 2 specimens there are 2 accessory stone-canals. The madreporite is variable in form, in most cases being irregular but some are elongated and others pear-shaped, or lens-shaped, or irregularly spherical. Only 40% have the spherical form characteristic of *Cucu-*

maria frondosa. The mean greatest diameter is 2,4 mm with a range from 0,7—8 mm.

Habitat. — Alaska to Okotsk Sea, Alaska, LUDWIG, 1874; Gulf of Sachalin, Okotsk Sea, BRITTEN, 1906.

Localities of the 49 specimens in the United States National Museum. — Atka, Alaska, abundant on rocky ledges just below low water-mark. Adakh Island. Bering Island.

The Zoological Station, Naples, June 14, 1910.

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Explanation of Plates.

(All the figures were drawn with the aid of an ABBE camera lucida.)

Plate 19.

Figs. 1—4. *Cucumaria frondosa* (GUNNER).

Fig. 1. Male genital papilla with twenty-two subdivisions, of which one is somewhat removed from the others. 6:1.

Fig. 2. Large irregularly square ridged perforated plate of the body-wall. 210:1.

Fig. 3. End view of pedicel showing the multiple end-plate, supporting perforated plates with spinose projecting ends; and smaller spicules in profile. 135:1.

Fig. 4. Knobbed supporting rod of the tentacle. 210:1.

Figs. 5—14. *Cucumaria californica* SEMPER.

Figs. 5—6. Irregular perforated plates of the body-wall. 210:1.

Figs. 7—10. Elongated rod-like perforated plates of the body-wall. 210:1.

Fig. 11. Supporting plate of the pedicel with two-pronged base and spinose distal branch. 210:1.

Fig. 12. End-plate of the pedicel. 210:1.

Fig. 13. Supporting rod of the tentacle. 210:1.

Fig. 14. Small round or conglomerate particles of the body-wall. 210:1.

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Figs. 15—16. *Cucumaria japonica* SEMPER.

Fig. 15. Knobbed perforated plate of the body-wall. 210 : 1.

Fig. 16. Large perforated plate from the cloacal region of the body-wall. 57 : 1.

Figs. 17—21. *Cucumaria miniata* (BRANDT).

Fig. 17. Elongated knobbed perforated plate of the body-wall. 210 : 1.

Fig. 18. Irregularly round perforated plate of the body-wall. 210 : 1.

Fig. 19. Large irregular perforated plate of the body-wall. 210 : 1.

Fig. 20. Supporting rod of the tentacle. 210 : 1.

Fig. 21. Stone-canal and three-lobed madreporite of a very young specimen. $4\frac{1}{2}$: 1.

Figs. 22—25. *Cucumaria fallax* LUDWIG.

Fig. 22. Perforated plate of the body-wall with one end pointed. 210 : 1.

Fig. 23. Rounded perforated plate of the body-wall. 210 : 1.

Fig. 24. Supporting plate of the pedicel. 210 : 1.

Fig. 25. Supporting rod of the tentacle. 210 : 1.



Fig. 1.

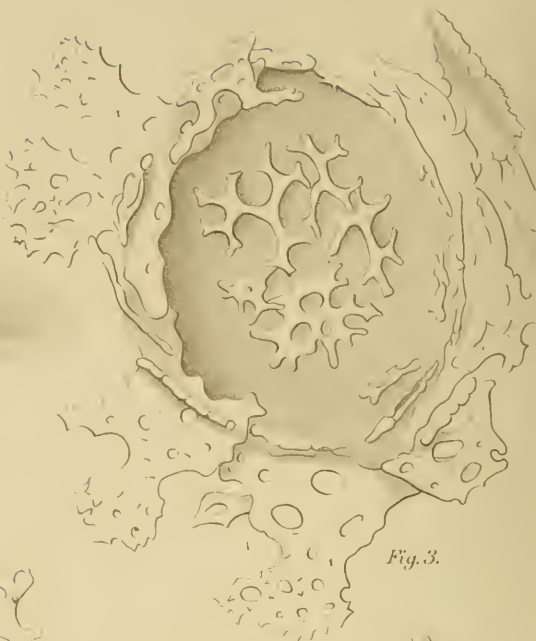


Fig. 3.



Fig. 12.



Fig. 13.



Fig. 14.

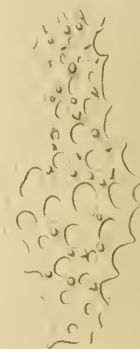


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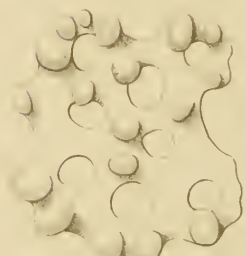


Fig. 19.



Fig. 20.

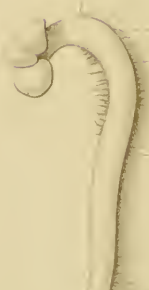


Fig. 21.



Fig. 22.



Fig. 2.

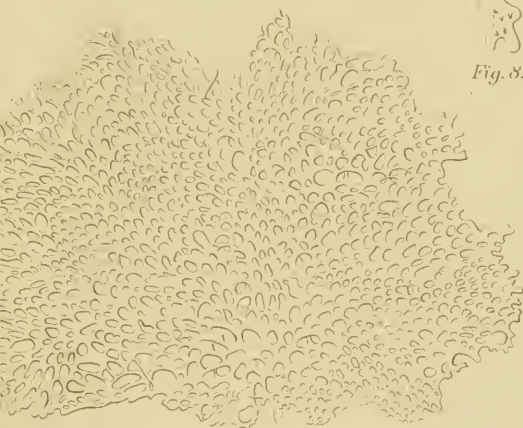


Fig. 16.

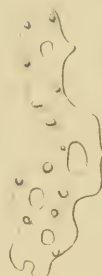


Fig. 4.



Fig. 5.

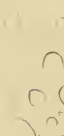


Fig. 6.



Fig. 7.



Fig. 8.



Fig. 9.



Fig. 10.



Fig. 11.



Fig. 17.



Fig. 18.



Fig. 25.

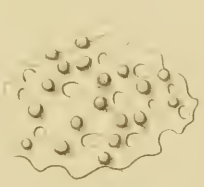


Fig. 23.



Fig. 24.



Fig. 1.

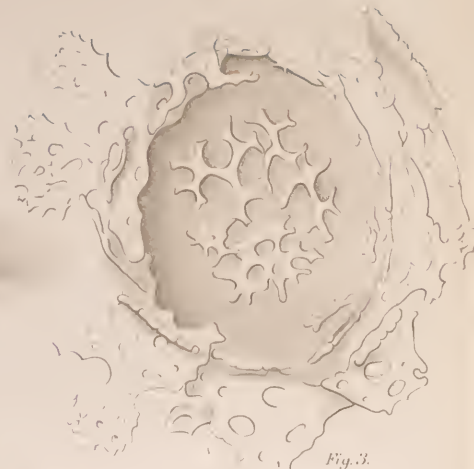


Fig. 3.



Fig. 2.



Fig. 4.



Fig. 5.

Fig. 6.



Fig. 7.



Fig. 12.



Fig. 13.



Fig. 14.

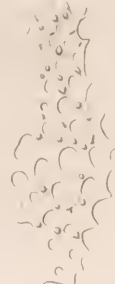


Fig. 15.

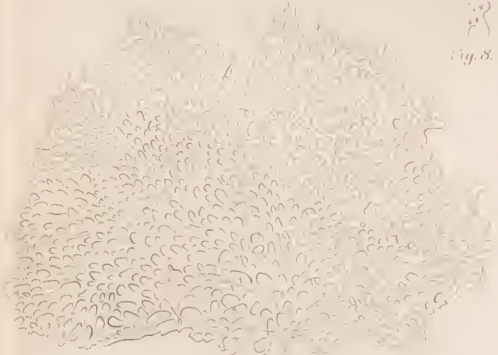


Fig. 16.



Fig. 18.



Fig. 19.



Fig. 20.



Fig. 21.



Fig. 19.



Fig. 20.



Fig. 21.



Fig. 22.



Fig. 23.



Fig. 24.



Fig. 25.



Fig. 26.



Fig. 27.

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Zeitschrift/Journal: [Zoologische Jahrbücher. Abteilung für Systematik, Geographie und Biologie der Tiere](#)

Jahr/Year: 1910

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