

THE HOLOTHURIANS OF THE NORTH PACIFIC COAST
OF NORTH AMERICA COLLECTED BY THE ALBATROSS
IN 1903.

By CHARLES LINCOLN EDWARDS,
Of Trinity College, Hartford, Connecticut.

This paper is based on a collection of Holothurians made by the Bureau of Fisheries steamer *Albatross* along the north Pacific coast of North America during the Alaska salmon investigations of 1903. The collection contains eleven species, one of which, *Chiridota albatrossii*, is a new form. The specimens have been added to the general collection of the United States National Museum.

The synonymy is given only for the species discussed. The literature bearing on such forms is appended. In filling out the habitats I am particularly indebted to the important work of Ludwig, published in 1900.

1. CHIRIDOTA LÆVIS (Fabricius) 1780.

June 20, 1903.—One tentacle-crown and one body fragment; Station 4193; lat. $49^{\circ} 20' 30''$ N., long. $123^{\circ} 35' 40''$ W.; 18 to 23 fathoms; bottom, temperature 50.3° , green mud and fine sand.

Habitat.—Eastern coast of North America from Massachusetts (lat. 42° N.) to Labrador (Ayers, 1852; Stimpson, 1853; Packard, 1860; Verrill, 1861, 1866; Selenka, 1867; Bush, 1883; Lampert, 1885; Ganong, 1884, 1886, 1890?; Whiteaves, 1901). West coast of Greenland to lat. 69° N. (Fabricius, 1780; Lütken, 1857; Stimpson, 1863; Norman, 1876; Duncan and Sladen, 1881; Ludwig, 1882). West and north of West Spitzbergen to lat. 80° N. (Ljungman, 1879). Norwegian coast to Finmark (Vahl, 1806; M. Sars, 1850, 1861); Danielssen, 1861; Bidentap, 1899; Östergren, 1902). Murman coast (Jarzynsky, 1885). Kara Sea (Stuxberg, 1886). Ludwig, 1900 (p. 165), gives the entire range from lat. 70° W. to 68° E., but Clark, 1902, reports this species from Sitka and the *Albatross* Alaska Salmon Investigations, 1903, from the Gulf of Georgia, Halibut Bank, Vancouver Island, British Columbia, so that now it can be given as circumpolar. Depth, 0 to 27 fathoms, exceptionally to 45 fathoms.

2. CHIRIDOTA ALBATROSSII Edwards, new species.

June 25, 1903.—No tentacle-crown, but twelve body fragments; Station 4201, 138 to 145 fathoms; bottom, temperature 45.5° , soft gray mud, sand, broken shells. July 6.—Three tentacle-crowns and eleven body fragments; Station 4223; lat. $55^{\circ} 1' 9''$ N., long. $130^{\circ} 42' 3''$ W.; 48 to 57 fathoms; bottom, temperature 44.6° , soft, green mud. July 7.—One body fragment; Station 4226; lat. $55^{\circ} 36' 18''$ N., long. $131^{\circ} 37' 16''$ W., 31 to 62 fathoms; bottom, temperature 44.8° , rocky. July 7.—One tentacle-crown and one body fragment; Station 4228; lat. $55^{\circ} 36' 15''$ N., long. $131^{\circ} 42' 30''$ W.; 41 to 134 fathoms; bottom, temperature 47.8° , gravel, sponge. July 7.—One body fragment; Station 4232; lat. $55^{\circ} 35' 36''$ N., long. $131^{\circ} 53' 49''$ W.; 77 to 93 fathoms; bottom, temperature 43.3° , green mud, sponge, rocky. July 9.—One body fragment; Station 4239; lat. $55^{\circ} 28' 35''$ N., long. $131^{\circ} 46' 48''$ W.; 206 to 248 fathoms; bottom, temperature 48.8° , coarse sand, rocky.

These specimens resemble *C. lævis* (Fabricius) in many respects, but the presence of rods in the anterior part of the body wall, the greater size of the body, and the larger number of wheel-papillæ constitute the chief differential characters of this new species.

In 1851 Pourtalés described a *Chiridota* from Florida under the name of *Synapta rotifera*. Pourtalés's species also has rods in addition to the wheels, but it is much smaller than *albatrossii* and lives among the branches of coral in shallow water.

Generally *C. lævis* has been taken from rather shallow water (up to 27 fathoms, only exceptionally up to 50 fathoms, Ludwig, 1900, p. 165), while these specimens come from a range of 31 to 248 fathoms.

Body.—Elongated, cylindrical. One fragment 21.5 cm. long and 9 mm. in diameter, whole posteriorly, has some of the detached ends of gonads in the anterior coelom, where it is broken off from the tentacular piece, so it may represent approximately the length of the individual in alcohol. But in this specimen the body wall is greatly contracted, as shown by the many thickened folds and the crowded dorsal wheel-papillæ. Therefore it is probable that the living animal is considerably longer. Another fragment, also with anal end intact, is 22 cm. long and the diameter varies from 6 mm., where most contracted, to 12 mm. in the well-expanded parts, where the skin is stretched thin. A third fragment, with both anterior and posterior ends missing, measures 17 cm. in length and 5 mm. in diameter. Since the remaining shorter pieces are of about the same average diameter as the above, it may be assumed that, with the tentacular part added, the species would have a length of 18 to 25 cm. and a diameter of 6 to 12 mm. In regard to the size of *C. lævis*, Duncan and Sladen, 1881 (p. 14), say: "The largest example of this species has been recorded by Sars, and measured 100 mm. in length; generally,

however, they range from 20 to 40 mm." Consequently this new species is over twice the greatest and seven times the average length of *C. lævis*.

Color.—In alcohol, vinaceous with spots of burnt sienna scattered all over the body and the tentacles.

Tentacles.—Twelve, generally with 8 to 12 digits; in one specimen some tentacles have 6 digits; in another, 14.

Spicules of the body wall.—Wheels in all respects like those of *C. lævis*. (See Duncan and Sladen, 1881, Plate I, fig. 18.) Diameter, 0.08 to 0.12 mm.; average, 0.1 mm. The wheel-papillæ are arranged in

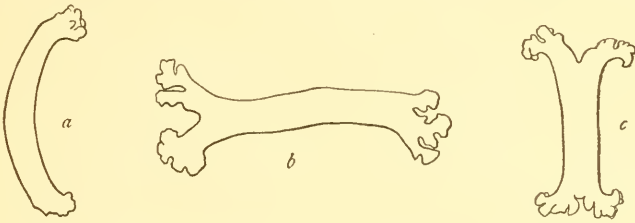


FIG. 1.—*CHIRIDOTA ALBATROSSII*. *a-c*, CALCAREOUS RODS. ($\times 340$.)

three rather irregular, more or less distinct, longitudinal rows in the dorsal inter-radii, while ventrally they are few and scattered. In the fragment of the body, 17 cm. long, there are about 68 to 75 in each row. In *C. lævis* there are 20 to 30 in each of the three rows.

Rods.—In the anterior body wall. In the longest specimen with tentacles these rods are at the posterior end of the piece, 4 cm. from the tentacles. The rods are straight to crescentic (fig. 1*a*), ends



FIG. 2.—*CHIRIDOTA ALBATROSSII*. *d-f*, CALCAREOUS RODS. ($\times 340$.)

spinose, now one (fig. 1*b*) and then both (fig. 1*c*) bifid, while very rarely the branches unite to make perforations. Often there is a small cluster of spines at the middle (fig. 2*d*).

Occasionally the rod has compound curves (fig. 2*e*), and very rarely it is triradiate (fig. 2*f*).

Size of rods in millimeters.—Length, 0.05 to 0.15, average, 0.1; width, 0.007 to 0.02; average, 0.01; width of branched ends, up to 0.06.

Spicules of the tentacles.—Rods similar to those in the body wall.

Calcareous ring.—Like *C. lævis*.

Polian vesicles.—In the four specimens, 10, 16, 17, and 18, scattered from right to left dorsal radius. In one specimen the longest is

10 mm. In the other three the longest are 5 mm. and the shortest 1.5 mm.

Stone canal.—Much coiled, adherent to the dorsal mesentery. The madreporite (fig. 3) has a number (in one case 27) of transverse folds, which project from the mesentery.

Gonads.—In two tufts, one each side of the mesentery; tubes dichotomously branched. Of the specimens with gonads, two are female and one male.

Retractor muscles.—Well developed.

Ciliated funnels.—On the mesentery, near the body wall, similar to those of *C. lewis* (Duncan and Sladen, 1881, Plate I, fig. 17).

Habitat.—Queen Charlotte Sound, off Fort Rupert, Vancouver Island, British Columbia; Boca de Quadra, vicinity of Naha Bay, Behm Canal, junction of Clarence Strait and Behm Canal, southeast Alaska. (*Albatross* Alaska Salmon Investigations, 1903.) These localities constitute the type region.

Type.—Cat. No. 25003, U.S.N.M.



FIG. 3.—CHIRIDOTA ALBATROSSII. STONE CANAL AND MADREPORITE. ($\times 29$.)

3. ANKYRODERMA JEFFREYSII Danielssen and Koren, 1879.

June 20, 1903—Six specimens; Station 4198; lat. $49^{\circ} 18' 30''$ N., long. $123^{\circ} 46' 12''$ W.; 157 to 230 fathoms; bottom temperature, 46.8° , soft, green mud. July 6—One specimen; Station 4224; lat. $55^{\circ} 9' 24''$ N., long. $130^{\circ} 41' 48''$ W.; 156 to 166 fathoms; bottom temperature, 43.7° , dark, green mud. July 7—One specimen; Station 4230; lat. $55^{\circ} 35' 13''$ N., long. $131^{\circ} 50' 11''$ W.; 108 to 240 fathoms; bottom temperature, 42.4° , rocky.

Not one anchor was found, albeit in most cases a stump of varying length is present. This I take to be the proximal part of the stock of the anchor, the distal part, with the arms having been broken off. As Théel, 1886 (p. 49), suggests, such a stump with broken end might easily have been taken

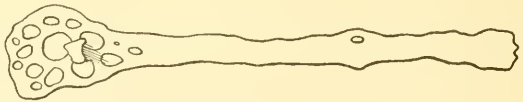


FIG. 4.—ANKYRODERMA JEFFREYSII. "SPOON-LIKE" ROD WITH RUDIMENTARY SPIRE. ($\times 111$.)

for the long process of the "cups" by v. Marenzeller in describing his *A. roretzii*. On many of the "spoon-like" rods there arises, about the middle of the widened part of the rod, a sort of rudimentary spire, or process (fig. 4), which hitherto has not been described. In some specimens a degeneration has affected the "spoon-like" rods so that they are wholly or partially absorbed, with, at the same time, a

deposition upon them of the red matter ordinarily peculiar to the wine-red bodies. Théel, 1886, notes a similar change of color in the tables of *Trochostoma antarcticum* Théel.

Habitat.—Lesser Antilles, lat. 12° to 16° N., long. 62° W.; also lat. 33° to 42° N., long. 66° to 76° W. (Théel, Blake Report, 1886). Finmark and north to Barents Sea to lat. 70° to 75° N., long. 21° to 31° E. (Danielssen and Koren, 1882, Hoffman, 1882, Sluiter, 1895). Northwest of Spitzbergen to lat. 80° N., long. 6° E. (Danielssen and Koren, 1882), lat. 81° to $81^{\circ} 15'$ N., long. 19° to 23° E. (Ludwig, 1900). Gulf of Georgia, Vancouver Island, British Columbia, Boca de Quadra, Naha Bay, southeast Alaska (*Albatross* Alaska Salmon Investigations, 1903).

4. TROCHOSTOMA OÖLITICUM (Pourtalès), 1851.

After the examination of a large series of specimens, Clark, 1904, concludes that *Molpadia borealis* Sars, 1861, is a synonym of the species described by Pourtalès in 1851 as *Chirodota oöliticum* and following Danielssen and Koren, 1879, usually given as *Trochostoma boreale*.

June 20, 1903.—Two specimens; Station 4194; lat. $49^{\circ} 19' 30''$ N., long. $123^{\circ} 35' 40''$ W.; 111 to 170 fathoms; bottom, temperature 48.3° , soft, green mud. June 20.—One specimen; Station 4198; lat. $49^{\circ} 18' 30''$ N., long. $123^{\circ} 46' 12''$ W.; 157 to 230 fathoms; bottom, temperature 46.8° , soft, green mud. July 8.—One specimen; Station 4237; lat. $55^{\circ} 50' 40''$ N., long. $131^{\circ} 46' 38''$ W.; 194 to 198 fathoms; bottom, temperature 42.6° , green mud. July 9.—One specimen; lat. $55^{\circ} 28' 0''$ N., long. $131^{\circ} 57' 40''$ W.; 248 to 256 fathoms; bottom, temperature 48.8° , hard coral.

Habitat.—Florida Reefs (Pourtalès, 1869). Lesser Antilles (Théel Blake Report, 1886). Portland, Maine (Verrill, 1873). Casco Bay, Maine (Kingsley, 1901). West of Norway (Danielssen and Koren, 1882, Östergren, 1902). Finmark and northward (M. Sars, 1861, Danielssen and Koren, 1882). South and northwest of Spitzbergen (Danielssen and Koren, 1882). Barents Sea (v. Marenzeller, 1877, Hoffman, 1882, Danielssen and Koren, 1882, Sluiter, 1895). Kara Sea (Stuxberg, 1879, 1880, 1886, Levinsen, 1886, Sluiter, 1895). East of Cape Tscheljuskin (Stuxberg, 1880). Point Barrow (Murdoch, 1885). Gulf of Georgia, Halibut Bank, Vancouver Island, British Columbia, Behm Canal, southeast Alaska (*Albatross* Alaska Salmon Investigations, 1903). The range given by Ludwig, 1900 (p. 161), as 287° degrees through the northern Atlantic Ocean to the Siberian Polar Sea from the Florida Reefs (long. 83° W.) to Point Barrow (long. 156° W.) is now extended south in the northern Pacific to Vancouver Island, British Columbia (lat. 50° N., long. 127° W.). Depth from 20 to 650 fathoms, usually more than 55 fathoms and less than 540 fathoms.

5. CUCUMARIA CALCIGERA (Stimpson), 1851.

1851. *Pentacta calcigera* STIMPSON, p. 67.
 1867. *Pentacta calcigera* PACKARD (cf. Whiteaves, p. 45).
 1867. *Cucumaria korevii* SELENKA, p. 350.
 1867. *Cucumaria calcigera* SELENKA, p. 351.
 1888. *Pentacta calcigera* GANONG, p. 52.
 1900. *Cucumaria calcigera* LUDWIG, p. 146.
 1901. *Cucumaria calcigera* CLARK, p. 162-171.
 1901a. *Cucumaria calcigera* CLARK, p. 492.
 1901. *Pentacta calcigera* KINGSLEY, p. 164.
 1901. *Pentacta calcigera* WHITEAVES, p. 45

(For other titles in the synonymy see Ludwig, 1900, p. 146).

July 7, 1903.—Four specimens; Station 4231; lat. $55^{\circ} 35' 36''$ N. long. $131^{\circ} 52' 33''$ W.; 82 to 113 fathoms; bottom, temperature 43.0° , green mud, slate fragments, sponge, rocky. July 8.—Two specimens; Station 4233; lat. $55^{\circ} 54' 16''$ N., long. $131^{\circ} 45' 58''$ W.; 39 to 45 fathoms; bottom, temperature, 44.7° , soft, gray mud, rocky. July 11.—Eleven specimens; Station 4246; lat. $55^{\circ} 27' 57''$ N., long. $132^{\circ} 15' 0''$ W.; 101 to 123 fathoms; bottom, temperature 44.1° , gray, green mud; coarse sand, shells.

The following description includes an account of the stone canal, perforated plates of the introvert (peristome), supporting rods of the tentacles and certain features of the spicules of the body wall, which up to this time have not been described.

Form.—The body is curved like a crescent tapering to both anterior and posterior extremities, the latter being much more slender. Often the curvature is so increased that the two ends come together. One example with the tentacles completely extruded (and thus 15.5 cm. long on the dorsal mid-line) shows the anterior fifth (2.8 cm.), straight, of a uniform diameter (0.8 cm.) and devoid of pedicels for 2 cm. from the base of the tentacles. This anterior portion is thin and flexible in contradistinction to the firm, stiff main part of the body, and may be called the introvert (peristome of Delage and Hérouard, 1903-4). When it is retracted the apparent anterior extremity, as seen in most alcoholic specimens, is as Théel, 1886 (p. 103), says "more truncated" than the caudal portion.

Size.—The average measurements of the 17 specimens in the collection gives in centimeters: Length from the apparent anterior end of the body (the introvert being retracted) to anus, along mid-dorsal line, 4.3, range 1.7 to 7.7; along mid-ventral line 8.42, range 3.5 to 12.7; largest diameter, dorso-ventral 1.45, range 0.7 to 2.2, transverse 1.28, range 0.6 to 1.7.

Color.—White, with tints of cream color to tawny olive in certain parts derived from slime which has been deposited, especially along the bands of pedicels. Oral disk, clove brown.

Tentacles.—Ten, the two ventral about half the size of the others and arising somewhat nearer the mouth. Color, mixed white and clove brown.

Genital papilla.—Three millimeters long, colored like the tentacles.

Pedicels.—Confined to the ambulacra; dorsal in two zigzag rows, ventral in four to five zigzag rows toward the middle. Smaller toward the extremities, especially posteriorly. Each pedicel is conical, non-retractile, the longest ventrally (2 to 3 mm.).

Body wall.—Thin (about 0.3 mm. thick), semitransparent, firm and rough to the touch from the numerous crowded, imbricated spicules. In the introvert, especially thin and transparent with scattered, knobbed plates.

Bell, 1883 (pp. 481-484), Lampert, 1885 (p. 142), Lütken, 1857 (pp. 6-7), Marenzeller, 1874 (pp. 11-12), Théel, 1886 (pp. 103-104), Duncan and Sladen, 1881 (p. 7), and Ludwig, 1886 (pp. 278-279), have described the spicules. The last two descriptions, together with that of Lütken, are especially good, but since I have found new spicules in the introvert and tentacles, as well as ridges on the perforated plates and the disks of the tables, I have concluded to

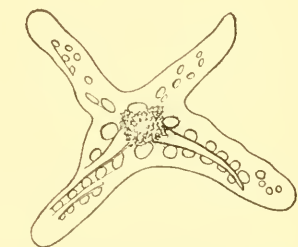


FIG. 5.—CUCUMARIA CALCIGERA. UPPER SURFACE OF TABLE FROM THE BODY-WALL. ($\times 110\frac{1}{2}$.)

redescribe the spicules in general.

Spicules of the body wall.—*Tables*.—Disk flat, very irregular, round to four-rayed with all intermediate forms. Four central holes surrounding the spire constitute a diamond (fig. 5), and vary from 0.02 to 0.04 mm. in diameter, being generally, but not always, larger than the peripheral holes, which vary from 0.01 to 0.04 mm. In the elongated and stellate forms the holes, numbering from four to forty, are in one to three rows. These rows are usually more distinct in the prolongations.



FIG. 6.—CUCUMARIA CALCIGERA. SIDE VIEW OF TABLE FROM THE BODY-WALL. ($\times 110\frac{1}{2}$.)

Besides the rows there are often additional holes irregularly distributed. In the circular disks the holes are in one to two irregular rings. Sometimes there are ridges running out from the spire onto the rays between the rows of holes (fig. 5).

Size of disks in millimeters.—Length 0.15 to 0.45, average 0.23; width 0.06 to 0.44, average 0.18; diameter of circular forms 0.1; average width of rays in stellate forms 0.08.

Spire.—Conical or club shaped (fig. 6); may be solid, but generally gives evidence of being composed of four rods, which, in their more or less complete fusion, leave from one to four distal holes, and sometimes one to two below these. In the young (10 to 15 mm. long) the

spires are present on all of the outer plates as drawn by Duncan and Sladen, 1881 (Plate I, fig. 6), but in older individuals I find that the spires may occur only occasionally. This agrees with the important and suggestive results obtained by Mitsukuri, 1897, for *Stichopus japonicus* Selenka.

Size of spire in millimeters.—Height 0.06 to 0.1, diameter 0.45.

Crown generally bears from 6 to 40 teeth, average number 13 (fig. 6). In some cases the teeth arise from projections which may be subdivided;

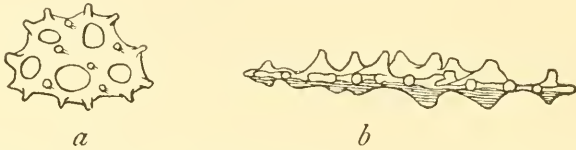


FIG. 7.—CUCUMARIA CALCIGERA. PERFORATED PLATE OF THE INTROVERT. a, UPPER SURFACE; b, PROFILE. ($\times 166$.)

vided; in other cases the teeth are very small and difficult to count, or, again, they may be almost fused into one mass (fig. 5).

Diameter of crown in millimeters.—0.02 to 0.04, average 0.03.

Perforated plates.—Smooth, round to four-rayed, holes arranged as in the disk of the tables, or irregularly distributed. Sometimes ridges arise running between the rows of holes.

Size of plates in millimeters.—Length 0.12 to 0.54, average 0.29; width 0.09 to 0.45, average 0.15; thickness 0.008 to 0.03, average 0.02; diameter of holes 0.008 to 0.03.

Spicules of the introvert.—Irregular perforated plates with jagged edges and bearing spines (fig. 7a); usually more numerous on one

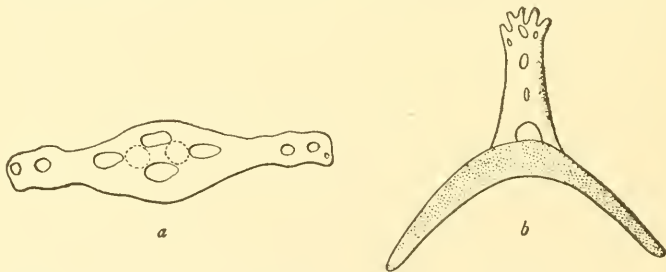


FIG. 8.—CUCUMARIA CALCIGERA. SUPPORTING TABLE FROM A PEDICEL. a, UPPER SURFACE; b, PROFILE. ($\times 340$.)

face than the other, as seen in the profile view (fig. 7b). The number of holes varies from 1 to 21, average 5.4; the number of spines from 1 to 21, average 11.8,

Size of plates in millimeters.—Length 0.11 to 0.27, average 0.17; width, 0.08 to 0.11; average, 0.09.

Spicules of pedicels.—No supporting rods other than the supporting tables (fig. 8a-b).

Disks.—Arched, elongated, wider at the middle, with four central holes and one to four holes in the ends of the two rays (fig. 8*a-b*).

Size of disk in millimeters.—Length 0.09 to 0.17, average 0.13; height of arch 0.02 to 0.06, average 0.05; width at middle 0.03 to 0.08, average 0.04; width of ends about one-half of that of middle.

Spire.—Composed of rods not so much fused as in the tables of the body wall, leaving one proximal hole, none to six distal holes, and sometimes a distinct hole between the proximal and distal holes (fig. 8). The spire is often compressed. The spires are longer and more slender than those drawn by Bell, 1883 (Plate VIII, fig. 2*a*), and Ludwig, 1886 (Plate VI, fig. 5). The figures of Bell are intermediate between that of Ludwig and my own, so that I think all may be taken as within the range of variation. I have often noticed spires which have been broken off that resemble Bell's figures.



FIG. 9.—*CUCUMARIA CALCIGERA*. SPINOSE, PERFORATED TENTACLE ROD. ($\times 110\frac{1}{2}$.)

Size of spire in millimeters.—Height 0.03 to 0.09, average 0.05; diameter at base 0.02 to 0.04, average 0.03; at crown 0.008 to 0.03, average, 0.02.

Crown.—Four to twenty generally simple teeth arise from the end and sides (fig. 8*b*). The crown may be compressed or rounded.

Terminal plate.—Holes may be all of the same size, or small at the center and larger peripherally, or vice versa.

Diameter in millimeters.—0.11 to 0.15, average 0.12.

Spicules of tentacles.—Supporting rods of very diverse form, occasionally irregular plates. The rods (fig. 9) are spinose and perforated. The plates also may bear spines. The spicules are apparently adapted in curvature and size to the special parts of the tentacles in which they occur. The plates are usually found in the terminal branches and resemble those of the introvert, except in size.

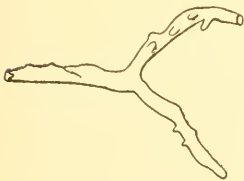


FIG. 10.—*CUCUMARIA CALCIGERA*. FRAGMENT OF CALCAREOUS RING NETWORK. ($\times 340$.)

Size in millimeters—Tentacular supporting rods.—Length 0.14 to 0.72, average 0.35; width 0.008 to 0.11, average 0.05. *Plates* 0.06 to 0.18, average 0.1; width 0.02 to 0.08, average 0.05.

Calcareous ring.—Of ten rather slender species, each being made up of a calcareous network (fig. 10), rather thicker in places, and therefore appearing composite. Radialia shallow-tailed posteriorly, the two prolongations extending to the ring canal. Interradialia wedge-shaped, pointed anteriorly.

Polian vesicle.—One, distended, pear-shaped. Length 0.7 to 1.2 mm., average 0.85 mm.

Stone canal.—Hitherto the small, delicate stone canal has been overlooked. It is single, straight, or convoluted, embedded in the dorsal mesentery until near the madreporite, which projects free in the cœlom generally to the right, but in one case to the left of the mesentery. The madreporite is kidney-shaped (fig. 11*a*), and consists of two leaves or valves with thickened edges as if a round, thick-lipped disk attached at the center to the stone canal had been once folded, so that the opposite edges lie near together, forming the distal portion of the structure. (Fig. 11*b*.) In the fifteen specimens examined one stone canal had its terminal part bifid for a short distance, each branch bearing a head of normal size; another had, besides the usual madreporite, two small subsidiary heads, sessile upon the main tube, a short distance from the distal end. Average length of the stalk 3 mm.; of the head 0.8 mm. After treatment with potash it is

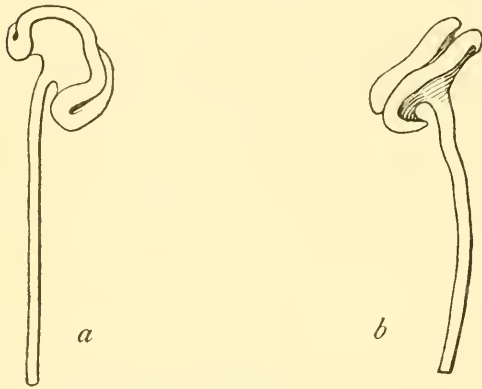


FIG. 11.—CUCUMARIA CALCIGERA. STONE CANAL AND MADREPORITE. *a*, SIDE VIEW; *b*, DISTAL VIEW. ($\times 27$.)

found that at the junction of the madreporite with the stone canal the calcareous network is comparatively coarse and open, but proceeding toward the periphery the calcareous threads become finer and the meshes smaller, until in the thickened rim they are decidedly finer, densely crowded, and clearly marked off from the central part of the disk.

Gonads.—In two tufts of simple tubules, one either side of the dorsal mesentery.

Respiratory trees.—Two, each with small branch given off near the cloacal origin. The main stems are in the right and left dorsal inter-radii, reaching nearly to the anterior end of the body, the right being slightly longer. The branches lie in the right and left ventral inter-radii, extending to about the middle of the body.

Retractor muscles.—Strongly developed. In comparison the longitudinal bands are weak.

Habitat.—Massachusetts (Stimpson 1851, Verrill 1866). Cape Breton Island, Nova Scotia (Whiteaves 1901). Labrador (Verrill 1866, Packard 1867). West Greenland to lat. 69° N. (Lütken 1857, Norman 1876, Ludwig 1883). Assistance Bay, lat. 74° N., North American Polar Sea to lat. 75° N., long. 95° W. (Forbes 1852. Duncan and Sladen 1881). Wajgatsch Island, lat. 73° N. Kara Sea to long. 64° E. (Stuxberg 1879, 1886). Plover Bay, Bering Sea (Lud-

wig 1886). Bering Strait (Stuxberg 1880). (Thus from long. 173° W. to long. 65° E., two-thirds circumpolar Ludwig, 1900). Pacific Grove, California (Clark 1901a). Naba and Yes Bays, Behm Canal, Prince of Wales Island, southeast Alaska (*Albatross* Alaska Salmon Investigations, 1903).

6. CUCUMARIA CHRONHJELMI Théel, 1886.

June 27, 1903.—One specimen; Quarantine Station, Dock Port Townsend, Washington. June 30.—One specimen; Station 4209; lat. 48° 8' 55" N., long. 122° 41' 10" W.; 24 to 25 fathoms; bottom, temperature 50.3°, rocky, coarse sand, shells.

The deficiency in figures of the spicules in Théel's original description is supplied by Clark, 1901. In the tentacles, the supporting rods vary in form to irregular plates, and either the rods or plates may bear spines, a fact not brought out by Clark's description, or figure.

Habitat.—Vancouver Island (Théel, 1886), Puget Sound (Clark, 1901), Port Townsend, Washington (*Albatross* Alaska Salmon Investigations, 1903).

7. CUCUMARIA VEGÆ Théel, 1886.

August 24, 1903.—One specimen from Shakan Beach, southeast Alaska.

This specimen, in general agreement with the description of Théel, 1886, has the following measurements in centimeters: Length, 2.7; dorso-ventral diameter, 1.2; transverse diameter, 1.1. The color of the specimen in alcohol is slate-black around the mouth and anus as well as in the dorsal region, shading laterally to mixed light gray and smoke gray on the ventral surface. The tentacles are black and the ends of the pedicels cream color. Usually, in larger individuals especially, the color is seal-brown dorsally shading to chocolate ventrally. There are many examples of this species in the collections of the United States National Museum which I have at hand, and, as Clark, 1902, notes, this species is very abundant in the North Pacific.

Habitat.—Bering Island, Théel Challenger Report, 1886. Sitka, Pribilof Islands, Copper Island (Clark, 1902). Shakan Beach, southeastern Alaska (*Albatross* Alaska Salmon Investigations, 1903).

8. CUCUMARIA FRONDOSA (Gunnerus), 1767.^a

Synonymy in Ludwig, 1900, p. 141-2.

August 3.—One specimen; Station 4272: Afognak Bay, Afognak Island; 12 to 17 fathoms; bottom, sticky mud. August 6.—One specimen; Station 4273; Alitak Bay, Kadiak Island; 36 fathoms; bottom, green mud, fine sand.

^a Ludwig, 1900, gives 1770 the date of the German translation instead of 1767, the date of publication of the original description of Gunnerus in Kongl. Vetenskaps Acad. Hand-lingar för Ar, 1767.

Size in millimeters.—Introvert extended, length; specimen *a*, 50; greatest diameter, 25; introvert retracted, length, specimen *b*, 90; greatest diameter, 70.

Spicules of body wall.—Irregular perforated plates as described and figured by Clark, 1904.

Culcarous ring.—Well developed when compared with *japonica*.

Polian Vesicle.—In *b*, one, rather long. In *a*, three; one in the right ventral interradius, one in the left ventral interradius, and one in the left ventral radius.

Stone canal.—One, short, in dorsal mesentery, with a single head of very closely crowded madreporites projecting from the dorsal mesentery toward the oral ring.

Ludwig, 1900, and Clark, 1901*a*, 1904, question the occurrence of this species on the Pacific coast of North America, but these two specimens, with the chief characters as briefly related above, are, beyond question, of the type *frondosa* as described, for instance, by Clark, 1904, page 566.

Habitat.—(?) Florida Reef (Pourtales, 1869). Massachusetts to Labrador (Gould, 1841, Ayers, 1851, Stimpson, 1853, Verrill, 1866, Packard, 1867, Ludwig, 1882, Ganong, 1884, 1888, Lampert, 1885, Ludwig, 1900, Kingsley, 1901, Whiteaves, 1901, Clark, 1904). Baffins Bay (Duncan and Sladen, 1877, 1881). Assistance Bay, Barrow Strait, lat. 75° N. (Forbes, 1852). West coast of Greenland to lat. 69° N. (Fabricius, 1780, O. F. Müller, 1788, Lütken, 1857, Stimpson, 1863, Norman, 1876, Ludwig, 1882, 1883). Iceland (O. F. Müller, 1788, Lütken, 1857, Ludwig, 1883). Jan Mayen (Fischer, 1886). Färöe Islands (Lütken, 1857, Bell, 1892, Sluiter, 1895, Hørring, 1902, Schmidt, 1904). South from Scandinavia to Kattegat (Düben and Koren, 1846). Coast of Norway, south to Hardanger fjord, lat. 59° N. North to North Cape and Finmark (Gunnerus, 1770, O. F. Müller, 1806, Düben and Koren, 1846, M. Sars, 1850, 1861, Lütken, 1857, M'Andrew and Barrett, 1857, Lampert, 1885, Kükenthal and Weissenborn, 1886, Grieg, 1889, and 1896, Nordgaard, 1893, Sluiter, 1895, Östergren, 1902). Bären Island (Danielssen and Koren, 1882). Shetland Islands (Forbes, 1841, Dalyell, 1851, Ludwig, 1882). Orkney Islands (Bell, 1892). Coast of Scotland (Forbes, 1841, Dalyell, 1851, M'Intosh, 1875, Bell, 1892). Ireland (Thompson, 1840, 1844, Théel, 1886. Southwest England to lat. 50° N. (Bell, 1892). Spitzbergen, to lat. 80° N. (v. Heuglin, 1874, Ljungman, 1879, Ludwig, 1900). Barent's Sea (Sluiter, 1895). Murman coast (Jarzynsky, 1885, Pfeffer, 1890). Kara Sea (Levinsen, 1886). Point Franklin, Alaska (Murdoch, 1885). San Francisco (Ayers, 1855). Admiralty Inlet, Port Townsend, Washington, Afognak Island, Kadiak Island (*Albatross*, Alaska Salmon Investigations, 1903). Ludwig, 1900 (p. 143), gives this species as two-thirds circumpolar.

Depth 0 to 218 fathoms; usually lives in from 2 to 30 fathoms.

9. CUCUMARIA JAPONICA Semper, 1868.

1868. *Cucumaria japonica* SEMPER, p. 236.
 1885. *Cucumaria japonica* LAMPERT, p. 143.
 1886. *Cucumaria japonica* THÉEL, p. 110.
 1900. *Cucumaria japonica* LUDWIG, p. 143.
 1902. *Cucumaria japonica* CLARK, p. 562.

June 29, 1903.—Three specimens: Station 4205; lat. 48° 8' 10" N., long. 122° 41' 48" W.; 15 to 26 fathoms: bottom, temperature 50.8°, rock, shells. August 24.—One specimen: Station 4302; off Shakan, Sumner Strait, southeast Alaska; 169 to 212 fathoms; bottom, temperature 44.2°, blue mud. Without data—two specimens.

Size in millimeters.—Introvert extended; length: specimens *a*, 55; *b*, 170; greatest diameter, *a*, 19; *b*, 38; introvert retracted, length, *c*, 24; *d*, 33; *e*, 40; *f*, 170; greatest diameter, *c*, 15; *d*, 19; *e*, 20; *f*, 65. Individuals *b* and *f* may be taken as adult and the others as young.

Color.—Dark, or light, tint of ecru-drab. *c*, heliotrope-purple, from which as a natural color, the ecru-drab might result after loss of color in alcohol.

Spicules of body wall.—Perforated plates of irregular form and size. In most of the specimens, as shown in sections, the large, radially placed, perforated plates are massed near the opening of the cloaca, as described by Semper, 1868 (Plate XXXIX, fig. 3). Clark, 1902, did not find these large plates in his four specimens, which otherwise agree with the descriptions given by Semper, 1868, and Lampert, 1885.

Calcareous ring.—In form like *frondosa*, but very delicate and generally greatly reduced, not, however, to the mere vestige described by Semper.

Polian vesicle.—Five specimens with one Polian vesicle, longer than the body, the terminal portion turned forward and coiled among the gonad tubes and branches of the respiratory trees. Length in *b*, 200 mm.; *f*, 354 mm. Since usually but one Polian vesicle has been given, it is worthy of note that *e* has 4, one in the right ventral radius, one either side of the mid-ventral radius, and one in the left dorsal interradius.

Stone canals.—*Length in millimeters.*—As generally twisted, 3; when straightened, 5; madreporite, 1. *Number and location.*—*a*, 5, in right and left tufts at edge of base of Polian vesicle; *d*, 6, around base of Polian vesicle; *e*, 9; *e*, 18, scattered around oral canal; *b*, 95; *f*, 140, closely crowded in a row around the posterior margin of the entire oral canal. This increase in number accompanies growth, which is strikingly demonstrated in the large number of canals in the adult. This fact I have shown for other Holothurians in a recent paper (Edwards, 1905). *Form.*—Simple, or distally bifid or trifid, each branch bearing a small madreporite. Stone canal twisted, sometimes two twisted together, or, again, two may be united at the base.

Habitat.—Japan (Semper, 1868). Gulf of Georgia (Lampert, 1885). Sitka (Clark, 1902). Shakan, Summer Strait, southeast Alaska (*Albatross* Alaska Salmon Investigations, 1903).

10. PANNYCHIA MOSELEYI Théel, 1882.

1882. *Pannychia moseleyi* THÉEL, pp. 88-90.

(?) 1894. *Pannychia moseleyi* var. *heirice* LUDWIG, pp. 95-99.

1901. *Pannychia moseleyi* SLUTER, pp. 71-72.

July 31, 1903.—One specimen; Station 4265; lat. $56^{\circ} 56' 30''$ N., long. $136^{\circ} 10' 0''$ W.; 590 fathoms; bottom, temperature 38.2° , green mud, rocky.

Form.—Flattened ventrally, arched dorsally.

Dimensions of body.—97 mm. long; 13 mm. wide; 10 mm. dorso-ventral diameter.

Color.—In alcohol heliotrope-purple above, white below. Pedicels and papillæ whitish, ends cream color. Tentacles like the body on the stalks, but with the ends cream color.

Number of tentacles.—Twenty, three broken off.

Distribution of pedicels.—Thirty-two in the right lateral ventral radius. Twenty-eight in the left lateral ventral radius. In both of these rows the posterior pedicels are smaller. Twenty-four in the mid-ventral radius.

Papillæ.—Length, 10 mm.; diameter, 0.4 mm. About 170 on each side of the bivium, being somewhat thicker along the radii. In the middle third of the mid-dorsal region there is a naked longitudinal space only 2 mm. wide. At the extreme anterior end of the bivium there are three papillæ on either side and in the line of the madreporic papilla one on either side, each with a stiff firm wall, thicker base (1 mm. diameter), and with the stalk colored heliotrope-purple.

Ampullæ.—Of the pedicels, covered in the body-wall. Of the papillæ, branched, projecting into the coelom.

Thickness of body wall.—Ventrally 0.5 to 2 mm.

Calcareous spicules.—In general like those described by Théel, 1882, and for the details I refer to his paper.

Spicules of the body wall.—In the bivium are found the large wheels of 13 or 14 spokes, but no spicules similar to the small wheel shaped plates or small round plates with 35 to 50 holes. In the trivium, to the contrary, the first-mentioned large wheels are lacking, while the small wheel-shaped plates and perforated plates with many holes, together with straight or arcuated, simple or branched, spinose supporting rods are present.

Spicules of the ambulacral appendages.—*Pedicels*.—Large wheels, small wheel-shaped plates, small round perforated plates, simple or branched, spinose supporting rods, large irregular plates at the top of

the processes, terminal plates with numerous holes in several layers, and net-like bodies with wide, irregular meshes.

Papillæ.—Scattered small wheel-shaped plates and simple or branched spinose supporting rods, with some of the large wheels near the tips.

Tentacles.—Many of the large wheels and small wheel-shaped plates in the stalks, but in the disks only the last, together with crowded spinose supporting rods.

Calcareous ring.—Rudimentary, fragile, spongy; its true form not distinct.

Polian vesicles.—Two, each 20 mm. long, 1.6 mm. diameter, with a common base for 3 mm.

Stone canal.—Ends in dorsal madreporic papilla, 1 mm. in diameter, 9 mm. posterior to the tentacles; a clear, slightly whitish, spherical body, of no particular structure.

Gonads.—On either side of dorsal mesentery one long (70 mm.) tube, giving off richly branched lateral branches. The gonaduct opens 10 mm. posterior to the tentacles.

Comparative.—The one individual above extends the geographical distribution of this species from one extreme of the Pacific to the other. From the three records now published, together with the above description of the *Albatross* specimen, it is difficult to say whether there are several varieties of Théel's type or just one very variable species. The descriptions of *Pannychia moseleyi* Théel, given by Théel, Sluiter, and myself, and of *P. moseleyi* var. *heurice* Ludwig agree well enough and so intergrade as to constitute the one species. Because of the inadequate description, the position of *Pannychia wood-masoni* Walsh, 1891, given by the author as closely allied to *P. moseleyi* Théel is very uncertain, as both Ludwig (pp. 95-96) and Sluiter (p. 72) have indicated.

Ludwig established his variety upon the smaller number of pedicels in the mid-ventral radius and the presence of three genital tubes, instead of one, on each side of the dorsal mesentery. The number of pedicels depends upon growth, although we have, as yet, no exact formula for the determination of the age of a Holothurian. The size, of course, in a general way gives some idea of age and maturity, as Mitsukuri, 1903, found in the case of *Stichopus japonicus* Selenka, and, as I have demonstrated in recent studies (1905), of *Holothuria floridana* Pourtalès and *H. atra* Jaeger.

While in general, as Ludwig suggests (p. 98), the number of appendages increases with size and age, yet my specimen, with a length included in Ludwig's smallest class (66 to 175 mm.), has a larger number of lateral pedicels than even Théel's type. The number of mid-ventral pedicels in my specimen (24) agrees exactly with that of Sluiter, and both are intermediate between Théel's type (55) and Lud-

wig's variety (2-14). Considering the variation recorded for the pedicels, it is doubtful, with our present knowledge of the species, if a variety should be established upon this basis. The presence of three genital tubes instead of one on each side of the mesentery, since in both cases they are of the same form, might also be taken as within the possible limits of variation and growth. Upon comparing my specimen with Théel's drawing (Plate XVII, fig. 2) I was impressed with the different appearance it presented. Instead of the rather scattered papillæ showing considerable inequality in size and the long, broad, naked mid-dorsal space, as pictured by Théel's artist, my specimen gives the impression of more nearly equal, more slender, shorter, and crowded papillæ. This impression is borne out by Théel's count of 100 papillæ on each side of the back, while I found about 170, and the length of the papillæ, which he gives as 15 to 20 mm., while 10 mm. is the longest in my specimen. Thus, in respect to form and distribution of papillæ, Théel's type is one extreme and my specimen the other, with Ludwig's (Plate X, fig. 2) intermediate. The anterior dorsal "transverse, thin, lobe-like extension of the skin, sending out several processes" of Théel (p. 89) is probably represented by the stiff-walled, heliotrope-purple colored papillæ, each with a base (1 mm. in diameter) twice the width of the ordinary papilla and arranged three on each side at the extreme anterior end, with an additional one on each side in the line of the madreporic papilla. The two Polian vesicles, with a common base in my example, may easily be regarded as a variation, as also the smaller size and lack of structure shown in the madreporic papilla when the latter is compared with Ludwig's specimen. The characters of Sluiter's two specimens are in general intermediate between those of Théel and Ludwig.

II. STICHOPUS CALIFORNICA (Stimpson), 1857.

June 20, 1903.—Two specimens; Station 4193; lat. $49^{\circ} 20' 30''$ N., long. $123^{\circ} 35' 40''$ W.; 18 to 23 fathoms; bottom, temperature 50.3° , green mud; fine sand. June 20.—Two specimens; Station 4197; lat. $49^{\circ} 20' 34''$ N., long. $123^{\circ} 35' 54''$ W.; 31 to 97 fathoms; bottom, temperature 46.8° , sticky, green; fine sand.

In these four small specimens (length 3.5 to 4.5 cm.) the gonads are not developed, but the spicules and other characters agree so well with what there is in the meager original description of Stimpson, 1857, and the much better characterization of Clark, 1901, that I have little hesitation in this determination.

Habitat.—Tomales Bay, Pacific coast (Stimpson 1857). Pacific Grove, California (Clark 1901a). Sitka (Clark 1902). Gulf of Georgia, Vancouver Island, British Columbia (*Albatross* Alaska Salmon Investigations 1903).

12. *STICHOPUS CHALLENGERI* (Théel), 1886.

July 7, 1903.—Three specimens; Station 4230; lat. $55^{\circ} 35' 13''$ N., long. $131^{\circ} 50' 11''$ W.; 108 to 240 fathoms; bottom, temperature 42.4° , rocky. August 14.—One specimen; Station 4289; Uyak Bay, Kadiak Island; 74 to 80 fathoms; bottom, temperature 42.2° , gray mud. August 15.—One specimen; Station 4291; lat. $57^{\circ} 45' 0''$ N., long. $154^{\circ} 2' 30''$ W.; 48 to 65 fathoms; bottom blue mud, sand, gravel. August 15.—One specimen; Station 4293; lat. $57^{\circ} 45' 0''$ N., long. $154^{\circ} 12' 0''$ W.; 106 to 112 fathoms; bottom blue mud, fine sand.

The study of these six individuals of *Stichopus challengeri*, which Théel described from "a single slightly macerated specimen," gives an opportunity to add a few things to the admirable description of that author. It is of interest that Théel's specimen, found in lat. $46^{\circ} 53'$ S., long. $51^{\circ} 52'$ E., gives the two regions now recorded for this species on opposite sides of the earth.

Body.—Size in centimeters: Length, 5.1 to 18.8; average, 12.3; dorso-ventral diameter, 1.2 to 2.3; average, 1.8; transverse diameter, 2.0 to 3.2; average, 2.7.

Color.—In alcohol; three specimens brownish drab dorsally, shading to light hair brown, or white, ventrally; the other three heliotrope-purple dorsally, shading to lavender ventrally.

Tentacles.—Nonretractile; four specimens with 20 and two with 19 (Théel's example had 19). Color cream-buff. Ampullæ extremely short, the longest being 3 mm.

Genital papilla.—Inconspicuous, at most 1.5 mm. high, 0.5 to 1.4 cm. from base of tentacles.

Pedicels.—Ventral, nonretractile, white, with cream-color ends. Three specimens have two rows the entire length of the ambulacra. In one specimen the two lateral ambulacra have two rows and the mid-ventral is partly with two and partly with four rows. The other two specimens have four rows in the mid-ventral ambulacrum in the middle of the body. This increase in number of rows is obviously due to contraction and is of interest in relation to Théel's description of the "median series, composed, apparently, of about four rows of pedicels on the posterior half of the body; anteriorly the odd ambulacrum carries only two rows of pedicels."

Papillæ.—Dorsal, usually the most anterior are longer and form a fringe projecting in front of the body. Length, 0.6 to 1.7 mm.; average, 1.1 mm.

Color.—Stalks, like body; some of the ends, white.

Body wall.—Rough, 0.1 to 5.0 mm. thick; average, 2.2 mm.

Spicules of the body wall.—In addition to the structures described by Théel, occasionally the four-rayed forms have the ends of the rays joined to make perforated disks of tables.

An incomplete table is shown in Théel's figure. All stages between the simple bifurcated, or perforated, ends of the rays to the completed disk may be observed. Théel's suggestion that the two C-shaped deposits he observed belonged to another species is borne out by the absence of any such spicules in the six *Albatross* specimens.

Spicules of the tentacles.—The supporting rods (fig. 12) vary greatly in size and degree of curvature. They may be straight or form a semicircle, or the curvature may be represented by an acute angle. Generally the ends are perforated. The rods are smallest at the tips of the tentacles.

Size of rods in millimeters.—Length of chord, 0.06 to 1.4; width of rod, 0.008 to 0.08.

Polian vesicle.—Only one in each of the six individuals in contradistinction to Théel's, which had two. Form, cylindrical. Length, 11.0 to 24.0 mm.; average, 13.5 mm.

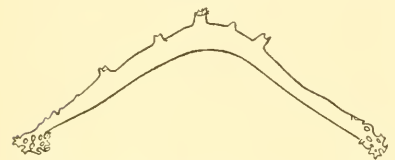


FIG. 12.—STICHOPUS CHALLENGERI. CURVED SUPPORTING ROD OF A TENTACLE. (× 50.)

Stone canal.—Single, in dorsal mesentery with madreporite adherent to coelomic epithelium. Length, 6.0 to 18.0 mm.; average, 13.0 mm. Madreporite, disk formed (in one case spherical) with stone canal attached to one edge. Diameter, 1.0

to 3.0 mm.

Gonads.—In both sexes like a string of beads. Gonaduct accompanies the stone canal anteriorly, joining the genital papilla just posterior to the madreporite. Five specimens were females, one male.

Respiratory trees.—Present in three specimens, with two branches as described by Théel, except in one individual, which has three. Length, trunk, 5.0 to 12.0 mm.; average, 8.0 mm.; longest branch, 30.0 to 59.0 mm.; average, 39.7 mm.; shortest branch, 23.0 to 43.0 mm.; average, 30.7 mm.

Habitat.—Lat. 46° 53' S.; long. 51° 52' E.; depth, 550 fathoms (Théel, *Challenger* Report, 1886). Nala Bay, Behm Canal, southeastern Alaska, Uyak Bay, Kadiak Island, Shelikof Strait (*Albatross*, Alaska Salmon Investigations, 1903).

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