THE CEPHALOPODS OF THE NORTH-EASTERN COAST OF AMERICA.

PART II.

THE SMALLER CEPHALOPODS, INCLUDING THE SQUIDS AND THE OCTOPI, WITH OTHER ALLIED FORMS.

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Part II. the smaller cephalopods, including the "squids" and the octopi, with other allied forms.

Before proceeding with the special subjects of this Part it seems desirable to describe in detail an important, though young and small, example of one of the gigantic species of *Architeuthis*, as a supplement to the first part of this article.

Description of a young example of Architeuthis Harveyi.

Plates XXVI and XXXVIII.

This specimen, which I have designated as No. 24, was received subsequent to the publication of the previous part of this article. It was found, dead and mutilated, floating at the surface, at the Grand Bank of Newfoundland, April, 1880, by Capt. O. A. Whitten and crew of the schooner "Wm. H. Oakes," and by them it was well preserved and presented to the U. S. Commission of Fish and Fisheries. It is of great interest because it furnishes the means of completing the description of parts that were lacking or badly preserved in the larger specimens, especially the sessile arms and the buccal membranes.

The specimen consists of a part of the head with all the arms attached, and with the suckers in a good state of preservation on all the arms, though the tips of all the short arms, except one, are destroyed, and all of the arms are more or less injured on their outer surfaces. The jaws and buccal membranes are intact, with the odontophore and œsophagus. Parts of the cartilaginous skull, with some of the ganglia and the collapsed eyes are present, but the external surface of the head is gone and the eyelids are badly mutilated. No part of the body was preserved. The tentacular-arms are in good preservation, with all the suckers present. Unfortunately the distal portions of both the ventral arms had been destroyed, so that the sex cannot be determined. The color of the head, so far as preserved, and of the external surfaces of the sessile arms is much like that of the common squids,—a rather dark purplish brown, due to minute crowded specks of that color, thickly distributed, with a pink-

ish white ground-color between them. The outer buccal membrane is darker; the inner surfaces of the arms are whitish; the peduncular portions of the tentacular arms have fewer color-specks, and are paler than the other arms.

Reproduction of lost parts.

This creature had been badly mutilated long before its death, as its healed wounds show, and to this fact many of the imperfections of the specimen are due. At the time of its death, or subsequently, the extremities of the ventral arms and of the third right arm appear to have been destroyed, besides other injuries. But both the dorsal arms and both the lateral arms of the left side had previously been truncated at 12 to 13 inches from their bases. The ends had not only healed up entirely, but each one had apparently commenced to reproduce the lost portion. The reproduced part consists, in each case, of an elongated, acute, soft papilla, arising from the otherwise obtuse end of the arm. At its base one or two small suckers have already been reproduced, and minute rudiments of others can be detected on some of them. Whether these arms would have been perfectly restored in course of time is, perhaps, doubtful,* but there can be no doubt that a partial restoration would, at least, have been effected. On the basal half of several of the arms some of the suckers had also been previously lost, and these were all in the process of restoration. The restored suckers were mostly less than one half the diameter of those adjacent, and in some cases less than one-third. Among the restored suckers were some malformations. One has a double aperture, with a double horny rim. In one case two small suckers, with pedicels in close contact, occupy the place of a single sucker. In another instance a small pedicelled sucker arises from the pedicel of a larger one, near its base.

The arms and suckers.

With the exception of the left arm of the second pair, none of the sessile arms have their tips perfect. Therefore it is not possible to give their relative lengths. The dorsal arms are the smallest at base and the third pair largest. They are all provided with a rather narrow marginal membrane along each border of the front side. These membranes are scarcely wide enough to reach to the level of the rims of the suckers, though they may have done so in life. The front margin, bearing the suckers is narrow on all the arms, but relatively

* That mutilations of the arms in species of *Octopus* are regularly restored is well-known, but it has been doubted whether this occurs in the ten-armed forms.

wider on the ventrals than on any of the others. Each sucker-pedicel arises from a muscular cushion, that is slightly raised and rounded on the inner side; these, alternating on the two sides, leave a zigzag depression along the middle of the arm; from each of these cushions two thickened muscular ridges run outward to the edge of the lateral membranes, one on each side of the pedicels of the suckers. These transverse muscular ridges give a scolloped outline to the margin of the membranes. These marginal membranes are narrowest and the suckers are smallest on the ventral arms. The dorsal and lateral arms are strongly compressed laterally, but slightly swollen or convex in the middle, and narrowed externally to a carina, which is most prominent along the middle of the arms, and most conspicuous on the third pair of arms. The dorsal arms are rather more slender than the second pair, and were probably somewhat shorter.

The left arm of the second pair has the tip preserved, with all its suckers present. On this arm there are 330 suckers, in all. The total length of the arm is 26·25 inches. The first 50 suckers extend to 12·25 inches from the base; the next 50 occupy 4·5 inches; the next 50 cover 3·5; the next 100 occupy 4·25 inches; the last 80 occupy 1·75 inches. This arm is ·80 of an inch in transverse diameter, near the base; 1·20 inches from front to back; breadth of its front or sucker-bearing surface (without the lateral membranes), is, where widest, near the base of the arm, ·50 of an inch; the width gradually decreases, to ·18 of an inch at 20 inches from the base; beyond this the arm tapers to a very slender tip, with numerous small crowded suckers in two regular rows. At the base (Plate XXVI, fig. 4) there is first one very small sucker; this is succeeded by two or three much larger ones, increasing a little in size; beyond these are the largest suckers, extending to about the 25th, beyond which they gradually change their form and regularly diminish in size to the tips. The larger proximal suckers, up to the 25th to 30th, are relatively broader than those beyond, and have a wider and more open aperture, and a more even and less oblique horny ring, which is sharply denticulate around the entire circumference, with the denticles rather smaller on the inner than on the outer margin, but similar in form. These are about ·31 of an inch in external diameter. They show a gradual transition to those with more oblique rims and smaller apertures. Beyond the 30th, the horny rims become decidedly more oblique and one-sided, with the denticles nearly or quite abortive on the inner side, and larger and more incurved on the outer margin, while the aperture becomes more contracted and oblique.

At first there are 8 to 10 denticles on the outer margin, but these diminish in number as the suckers diminish in size, till at about 6 inches from the tip there are mostly but two or three, and the aperture is very contracted. Still nearer the tip there are but two, blunt ones; then these become reduced to a single bilobed one; and finally only one, which is squarish, appears in the minute suckers of the last two inches of the tip. The first two or three suckers at the base of the arm are more feebly denticulated than those beyond, with smaller apertures.

On many of the suckers (Plate XXXVIII, fig. 3) there are still remaining, in more or less complete preservation, a circle of minute horny plates arranged radially, or transversely, on the edge of the membrane around the aperture, similar in arrangement to those already described in the former part of this article (p. 230) on the suckers of *Sthenoteuthis pteropus* (Plate XXXVI, fig. 9). They are less developed, however, than in that species, being thinner and more delicate, nor do their ends appear to turn up in the form of hooks. They seem to be generally very thin, oblong, scale-like structures, with rounded or blunt ends and slightly thickened margins. These structures will probably be found to vary with age, and perhaps with the season. They appear to be easily desiduous, and are often absent in preserved specimens.

On the dorsal and third pairs of arms the suckers have essentially the same arrangement, form and structure, and on these three pairs of arms the larger suckers differ but slightly in size. The character and arrangement of the suckers on the distal portion of these arms is well shown on Plate XXVI, figs. 3, 3*a*, which represent a portion of one of the third pair of arms, commencing at the 67th sucker.

The ventral arms are trapezoidal in section, at base, and rather stout. Breadth of front surface, near the base, exclusive of membranes, ·55; transverse diameter, ·95; front to back, 1·25 inches. The sucker-bearing surface is, therefore, broader than in the other arms. The suckers are, however, distinctly smaller and the proximal ones are different in form from the corresponding ones on the other arms. They are narrower and deeper, with more oblique and more contracted apertures, more oblique horny rims, which are denticulated on the outer margins only. On the larger ones there are 12 to 15 sharp incurved denticles. In fact, the proximal suckers on the ventral arms agree better with the middle suckers, beyond the 30th, on the other arms, for there are none having wide open apertures, surrounded by nearly even horny rims, denticulated all around. The

Young Architeuthis Harveyi. Measurements of arms (in inches).

		Near base.	At 5 in.	At 10 in.	At 15 in.	At 20 in.
Dorsal pair.						
Breadth of front, excluding membranes,	--	·35	·50	·30	--	--
Breadth of lateral membranes,	--	·20	·30	·20	--	--
Diameter, transversely,	--	·75	·60	·40	--	--
Diameter from front to back,	--	1·05	·90	·70	--	--
Second pair.						
Total length,	26·25	--	--	--	--	--
Breadth of front,	--	·40	·50	·35	·22	·18
Breadth or membranes,	--	·25	·30	·15	--	--
Diameter, transversely,	--	·80	·65	·35	·30	·16
Diameter, front to back,	--	1·20	1·20	·85	·60	·40
Third pair.						
Breadth of front,	--	·50	·50	·40	--	--
Breadth of membranes,	--	·20	·25	·15	--	--
Diameter, transversely,	--	1·10	·70	·40	--	--
Diameter, front to back,	--	1·08	1·60	1·20	--	--
Fourth pair.						
Breadth of front,	--	·40	·55	·30	--	--
Breadth of membranes,	--	·20	·25	·10	--	--
Diameter, transversely,	--	·98	·90	--	--	--
Diameter, front to back,	--	1·40	1·12	--	--	--
Tentacular-arms.						
Total length,	67·	--	--	--	--	--
Base to expansion of club,	58·75	--	--	--	--	--
Diameter of slender portion,	·4–·6	--	--	--	--	--
Length of club,	8·25	--	--	--	--	--
Length of part occupied by 24 largest suckers,	4·25	--	--	--	--	--
Length of part occupied by small distal suckers,	2·60	--	--	--	--	--
Greatest breadth of club,	·70	--	--	--	--	--
Diameter, front to back,	·60	--	--	--	--	--

Sessile arms, from base to particular suckers.

	To 25th.	To 50th.	To 100th.	To 150th.	To 200th.	To 250th.	To 300th.	To tip.
Dorsal pair, base to suckers,	7·5	12·25	--	--	--	--	--	--
Second pair, base to suckers,	7·75	12·25	16·75	20·25	22·90	24·50	25·75	26·25
Third pair, base to suckers,	7·25	12·25	--	--	--	--	--	--
Fourth pair, base to suckers,	6·25	10·	16·50	20·75	--	--	--	--

Measurments of suckers of sessile arms (in inches).

	15th.	30th.	50th.	100th.
On 1st pair of arms, external diameter,	·31	·24	·16	--
On 1st pair of arms, aperture diameter,	·25	·15	·10	--
On 2d pair of arms, external diameter,	·31	·27	·20	·15
On 2d pair of arms, aperture diameter,	·25	·18	·11	·08
On 3d pair of arms, external diameter,	·31	·28	·22	--
On 3d pair of arms, aperture diameter,	·22	·18	·12	--
On 4th pair of arms, external diameter,	·25	·21	·16	·14
On 4th pair of arms, aperture diameter,	·15	·11	·10	·07

suckers diminish regularly in size, and in the number of denticles, till at the 200th (where the arms are broken off) there are but three denticles.

Tentacular-arms.

PLATE XXVI, fig. 2.

The tentacular-arms are both entire, with all the suckers well preserved. The total length is 65 and 67 inches respectively; length of the expanded portion or club, 8·25 inches; diameter of the peduncular portion varies from ·40 to ·70 of an inch; at the base, ·90; breadth of the proximal part of the club, where it is broadest, ·70; diameter from front to back, ·60; external diameter of the largest suckers, ·35 of an inch; height of their cups, ·28; of lateral suckers, ·18; of the largest marginal suckers on the distal portion, ·14.

The peduncular portion is somewhat thickened and rounded at the base, but through most of its length it is slender, varying in size, and nearly triangular in section, with the corners rounded, each side measuring, where largest, ·60 of an inch in breadth. At about a foot from the base the small smooth-rimmed suckers and their opposing tubercles begin to appear on the inner surface. At first these are placed singly and at considerable intervals (2·5 to 3·5 inches), each sucker alternating with a tubercle on each arm; further out they are nearer together, and towards the club they alternate, two by two, on each arm; near the commencement of the club they become more numerous and are arranged somewhat in two rows; just at the commencement of the club they become more crowded, forming three and then four oblique transverse rows of suckers, with the same number of tubercles alongside of them; on the basal expansion of the club, which is its thickest portion, these suckers and tubercles become very numerous, covering nearly the whole inner surface, forming rather crowded and irregular oblique rows of six or more. These smooth-rimmed suckers are followed by an irregular group of about twenty, somewhat larger, denticulated suckers, occupying the entire breadth for a very short distance. Then follow the two median rows of large suckers, alternating with a row of marginal ones, of about half their size, on each side. The first three or four large suckers of each row gradually increase in size; then follow six to eight nearly equal ones of the largest size; these are followed by two to four distal ones, decreasing in size. In one of the rows there are fourteen that distinctly belong to the large series; in the other row there are twelve. The distal section of the club is occupied by

four regular rows of small denticulated suckers, more strongly toothed on the outer margins, and similar in form to the marginal suckers of the middle region. Of these the two rows next the upper (?) margin are decidedly larger than those of the two lower (?) rows. Close to the tip there is a group of about a dozen minute suckers, with smooth even rims. The middle portion of the club is bordered on each side by a rather broad, thin scalloped membrane. The distal section has a broad keel on the outer margin.

Suckers of tentacular-arms.

Diameter of largest,	·35
Height of largest,	·28
Diameter of lateral,	·18
Height of lateral,	·09
Diameter of smooth-rimmed ones,	·10
Diameter of tubercles,	·08
Of largest lateral ones of distal section,	·14
Of median lateral ones of distal section,	·11

Buccal membranes and jaws.

PLATE XXVI, fig. 7.

This specimen fortunately had the buccal membranes and other parts about the mouth perfectly preserved, which has not been the case in the large specimens. The outer buccal membrane is broad and thin, rather deeply colored externally. Its margin extends into seven acute angles—one of which is opposite each of the lateral and ventral arms, but on the dorsal side there is only one, which corresponds to the interval between the two dorsal arms. From each of these angles a membrane runs to, and for a short distance along the side of the opposite arm, except from the dorsal one, which sends off a membrane which divides, one part going to the inner lateral surface of each dorsal arm. The membranes from the upper lateral and ventral angles join the upper lateral sides of their corresponding arms; those from the lower lateral angles go to the lower lateral sides of the third pair of arms. The inner surface of the buccal membrane is whitish and deeply and irregularly reticulated by conspicuous, soft, wrinkles and furrows, which become somewhat concentric toward the margin. Beneath this membrane are openings to the aquiferous cavities. The inner buccal membrane, immediately surrounding the beak, is whitish, thickened at the margin, and strongly irregularly wrinkled and puckered.

The jaws have sharp, dark brown tips, changing to clear brown backward, with the laminæ very thin, transparent, and whitish. The

upper mandible has the rostrum regularly curved, with a distinct ridge, in continuation with its inner edges, extending down the sides, and only a slight notch at its base.

The lower mandible has a notch close to the tip, with the rest of the inner edge nearly straight; at the base is a rather large and wide V-shaped notch; the tooth beyond it being broad-triangular and rather large; beyond the tooth the alæ are white, soft and cartilaginous.

Measurements of jaws (in inches).

Transverse diameter of buccal mass,	1·50
Vertical diameter of buccal mass,	1·70
Upper Mandible:	
Tip to end of frontal lamina,	1·25
Tip to notch,	·37
Tip to lateral border of lamina,	·77
Lower Mandible:	
Tip to border of mentum,	·45
Tip to lateral border of alæ,	·70
Tip to inner end of alæ,	1·02
Tip to bottom of notch,	·32
Height of tooth,	·06
Notch to inner end of alæ,	·80
Mentum to inner end of alæ,	1·20

The portion of the œsophagus preserved is 14·75 inches long and about ·15 of an inch broad, in its flattened condition.

The odontophore (Plate XXXVIII, figs. 1, 2) is amber-color, ·18 of an inch broad. The tridentate median teeth have moderately long but not very acute points, of which the middle one is a little the longest. The inner lateral teeth are bidentate and somewhat broader and longer than the median ones; their outer denticle is well-developed, but considerably shorter than the inner one. The next to the outer lateral teeth are larger at base and much longer, simple, broad, tapering, flattened, slightly curved, acute at tip. They appear not to have the small lateral denticle observed on the corresponding teeth of the adult *Architeuthis* (see Plate XVI*a*, figs. 1, 2). The outer lateral teeth are similar to the preceding, but rather larger and not quite so broad at base. The marginal plates are well-developed, thin, somewhat rhomboidal.

The internal cavity of the ears is somewhat irregularly three-lobed, with several rounded papillæ projecting inward from its sides, very much as in those of *Ommastrephes*. Each ear contained two irregular-shaped otoliths, one of which (Plate XXXVIII, fig. 4) was much larger than the other, in each ear.

The eyes were both burst, and most of their internal structure was destroyed. So far as preserved they closely agree with those of

Ommastrephes. The eye-balls were large and somewhat oblong in form, and appear to have been nearly two inches broad and three long. The eye-lids are badly mutilated, but the anterior sinus can be imperfectly made out. It seems to have been broad and rounded. The aquiferous cavities appear to have been like those of *Ommastrephes.* The form and structure of the cartilaginous 'brain-box' also appear to be essentially the same as in the genus last named.

Ommastrephes.

Ommastrephes (*pars*) D'Orbigny, Voy. Am. Merid., 1835; Cephal. Acétabulifers, p. 341.

Body elongated, pointed posteriorly. Caudal fin broad, transversely rhomboidal. Pen narrowed behind the middle, with a strong median rib and large marginal ribs on each side; near the posterior end thin and concave, expanded into a lanceolate form, with the tip infolded and slightly hooded. Head large. Eyes with lids, having a distinct sinus in front.

Arms stout, the third pair stoutest, with a dorsal keel; all the arms have marginal membranes exterior to the suckers. Suckers of the arms deep and oblique, with horny rims which are strongly denticulate on the outer margin, the median tooth usually largest. Tentacular-arms rather long and contractile, stout, with a moderately wide terminal club, which has along its middle region two rows of large central suckers, and a row of smaller marginal ones alternating with them, on each side; proximal part of club with small denticulate suckers only; distal part of club with four to eight rows of small denticulate suckers.

Siphon-tube placed in a depression of the under side of the head, and attached to the head by a lateral bridle on each side, behind the eyes, and by a pair of bridles on its dorsal surface, at the bottom of the depression in which it is lodged. Terminal orifice transversely elliptical, furnished with an internal valve.

Mantle-fastenings ('apparatus of resistance'), situated on the basal extension of the siphon, consist, on the ventral side, of two large triangular bosses, with an elongated and somewhat ear-shaped longitudinal fosse, and a shallower transverse one; and on each side of the inner surface of the mantle, of a corresponding short, raised, longitudinal ridge, swollen posteriorly, and a lower transverse ridge, which fit closely into the fosses. The dorsal side of the head has a median, longitudinal facet, that fits upon its counterpart on the mantle, over the anterior part of the pen, which gives it support.

The nuchal lamellæ are formed by a transverse tegumentary fold behind the eyes, from which run backward, on each side, three longitudinal lamellæ, which are delicate, and have a sensory (perhaps olfactory) function.

Buccal membrane seven-angled, thin, corrugated on the inner surface, destitute of suckers.

Branchial auricles, and gills large. Liver and stomach voluminous.

The male has one of the ventral arms (which may be either right or left in our species) hectocotylized near the tip, by enlargement and flattening of the bases of the sucker-stalks, while their cups become small or abortive.

The female has oviducts developed on both sides, but they are small, and simple, opening far back. Two pairs of nidamental glands, which are small and simple.

Ommastrephes illecebrosa Verrill. (Short-finned squid.)

Loligo illecebrosa Lesueur, Journ. Phil. Acad. Nat. Sci., ii, p. 95, Plate 10, figs. 18–21, 1821 (figures incorrect).

Blainville, Dict. des Sci. nat., vol. xxvii, p. 142, 1823.

Gould, Invert. Mass., ed. I, p. 318, 1841 (habits).

Loligo piscatorum La Pylaie, Ann. des Sci. nat., iv, p. 319, 1825, Pl. 16 (habits as observed at Saint Pierre).

Ommastrephes sagittatus (*pars*) D'Orbig., Cephal. Acétab., p. 345, Plate 7, figs. 1–3 (after Lesueur).

Gray (*pars*), Catalogue Moll. of British Mus., Part I, Cephal. Antep., p. 58, 1849.

Binney, in Gould's Invert. Mass., ed. II, p. 510, 1870 (excl. syn.), Pl. 26, figs. 341–4 [341 is imperfect],* *not* Plate 25, fig. 339.

Tryon (*pars*), Man. Conch., I, p. 177, Pl. 78, fig. 342 (very poor, after Lesueur), Pl. 79, fig. 343, 1879 (*not* Plate 78, figs. 341, 345).

Ommastrephes illecebrosa Verrill, Amer. Jour. Sci., vol. iii, p. 281, 1872 (synonymy); Report on Invert. Viney. Sd., etc., 1873, pp. 441 (habits), 634 (descr.); Amer. Jour. Science, vol. xix, p. 289, April, 1880.

Plates XXVIII; XXIX, figs. 5, 5*a*; XXXVII, fig. 8; XXXIX.

Body, in the younger specimens, long and slender; in the adults, especially when the stomach is distended with food, and in the breeding season, rather stout; most so in the gravid female; in preserved specimens the apparent stoutness of the body depends very much upon whether the mantle was in a contracted or expanded

* This species is not well figured in the last edition of Gould's Invertebrates. Plate 25, fig. 339, which Mr. Binney refers to it, really represents a *Loligo*. Plate 26, figs. 341–344 (erroneously referred to *Loligopsis pavo*), was doubtless made from a specimen of this species, but if so, the long arms were incorrectly drawn, and confused with the short arms.

state when the animal died. Caudal fin transversely rhomboidal, or broad spear-shape, about one-third wider than long; its breadth usually less than half the length of the mantle; the posterior borders are nearly straight and form nearly a right angle at the posterior end; the anterior margins are somewhat convexly rounded, and the front margin extends, at the sides of the body, considerably forward beyond the insertion of the fin. Ratio of fin-length to mantle-length 1 : 2·48 to 1 : 3·00 (the latter in the young ones). Average proportions in eight adult specimens: of fin-length (from insertion) to length of dorsal side of mantle, about 1 : 2·55; breadth of fin to length of mantle, average, 1 : 1·90; length of head (dorsal edge of mantle to base of arms) to mantle-length, average, 1 : 7·15.

The head is large, well-rounded; the exposed portion is shorter than broad, its breadth about equals that of the body, in ordinary contraction; its sides, in the region of the eyes, are somewhat swollen; the under surface is flattened, and has a deep excavation in front, semi-circular, or rather semi-elliptical, in outline, to receive the dorsal half of the siphon-tube, which fits into it closely.

The sides of the head, back of the eyes, have a rather prominent, transverse ridge, back of which the head suddenly narrows, to the neck. The transverse ridges curve backward slightly and meet on the dorsal side of the head, where they are less prominent. Three thin, lamelliform, erect folds of the skin extend backward from the transverse ridge, on each side of the head; of these the middle or lateral one is about in line with the lower eye-lid; the upper one is, at its origin, about midway between the latter and the median dorsal line, but its posterior edge bends downward and joins that of the one below; the lowest of the three is shorter and curves upward, and finally joins the middle one, at its posterior edge. These folds form, therefore, in connection with the transverse ridge, two well-defined lateral areas or facets, of delicate and probably very sensitive integument, placed just in front of the mantle-opening, on each side, where they must be bathed by the inflowing currents of water. It seems probable to me, therefore, that they are the seat of a special sense, analogous to, if not identical with, that of smell. They are, also, closely connected with the organs of hearing, and may be of some service in concentrating sound-vibrations. A small pore is situated within the lower facet.

The pupils are round and the eyes are large, though the opening between the lids is usually rather small, especially in alcoholic specimens. In these the aperture is usually contracted to a small obliquely transverse, irregular-triangular form, or even to a narrow oblique slit;

when more open the aperture is still usually somewhat angular; the anterior sinus is narrow and extends downward and forward.

The eye-lids form, when nearly expanded, an irregular oval, the longest diameter placed transversely and somewhat obliquely, while the narrow and deep sinus extends forward and somewhat downward. When partly closed (Plate XXIX, fig. 5) the opening between the lids generally becomes more oblong and sometimes approaches a triangular form.

The mantle is thick and very muscular; its anterior margin has a concave outline beneath, forming a slightly prominent angle on each side; from these angles it advances somewhat to the slight median dorsal angle, which projects forward but little, and does not form a distinct lobe, and sometimes it is hardly noticeable, even as an angle, the transverse outline of the edge on the dorsal side being, in that case, nearly straight, or advancing a very little in the middle.

The sessile arms are rather stout, tapering to acute tips. The dorsal arms are a little smaller and shorter than the others; the second and third pairs are nearly equal in size and length, the second often a trifle the longer; those of the fourth pair are usually intermediate in length between the first and second pairs.

All the sessile arms are stout and armed with similar suckers. Along their inner angles, outside the suckers, they are all similarly provided with marginal membranes, which rise to about the same height as the suckers, on each side. Just proximal to each sucker on the inner face of the arm, arises a thickened, transverse, muscular fold, that extends to the edge of the lateral membrane, which often recedes between their extremities, so as to have a scolloped outline.

The dorsal arms are a little shorter and decidedly smaller than the others. The two lateral pairs of arms are stoutest and longest, and nearly equal, sometimes one pair and sometimes the other, being longest. The ventral arms are a little longer than the dorsal and shorter than the lateral ones. The dorsal and upper-lateral arms are trapezoidal in section, with the inner face rather broad. The dorsal arms have a slightly elevated, median dorsal fold, commencing near the base and running to the tip. Those of the second pair have a broader, membranous fold on the lower-outer angle, along the whole length. Those of the third pair are stouter than the others, and much compressed laterally, with the outer surface rounded, close to the base, but becoming compressed and keeled farther out, and having a high median ridge along its middle region, becoming narrow toward the tip. The ventral arms are trapezoidal in section, with a narrow fold

along the outer angle, which is acute, while the ventral angle is rounded.

The tentacular-arms (Plate XXVIII, figs. 1*a*, 2) are long; when extended, in fresh specimens, they reach back beyond the base of the caudal fin. They are rather stout, rounded-trapezoidal along the peduncular portion; along the upper-outer angle a thin fold runs from the base to the tip, becoming a wide carina on the backside of the club; two less marked folds run along the inner angles, defining a narrow inner face, along the whole length, but on this face there are no suckers, except close to where it begins to expand into the broader face of the club; along the sides of the club, the marginal membranes become much wider, rising to a level with the suckers.

In the male of our species, one of the ventral arms (Plate XXVIII, figs. 3, 3*a*) is strongly hectocotylized, somewhat as in *Loligo*. But in this species it is the right arm, about as often as the left, that is modified. Toward the tip of the arm, for some distance, the pedicels of the suckers, especially of the outer row, become shorter, and the bases of the sucker-stalks become larger, broader, and transversely compressed, while the cups of the suckers themselves decrease rapidly, till they become very minute, and on a number of the most flattened and largest stalks, they are entirely abortive, in the case of the medium sized males, but, very close to the tip, they may again become normal. The inner row of suckers is more or less modified, in a similar manner; but fewer of the sucker stalks are affected, and these are, usually, not so extensively altered, though in the larger males many of them are commonly destitute of cups and have the same flattened form as those of the outer row, with which they are usually united along the median line of the arm, forming a zigzag ridge. In a very large male (J), with the right ventral arm modified, the alteration of the sucker-stalks becomes obvious at about the 45th sucker, and there are, beyond this, about 80 modified suckers, extending to the very tip; of these about 30, in the outer row, are represented only by the flat, lamelliform bases of the sucker-stalks, without cups; on the inner row, the small cups extend for about ten suckers farther than on the outer. The lamelliform processes are united medially in a zigzag line, along the entire tip. The modified part is about an inch in length. This arm is as long as its mate, (though in other specimens it is often shorter); but it is broader, stouter, and more blunt at tip, both the inner face and lateral membrane being increased in width. The younger males, 4 to 6 in. long, have the corresponding suckers less extensively modified, and the cups, though very much reduced in size, are usually present on all or nearly all the stalks.

The portion of the tentacles which bears suckers is always less than half the whole length. The relative size of the suckers varies greatly in both sexes, perhaps in connection with a periodical renewal of their horny rings.

The club is long and moderately broad, gradually widening from the peduncular part of the arm, and tapering at the end to a rather blunt, flattened and curved tip, which is strongly carinated on the outer side by a thin lamina. The suckers commence a short distance in advance of the expansion of the club. They are at first small, deep cup-shaped, and somewhat scattered, in two alternate rows, but all of these small ones have oblique rims, strongly denticulated on the outer margin with four or five long incurved teeth, while the inner edge is smooth. Of the small ones, before the commencement of the two median rows of large suckers, there are from ten to fifteen.

The middle region of the club is occupied by two rows of large suckers (fig. 7) and by a row of small marginal ones, on each side, alternating with the large ones. The uppermost of the two rows of large suckers contains one or two more suckers than the lower, and they are also larger. The number in the upper row is seven to nine, in the lower five to seven, the largest specimens having the greater number. Of these, the three to five middle ones in each row are decidedly the largest and have the edge of the marginal ring nearly smooth and even; at each end of each row the suckers diminish in size and the edge becomes denticulate, at first by the formation of narrow incisions, which leave broad, stout, blunt denticles; but as the suckers diminish in size these become longer, narrower and more acute; their inner margins remain smooth. The large suckers are broad and moderately deep, somewhat swollen below, and a little oblique. The marginal suckers are much smaller, shallower, more oblique, and have the entire rim finely and sharply denticulate, the denticles being longer and strongly incurved on the outer margin. Beyond the rows of large suckers there is, at first, a small group of sharply denticulate suckers, in four rows, resembling the marginal ones in form and size; but these rapidly decrease in size and are succeeded by eight crowded rows of very small suckers, with minute apertures, which occupy the entire face of the terminal section to the tip.

The suckers of the sessile arms are largest on the two lateral pairs, on which they are nearly equal, and the largest are about the same in size as those on the tentacular-club;* those of the ventral arms are smallest; those of the dorsal arms are intermediate in size between

* In the males the tentacular suckers are usually the smaller; in the females often the larger.

those of the lateral and ventral arms. The first few suckers (three to five), at the base of each arm, are smaller than those beyond, but increase regularly in size; they have the edge of the rim nearly entire, or with only a few blunt teeth on the outer margin; then follow about twelve suckers, of the largest size. These large suckers (Plate XXVIII, figs. 5, 5*a*) are deep, oblique cup-shaped, somewhat swollen in the middle, with oblique horny rims, which are entire on the inner margin, but on the outer have a large, strongly incurved, acute median tooth, on each side of which there are usually four or five shorter, flat, blunt teeth; but toward the base of the arms these are fewer and shorter, while distally they become more numerous, longer, and more acute, and often the edge is more or less denticulate nearly all around. The larger suckers are followed by a regularly decreasing series of thirty to forty smaller secondary ones (figs. 6, 6*a*), not counting the numerous very small ones, within one-third of an inch of the tip. These secondary suckers grade gradually into the large or primary ones, both in size and form; they are, however, armed with four or five very sharp incurved teeth, on the outer margin, of which the median one is longest, while the inner margin is usually entire. They are very oblique and one-sided in form. The membrane around the rim of all the suckers is thickened, but most so on the basal ones; it usually recedes behind the large median tooth, leaving there an emargination.

The outer buccal membrane is not very large; its inner surface is closely covered with lamelliform folds and wrinkles; its border is prolonged into seven acute angles, from which membranes extend to the opposite arms, going to the upper sides of the second and fourth pairs of arms; to the lower side of the third pair; but the seventh angle is in the median dorsal line, and the membrane from it bifurcates, one-half going to the inner side of each dorsal arm. Immediately around the jaws there is a circular, thickened, rugose oral membrane, with a strongly lobed edge, while its inner surface is radially wrinkled and covered with scattered rounded verrucæ. A plain fold intervenes between this and the outer buccal membranes.

The jaws are sharp and incurved at tip, reddish brown to brownish black in color, with the posterior borders of the laminæ whitish and translucent. The upper mandible has a much incurved tip, with the cutting edges regularly curved, and with a shallow notch at their bases, beyond which the anterior edges rise into a broad obtuse lobe or low tooth, by which the hardened and dark-colored part, as seen by transmitted light, has the form of a sharp angular tooth, but its

actual projection anteriorly is but slight, because the translucent edge beyond it rises to about the same level. The lateral-posterior borders of the frontal laminæ are sinuous and incurved in the middle; the palatine lamina is broad, with the posterior lateral edges incurved and sinuous.

The lower mandible has the extreme tip strongly incurved, forming a slight notch, close to the tip, below which the edges are slightly incurved or nearly straight, with a decided V-shaped notch at the base; the anterior edges, beyond the notch, form a triangular tooth of the inner laminæ, but this is obscured, unless viewed by transmitted light, by the outer alar laminæ, which rises at its anterior edge, which is translucent, nearly to a level with the tooth; the inner ends of the alæ are wider than the middle, and broadly rounded; the gular laminæ are short, narrowed posteriorly, with their inner edges incurved, and with a thickened, prominent ventral carina.

The jaws of a large specimen measure as follows: upper mandible, tip to posterior end of palatine lamina, 22^{mm}; to dorsal end of frontal lamina, 16; to posterior lateral edge of same, 9; to base of cutting edge, 5; inner edge of palatine lamina to dorsal end of frontal lamina, 17. Lower mandible, tip to inner end of alæ, 13^{mm}; to ventral notch of alæ, 4; to ventral notch of gular laminæ, 9; to posterior end of same, 16; to base of cutting edges, 5.

The buccal mass has, on the outer surface of the dorsal and lateral sides, a broad, thin, brown horny plate, with a notch posteriorly, in the median line.

The odontophore (Plate XXXVII, fig. 8), is remarkable for the length and sharpness of the teeth, especially of the central and outer rows. The median teeth have a long and very acute median denticle, with much shorter lateral ones. The inner lateral teeth have broad bases and a long and very sharp central denticle, with a much shorter lateral one, on the outside. The next to the outer lateral teeth are simple, slender and sharp. The outer lateral teeth are much longer, strongly curved, and very acute.

The pen (Plate XXVIII, fig. 4) is long and slender, with a slender midrib and strong marginal ribs; the anterior end is thin, broad pen-shaped, subacute; from very near the anterior end it tapers gradually backward to about the posterior fourth, where it becomes very narrow, apparently consisting only of the consolidated lateral ribs and midrib, the former showing on the ventral side a thin groove between them, the latter appearing as a slender ridge on the dorsal side. The posterior portion is narrow-lanceolate in form, with thin

edges, and a strong midrib, composed of the united marginal ribs of the anterior portion; the thin edges are incurved, so as to give a canoe-shaped form to this portion, and near the tip, the edges unite beneath into a short hood-like tip. Anteriorly the lateral ribs show two grooves on the ventral side, and appear to be composed of three united ribs.

The ground-color of a specimen taken by me, in 1870, at Eastport, Maine, when first caught, was pale bluish-white, with green, blue and yellow iridescence on the sides and lower surface; the whole body, head, and outer surfaces of arms and fins were more or less thickly covered with small, unequal, circular, orange-brown and dark brown spots, having crenulate margins; these spots were continually changing in size, from mere points, when they were nearly black, to spots 1^{mm} to $1{\cdot}5^{mm}$ in diameter, when they were pale orange-brown, becoming lighter colored as they expanded. On the lower side of body, head, and siphon the spots were more scattered, but the intervals were generally less than the diameter of the spots. On the upper side the spots were much crowded and in different planes, with the edges often overlapping, thus increasing the variety of the tints. Along the middle of the back the ground-color was pale flesh-color, with a distinct median dorsal band, along which the spots were more crowded and tinged with green, in fine specks. Above each eye there was a broad lunate spot of light purplish red, with smaller and much crowded brown spots. The upper surface of the head was deeply colored by the brown spots, which were here larger, darker, and more crowded than elsewhere, and situated in several strata. The under sides of the arms and fins were colored like the body, except that the spots were smaller and much less numerous. The suckers were pure white. The eyes were dark, blue-black, surrounded by an iridescent border.

The colors change constantly, when living or recently dead, by means of the continual contraction and dilation of the chromatophores. The different tints pass over the surface like blushes.

In specimens recently preserved in alcohol, the same pattern of coloration is usually visible. The dark dorsal band on the body and head, and the dark patches above the eyes, as well as smaller dark patches in front of the eyes, can be plainly seen. In these darker parts the chromatophores are much crowded, and have a purplish brown color, varying to chocolate-brown in specimens longer preserved. On other parts of the body the chromatophores are more scattered and usually reddish brown in color, with a circular or elliptical outline; when expanded, the larger ones are about 1^{mm} in diam-

eter. The under surfaces of the fins, siphon, head, and arms have fewer and smaller spots, and are, therefore, lighter colored, and appear nearly white when these spots are contracted.

A fresh specimen, caught in Casco Bay, in 1873, had the following proportions: Length of head and body, not including the arms, 221^{mm}; length of caudal fin, 86; breadth of fin, 90; diameter of body, 35; length of upper arms, 80; of second pair, 100; of third pair, 100; of the ventral pair, 90; of tentacular-arms, 182^{mm}.

Of our species, I have measured large numbers of specimens, preserved in different ways, and also fresh, and have found no great variation in the form and relative length of the caudal fin, among specimens of similar size and in similar states of preservation, nor do the sexes differ in this respect. The young, however, differ very decidedly from the large specimens in these respects. The modes of preservation also cause much of the variation in the proportions of fins and arms to the mantle. The two sexes are probably equally numerous, but in our collections the females usually predominate, and the largest specimens are usually females, though equally large males occur. In 31 measured specimens, in alcohol, from various localities and of both sexes, the average length, from tip of tail to dorsal edge of the mantle, was 176^{mm} (6·96 inches); from tip of tail to insertion of fin, 66^{mm} (2·60 inches); average proportion of fin to mantle-length, 1 : 2·68. Among these the proportions varied from as low as 1 : 2·48, in some of the larger ones (with mantle above 8 inches), up to 1 : 3·00, in the smaller ones (with the mantle less than 3 inches long).

The following tables are intended to illustrate the natural variation in the proportions, due mainly to age, and the accidental variations caused by differences in the modes of preservation and strength of the alcohol.

The specimens from Eastport, Me., designated G. H. I. R., were collected at one time, in midsummer, and preserved in the same way, in alcohol of moderate strength, repeatedly changed; at the present time the strength of the alcohol is about 80 per cent. They are in good condition, moderately firm and not badly contracted. Those designated as D. E. F. N. O. P., were also collected at one time, in August, and preserved together. They are in fair condition, but not so well preserved as the former lot. Those numbered ii to xiv were preserved together, about the last of July. They were placed in strong alcohol and are hard and badly contracted. J. K. and L. were preserved together, but were originally found dead on the beach and in a relaxed state. They are only moderately contracted by the alcohol.

Measurements of Ommastrephes illecebrosa (in inches).

	O ♀	P ♀	D ♀	E ♀	J ♂	I ♂	R ♂	W ♂	Fresh.
Tail to tip of dorsal arms,	13·40	13·00	12·75	10·50	13·50	10·50	10·50	8·25	--
Tail to tip of second pair arms,	14·20	13·70	--	--	14·30	10·80	11·10	--	--
Tail to tip of third pair arms,	14·20	13·70	13·25	11·00	14·20	11·00	11·20	--	--
Tail to tip of fourth pair arms,	13·10	13·60	--	--	13·40	10·60	11·00	--	--
Tail to tip of tentacular-arms,	16·50	17·50	15·5	12·00	15·50	12·20	12·50	--	--
Tail to base of dorsal arms,	10·00	9·40	9·00	7·90	10·00	8·30	8·20	6·50	8·84
Tail to center of eye,	9·30	8·90	8·25	7·35	9·50	7·75	7·70	--	--
Tail to edge of mantle, above,	8·60	8·00	7·75	7·10	8·70	7·50	7·20	5·70	--
Tail to edge of mantle, below,	8·20	7·50	7·30	--	8·10	7·15	6·65	5·38	--
Tail to insertion of fin,	3·30	3·20	3·10	2·75	3·50	2·90	2·80	2·10	3·44?
Breadth of fin,	4·20	4·30	4·25	3·78	5·15	3·80	3·90	2·65	3·60
Distance between lateral insertions,	--	--	·50	·40	·65	·45	--	--	--
Front edge, outer angle to insertion,	2·20	2·20	2·00	1·90	2·50	2·80	2·10	1·45	--
Back edge, outer angle to tip of tail,	3·30	3·25	3·15	2·90	3·50	3·00	2·90	2·00	--
Circumference of body,	4·80	4·80	--	--	6·50	4·30	4·00	--	--
Breadth of body,	1·70	1·60	--	--	2·15	1·30	1·40	1·10	1·40
Breadth of head at eyes,	1·60	1·50	1·35	1·15	1·65	1·20	1·30	1·00	--
Breadth of eye-opening,	·40	·45	·35	--	·36	·20	·23	·25	--
Breadth of siphon at bridle,	·75	·70	·65	·55	·78	·60	·55	--	--
Length of head, mantle to base of dorsal arms,	1·40	1·40	1·25	·80	1·30	·80	1·00	·80	--
Length of dorsal arms,	3·75	3·60	3·25	2·70	2·65	2·20	2·43	1·75	3·20
Length of 2d pair,	4·30	4·20	4·00	3·15	4·40	2·70	3·12	2·25	4·00
Length of 3d pair,	4·10	4·25	4·00	3·00	4·55	2·67	3·15	2·25	4·00
Length of 4th pair,	3·60	3·80	3·50	2·80	3·80	2·43	2·75	2·00	3·60
Length of tentacular-arms,	6·80	8·00	6·50	4·00	5·80	4·00	4·10	4·50	7·28
Length of club,	3·30	3·50	2·75	1·85	2·55	1·75	1·90	1·30	--
Breadth of dorsal arms,	·35	·36	·28	·25	·35	·30	--	·20	--
Breadth of 2d pair,	·45	·44	·35	·30	·45	·35	--	·25	--
Breadth of 3d pair,	·45	·44	·35	·28	·50	·35	--	·25	--
Breadth of 4th pair,	·44	·42	·32	·30	·45	·35	--	·25	--
Breadth of tentacular-arms,	·25	·28	·30	·30	·28	·20	--	·17	--
Breadth of club,	·30	·30	·22	·18	·25	·22	--	--	--
Front to back of 3d pair,	·65	·60	·50	·40	·65	·45	--	--	--
Diameter of Suckers:									
Largest on tentacular-arms,	·18	·17	·15	·11	·18	·10	·13	--	--
Largest on 3d pair,	·18	·16	·14	·11	·21	·14	·14	--	--
Largest on ventral arms,	·11	·11	·10	·09	·11	·09	·07	--	--
Proportions:									
Length of fin to mantle length, 1:	2·60	2·50	2·50	2·58	2·48	2·58	2·57	2·71	--
Breadth of fin to mantle length, 1:	2·04	1·86	1·82	1·87	1·69	1·97	1·84	2·15	--
Length* to breadth of fin, 1:	1·27	1·34	1·37	1·37	1·46	1·30	1·39	1·26	--
Length of head to mantle, 1:	6·14	5·70	6·20	8·87	6·70	9·30	7·20	7·12	--

The same specimens, included both in this and the following tables, show small differences in their measurements (made at different times), due partly to the different degrees of extension employed in measuring them, and partly to the fact that the alcohol had been changed, and its strength altered.

* The length of the fin, in these tables, means the distance from the lateral insertions to the tip of the tail, which is somewhat less than the extreme length.