not be seen with the naked eye; they are deep, cup-shaped, with a small circular aperture, supported by a horny rim, which is often armed with two or three sharp teeth on one side (fig. 3*e*).

Color of body and arms, so far as preserved, in alcohol, deep brownish orange; on the upper side of the back and caudal fin the color is better preserved, and shows small, ocellated, circular spots of orange-brown, with an inner circle of whitish, and a central spot of purplish brown. Similar spots also exist on the head and arms, and also on the lower side of the body, where the color is best preserved.

A considerable amount of a bright orange oily fluid, insoluble in alcohol, exuded from the viscera. Examined by means of the spectroscope this fluid absorbed part of the green, all of the blue, and most of the violet rays. The stomach contained fragments of small crustacea. The pen is pale yellow, thin, and slender anteriorly, with two sublateral costæ, and narrow delicate margins outside the costæ; in the middle it becomes still thinner and narrower, with the margin inrolled; beyond, the margins become much wider and then unite together ventrally, forming a long, hollow, conical portion, extending to the acute posterior tip; this portion is not so broad as deep, and has a slight dorsal keel and ventral groove.

Measurements in millimeters.

	Male.	Male.
Total length to end of sessile arms	137	232
Head and body combined	59	122
Length of body	46	99
Length of caudal fin, from origin	30	60
Breadth of caudal fin	42	75
Breadth of body	15	23
Length of dorsal arms	24	45
Length of 2d pair of arms	33	60
Length of 3d pair of arms	34	60
Length of ventral arms	80	112
Length of tentacular arms	--	312
Breadth of dorsal arms, at base	3	4
Breadth of ventral arms	6	7
Breadth of tentacular arms	2	4
Diameter of eye	7·5	9
Length of pen	--	198
Breadth of pen anteriorly	--	2·25
Breadth of pen posteriorly	--	2·50
Depth of pen posteriorly	--	4·50

Specimens examined.

No.	Locality.	Fath.	When Rec'd.	Name of Vessel.	Rec'd from	Spec. No.	Sex.
24	cccxxv. N.L. 33°25′20″ W.Lg. 76°	647	1880	Blake	Mus.Comp.Zool.	1	♂
25	cccxxviii. N.L. 34°28′25″ W.Lg. 75°22′50″	1632	1880	Blake	Mus.Comp.Zool.	1	♂

Chiroteuthis Bonplandi D'Orb. (?).

Loligopsis Bonplandi Verany, Acad. Turin, ser. II, vol. i, Pl. 5. (Specimen without tentacular arms, t. D'Orb.).

Chiroteuthis Bonplandi D'Orbigny, Céphal. Acétab., p. 226. (Description compiled from Verany).

Verrill, Bulletin Mus. Comp. Zoöl., vol. viii, Pl. 3, figs. 1–1*b*, 1881.

PLATE XLVII, FIGURES 1–1*b*.

A detached tentacular arm, belonging to a species of *Chiroteuthis*, was taken by the U. S. Coast Survey steamer "Blake," in the summer of 1880, at station CCCIII, lat. 41° 34′ 30″, long. 65° 54′ 30″, in 306 fathoms.

The arm is very long and slender; the length being 780^{mm} (or over 30 inches); its diameter being from 1·5 to 2^{mm}, except near the base, where it is 3^{mm}, and at the terminal club, which is 6^{mm} broad, and 54^{mm} long. The arm is white, with purplish specks, and is generally roundish, except at the club; along the greater part of its length there is a row of rather distant sessile suckers, the distance between them being usually from $12–18^{mm}$; these suckers are larger than those of the club and have a nearly flat upper surface and no horny marginal rim. A row of small, simple, scattered pits, perhaps homologues of these suckers, extends up the back side of the club. These smooth suckers evidently serve to unite the tentacular arms together, when used in concert. The club is stouter than the rest of the arm, convex on both sides, and but little flattened; on each side it is bordered by a well developed, marginal membrane, supported by a series of transverse, thickened, but flat, tapering, acute, muscular processes, with their ends projecting beyond the edge of the membrane, as digitations; on the distal half of the club, these are separated by spaces greater than their breadth, but on the proximal portion they subdivide into two or three parts, which become crowded close together, showing only narrow intervals or merely a groove between them. At the tip of the arm there is a thick, ovate, dark purple, spoon-shaped, hollow organ, about 4^{mm} long, with its opening on the back side of the arm. This so strongly resembles the spoon-shaped organ of the hectocotylized arm of some Octopods, as to suggest the possibility of a similar use, for sexual purposes. The suckers are crowded in 4 to 8 indistinct rows. Their pedicels are long and slender, having beyond the middle a large, dark purple, fluted, swollen portion, beyond which the pedicel is more slender; the cup of the sucker is small and deep, with a very oblique, oblong-ovate, lateral opening; horny rim, not distinctly toothed (fig. 1*b*).

Histioteuthis Collinsii Verrill.

Amer. Journ. Sci., xvii, p. 241, March, 1879; xix, p. 290, 1880.
Tryon, Man. Conch., i, p. 166, 1879, (copied from preceding.)
Verrill, this vol., p. 234, Plate 22, Feb., 1879.

PLATE XXII. PLATE XXVII, FIGURES 3-5. PLATE XXXVII, FIGURE 5.

In addition to the original specimen, figured and described in Part I of this article (see p. 234), another specimen, represented by the jaws alone, has been received by the U. S. Fish Commission, from the Gloucester fisheries. (Lot 843.)

This was obtained on the Western Bank, off Nova Scotia.

Another beak was dredged by the "Fish Hawk," at station 893, south of Newport, R. I., in 372 fathoms.

These jaws agree well in size and all other characters, with those of the original specimen (Pl. XXVII, fig. 4).

Family.—DESMOTEUTHIDÆ nov.

For the reception of the genera, *Desmoteuthis* V. and *Taonius* St., as defined below, I propose to establish this new family, which has hitherto been confounded with *Cranchidæ* and *Loligopsidæ*.

Body much elongated, pointed posteriorly; caudal fin narrow, terminal, mantle united to neck by a dorsal and two lateral muscular commissures. Pen lance-shaped, as long as the mantle, with a long narrow shaft; blade incurved or hooded posteriorly. Œsophagus and intestine very much elongated. Nidamental glands large, symmetrical. Eyes large, protuberant; lids free and simple. No auditory crests. Siphon large, with neither internal valve nor dorsal bridle. Arms with depressed suckers. Tentacular arms with a well-developed club, bearing suckers.

Desmoteuthis, gen. nov.

Taonius (*pars*) Steenstrup, 1861.

Body very long, tapering backward to a long, slender, acute caudal portion. Caudal fin long, narrow, tapering to a long acute tip. Anterior edge of the mantle united directly to the head, on the dorsal side, by a commissure, so that there is no free edge, medially, and the surface is continuous, as in *Sepiola*; the dorsal commissure extends backward and diverges within the mantle; two additional muscular commissures unite the lateral inner surfaces of the mantle to the sides of the siphon. Eyes very large and prominent, with simple circular lids. No aquiferous pores. Siphon large and prominent, with neither valve nor dorsal bridles. Arms small and short,

subequal, with a basal web and lateral membranes; suckers smallest on the ventral arms, and urceolate; largest and flatish on the middle of the lateral and dorsal arms; feebly toothed. Pen extending the whole length of the body, very slender and of uniform width for more than half the length, then becoming broad-lanceolate, the terminal portion having the edges involute, forming a long slender cone, into which the ovary extends. Nidamental glands large, symmetrically developed on the two sides. Gills small, situated in front of the middle of the body.

The genus *Taonius* was proposed by Steenstrup to include this and *T. pavo* (Les. sp.), but he has never, to my knowledge, definitely defined the genus. As *T. pavo* appears to be generically distinct from the present genus, I propose to retain *Taonius*, with *T. pavo* for its type. By many writers *T. pavo* has been placed in *Loligopsis*, or *Leachia*. Steenstrup himself, formerly referred *D. hyperborea* to *Leachia*. By Tryon, both have been referred back to *Loligopsis*.

Loligopsis, as defined by D'Orbigny, in 1839, included *T. pavo*, as well as the type of *Leachia*, but he referred Lamarck's original type of *Loligopsis* to the genus, as emended by him, only with doubt.

It seems desirable, therefore, to explain this confusion, so far as possible.

Loligopsis Lamarck,* 1812 and 1822, was based only on an imperfect figure, made by Péron, of a small oceanic squid, which had lost its tentacular arms. The supposed character of having *eight arms* was, for him, the only basis for the genus, no others being mentioned. The species (*L. Peronii*) was, however, described very briefly as a small squid with eight equal arms and two posterior, distinct caudal fins, and it was compared to *Sepiola*. It has apparently not been rediscovered by later writers, unless *L. chrysophthalma* D'Orb., be the same species, which is quite possible. The latter, as figured, is a small, *short-bodied species, with distinct, separate, small, caudal fins, which are free from the end of the body;* its mantle-edge is also represented as free, dorsally. This evidently is a generic type distinct from *Taonius* and *Desmoteuthis*. Indeed, it probably will be found not to belong to the same *family*, when actually studied. Therefore it seems necessary to allow the name *Loligopsis* to remain connected with such small, short-bodied species, for which, alone, it was originally used. The genus, in its original sense, cannot yet be regarded as fully established.

* Extr. de Cours de Zoöl., p. 123, 1812 (t. D'Orb.); Animaux sans vert., vii, p. 659, 1822.

Leachia Lesueur, 1821* (= *Perothis* (Esch.) Rathke, 1835), was also based on an *imperfect figure* of a small Pacific Ocean squid, which had likewise lost its tentacular arms. The only generic character given was, as in Lamarck's case, the presence of only eight arms,—a purely fictitious character. The type of this genus was *Leachia cyclura* Les. It has a more elongated body, slender posteriorly, with a more or less rounded caudal fin, the two sides of the fin completely united together and to the posterior end of the body. The third pair of arms is much larger than the others. The anterior dorsal edge of the mantle is represented as *free*, in all the figures, but, according to D'Orbigny, there is an internal, dorsal commissure, and also two lateral ones. The visceral anatomy of one species of this group (*L. guttata* Grant), which D'Orbigny refers, probably correctly,† to the original *L. cyclura*, is pretty well known, and is widely different from that of *Desmoteuthis* (see Pl. XXXIX, fig. 1), as well as from that of *Taonius*, so far as the latter is known.

There can be no doubt whatever as to the generic distinctness of *Leachia*, if the *anatomy* be taken into account. (See the figures of Grant and D'Orbigny.)

Taonius Steenstrup, 1861, (type *T. pavo*). This differs from the two preceding genera in its more elongated form, narrow caudal fin, etc. From *Leachia* and *Desmoteuthis* it differs in the form of its pen. The dorsal edge of the mantle is represented and described as free by D'Orbigny. The anatomical characters are not known.

Desmoteuthis hyperborea Verrill.

Leachia hyperborea Steenstrup, Kongelige Danske Vidensk. Selsk. Skrifter, 5 r., iv, p. 200, 1856 (sep. copies, p. 16).

Taonius hyperboreus Steenst., Oversigt Kgl. Danske Vidensk. Selsk., Forhandlinger, 1861, p. 83.

Verrill, Amer. Journ. Sci., xvii, p. 243, 1879; xix, p. 290, 1880.

Loligopsis hyperboreus Tryon, op. cit., p. 162 (inaccurate translation, after Steenstrup).

PLATE XXVII, FIGURES 1, 2. PLATE XXXIX, FIGURE 1 (anatomy).

♀. Body very long, tapering gradually backward, and ending in a long, slender, acute tail; mantle soft and flabby, with a capacious branchial cavity; anterior dorsal edge advancing somewhat in the

* Journal Philad. Acad., ii, p. 89, pl. 2.

† Tryon criticizes this determination, because Lesueur "describes and figures a smooth species," while *L. guttata* has two rows of curious tubercles *on the ventral side*. But as Lesueur only *described a figure of the dorsal surface*, his objection to this identification is absurd.

middle and directly united to the head, so as to leave no free edge medially, by a rather wide commissural band, the sides of which diverge as they extend backward within the mantle. Caudal fin long, narrow, lanceolate, narrowly acuminate to a very long, acute tip; the anterior insertions are wide apart, and the anterior border is rounded. Head short and small, exclusive of the eyes, which are very large, globular, and prominent, their lower sides in contact beneath the head; openings round, looking somewhat downward; pupils large and round; lids thin and simple. Siphon very large and prominent, extending forward between the eyes, but without a special groove; dorsal surface firmly united to the head by a thick commissure, leaving about half the length free; opening large, without any valve.

Arms comparatively small and short, none of them complete, in our specimen, except those of the 3d and 4th pairs, which are nearly equal in length, the ventral ones a little the shortest and most slender; the dorsal and 2d pairs of arms have lost their distal portions, but the parts of the dorsal arms remaining correspond in size with the ventral ones; and those of the 2d pair with the 3d pair. The arms are all united together by a thin, delicate basal web, which extends up some distance between the arms (farthest between the dorsal pair), and then runs along the sides of the arms, as broad, thin, marginal membranes, to the tips. Suckers of the ventral arms smaller and different in form from those of the others, all of them being urceolate, with narrow apertures, surrounded by a slightly enlarged border, and having small horny rings with the edge entire, or nearly so, on the proximal suckers, but on the smaller ones, toward the tip, with a few broad blunt teeth on the outer edge. On the dorsal and lateral arms the basal suckers are ventricose and urceolate, like those of the ventral arms, but along the middle portion of these arms the suckers become much larger, and have a broad shallow form, with wide apertures and expanded bases; the horny rings of these larger suckers are divided into several broad, bluntly rounded teeth on the outer edge; toward the tips of the arms the smaller suckers again become deeper, with more contracted apertures, and with a few more prominent denticles on the rings.

Outer buccal membrane with seven obtuse angles, and united to the arms by eight bridles, or commissures, of which the upper one is double. Exposed part of the beak black; mandibles very acute, strongly incurved.

Pen very thin and narrow, and of nearly uniform width (4^{mm}) for more than half its length; at about four-sevenths of its length, from

the anterior end, it gradually expands laterally into a broad, very thin, lanceolate form, becoming, opposite the broadest part of the fin, 30^{mm} wide, with very delicate lateral expansions and with a pretty strong dorsal keel; farther back it tapers and is very acuminate, the lateral margins becoming involute, so as to form a very long, slender, acute, terminal, hollow cone, extending to the tip of the tail. The anterior end is obtusely rounded and thin; a short distance from the anterior end there are two thin lateral processes, directed forward, to which the commissural muscles were attached.

Color of entire body, siphon, and caudal fin, dark brown, thickly covered with large roundish unequal spots of darker brown, and paler brown, intermixed; head, eyes, arms, and web, dark brownish purple, with crowded chomatophores; suckers yellowish.

Total length, to end of lateral arms, 16 inches; to dorsal edge of mantle, 13; length of head, 1; diameter of eye, 1; length of caudal fin, 5; its breadth, 1·80 inches.*

Measurements in millimeters.

	A. ♀	B.
Length to tip of lateral arms,	410	---
Length to base of arms,	354	---
Length to edge of mantle, above,	330	210
Length of caudal fin,	127	103
Breadth of caudal fin,	46	18
Diameter of body,	57	---
Diameter of eye,	25	26
Length of 3d pair of arms,	56	63
Length of ventral arms,	52	38
Diameter of largest suckers of lateral arms,	3	5
Length of pen,	330	--
Of anterior linear portion,	180	--
Of posterior lanceolate part,	150	--
Breadth of anterior portion,	3	--
Breadth of lanceolate part,	30	--

A. is the specimen described above; B. is the specimen described by Steenstrup from Greenland. The latter had the dorsal arms 40^{mm} long; 2d pair 50^{mm}; tentacular arms 68 and 70^{mm} respectively. The larger size of the suckers of the latter may indicate that it was a male.

Our specimen was taken near the northern edge of the Gulf Stream, W. long. 55°, by Thomas Lee, of the schooner "Wm. H. Oaks," Jan., 1879, and by him presented to the U. S. Fish Commission. Baffin's Bay, Northern Greenland (Steenstrup).

* Some of these measurements are slightly larger than those originally given. This is due to the fact that the specimen has been kept, since first received, in somewhat weaker alcohol, and has become more relaxed in consequence of this, combined with repeated handling.

Notes on the Visceral Anatomy.

PLATE XXXIX, FIGURE 1.

The only specimen of this species obtained had the internal organs considerably injured, but the anatomy is so unlike that of the more common genera of squids, that it seemed to me desirable to figure such parts as are preserved.

This specimen is a female and the large nidamental glands (*x'*, *xx*, *xx'*) are symmetrically developed, on the two sides; these are swollen, voluminous organs, composed of great numbers of internal lamellæ; the anterior ones (*x'*) occupy the region around, and in front of the bases of the gills, extending forward and having an oblique, oblong opening (*op*, *op'*) on the outside of the anterior ends; the posterior ones (*xx*, *xx'*) are behind the gills and cover the branchial auricles, the oblique, slit-like opening is on the outside of the posterior ends; the gland on the left side (*xx'*) was mutilated; the posterior vena-cava, in front of *r'*, passes through the center of the posterior gland (*xx*). The ovary (*ov*) is a very long organ, attached to the stomach (*s*) and to the sides of its long cæcal appendage; it extends far backward to near the tip of the tail, occupying the concavity of the pen (*p*); it consists of great numbers of small clustered folicles; connected with its anterior end, and attached to the stomach, there is a convoluted tube, probably an oviduct, not shown in the figure; connected with the intestine, near its origin (between *s* and *l*), there is a firm, rounded organ (gizzard ?), with internal lamellæ, opening into the intestine. The stomach was much mutilated, so that its form could not be certainly made out; its cavity is occupied by numerous longitudinal folds; a very long, saccular cæcal appendage, longitudinally plicated within, runs back, along the ovary, into the caudal cavity of the pen. The œsophagus had been destroyed. The intestine (*l*, *h*) is very long and slender, internally longitudinally plicated, and externally covered along nearly its whole length, on one side, by close groups of small, glandular folicles (*l*, *l*); the posterior portion is closely attached to the ventral edge of the smooth, compressed, oblong-ovate liver (*i*), and the free, stout, anal end (*h*) is provided with two slender, tapering cirri. Ink-sac small, pyriform.

The gills (*g*, *g*) are small and short, situated far forward, and connected to the ventricle of the heart (*H*), by long afferent vessels (*bo*); the branchial auricles (*au*, *au*) are rounded, without terminal capsules; the ventricle of the heart (*H*), as preserved, is small and four-lobed. The largest lobe directed forward and passing into the anterior aorta. The condition of the specimen did not permit the circulation to

be much studied. The two large, fusiform, cellular organs (r', r') are probably renal in nature; their interior is filled with large, irregular cavities or lacunæ, which appear to be connected with the posterior venæ cavæ (vc'').

Taonius Steenstrup.

Loligo (*pars*) Lesueur, Journ. Philad. Acad., ii, p. 96, 1821.
Loligopsis (*pars*) D'Orbigny, Céph. Acétab., p. 320, (*non* Lamarck).
Gray (*pars*), Catal. Moll. Brit. Mus., i, p. 39, 1849.
Taonius (*pars*) Steenstrup, Oversigt Kgl. Danske Vidensk. Selsk. Forh., 1861, pp. 70, 85.

This genus seems to bear about the same relation to *Desmoteuthis* that *Rossia* does to *Sepiola*. Its relations with *Loligopsis* and *Leachia* have already been discussed (pp. 301, 302). The body is short-pointed posteriorly. The caudal fin is long-cordate, but not slender pointed. The pen is lance-shaped, the anterior portion being long, narrow, of nearly uniform width; posterior end broad-lanceolate, short-pointed posteriorly, and, according to the figures, without a cone at the tip. The anterior dorsal edge of the mantle is represented as free externally, but there is a dorsal commissure within the mantle-cavity, and a lateral one on each side. Arms short, subequal; suckers flat, denticulate; those of the tentacles with sharp, incurved teeth. Eyes large, globular, prominent, lids free and simple.

Siphon with neither valve, nor dorsal bridle. No external ears, nuchal crests, nor cephalic aquiferous pores.

Taonius pavo Steenstrup.

Loligo pavo Lesueur, Journal Acad. Nat. Science Philad., ii, p. 96, with a Plate, 1821.
Loligopsis pavo Ferussac and D'Orb., Céph. Acétab., p. 321, Calmars, Pl. 6, figs. 1–4, (after Lesueur); Loligopsis, Pl. 4, figs. 1–8 (details, original).
Binney, in Gould, Invert. Mass., ed. II, p. 309, (but *not* the figure, Pl. 26).
Verrill, Amer. Journ. Sci., xix, p. 290, 1880.
Tryon, Amer. Mar. Conch., p. 9, Pl. 1, fig. 3 (after Lesueur); Man. Conch., i, p. 163, Pl. 68, fig. 252, Pl. 69, fig. 253, 1879 (descr. from Gray, figures from Lesueur and D'Orb.).
Taonius pavo Steenst., Oversigt Kgl. Danske Vidensk. Selsk. Forh., 1861, pp. 70 and 85.

This species differs externally from the preceding in having a much shorter, obtuse, oblong-cordate, fin, instead of a long, slender, pointed one, and by its very distinct coloration. According to Lesueur the general color is carmine-brown, the mantle, head, and arms "covered on every part with very large ocellations, which are connected together by smaller intermediate ones." Length of mantle, 10 inches.

Sandy Bay, Mass. (Lesueur). Newfoundland (Steenstrup). Off Madeira (D'Orbigny).

No instance of the occurrence of this oceanic species on the New England coast has been recorded since the original specimen was described by Lesueur, in 1821. The circumstances connected with the history of his specimen are such as to render it not improbable that some interchange of labels had occurred in his case. Therefore, the New England habitat, for this species, needs confirmation.

Lesueur's statement (loc. cit., p. 94) is that when at Sandy Bay, Mass. (on Cape Ann), in 1816, he saw a "great number" of squids ("*Loligos*") that had been taken by the fishermen for bait, and that: "The beautiful color with which they were ornamented, induced me to take a drawing of one immediately, but not then having leisure to complete it, I took a specimen with me to finish the drawing at my leisure. But recently [in 1821] upon comparing this specimen with my drawing, I was much surprised to perceive that I had brought with me a very distinct species from that which I had observed [*O. illecebrosus*]. I mention this circumstance to explain the cause of the brevity of the following description [of *O. illecebrosus*] taken from my drawing." The drawing was also inaccurate, for the same reason.

Loligo Lamarck, 1779.

Loligo (*pars*) Lamarck, Syst. Anim. sans vert., p. 60, 1801.
Pteroteuthis (sub-genus) Blainville, Man. Malac., p. 367, 1825.
Loligo (restricted) D'Orbigny, Céph. Acétab., p. 305, 1848.

Body more or less elongated, tapering to a point behind; anterior edge of mantle free dorsally, and prolonged into a lobe, covering the end of the pen. Caudal fin elongated-rhomboidal, united to the sides of the body to the tip. Mantle connected to the neck by a dorsal and two lateral connective cartilages; lateral cartilages of the mantle simple, longitudinal ridges; corresponding cartilages, on the base of the siphon, irregularly ovate, with a median groove. Pen as long as the mantle, anteriorly narrow, with a central keel, and two lateral ridges; posteriorly broad, thin, lanceolate, concave, but not involute. Head rather large; eyes without lids, covered with transparent skin, pupil encroached upon dorsally by the iris; a small pore in front of the eyes; behind the eyes, on each side, there is an oblique transverse, and two longitudinal, erect, thin crests, in relation with the ears. Siphon situated in a shallow groove, united to the head by two dorsal bridles, and furnished with an internal valve. Six buccal aquiferous pores, and a pair of branchial pores, one on

each side, between the bases of the 3d and 4th pairs of arms. Buccal membrane with seven elongated points, covered on their inner surfaces with small suckers; in the female with a special organ (Pl. XXIX, fig. 4, *s*), below the beak, on the ventral side, for the attachment of the spermatophores.

Sessile arms angular; basal web rudimentary or none; suckers in two rows, oblique, deep cup-shaped; horny rings toothed on the broad side, and surrounded with a median ridge. Male with one of the ventral arms (usually the left) hectocotylized, near the tip, by an enlargement of the bases of the pedicels of the suckers and a decrease, or disappearance, of the cups. Tentacular arms long and strong, with an expanded club, provided with marginal membranes and a dorsal keel; suckers, on the widest part, usually in four rows, those in the two central rows larger, broad urceolate; smaller ones cover the proximal and distal portions; no connective suckers on the club or along the arm.

Oviduct large, developed only on the left side. Nidamental glands large, in front of heart. Eggs in fusiform, gelatinous capsules, attached by one end, and usually radially united into large clusters.

Loligo Pealei Lesueur.

Typical form.

Loligo Pealei Lesueur, Journ. Acad. Nat. Sci. Philad., vol. ii, p. 92, Plate 8, 1821.

Loligo Pealii Blainville, Dict. Sci. Nat., xxvii, p. 144, 1823.

Férussac and D'Orbigny, Céph. Acétab., p. 311, Calmars, Pl. 11, figs. 1–5, Pl. 20, figs. 17–21 (details).

Gray (*Pealii*), Catal. Moll. Brit. Mus., i, p. 71, 1849.

Binney in Gould's Invert. Mass., ed. 2, p. 514, Pl. 25, figs. 339, 340, (figure erroneously referred to *O. Bartramii*).

Verrill (*Pealii*), Report on Invert. Vineyard Sd., pp. 440, 635 (sep. copies, p. 341), Pl. 20, figs. 102–105, 1877.

Tryon (*Pealii*), Man. Conch., i, p. 142, Pl. 51, figs. 133–140, (figs. from Fér. and D'Orb., and Dekay).

Verrill, Amer. Journ. Sci., iii, p. 281, 1872; Amer. Naturalist, viii, p. 170 (habits); Amer. Journ. Sci., xix, p. 292, 1880 (descr.).

Loligo punctata Dekay, Nat. Hist. N. Y., Mollusca, p. 3, Pl. 1, fig. 1, 1843 (young).

Binney, in Gould Invert. Mass., p. 513 (after Dekay).

Tryon, Amer. Mar. Conch., p. 14, Pl. 43, figs. 10, 11 (after Dekay).

Variety, borealis Verrill.

Loligo Pealei, var. borealis Verrill, Amer. Journ. Sci., xix, p. 292, 1880.

Variety, pallida Verrill.

Loligo pallida Verrill, Rep. Invert. Viney. Sd., in Rep. U. S. Com. Fish and Fisheries, i, p. 635, [341], Pl. 20, figs. 101, 101a, 1874.

Loligo Pealei Lesueur (continued).

Tryon, Man. Conch., p. 143, Pl. 52, figs. 141, 142, (descr., and figs. copied from preceding).

Verrill, Amer. Journ. Sci., xix, p. 292, 1880.

PLATE XXIX, FIGS. 1–4. PLATE XXXVII, FIGS. 1–3 (pens). PLATE XXXIX, FIG. 4 (odontophore). PLATE XL (anatomy). PLATE XLI (anatomy and young). PLATE XLV, FIGS. 3, 4 (young).

Body rather elongated, more or less stout, according to state of distention or contraction,* tapering backward to a moderately acute posterior end, more acute in the male than in the female. Caudal fin long-rhomboidal, with the outer angles very obtusely rounded; and varying, according to age, in the ratio of its length to its breadth, and greatly, also, in the proportion that its length bears to that of the mantle.† The length of the caudal fin, in proportion to that of the body (mantle), although variable, normally increases with age, even after sexual maturity. In this species, with specimens having the mantle from 100 to 125^{mm} long, the ratio of the fin to the mantle usually varies from 1 : 1·80 to 1 : 1·90; with the mantle 150 to 175^{mm} long, the ratio usually becomes 1 : 1·65 to 1 : 1·75; in the largest specimens, with the mantle, 260 to 400^{mm} long, the ratio varies from 1 : 1·50 to 1 : 1·65, rarely becoming 1 : 1·75. The ratio of the breadth of the caudal fin to the length of the mantle, in the larger male specimens, ranges from 1 : 2·12 to 1 : 2·40, varying considerably according to the mode of preservation; in the larger females it varies from 1 : 1·70 to 1 : 2·12.

The anterior ventral edge of the mantle recedes, in front of the siphon, in a broad curve, leaving an obtuse angle at either side, opposite the lateral cartilages; from these angles it again recedes, on the sides, in a concave line, and then projects considerably forward, forming a prominent, median, dorsal lobe, which gradually tapers from the base, and then rather suddenly narrows to a point, over the end of the pen; the point, when in its normal position, reaches as far

* The mantle, when the gill-cavity is distended with water, has a larger size than when the water is expelled by the contraction of its walls, which is usually the condition in which specimens die. Moreover, when the large stomach is distended with food, and when the ovary is distended, in the breeding season, with eggs, the form is stouter than usual.

† This variation is largely independent of sex, and is due partly to the ordinary changes during growth; partly to the condition of the muscular tissues at the time of death; and partly to the effects of the alcohol in which they have been preserved. These latter causes, in the case of preserved specimens, more or less obscure the effects of growth in causing the proportions to change.

forward as the posterior border of the eye, or even beyond it. Dorsal connective cartilage long, tapering backwards, with a very prominent, broad, dorsal keel; the anterior end is free and shaped like the end of the pen. Siphon large, rounded anteriorly, with a broad, bilabiate opening; lateral cartilages (Pl. XL, fig. 1, *f*) long and narrow, subacute anteriorly, posterior end with a thin, rounded, outer lobe; median groove narrow. The connective cartilages of the mantle (fig. 1, *f'*) are simple, longitudinal ridges, fading out gradually posteriorly. Head moderately large, usually narrower than the mantle; smaller in the male than in the female; eyes large; nuchal crests (fig. 1, *ob*) above the ear, formed by longer upper, and shorter inferior, oblique, longitudinal membranes, the two united by a doubly curved, or V-shaped membrane, having its angle directed forward, the whole having a rude, W-shaped form.

Arms large, stout, the three upper pairs successively longer; the ventral ones a little shorter than the third pair, and a little longer than the second pair. All the arms have narrow, thin, marginal membranes, strengthened by strong, transverse, muscular ridges. The first and second pairs of arms are trapezoidal at base; third pair stouter, compressed, with a keel on the middle of the outer side. Suckers in two regular rows on all the arms, deep, very oblique; largest on the lateral arms; those on the ventral arms are smaller, but otherwise similar. Horny rings yellowish, or brownish (white when fresh), strong; on the larger proximal suckers the outer or higher side is divided into about six broad, flattened, incurved teeth, which are blunt, subtruncate, and sometimes even emarginate at tip, remainder of margin nearly even; the smaller suckers, toward the tips of the arms, have the teeth longer, much more slender, and more acute.

The tentacular arm (Pl. XXIX, fig. 2) with fresh specimens, in full extension, may reach back nearly to the end of the body; with preserved specimens it seldom extends beyond the middle of the caudal fin; it is rather slender, compressed, and has a narrow, thin, membranous keel along the outer edge, which becomes wider at the club; on the distal half of the club it is much wider and runs a little obliquely along the back part of the upper side, where it is usually folded down against the side, its inner surface being whitish. The club is rather broad and thick, with a wide, scalloped, marginal membrane along each edge; these membranes are strengthened by transverse muscular ridges, which commence between the large central suckers and fork at the pedicels of the marginal ones. Along

the center of the club there are two alternating rows of large, broad, depressed suckers, about seven in each, with a few smaller ones, of the same series, at both ends; along each edge, alternating with the large suckers, there is a row of smaller and more oblique marginal suckers, about half as large. The proximal part of the club bears only a few small denticulated suckers; the distal part bears a large number of small, sharply denticulated, pedicelled suckers, crowdedly arranged in four rows; close to the tips of the arms about twenty of the small suckers have smooth rims and very short pedicels, but are still in four rows. The large suckers vary greatly in relative size, according to age, sex, season, and locality; they are a little higher on one side than on the other, with a broad aperture, surrounded by a horny, marginal ring, which is divided all around into sharp, unequal teeth, which are larger on the outer side (Pl. XL, fig. 5); usually one minute, sharp tooth stands between two larger ones, and these sets of three stand between still larger and less acute ones; the horny ring is surrounded by a wide, thick, soft, marginal membrane; below the border, a groove surrounds the sucker, and below this there is a basal swelling, equalling or exceeding the margin in diameter. The smaller marginal suckers (Pl. XL, fig. 4*a*, 4*b*) have the aperture more oblique and the horny ring much wider on the outer side, with its outer, sharp, marginal teeth longer and more incurved; usually these have the teeth alternately larger and smaller.

The outer buccal membrane (Plate XXIX, fig. 4) is large, thin, with seven prominent, elongated, acute angles, all of which have a cluster of about ten to fifteen, small, pedicelled suckers, in two rows, on the inner surface (*a*, *b*, *c*, *d*). These suckers have horny rings, denticulated on one side. In the female there is a special thickened organ (*s*) in the form of a horse-shoe, on the inner ventral surface of the buccal membrane. This in the breeding season serves for the attachment of the spermatophores by the male.

The muscular pharynx (fig. 4, *e*, *f*) containing the jaws can be protruded its whole length. The inner buccal membrane (*f*) or sheath enclosing the beak (*m*), has a prominent, thickened, radially-wrinkled and puckered anterior margin. On the ventral side the pharynx bears, externally, two thin chitinous plates, not connected with the jaws. The points and exposed edges of the beak are hard and black, becoming dark reddish brown farther back; the alæ, gular and palatine laminæ are thin and pale yellowish or light amber-color, in alcoholic specimens. The upper mandible (Pl. XXXIV, figs. 4, 4*a*, *var. pallida*) has a sharp, strongly-incurved point; cutting edge regularly

curved, with a triangular notch at its base, followed by a prominent triangular tooth on the alar edge, beyond which the edge is nearly straight, but recedes somewhat. Lower mandible with a sharply incurved point and sinuous cutting edges, which have a slight tooth below the middle and only a slight rounded notch at base, which passes gradually into the very oblique and receding alar edge. The bilobed palate is covered with a chitinous membrane which bears transparent, small, sharp, recurved denticles.

Odontophore with pale amber-colored teeth, and thin transparent borders. The median teeth (Pl. XXXIV, fig. 3; Pl. XXXVII, fig. 6, *a*; Pl. XXXIX, fig. 4) are broad with a long acute median denticle, and a shorter curved and less acute lateral one, on each side; the inner lateral teeth are short, strongly incurved, with a longer acute central denticle and a smaller outer one, and with the inner angle of the base slightly prominent; the next to the outer lateral teeth (fig. 6, *c*) are much longer, broad, tapered, curved, acute; the outer teeth (fig. 6, *d*) are longer, more slender, more curved, triquetral, and very acute with a large basal lobe. A row of thin, distinct, roundish scales (fig.6, *e*) forms a border, outside the teeth.

The pen is thin, translucent, pale yellowish, in fresh specimens, but brownish or amber-color in alcoholic specimens. It has a short, narrow, anterior shaft and a long, very thin, lanceolate blade, which is concave beneath, especially posteriorly, for the edges curve downward, but are not involute; the posterior tip is acute, slightly thickened and curved downward, so that the posterior end is shaped something like the forward part of a shallow canoe. In the male the pen is relatively longer and the blade narrower than in the female. The extreme anterior end is thin and flexible, and rather abruptly pointed, being shaped like a pen; the shaft is rather stiff, with a strong, regularly rounded keel, convex above and concave beneath; outside of the keel the marginal portion curves outward and then upward, so that its convex surface is below, and the edge slightly turns up. The shaft, with its central keel and marginal ridges, extends to the posterior tip of the pen, decreasing regularly in width beyond the commencement of the blade. The blade is at first very narrow, and gradually increases in width; it is marked by numerous slightly thickened ridges, which diverge from the central line as they extend backward; the edges are very thin.

In the larger males the proportion of the greatest breadth of the blade to the total length of the pen varies from 1 : 7·50 to 1 : 9·36. In the females it varies from 1 ; 5·60 to 1 ; 6·10.

The following description of the colors was made from a freshly caught, adult, male specimen (1 G); taken in New Haven Harbor, May 18, 1880.

Upper surfaces of the body, head and caudal fin thickly covered with rather large chromatophores, which are mostly rounded or nearly circular, except along the middle of the back, where they are more crowded and darker, and mostly have a long-elliptical form (perhaps accidental).

The chromatophores, when expanded, are light red to dark lake-red, varying to purplish red and pink; when contracted to small points, they become brownish purple.

On the head, behind the middle of the eyes, and toward the margin of the caudal fin, the spots are smaller and less numerous, the intervening bluish white ground-color showing more largely. Over most of the dorsal surface the chromatophores are arranged more or less evidently in circular groups; usually the central chromatophore is a large, round, dark purplish spot; this is surrounded by a circular space of whitish ground-color; and by a circle of roundish chromatophores, mostly of different shades of lake-red and pink, and a deeper lying circle of pale canary-yellow ones. On the lower side they are so thinly scattered that they leave much of the translucent bluish white ground-color visible between them; along the median ventral line the spots are more numerous, producing a distinct median stripe. The caudal fin is clear bluish white beneath, and very translucent, becoming almost transparent near the margin.

Exposed part of the siphon similar to the ventral surface of the body, but with the spots more sparse, and mostly disappearing near the margin and at the base; lower side of the head, in front of the eyes, sparsely spotted. Outer and upper sides of the upper arms, and outer surfaces of the ventral pair similarly, but somewhat more densely, specked; both sides of the ventral arms and lower sides of the lateral arms pinkish white and unspotted. Tentacular arms pale translucent, bluish white, with the outer surface, except at base, rather thinly specked with small purplish chromatophores; the inner surface and upper side of the tip and the suckers are translucent white; rings of suckers white.

On the inner surface of the dorsal and lateral arms, between the suckers, there are a few large chromatophores, and a double row of them runs out obliquely on the muscular thickenings of the marginal membrane, alternating with the suckers, on each side; suckers pure translucent, bluish white (becoming yellow or brown in alcohol).

The pupils of the eyes are deep bluish black; on the upper side they are encroached upon by a sinuous, downward extension of the iris, which is silvery or pearly white, with brilliant, green, opalescent reflections at the upper margin.

Sexual differences.

The sexes differ to a considerable extent, in proportions. If we compare specimens of equal length, the female will have the body relatively stouter and less tapered posteriorly than the male; the head is decidedly larger;* the arms are longer; the suckers are usually distinctly larger, especially those of the tentacular arms. But if we compare specimens having the head and arms of equal size, the male will be found to have a decidedly longer, more slender and more tapered body, and a somewhat longer and narrower fin. (See table B, for comparative proportions.)

In the adult male the circumference of the head to the mantle-length usually varies from 1 : 2·55 to 3·45, averaging about 1 : 3·10; in the female from 1 : 1·75 to 1 : 2·45, averaging about 1 : 2·25.

The ratio of the breadth of the fin to the mantle-length, in the male, varies from 1 : 2·12 to 1 : 2·45, averaging about 1 : 2·25; in the female, from 1 : 1·70 to 1 : 2·12, averaging about 1 : 1·90.

The ratio of the diameter of the largest tentacular suckers to the mantle-length varies, in the male, from 1 : 50 to 1 : 90, averaging about 1 : 65; in the female it varies from 1 : 36 to 1 : 54, averaging about 1 : 45.

The proportion of the length of the dorsal arms to the mantle-length, in the male, averages about 1 : 3·50; in the female about 1 : 2·75.

The most marked effect of strong alcohol is to reduce the diameter of the body and the breadth of the caudal fin to a proportionally far greater extent than it does the length of the mantle and fin. Therefore, specimens that have been preserved in too strong alcohol often look like a different species, and the females often resemble the males, on account of their apparently longer and narrower fins and unnaturally slender bodies.

The pen of the female is relatively broader and shorter than that of the male (see table A).

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* Some of the nominal European species of *Loligo*, that have been based on the smaller size of the head, arms, and suckers are probably only the males of the common species. The sexual variations in this genus have apparently been very imperfectly understood by European writers generally.

The best and most positive external characters for distinguishing the sexes, are the hectocotylized condition of the left ventral arm of the male, near the tip (Plate XXIX, fig. 3, 3*a*); and the presence, in the female, of a horse-shoe shaped sucker, or place for attachment of the spermatophores, on the inner buccal membrane, below the beak (fig. 4, *s*). These characters, however, are not present in the very young individuals, and in those with the mantle two or three inches long they appear only in a very rudimentary state.*

A.—*Sexual variations in the pen.* (*Measurements in inches*).

	♂ P.	♂ 9V.	♂ 10V	♂ W.	♀ E.	♀ EE.	♀ 17V	♀ An.
Length of pen	10·50	10·20	9·55	8·50	7·75	7·65	7·55	7·50
Length of shaft	1·40	2·10	2·20	2·00	2·00	1·10	1·50	1·50
Length of blade	9·10	8·10	7·35	6·50	5·75	6·55	6·05	6·00
Breadth of shaft	·50	·35	·40	·40	·15	·38	·35	·35
Breadth of blade	1·40	1·15	1·02	·98	1·00	1·35	1·25	1 30
Proportions:								
Greatest breadth to length, 1:	7·50	8·86	9·36	8·67	7·75	5·66	6.04	5·76

The specimen marked An. is from Cape Ann, Mass. (*var. borealis*); that marked ♀ E., is *var. pallida* from Astoria, N. Y.; the rest are from Vineyard Sound, Mass.

The adult males have the left ventral arm conspicuously hectocotylized (Plate XXIX, figs. 3, 3*a*) by an alteration and enlargement of the sucker-pedicels and a decrease in the size of the cups of the suckers, some of which usually disappear entirely, especially in the outer row. The modification commences at about the 18th to 20th sucker, by the swelling of the bases of the pedicels; on succeeding suckers this rapidly becomes more marked and the swollen bases of the pedicels become more elongated and gradually become compressed transversely, while the size of the cups rapidly decreases till at about the 28th to 30th they are very minute and rest at the summits of the large, flattened, acute-triangular supports; from the 30th to 35th the cups usually become mere rudiments or disappear, in large males; beyond this the cups again grow larger and the pedicels decrease in size, till the small suckers become normal on the tip of the arm. About twenty-five to thirty of the suckers of the outer row are thus

* Professor Steenstrup formerly advanced the opinion that the males of *Octopus* and other genera of Cephalopods were provided with the hectocotylized arm from the first, but this we have not found to be the case. The hectocotylized condition of the arm in *Loligo* is developed in proportion to the development of the internal sexual organs, and is first distinctly noticeable in the larger of the young ones taken in autumn, and in the spring, in the young ones that have survived their first winter.

modified in the larger males. Of the inner row, a somewhat smaller number of suckers show distinct alteration, and these are less extensively altered; their pedicels are swollen and their cups reduced, but not to so great an extent, and usually none of the cups are entirely absent.

In young males, with the mantle about 70^{mm} to 90^{mm}, (young of the previous year, or perhaps of the first year, when three to five months old,) these modifications of the suckers begin to appear, at first very indistinctly, by a slight enlargement of the bases of the pedicels and a scarcely noticeable decrease in the size of the cups. In specimens with the mantle 100^{mm} to 130^{mm} long (probably young of the previous year, nine months to a year old) the modification of the suckers, though much less marked than in the adults, is sufficiently distinct, the pedicels having become distinctly longer and stouter, while the cups are evidently reduced in size, but none of them are abortive in such specimens.

Loligo Pealei, var. borealis Verrill.

PLATE XXXVII, FIGURE 2 (pen). PLATE XLI, FIGURE 1, (anatomy).

Since this variety was described I have had opportunities to examine a much larger series of specimens from Cape Ann. These show very plainly that this form passes by intermediate gradations, into the typical form, so that it cannot be considered as anything more than a local or geographical variety. The differences in the proportion of the fin to the mantle, noticed in the original specimens, do not hold good, with a larger series. The only varietal character, of much importance, is the relatively smaller suckers, and this is much less marked in most of the later examples than in the former ones, and is a character that varies greatly in the specimens from every locality.*

In the original specimens the 'pen' (Pl. XXXVII, fig. 2) while having the general form of that of *L. Pealei*, tapers more gradually anteriorly, and has a narrower, more tapered, sharper and stiffer anterior tip. The variations in proportion are sufficiently indicated by the measurements given in tables A, B and C, in which those specimens designated as 2 G. to 5 G. were measured while fresh. The one marked An. ♀ is from the lot originally described as variety *borealis*, and illustrates the abnormally small size of the suckers.

* Probably those with abnormally small tentacular suckers are instances in which the arms, the clubs, or the suckers have been lost and afterwards reproduced, as explained below.

Loligo Pealei, var. **pallida** Verrill.

PLATE XXXIV, FIGURES 1–4: PLATE XXXVII, FIGURES 9–11, (suckers).
PLATE XL, FIGURE 1, (anatomy).

This geographical variety or sub-species is distinguished from the typical form chiefly by its shorter and stouter body, in both sexes, its broader and larger caudal fin, and the larger size of the suckers, especially those of the tentacular club.

The caudal fin is broad-rhomboidal, often as broad as long, or even broader than long, in adult specimens. The ratio of the breadth of the fin to the mantle-length, in the larger specimens (with mantle 150^{mm} to 225^{mm} long) is, in the males, from 1 : 1·75 to 1 : 2·00, while in *L. Pealei*, of corresponding size, the ratio is 1 : 2·15 to 1 : 2·30; in the females of *var. pallida*, of similar size, the ratio varies from 1 : 1·45 to 1 : 1·75 (see tables F, G). Tentacular arms long and slender, varying in length according to the amount of contraction, in extension longer than the body, the club or portion that bears suckers forming about one-third the whole length. In a few males the larger suckers on the middle of this portion are not so large as the largest on the other arms, but usually they are twice as large. In some females the principal suckers of the tentacular arms are very much larger than in others, and considerably exceed those of the males of equal length; they form two alternating rows, of eight to ten each, along the middle of the club; external to them there is a row of smaller suckers alternating with them on each side; the suckers toward the tips are very numerous, small and crowded in four rows; at the tip there is a group of about twenty minute, smooth-edged suckers, in four rows. Outside of the suckers, on each side, there is a broad marginal membrane, having the edges scalloped and strengthened between the scallops by strong, transverse, muscular ridges; another membranous fold runs along the back side, expanding into a broad membranous keel or crest near the end. The arms of the ventral pair are intermediate in length between those of the second and third pairs.

Ground-color of the body, head, arms and fins, pale, translucent yellowish white; the upper surface is covered with pale brown, unequal, circular spots, which are not crowded, having spaces of whitish between them; the spots are more sparse on the head and arms, but somewhat clustered above the eyes; entire ventral surface pale, with small, distant, brownish, circular spots, which are nearly obsolete on the siphon and arms. The general appearance of the animal, when fresh, is unusually pale and gelatinous. The pen is broad, quill-shaped, translucent and amber-colored.