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Notes on the Long-Snouted Chimaeroid of Japan, Rhinochimæra (Harriotta) Pacifica

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By

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With 2 Plates.

Historical.

Harriotta described in 1894 by Goode and Bean, (*P. U. S. Nat. Mus. Vol.* XVII, pp. 471-473, Pl. XIX) added a third genus[1] to the important but now greatly depleted group of Chimæroid fishes. The new genus was created upon an examination of four specimens obtained by the "Albatross" in water of from about 700 to 1100 fathoms, between latitude 35°and 39°and longitude 70°and 74°. And the specimens are referred by their describers to a new species, *raleighana*. The largest specimen, a female, measured 64 cm. in length, a male 49 cm. and two "young individuals" 10 cm. or thereabouts in length. As

1) To Chimaera and Callorhynchus Dr. Gill in 1862 (*P. Acad. Nat. Sci. Phila.* p. 331) suggested the addition of a genus Hydrolagus, on the ground of certain structural differences which he observed in *Chimaera colliei*, of the eastern Pacific. This form he distinguishes generically on account of its lacking a distinct anal fin, and of its possessing in the male a bifid instead of a trifid ventral clasping organ. I do not believe, however, that these differences can be accepted as of generic valne, for in my studies upon this species I fail to confirm the observation as to the distinct character of the clasping organ in adult specimens, for this is sometimes trifid, and I find furthermore that there is considerable variation in the matter of the anal fin. The latter is adipose-like but varies to such a degree that one cannot draw a hard and fast line as to its presence or absence.

far as I am aware these are the only examples of the species extant.[1] A second species of "Harriotta" was next described in 1895 by Professor Mitsukuri as *Harriotta pacifica*.[2] Of this species, specimens have up to the present time been taken in the single region, that of Misaki, near the mouth of the bay of Tokyo, a locality which has become classic as the habitat of such rare and interesting fishes as *Chlamydoselachus* and *Mitsukurina*. As far as I am aware, all specimens of this Japanese species, save one, have been obtained in the fish market of Tokyo. Altogether seven individuals appear to have been preserved: three of these are now in the Imperial University of Tokyo, the fourth in the Museum of Comparative Zoology, Harvard University, the fifth in the Bohemian National Museum at Prague, the sixth in Columbia University, New York, and a seventh is now in the hands of Mr. Alan Owston, of Yokohama. The male specimen, which is apparently unique, was taken by the well known collector of the Misaki zoological station, Kuma Aoki. This is one of those in the Tokyo Museum[3]

In spite of the many interesting features which a surface study

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1) A fifth specimen, a young male similar to the foregoing, has since been collected, and is preserved in the National Museum at Washington.

2) *Zool. Mag. Tokyo.* Vol. VII, No. 80, pp. 1–2.

3) The record of the specimens in Tokyo has been kindly forwarded me by Professor Mitsukuri. The first was obtained April 19, 1883, and was said to have been caught near Kurihama; the second, the male, was taken on May 9, 1898, by Kuma Aoki, on mutsu line, at a depth of about 400 fathoms, off the entrance of the bay of Tokyo, on the fisherman's ranges "Sengenzuka gaké: Nago hitotsu:" the third, which was brought to the museum during Professor Mitsukuri's absence, 1898–99, has no definite label.

The present paper was prepared during my visit to Japan (1900–1901). Since then I have received from my friend Mr. Garman an important note, extr. from the *Proceedings of the New England Zoological Club*, Nov. 2d. 1901, Vol. II pp. 75–77, in which he regards the Japanese "Harriotta" as representing a new genus *Rhinochimaera*. Mr. Garman had had the privilege of comparing critically a type of *Harriotta raleighana* with a specimen of the Japanese form, and found marked differences in the character of the dental plates. I myself have since had the opportunity of examining in some detail the same type of *H. raleighana*, generously loaned me by the Smithsonian Institution, and I am able to confirm Garman's observation. Adopting the new generic name I have thought it best to allow the present paper to be published as it was written. I have changed my MS. therefore to read: "Harriotta" (in quotation marks) for the Japanese form.

of Harriotta at once suggested, from the standpoint of an understanding of the relationships of the Chimaeroid group, there are as yet recorded no observations upon the structural characters of this form, or even of its dental plates. Goode and Bean's description of *H. raleighana* was based upon purely superficial features, and the sanctity of the type specimens has hitherto precluded the National Museum from allowing an intimate knowledge of the genus to be obtained. I am accordingly under many obligations to my friend, Professor Mitsukuri, for the rare opportunity of examining in some detail one of the specimens of "*Harriotta*" *pacifica* of the Tokyo University. Among further kindnesses,—and I have to acknowledge many during my stay in Japan.—I am indebted to Dr. Mitsukuri for generously placing at my disposal his original drawings of this chimaeroid (Cf. Pl. I, Figs. 2–3), and furthering my work at the laboratory in every way in his power. And in publishing the present paper I should not fail to express my sincere thanks to Prof. Watasé, of the Imperial University, for his cares in editing the MS. and in correcting my proof—favors which an author far distant especially appreciates.

By a long way the most interesting feature which "Harriotta" presents, at least in the single adult specimen examined, is the distinctness of its palato-quadrate cartilage.[1] This can be clearly outlined on both sides of the skull,[2] and appears to be the only case in which this important morphological suture has been observed in any adult chimaeroid. It may be noted that the embryo of *Chimæra colliei* presents a somewhat similar appearance. On the other hand, my observations on "*H.*" *pacifica* have convinced me that this chimaeroid is

1) In Chimaeroids this element cannot be identified in the mature skull, it having fused completely with the sides of the cranium, producing the well known "holocephalous" skull. But in the specimen of "*Harriotta*" the dorsal sutural joint is still retained, enabling the outline of this element to be clearly followed.

2) Sad to relate, this feature is probably exceptional! *Vide infra.*

not as widely distinct from the other genera as I had been led to believe from the work of Goode and Bean,—always granting that the species *raleighana* and *pacifica* belong to the same genus, and of this we cannot be sure until there can be had a better knowledge of the specimens in Washington. I thus find that "clasping organs" are present in "*Harriotta*" *pacifica*, very much as in other Chimaeroids, and we are led to infer that the male specimen (49 cm.) of *H. raleighana* was distinctly immature. But upon this again we cannot decide until there has been a more critical examination of the type specimens.

The notes I have collected regarding the Japanese "Harriotta" are arranged as follows:

I External Characters.
II Integument.
III Skeleton (including fin structures).
IV Viscera.
  a. Gills.
  b. Circulatory.
  c. Digestive tract and appendages.
  d. Urogenital.
V Characters of the egg-case.
VI General Considerations.

I. External Characters. Pl. I, Figs. 1, 2, 3 and 8.

A mature specimen of a female "*Harriotta*" *pacifica* measures about 120 cm. in length, and of a male about 90 cm. The specimen which I dissected, a full grown female, measured over 130 cm.

In outward appearance, "Harriotta" suggests more closely Callorhynchus than Chimaera. It has thus the broad, somewhat heterocercal tail, a greatly produced snout, and fewer dermal denticles. As in most chimaeroids, a distinct opisthure is present. The color in this

species cannot be accurately determined, since all specimens have been discolored in alcohol. The general tone of the trunk, however, seems to have been plumbeous, darker above than below. The muzzle is white, and this color extends forward along the sides and ventral margin of the greatly produced snout. No definite markings are present. In the specimens examined the sides of the trunk show many transverse foldings which I have not observed in similarly preserved specimens of Chimaera, and they are probably to be interpreted as symptoms of abyssal living. The dorsal fins are margined with a dusky band, and the paired fins are darkest along their anterior margin. The dorsal spine differs little from that in the other genera ; if anything, it is somewhat more delicate, and I cannot confirm in " *H.*" *pacifica* at least the presence of the " broad triangular spine " which Goode and Bean have laid stress upon in their definition of the genus. I noticed in one Japanese specimen, the best preserved, in fact, that the floor of the sensory canals is in many places black, a condition which seemed at first due to the presence of foreign matter. Closer examination, however, showed that this was normal pigmentation, and traces of it were afterward found in other specimens.

The clasping organ (mixipterygium) of the male is indicated in Pl. I, Fig. 8 (its tip at *c*) : it is essentially similar to that in Callorhynchus. Near the antero-proximal rim of the ventral fin occurs the usual protractile organ at Fig. 8 *a* (its tip at *b*); it preserves 4 anterior marginal denticles and the same number occurs on its fellow. Its sharply truncated lobate end distinguishes it from the similar structure in Chimaera. The mixipterygium is remarkably long and slender, its supports combining to form a single element. Its distal end is enlarged, globular, and is furnished with dermal denticles, as shown in the Fig. 8. The frontal clasper, 8 *d*, differs little from that of other recent chimaeroids ; its dermal denticles, however, are fewer (but

55 were counted) and smaller. Incidentally, the sheath of the frontal organ is longer, and from the great length of the socket-like depressions, which form sheaths for the superjacent denticles, one can reasonably conclude that the snout of "Harriotta" was capable of considerable vertical movement.

From our present knowledge *H. raleighana* and "*H.*" *pacifica* differ from one another in the following regards:

H. raleighana Goode and Bean.

Head length, measured from in front of gill opening, constitutes one fourth that of entire animal. Snout tapers somewhat suddenly. Paired fins broad at bases thence narrow acutely. Second dorsal fin low, with margin nearly straight. Dorsal lobe of caudal fin with well marked dermal rays. Series of conspicuous dermal tubercles situated along the dorsal region of the trunk, near the unpaired fin.

"*H.*" *pacifica* Mitsukuri.

Head length about two sevenths that of entire animal. Snout tapers gradually, *i.e.*, in verp acute angle. Paired fins narrow and long. Second dorsal fin high, with margin rounded. Dorsal lobe of caudal fin fleshy with indistinct dermal rays. Dermal denticles along dorsal margin of caudal fin, but absent on the trunk. In addition to these characters the present species has thin, flat tritorless dental plates, produced ectad so as to form a sectorial mouth-rim. Also an undivided mixipterygium. The corresponding features in *raleighana* have not as yet been described.[1]

II. Integument.

The only dermal denticles observed in the female specimen are scattered along the dorsal rim of the caudal fin. Over fifty of these were counted, situated at irregular intervals (about 3–5 mm.) apart.

1) Cf., however, Garman's recent paper, *op. cit.*

They are located usually in pairs and together straddle the rim of the fin, causing this in profile to appear somewhat serrate. The denticles themselves are somewhat tumid, imperfectly calcified.

In the male dermal denticles occur in the customary positions: *i.e.*, on the frontal and on the two ventral pairs of clasping organs. The condition of the frontal clasping spine is illustrated in Pl. I, Fig. 8 *d*. The antero-ventral pair of clasping organs is shown in the same plate, Fig. 8 *a*, *b*, and of these the stout recurred marginal denticles differ little from those in Chimaera. The denticles on the mixipterygium are also essentially similar to those of the other genera. In connection with the mucous canal system, however, I fail to find in " Harriotta " the distinct dermal supporting plates well known in Chimaera. We thus find that the mucous canals of the suborbital region are not provided with prominent and almost plate-like supports: one infers, however, that these supports are present in a reduced form after drawing a needle sharply along the floor of a canal. It is observed that in " Harriotta " the mucous canals, although distinctly of the chimaeroid pattern, do not open widely to the surface, as in the case of many bathybial forms. So closely are the opposing margins drawn together[1] in this type that the point of a common needle can hardly be drawn through the canal without causing its margins to separate. In the disposition of the sensory canals, " Harriotta " approaches more closely Callorhynchus than Chimaera.

III. Skeleton. Pl. I, Figs. 4. 4*a*, 5, 6, 6*a*, 7.

The skull, as has already been noted, retains a well-marked line showing where the palato-quadrate is completing its fusion with the skull. It may be noted that this distinctness of the palato-quadrate

1) This condition can hardly be due to artifact since it does not occur in the case of the allied forms, Callorhynchus or Chimaera, when similarly preserved.

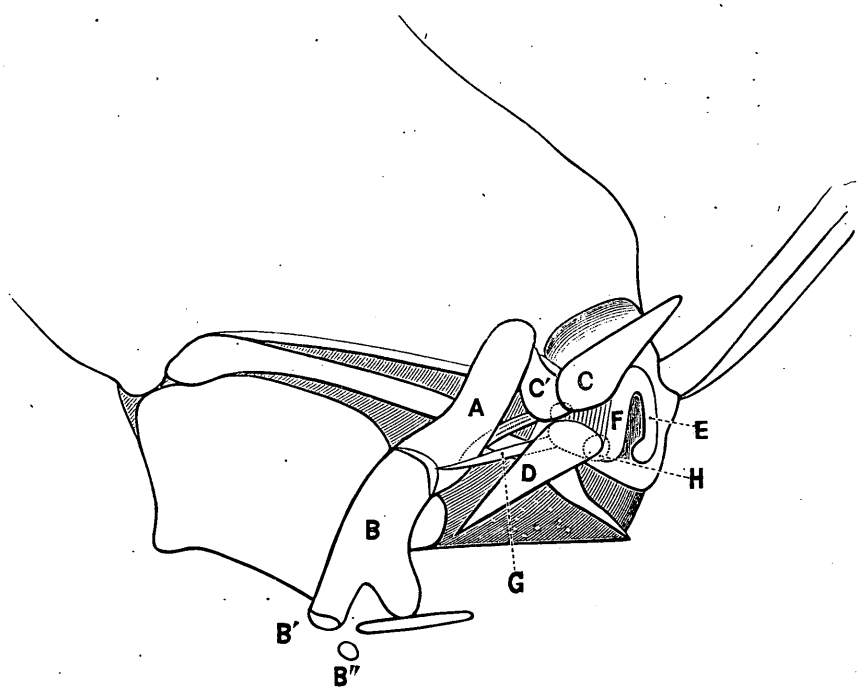
element, unique in an adult chimaeroid, appears on both sides of the specimen dissected.[1] If we accept this important character as a normal one it is remarkable that the skull differs in further regards so little from the well known conditions in the other Chimaeroids. For, if we except the great size and shape of the upper median (rostral) cartilage there remains little to distinguish "Harriotta" from Callorhynchus. The contour of the cranium is closely similar, as is also the proportional size of the orbits, and the position of the foramina of the nerves. Referring again to the palato-quadrate element I note that this is most distinctly marked out at its hinder border, as indicated in the figure. I found however by slicing the cartilage in this region that the separateness of the element is in a measure deceptive, for it is superficial only. On the other hand, in the region of the anterior rim of the orbit the line of suture can be followed deeply into the cartilage. The striking feature in the mouth of this form is in the beak like development of the dental plates, in this regard quite unlike any Chimaeroid described, for the plates themselves are reduced to an almost horn like texture, losing the calcified tritoral points, so characteristic of the entire group. And their edges are sectorial, narrowing away beak fashion from their surface of origin. The appearance of the mandibular plates is given in Figs. 6, 6*a*. The "maxillary" plates are proportioned larger and narrower than in other recent chimaeroids, over three times as long as wide ; and there is thus a narrower band of pulp from which the plate takes its origin. The "pre-maxillary" plates are also constricted : instead of becoming opposed to one another in

1) In the specimen in the museum of Columbia University, which I have had the opportunity of examining since the above was written, no trace of this suture occurs on either side! Accordingly, in the absence of further data, I am led to believe that the sutural condition in the former specimen is exceptional. For, upon examination of a series of preparations of the sutural region on *Chimaera colliei*, I have found in a single specimen, nearly full grown, a male, that a distinct line of union is indicated. In this instance, however, the line is not as distinct as in the above described specimen.

an almost transverse plane, as in Chimaera, for example, they meet in an acute angle, their free edges continuing the long cutting plane of the " maxillary " plates. (Plate I, Fig. 5).

In the region of the snout the unpaired (rostral) cartilage is of extraordinary size. It measures one and one half times the length of the entire cranium. It is stout, narrow, and somewhat spatulate : at its proximal end, where it is securely attached to the cranium, there is a (movable) joint. The shorter, more anterior supporting element of the snout is one of a pair, its fellow arising close beside it, as is shown in the figure.

The more prominent relations of the complex labial and related cartilages are indicated in Text-fig. 1, the elements having been



Text-Fig. 1. Diagram showing lateral aspect of mouth cartilages of *" Harriotta " pacifica.*

denoted by letters, since they have not as yet been compared satisfactorily with those of other chimaeroids. The cartilages are connected with the skin by fascia: their other attachments are es follows:

Element.	*Attachment.*
A	Attached to anterior dorsal as well as to caudal arm of the element *C.*, articularly to *B.*, and posteriorly to the skin and skull by muscles.
B	With *A* strengthens the integumental fold forming the outer angle of the mouth. From an antero-ventral eminence this plate supports a loose fold of the margin of the lip. This eminence forms also in part the posterior support for the broard under lip, which depends notably from the jaw. *B'* and *B''* are small elements closely related to the ligaments attached to the ventro-posterior arm of *B*.
C	Connected by ligaments with the anterior projecting pair of cartilages, forming in connection with the latter a mechanism which raises or depresses the whole labial apparatus. Connected ventro-mesad with the dorsal rim of the folding pair of cartilages *E–F*; ecto-distad, by muscle and ligament, to *D*; attached, also, along extended hinder (caudad) rim, mainly ectal, to *A*. Its hinder arm, the
C'	element *C'*, attached proximad to skull by strong ligament (near and dorsal to the posterior nasal opening).
D	Connected anteriorly with *C*. Its posterior arm, enveloped in a loose marginal fold of the skin, passes outside the angle of the mouth.
E, F	*E* and *F* together (with hinge joint) form the rim of the nasal opening, a movable arm constituting the septum

between the anterior and posterior navial openings. *E* is attached strongly to skull by ligaments in the region immediately above the "premaxillary" dental plates. Also to *C*, as above noted. The septum is moved notably by means of the element *G* attached to its posterior eminence.

G Connected by ligament to the element *F* and to the joint *A–C* : by fascia to *B*.

H A small element attached to the side of *F*. In this region other small elements are to be noted, connected with nasal flap on the one hand and with the upper lip on the other.

In the structure of the cartilaginous gill arches "Harriotta" again resembles closely Callorhynchus. These elements are figured in lateral and in ventral aspects in Pl. I., Figs. 4 and 7. The suspensorium consists of the usual chimaeroid elements, a stout ceratohyal, a greatly reduced hyomandibular terminating in a small element to which in other chimaeroids various homologies have been ascribed. This element may be regarded provisionally, *i.e.*, until its development is known, as the serial homologue of a pharyngobranchial. Accepting this determination it will be seen that the reduced hyomandibular is coming to establish an articular relation directly with the cranium, a character of considerable importance in vertebrate morphology. Of the remaining five arches the first two are complete, possessing hypobasibranchial, ceratobranchial, epibranchial and pharyngobranchial elements. The third true gill arch possesses but hypobranchial and ceratobranchial elements, its pharyngobranchial segment occurring in conmon with that of the fourth gill arch. In the latter arch, what appears to be the somewhat displaced hypobranchial segment probably represents a fusion with the hypobrancnial element

of the fifth arch as well. The fifth arch, rudimentary, exhibits a cerato-branchial, and a greatly reduced pharyngobranchial in the shape of a discrete tubercle of cartilage attached to its dorsal terminal. The unpaired median series of ventral cartilages is poorly represented. A basihyal is closely moulded to a stout hypobranchial, and this alone of the median elements is directly articulated with an arch. It is stoutly attached to the ceratohyal. I note also a pisiform cartilage which is attached by ligament to the hypobranchial of the third gill. The posterior median element is a stout ensiform plate attached by a broad ligament to the common hypobranchial of the fourth (and fifth ?) arch and to the ceratohyal of the fifth arch.

Vertebral Column.

As in other chimaeroids, the notochord is strengthened by calcified rings occurring within the notochordal sheath. Neural and haemal arches, however, are represented throughout the anterior three-quartors of the column. In the region of the anterior half of the column there are neural and interneural cartilages. On the ventral side of the chorda, appear haemal plates more or less irregular in size, and often exhibiting fusion. These characters are well shown in Pl. I., Fig. 4. In the block-like portion of the column which immediately follows the skull a number of foramina are present for the dorsal and ventral narve-roots. The openings, representing about twelve nerves, are obviously crowded together and afford conclusive evidence that a considerable shortening of the column has taken place, especially in the more anterior region.[1] Furthermore, according to the relations of the posterior portion of this plate to the adjacent neural and interneural plates, one can, I believe, safely infer that the dorsal expansion of this compound element is equivalent to

1) Similar conditions occur in *C. colliei.*

the fused neural plates of the original segments whose presence is attested by the distinct openings for the exit of spinal nerves. This great expansion of the neural elements has probably been concomitant with the evolution of an erectile dorsal fin which required a firm hinge for its anterior spine. The disposition of the muscles which erect and depress the fin bespeak a thinning away of the median portion of this neural plate, and the thickening of its anterior margin. Further examination of this portion of the column gives no evidence that discrete centra, in the elasmobranchian sense, are represented. The cartilage which encases the sides of the notochord can in this form best be interpreted as coalescence of the neural and haemal cartilages, a coalescence apparently the result of a specialization of structures for supporting and operating the dorsal fin.

Unpaired Fins. Pl. I, Fig. 4.

The series of dorsal fins is more clearly marked than in Chimaera. The first dorsal fin is separated from the second by a low, extended and rayless fold of integument. The second dorsal, which presents a rounded upper margin, bears a series of close-set dermal rays. This again is separated by a considerable interval from the dorsal lobe of the caudal fin. In this lobe, which is somewhat adipose, dermal rays are present, but are inconspicuous. The first dorsal fin dossesses the basal support usual in chimaeroids. Its dermal rays are drawn together into about half a dozen strong supporting elements of the fin web, as shown in the figure. The anterior spine is slender and remarkably delicate ; its tip, in fact, is broken off in all but two of the specimens examined. And it is in the tip, only, *i. e.*, in the upper third of the spine, that a postero-lateral marginal serration occurs. The " denticles " are here minute and disposed somewhat irregularly. The surface of the spine is ornamented with a few

indistinct ridges, which are arranged in a somewhat wavy pattern near the base of the spine.

The cartilaginous basal supports of the dorsal are about seventy in number : they are similar in shape but are graded somewhat in size, the foremost and hindmost being the smallest. The first element in this series is inclined forward and is the only one in this position. A similar series of cartilaginous elements support the dorsal lobe of the caudal fin : of these first two are small and separate, but the next set, thirty odd in number, follow in a graded series, compact, with tips and bases apposed. Further caudad still the supporting elements string along loosely, like neural spines.

There is no anal fin. The ventral lobe of the caudal, however, is of considerable size, and is closely set with dermal rays. Its basal supports are first evident in a position much further caudal than one would expect from the disposition of the dermal rays, and they are altogether smaller and more delicate than one would naturally expect from the size of the web of the fin. The first two elements of the row are inconspicuous and—as an individual variation perhaps—are situated at a considerable distance from the column ; the remainder, although close to the column, are not firmly connected with it. One need hardly add that in the urostyle no traces of haemal or neural elements can be determined.

Paired Fins and Girdles. Pl. I, Fig. 4.

The cartilaginous supports of the pectoral fin occupy a great extent of its entire surface, greater in proportion than in the case of other chimaeroids. And the fin is in general a narrower one. About the usual number of radialia are present, twenty-six rows in this specimen, having the usual relations to basalia. A thick distal row of cartilages, representing the terminal segments of corresponding

radalia, is prominently marked off on the preaxial region of the fin, a structural difference from other chimaeroids, correlated doubtless with a greater degree of movement of the anterior rim of the fin. It is to be noted that the element best known as mesopterygial has attained considerable physiological importance, functioning as a kind of "humerus" for the fin. It is a stout narrow plate possessing considerable mobility, both at its juncture with the shoulder girdle and with the pro- and metapterygial elements. The shoulder giadle is strong, even for a chimaeroid, especially in its ventral moiety.

The ventral fin is notably narrowed — *i.e.*, antero-posteriorly. Basalia, greatly constricted, are represented in a single oblong plate, with which fuse also the two most anterior radials. The anterior margin of the supporting lobe of the fin is formed, is in the pectoral fin, by an encircling row of stout cartilages, which doubtless represent the distal segments of the anterior radials. The most anterior element of this row of supports is an elongated cartilage which may represent either the distal end of the first radial, or, more probably, a union of this element with a still more anterior cartilage. In the present example twelve distinct radials are counted. Posterior to the fin proper, and loosely attached by ligament to the plate of fused basals appears a rudiment of the mixipterygium of the male. This structure, now noted for the first time in a chimaeroid,* is seen to consist of two short and delicate segments. A further peculiarity of the pelvic fin is the greatly reduced size of its articulation to the girdle. The girdle itself is small, thin and delicate. Its upper blade

* The rudimentary "clasping organ" is so well known in female sharks that the present writer was led to represent it in such a condition in his "Fishes Living and Fossil." Unfortunately he did not think it necessary at the time to insert the word "rudimentary" in the brief explanation attached to this figure, and he has therefore caused Dr. C. F. Jungerson to believe that it was his intention to append a functional "clasping organ" to a female shark! Jungerson's misunderstanding would not have occurred had he taken the pains to consult the text which accompanied the figure.

terminates in a posteriorly curved process which is doubtless the serial homologue of the dorsal terminal of the shoulder girdle. The ventral blade of the girdle bends ventro-mesad and come to lie in an almost horizontal planes.

IV. Viscera.

A. Gills.

As in other chimaeroids an opercular fold arises from the posterior margin of the first ceratohyal, is strengthened by a series of parallel cartilaginous rods, and encloses completely the excurrent openings of the gill. An interesting feature however in the present form is that the outer margins of the supporting tissue of the remaining gill bars fuse together ectad, both dorsally and ventrally, and together form a series of grooves which pass outward and fade away near the external opening of the opercular fold. In the opercular gill the vascular lamellae extend outward from the gill bar halfway to the free margin of the fold, following closely the parallel cartilaginous rays which strengthen it. In the remaining gills the median supporting septa extend no further outward than the tips of the vascular lamellae, a condition, however, which does not, of course, apply to the extension of the supporting septa at their dorsal and ventral ends, as already noted. Four gill slits are present, the fifth having been suppressed. There is no trace of a spiracle. The number of lamellae in the gills averages fifty : they are slightly less numerous in the opercular gill, and in the hindmost hemibranch about forty-five are present. It is interesting to note that the gill lamellae are continued around the dorsal margins of the gill slits, and that traces of them can be found around the ventral margins. Gill rakers are present, but they are small, fleshy and widely separate from one another, to be interpreted therefore, as rudimentary organs.

In the different rows they vary from four to ten, eight being about the average number.

B. Circulatory. Pl. II, Figs. 9 and 11.

The branches of the dorsal aorta are stouter than in specimens of Chimaera of a similar size. And the length of the branches supplying the digestive tract is notably greater. The conus arteriosus presents two rows of valves, approximately equal in size. Four valves are present in the anterior row, and three in the posterior. In addition to these, several rudimentary valves are situated in the folds of the conus near its opening into the heart.

C. Digestive Tract and Appendages. Pl. II, Fig. 9.

The gut is narrower in calibre and proportionally longer than in other Chimaeroids examined. The spiral valve completes four turnes. The liver is bilobed, and is somewhat smaller than in Chimaera. If one recalls the sectorial dental plates in this form and the absence of tritoral areas it is interesting to findthat the gut contained débris of small fishes, and was altogether lacking in the remains of hard shelled forms, crustacean or molluscan.

D. Urogenital System. Pl. II, Figs. 9 and 10.

The oviducts differ little from those of Chimaera. They are more conspicuous in that they lie unpigmented (*ovd.*) against the black dorsal wall of the body cavity. Minor differences include the shape of the capsular gland which in surface view presents a Y-shaped appearance on account of the mode of grouping of its lamellae. In the specimen dissected, a single external opening was present for both oviducts (*u.g.*). I am, however, inclined to regard this as a condition of artifact, since I have seen a somewhat similar appearance in polyor

preserved specimens of Chimaera. In Pl. II, Fig. 10, the lower apertures are seen to be marked by tumid eminences (*o.l.o.*) lying just within the opening above referred to. In the same figure there is a well defined central area (*c.*) in which is moulded the rounded egg-containing portion of the case ; also at the sides a wide flat tract (*m.*) in which the lateral flaps of the egg-case are formed. In the crease at the outer margin of this area there happened to be present in the specimen a small portion of the lateral flap of an egg-case here worthy of mention since it afterward proved of value in identifying a separately collected egg-case of this form. Both right and left ovaries were present in the specimen, though only one of them has been figured. In size and position they correspond to Chimaera. The kidney is apparently a less conspicuous organ than in Chimaera ; it is greatly flattened relatively, and is entirely concealed by the pigmented peritoneum. The urinal papilla is similar to that of Chimaera.

V. **The Egg-Case.** Pl. II, Figs. 12, 12a, 12b.

Two egg-cases of an undetermined chimaeroid are preserved in the collection of the Imperial University of Tokyo, and a similar one, but less perfect, I was able to secure for Columbia University, through a local collector. The locality in which these egg cases were obtained corresponds to that of "Harriotta" pacifica, and, by an examination of the oviducts in this form and by a comparison of a portion of an egg-case taken from the oviduct, I find that the problematical specimens can be referred to "Hariotta" with reasonable certainty.

From an examination of the specimens preserved in Tokyo, which, by the way, are alcoholic and quite well preserved, one is at first given the impression that the eggs belong to Callorhynchus : there is the same broad lateral flange and the same general shape of

the egg-surrounding part. As Callorhynchus, however, is not known to occur in Japanese waters, and as closer study brings out distinct differences in these egg-cases, one would naturally refer them to "Hariotta," even if a fragment of the undoubted egg of this form had not been discovered. The egg-case, Pl. II., Fig. 12, is of extraordinary size, measuring over 26 cm. in length. A dried specimen measures 16.5 cm. The median portion of the capsule resembles that of Chimaera, save in the greater proportional length of its wider, or exit-end. On the longer, narrower end, however, no keel-like ridge is present. At the immediate sides of the narrow and (Fig. 12*a*) the apertures for ingress of water are restricted to a shorter space, but, apparently in compensation, are produced further lateral: they do not pass through to the opposite side. The exit-end of the egg-case (Fig. 12*b*) is furnished with a series of interllapping lamellae somewhat as in Chimaera, but they are restricted to a shorter space. I notice also in an egg-case which bears evidence of having been long deposited, a large mass of horny fibres closely felted together, concealing this region of the egg. These fibres arise both from the outer margins of the opercular-like folds, as well as from the egg surface lying between them. The lateral flaps of the egg-case recall of Callorhynchus: they are strengthened by sixty or more thickened and folded ribs, and the marginal line is smooth and delicate. In texture, shape and color the entire case resembles strikingly a "branch" of a heavy fucoid alga.

VI. General Considerations.

At the time of its original description, Harriotta was said to possess "no cephalic organ," and that its claspers were "small and simple." From these characters, unique among chimaeroids, a reader was naturally led to expect that the new type might prove of value as

a key to the relationships of its group. An examination of allied Pacific species, however, demonstrates, as we have seen, that such expectations are not to be realized, ank that this form of Chimaeroid is to be looked upon as of no greater value than the better known genera. Even its skull structure is not convincingly primitive, for certainly little stress can be laid upon the distinctness of the palato-quadrate suture in one specimen when it is altogether lacking in a second one. In some regards, on the contrary, this chimaeroid is even furthest away from our conception of the ancient form, *e.g.* in its highly specialized rostral and labial cartilages, its greatly produced snout and tritorless dental plates,* its coalesced gill supporting elements, its compressed paired fins, its more perfectly obliterated mesenteries. And so far from possessing no well marked clasping organs, it has them in a condition of high specialization ; thus in the case of the mixipterygium I have evidence that three supporting elements of the other chimaeroids are present, but have undergone a process of coalescence, to the degree of producing a narrow and delicate appendage, bulbous at the tip, and provided with fewer and larger denticles than in other forms. Moreover, as there is reason to believe that this type of chimaeroid is from deeper water than the other members of the group, we can hardly expect that its further study will yield convincing data as to its primitiveness. In its egg-case it is as highly specialized as *Callorhynchus*.

* From Garman's preliminary note he is evidently of the opinion that the tritorless condition is primitive in the dental plates of chimaeroids. This rather startling view ;—for without further explanation, it implies that the dental plates are not to be derived from elasmobranchian conditions,—is based upon two untenable premises: (1), resemblance to the dental plates of cTrias or Jura) myriacanths, and (2), similarity to the very early conditions of the teeth of other living Chimaeroids. The first of these premises is, I am convinced, based upon a misconception of the dental characters of *Myriacanthus*, in which many tritoral areas *are* present; the second upon an interesting larvalism which the young plates present, growth occurring precociously at one rim of the plate. From my study of the development of *Chimaera colliei* I am led to believe that the dental plates of Rhinochimaera persist in a larval condition: they have never passed through the stage represented in Harriotta, and the two forms are thus more than generically distinct. The latter genus is, therefore, to be removed rom the Rhinochimaeridae, and becomes the type of a new family-*Harriottidae.* Upon Harriotta the writer has in preparation a separate paper.

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Notes on the Long-Snouted Chimaeroid of Japan, *RHINOCHIMAERA PACIFICA.*

PLATE I.

PLATE I.

"*Harriotta*" *Pacifica*, Mitsukuri. Superficial characters and skeleton.

Fig. 1 Lateral view of adult female. X about $\frac{5}{13}$.

2 Dorsal view of head of same specimen.

3 Ventral „ „ „ „ „ „

4 Skeleton of same specimen.

4 a Ventral view of pelvic girdle.

6, 6 a Mandible, ventral and dorsal (visceral) aspects.

7 Visceral arches, ventral aspect.

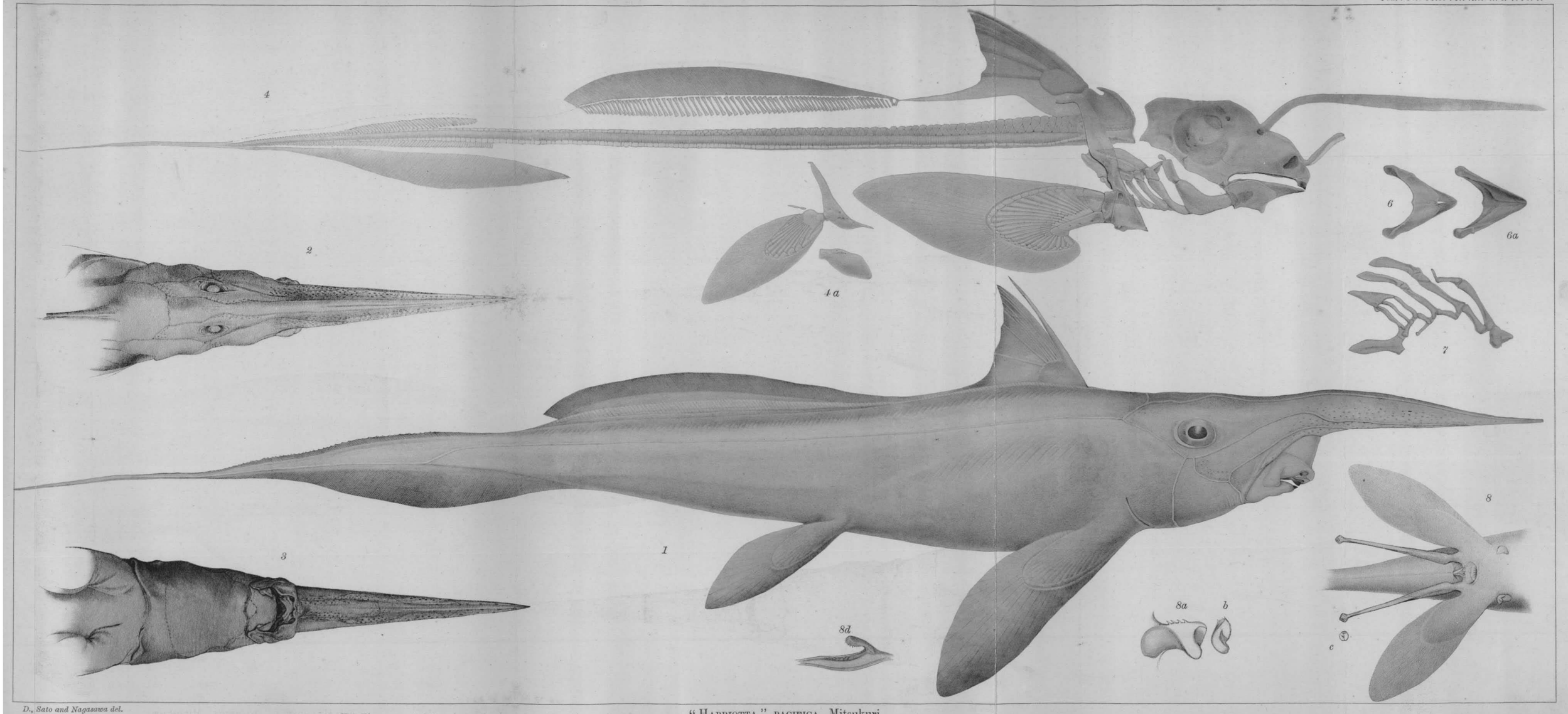
8 Ventral fins and mixipterygia of male. X about $\frac{1}{2}$

8 a Antero-lateral clasping organ, ventral aspect. X about 1.

8 b Antero-lateral clasping organ, view of tip. X about 1.

8 c Tip of mixipterygium.

8 d Frontal clasping organ. Slightly reduced.



D., Sato and Nagasawa del.

"HARRIOTTA" PACIFICA, Mitsukuri.

BASHFORD DEAN.

Notes on the Long-Snouted Chimaeroid of Japan,
RHINOCHIMAERA (HARRIOTTA) PACIFICA.

PLATE II.

PLATE II.

"*Hariotta*" *pacifica*, Mitsukuri. Viscera and Egg case.

Fig. 9 Body cavity opened, exposing liver, gall-bladder and duct, right ovary (left has been removed), alimentary canal with mesenteric vessels, and oviducts (*ovd.*). Urogenital opening is indicated at *ug.* and rectum at *r.*

10 Oviduct, right, laid open. *c.* Central portion of capsular region. *l.* Capsular gland, showing closely arranged lamellae. *m.* Marginal portion of capsular region. *o.l.o.* Opening of left oviduct.

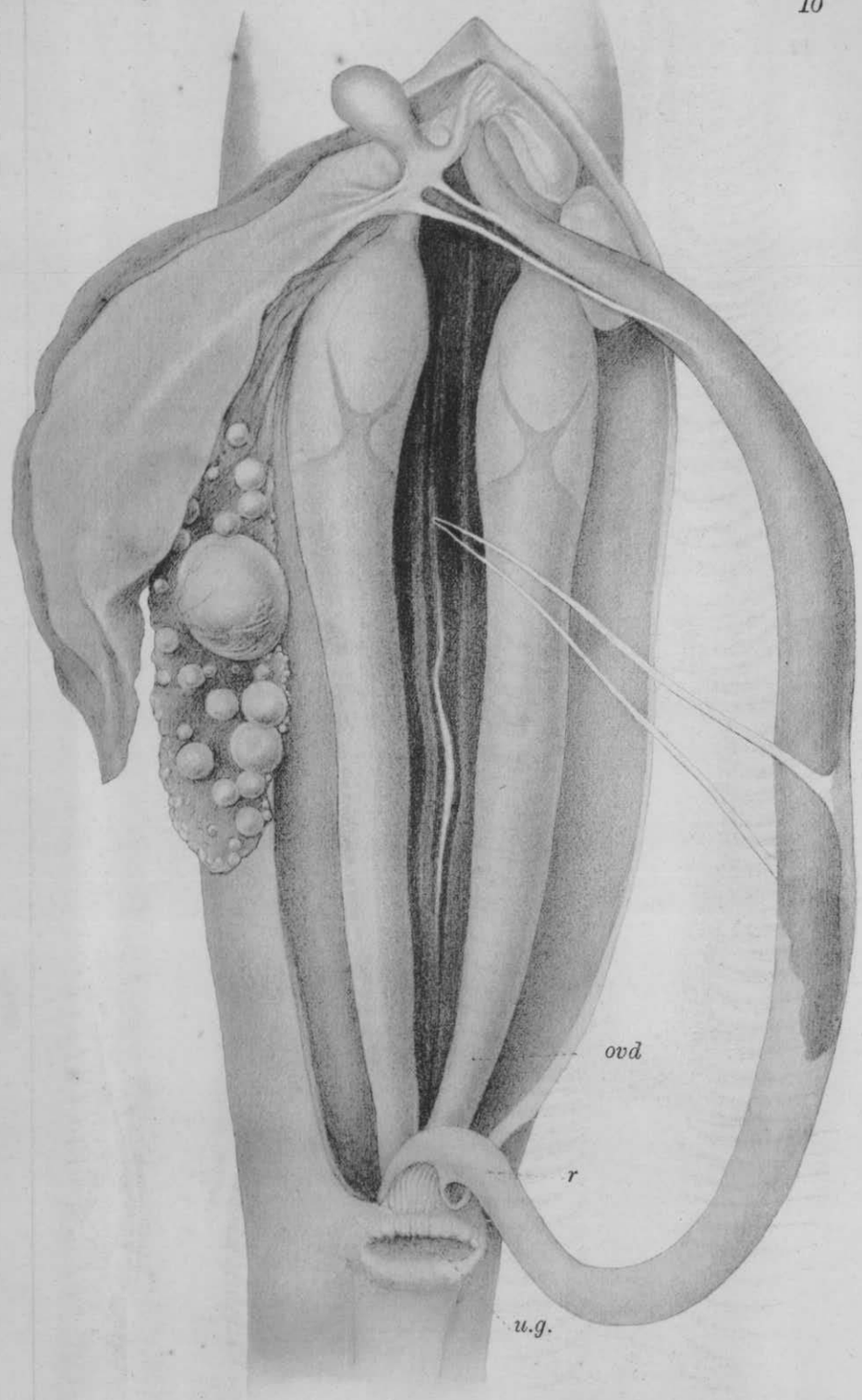
11 Conus arteriosus, laid open, exposing rows of valves. X about 5.

12 Egg capsule. X about $\frac{2}{3}$. Oka del.

12 a Detail of posterior end of egg capsule (dorsal aspect) showing ventilating apertures.

12 b Detail of anterior end of egg capsule (dorsal aspect), showing mode of opening, the lamellae of the left side having been separated. (This side corresponds to the keeled side of the egg case in Chimaera).

Fig. 9



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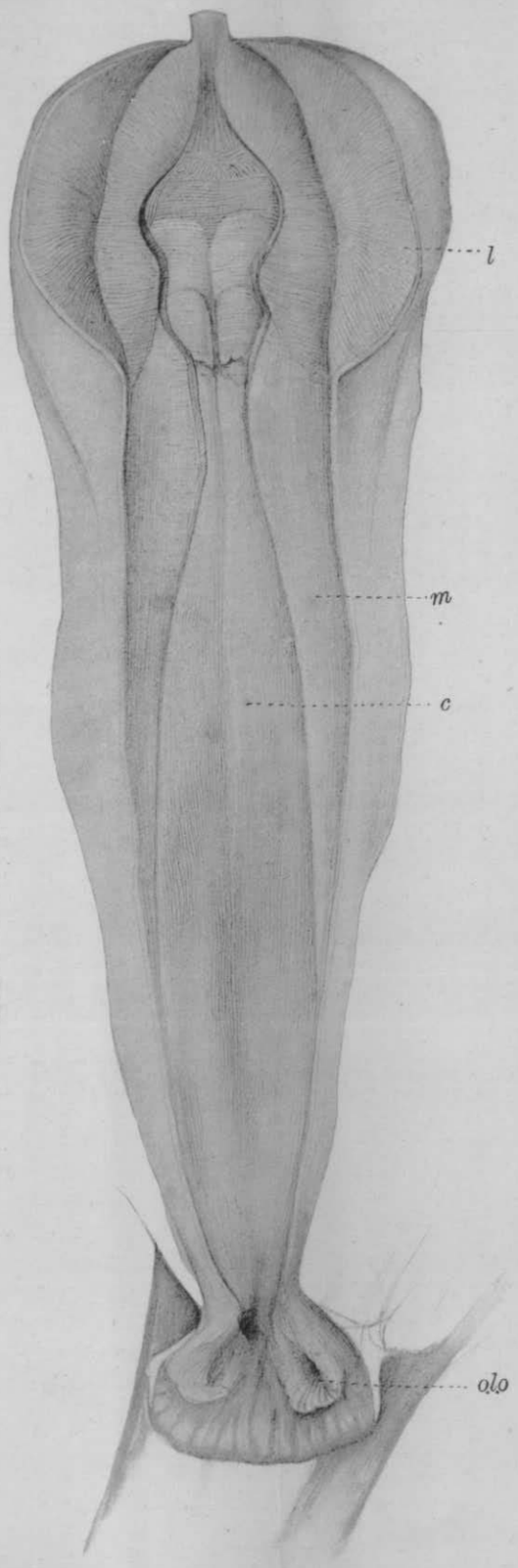

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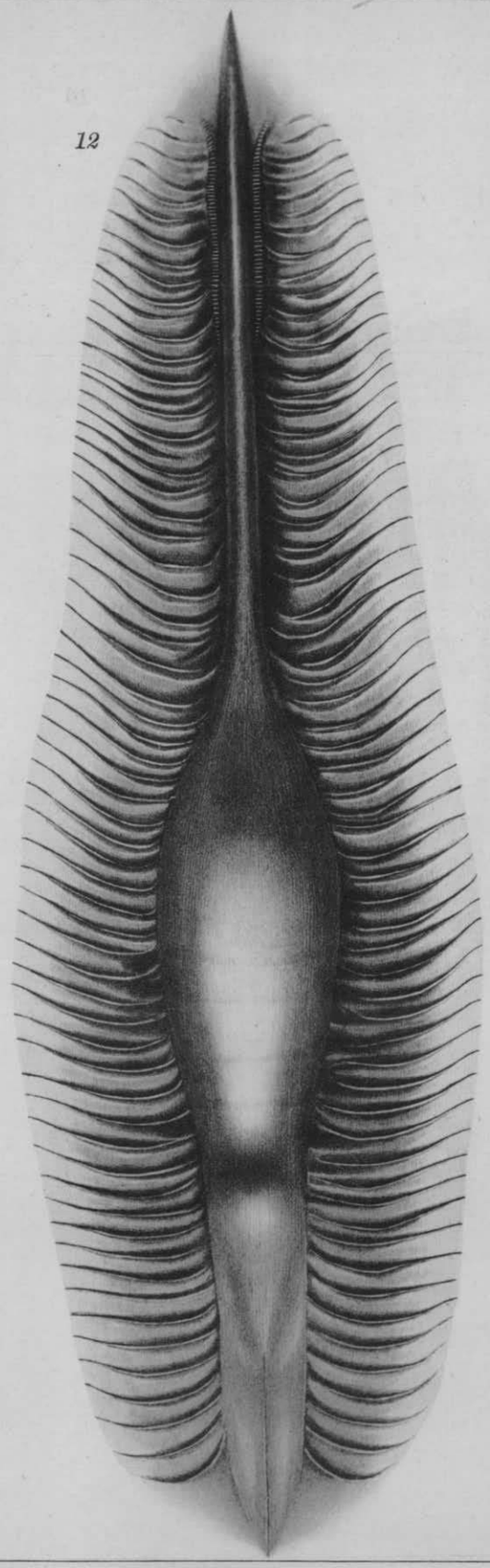

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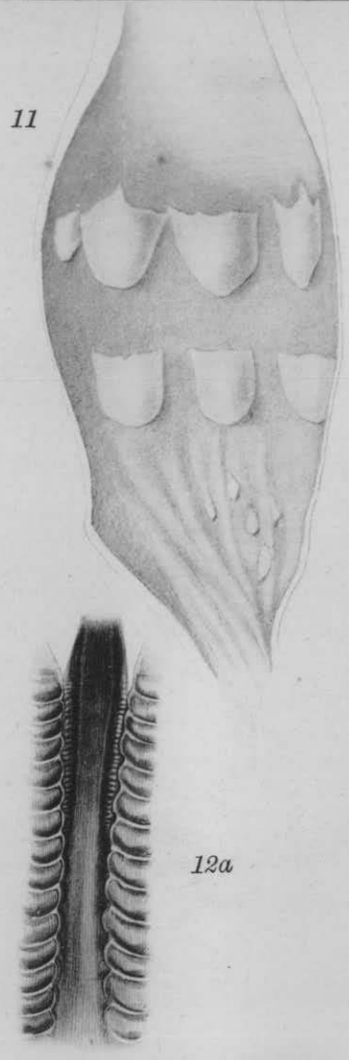
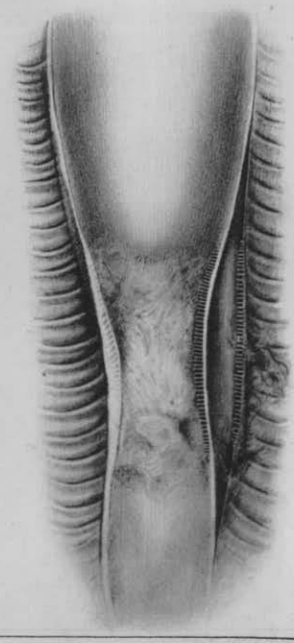


12a

12b



Oka and Sato del.

"HARRIOTTA" PACIFICA, Mitsukuri.