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Notes on Japanese Myxinoids.

A NEW GENUS *PARAMYXINE*, AND A NEW SPECIES *HOMEA** *OKINOSEANA*. REFERENCE ALSO TO THEIR EGGS.

By

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With 1 Plate.

In the recent preliminary check list of the fishes of Japan by Jordan and Snyder, (1901, Tokyo, *Annotationes Zoologicae Japonensis*, Vol. III, Parts II-III, p. 126) two myxinoids are mentioned, *Homea burgeri* Girard, and *Myxine australis* Jenyns. The first represents the form described as *Heptatrema cirrhatum* by Temminck and Schlegel (1847, *Fauna Japonica: Poissons*): the second was identified, *fide* Dr. Günther, on the evidence of specimens taken by the Challenger on the "Hyalonema ground" off Misaki. In a subsequent paper Jordan and Snyder ("A Review of the Lancelets, Hag-fishes and Lampreys of Japan with a Description of Two New Species." *Pro. U. S. Nat. Mus.* Vol. XXIII, pp. 725–734, 1901.) describe the Japanese Myxine as a new species, *M. garmani*.

* Realizing that the time-honored name, *Bdellostoma*, for this genus must be superseded I conclude with Mr. Garman that *Homea* (1822, Fleming) should be selected instead of a name prior by several years (1819, Duméril, *fide* Cloquet, *Dict. Sci. Nat.* XV. p. 134). To one who is not an out-and-out purist the earlier name "*Eptatretus*" to say nothing of its unaspirated condition.....is clearly a misnomer for forms which usually *have not seven gill openings:*

In addition to the myxinoids above referred to, the present writer during a stay at Misaki, as a guest of the Marine Laboratory of the Imperial University of Tokyo, was able to secure two undescribed species, one of which is remarkable for its large size, and in the possession of eight gill openings, the only myxinoid, indeed, in which this number is known normally to occur. The second presents characters closely transitional from *Homea* to *Myxine* and is regarded as representing a new genus. These forms are described on the following pages and reference is made to the eggs of three myxinoids and to the breeding characters of the common *Homea burgeri*.

The present studies were carried on largely at the marine station at Misaki, and partly at the Zoological Institute of the Imperial University of Tokyo. In both of these laboratories every facility was generously granted me, and I wish to acknowledge with especial gratitude the many courtesies of their director, Professor Kakichi Mitsukuri. My thanks are also due to Professor S. Watasé of the Imperial University, for his kindness in editing and publishing the present paper, favors which I especially appreciated in view of the difficulties attending proof-correction when an author is distant half way around the world.

HOMEA BURGERI.

This species is taken in large numbers in shallow water in the small bays in the neighbourhood of the marine station at Misaki. Most of the specimens I examined were taken in water of three or four fathoms, and they occur in even shallower, for I have seen them near the stone steps of the laboratory. In this region specimens were obtained throughout the year, save during an interval of several weeks (September and October), when the fish were found to be

spawning. From my notes I give the following abstract relating to their life habits.

In the matter of feeding: They are not exclusively bottom feeders, for they found their way into a fish float which was anchored near the shore in a couple of fathoms water. And they here showed their predatory habits in a way which upon several occasions I would gladly have dispensed with. They would find their way into the float through crevices which seemed too narrow for their entrance, and they would attack and kill living fishes. I found that even electric rays, *Astrape dipterygia*, were not immune, for in several instances I detected hag-fish in the fish float side by side with these rays and noticed that the fin margins of the latter showed the rasped sores which are typical of the injuries caused by hag fishes. This is still another instance that even elasmobranchs are subject to their attack.* The rays, it may be noted, were active, having been freshly caught, and were, one might reasonably conclude, well protected by powerful electric organs: to be sure, they were confined in a float, but it was of such a size as to give them plenty of room in which to move about: their only disadvantage was that they were unable to escape the continued pursuit of their enemies. That the hag-fish, moreover, exhibits to a greater degree than hitherto recorded, activity and persistence in pursuit of free swimming prey is more than probable from the following incident. According to Mr. Tsuchida, an assistant at the Misaki Laboratory, squid had often been successfully kept alive in a neighboring fish float: one night, however, living squid were confined in the float, but by some accident the lid was not

* This is mentioned, since it has been stated (Ayers, H., *Wood Hole Biol. Lectures*, 1894, p. 133) that these fishes are not subject to their attacks. I have already (*Kupffer Festschrift*, 1899, p. 224) noted the example cited by Johannes Müller. Doflein has observed recently hat a hag-fish entered the visceral cavity of a ray which was confined in the same pail.

tightly closed, and in the morning the float was found to contain several hag-fishes and the debris of squid. The conclusion is, therefore, that the squid had been caught while yet alive, in spite of their activity and keen noctural vision.

With a view of determining with some accuracy the sex characters

Homea Burgeri: Table

Date.	Number examined	Percentages*			Size				Percentage having eggs of approx. uniform size.
		♂	♀	juv.	♂ max.	& min.	♀ max.	& min.	
1900.									
July 18.	37	63%	32%	5%	45–	30 cm.	45–	30 cm.	50%
Aug. 29.	41	83	14	3	54.5	29	45–	33	60
Sept.									
Oct. 28.	16	13	87	—	41.5	32	46–	32	63
30.	29	24	76	—	45–	29	46.5–	30.5	90
Nov. 25.	96	37	63	—	50–	28	60–	24	98
Dec. 15.	40	45	55	—	47–	29	47.5–	32	85
1901.									
Jan. 15.	33	45	55	—	48–	28	46–	30	95
Mar. 30.	96	31	65	4	47–	30	48–	32	81
June 5.	60	42	58	—	45–	31	45–	29	63
June 18.	14	60	40	—	49–	35	40–	37	83
June 30.	59	50	46	4	52–	30	50–	35	87
July 25.	91	78	22	3	54–	30	52–	27	80

* Percentages are approximate. "Immature" specimens are

in this myxinoid, I took the opportunity of collecting an abundant material at various intervals during a period of somewhat over a year. In this time upward of six hundred specimens were examined, and from the notes made upon them, the following table was prepared.

of Sex Characters.

Number of eggs of foregoing.			Size of eggs (mm.) of foregoing.			Remarks.
max.	min.	average	max.	min.	ave.	
23–	13–	18	23	22	22.9	Females with eggs either nearly mature, or very immature (3 mm. or less).
24–	5–	15	25	22	23	Many large males, average size about 48 cm.
						4 collecting trips: failed to get specimens.
27–	17–	23	—	—	—	Follicular capsules empty, from 9–12 mm. long.
—	—	—	—	—	—	All mature males spent. Follicular capsules empty.
—	—	—	—	—	—	Exceptions: 1 female, in which eggs measured 11-14 mm.
—	—	—	8	3	4.4	Exceptions: 1 female, in which eggs measured 12 mm.
—	—	—	7.2–	2–	4.2–	1 female: eggs 2 mm....2 females: eggs 5 mm. rest bet. 7-14 mm.
36–	2–	17	20–	5–	11.9	2 females: 5 and 4 mm.
24–	5–	17	22–	16–	18.9	1 female: small eggs.
18–	9–	14	23–	3–	20	6 females: small eggs.
27–	4–	17	23	–19–	20+	1 female: small eggs: 1 male ripe.
32–	10–	19	25	–3–	22	

those in which sex could not be distinguished macroscopically.

From the foregoing data, we can, I believe, conclude very definitely that in the case of one myxinoid at least, a definite period of spawning occurs.* For it will be seen that a very large proportion of the full grown females taken during the year are with eggs of a uniform degree of development. Furthermore, during the late fall it is found that nearly every full-grown female taken presents empty follicular capsules. And finally there can be traced a regular growth in the size of the ovarian eggs from the winter months to the late summer. Exceptions to these rules undoubtedly occur, but they are, as the table shows, far from common. The rate of growth of the egg in length is estimated approximately at 3 mm. per month. It may be safely said that the ovarian eggs begin to differentiate distinctly during the month of January, and that their growth (in length) is completed by the middle of August. The spawning season appears to the last from about this time until the end of October. By the middle of the latter month, however, more than half of the females appear to have spawned. By the end of November the spawning season is probably finished. I have noticed also that the sexual development of the male corresponds in general with that of the female. All males taken at the end of October were completely spent. Those taken during July showed clearly late stages in spermatogenesis, and ripe specimens were not uncommon.

As in the case of the Californian myxinoid, *Homea stouti*, there can be little question that in the Japanese species, too, hermaphroditism does not occur, to say nothing of its protandric form. At certain seasons of the year, however, males are uncommon, and in certain

* It is by no means impossible that a systematic examination of other myxinoids will yield a similar result, although it cannot be denied that *some* spawning may occur all the year around. In *H. stouti* there is also evidence that the greater number of females deposit their eggs at nearly the same time.

localities it is probable that female specimens may alone be taken. That this condition sometimes occurs I have the testimony of Dr. P. Schmidt of the Fishery Board of the Russian Government, who informs me that during his stay at Kagoshima, he had an excellent opportunity of examining this myxinoid and that among the many specimens taken he was unable to discover a single adult male. In further detail: The males are taken in greater and greater abundance from March until breeding time, when they are about three times as plentiful as females. In the fall, on the other hand, the relative abundance of the sexes is more than reversed, six times as many females having been taken toward the end of October. From this time onward, with the exception of an inconsiderable fluctuation during the spring, males increase and females decrease in number in the catches, until spawning time occurs again. The great catch of females during the period immediately after spawning attests either that these fish have not taken food for a long period, or that they then require an exceptional amount of food to condition them for the task of resorbing the empty ovarian capsules and of initiating the growth of the eggs of the new season, or, possibly indeed, both causes may have operated. In regard to the proportion of the sexes taken during July and August, I may note that I have found similar results on the Californian coast in the case of *H. stouti*, in a tabulation of three hundred and fifty odd dissections. It is noteworthy that small, sexually undifferentiated specimens were rarely taken at Misaki, scarcely two per cent. of all material examined. In regard to the size relations of the sexes, furthermore, the present observations are closely in keeping with those which the writer has made on the Californian species. The largest specimen recorded was a female measuring 60 cm. in length; and the largest male measured 54.5 cm. On the other hand, the average size of one hundred males,

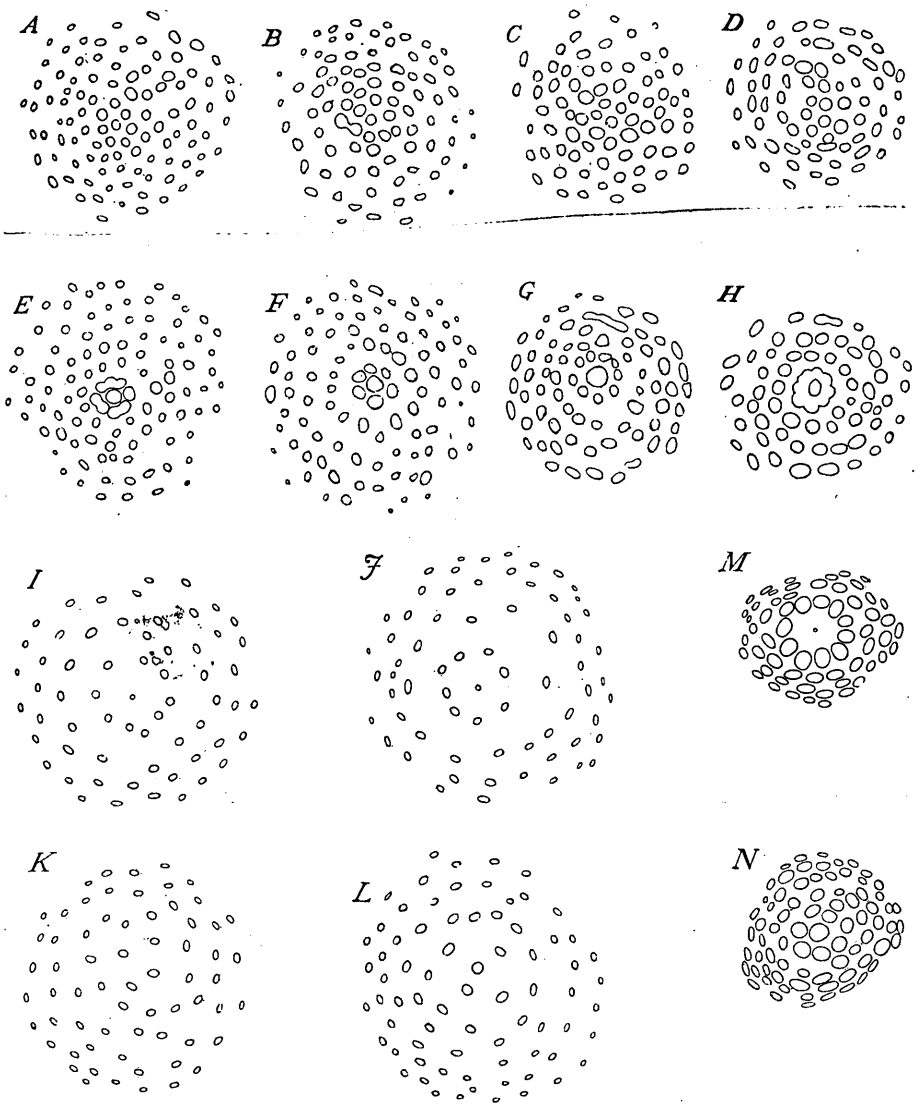
taken at random, was found to be 42 cm., and of one hundred females 41 cm. In general the largest males are more abundant than the largest females. The average number of eggs in the species is computed to be eighteen (in 400 individuals). The length of the egg at the time of spawning measures about 22 mm. not including the terminal filaments. An opercular ring is occasionally present at the vegetal pole. The anchor filaments are more numerous than in any known myxinoid, 100 or more being often present.

The egg of this species is shown in Pl. I. Fig. 7, and may be compared with those of other Japanese myxinoids figured in the same plate. In Text-figure 1 is shown the pattern formed by the bases of the anchor filaments in the case of four eggs selected at random : at the vegetal pole (*A*, *B*, *C*, *D*) the number of filaments varies between 91 and 72, at the animal pole (*E*, *F*, *G*, *H*) between 119 and 67. The average of ten specimens examined is 79 and 88 respectively Surrounding the micropylar funnel the first ring of filaments is made up of eight (average) components and they are situated close to the micropyle.

As far as the chances of obtaining embryonic material is concerned, I have no doubt that a determined effort would procure eggs in the neighborhood of Misaki as readily as on the Californian coast. And I may add that while absent from Misaki during the late fall, specimens were secured for me which yielded eggs in the same manner as those obtained in California. On that occasion more than a score of eggs were taken from the slime enclosing a captured hag. It is probable that some of these eggs, if not the majority of them, had first been in the fishes' gut.

HOMEA OKINOSEANA, n. s.

Of this species I have examined three adult specimens, two



Text Fig. 1. *A—H*, Pattern formed by bases of anchor filaments of the eggs of *Homea burgeri*.
A, B, C, D. At vegetal pole of egg.
E, F, G, H. At animal pole of egg.
I—N, Pattern formed by bases of anchor filaments of the eggs of *Homea okinoseana* (*I—L*), and *Paramyxine atami* (*M, N*).
I, J. At animal pole.
K, L. At vegetal pole.
M. At animal pole.
N. At vegetal pole.

males and a female. The former measures 64 and 70 cm. the latter 80 cm. I learn, however, from Kuma Aoki, the skilful collector of the Misaki station, through whom I secured the specimens, that this species is not uncommon in the region "Outside Okinosé." Okinosé,* it may be remarked, is one of the well-known fishing banks off the mouth af the bay of Tokyo, long famous as a collecting ground of glass sponges. The southern end of this bank deepens suddenly from forty to about three hundred fathoms, within a surfece distance of about a kilometer. The present specimens were taken in water of four hundred fathoms in a tract well known to the fishermen by a name equivalent to "myxine ground." Kuma tells me, furthermore, that this particular species is in especial disfavour with the fishermen on account of the great amount of slime with which it befouls the trawl-lines. This can readily be believed, judging from the large size of the present specimens.

In point of size, if it is fair to conclude from but the three specimens examined, *H. okinoseana* is the largest myxinoid known. It is stout moreover in proportion to its length, as is shown in the accompanying figures (Text-figure 2, *A*—*E* p. 11),† of five species of myxinoids, which have been drawn in ventral aspect and reduced to a common scale. In each of the three specimens examined, eight branchial openings are present on either side. And in each case, as dissection shows, the eighth branchial sac is present on the left side, its outer duct merging into the ductus œsophagœus near its external

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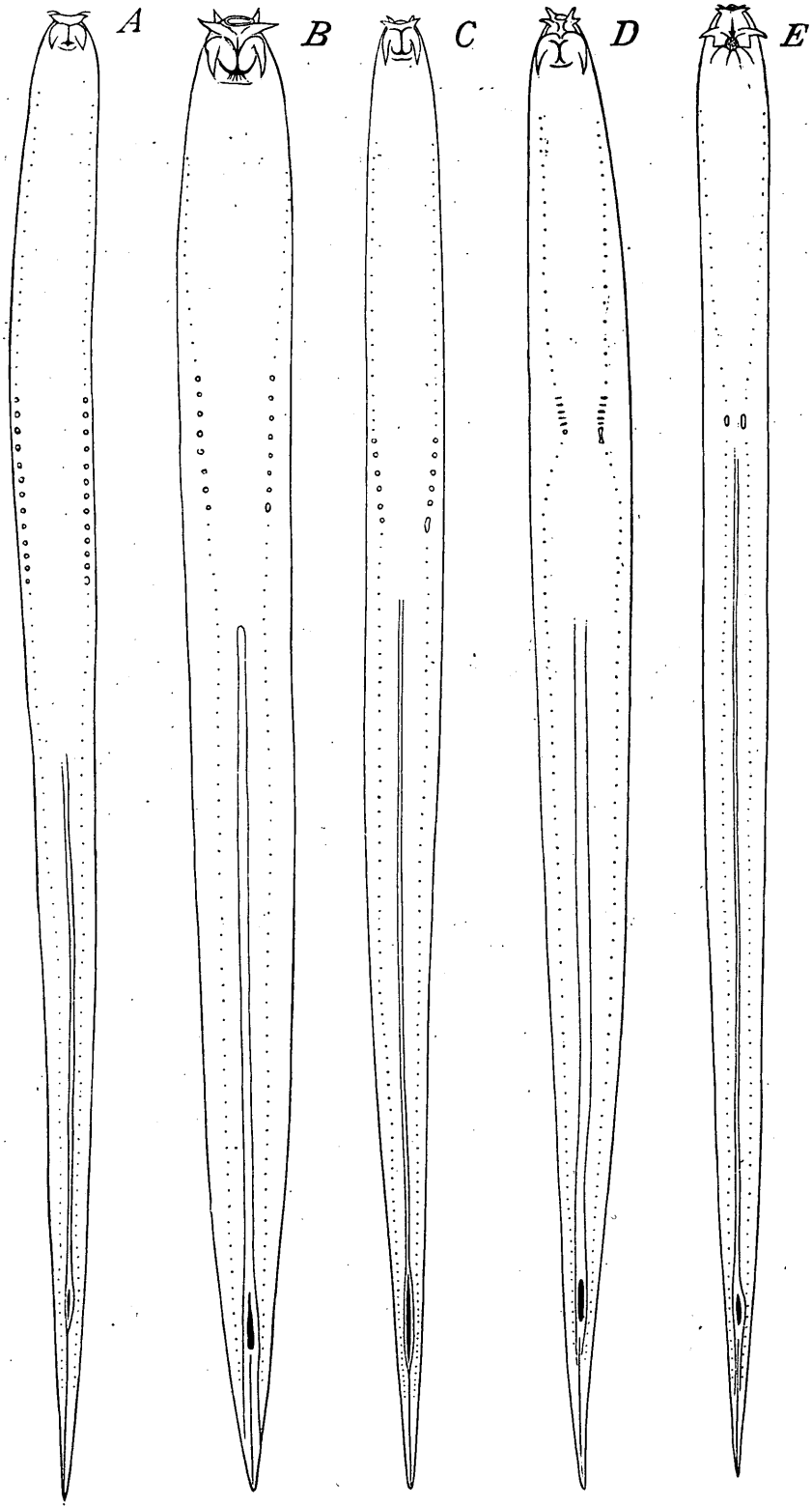
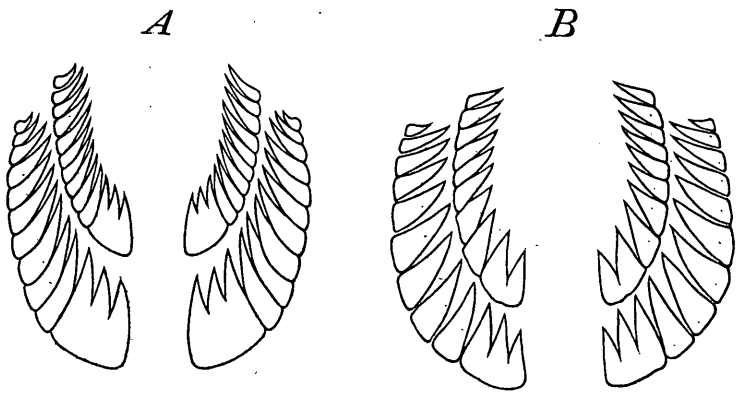
* Cf. I. Ijima. Studies on the Hexactinellida. J. Sci. Coll. Tokyo. Vol. XV, 1901, p. 8.

† **Text Figs.** 2 Various myxinoids, ventral aspect, reduced to common length.

A. *Homea stouti* Lockington.
B. „ *okinoseana* Dean.
C. „ *burgeri* Girard.
D. „ *Paramyxine atami* Dean.
E. „ *Myxine garmani* Jordan and Synder.


A
B
C
D
E

opening. Accordingly in the numerical relations of the gills the present species fills up the gap which has existed between the bdellostomas with a small number of gills, *i.e.*, those of five and six (seven) gill-pairs, and those of many gills, from ten to fifteen. For in addition to the regular number of eight gills in the new species, we must include the ductus œsophagœus as representing on one side at least a ninth gill. Judging by the conditions in other hag-fish, moreover, I have no doubt that variations occur in the present species which would make the foregoing transition still more convincing. I



Text Fig. 3. Dental cusps of new Japanese myxinoids.
A. *Paramyxine atami.*
B. *Homea okinoseana.*

note in this connection that a numerical variation occurs in the gills of *H. burgeri.* In as large a proportion as ten per cent. of the material examined, I find that the excurrent opening of the sixth left branchial sac opens to the surface in front of the ductus œsophagœus.

On Pl. I, Fig. 1 is shown the lateral view of this species. It has been drawn to scale so that the proportion of "head" and "trunk" can be estimated. By comparison of Text-fig. 2 *B* with Text-figs. 2 *A*, *C*, *D*, *E*, it will be seen that the outer gill openings

are situated somewhat further forward than in *H. burgeri*. I note that a well marked median ventral "fin" is present, and that the dorsal finfold is restricted to the region of the tail tip.* The dental formula in two specimens was $\frac{11}{12} | \frac{11}{12}$ of the third $\frac{10}{12} | \frac{10}{12}$. The more median teeth on either side are confluent at their bases, three of the outer and two of the inner rows. (Cf. Text-fig. 3 *B*). The base of the tongue extends backward between the second and third pairs of branchial sacs; the afferent artery, however, divides opposite the seventh pair. The lateral mucous pores are dark-colored and inconspicuous. The color of the present species is dark purplish brown.

In the female specimen above referred to the ovary contains 44 eggs. These are in a late stage of development and enable us to determine with reasonable accuracy the size of the egg at maturity together with the number of the anchor filaments. I find, accordingly, that the length of the egg averages 35 mm., its diameter 12 mm., its general shape and its actual length being indicated in Pl. I, Fig. 2. In two specimens examined by Mr. Naohidé Yatsu, who kindly prepared Text-Fig. 1, p. 9, the number of filaments at the animal pole were 62 and 63 and at the vegetal pole 64 and 74. (Text-fig. 1, *I*—*L*). It is possible, however, that the number of filaments in these eggs was not yet completed. The figures indicate that the central ring of filaments surrounding the micropylar funnel (*I*—*J*) is of greater diametre relatively than in other myxinoids described.

Two of the types are preserved in the Museum of the Science College of the Imperial University of Tokyo, the third in Columbia University, New York City.

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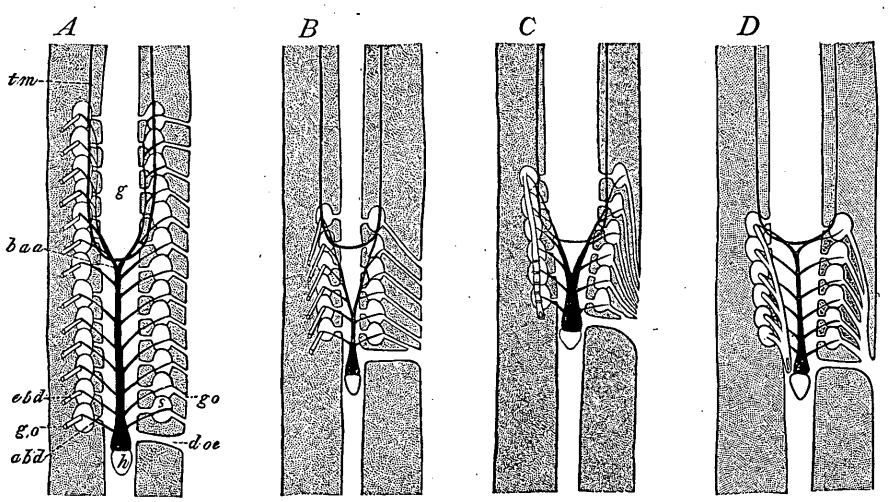
* The anterior extension of these fins is somewhat variable, depending upon the amount of blood which their sinuses contain.

PARAMYXINE ATAMI, nov. gen., nov. sp.

The single specimen upon which the present description is based was obtained in water of 270 fathoms off Cape Manazuru, near the famous hot springs of Atami (*Izu* : Sagami Sea), a local name which may appropriately be used to distinguish the species. Kuma Aoki, by whom the specimen was collected, tells me that it is the first which he has seen during his many years fishing and collecting.



Text Fig. 4. Diagrams of brancial regions of various myxinoids. Ventral aspect. In each the branchial ducts appear at the left in their normal position, at the right schematized so as open directly lateral.

A. *Homea stouti* Lockington.
B. *Homea burgeri* Girard.
C. *Paramyxine atami* Dean.
a. b. d. afferent branchial duct.
b. a. a. bifurcation of afferent aorta.
d. oe. ductus œsophagœus.
g. gut.
g. o. gill opening.
h. heart.
s. gill sac.
t. m. dark line showing position of tongue muscle.

The type, a female, measures 55 cm. in length. It is preserved in the Imperial University of Tokyo. On a following page (p. 22) are given the distinguishing characters of this genus and species. I note, however, that the figures drawn by Mr. Kuwabara,

given in Pl. 1, Figs. 3 and 4, give a good idea of its external characters : also in Text-fig. 2 of its proportional measurements in terms of other species. Its " teeth " are shown in Text-fig. 3 *A*. And in Text-fig. 4 *C* a diagram indicates the relations of the branchial ducts and the afferent vessels. Its egg is figured in Pl. I, Fig. 5, and the arrangement of its anchor-filaments at either pole is shown in Text-fig. 1 *M*, *N*. In this myxinoid the pointed shape of the head and the close approximation of the external gill openings suggest closely *Myxine*.

MYXINE GARMANI, Jordan and Snyder.

All specimens of this species recorded were taken in the neighborhood of the mouth of the bay of Tokyo. The most famous Myxine ground appears to be the one situated in Outside Okinosé. It is from this region, or near it, that the specimens of the *Challenger* were obtained. I have received five specimens from this region, of which three were immature, measuring about 35 cm. in length. The species is a large one, its adult averaging about 50 cm. Its color is dark indigo purple, somewhat bright in tone.

In distinguishing this species from *M. australis* Jenyns, to which Günther referred it, I add to the reasons adduced by Jordan and Synder the following :—

It is a larger species, its dental cusps are more numerous and the base of the tongue muscles extends further tailward than the first pair of gills. The more median dental cusps fuse as in the southern Pacific species, but they are smaller than the more lateral ones. A more definite comparison of the normal of this species with the normal of the southern Pacific one, may render it advisable to regard the Japanese form as a variety of *M. australis*, but the differences as above pointed out, viewed in connection with the emphatic geographic-

al distinctness of the two forms, are at present I believe sufficiently striking to warrant the creation of a new species.

GENERAL CONSIDERATIONS.

As far as our present knowledge goes, Japan is the most favorable region for the study of myxinoids. In no other known locality are four species, representing three genera of these important chordates, found living practically side by side,—for in the neighborhood of Misaki they occur within a distance of 30 kilometers. Here too, a form of myxinoid can be obtained in greater abundance than in any locality known to me, and there is also a promising field* for collecting developmental stages. Hitherto the bay of Monterey has provided all myxinoid embryos recorded, but in the latter locality, one may add in parenthesis, the collection of hag-fish eggs has been due to the labors of practically a single fisherman, Ah Tack Lee, whose energetic help is thus almost a *sine qua non.*

It was especially interesting to me to ascertain that the relations of sex in *Homea burgeri* were in every way similar to those of the Californian *H. stouti*, in spite of the fact that the former represents a a six and the latter a twelve-gilled form. Accordingly, realizing that the only conspicuous structural difference between *H. burgeri* and *Myxine* is in the matter of the position and confluence of the outer ends of the branchial ducts, the number of the gills being the same—there seems less ground than ever for attributing to *Myxine* protandric hermaphroditism. The authors who maintain this, Cunningham and Nansen, have to my mind been so unfortunate as to have collected their specimens in a locality where females alone were abundant

* I have since learned that Professor Hatta deserves the credit of being the first scientist to obtain empbryos of a myxinoid. In the eariy nineties he was successful in obtaining eggs and embryos of *H. burgeri* in the Bay of Tokyo, not far from Ōmori.

among adult specimens. And in order to account for general absence of full-grown males, they have concluded that the females had in earlier condition been males. In support of this hypothesis they have found eggs in the anterior portion of the testis in certain of the immature males, a teratological condition which is now known to be not uncommon in other chordates. Perhaps in Japan an author might have fallen into a similar fallacy in examining *H. burgeri*, had his observations been carried on in the region of Kagoshima (Satsuma), according to Dr. Schmidt's observation already referred to. I confess, however, my suspicions that even in the localities in which Cunningham and Nansen collected, full grown males would be forthcoming in comparative abundance (both authors agreeing that full-grown males *do* occur occasionally), if a very large number of specimens are taken and at various seasons of the year. Neither author, by the way, as far as I am aware, has given any definite idea of the relative number and size of the specimens taken, or even of the total number upon which their generalization was based.

It is a significant fact that in practically the same locality there occur several forms of myxinoids. It affords, it seems to me, an additional support for the belief that the myxinoids are an ancient group, which has passed through a period of evolutional prosperity, after the fashion of sharks, lung-fishes or ganoids, a belief which has already found favor by reason of their singularly wide geographical distribution. Garman, moreover, in his recent (1899) report on the fishes collected by the *Albatross*, has given important data which one interprets as bearing favorably upon this matter from the stand point of vertical distribution. And now in an especially conservative locality, as at Misaki, we can still catch a glimpse, so to speak, of the better days of the myxinoids, for here there are living side by side three distinct genera represented by at least four species.

The wide range in the variational characters in species of myxinoids has long been appreciated, in the matter, for example, of the number of gills and 'teeth' and in the proportions of body regions and fins. My own observations lead me to the belief that in the case of myxinoids it is peculiarly necessary to base specific determinations upon the average characters of as great a number of individuals as practicable. Unfortunately, but few specimens of the southern species have as yet been examined critically, and until the contrary is proven, we have, therefore, to accept their characters already described as representing the average for these species. As far as my own observations go, there is the greatest relative constancy in the position of the outer branchial openings, *i.e.*, in respect to their location dorsal or ventral, anteriorly and posteriorly, and as to the interspaces of the openings in each row. The relative length of the external portion of the branchial duct in the last as distinguished from the first gill pouches is also found to be notably constant. Dental characters present somewhat wide variations, although as far as numerical variations go, it is not difficult to obtain the normal for each species. In such a calculation the most troublesome question is to what degree immature 'teeth' should be counted:—or rather, the minimum size of those which must be taken into account. For one often finds at the posterior end of each row of 'teeth' several more or less minute cusps, which strictly speaking can be counted as 'teeth,' although not actually functional. And by reckoning or not reckoning these one would easily obtain the wide variations in a dental formula which Ayers, for example, has given for *H. stouti*. The fusion of the two or three cusps at the median end of each row of teeth appears to be moderately constant for the species. It certainly has no value, however, as a generic character, for we find that the same degree of

the fusion of these elements occurs in *H. burgeri* as in *Myxine*. As far as my observations go, furthermore, there is considerable constancy in the degree of bifurcation of the afferent aorta and in the degree to which the tongue muscle extends hindward, both characters measured with reference to the position of the branchial sacs. The number of the mucous pores, whether "pectoral" or "abdominal," on the other hand, appears to me of minor value: not only do they vary in number palpably, but the anteriormost as well as the posteriormost are very difficult to count, so that in a given specimen, one cannot I believe, conclude what the number is without allowing for a possible error of two or more on either side, a discrepancy which in many cases is sufficient to invalidate the usefulness of this specific test.

The character of the egg, on the other hand, is found of no little importance in determining species: for each species presents well marked differences in the number, size and shape of the eggs, and in the number and distribution of the anchor filaments at the poles.

The above considerations have, as far as possible, been taken into account in the case of two genera of Hyperotretes in the preparation of the following synopsis.

(Class) MARSIPOBRANCHII.

(Sab class) HYPEROTRETA.

(Order) MYXINIA.

(*Family*) MYXINIDAE.

(*Genus I*) **HOMEA** Fleming, 1822. *Phil. Zool.*, II, 374. (=*Bdellostoma*, Müller, 1834).

Hyperotretes with branchial apertures, six to fourteen in number, lateral of branchial sacs. Ectal efferent branchial ducts of approx-

imately equal length. Transverse muscles (branchial constrictors) situated along a considerable space ventrad of the gill sacs. Aperture of ductus œsophagœus somewhat larger than gill openings. (Cf. Text-fig. 4, *A*, *B*).

(Species I) **Stouti**. Lockington, 1878, *Am. Nat.*, p. 793.

Twelve gills (variations from 10 to 15). External branchial ducts short. Base of tongue muscles between fifth or six pair of gills. Dental formula $\frac{10}{10}|\frac{10}{10}$ (variations from $\frac{9}{9}|\frac{8}{9}$ to $\frac{12}{11}|\frac{12}{11}$). Average size of adult (based upon 100 specimens) 42 cm. Brownish purple, with margins of branchial apertures and mucous pores white.

Eggs average 20 in number, each (all lengths here given not including filaments) about 23 mm. long by 8 mm. thick: anchor filaments average about 45 at animal pole, 35 at vegetal. Operculum almost invariably wanting near vegetal pole.

Habitat, Coast of California.

(2) **Polytrema**, Girard, 1854. *Pro. Acad. Nat. Sci. Phila.*, p. 199. (=Le Gastrobranche dombey (non-binomial), Lacepede. 1798. *Nat. Hist. Pois.* I, p. 531): (=bishoffi, Schneider.)

Ten gills (variation to 14). External branchial ducts short. Base of tongue muscles between seventh and eighth pair of gills (Putnam). Dental formula varies (Ayers) from $\frac{11}{7}|\frac{11}{7}$ to $\frac{13}{12}|\frac{13}{12}$. Average size 45 cm.

Eggs in single instance—probably of *H. polytrema*—34 in number (Plate), measuring about 22.5 by 9.5 mm. Filaments at either pole about 80 and relatively long. Operculum common at vegetal pole.

Habitat, Coast of Chili.

(3) **Okinoseana**, *nov. sp.*

Eight gills. External branchial ducts short. Base of tongue between second or third pair of branchial sacs (afferent artery divides opposite seventh pair). Dental formula $\frac{11}{12}|\frac{11}{12}$ ($\frac{10}{12}|\frac{10}{12}$ in one speci-

men): three more median teeth of outer row, two of inner row confluent at bases: of these the median are the smaller elements. Average length of specimens (2 male, 1 female) 71 cm. Color dark purplish. Gill apertures and mucous pores obscure.

Eggs (in one specimen) 44 in number, averaging 35 mm. in length: about 12 mm. in thickness. Operculum at one pole only: filaments about 65 in number at animal, and 70 at vegetal pole. Innermost filamental at animal pole somewhat widely removed from the micropyle. *Habitat*, Sagami Sea, Japan.

(4) **Cirrhata** Sch. 1801. (=*Heterotrema forsteri*).

Six (or seven) gills. External ducts slightly longer in anterior gills than in posterior. Base of tongue between first pair of gills. Dental formula $\frac{10}{10} | \frac{10}{10}$ variation (Ayers) $\frac{8}{7} | \frac{8}{7}$ to $\frac{12}{11} | \frac{12}{12}$. Average size about 48 cm. Coloration and *Eggs* undescribed.

Habitat, Coast of South Africa, and New Zealand.

(5) **Burgeri** Girard. 1854. *Pro. Acad. Nat. Sci. Phila.*, p. 199.

Six (variation seven) gills. External ducts somewhat longer in anterior gill than in posterior. Base of tongue between second (or first) pair of gills. Dental formula $\frac{9}{9} | \frac{9}{9}$ variation $\frac{8}{9} | \frac{9}{9}$ to $\frac{9}{10} | \frac{9}{9}$. Largest (median) three teeth of outer row confluent at bases, largest two teeth of inner row also. Average size 41.5 cm. Light brownish purple, unpigmented median dorsal band.

Eggs average 18 in number, each about 22.4 × 8.6, averaging 90 filaments at animal, 80 at vegetal pole. Operculum not uncommon at vegetal pole—in my material in 5 specimens out of 20: in none, however, is the opercular line sharply marked, altogether complete, or situated at any distance from the marginal filaments. Innermost filaments at animal pole located close to the micropyle.

Habitat, coast of Japan.

(*Genus* II) **PARAMYXINE**, *nov. gen.*

Hyperotretes with branchial apertures ventrad of sacs. Ectal branchial ducts of distinctly unequal length, the most anterior several times the length of the most posterior. The duct of the most anterior gill opening at the surface opposite the fourth (or fifth) gill sac. Openings of branchial ducts drawn close together and compressed transversely, that of the ductus œsophagœus, however, longitudinally, the latter aperture of large size, its length equalling that of the sum of the interspaces of several gills. Transverse constrictor muscles of the branchial region developed as a distinct element in the region of the hindmost branchial sacs. (Cf. Text-fig. 4, *C*).

(Species I) **Atami** *sp. nov.*

Six gills. Ectal duct of the most anterior gill three or more times the length of the most posterior. Base of tongue muscles between third pair of branchial sacs. Dental formula $\frac{1\,3}{1\,3} \mid \frac{1\,2}{1\,3}$. Three teeth, the most nearly median of each row, confluent at bases. Length about 55 cm. Dark purplish : gill apertures white : mucous pores conspicuous and dark colored.

Eggs in type specimen 25 in number, each about 30 mm. by 8 : narrow, therefore, and long : blunt ends. In two similar eggs taken separately on trawl line measurements are 30 by 7. No opercular ring at vegetal pole. Filaments about 75 in number at either pole, arising close together. The inner circle of filaments at animal pole separated somewhat widely from micropyle.

Habitat, Sea of Sagami, Japan.

(*Genus* III) **MYXINE** Linné. 1754. *Mus. Ad. Fridr.*, I, p. 91.

(*Cf.* esp. German, 1899, (Fishes collected by the *Albatross* pp. 342-350).

Hyperotretes with but a pair (variation one and one half pairs)

of external openings of the branchial sacs. The latter six in number, their outer ducts confluent. Distinct transverse muscles present, constricting branchial region. (Cf. Text-fig. 4, *D*).

(Species I) **Australis** Jenyns, 1842. *V. of Beagle.* Fishes. p, 159.
(Variety 1) *tridentiger* Garman, 1899. (op. cit. as *species*).
(„ 2) *acutifrons* „ „ („ „ „ „).
(„ 2) **Glutinosa** Linné, 1754. *Mus. Ad. Fridr.* I, p. 91.
(„ 3) **Limosa** Girard, 1858. *Pr. Phila. Acad.* p. 223.
(„ 5) **Garmani** Jordan and Snyder, 1901. *Pro. U. S. Nat Mus.* p. 731.
(„ 6) **Circifrons** Garman, 1899. (op. cit.)

BASHFORD DEAN.

Notes on Japanese Myxinoids.

PLATE I.

PLATE I.

Fig. 1. *Homea okinoseana.* ♂ × 2/3.

2. *Homea okinoseana.* Late ovarian egg ; *a*, its actual length.

3. *Paramyxine atami.* ♀ × 2/3.

4. *Paramyxine atami.* Ventral view of head region.

5. *Paramyxine atami.* Naturally deposited egg ; *a*, its actual length.

6. *Myxine garmani.* Late ovarian egg. × 1.

7. *H. burgeri.* Naturally deposited egg. × 1.

(Figs. 1–5 drawn by Mr. Kuwabara, 6, 7, by Mr. Yatsu).

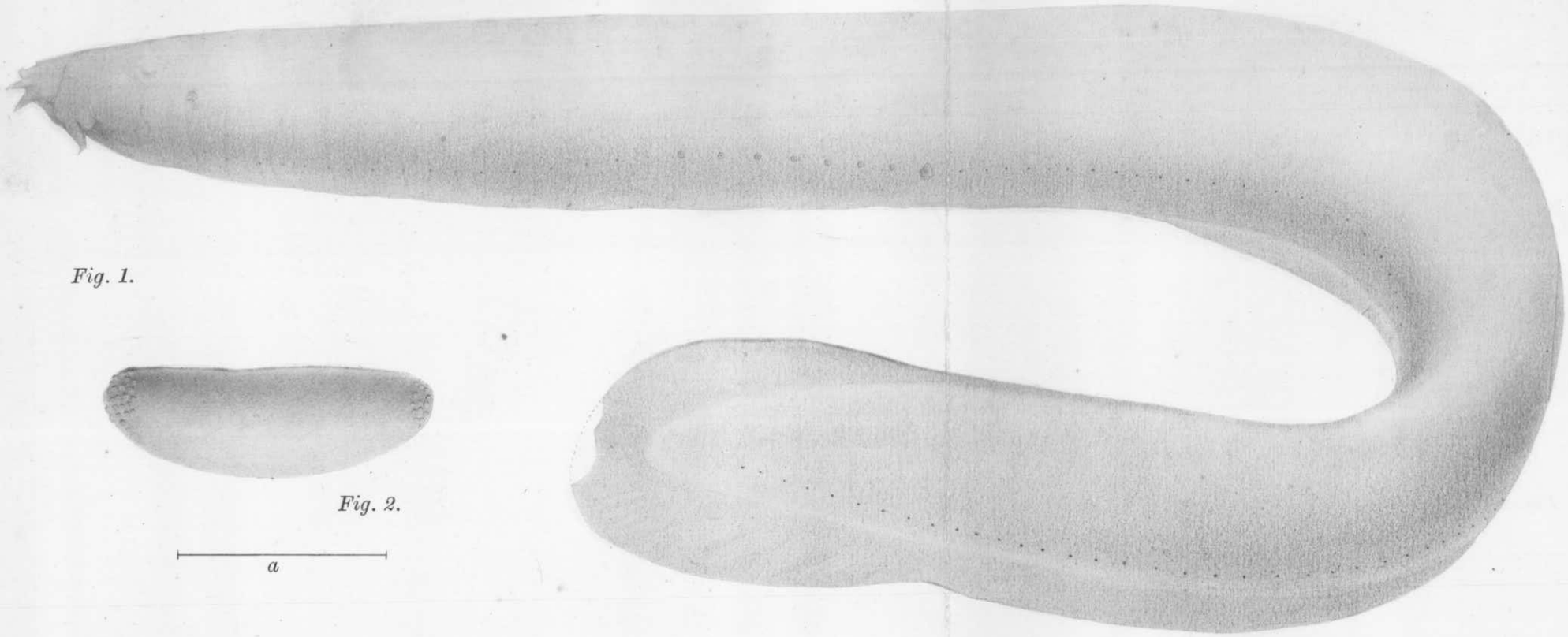
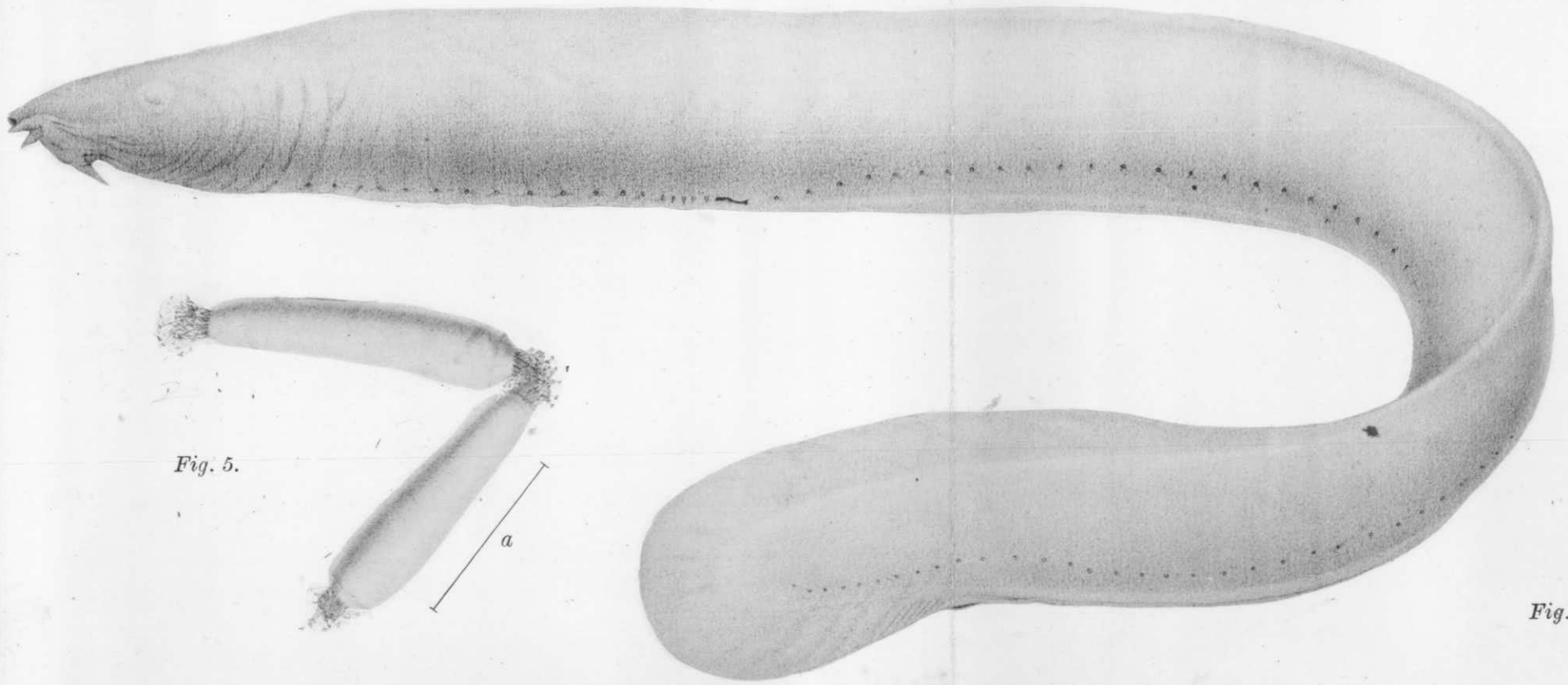


Fig. 1.

Fig. 2.

a

Fig. 3.



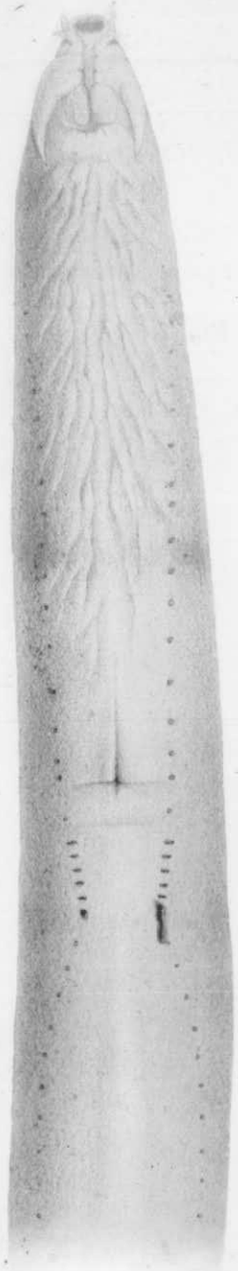


Fig. 4.

Fig. 5.

a

Fig. 6.

Fig. 7.

Kuwabara del

New Japanese MYXINOIDS and their Eggs.