

AN ABSTRACT OF THE THESIS OF

LARRY THOMAS SPENCER for the M. A. in ZOOLOGY
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Title A MORPHOLOGICAL STUDY OF GONATID SQUIDS FOUND
OFF THE OREGON COAST

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Gonatus fabricii (Lichtenstein, 1818), G. magister Berry, 1913, G. anonychus Pearcy and Voss, 1963, and Gonatopsis borealis Sasaki, 1923 (Gonatidae) are squid forming a major portion of the cephalopod fauna found off the Oregon coast. A study was undertaken to determine the morphological differences among the four species of squid.

The adult squid of all four species were studied, and also the larval stages of Gonatus fabricii, G. magister, and Gonatopsis borealis were observed. The growth patterns of Gonatus fabricii and Gonatopsis borealis were determined for the first time, and an attempt was made to determine reasons for the differences in the growth patterns. The development of the structure of the tentacle club of G. fabricii was recorded. Wide variations were noted in the armature of the adult tentacle club, but none were similar to that described by Young.

A MORPHOLOGICAL STUDY OF GONATID
SQUIDS FOUND OFF THE OREGON COAST

by

LARRY THOMAS SPENCER

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Professor of Zoology

In Charge of Major

Redacted for Privacy

Chairman of Department of Zoology

Redacted for Privacy

Dean of Graduate School

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TABLE OF CONTENTS

I.	INTRODUCTION	1
	Family GONATIDAE Hoyle, 1886.	1
	<u>Gonatus fabricii</u> (Lichtenstein, 1818).	2
	<u>Gonatus magister</u> Berry, 1913	3
	<u>Gonatus anonychus</u> Pearcy and Voss, 1963	3
	<u>Gonatopsis borealis</u> Sasaki, 1923	3
II.	MATERIALS AND METHODS	4
	Source of Animals Used in the Study	4
	Methods Used in Studying the Squid	4
III.	GENERAL MORPHOLOGY OF ADULT SQUIDS	6
	Size and Shape of Mantle and Fins	6
	Size and Shape of Head and Funnel	7
	The Arms and Their Armature	9
	The Tentacles and Their Armature	9
	Internal Structures	11
IV.	MORPHOLOGY OF LARVAL AND ADOLESCENT FORMS	12
	Larval Morphology	12
	Adolescent Morphology	14
V.	GROWTH PATTERNS OF <u>GONATUS FABRICII</u> AND <u>GONATOPSIS BOREALIS</u>	15
	The Growth Patterns	15
	Mantle Width.	15
	Head Width	16
	Head Length	16
	Nuchal Cartilage	17
	Siphon Width and Siphon Length.	17
	Fin Width and Fin Length	17
	Club Length	18
	Club Development	18
	The Suckers	18
	Hook Development.	19

TABLE OF CONTENTS (continued)

VI.	DISCUSSION.	21
VII.	SUMMARY	24
	BIBLIOGRAPHY.	33

LIST OF FIGURES

1. Growth patterns of mantle width, head width, head length, and nuchal cartilage length of Gonatus fabricii (Lichtenstein) 26
2. Growth patterns of mantle width, head width, head length, and nuchal cartilage length of Gonatopsis borealis Sasaki 27
3. Growth patterns of fin width, fin length, siphon width, siphon length, and club length of Gonatus fabricii (Lichtenstein) 28
4. Growth patterns of fin width, fin length, siphon width, and siphon length of Gonatopsis borealis Sasaki 29
5. Oral aspect of tentacle club of Gonatus fabricii (Lichtenstein) x 15 30
6. Ventral view of Gonatus magister Berry and Gonatopsis borealis Sasaki 31
7. Ventral view of Gonatus fabricii (Lichtenstein) and G. anonychus Percy and Voss 32

A MORPHOLOGICAL STUDY OF GONATID SQUIDS FOUND OFF THE OREGON COAST

I. INTRODUCTION

Some of the most common nektonic animals found off Oregon are the squid of the family Gonatidae. This group was described by Hoyle (1886) who worked with the cephalopods collected by the "Challenger" expedition. The family contains two genera and five known species. Gonatopsis borealis, Gonatus fabricii, G. magister and G. anonychus are found off Oregon. The species are readily identifiable in spite of variations, particularly of the armature of the tentacles. This investigation was undertaken to determine the extent of the variations and to ascertain the patterns of growth leading to the variations.

Family GONATIDAE Hoyle, 1886

The gonatid squids are characterized by having a cylindrical-conical body, with broad fins that join medially and extend beyond the apex of the mantle. The arms have four rows of suckers. Only suckers are present in the larval, while in the adult the medial rows of suckers of all the arms excepting the ventral pair develop into hooks (except Gonatus anonychus). Tentacles may or may not be present. In the adult, the tentacles sometimes have hooks. A

key to the species, except Gonatus anonychus, was published by Sasaki (1929).

Gonatus fabricii (Lichtenstein, 1818)

This species is characterized by having large hooks on the adult tentacle club. The development of these hooks can be traced from animals of 15 mm mantle length until they reach the adult form found in animals of 40 mm. The arms have the typical arrangement of gonatid squids. The species has been described by many authors. A fairly complete synonymy was given by Berry (1912), and a more complete description of larval, adolescent, and adult stages by Sasaki (1929). Richard Young¹ (In Litt.) indicated that he was of the opinion that Gonatus fabricii was actually a complex of species and that two species (not established) occur sympatrically off Southern California. He based the separation on the number of rows of suckers on the ventral side of the club, the toothed suckers of the tentacle stalk, and the ratio of the tentacle club to mantle length. Naef (1923) described another form of G. fabricii, but did not set it up as a species. Gonatus fabricii occurs in the arctic and antarctic regions of the Pacific and Atlantic Oceans.

¹ Young, Richard The Marine Laboratory, University of Miami
Miami, Florida

Gonatus magister Berry, 1913

Gonatus magister differs from G. fabricii in that the tentacles have only suckers. Hooks are never present even in the adult stage. The hooks of the arms are slightly smaller and less prominent than those of G. fabricii. Berry (1912) first described G. magister as a variety of G. fabricii, but he did so with reservations. In 1913, he described a new species based on the above-mentioned features (Berry, 1913). This species has been found only in the Northern Pacific Ocean.

Gonatus anonychus Pearcy and Voss, 1963

Gonatus anonychus differs from the preceeding two species by the lack of hooks on the tentacles, by the lack of hooks on the arms of the male, and by the presence of only a few small un-sheathed hooks on the arms of the female. It possesses three nuchal folds instead of the four found in G. magister. It has been taken only by dip netting off Oregon

Gonatopsis borealis Sasaki, 1923

Gonatopsis borealis located in the Northern Pacific Ocean is separated from other gonatid squid by the lack of tentacles. Sasaki (1929) thought this species might be adapted to very cold water.

II. MATERIALS AND METHODS

Source of Animals Used in the Study

The animals used in this study were from three sources and were from the collections of the Department of Oceanography, Oregon State University. Most of the material was collected with a six foot Isaacs-Kidd midwater trawl and dip-netting at a night light at sample stations off Oregon during general sampling operations by the staff of the Department of Oceanography (Pearcy, 1964). Some specimens were taken using the Multiple Plankton Sampler, and some with a ten foot Isaacs-Kidd midwater trawl. The gonatid squid in collections on loan to the Department of Oceanography by the University of Washington and the U. S. Fish and Wildlife Service were included in this study.

Methods Used in Studying the Squid

External and internal observations of the morphology of 200 squid were followed by sketches and measurements. The tentacle club of Gonatus fabricii was drawn because the position of the suckers and hooks were of taxonomic value in separating this species from the others.

The squid were measured according to the procedures used

by Voss (1963) and by Haefner (1964). It was hoped to measure a number of developing squid of various sizes of each species, but adequate specimens were available for only Gonatus fabricii and Gonatopsis borealis. Measurements taken were: dorsal mantle length, mantle width, head width, head length, nuchal cartilage length, club length, siphon width, and siphon cartilage length. Although the lengths of the arms and of the tentacles were measured, they varied too greatly within a species to be of diagnostic value. Ratios were then obtained by dividing the measurements of the part in question by the mantle length. These ratios are found in Figures 1, 2, 3, and 4.

The ratios indicate growth of the different body parts in relationship to growth of the mantle. An increasing growth ratio indicates that the structure was growing at a rate greater than was the mantle. Likewise, a decreasing ratio indicates that there was a slower rate of growth of that part in relation to the growth rate of the mantle. The ratio is also useful in species identification, since different species have differing growth rates. This is what Haefner (1964) attempted to do with Loligo pealei and Loliguncula brevis.

III. GENERAL MORPHOLOGY OF ADULT SQUIDS

Size and Shape of Mantle and Fins

The mantle (except Gonatus fabricii) was thick and retained its shape even when preserved in all species. In G. fabricii it was very thin and flaccid, and the body shape became distorted when too many were preserved in the same container. In all species the diameter or width of the anterior two thirds of the mantle was constant; the latter third tapered. The widest part of the mantle was about one-fourth to one-fifth of the mantle length. The nuchal articulating ridge formed a slight projection on the dorsal surface of the mantle. The siphonal articulating ridges also projected slightly beyond the edge of the mantle and a crescent-shaped depression was formed between them on the ventral surface. This was more noticeable in G. anonychus and Gonatopsis borealis, but was also seen in the other two species.

The fins joined medially and extended beyond the apex of the mantle. The posterior edge was straight, the anterior edge slightly rounded and auricle-shaped at the point of junction with the mantle. In Gonatus fabricii, the fin length was about one-half the mantle length and almost equaled the fin width. The apex of the fins formed slightly less than a right angle. In G. magister and

Gonatopsis borealis, the fin length was slightly less than one-half the mantle length. The fin width was about three-fifths the mantle length and the apex of the fins formed an obtuse angle. In Gonatus anonychus, the fin length was about one-third the mantle length, and their width was about one-half the mantle length.

Size and Shape of Head and Funnel

The head was almost square but with a slightly rounded dorsal surface. The eyes were large. The ventral surface had a slight depression between the eyes and a deep depression in the region of the siphon, forming a funnel groove. The head in Gonatus fabricii and G. anonychus was slightly smaller than the mantle opening, while in the other two species, it was as broad as the opening, sometimes broader. In all species the neck was strongly constricted. The anterior end of the head tapered sharply in G. fabricii and G. anonychus so that the region of the head where the arms arise was not as wide as the rest of the head. This was not so in the other species. The eye opening in all species was large and had a deep anteriorly-directed sinus. Gonatus magister had four longitudinal folds which formed part of the olfactory crest structure; the others, three. An olfactory tubercle was located on the middle longitudinal fold. The nuchal cartilage of all species measured

about one-sixteenth of the mantle length. In G. fabricii and G. anonychus, it was slightly expanded at the ends, while in the other two species, the cartilage was not only expanded at the ends, but also constricted slightly at the middle.

In all species, the funnel groove extended along the ventral surface of the head. In Gonatus magister, it ended at about one-third the length of the head; in the others, to about the middle of the eyes. The funnel groove of G. magister and G. anonychus had small longitudinal folds, while the groove of the other species was smooth. The funnel contained the typical cephalopod funnel organs. The ventral pair consisted of small ovate to angular pads, the dorsal pair met at their anterior tips and formed an inverted V-shaped pad. The funnel cartilages were usually narrow anteriorly and broadened posteriorly. A sulcus ran down the middle of the cartilage. In G. fabricii and G. anonychus, the sulcus was slightly sinuous and deep in the anterior two-thirds, gradually disappearing. It was also slightly off the median line. The sulcus of the funnel cartilage of G. magister and Gonatopsis borealis was present only in the anterior half of the cartilage. It ran along the median line of the cartilage. The cartilage of Gonatus magister was slightly broader than that of Gonatopsis borealis.

The Arms and Their Armature

The arms of Gonatus anonychus and Gonatopsis borealis were short, the other two species had longer and much more slender arms. A swimming keel was present on the third pair of arms in all the species, and the fourth pair had a broad tentacular sheath at their base. The armature of the arms was quadriserial. In Gonatus fabricii, G. magister, and Gonatopsis borealis, it consisted of two medial rows of hooks and two lateral rows of suckers on the first three pairs of arms, and only of suckers on the fourth or ventral pair of arms. Only in Gonatus fabricii were the medial hooks very large in comparison to the lateral pedicellate suckers. The hooks were not present on the basal portion of the arms. At the tip of the arms, the hooks became smaller, and the quadriserial arrangement, although still present, was not obvious.

The armature of Gonatus anonychus differed from the others because the medial hooks were present only in the female as reduced, unsheathed hooks. The male had no hooks.

The Tentacles and Their Armature

Gonatopsis borealis differed from the other three gonatid squids in that it lacked tentacles. The other three had tentacles, but differed in their armature. Gonatus fabricii had long, slender

tentacles (Figure 5), with an expanded terminal club demarcated from the rest of the tentacles by a carpus. The tip was made up of a circle of small suckers, usually 11 in number. On the narrow distal portion of the club there were four rows of suckers, but midway, the club expanded leaving a space in the middle of the club bare. On the dorsal side of the club, the suckers became modified into the fixing apparatus. This consisted of suckers alternating with pads or tubercles. These began on the proximal portion of the club and continued down the tentacle stalk. The distal six suckers were pedicellate and had ridges extending to the edge of the club. The fixing pads were located in the valleys between the ridges. The ventral suckers were present in rows of three, four, or even five, on different parts of the club. An inner median row of small suckers was present sometimes. The suckers continued proximally along the tentacle and merged into one row. The small suckers on the tentacle were toothless, but those on the club had six teeth. In the middle, bare portion of the club were located a series of hooks. The most distal was medium sized, followed just slightly proximally by a large hook. The remaining small hooks continued down the middle of the club and usually were six in number. The more proximal were occasionally only suckers, or suckers in the process of becoming hooks. The distal half of the club had a web that extended to the tip of the

club on the aboral surface.

The tentacles of Gonatus anonychus and G. magister differed from those of G. fabricii because neither had hooks present on the oral side of the tentacle. The fixing apparatus in G. anonychus was only present on the proximal half of the club, while in G. magister it extended from the club to about one-half the distance to the base of the tentacle. In G. magister the suckers at the center of the club were strongly pedicellate, those of G. anonychus were not. Also the center suckers were about twice the size of those located laterally.

Internal Structures

The gladius in all the species was very similar, consisting of a long, narrow strip of chitin, ending posteriorly in a hollow cone. The radula of Gonatus magister, G. anonychus, and Gonatopsis borealis consisted of seven rows of teeth; a medial row of tricuspid teeth, two medio-lateral rows of bicuspid teeth, and four lateral rows of unicuspid teeth. In Gonatus fabricii, the bicuspid tooth rows were absent and the radula contained only five rows of teeth. The internal anatomy of all the species was similar, with no distinguishing features, and has been described for G. fabricii by Hoyle (1889) and Verrill (1880-81). The anatomy of Gonatopsis borealis has also been partially described by Sasaki (1929).

IV. MORPHOLOGY OF LARVAL AND ADOLESCENT FORMS

An adequate size series of Gonatus fabricii and Gonatopsis borealis was obtained allowing good comparisons to be made. The only immature specimens of Gonatus magister examined were 15-21 mm in size and a few slightly larger specimens. No larval G. anonychus were available. For comparative purposes we have considered animals of 10-25 mm as larval, and individuals of 25-40 mm as adolescent, although this was arbitrary.

Larval Morphology

In body shape, Gonatopsis borealis can immediately be separated from Gonatus magister and G. fabricii because even when small, the body of the first was cylindrical in the anterior region and conical towards the apex. It was only slightly expanded at the middle of the body. The mantle opening was slightly smaller than the head. The fins were well-defined and formed an obtuse angle at their apex. In contrast to this, the bodies of the young of the other two species, were greatly expanded at the middle, and without the same definite form found in Gonatopsis borealis. The body wall was translucent, and the fins were barely attached at the posterior end. The apex of the fins was almost straight.

In internal structure, differences were just as great. In

Gonatus fabricii, the liver was at an angle to the body axis and extended between the siphon and cephalic retractor muscles. This condition remained until about the 37 mm stage. In the other squid the livers were in the normal adult position.

There were other differences in the arms of the three squid. In both Gonatopsis borealis and Gonatus magister, the suckers appeared in four simple rows, with all suckers of about equal size, and with what appeared to be chitinized rings. In G. fabricii, the suckers were also in four rows, but the rows appeared more irregular than those of the above. Also, the lateral suckers were slightly larger than the medial ones. The above differences in the larvae were not invariable.

One difference always present was the absence of tentacles on Gonatopsis borealis. It was more difficult to differentiate between Gonatus magister and G. fabricii by tentacle characteristics, since the hook does not start to develop until about the 19 mm stage, and was not always present then. Before the hook begins to develop, the oral surface was completely covered by suckers. In some specimens, the suckers were quadriserially arranged, but in one they were in rows of five. Until the hook develops, it was impossible to distinguish between G. fabricii and G. magister, except for the characteristic liver, and this was not valid below the 13 mm

stage.

Adolescent Morphology

The body shape of Gonatopsis borealis seemed much more constant and this was probably due to the slightly thicker mantle wall. Internally it also differed from Gonatus fabricii because the liver was in the normal position. Externally it differed by the lack of tentacles. The armature of the arms was also different. Hooks began forming in G. fabricii around the 30 mm stage and were completely formed and present by the 35 mm stage. The Gonatopsis borealis varied greatly. No hooks were found on any individual shorter than 40 mm and those present were forming only at the base of the arm. One of 77 mm did not have any hooks, although this was probably aberrant, since others of a smaller size had definite hooks.

V. GROWTH PATTERNS OF GONATUS FABRICII AND GONATOPSIS BOREALIS

At the beginning of the study it was hoped to get a complete size series for each species. Series for the above two species were obtained, but even these were limited. Specimens of 13 mm to 154 mm with only a gap between 95-118 mm were obtained for Gonatopsis borealis. A series from 15 mm to 60 mm and some representatives from about 140 to 200 was obtained for Gonatus fabricii. The lack of any intermediate sized individuals can be explained by the fact that when the six foot Isaacs-Kidd midwater trawl is used, only the small squid are obtained because the larger ones are able to outswim the net. When an otter trawl is used, the larger ones get caught, but the smaller ones are able to escape through the mesh. With the new developments in sampling equipment, this gap will soon be filled. The ratio for each feature was very close for the two species except for the fin width and the fin length. This would indicate that the interpolation for sizes of G. fabricii not measured was probably reasonable.

The Growth Patterns

Mantle Width (Figures 1 and 2)

The mantle width index (ratio of width to mantle length)

decreased rapidly from the larval squid of 15 mm from a value above 0.40 to a value of 0.29 at 32 mm. It then decreased very slightly to a value of 0.22 in the mature squid of 150 mm. The only difference in the patterns was that Gonatus fabricii showed a slight transitory increase in the relationship of the width of the mantle, from 50-60 mm.

Head Width (Figures 1 and 2)

The head remained about the same width from the larval to 30 mm stage while the mantle at this time was increasing in length. It then increased in size slightly until reaching adult stage, following which it grew slightly slower than did the mantle. The only difference in the patterns, was that in Gonatopsis borealis, the head of the larvae hardly grew at all until about 30 mm, and this caused the rapid decrease of the ratio between those two points.

Head Length (Figures 1 and 2)

The head grew very slowly at the start, increased slightly at 20 mm, but remained at a slower rate of growth than did the mantle.

Nuchal Cartilage (Figures 1 and 2)

The nuchal cartilage grew at a slower rate than did the mantle during the life of the animal.

Siphon Width and Siphon Length (Figures 3 and 4)

The siphon width and length grew at a slightly slower rate than the mantle during the life of the squid. One reason for this may be that the smaller siphon size gave the animal a greater propulsive force, since the smaller the opening, the greater the force of the water rushing through it. This would be of adaptive value to the adult.

Fin Width and Fin Length (Figures 3 and 4)

Both species had the same general pattern of rapid growth followed by a decrease in the rate of growth, which then leveled out to the adult rate. In fin width, this peak of growth was reached in Gonatopsis borealis around the 60 mm stage, while in Gonatus fabricii the peak was reached at 40 mm. Although both rates declined, that of Gonatopsis borealis remained at a greater value than that of Gonatus fabricii. In length, the pattern was one of rapid growth, followed by lesser growth, although still greater than the mantle rate. The fin length of G. fabricii reached the same rate as the fin width, while in Gonatopsis borealis this never

occurred.

Club Length (Figure 3)

The club grew at a slightly greater rate than the mantle and the rate of growth remained very constant.

Club Development

The Suckers

In the larval tentacle the whole oral surface was covered with suckers, usually in a quadriserial arrangement. As growth continued, a sucker about two-thirds the length from the base of the tentacle began to form a hook. In most of the young squid, the suckers proximal were in four definite rows. As growth continued, the end of the tentacle began to expand and to form the club. The suckers of the ventral edge then appeared in four definite rows. Those of the extreme dorsal edge along the distal one-fourth of the club became pedicellate and the ridges and pads of the fixing apparatus began to develop. This was at about the 30 mm stage. The ventral suckers at this time were beginning to become pedicellate, especially those at the edge. The edge itself became thin and slight ribs under the skin appeared, from which the suckers arose. Rows of three, four, and five suckers across were present, but those of four predominated

In some animals a small medial row of suckers was present. There was only one specimen in which three suckers were present with the outer represented by large suckers and the inner row by a small sucker. All other animals having three rows had three large suckers. The suckers had six teeth, and these toothed suckers extended down the side of the tentacle. Those proximal were toothless.

Hook Development

The hook began development as an extra large sucker in a region about two-thirds distally along the tentacle. The sucker had a chitinized rim, with teeth. This was the stage that could be found in advanced larval forms of 15 mm. As development proceeded, the teeth on the distal edge appeared to coalesce into a single large tooth. This development could be found in the 19-24 mm stage. At this stage the tooth remained as a small projection and the sucker opening was large and usually oval. The complete hook appeared at 27-28 mm. To form it, the following took place. The tooth elongated and as it did so, it closed along its oral surface, leaving only a small opening in the dorsal part of the sucker. As it elongated, part of the fleshy part of the sucker remained with the hook as a sheath. At this time the hook rotated away from the longitudinal

axis of the tentacle and began to point dorsally.

The number of hooks on the club also varied. Normally, only one hook was found on the club up to the 60 mm stage. Exceptions to this were found. Individuals of 38, 46, and 52 mm were observed in which the adult pattern of hooks, as mentioned on page 11, was present. In those animals with only one hook, there was usually a row of six suckers extending down the club proximally, and also one large sucker just distal to the hook. It is possible that in those individuals with more than one hook, these suckers matured into hooks.

VI. DISCUSSION

The description of the adult Gonatus fabricii, G. magister, and Gonatopsis borealis agrees with the description given by Sasaki (1929) for those species, except that he says that the mantle of Gonatus magister is very soft and choroidal, and easily mutilated. The mantle of the adult was very thick, and not as Sasaki described it to be. Possibly this difference may be due to the methods of preservation. His descriptions of the adolescent and larval forms of G. fabricii agree with those from Oregon, except for the length of the arms of the adolescent animals. The length of the arms as recorded by Sasaki (1929) are much longer than those from Oregon.

	Japan	Oregon
Mantle Length	40 mm	40 mm
First Arms	30 "	16 "
Second Arms	37 "	19 "
Third Arms	37 "	20 "
Fourth Arms	23 "	17 "

The details of the club armature of Gonatus fabricii vary greatly, as was mentioned by both Berry (1912) and Sasaki (1929), but agreed generally with their descriptions. Variation was present

in all sizes and may possibly be related to the effect of the different water temperatures the animals experience. The differences, although present in the collections examined, in no way seemed to warrant the need for a new species, as was suggested by Young. Of all the animals seen, there was only one specimen which had all the characteristics Young mentioned in his description of his proposed Gonatus berryi. Until more animals having the characteristics mentioned by Young are examined, no decision can be made as to the validity of his observations.

The growth patterns of Gonatus fabricii and Gonatopsis borealis are similar except for the pattern of fin growth, and the differences here have already been mentioned. The patterns obtained were very much like those obtained by Haefner (1964) for Loligo pealei and Loliguncula brevis, except that he also noted a decrease in the fin width ration, which was not noted in this study. He also found that the fin growth pattern differed between the two species he observed, and he gave it as a means of differentiation. Although this is likewise true between Gonatus fabricii and Gonatopsis borealis, the absence of tentacles on G. borealis is a better way of separating the two species.

Looking at the fin growth patterns of the two species from possible habitat relationships provides some interesting speculation. A possible explanation of the fact that the fin of Gonatus fabricii is

as broad as long, while that of Gonatopsis borealis is much broader than long is offered. When young, the squid are able to maintain their position in the water because their specific gravity is about the same as the water. As the squid grows, the body weight increases, with a corresponding increase in the specific gravity. To compensate for this, the animal may develop a more efficient locomotory system, or it may adjust its specific gravity. It appears that G. borealis has done the former because the mantle is muscular, and the fins are broad and thick. The development of the mantle increases the propulsive force and possibly the increase in the breadth of the fins allows for greater stability and provides greater lift. The lesser development of the mantle wall and the fins of Gonatus fabricii indicates that it has taken the other mechanism.

VII. SUMMARY

1. The adult gonatid squid were alike except for minor differences in body structure, and in the armature of the arms and tentacles. The differences were great enough to provide for accurate identification.
2. The adolescent squid were also alike, but can be separated on the basis of the armature of the arms and tentacles.
3. The larval squid were very much alike, but could be distinguished from each other on the basis of the tentacle armature, the disposition of the liver, and partially on the body consistency.
4. The growth patterns of Gonatus fabricii and Gonatopsis borealis were similar except for the relative ratio of fin growth. All ratios of growth in relation to mantle growth showed a decrease during development, except for those pertaining to the fin. These showed a relative increase, rapid at first, but still growing faster than the mantle during the life of the squid.
5. The club development of Gonatus fabricii was described for the first time. The hook began to develop in the 19 mm squid and was fully formed by the 27-28 mm stage. It was formed by the elongation and coalescence of the chitinized sucker rim of a large sucker in the middle of the tentacle. The other

hooks developed as the animal matured. The suckers were in rows of four distal to the hook, but the proximal pattern varied, especially on the ventral side. This variety was great enough so that the pattern mentioned by Young as indicating another species may be just a variation. Additional specimens from Southern California should be sought.

6. A possible explanation for difference in the growth patterns of the fin is given. This difference may be caused by the relative development of the mantle.

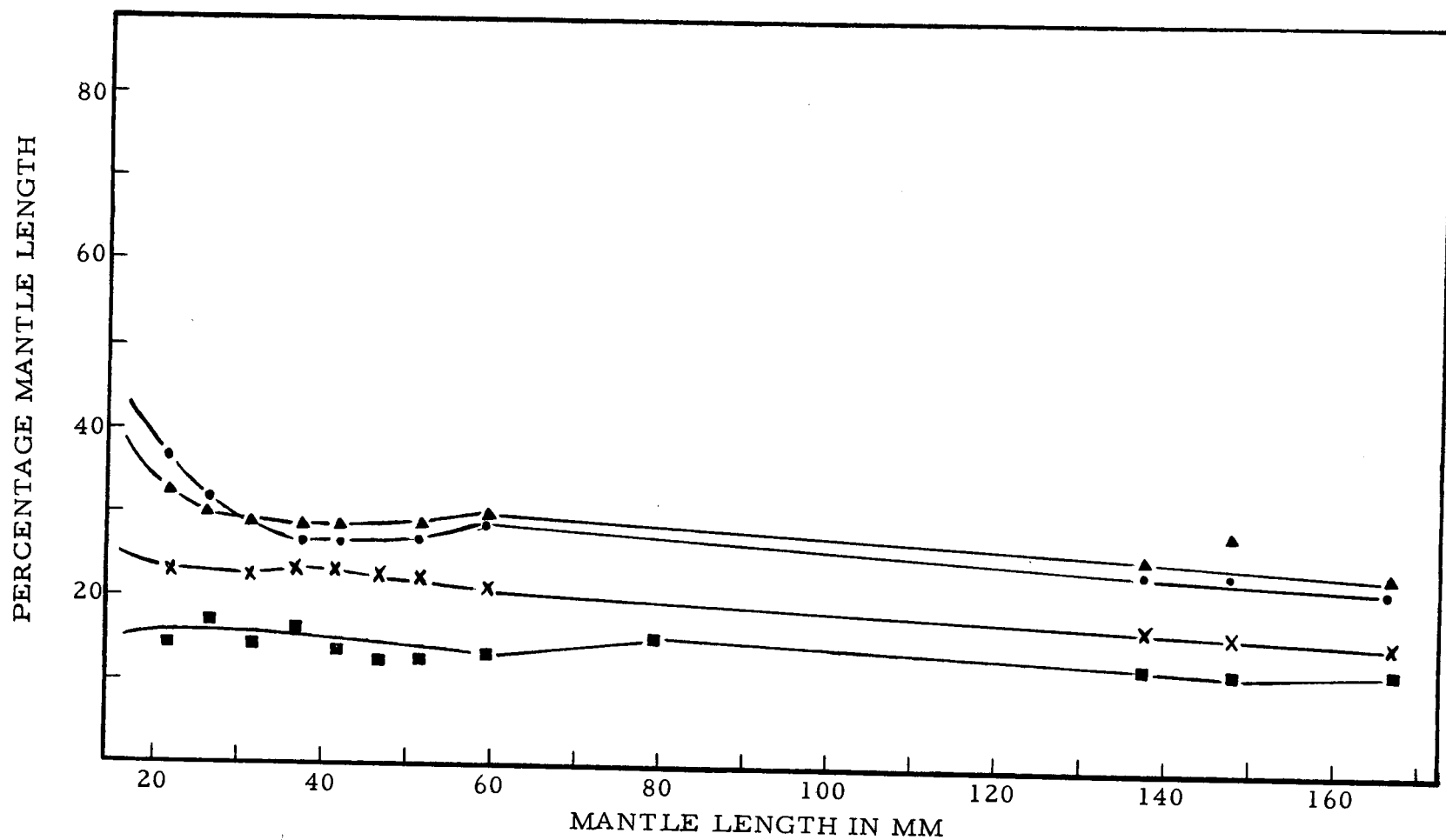


FIGURE 1. Growth patterns of (•) mantle width, (▲) head width, (×) head length, and (■) nuchal cartilage length of *Gonatus fabricii* (Lichtenstein).

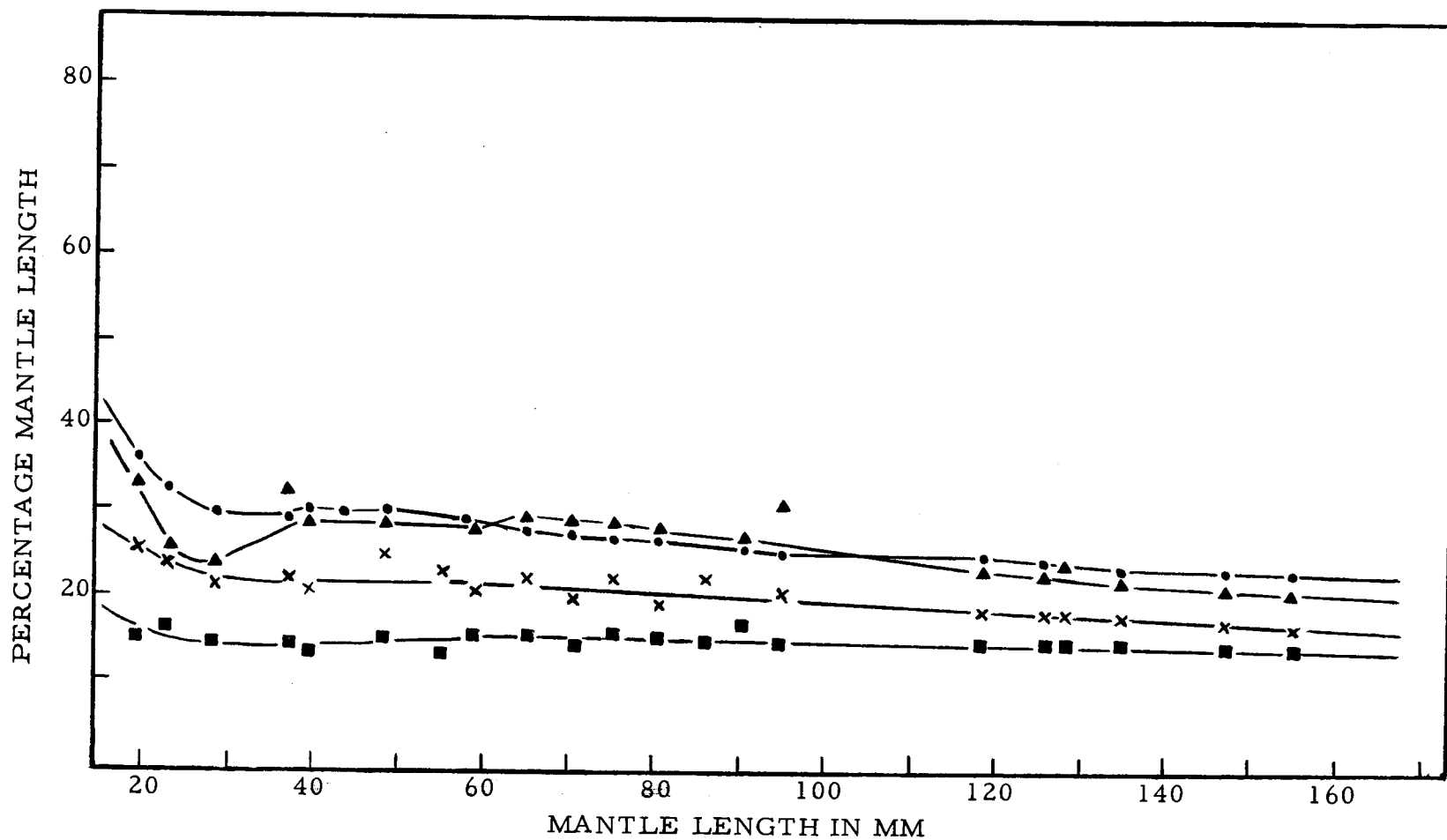


FIGURE 2. Growth patterns of (•) mantle width, (▲) head width, (×) head length, and (■) nuchal cartilage length of *Gonatopsis borealis* Sasaki.

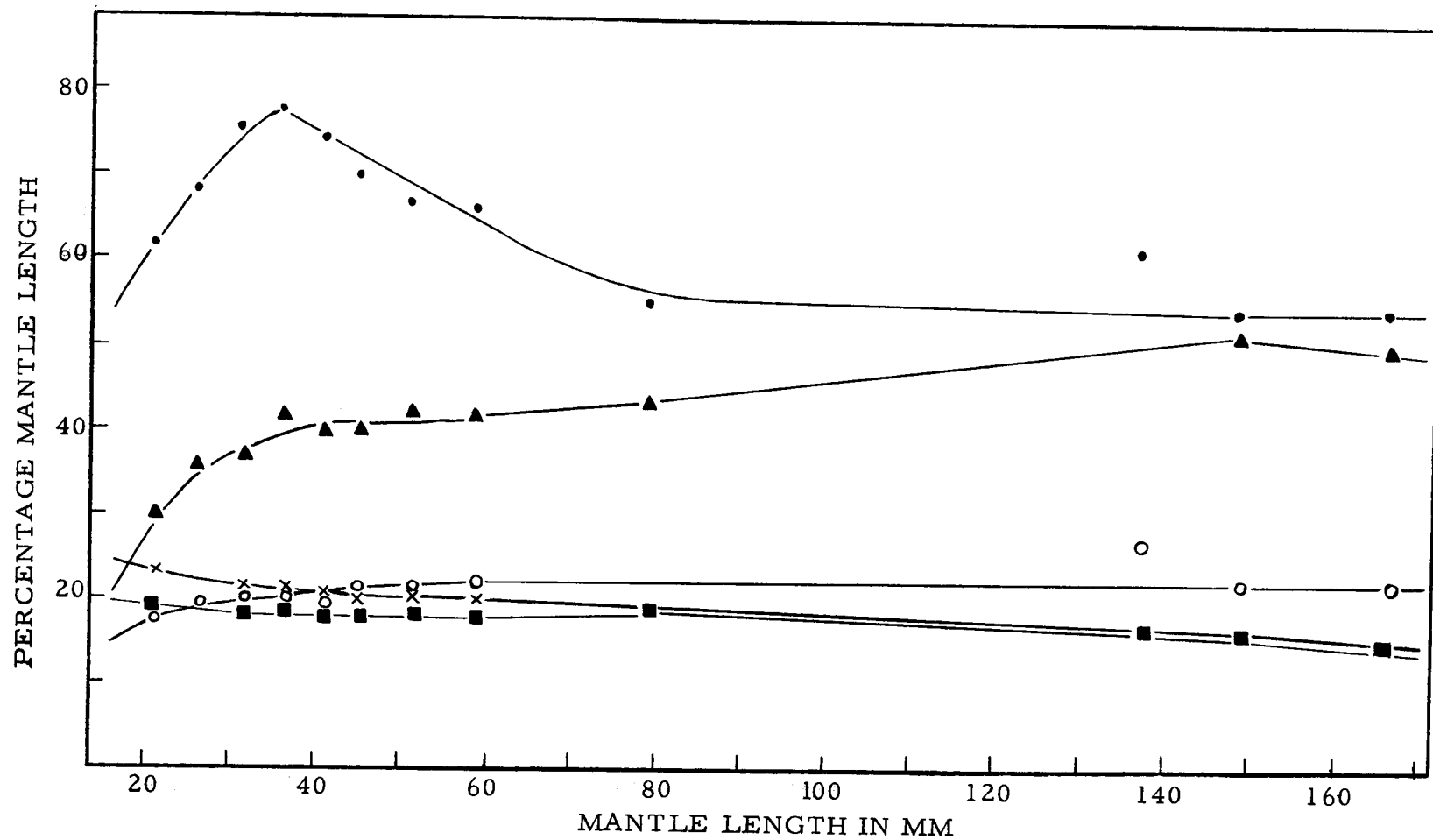


FIGURE 3. Growth patterns of (●) fin width, (▲) fin length, (×) siphon width, (■) siphon length, and (○) club length of *Gonatus fabricii* (Lichtenstein).

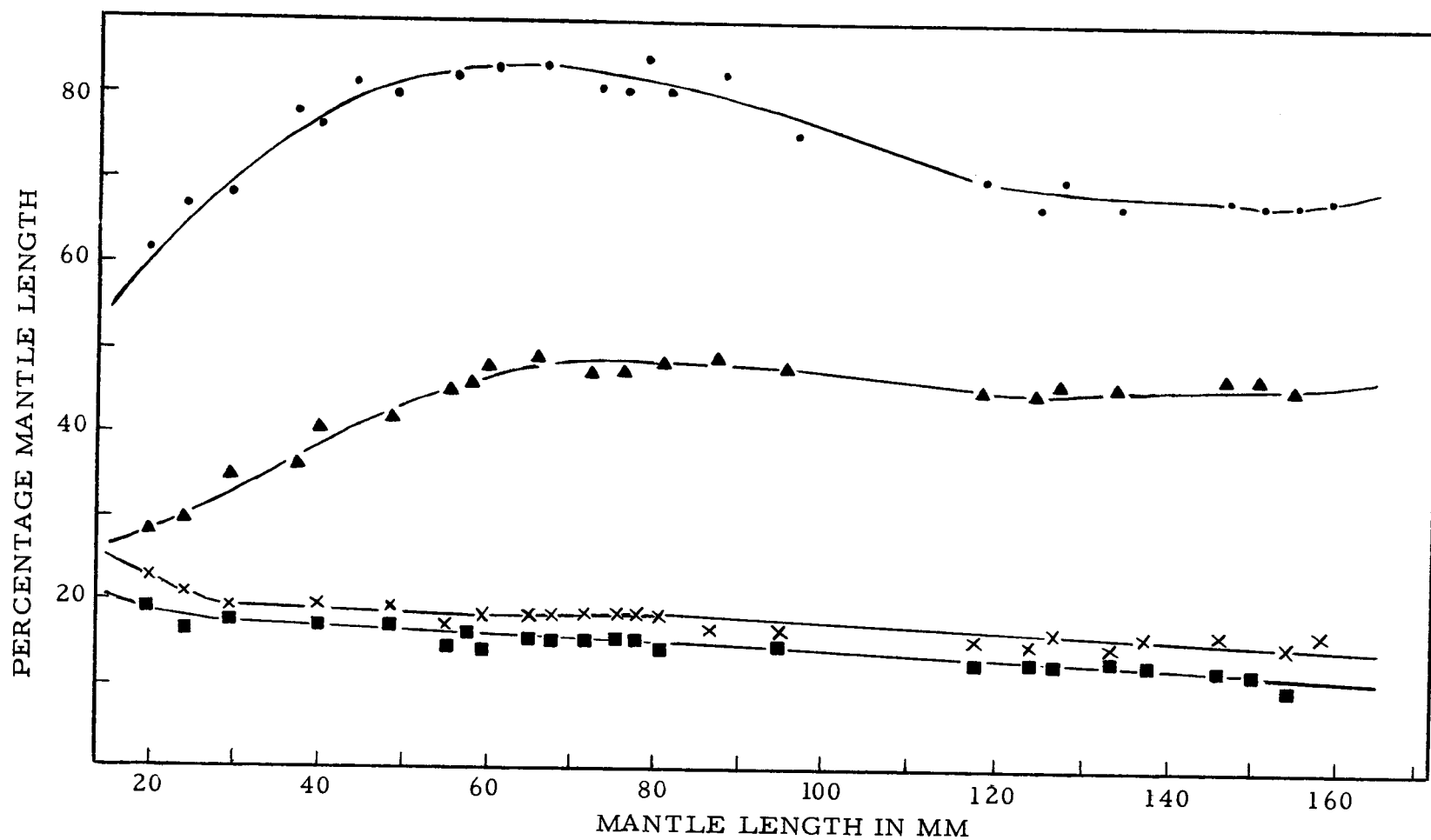


FIGURE 4. Growth patterns of (●) fin width, (▲) fin length, (×) siphon width, and (■) siphon length, of Gonatopsis borealis Sasaki.

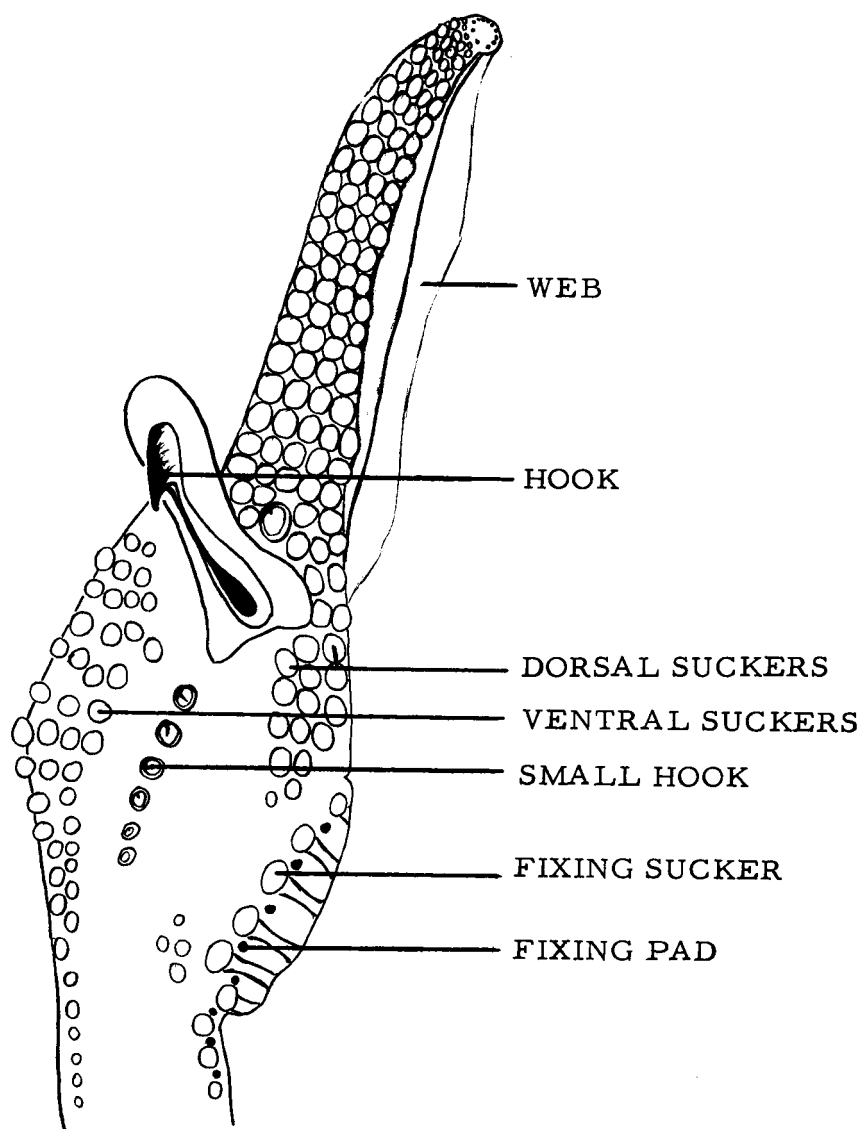


FIGURE 5. Oral Aspect of Tentacle Club of Gonatus fabricii (Lichtenstein) x 15.

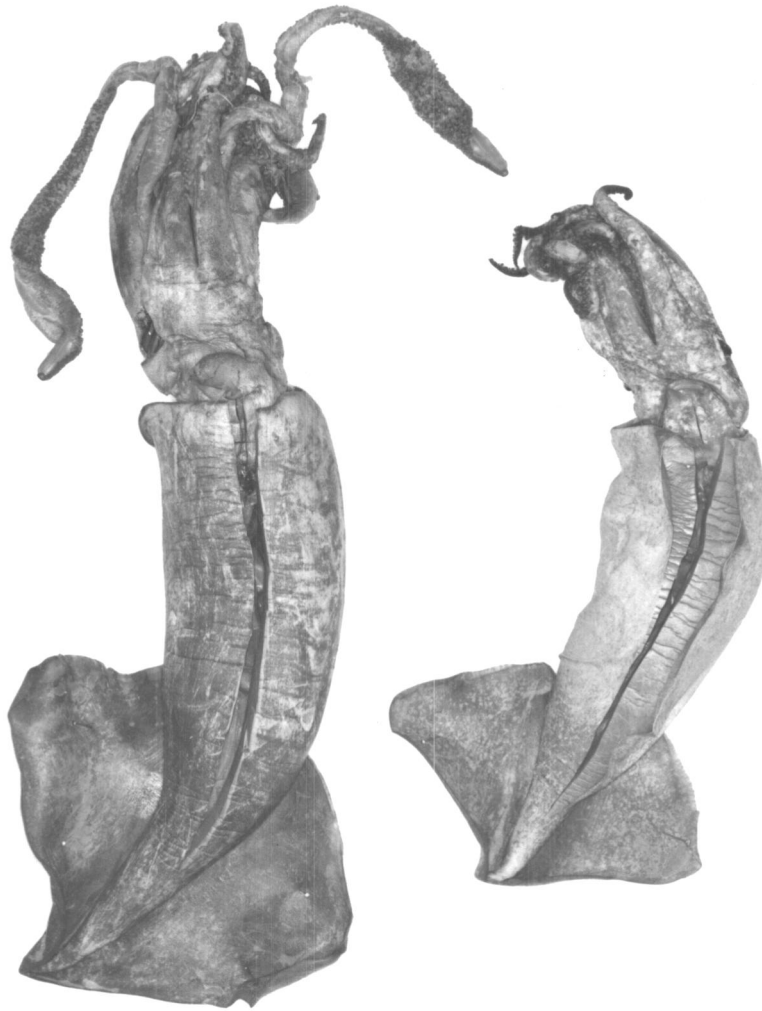


FIGURE 6. Ventral view of Gonatus magister Berry (left) and Gonatopsis borealis Sasaki (right).



FIGURE 7. Ventral view of Gonatus fabricii (Lichtenstein) (left) and G. anonychus Percy and Voss (right).

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