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On The Occurrence of Loligo pealii (Lesueur)

At St. Andrews, N.B., during summer 1932

Author

J. A. Stevenson

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ON THE OCCURRENCE OF LOLIGO PEALII (LESUEUR) AT ST. ANDREWS, N.B. DURING SUMMER, 1932.

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by

J.A. STEVENSON,

QUEENS UNIVERSITY, KINGSTON, ONTARIO.

CONTENTS:

INTRODUCTION:

1 Description of the weir.

During the spring of 1932 a weir of stakes and brushwood was erected on the shore at low-water mark in front of the Biological Station at St. Andrews. This weir consisted of two arms, the one reaching to one side, and the other, at an angle of about 90 degrees, to the opposite side, of a depression between two ridges of rocks, that extended from low- to high-water mark. The two arms of the weir joined in the centre of this depression, the lower end of which was thus completely closed in by the weir. This was so constructed that when it was left bare by the receding tide, a pond remained at the angle of the two arms. In this pond, such animals as happened to be trapped by the receding tide could remain alive until attended to. A drain-pipe led from the pond to the seaward side of the weir, permitting the drainage of water in the pond if necessary. Fish and other animals that ventured between the weir and the shore at high tide, found their retreat to the sea cut off by the arms of the weir; and at low tide their only place of refuge was in the weir-pond.

Observations were made throughout the summer upon the animals that were caught in this weir. It was noticed early in the summer that the long-finned Squid (Loligo pealii (Lesueur)) occurred frequently. In the hope of obtaining some interesting information on this animal, which forms a very valuable source of bait to the fisherman at certain seasons, the writer decided early in July to study its occurrences throughout the summer.

2. Purposes of the investigation.

The purposes of this study were general. Very little work has been done upon Loligo in Canada. It was hoped, however, that by a careful periodic examination of specimens throughout the summer, some light might be thrown upon:

The food of squids.

Duration of their spawning period.

Sex-ratio.

The possibility of periodicity in spawning activities.

Inshore and offshore migrations.

Growth rate during the summer.

The observations were, however, by no means confined to the above, and whenever anything else of interest materialised, it was noted.

3. Literature.

Little or no work appears to have been done in Canada upon Loligo. Working at Woods Hole, Massachusetts, Drew (1911) studied the sexual activities of this animal in some detail. He found that female squids caught during the summer would quite often deposit their egg-strings in the station aquaria and this afforded an excellent opportunity to study the methods of fertilization and laying of these strings. Apart from this, it is surprising to find how little attention this very interesting and useful animal has received from investigators.

OBSERVATIONS:

1. Methods of capture and study.

During the spring tides it was found possible completely to empty the weir-pond at low tide by opening the drain-pipe. All the animals in the pond were thus stranded, and it was a simple matter to pick them up and put them in a tub for future examination in the laboratory. During the neap tides, however, the weir at low tide often contained up to three feet of water.

In such cases a small seine net constructed for the purpose was used to capture the animals. It is probable that, due to the muddy nature of the water, many squid escaped the net unseen. If it seemed that some had done this, further hauls of the seine were made until it was thought all had been caught.

The squids were taken to the laboratory, where they were counted. Large numbers were also measured for

(a) Length, and afterwards opened up by an incision along the ventral side and examined for:

(a) Sex.

(b) Condition of gonads.

(c) Stomach contents.

(d) Presence or absence of parasites.

The results of these examinations were noted down on forms prepared beforehand.

In addition to the above, observations were made upon the behaviour of the squids in both the pond and the artificially constructed tidal pool further up the beach, in which many squid also became trapped.

2. Behaviour of the squids.

The squids swam into the weir in schools. Assuming that those present in the weir comprised at least one whole school, the number of individuals in a school varied considerably. It is probable that on occasions when many hundreds were taken at one tide, more than one school was represented. A fairly average figure for squids present in the weir at one tide was from 150 to 200. However, early in the season the numbers were considerably below this -- a fact which would be probably explained by the inshore summer migration not yet having properly started. Observation indicated that the schools of squids occurring at the Biological Station increased somewhat in size until the middle of August, after which they decreased.

When trapped in the weir at low tide the squids collected together at the deepest part of the pond, and remained when undisturbed, quietly oscillating to and fro an inch or two off the bottom, close together and all facing in one direction. When they were not alarmed their colour was generally a rich red-brown all over their bodies. As long as they were not disturbed they would behave quietly like this, their fins undulating and acting as elevators to the posterior ends of their bodies. Their movement was alternately forwards and

backwards, with an amplitude of a few inches. The arms were spread in such a way that they formed a vane that alternately adjusted itself to forward and backward movement, so as to elevate the fore-part of the animal.

When a small pebble was thrown into the water immediately above the school, causing sufficient splash to alarm the squids mildly, they responded immediately and in practically every case by suddenly darting, either forwards or backwards, depending upon their position, away from the source of disturbance. Their colour would flash suddenly to a pallid white, but after a few moments would regain the normal red-brown. Some, in darting back, would eject a small cloud of sepia. This only occurred in a small percentage of individuals, however. The squids would dart away from the splash for a few feet, then collect together, all facing it. If in their rush they had gone too near the edge of the pond, they would advance head-foremost, slowly, towards the deeper water, ready on an instant to dart back again if danger threatened. After about three minutes, if there was no more disturbance, they would finally take up their original position in the deepest part of the pool.

When, instead of a small pebble, a large rock was thrown into the pool, sufficient to cause a big splash and thoroughly to scare the squids, a somewhat different and very interesting reaction was observed. Immediately the rock struck the water, the first reaction of the squids was to dart away from the splash. Some ejected a little ink. When, however, the magnitude of the disturbance became apparent, they completely changed their tactics. Every single squid in the school immediately did two things: it sank like a stone to the bottom of the pond, and it changed its colour in such a way as to harmonize with that of the bottom. When the ripples from the splash had subsided, it was at first very hard to understand the apparently complete disappearance of the school. Closer observation, however, revealed the squids lying absolutely motionless on the bottom. This they continued to do for fully five minutes, when, the danger apparently past, one by one they arose from the bottom, assumed their natural red-brown colour, and continued their normal oscillating movement. The colour-scheme of the squids when frightened and "playing 'possum" consisted of a whitish background, with three or four red-brown bands of expanded chromatophores across the dorsal surface. One of these bands was always present across the head.

It is easy to understand how the squids could benefit by this extremely effective defence method of protective colouration. As long as they remained absolutely still on the bottom, it is not probable that a predatory fish or other animal

intent upon eating them would ever notice them in this state, so closely do they resemble the bottom.

It was noticed that the squids would often lie on the bottom in same manner, after they had been put to undue exertion. When, for instance, they had been chased around the pool several times, they often lay upon the bottom as if recuperating after the exertion of swimming. The ejection of ink also appeared to fatigue them considerably, since they generally rested a while after it.

Observations made over the weir from a row-boat at high tide showed the squids swimming in schools in mid-water. The squids in one school did not swim very close together, but they never lost each other. When not disturbed their motion was forwards; but when the water was splashed with an oar, they shot away backwards. Their siphons were used constantly for both forward and backward swimming.

Throughout the summer, whenever large numbers of squids were trapped in the weir, it was noticed that a large proportion of them stranded on the shore, even at half-tide. Their movements were watched at about half-tide one day (July 30). It appeared that they were trying to seek an escape, on finding their retreat seawards blocked by the weir, by exploring around the edge of the enclosed water. When one hit a bunch of seaweed, it would shoot either directly away from, or directly into it; generally the latter. It would struggle vainly for a few minutes in an endeavour to extricate itself from the weed. Finally it would calm down and rest on the bottom. It would remain thus until the tide would leave it high and dry; and would only seem to realise its predicament when it could not possibly save itself. Its struggles would then be extremely violent, as it tried to regain the water. Finally it would succumb to lack of water and the heat of the sun.

Other squids, exploring to find a way to the sea, would appear to become panicky and dash violently about, sooner or later running ashore when, due to the force of their dashes, they would find that they could not get back; and would succumb also to lack of water and the heat of the sun. They showed very little resistance to such exposure, generally dying in the course of two or three minutes.

The spawning activities of Loligo have been studied carefully by Drew (1911). Squids were seen to be spawning during the summer of 1932 in the tidal pool opposite the Biological Station at St. Andrews. The following observations were made;

On the evening of August 23rd, twenty-five Loligo were seen to be swimming about in the tidal pool, which is near high-tide mark. Upon observation, it was seen that there was a small bunch (about 10) of egg-capsules attached to a piece of weed on the bottom, in about three and a half feet of water. A large male squid with a frayed fin was swimming beside a smaller one (presumably a female) close to the egg-bunch, which it did not leave. The rest of the squids did not appear to approach the pair closely. Next morning, after the tide had been in and ebbed once, the twenty-five squid were still in the pool, in which they had apparently chosen to remain at high tide. The egg-bunch seemed to consist of about the same number of capsules. The large male of the evening before, recognised by its frayed fin, was seen by itself patrolling back and forth past the egg-bunch. There was no pairing together among the squids in the daylight. Whenever another squid approached to within about six feet of the eggs, the large male dashed towards it and drove it away, generally edging it off in the same manner in which a sheep-dog drives sheep. The other squids seemed very curious, and were continually striving to reach the eggs, generally being driven away by the large male. This specimen was the largest squid in the pool. Some did manage to reach the eggs, which they appeared to grasp in their arms and shake vigorously. Later in the day, when the heat became more intense and the water in the pool warm, some of the squids were observed resting in their characteristic position on the bottom, but another large male, distinguished as such by its size and by the absence of any fraying on its fins, had taken up the position formerly occupied by the largest male, which now, too, was resting. Later in the day, the largest male was again back in its place on guard.

On August 25th, the egg-bunch was seen to have increased in size, there being about twenty capsules. The large male was still on guard, though it was seen frequently to be resting on the bottom near the eggs. All the twenty-five squids had remained through two flood tides in the pool. The fact that the egg-bunch contained so many capsules seemed to show that it was the product not of one, but of many female squids. In the dissection of female squids throughout the summer, it was found that only four, rarely five or six, capsules were ripe at the same time; hence deposited at about the same time. Drew (1911) states that he observed one female to deposit no less than twenty-three egg-capsules in an hour and thirty-five minutes in the Woods Hole aquarium. Possibly conditions further south are different; but no female squids upon dissection at St. Andrews showed nearly as many mature or even partially mature capsules at this. It is probable that the egg-bunch up to this date had been

produced by five or six female squids that were in the tidal-pool school. The observations also lead to the belief that the eggs were nearly all fertilised by the same large male, which was the only one in the school that was seen to be pairing.

On August 26 the egg-bunch had again increased slightly, and the same large male was on guard. All twenty-five squids were still in the pond. On the next day, however, all the squids had disappeared, leaving the egg-bunch in the pool.

The above observations seem to show clearly that the "parental instinct" is found in Loligo pealii. The writer has seen no reference to this habit of the male guarding the egg-capsules in any papers upon Loligo. On and after August 27, when the squids left the tidal pool and the eggs, it was noted that few or no squids were taken in the weir itself. Possibly the winter migration to deep water had begun.

Occasionally, particularly in the larger schools of Loligo taken in the weir, the short-finned squid (Illex illecebrosus) occurred. These specimens were examined, and in all cases proved to be immature. No schools consisting entirely of Illex were seen during the summer, though in former years they have occurred in very large numbers.

3. Occurrence of Loligo throughout the summer.

From the time observations were begun (July 10, approx.) up to September 6, when they were discontinued, a daily record was kept of the number of squids caught in the weir. These records are embodied in Table I and Figure 1.

It can be seen clearly from Figure 1 that the squids were present close to shore in greatest numbers at about the middle of August. Since Loligo naturally spawns in comparatively shallow water; and since all the specimens examined during the summer were ready, or had been engaged in spawning, it is reasonable to suppose that this inshore migration during the summer was undertaken by the squids chiefly with a view to spawning. To judge by the numbers taken, the middle of August was the height of the spawning season. Unfortunately, the spawning season had already begun when the first squids were taken in the weir, and apparently had not yet stopped when they ceased to appear in the weir; hence no accurate estimation of the extent of the spawning season at St. Andrews can yet be made. Suffice it to say that it lasted at least from the beginning of July until about the 6th of September. No squids were taken outside the period between those times; hence no examinations of the genital organs could be made to determine

Date	No.	Date	No.	Date	No.
July 10	--	July 30	Ca.600	Aug. 19	3
" 11	3	" 31	15	" 20	4
" 12	--	Aug. 1	25	" 21	64
" 13	24	" 2	163	" 22	532
" 14	--	" 3	79	" 23	18
" 15	2	" 4	--	" 24	Ca. 147
" 16	7	" 5	55	" 25	6
" 17	--	" 6	Ca.436	" 26	239
" 18	--	" 7	226	" 27	--
" 19	12	" 8	294	" 28	--
" 20	51	" 9	216	" 29	54
" 21	27	" 10	--	" 30	1
" 22	--	" 11	10	" 31	16
" 23	--	" 12	199	Sept. 1	2
" 24	--	" 13	464	" 2	--
" 25	--	" 14	458	" 3	42
" 26	2	" 15	Ca.1240	" 4	--
" 27	--	" 16	Ca.541	" 5	--
" 28	--	" 17	Ca.290	" 6	2
" 29	94	" 18	412		

TOTAL.....7075

TABLE I. Occurrence of Lolira in the Station weir throughout the summer of 1932.

their maturity. It seems evident that th spawning season of Loligo pealii is a fairly extended one.

The occurrence of Loligo in the weir throughout the summer was compared with the curves plotted from the daily temperature records at the end of the station wharf for the same period of time. These temperatures were taken twice daily, in the morning and evening. It was found (Fig. 1) that with the steady increase in temperature, the numbers of squids caught in the weir increased from the time the minimum temperature was approximately 10 degrees Centigrade up till the middle of August. After that, however, though the temperatures continued to increase up till the end of August, the numbers of squids decreased, until by the time that the maximum temperatures were occurring, hardly any were caught at all. It seems probable that although temperature may be a dominant factor in determining the time of the inshore migration of the squids during the earlier part of the summer, it is of less consequence in determining their offshore migration in the fall. Possibly other factors, such as equinoctial gales, enter at this point.

4. Length-frequencies.

All squids examined were measured for length. The method of length-measurement is shown in Figure 2. Length was taken as the greatest linear distance from the posterior end of the mantle to the tips of the longest of the intractible arms. On July 30, and again on August 26 (nearly a month later) two large entire samples were measured for length-frequencies. It was thought that the difference in time of capture of about one month might be reflected in the positions of the dominant modes in the frequency curves. These curves (Figs. 3 & 4) possess only one significant peak, it will be seen. There is no apparent division into definite age-groups. This may possibly be explained by the extended nature of the spawning season. Young squids of many different sizes may exist towards the end of the spawning season, their size corresponding to their age. This disparity in size would be apparent as they grew larger, and would confuse identification of the different age-groups, consisting of individuals produced in different spawning seasons.

It is to be noted in Figures 3 and 4, however, that the mode of the smoothed curve for August squids has advanced between four and five centimetres beyond the position of the mode in the corresponding curve for the July squids. Also, this applies not only to the mode, but to the whole curve. It is possible that this five centimetres difference corresponds to a general increase in the length of the squids of five cms.

Lengths cms.	July 30.	August 26.
14	3	
15	7	
16	15	
17	27	2
18	48	2
19	41	6
20	47	9
21	50	20
22	50	11
23	46	15
24	54	14
25	37	20
26	29	16
27	22	17
28	26	15
29	12	23
30	15	21
31	7	15
32	6	11
33	4	9
34	3	5
35		0
36		0
37		1
38		2
TOTALS	549	 233

TABLE II. Length-frequencies of Lolige taken in the weir at the Biological Station on July 30 and August 26, 1932.

in one month. This is debatable, since insufficient material is at hand for any definite conclusions to be made. It is very suggestive, however. Five centimetres in one month might be considered a very rapid increase in size. When the rapacious, actively predatory nature of the squids is considered, however, it appears more reasonable that rapid growth such as this should occur.

5. Sex-ratio.

A total of 922 Loligo were examined throughout the summer for sex determination. Females were identified by the presence of the ovaries and the nidamental glands. The accessory nidamental glands also served as a very useful method of distinction, since throughout the spawning season they are orange-red in colour. In fresh specimens, in which the mantle was relatively translucent, these accessory nidamental glands could be seen distinctly without the necessity of dissection.

Of the 922 squids examined, 699 were found to be males, and 223 females. The ratio of males to females was therefore 3.13:1.

This estimate is based on squids taken at all times between early July and September. It was noticed in July that the percentage of females present in the schools was considerably lower than later on. In a sample of 49 squids taken on July 20, there were only seven females (ratio 7:1); while about a month later, on August 17, in a random sample of 50 squids there were found to be 17 females (ratio 2.94:1). It is difficult to suggest a reason for this. Perhaps some of the males, after completing their spawning activities, had migrated early to deep water, the females remaining in shallow water to finish the actual spawning. This is merely surmise, however; more data are necessary before conclusions on this phase of the subject can be drawn. The ratio of males to females at different periods during the summer can be seen from Table III.

DATE	FEMALES	MALES	NO. OF SQUIDS EXAMINED
July 13-29.	1	5.46	202
July 30-Aug.18	1	3.56	420
Aug. 19-Sept. 6	1	4.04	97

TABLE III. Sex-ratio in Loligo throughout the summer.

It was early noticed that there was a difference in the average sizes of the male and female squids. The females were in all cases shorter. The average length of 65 male squids taken on July 30 was 256 millimetres; and that of 24 female squids in the same sample, 219 millimetres, about four centimetres less. Male squids were often found to exceed 300 mm. in length; whereas females never appeared to approach this size.

6. Absence of periodicity in spawning activities.

All squids that were opened were examined for the condition of their gonads, both male and female. Though a careful examination was made in every case, no regular periodicity of the different stages of maturity coinciding with definite tidal phases, could be found. Such periodicity has been found in several mud-inhabiting molluscs at St. Andrews (Battle, 1932) and it was thought that it might also exist in Loligo. All stages of maturation of both ova and spermatophores could at any time be found in squids belonging to any one fairly large sample. This apparently complete absence of periodicity in the maturation of the genital products is probably explained by the active, pelagic existence that the squids undergo - they have probably become so accustomed to extreme changes in environmental conditions that they do not respond as do some more sluggish animals to the comparatively weak stimuli of tidal phases or cycles.

7. Food of squids.

During the summer, 767 stomachs of squids were examined. The vast majority contained no food whatever. Some, however, contained the remains of fish-flesh, usually young herring, to judge from its appearance (scales and silvery skin). One squid was found to have its stomach crammed full of small pieces of squid flesh, recognised by the chromatophores. This squid, however, had been caught in the weir pond at a time when a number of dead Loligo were lying on the bottom. It had probably eaten one of these dead specimens.

8. Enemies.

It is a well-known fact that such predatory fish as cod are very fond of squids. The latter are so active, however, that it must take a very swift fish to catch them in their normal habitat. In the confines of the weir a different state of affairs existed. Here the squids were hemmed in comparatively closely, and could not easily escape the jaws of those predatory fish that happened also to be trapped. Thus it was found that several sculpins

(Hemitripterus octodecimspinosus and H. americus) taken from the weir during the squid season, upon dissection revealed squids they had swallowed, presumably in the weir. Whether or not these squids were originally dead specimens is not certain; but sometimes when both sculpins and squids were trapped together in large numbers, it was not an uncommon sight to see the fish snapping at the molluscs as they swam by. Flounders (Pseudopleuronectes), too, were found to be eating the eyes out of the bodies of dead squids lying on the bottom.

Apart from these, no observations were made that might suggest that the squids inshore had many enemies. They certainly have great protective power in their speed and agility in the water, provided the water is reasonably deep.

9. Parasites.

One parasite was found to occur very commonly in both Loligo and Illex, during the whole of the summer. Some specimens were identified by Dr. H. A. Baylis, of the Kensington Museum of Natural History, as the larvae of the cestode Phyllobothrium loliginis (Leidy, 1887). To quote him: "The adult form is considered by Linton to be the species described by him as P. tumidum, and occurring in sharks (Isurus dekayi, Carcharodon carcharias) - see Linton, 1922".

Since this form does not appear to have been noticed hitherto on the Canadian Atlantic coast, a few remarks upon what observations were made will not be out of place.

During the investigation, some 544 male squids and 223 females were examined for these parasites. 12.38 per cent. of the males and 17.49 per cent. of the females were found to be infested. In all cases the parasites were in the digestive tract of the molluscs, generally in the stomach.

The number of cestodes occurring in any one squid varied from one to five. Of the 138 infested squids seen, 110 contained only one cestode 19 contained two, 8 contained three and only one squid contained five. These figures refer to Loligo alone (see Fig. 5). The parasites were also found in the digestive tracts of some of the few Illex that occasionally accompanied the schools of Loligo.

Apparently these larval cestode parasites are not noticeably harmful to their hosts, for in no case was a squid found to be suffering in any way from their presence. For the most part, the larger the squids were, the more parasites they contained. The specimen containing five cestodes was a large male, 31.9 centimetres in length.

SUMMARY:

Advantage was taken of the fact that squid in large numbers were being caught almost daily during the summer in the newly-erected Station weir to make a study of their occurrence and condition.

The squid first came close enough inshore to be caught in the weir about July 11. The numbers caught daily increased until August 15, then diminished to September 6, after which none was taken. During the whole of this period they were engaged in spawning, a fact indicated by the presence of fully matured ova and spermatophores within the specimens at all times during July, August and early September. No periodicity in spawning activities, coinciding with definite phases of the moon, was observed.

Observations of the spawning of squids in the tidal pool at the Biological Station revealed the fact that the male squid, under certain circumstances at least, will guard the egg-bunch for a time after their deposition.

During the summer, 972 squids were opened for sex determination. The ratio of all the males to all the females was found to be 3.13:1.00.

An attempt was made to determine the growth-rate throughout the summer; but it was found that the length-frequency curve of any one sample showed only one peak, with no definite length-groups. However, it was noted that the peak in a large sample taken on August 26 was approximately 5 centimetres ahead of that of another large sample obtained on July 30.

The stomachs of 723 squids were examined for food content. The vast majority were empty; but some contained the remains of fish, particularly herring, and one was crammed with pieces of squid flesh.

A larval cestode parasite, identified by Dr. Baylis of the British Museum as Phyllobothrium loliginis (Leidy) was found to be present in the digestive systems of 18.38 per cent. of 544 males, and of 17.49 per cent. of 223 females that were examined. The infested squids showed no apparent symptoms of distress. Linton (1922) considered that this cestode was the same as one described by him as P. tumidum, which occurred in the adult form in certain sharks.

ACKNOWLEDGEMENT:

The writer wishes to convey his thanks to Dr. H. A. Baylis of the British Museum for his prompt and efficient identification of the larval cestodes taken from the digestive tracts of the squids.

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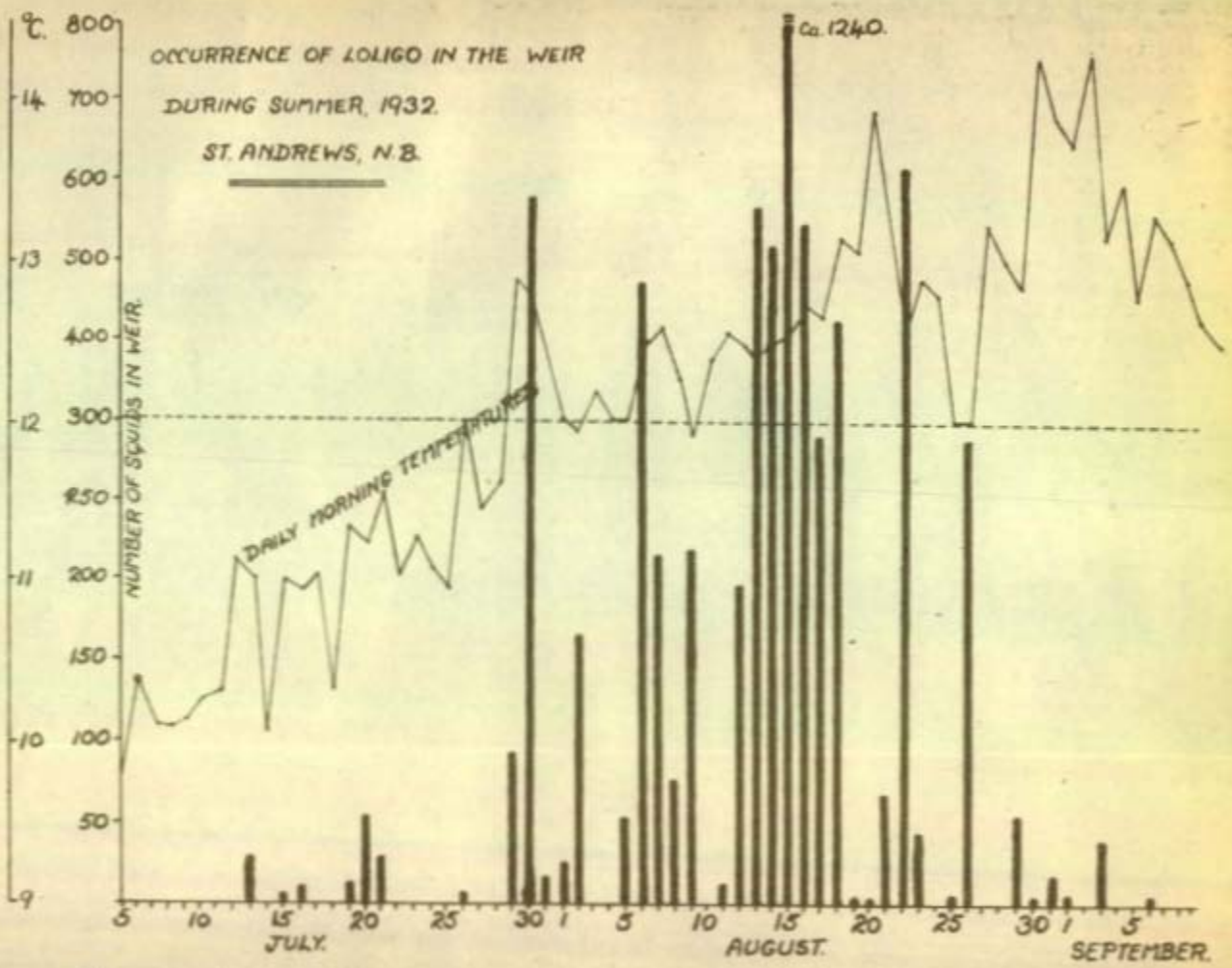
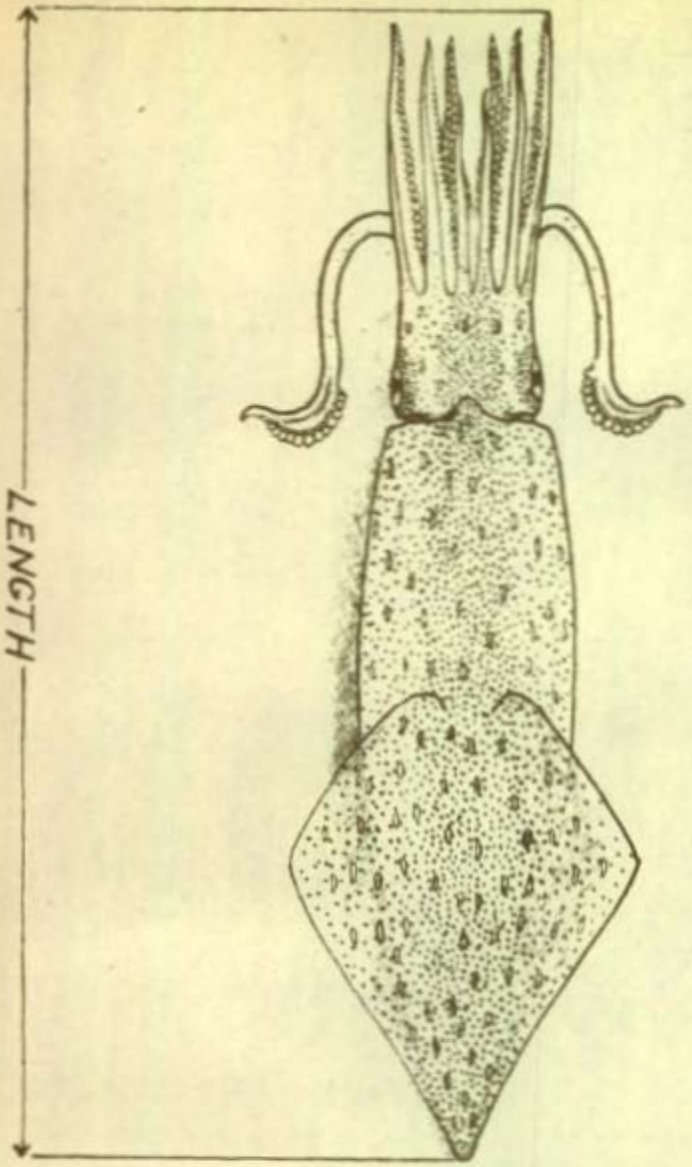

°C.
800
14
700
600
13
500
400
12
300
250
11
200
150
10
100
50
9
OCCURRENCE OF LOLIGO IN THE WEIR
DURING SUMMER, 1932.
ST. ANDREWS, N.B.
Ca. 1240.
NUMBER OF SQUIDS IN WEIR.
DAILY MORNING TEMPERATURES
5
10
15
20
25
30
1
5
10
15
20
25
30
1
5
JULY.
AUGUST.
SEPTEMBER.

Figure 1.



LOLIGO. SHOWING METHOD OF LENGTH MEASUREMENT.

Figure 2.

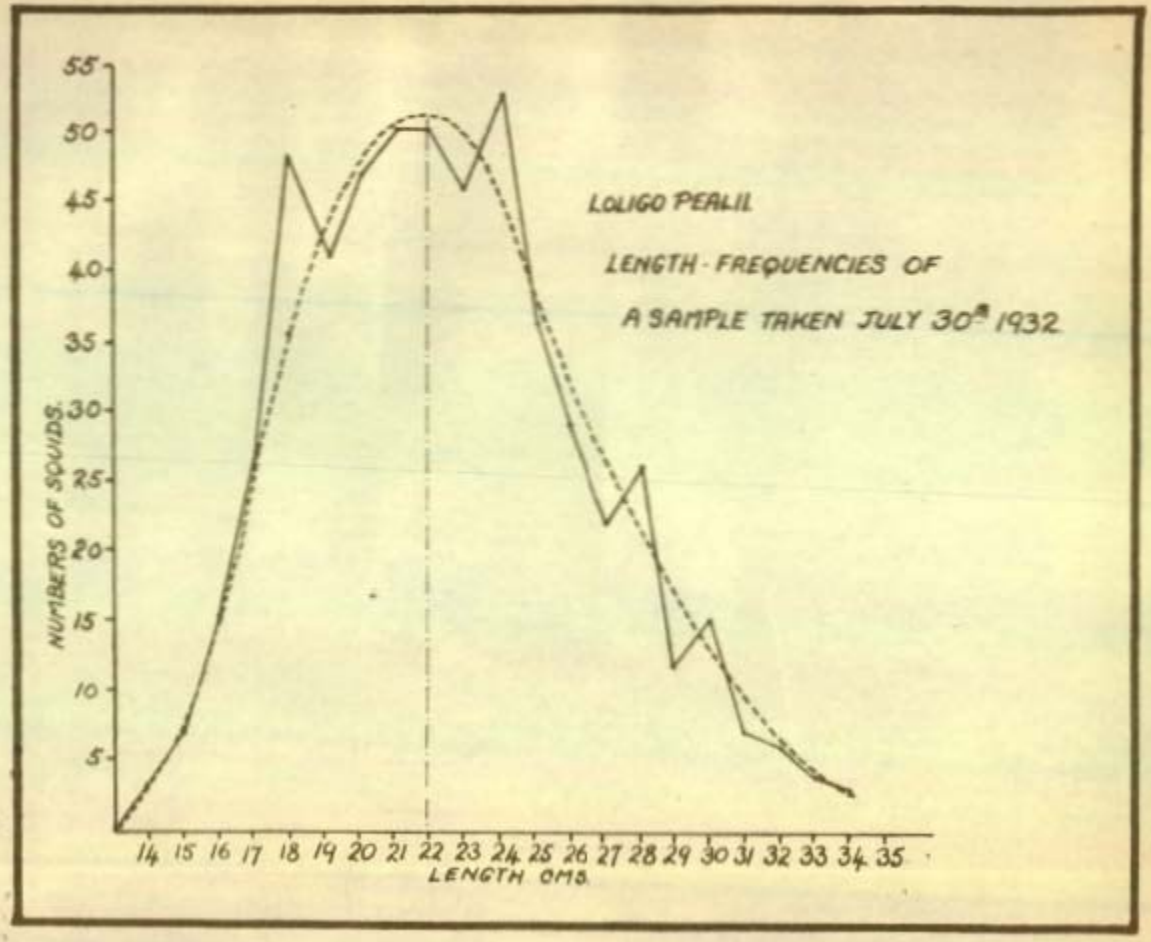

LOLIGO PEALII
LENGTH-FREQUENCIES OF
A SAMPLE TAKEN JULY 30th 1932
NUMBERS OF SQUIDS.
55
50
45
40
35
30
25
20
15
10
5
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
LENGTH CMS.

Figure 3.

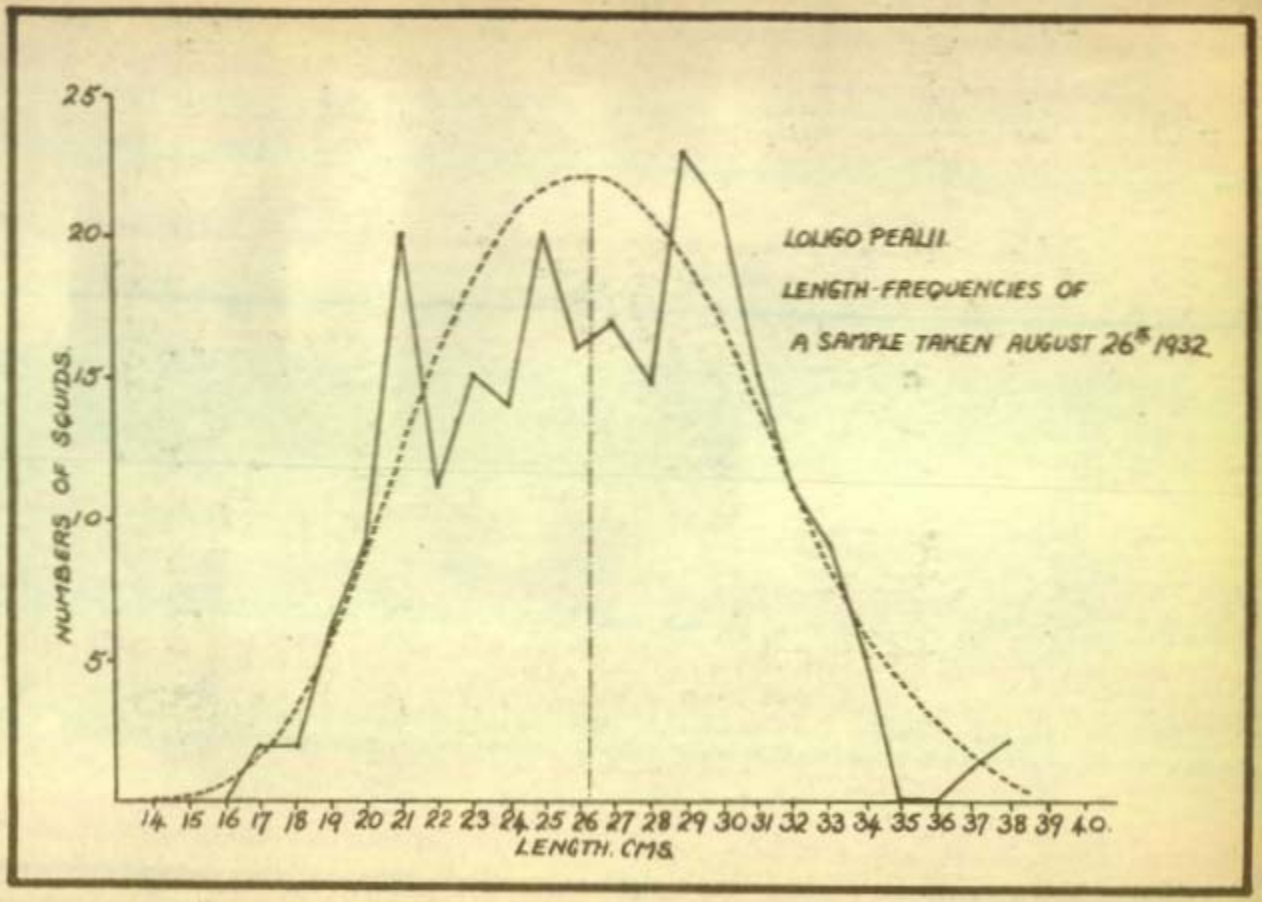

LOLIGO PEALII.
LENGTH-FREQUENCIES OF
A SAMPLE TAKEN AUGUST 26th 1932.
NUMBERS OF SQUIDS.
25
20
15
10
5
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40.
LENGTH. CMS.

Figure 4.

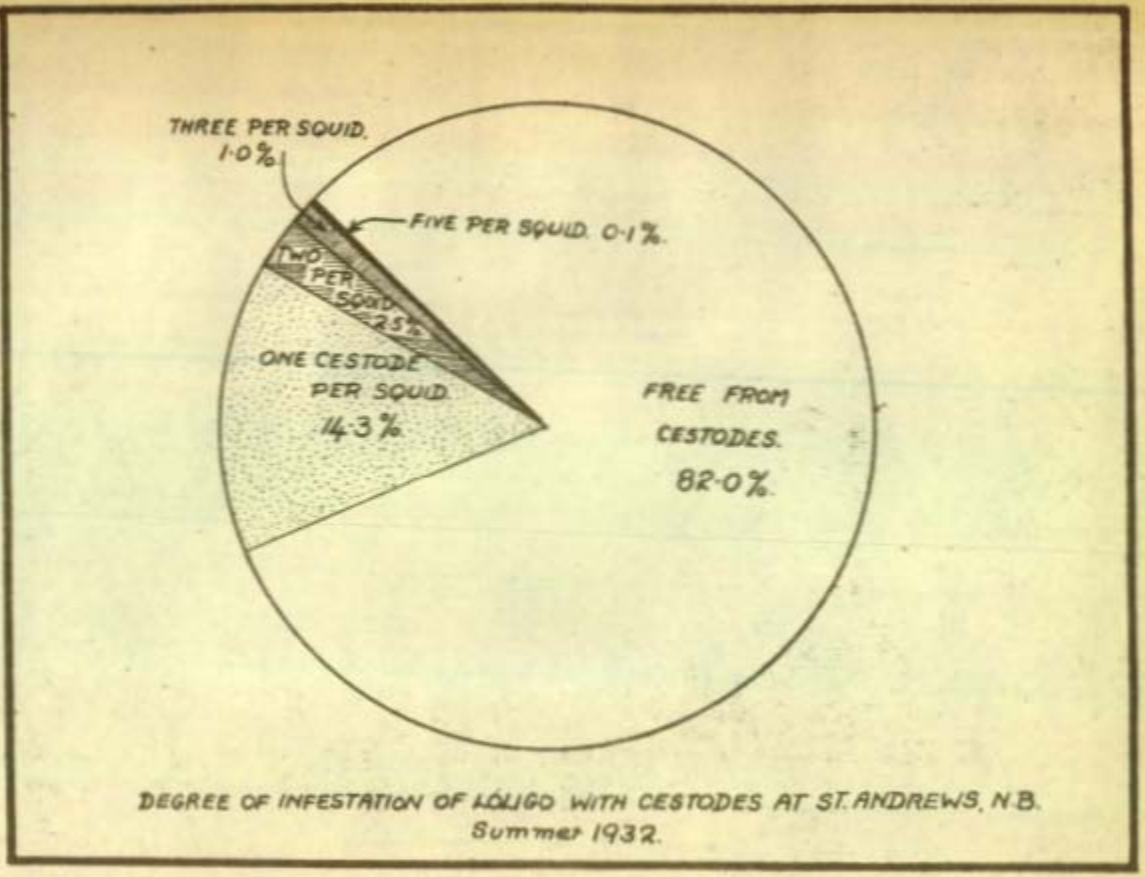

THREE PER SQUID.
1·0%
FIVE PER SQUID. 0·1%.
TWO PER SQUID. 2·5%
ONE CESTODE PER SQUID.
14·3%
FREE FROM CESTODES.
82·0%.
DEGREE OF INFESTATION OF LOLIGO WITH CESTODES AT ST. ANDREWS, N.B.
Summer 1932.

Figure 5.