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OBSERVATIONS ON THE LIFE HISTORY, OCCURRENCE, AND DISTRIBUTION OF THE REDFISH PARASITE SPHYRION LUMPI

Introduction

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Parasites of one sort or another affect practically all kinds of animals and their elimination may create a problem of considerable importance when they are found on species used for human food. The redfish parasite Sphyrion lumpi recently has received considerable attention from the fishing industry due to its effect on redfish fillets, and methods are being developed to eliminate infested material from the catch. Objections to this material are based chiefly on the grounds that the parasite and the sores sometimes caused by it, are unsightly and objectionable to the consumer, rather than on grounds of its possible harmfulness to man. So far as is known, no scientific study has been made to determine its toxicity.

Solution of this problem is of importance to all those concerned with the young and growing redfish industry, which in recent years has produced a catch of over 50,000,000 pounds annually. This report has been prepared to make available to fishermen and dealers such information as is available concerning the parasite and its occurrence and distribution, together with tentative conclusions as to measures required to eliminate infested material from their product.

Fortunately, a considerable amount of data concerning the redfish parasite are available through the efforts of Messrs. Firth and Bearse, Bureau of Fisheries biologists engaged in the collection of mackerel and haddock data on the Boston Fish Pier. Early in the development of the redfish fishery, these observers noticed that in some trips considerable numbers of fish were infested by the parasite Sphyrion lumpi. It seemed that the effect of this parasitization eventually might become a matter of concern to the industry and that information concerning the life history and occurrence of the parasite would be of value. Consequently, both biologists began in 1938 to collect such occasional data on the subject as was possible in the course of their regular duties. The life history material was worked up by Mr. F. E. Firth assisting Dr. Ross F. Nigrelli of New York University and the occurrence and distribution data by Mr. H. M. Bearse. An abstract of the information concerning the life history and a discussion of the data concerning occurrence and distribution are covered in the main body of this report. Although the data in some cases are limited, it was decided that they should be made available to interested parties without delay, in view of the present importance of the problems involved.

General conclusions concerning the degree and distribution of infestation (based on external examination of the fish) indicate that it is heaviest along the coast of Maine and eastern Massachusetts south to the offing of Highland Light, north of latitude 42° N (Area A, fig. 1). The average for this area was about 11 percent. In South Channel (Area B) south of latitude 42° N, the average was about 4 percent, while east of longtitude 69° 10' W and north of latitude 42° N (Area C) the average was about 1 percent. The parasite has never yet been found and reported from redfish caught on Browns Bank (Area D) and to the eastward. Some seasonal difference in degree of infestation was indicated by the data, but insufficient material yet is available to definitely prove this to be the case. Infestation appeared to be highest during the spring, lowest in the summer, and intermediate during the late fall and winter.

The figures for infestation given in this report are based on the number of parasites or sores which could be detected by an ordinary external inspection. However, when the fish were filleted, additional cases could be found, usually consisting of small, immature parasites just under the skin. In order to determine the ratio between the number showing externally and the total number as shown by the type of examination made by inspectors of the Food and Drug Administration of the Department of Agriculture, an experiment was carried out with the cooperation of representatives of that organization and the General Seafoods Corporation.

A sample of about 213 redfish was examined externally by the usual method, and parasites were noted on 8 fish, 2 of these having parasites on both sides. Thus, 3.8 percent of the fish were infested, but if each fish were considered as 2 fillets, the percentage of infested fillets was 2.4. (Six infested fillets from fish with parasites on one side and four from the two fish with parasites on both sides, totalling ten out of 426 fillets.) The same fish then were filleted and the fillets examined by means of candling (fillets were placed on a piece of frosted glass covering a box with a strong light within). Examined in this way, nearly 11 percent were found to be infested, a figure more than 4 times as great as was shown by external examination. Thus, it is evident that the figures for infestation shown by Mr. Bearse's work are considerably lower than would be found by an examination such as performed by inspectors of the Food and Drug Administration.

One other experiment was tried to provide some information as to the effectiveness of culling by fillet cutters and a line inspector. Fillet cutters were instructed to throw out all fillets on which parasites or sores were observed and a plant inspector was stationed at the end of the filleting line where the fillets were discharged from the belt. Since he was watching the output of about 40 cutters, it was impossible to more than superficially examine the fillets. (No candling was involved.) A large batch of redfish, from the same trip as was sampled before, was run through the filleting line and occasional samples of fillets removed after being inspected as just described. These were candled as before. Out of 320 examined, 13 or 4.1 percent were found to show some degree of infestation. Thus, the inspection exercised by the cutters and one inspector served to eliminate enough of the bad material to reduce the percentage infestation from somewhere around 11 percent as found in our original candling test to about 4 percent. At the time this experiment was made, the use of a glass-topped table with suitable lighting underneath, had not yet been used for inspecting, but it was evident that such facilities would make inspection much easier and also more effective. Reports of results from use of such equipment at a later date indicate that by its use the final product could be kept considerably below the 4 percent limit mentioned above.

Obviously, it is highly desirable to eliminate all badly infested material and to keep the slightly affected material at the lowest practical level. The Food and Drug Administration requires that infestation on shipments subject to their jurisdiction be kept to the lowest level that can be obtained by following generally accepted "best commercial practice". In view of the results that have been achieved by the use of the "candling table", it appears that to be on the safe side, fillets from all redfish coming from the badly infested areas should be tested in this way. Where the processor can be certain that his fish come from areas of no or slight infestation, the candling table may not be essential.

Conclusions

1. Samples (100 fish each) of redfish landed at Boston between January 1938 and February 1939 were examined externally for the parasite Sphyrion lumpi or for sores left by this parasite. The following results were obtained: About 11 percent or more of the fish caught along the eastern Massachusetts coast north of latitude 42° N and west of longitude 59° 10' W, and along the coast of New Hampshire and Maine, were infested; about 4 percent of those caught in South Channel south of latitude 42° N were similarly infested; about 1 percent of those caught in the area north of latitude 42° N and east of longitude 69° 10' W were infested; while on Browns Bank and eastward, no infestation was found.

2. Observations indicate that infestation is highest in the spring and lowest during the summer. However, more observations are required before this difference can be established.

3. Total infestation as determined by candling usually is much higher than infestation determined by external inspection.

4. When infestation shown by external examination is high, it appears that the final product can be kept within acceptable limits only through the use of special inspection and a "candling table" (glass-topped table with suitable light beneath), or the equivalent.

5. When infestation shown by external examination is about 4 percent, it appears from limited data that the final product can be kept below 5 percent total infestation through the exercise of care by the cutters and the services of one inspector per cutting line. However, best results cannot be obtained without the use of a "candling table".

6. When infestation determined from external inspection is zero or very low, the use of a candling table may not be necessary. Our samples indicate that the only fish meeting this requirement are those from Browns Bank and eastward, and possibly those from the area south of Cashes (east of longitude 69° 10' W, and north of 42° N latitude).

OCCURRENCE AND DISTRIBUTION

by
Henry M. Bearse
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During the course of field work at the Boston Fish Pier in 1937, it was noticed that catches of redfish (Sebastes marinus) included many fish infested with a large copepod parasite which was identified as Sphyrion lumpi. In addition to the presence of the parasites, in some cases there were secondary infestations such as sores and tumors due to the action of the parasites.

The purpose of this paper is to present the data collected between January 1938 and February 1939 and the conclusions to be drawn from their analysis.

Sampling methods.--The method used in obtaining the data presented in the following tables and figures was as follows: Whenever other duties permitted, samples of redfish were examined from trips coming from the various fishing grounds. In each case, 100 fish were examined by external inspection and notes made on the numbers of infested fish, the number of infestations per fish, and in about a third of the samples, the position of the infestation on the body of the fish. This method of examination discloses only those infestations showing externally and does not show the small parasites present under the skin. Since sores and suppurations of various kinds were fully as objectionable as the parasite itself, all outwardly visible sores or large raised areas were counted. Therefore, the term "parasite" as used in the tables, unless otherwise noted, means both visible parasites and sores resulting after the parasite itself has left the body of the fish.

Description of areas.--The 65 samples collected over a period of approximately 14 months were grouped into the 5 areas A to E shown on figure 1. These areas were selected with the intention of grouping data from natural areas or because the incidence of infestation obtained was reasonably consistent where no natural barrier existed.

The data included in Area A_1 come from fishing grounds fished almost exclusively by a fleet of small draggers. These fishing grounds are rather definitely set off from those to the southeastward and are considered by the trade as a shore fishery.

The Areas A_2, A_3, B, and C include grounds fished by large and medium otter trawlers. As far as we know, there are no natural barriers that would prevent redfish in these three areas from intermingling. The only valid reason we have for making these separations is the difference in percentage infestation.

The two Areas D and E are definitely set off from the first four. The Browns Bank area is an important fishing ground for redfish and except for the presence of many small-sized fish, would be even more important. Area E includes the gully a few miles north of Sable Island. Redfishing on this ground is purely incidental to the pursuit of other species and redfish are saved only during the last day or two of the trip.

Discussion.—Geographical distribution of the parasite.—The 13 samples collected from Area A_1 and shown in table 1 give a consistently high percentage. This area covers fishing grounds commonly fished by small otter trawlers. The lowest number of parasites per hundred was five and the highest, nineteen, with an average of 13 percent. Moving southeastward, the subdivisions A_2 and A_3 are closely adjacent to the tip of Cape Cod. Subdivision A_2 shows twice as high a percentage as A_3. The two subdivisions are close together and, it would be reasonable to suppose, support the same population of redfish; yet the difference is great enough to indicate the possibility that the populations of the two areas are independent. It may be argued that the number of samples in A_2 is too small to give a complete picture of the percentage infestation in this area. However, this region is notorious for the large number of parasite copepods, even among the people not generally observant of such things. Fishermen have remarked to the author that they have stopped fishing in Area A_2 because of the large number of infested fish.

Area B (table 1) is an area fished extensively for redfish and other species by practically all the offshore fleet. The percentage of infestation found runs from zero to six percent except for two samples taken in March 1938 on the same day. These two odd samples had a very high percentage of infestation and indicate that occasionally trips of fish from this area are as heavily infested as any of the inshore samples. The average for the 16 samples in this area is only a third of that for Areas A_1 and A_2. In view of the fact that a large proportion of the redfish landed at Boston and Gloucester comes from this area, it is useful to know that on the average, the percentage of externally visible infestation is less than 5 percent.

Table 1.—Records of redfish infestation by areas

Area	Month	Samples	Fish	Infested fish	Total parasites	Parasites per fish	Percent of fish parasitized
		Number	Number	Number	Number	Number	
A_1 1/	Feb.1938	1	94	18	25	1.4	19.1
A_1	Mar.1938	1	75	10	11	1.1	13.3
A_1	Nov.1938	1	100	12	12	1.0	12.0
A_1	Nov.1938	1	102	17	17	1.0	17.0
A_1	Nov.1938	1	100	5	5	1.0	5.0
A_1	Dec.1938	1	100	11	12	1.1	11.0
A_1	Dec.1938	1	100	11	11	1.0	11.0
A_1	Jan.1939	1	50	5	5	1.0	10.0
A_1	Jan.1939	1	50	7	8	1.1	14.0
A_1	Jan.1939	1	100	17	22	1.3	17.0
A_1	Jan.1939	1	66	9	10	1.1	13.6
A_1	Feb.1939	1	100	19	24	1.3	19.0
Total		12	1,062	141	162	1.2	13.3
A_2 2/	Jan.1938	1	100	14	20	1.4	14.0
A_2	May 1938	1	100	17	24	1.4	17.0
A_2	June 1938	1	100	12	17	1.4	12.0
A_2	June 1938	1	100	15	19	1.3	15.0
Total		4	400	58	80	1.38	14.5
A_3 3/	July 1938	1	100	6	6	1.0	6.0
A_3	Aug. 1938	1	100	8	9	1.1	8.0
A_3	Aug. 1938	1	100	8	11	1.4	8.0
A_3	Aug. 1938	1	100	5	5	1.0	5.0
A_3	Aug. 1938	1	100	7	7	1.0	7.0
A_3	Sept.1938	1	100	8	9	1.1	8.0
A_3	Sept.1938	1	100	5	7	1.4	5.0
A_3	Sept.1938	1	100	1	2	2.0	1.0
A_3	Nov. 1938	1	100	10	12	1.2	10.0
A_3	Dec. 1938	1	127	13	14	1.1	10.2
Total		10	1,027	71	82	1.15	6.91
Total, Area A_1- A_3		26	2,489	270	324	1.20	10.85

1/ Coast of Maine, New Hampshire, and northeastern Massachusetts

2/ ENE of Highland Light

3/ ExS of Highland Light

Table 1.(Cont'd)--Records of redfish infestation by areas

Area	Month	Samples	Fish	Infested fish	Total parasites	Parasites per fish	Percent of fish parasitized
		Number	Number	Number	Number	Number	
B 4/	Jan.1938	1	100	0	0	0.0	0.0
B	Jan.1938	1	100	5	11	2.2	5.0
B	Feb.1938	1	100	3	4	1.3	3.0
B	Feb.1938	1	100	1	1	1.0	1.0
B	Mar.1938	1	100	0	0	0.0	0.0
B	Mar.1938 5/	1	100	20	25	1.2	20.0
B	Mar.1938 5/	1	100	17	25	1.5	17.0
B	Mar.1938	1	100	3	3	1.0	3.0
B	Apr.1938	1	100	6	10	1.7	6.0
B	May 1938	1	100	2	2	1.0	2.0
B	Sept.1938	1	100	3	3	1.0	3.0
B	Nov.1938	1	100	1	1	1.0	1.0
B	Nov.1938	1	100	4	5	1.2	4.0
B	Nov.1938	1	100	1	1	1.0	1.0
B	Dec.1938	1	100	1	1	1.0	1.0
B	Dec.1938	1	100	3	3	1.0	3.0
Total		16	1,600	70	95	1.36	4.38
C 6/	Feb.1938	1	100	2	4	2.0	2.0
C	May 1938	1	100	0	0	0.0	0.0
C	Aug.1938	1	100	0	0	0.0	0.0
C	Aug.1938	1	100	1	1	1.0	1.0
C	Aug.1938	1	100	1	1	1.0	1.0
C	Sept.1938	1	100	3	3	1.0	3.0
C	Sept.1938	1	100	0	0	0.0	0.0
C	Nov.1938	1	100	0	0	0.0	0.0
C	Nov.1938	1	100	2	2	1.0	2.0
C	Dec.1938	1	100	3	4	1.3	3.0
Total		10	1,000	12	15	1.25	1.2
D 7/	Jan.1938	1	100	0	0	0.0	0.0
D	Jan.1938	1	100	0	0	0.0	0.0
D	Mar.1938	1	100	0	0	0.0	0.0
D	Mar.1938	1	100	0	0	0.0	0.0
D	May 1938	1	100	0	0	0.0	0.0
D	June 1938	1	100	0	0	0.0	0.0
D	July 1938	1	100	0	0	0.0	0.0
D	Aug.1938	1	100	0	0	0.0	0.0
D	Aug.1938	1	100	0	0	0.0	0.0
D	Dec.1938	1	50	0	0	0.0	0.0
D	Dec.1938	1	100	0	0	0.0	0.0
Total		11	1,050	0	0	0.0	0.0

4/ South Channel, south of latitude 42°

5/ The infestation shown by these two samples appears abnormally high for this area; but the positions have been checked and there does not appear to be valid grounds for believing their positions less accurate than that of the other trips.

6/ South of Cashes, north of latitude 42°

7/ Browns Bank

Table 1.(Cont'd)--Records of redfish infestation by areas

Area	Month	Samples	Fish	Infested fish	Total parasites	Parasites per fish	Percent of fish parasitized
		Number	Number	Number	Number	Number	
E 8/	Jan.1939	1	50	0	0	0.0	0.0
E	Feb.1939	1	100	0	0	0.0	0.0
Total		2	150	0	0	0.0	0.0

8/ Sable Island

The area covered in table 1, Area C, commonly is referred to as "South of Cashes" or the "Ridges". This is the farthest offshore of the Gulf of Maine redfish grounds. The average infestation in samples from this area was only 1.2 percent.

Area D, table 1, includes the deep hole north of the eastern tip of Browns Bank, while Area E covers the gully north of Sable Island. Trips from Area E have been rare except for the first 2 months of 1939. At no time have parasites been noted on any fish from these 2 areas. The author has talked to captains fishing these areas, and they confirm the above statement. However, it is possible that occasional parasites might be found if more extensive sampling and examination were undertaken.

Seasonal distribution of the parasite.--The data shown in table 2 indicate that there is some difference in degree of infestation, as shown by external examination, from one part of the year to another with that during February to May, the heaviest. However, the differences do not appear to be great and the data show that in Areas A to C there is no season of the year when redfish are free of parasitic infestation; and that there is a high probability that any redfish coming from Areas A and B will be moderately or heavily infested, regardless of the season of year when taken.

From other sources there is some reason to believe that the numbers of parasites visible externally should be lower in the later summer or fall. Evidence obtained by Nigrelli and Firth tends to prove that the young parasites enter the flesh at this time and do not immediately become visible. There is some indication of this in Sub-area A_2 and Area B, but more data will have to be obtained to finally settle this point.

Table 2.--Summary of data concerning redfish infestation by areas and seasons.

Area	Season	Samples	Fish	Infested fish	Total parasites	Percent of fish parasitized
		Number	Number	Number	Number	
A_1	Feb.-May, 1938	3	269	47	60	17.47
A_1	June-Sept., 1938	-	-	-	-	--
A_1	Oct., 1938-Jan., 1939	10	868	101	111	11.63
	Total	13	1,137	148	171	13.01
A_2	Feb.-May, 1938	1	100	17	24	17.00
A_2	June-Sept., 1938	2	200	27	36	13.50
A_2	Oct., 1938-Jan., 1939	1	100	14	20	14.00
	Total	4	400	58	80	14.50
A_3	Feb.-May, 1938	-	-	-	-	--
A_3	June-Sept., 1938	8	800	48	56	6.00
A_3	Oct., 1938-Jan., 1939	2	227	23	26	10.13
	Total	10	1,027	71	82	6.91
B	Feb.-May, 1938	8	800	52	70	6.50
B	June-Sept., 1938	1	100	3	3	3.00
B	Oct., 1938-Jan., 1939	7	700	15	22	2.14
	Total	16	1,600	70	95	4.37
C	Feb.-May, 1938	2	200	2	4	1.00
C	June-Sept., 1938	5	500	5	5	1.00
C	Oct., 1938-Jan., 1939	3	300	5	0	1.67
	Total	10	1,000	12	15	1.20

Distribution of parasites on the body of the fish.--Analysis of the data concerning the position of the parasites on the redfish gave the results shown in figure 2 and table 3. About 87 percent of the parasites or resulting sores were on parts of the body that would affect the fillets. However, it is of interest to note that nearly 80 percent occurred between the lateral line and the dorsal fin, generally just below the base of the fin. Thus, it is apparent that a large proportion of the infested fillets can be saved by suitable inspection and trimming of the affected portions.

Conclusion.--The facts presented in the preceding pages should be of practical value to the fishing industry in that they show that the percentage of parasitized redfish is high only in certain fairly well-defined areas. If inspection and candling of fillets is impractical, the foregoing data demonstrate that from at least Areas D and E, the numbers of these parasites are negligible or small. Thus, the accompanying chart could be used as a guide by the redfish fleet to avoid badly-infested areas. In conclusion, it may be said that a fish infested with these external parasites shows no signs of undue emaciation or sickness; apparently, the infection is purely local and is handled by the fish in much the same way as a boil in humans: that is, by cystation or walling off by the tissues. It appears that fish from heavily-infested areas can be used if the material is carefully inspected and infested parts cut away.

Table 3.--Position on the fish of all parasites and sores found on 1,693 redfish in 18 samples

Body area 1/	Parasites	Sores	Total	Percent
	Number	Number	Number	
A	13	4	17	10.6
B	63	50	113	70.3
C	6	4	10	6.2
D	8	3	11	6.9
E	9	0	9	5.6
Total	99	61	160	99.6

1/ See figure 2 for explanation of area letters.

Biology and Life History 1/

1/ Abstracted from a paper by Dr. Ross F. Nigrelli, New York Aquarium and Frank E. Firth, Bureau of Fisheries, entitled "On Sphyrion lumpi (Kryer), Copepod Parasite on the Redfish, Sebastes marinus (Linnaeus), with special reference to the Host-Parasite Relationships", to appear in Zoologica, Vol. XXIV, pt. 1, April 1939.

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Many parasites of fishes have little or no appreciable effect on the host tissues, but others, especially external types, affect the flesh in such a manner as to impair its marketable value. The copepod parasite Sphyrion lumpi comes within this group. The bodies of redfish (Sebastes marinus) often become infested with this parasite, but fortunately the infected areas can be removed in the process of filleting, if care is taken.

The parasite found on the redfish belongs to the family Sphyrudae and has been observed in limited numbers on the lumpfish from the Danish coast by Kryer, and it has also been reported on the wolffish in European waters.

The parasites generally seen are females; no males have as yet been seen in the course of this investigation. These females are approximately 1½" to 4" long (fig. 3), while from a description by C. B. Wilson, 1915, we understand that the males are only about 1/8 inch long.

The eggs are fertilized by these minute males which attach themselves to the females, and when they hatch out, give rise to free-swimming, free-living larvae. These then infect other parts of the same fish (the host) or other fish. Although they have no leg appendages, they do have typical mouth parts, and by means of these structures they can propel themselves, crawl around, and eat their way through the tissues of the skin of the fish, where they begin to develop and grow. All stages of growth of the females have been observed. The minute, young forms, are indicated by small, dark, lumpy growths on the skin, the external openings of which are barely visible.

During the process of burrowing into the skin, the parasites digest away the muscle of the host, until eventually they actually live in the little holes that they have dug out. Host connective tissues make up these "pocket" walls. Most of these parasites try to reach the dorsal blood vessel from which to obtain their nutriment. However, they do find a blood supply from the many little blood streams (capillaries) nearby. This is substantiated by the fact that digested blood is usually found in the intestine of the parasite. The parasites also feed on the lymph bathing the muscle tissues.

Occasionally, tumors may develop as a result of this burrowing or digging in process. These tumors are called haemoagioma, or tumors of the blood vessels and capillaries: that is, a heavy network of fine and coarse blood vessels interposed with muscle fibres which develop around and encapsulate the parasite or the spot where the parasite had been. Whether these are derived from the dorsal blood vessels or those more to the outside (periphery) is impossible to tell. For the present, these are called "angiomia-like" tumors.

When the parasite drops off, due to death or being torn away, the hole left in the fish may become secondarily infected with bacteria, flagellates and algae. The algae is the most characteristic thing present in the yellowish pus-like material usually found in these sores, and the usual host cellular elements, with the bacteria present in minute quantity.

Evidence points to the fact that the spawning period of these parasites is late summer and early fall, for there is then a marked increase in the numbers of young immature parasites found under the skin of the host or protruding externally as very small forms, in the process of their development. (Figure 4)

In the majority of redfish examined, the parasites were found buried deep in the skin and musclature in the region dorsal to the lateral line, usually at the base of the dorsal fin. (Figure 5). Occasionally, however, they were found attached in the body wall in the region below the lateral line. These invariably had penetrated the body cavity. Several specimens were found attached to the eye, and quite a number on the gill covers or operculums. (Figure 6). In this latter group, the parasites had penetrated through the covers and attached themselves to the gill arches where there is an abundance of blood, often destroying parts of the gill filaments.

The largest number of parasites recovered from a single fish was six, although the average per infested fish was but 1½. In a badly infested fish, the damage done is considerable, for each parasite eats and digests tissue from approximately 1/16 to 1/8 inch in depth and about 1/16 inch in width. However, these figures are not entirely accurate, for one fish examined in the laboratory showed 3 external parasites and 2 sores or tumors. These external tumors range from 1/4 to 3/4 inches in diameter. Microscopic examination of the skin revealed as many as 12 minute forms.

There appears to be a very marked host specificity displayed by the parasites, for while infested redfish are taken in areas where numerous other species of fish abound, no other New England species has been reported with this infestation. The concentration of parasitized redfish in a definite area off the coast of Maine and Massachusetts is the striking thing in the present studies.

July 1939

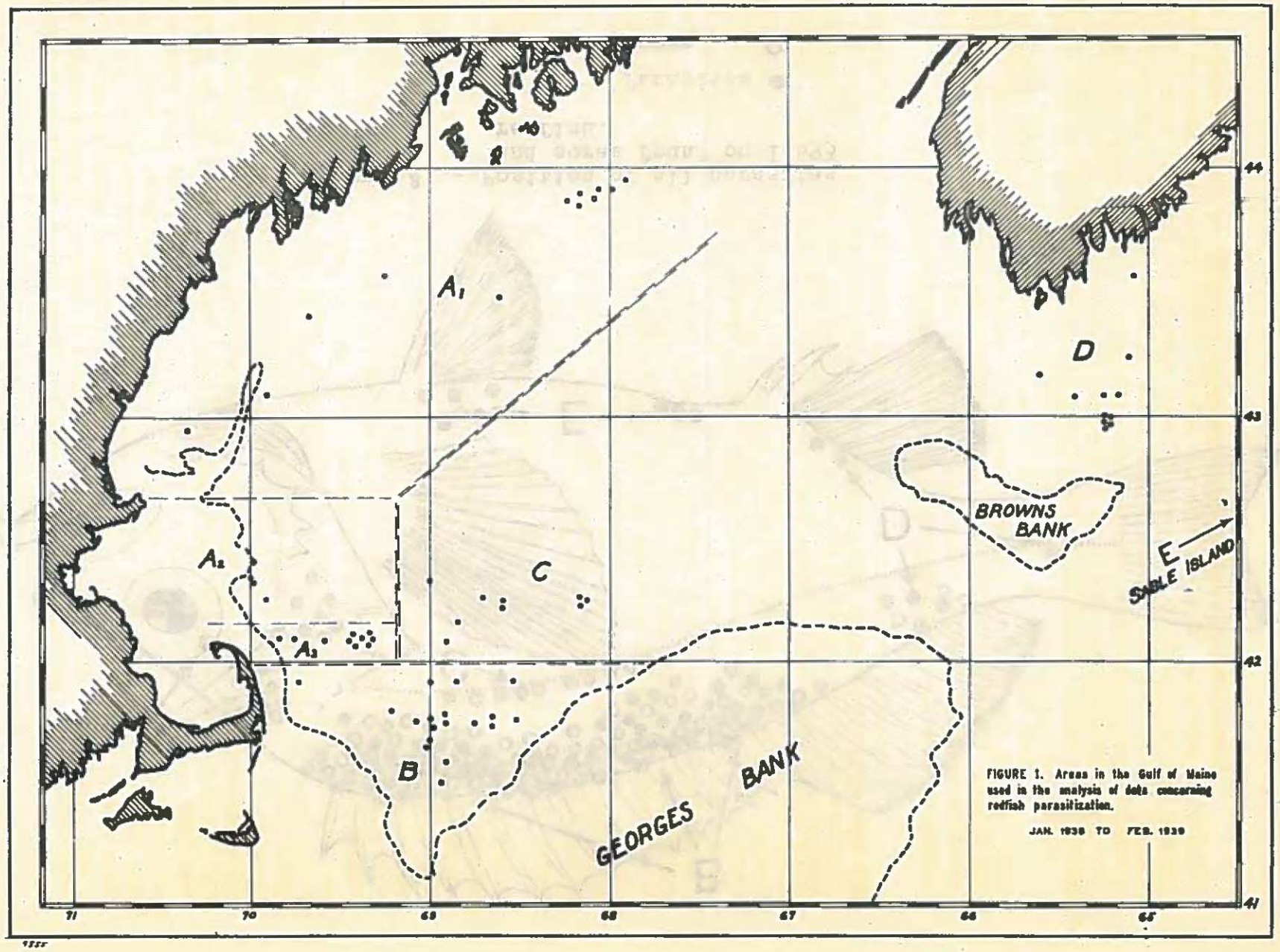

FIGURE 1. Areas in the Gulf of Maine used in the analysis of data concerning redfish parasitization.

JAN. 1938 TO FEB. 1939

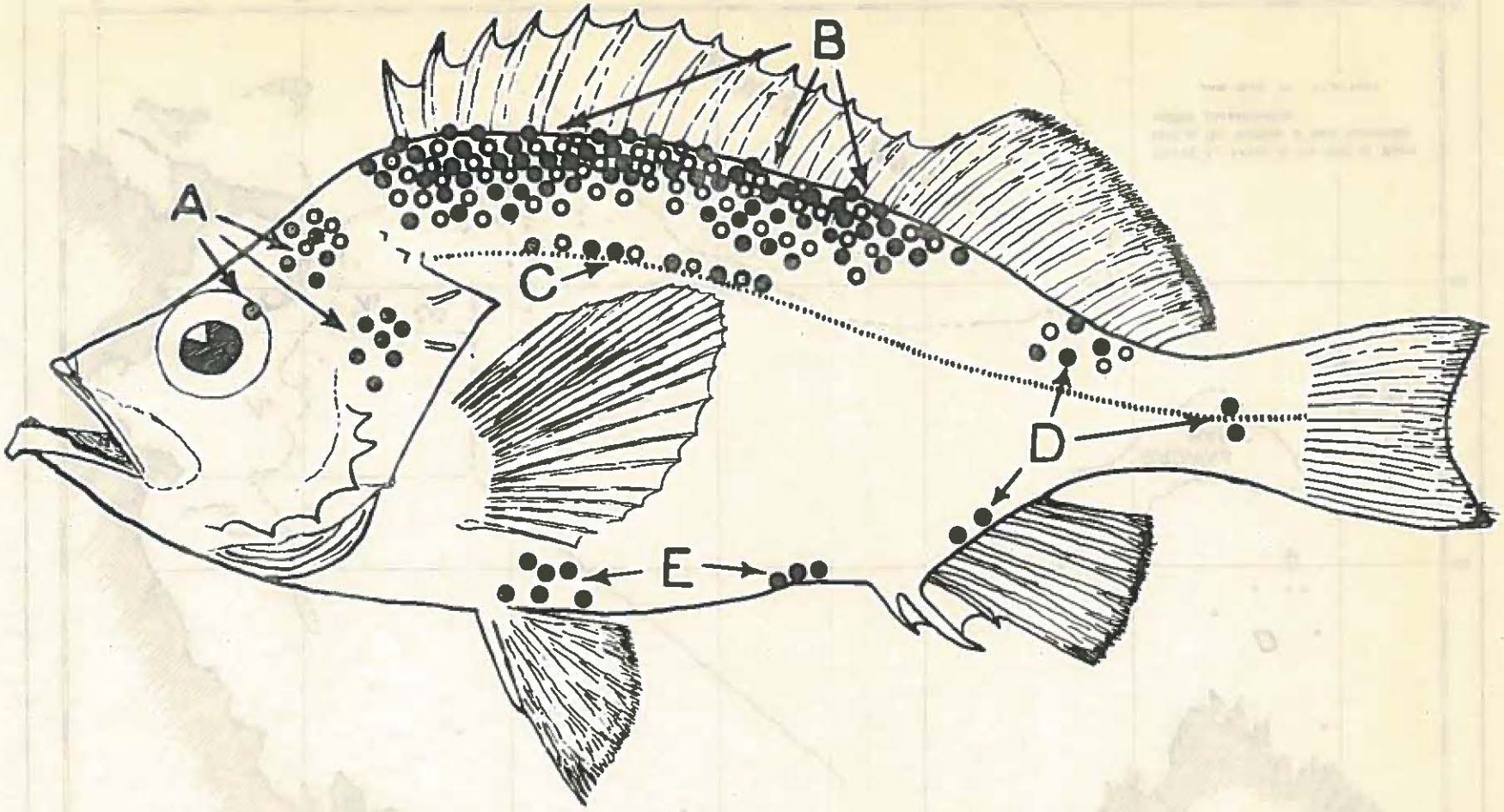

Figure 2 .--Position of all parasites and sores found on 1,693 redfish.

Parasites ●

Sores ○

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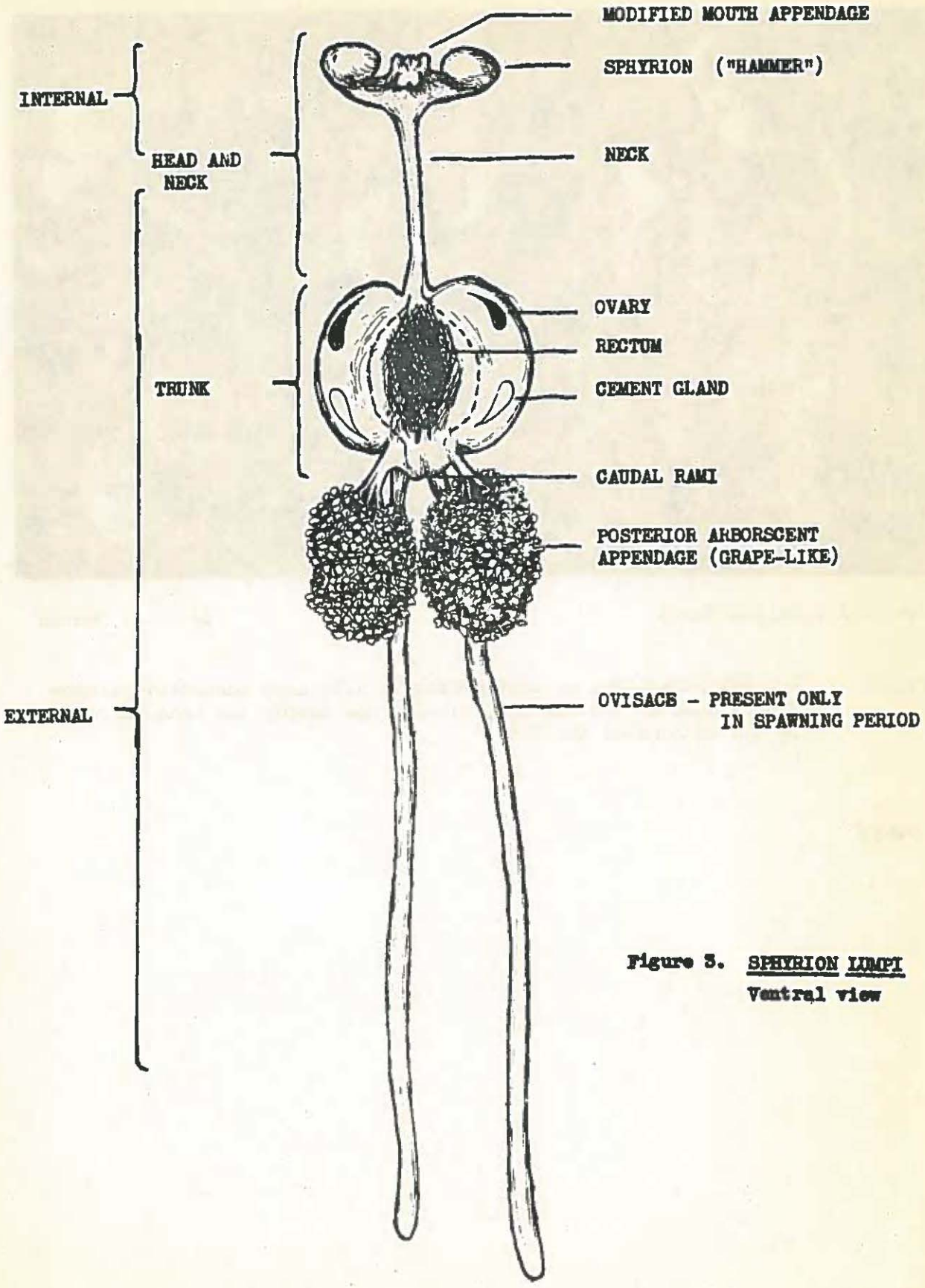

Figure 3. SPHYRION LUMPI
Ventral view

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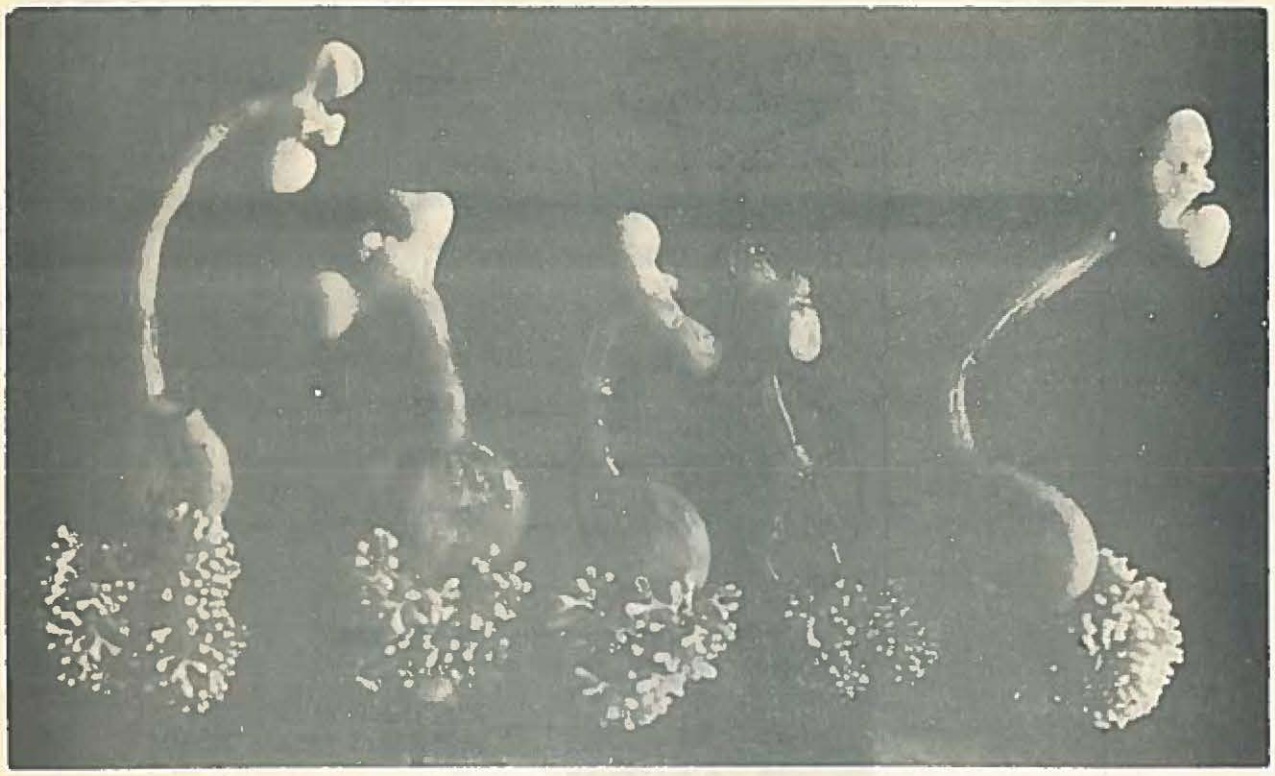

New York Aquarium Photo By S. C. Dunton

Figure 4. Typical parasites, without ovisacs. Note host connective tissue around neck of central one, showing how deeply the head burrows in and anchors on the fish.

7855

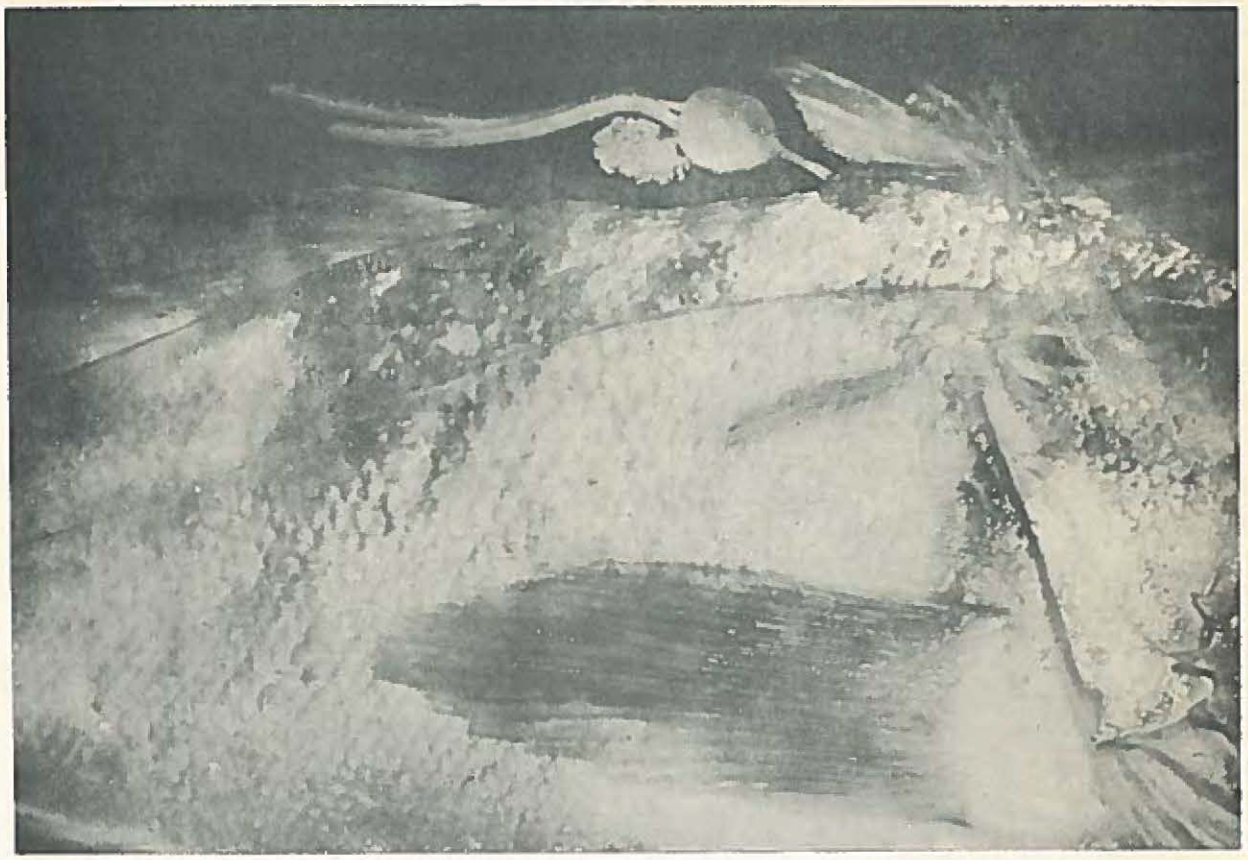

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Figure 5. Retouched photo showing position of parasite as it is found attached to redfish.

7855

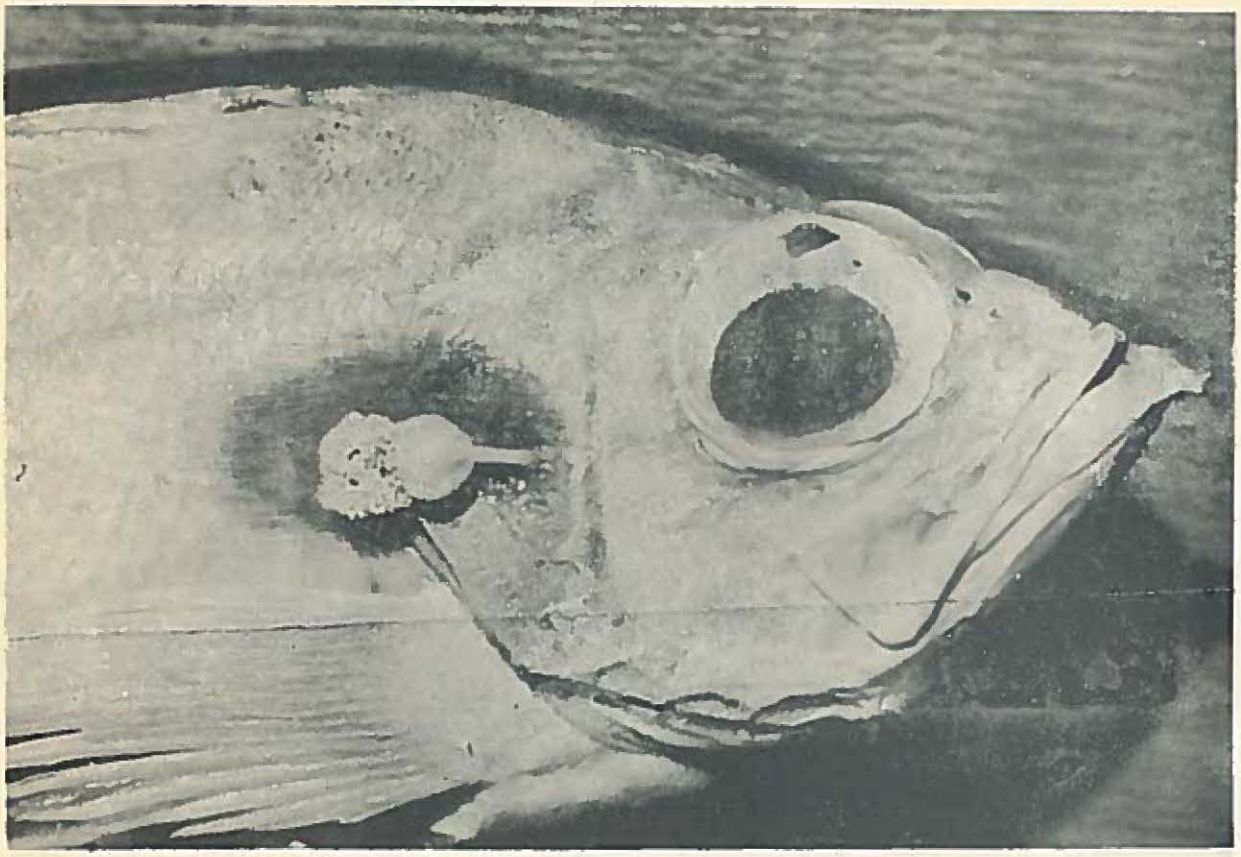

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Figure 6. Young parasite, without ovisacs, showing the place of attachment on the gill cover of a redfish. (Shaded around parasite to make it clearer.)

7856