UNION OF SOUTH AFRICA.

PROVINCE OF THE CAPE OF GOOD HOPE.

MARINE BIOLOGICAL REPORT No. 1.

FOR THE YEAR ENDING

31st DECEMBER, 1912

AND FOR THE HALF YEAR ENDING

30th JUNE, 1913.

April 18, 1914.

UNION OF SOUTH AFRICA.

PROVINCE OF THE CAPE OF GOOD HOPE.

MARINE BIOLOGICAL REPORT

No. 1.

FOR THE YEAR ENDED 31ST DECEMBER, 1912.

AND

FOR THE HALF YEAR ENDING 30TH JUNE, 1913.

To be Presented to the Provincial Council.

CAPE TOWN:
CAPE TIMES LIMITED, GOVERNMENT PRINTERS.
1913.

[C.P. 5—'13.]

B.4/22274.750.6.13.
C.T.Ltd.—B.1210.

THE PROVINCIAL SECRETARY,

SIR,—I have the honour to submit the following special Reports on the Cape Crawfish and Crawfish Industry, the Clupeidæ (Herrings, Anchovies, White Bait, &c.) of South Africa, and the proposed Acclimatisation of "Millions," with recommendations on the practical questions which have arisen in connection with these subjects.

I have the honour to be,

Sir,

Your obedient Servant,

J. D. F. GILCHRIST.

Cape Town,

30th June, 1913.

[C.P. 5—'13.]

CONTENTS.

[C.P. 5—'13.]

UNION OF SOUTH AFRICA.

MARINE BIOLOGICAL REPORT.

I. THE CAPE CRAWFISH AND CRAWFISH INDUSTRY.

Introduction.

Much difficulty has been experienced in dealing with variou questions which have from time to time cropped up with regard to the Crawfish Industry. In the early stages of this industry it seemed to be the general impression that the supply of the fish was inexhaustible, and that no steps need be taken to prevent over-fishing and the possible extermination of the animal. Very soon, however, it was observed that, apparently in consequence of the very extensive operations of the canning companies, the supply was being seriously endangered, and the question of some restricting measures which might safeguard the industry was raised at the instance of the canning factories. Measures of this nature generally take the form of (1) a close season, during which no fishing is allowed, or (2) a size limit, or size below which no fish are allowed to be taken, thus protecting the immature forms and giving them a chance to breed.

It was finally resolved to impose a close season. Little or nothing, however, was known as to the times of spawning or the habits generally of the crawfish, which would indicate at what time of the year this close season should be fixed in order to be effective. Naturally the fishermen, though generally convinced that a close season was desirable, did not desire that this should interfere with their fishing operations, and the close season was fixed for the months of the year in which little or no fish were caught, namely, when they were in a condition known as "sick." The question has, therefore, been raised as to whether this measure is really effective, as no extensive fishing would take place during this period in any case. Clearly what is desired is further information as to the times of spawning and the life history of the fish generally.

[C.P. 5—'13.]

Again, the imposition of a size limit was suggested. Attention was drawn to the practice of catching very small crawfish, and it was suggested that the destruction of these immature forms was responsible for the falling off of the supply. These small crawfish form a particularly palatable dish, and it was pointed out that in many cases young forms of various sea animals were extensively utilised for food purposes without deleterious effects, and, besides, there were some experienced fishermen who maintained that these small forms were not the young of the common crawfish, but belonged to another and smaller species, which did not grow larger.

A size limit was, however, imposed, and it was made illegal to catch these small crawfish. Here again it was clearly indicated that what was wanted was further and reliable scientific information, particularly with regard to the early and possibly somewhat different stages of the fish.

Even these restrictions were not deemed sufficient, and it was decided further to protect the females "in berry," that is, carrying the eggs externally, as is the habit of the crawfish. This appears on the face of it to be a very rational method of dealing with the difficulty, especially if it be reckoned that the destruction of a female carrying thousands of eggs means not only the destruction of one individual but of thousands of young. However plausible this may be, there are reasons, as will be seen later on, for suspecting that there is a fallacy in this line of reasoning. What is wanted is further information as to the time of maturity, time of life of greatest fertility, the life history of the young, time and cause of greatest fatality among the young, etc.

There is a special need for such investigation at the present time, as, owing to certain circumstances which will be indicated later on, the industry has entered on a new and prosperous phase, so that for the last few years the capture and canning of the fish for export purposes has been energetically carried on —so energetically, it is stated by some who are engaged in the industry and presumably in a position to know, that it can only last a few years longer. Attracted by the success of the present canning companies, several others are now about to begin operations on an extensive scale, for which reason it is all the more urgent that effective measures be devised for the safeguarding of the industry from a fate similar to that which has befallen the lobster industry of Europe and America.

The following notes on the Cape Crawfish, its life history and habits, are intended as a contribution to a fuller knowledge of some of these points and a possible solution of the practical difficulties met with.

The notes are arranged under the following headings:

1. History of the Cape Crawfish Industry.
2. Experimental hauls of Crawfish in and around Table Bay.
3. Observations at the Marine Laboratory at St. James to determine the breeding habits, &c., of the Crawfish.
4. Geographical distribution of Cape Crawfish.
5. Sexual differences in the Crawfish.
6. Early Stages of the Crawfish.
7. Habits of the larval Crawfish.
8. Age, rate of growth, &c., of Crawfish.
9. Enemies of the Crawfish.
10. Food of the Crawfish.
11. Migration and movements of the Crawfish
12. Life history of the Crawfish.
13. Preservation of the Crawfish.

1. History of the Cape Crawfish Industry.

The crawfish though a valuable article of food, easily procured and occurring in large numbers at the Cape, seems to have been practically overlooked in the early days. Frequent reference is made to the "fine" Cape fishes, many of the common kinds being mentioned by name, such as snoek, steenbras, herring, harders, and even soles, but there appears to be only casual reference to "some fine crawfish" presented to Van Riebeek by two or three Hottentots. (See Precis of the Archives, 4th September, 1852.)

This neglect of a valuable article of food was typical of much later days and its value does not seem to have been appreciated except by the natives. This is all the more remarkable as its representatives in Europe, the Langouste, Spiny or Rock Lobster (*Palinurus vulgaris*), to which it is not inferior, is an important article of food, particularly in France and on the coast of the Mediterranean and its islands. In London it commands a good price and its flesh is by many considered quite as delicate as that of the true lobster. It is significant also that in Natal a species of crawfish is found but is rather rare, and is much more highly valued than the Cape crawfish is at the Cape.

About the time of Lamarok (1744–1829) the Cape crawfish became known to the scientific world in Europe and is mentioned by this author in M.S. (in Museum, Jardin des Plantes) under the name *Palinurus lalandii*, that is, a species of the Langouste (*Palinurus vulgaris*) so well known in France. It is probably due to the fact that a crustacean, very similar to the Cape crawfish, is so well known and esteemed in France that some of the earliest enterprises in connection with the industry at the Cape were French in origin.

Before these however the potentialities of the industry were realised and attempts were made within the Colony itself to put it on a proper basis. The Right Honourable John X. Merriman was the pioneer in the new industry and, although his enterprise met with little encouragement, and even with ridicule from some quarters at the time, it marks the first successful step in a series of experiments, which have led up to the present condition of the industry.

In the year 1874, in conjunction with Mr. Charles Manuel, he imported an expert in the canning business from Messrs. Crosse and Blackwell. A beginning was made with the canning of crawfish, but with limited success. Attention was then turned to fruit and jam making, and, with such results, that the produce found a ready sale. Experiments on crawfish canning, however, were continued, and a satisfactory method for preserving it was at last devised. The canned products were exhibited at the Philadelphia Exhibition of 1876, and were awarded a Bronze Medal. In 1875 Mr. Merriman joined the Government, and disposed of the business to Messrs King and Son, but, in consequence of some difficulty with the operator, the enterprise was allowed to drop.

It was not again until 1890 that the idea of canning the crawfish was taken up. In that year Baron Eugene Oppenheim, the Consul for the Transvaal Government, observing the large quantities of crawfish to be easily caught in Table Bay, conceived the idea of canning and exporting them to Europe. Along with his brother he formed a syndicate under the name of the "South Atlantic Lobster Syndicate," and, utilizing an old mill between the Old Somerset Hospital and the Docks as a factory, commenced to experiment in preserving the fish in tins. Mr. Carl Poppe was manager. The crawfish were got in abundance, chiefly from beyond the Woodstock beach, near Milnerton, or at Mouille Point, and no difficulty was experienced in procuring the raw material in sufficient quantity. From this factory about 4 or 5 thousand cases were turned out per year (about 96 small and 48 large tins in a case with an average of about 2 crawfish per tin). At this time the crawfish was not only abundant, but very large specimens were often taken. Owing, however, to difficulties in devising a proper method for preserving the fish and the consequent bad condition of the produce when placed on the market (Paris chiefly) there was little sale for the crawfish, and this syndicate soon went into liquidation.

At a later date Baron Oppenheim, who still had faith in the ultimate success of the enterprise, started another factory under the name of "Trebor Bros." at Woodstock about the year 1893 under the management of Mr. Lefevre.

Soon afterwards another small factory was started at Woodstock by Captain Malcolm near the first, and shortly afterwards yet another by Mr. Hansel Maier, where the present Woodstock factory (Ovenstone's) now is.

All of these, in spite of apparently promising beginnings, were ultimately closed down, the promoters having lost heavily in the undertaking.

Soon afterwards (1894), however, the "Cape Canning Company" was started at Mouille Point, and, after losing, it is said, about £17,000, went into liquidation like the Trebor Bros. Company two years before.

Some idea of the quantity of Crawfish procured by this Company may be obtained from the following figures of a year's catch :—

1894,	July,	29,962
	August,	97,265
	September,	124,580
	October,	240,160
	November,	60,150
	December (close season)	
1895,	January (close season)	
	February,	29,360
	March;	62,420
	April,	67,640
	May,	72,320
	June,	57,900
Total for one year,		841,757

The chief cause of failure seems to have been defective canning and the impossibility of competing with the canned lobster of America, which was then in great abundance.

It was during the operation of this last Company that fear was entertained that the supply of crawfish was being seriously endangered, and the necessity was represented to Government of some legislative measure for the imposition of a close season, and the prevention of the capture of the young immature forms. Considerable alarm was also felt lest a similar fate to that of the lobster of the Northern Hemisphere should befall the Cape lobster. In Europe, America and Canada so great had been the unrestricted operation in this industry that it had practically ceased to exist on the former large scale. It was partly due to this extensive fishing and the consequent cheapness of this article (9d. per tin in Paris in 1895) that the demand for the Cape article fell off.

[C.P. 5—'13.]

For several years after this the factories practically ceased to exist at the Cape, and for the first time again a small factory was started at North Bay (Saldanha Bay) by Hinchliffe and Holland in 1902. This site proved unsatisfactory, and the factory was transferred to Hoetjes Bay, not far off. An idea of the extent of the operation of this company may be obtained from the fact that the annual wages paid to Colonial fishermen amounted to about £3,500 per annum. The same firm later on erected another factory at Steenberg's Cove. From this factory alone during the year 1912 over 10,000 cases of crawfish (representing over a million fish) were exported, realising 37s. 6d. per case of 96 half-pound tins.

Meanwhile a new factory was started at Hout Bay by Plessis in 1903, and met with success. Recently another has appeared at Woodstock (Ovenstone), another near the Docks, and several others are contemplated.

With improved method of packing, along with an improved market owing to the decay in the lobster industry, the potentialities of the industry are being recognised. The chief market for the fish was, and is still largely, Paris, and, for long, the London market would not look at the article, owing, it is said, to bad packing. This impression was removed at some trouble, and samples of what could be produced were submitted (by Mr. Reid) to a London firm. These compared so favourably with the canned lobster on the market that an offer was made to accept the annual output, (30,000 or 40,000 cases) up to a quarter of a million cases, a fact which will indicate the possibilities of the industries now that the great markets of Europe are prepared to accept the article.

2. Experimental Hauls of Crawfish in and around Table Bay.

In order to procure definite and reliable information with regard to the occurrence and condition of the crawfish at different times and places, a number of experimental hauls under the supervision of the Fisheries Officer were made in Table Bay and its neighbourhood (off Woodstock Beach, near Robben Island, and near Hout Bay). These hauls were made with an ordinary crawfish net, 39 inches in diameter, down for a period of quarter of an hour. Notes were taken of locality, state of sea, depth and temperature, and the size of each specimen was measured, from rostrum to end of carapace. This method of measurement was adopted in preference to the method specified in the fishery regulations, as being more accurate and not differing materially from it. The legal method is from the base of the eyestalk to the end

of the carapace or shield, and is slightly smaller than the measurement here used, in about the proportion of 8 to 9. For purposes of comparison the various sizes are classified into those of 1 inch up to, but not including 2 inches, 2 inches up to, but not including 3 inches, and so on, this being expressed by the numbers 1 +, 2 +, etc.

The condition of the fish is indicated by the distinction between those in (1) hard old shell, (2) hard new shell, (3) soft old shell, and (4) soft new shell.

No. 1.

Date : 2/11/12. Number of hauls : 24.
Locality : South East of Robben Island.
Condition of sea : Smooth, with heavy westerly swell.
Depth : 13 fathoms.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	..	..	..	41	71	83	78	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	1	..	..	..
Soft new shell ..	..	..	..	1	4	10	1	..

Total of males : 290. Average number per haul : 12.086.
Average size : 5.65 inches.

Female Crawfish.
None.

No. 2.

Date : 6/11/1912. Number of hauls : 24.
Locality : South East of Robben Island.
Condition of sea : Smooth, with slight westerly swell.
Depth : 13 fathoms.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +,
Hard old shell ..	..	4	..	2	7	5	1	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	5	17	20	..	..	..

Total of males : 61. Average number per haul : 2·541
Average size : 2,7 inches.

Female Crawfish.
None.

[C.P. 5—'13.]

No. 3.

Date : 12/11/1912. Number of hauls : 4.
Locality : Near the sewer, off Woodstock Beach.
Condition of sea : Choppy.
Depth : $2\frac{1}{2}$ fathoms. Temperature 50·8°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +,
Hard old shell ..	2	9	..	..	..	..	..	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	..	..	..	..

Total of males : 11. Average her haul : 2·75.
Average size : 1·18 inches.

Female Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	5	7	..	..	..	..	..	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	..	..	..	..
In berry ..	..	..	2	..	..	..	..	..
In eyed berry ..	..	..	..	..	..	..	..	..

Total of females : 14. Average number per haul : 3·5.
Average size : 1·78 inches.
Total number of males and females : 25.
Average size : 1·48 inches. Average number per haul : 6·25.

No. 4.

Date : 13/11/1912. Number of hauls : 16.
Locality : South East of Robben Island.
Condition of sea : Choppy, with slight westerly swell.
Depth : 13 fathoms. Temperature : 50·6°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7, +,	8 +
Hard old shell ..	..	..	..	..	4	2	..	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	2	1	..	..

Total of males : 9. Average number per haul : ·562.
Average size : 5·33 inches.

Female Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	1	3	..	..	..	..
Hard new shell	..	..	..	..	..	..	..	..
Soft old shell	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..
In berry	..	..	..	..	..	..	..	..
In eyed berry	..	..	..	..	..	..	..	..

Total of females: 3·77. Average number per haul: ·25.
Average size: 4 inches.
Total number of males and females: 13.
Average size: 4·55 inches. Average number per haul: ·812.

No. 5.

Date: 28/11/1912. Number of hauls: 8.
Locality: Between "America Wreck" and Woodstock Beach.
Condition of sea: Rough and very choppy.
Depth: 4 fathoms. Temperature: 50·7°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	11	7	..	..	..	..	..	..
Hard new shell	..								
Soft old shell	..	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..	..

Total of males: 18. Average number of hauls: 2·25.
Average size per haul: 1·39 inches.

Female Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	..	..	..	..	..	..	..
Hard new shell	..	..	..	..	..	..	..	..	..
Soft old shell	..	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..	..
In berry	..	..	..	5	3	2	..	..	..
In eyed berry	..	..	..	..	..	..	..	..	..

Total of females: 10. Average number per haul: 1·25.
Average size: 3·7 inches.
Total number of males and females: 28.
Average size: 2·54 inches. Average number per haul: 3·5.
[C.P. 5—'13.]

No. 6.

Date: 5/12/1912. Number of hauls: 16.
Locality: Near the mouth of the sewer at Woodstock Beach and near the "America Wreck."
Condition of sea: Very smooth, calm and clear.
Depth: 4 to 5 fathoms. Temperature: 50·4°.
None caught.

No. 7.

Date: 12/12/1912. Number of hauls: 14.
Locality: Between "America Wreck" and Woodstock sewer.
Condition of sea: Choppy, from the South East.
Depth: 5 fathoms. Temperature: 50·4°.

Male Crawfish.

Size in inches	1 +	2 +	3 +	4 +	5 +	6 +	7 +	8 +
Hard old shell	4	2	..	..	3	4	3	..
Hard new shell	..	..	..	..	..	..	..	..
Soft old shell	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..

Total of males: 16. Average number per haul: 1·142.
Average size: 4·3 inches.

Female Crawfish.

Size in inches	1 +	2 +	3 +	4 +	5 +	6 +	7 +	8 +
Hard old shell	2	2	..	..	..	..	..	..
Hard new shell	..	..	..	..	..	..	..	..
Soft old shell	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..
In berry	..	..	2	..	1	..	..	..
In eyed berry	..	..	2	..	..	..	..	..

Total of females: 11. Average number per haul: ·785.
Average size: 2·42 inches.
Total number of males and females: 27.
Average size. 3·36 inches. Average number per haul: 1·928.

No. 8.

Date: 17/12/1912. Number of hauls: 14.
Locality: Between "America" wreck and Woodstock Beach.
Condition of sea: Very calm and oily.
Depth: 5 fathoms. Temperature: 50·6°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	8	10	..	..	..	1	..	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	..	..	..	..

Total of males: 19. Average number per haul: 1·357.
Average size: 1·78 inches.

Female Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	12	4	..	..	..	..	..	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	..	..	..	..
In berry / In eyed berry	..	..	..	6	..	..	..	..

Total of females: 22. Average number per haul: 1·571.
Average size: 2 inches.
Total number of males and females: 41.
Average size: 1·89 inches. Average number per haul: 2·928.

No. 9.

Date: 30/12/1912. Number of hauls: 14.
Locality: Near the "America" wreck.
Condition of sea: Choppy from South East.
Depth: 5½ fathoms. Temperature: 50·2°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	..	..	..	1	2	7	..	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	..	..	..	..

Total of males: 10. Average number per haul: ·714.
Average size: 5·6 inches.

Female Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	..	..	..	..	..	..	..	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	..	..	..	..
In berry ..	..	..	..	..	..	..	..	..
In eyed berry ..	..	..	..	1	..	..	..	..

Total of females: 1. Average number per haul: ·071.
Average size: 4 inches.
Total number of males and females: 11.
Average size: 4·8 inches. Average number per haul: ·785.

No. 10.

Date: 7/1/1913. Number of hauls: 14.
Locality: Between "America" wreck and Woodstock sewer.
Condition of sea: Choppy from North.
Depth: 5½ fathoms. Temperature: 50·6°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	..	..	6	..	3	..	..
Hard new shell	..	..	..	1	6	..	..	..	..
Soft old shell	..	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..	..

Total of males: 16. Average number per haul: 1·142.
Average size: 4·31 inches.

Female Crawfish

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	..	..	..	..	..	..	..
Hard new shell	..	..	..	..	..	..	..	..	..
Soft old shell	..	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..	..
In berry / In eyed berry	..	..	19	2	..	..	..	..	..

Total of females: 21. Average number per haul: 1·5.
Average size: 3·1 inches.
Total number of males and females: 37.
Average size: 3·7 inches. Average number per haul: 2·642.

No. 11.

Date: 10/1/1913. Number of hauls: 14.
Locality: Between "America" wreck and Woodstock sewer.
Condition of sea: Very choppy, from East.
Depth: 5½ fathoms. Temperature 50·8°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	..	..	..	5	12	1	..	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	3	2	1	..	..	..

Total of males: 24. Average number per haul: 1·714.
Average size: 4·45 inches.

Female Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	..	..	..	..	..	..	..	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	..	..	..	..
In berry / In eyed berry	..	..	2	1	..	..	..	..

Total of females: 3. Average number per haul: ·214.
Average size: 3·33 inches.
Total number of males and females: 27.
Average size: 3·89 inches. Average number per haul: 1·928.

No. 12.

Date: 14/1/1913. Number of hauls: 14.
Locality: Near the "America" wreck.
Condition of sea: Very calm and clear.
Depth: 5 fathoms. Temperature: 50·8°.
None caught.

No. 13.

Date: 21/1/1913. Number of hauls: 14.
Locality: Between the "America" wreck and Woodstock sewer.
Condition of sea: Very choppy from South East.
Depth: 5½ fathoms. Temperature: 50·8°.

Female Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	..	..	..	..	..	..	..	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	..	..	..	..
In berry / In eyed berry	..	2	5	..	..	..	..	..

Total of females: 7. Average number per haul: ·5.
Average size: 2·71 inches.
[C.P. 5—'13.]

No. 14.

Date: 28/1/1913. Number of hauls: 14.
Locality: Between "America" wreck and Woodstock sewer.
Condition of sea: Very calm.
Depth: 5½ fathoms. Temperature: 50·2°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	..	..	..	2	..	..
Hard new shell	..	..	..	..	..	..	..	..
Soft old shell	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..

Total of males: 2. Average number per haul: ·142.
Average size per haul: 6 inches.

No. 15.

Date: 4/2/1913. Number of hauls: 14.
Locality: Near "America" wreck.
Condition of sea: Very choppy from South East.
Depth: 5½ fathoms. Temperature: 50·2°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	..	..	..	..	..	..
Hard new shell	..	..	..	..	4	2	..	..
Soft old shell	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..

Total of males: 6. Average number per haul: ·428.
Average size: 5·33 inches.

No. 16.

Date: 6/2/1913. Number of hauls: 14.
Locality: "Bad Tamboer" entrance to Hout Bay.
Condition of sea: Very choppy, slight North West wind.
Depth: 10 fathoms. Temperature: 50·4°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	..	..	23	22	8	..	..
Hard new shell	..	..	..	..	..	..	..	..	..
Soft old shell	..	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..	..

Total of males: 53. Average number per haul: 3·785.
Average size: 4·71 inches.

Female Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	..	..	19	8	..	..	..	..
Hard new shell ..								
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	..	..	..	..
In berry ..	..	..	..	..	..	..	..	..
In eyed berry ..	..	..	..	..	..	..	..	..

Total of females: 27. Average number per haul: 1·928.
Average size: 3.3 inches.
Total number of males and females: 80.
Average size: 4 inches. Average number per haul: 5.

No. 17.

Date: 12/2/1913. Number of hauls: 4.
Locality: Near the "America" wreck.
Condition of sea: Very rough, South East swell.
Depth: 5½ fathoms. Temperature: 50·2°.
None caught.

No. 18.

Date: 14/2/1913. Number of hauls: 14.
Locality: Near Duiker Point (Cape Town direction).
Condition of sea: Very choppy, heavy westerly swell.
Depth: 8½ fathoms. Temperature: 50·25°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	..	..	..	..	..	..	..	..
Hard new shell ..	..	..	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	14	13	4	..	..

Total of males: 31. Average number per haul: 2·214.
Average size: 4·67 inches.

Female Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell ..	..	..	..	..	..	..	..	..
Hard new shell ..	11	17	..	..	..	..	..	..
Soft old shell ..	..	..	..	..	..	..	..	..
Soft new shell ..	..	..	..	..	..	..	..	..
In berry ..	..	..	..	..	..	..	..	..
In eyed berry ..	..	..	..	..	..	..	..	..

Total of females: 28. Average number per haul: 2.
Average size: 1·6 inches.
Total number of males and females: 59.
Average size: 3·13 inches. Average number per haul: 4·214.
[C.P. 5—'13.]

No. 19.

Date: 18/2/1913. Number of hauls: 14.
Locality: Near "America" wreck and Woodstock sewer.
Condition of sea: Very calm and smooth.
Depth: 5½ fathoms. Temperature: 50·8°.
None caught.

No. 20.

Date: 24/2/1913. Number of hauls: 14.
Locality: Duiker Point (Cape Town side of).
Condition of sea: Very choppy, heavy westerly swell.
Depth: 6½ fathoms. Temperature: 40·8°.

Male Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	..	..	..	..	..	..
Hard new shell	..	..	..	..	4	6	..	..
Soft old shell	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	10	7	..	..

Total of males: 27. Average number per haul: 1·928.
Average size: 5·48 inches.

Female Crawfish.

Size in inches	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	..	..	..	..	..	..
Hard new shell	..	..	55	18	..	..	..	..
Soft old shell	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..
In berry	..	..	..	..	..	..	..	..
In eyed berry	..	..	..	..	..	..	..	..

Total of females: 73. Average number per haul: 5·214.
Average size: 3·24 inches.
Total number of males and females: 100.
Average size: 4·36 inches. Average number per haul: 7·142.

No. 21.

Date: 11/4/1913. Number of Hauls: 12.
Locality: Opposite the Milnerton Hotel and "America" wreck.
Condition of sea: Calm, with heavy westerly swell.
Depth: 5½ fathoms. Temperature: 50·8°.

Male Crawfish.

Size in inches.	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	..	..	..	2	..	..
Hard new shell	..	..	..	..	..	..	..	..
Soft old shell	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..

Total of males: 2. Average number per haul: ·16.
Average size, 6 inches.

Female Crawfish.

Size in inches.	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	..	1	6	..	..	..
Hard new shell	..	..	..	..	..	..	..	..
Soft old shell	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..
In berry ..	..	..	..	..	..	..	..	..
In eyed berry	..	..	..	..	..	..	..	..

Total of females: 7. Average number per haul: ·583
Average size: 3·9 inches.
Total number of males and females: 9.
Average size: 4·95 inches. Average number per haul: ·75.

No. 22.

Date: 23/4/1913. Number of Hauls: 12.
Locality: Opposite the Milnerton Hotel.
Condition of sea: Moderate, long heavy swell from the west.
Depth: 8 fathoms. Temperature: 60·0°.

Male Crawfish.

Size in inches.	1 +,	2 +,	3 +,	4 +,	5 +,	6 +,	7 +,	8 +
Hard old shell	..	..	..	..	..	..	..	..
Hard new shell	..	..	1	4	4	3	..	..
Soft old shell	..	..	..	..	..	..	..	..
Soft new shell	..	..	..	..	..	..	..	..

Total of males: 12. Average number per haul: 1.
Average size: 3·75 inches.

Female Crawfish.

None caught.

[C.P. 5—'13.]

These data are as yet not sufficient to throw much light on the habits of the crawfish, but some general conclusions may be indicated.

Males.

A large number of males by themselves were found in 13 fathoms near Robben Island on the 2nd November. Most of these still had their old shell, but some had moulted. On the 6th of the same month a somewhat similar condition was met with.

Meanwhile in shallow water ($2\frac{1}{2}$ fathoms) off Woodstock Beach a small number of immature males were found together with females.

The first locality was visited again on the 13th November and a smaller number of males were found, some still in the old shell, some in the new, together with 4 mature females in hard shell.

The second locality (off Woodstock Beach) showed, as before, small males together with females in berry. On the 12th, in 5 fathoms, in addition to small males, a number of large males were present with mature and immature females. Five days later conditions were somewhat similar, but only one large male was found. On the 7th January adult males were got with berried females in about equal numbers. Later, on the 10th January, the adult males were much in excess of the females (3 berried), and there was a marked absence of small males. On the 14th and 21st no males were got; on the 28th, 2 large males and no females, and again on the 4th February large males but no females were found.

It would appear from this that the large males had retreated to deep water (13 fathoms) and there cast their shell, the smaller males in the meanwhile being in shallow water with the berried females. Later on, the large males with new shell, appeared in the shallow water apparently driving off the small forms and adult females. It will be seen by glancing over the schedules that very seldom are adult males procured together with young forms. That the larger fish drive off the smaller is also indicated by the fact that it has been observed that in fishing operations the smaller fish are at first got and a little later only large fish. The behaviour of the animals in the tanks also confirm this, as it was often observed that, although the small crawfish could by their superior agility, and apparently keener sensory organs, first detect the bait and make off with it, yet they were no match for the heavier and stronger adults in the struggle for possession of food.

The smallest male (1½ inches) was procured from Woodstock Beach at 5 fathoms of water. The largest (7½ inches) were procured at Robben Island at 13 fathoms and at Woodstock Beach at 5—2½ fathoms. The total number of males procured at the different sizes mentioned in the tables were as follows :—

Sizes in inches.	1 +	2 +	3 +	4 +	5 +	6 +	7 +	8 +
(1)	..	..	..	..	42	76	43	79	..
(2)	..	..	4	5	19	27	5	1	..
(3)	..	2	9	..	..	6	3	..	..
(4)	..	..	..	..	..	4	2	..	..
(5)	..	11	7	..	..	..	..	..	..
(6)	..	4	2	..	..	3	4	3	..
(8)	..	8	10	..	..	..	1	..	..
(9)	..	..	..	..	1	2	7	..	..
(10)	..	..	..	1	12	..	3	..	..
(11)	..	..	..	3	7	13	1	..	..
(14)	..	..	..	..	..	1	1	..	..
(15)	..	..	..	..	..	4	2	..	..
(16)	..	..	..	..	23	12	8	..	..
(18)	..	..	..	..	14	13	4	..	..
(20)	..	..	..	..	..	14	13	..	..
(21)	..	..	..	..	..	..	2	..	..
(22)	..	..	1	4	4	3	..	..	..
	25	33	13	122	178	149	83	..

The largest number of males were those between 5 and 6 inches, though not much in excess of those between 6 and 7 inches, and a fair number were over 7 inches.

If these catches are representative, therefore, the protection of males under 4 inches would be no great burden on the industry.

The average size of all the males procured was 4·9 inches, of the females 3·8 inches.

Females.

In the three visits to the deeper waters off Robben Island, females were absent, with the exception of the third, in which 3 adult females in hard shell were procured.

The hauls in the shallower waters off Woodstock Beach showed that the females were abundant there, and were in berry at this time (November). That this is a normal occurrence is well known to fishermen who, during the close season when the crawfish is only allowed to be taken for bait, often procure these berried females, as they are within easier reach in the shallow waters near Woodstock Beach than are the

males in the deeper water further outside the Bay. From the returns it will be observed that *all* the females above 3 inches procured in the first hauls (12th and 28th November; 12th, 17th, and 30th December; 7th, 10th, and 21st January) were in berry. Those in hard old shell (12th November, 12th December, 17th December) were under 3 inches or, if larger, were in deeper waters near Robben Island (13th November).

On the 28th January and again on the 4th February large males were got, but no females.

On the 6th, 14th and 24th February the neighbourhood of Hout Bay was visited, and only large males and females (without eggs) were got. This locality is said to be somewhat earlier than Table Bay, but no valid conclusion can be drawn from these few hauls.

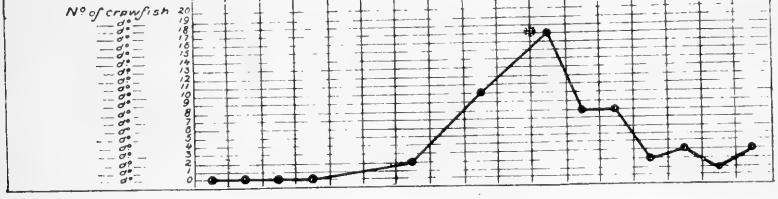
The tables throw some light on the much-discussed question of the size at maturity of the female. This can best be shown by the following tables of size and numbers of berried females:—

Size in inches ..	1 +	2 +	3 +	4 +	5 +	6 +	7 +	8 +
Hauls No. 3 ..	..	..	2	..	..	..	..	..
„ No. 5 ..	..	..	5	3	2	..	..	..
„ No. 7 ..	..	..	2	..	1	..	..	..
„ No. 8 ..	..	..	..	6	..	..	..	..
„ No. 9 ..	..	..	..	1	..	..	..	..
„ No. 10 ..	..	..	19	2	..	..	..	..
„ No. 11 ..	..	..	2	1	..	..	..	..
„ No. 13 ..	..	2	5	..	..	..	..	..
	0	2	35	13	3	..	..	..

From this it is seen that the smallest female in berry was between 2 and 3 inches. Berried females between 3 and 4 inches were by far the most abundant, and there was a rapid falling off above 4 inches, there being only 13 between 4 and 5 inches, 3 between 5 and 6 inches, and none above 6 inches. No females of any kind, in berry or not, were procured above this last size, though several males were procured over 6 inches.

Closer details of this may be shown by considering the actual measurements of the berried females. These are shown in the following table and curve :—

No. of haul	Date	1"	1¼"	1½"	1¾"	2"	2¼"	2½"	2¾"	3"	3¼"	3½"	3¾"	4"	4¼"	4½"	4¾"	5"
3	12.11.12													2				
5	4.11.12.											2	3			2		2
7	12.12.12			1	1							4						1
8	12.12.12													3	2		1	
9	30.12.12															1		
10	8.1.13									8		8	5	2				
11	13.1.13									1		1		1				
13	12.1.13							2		1		4						
	Total			1	1			2		10		17	8	8	2	3	1	3



From this it will be observed that the number of berried females rapidly increases up to $3\frac{1}{2}$ inches and as rapidly decreases beyond that size. Beyond 4 inches there is again a rapid drop, there being very few females in berry of a larger size. The present legal size limit of 3 inches falls just before the size of greatest fertility according to these figures. It represents $3\frac{3}{8}$ inches in the method of measurement here adopted and is represented by the asterisk in the diagram. To ensure adequate protection of the female, the size limit should be increased to $4\frac{1}{4}$ or $4\frac{1}{2}$ inches.

From the data given above, the condition of the female may be noted at different seasons, though only very generally, as the data are not sufficient. In November, 11 berried females were got on two occasions. In December, 14 on three occasions. In January, 31 on three occasions. The largest number were got about the beginning of January, and none after the 22nd January, which may therefore be provisionally taken as the end of the spawning season.

We may note also that the smallest crawfish in berry was $2\frac{1}{2}$ inches, procured on the 12th January off Woodstock Beach in $5\frac{1}{2}$ fathoms of water and that such small forms were very rare.

The largest female was 5 inches, there being only 3 of this size, 1 from Woodstock Beach from 4 fathoms, 28th November, and 2 from the same place from 5 fathoms on the 12th December.

[C.P. 5—'13.]

3. Observations at the Marine Laboratory at St. James to Determine the Breeding Habits, Etc., of the Crawfish.

About the beginning of October, 1906, four females were procured from Saldanha Bay and placed in the tanks of the Marine Station at St. James. They were obtained in the course of an enquiry to determine the smallest size of mature females carrying eggs with a view to the fixing of a size limit. After about two hours' fishing, the fishermen, who knew at once in what locality females in berry could be caught at that time, were able to procure ample material in the form of a full boat-load, all females in berry. There were about 600 in all and were from near the mouth of the Bay. Four of the smallest of these were selected, all being about the same size, namely, $3\frac{1}{2}$ inches in length of carapace. These may be designated A, B, etc., and there subsequent history was as follows :—

Female A.—On the 15th October, 1906, the eggs hatched out and produced numerous larvæ. On the 28th April of the following year (1907) the crawfish cast its shell, and again on the 4th July of the same year. About the 18th and 19th it was attended by two males, which had been placed in the tank, and on the 20th it was observed to be carrying a full mass of eggs below the tail, copulation and the extrusion of eggs, as in nearly all other cases, having taken place during the night. The two males about this time were very pugnacious, the larger driving off the smaller. After the extrusion of the eggs, the larger male returned to his customary place in the tank, though keeping a watchful eye on the other male. At times he resumed his attacks on his rival, driving him off to remote corners of the tank, and even then occasionally renewing his hostilities. It was not until, by accident or superior intelligence, the smaller male was able to reach a stone suspended in the tank that he was left in peace, the larger male, in spite of repeated attempts to reach him, being unable to do so. Thereafter the larger male was left in undisputed possession of the females. It would appear, therefore, that the animal is polygamous in its habits, a fact of importance in restrictive measures which may be adopted to regulate the industry.

The eggs were shed about the 5th October, 1907. On the 29th of May of the following year (1908) the shell was again cast, and on the 6th July the crawfish was again carrying eggs externally ; these were shed on the 18th of September.

On the 29th May, 1909, and again on the 21st October of the same year, the shell was cast, but there were no eggs during the whole of this year.

In 1910 the shell was cast on the 27th May, and again on the 11th August. On the 25th of the same month copulation was observed with a male, and on the 26th the female was observed to be carrying eggs. These were of a pale whitish colour, but in a few days acquired a yellowish tinge. About the beginning of October the eggs were cast off from the abdominal appendages, and by the 8th only a few were left.

On the 8th July, 1911, the shell was again cast.

Female B shed eggs about the middle of October, 1906, cast shell 16th April, 1907, and was carrying eggs some time before the 2nd June (the first of the four to have eggs again). It cast its shell again on the 26th October with the eggs still attached, an entirely abnormal occurrence. On the 9th June, 1908, the shell was again cast. The animal died on the 20th.

Female C shed eggs about the middle of October, 1906, cast shell 28th April, 1907, had eggs about 15th June, 1907, and shed eggs 25th October, 1907; cast shell 2nd June, 1908, and had eggs shortly afterwards. Cast shell 7th June, 1909, but had no eggs that year. Cast shell 3rd June, 1910, and had eggs shortly afterwards, being attended by male some days before. On 19th June, 1910, cast shell.

Female D shed eggs about middle of October, 1906, cast shell 7th June, 1907, attended by male 22nd June, 1907, and had eggs on the 24th. By the 25th October all eggs were shed. On the 26th May, 1908, cast shell, and had eggs. On the 29th June, 1909, cast shell, and had no eggs this year.

In drawing any conclusions from these experiments allowance must of course be made for the more or less unnatural conditions under which the animals lived (in the confined space of the aquarium tanks). That this had some influence, though the animals themselves were apparently quite normal, is shown by the fact that in all but the first year the ova did not develop normally and no larvæ hatched out.

Several important conclusions may, however, be drawn—for instance, that the females cast their shell about mid-winter, that soon after casting their shell and while still soft they are fertilised by the male and almost at once extrude the eggs, which are carried externally for about five months. The date of the casting of the shell in the females may therefore be taken as at the beginning of the spawning time.

The dates of the casting of the shell in the case of the four individuals are shown more clearly in the following table :—

[C.P.: 5—'13.]

Dates of casting of shell in four females from Saldanha Bay :

	A.	B.	C.	D.
1907	8th April 4th July	16th April 26th September.	28th April	7th June.
1908	29th May.	9th June. (died.)	2nd June.	26th May.
1909	28th May. 21st October.		7th June.	29th June.
1910	27th May. 11th August.		31d June.	12th July. (Died casting shell.)
1911	8th July.		19th June.	

The question as to *how often crawfish cast their shell* has not yet been investigated. Judging from the analogy of the European lobster, whose life history is now well known, this would occur several times a year in the young and, as a rule, once a year in the adults. In the above table we note that A (90 mm. in length of carapace) cast its shell twice a year with the exception of two years (1908 and 1911) ; C (104 mm. in length and presumably older) cast its shell only once a year throughout the five years, and at very regular intervals, with the exception of the first (1907).

The *time of casting of the shell* is mostly in the month of June, but may be from April to October. This last date was observed in the case of A in 1909, and is probably very exceptional, and perhaps connected with the fact that in this year there was no spawning.

The *time of spawning*—that is, the time of the extrusion of the eggs from the body—was, as a rule, some days after the casting of the shell. In cases in which the shell was cast twice in the year it was after the second casting. In these cases also it is noted that the spawning season is later. Thus in specimen A, in which the shell was shed twice a year, spawning took place in July and August (20th July, 1907 ; 6th July, 1908 ; 26th August, 1910), while in specimen C, which only moulted once a year, spawning took place in June as a rule (15th June, 1907 ; 23rd June, 1908 ; 28th June, 1910 ; 11th July, 1911). Specimen C was older than A, and it may be concluded, as far at least at these two cases are concerned, that spawning is later in the younger specimen.

With regard to the *frequency of spawning*, this appears to be not more than once a year, and this was so even in the case in which the shell was cast twice in the year, namely, after the second moult. It has for long been a disputed point as

to whether or not the lobster of the northern hemisphere lays her eggs only once in two years, and, while it is still not absolutely accepted, there seems to be very conclusive evidence that this is so. In the case of the crawfish, our experiments seem to indicate that this may take place every year; but it is to be noted that none of the females had eggs in one year (1909). It may be, therefore, that the frequency of spawning is more than once in two years and yet less than every year.

With regard to the *time of casting of shell of the male*, among the specimens (from Table Bay) kept in the tanks, this was in October and September.

The *rate of growth* or age of the Cape Crawfish is a matter which has not yet been investigated. Judging from the experiments at the Marine Station, St. James, the increase in size is not rapid and is unequal. In the case of Female A it was 1·5 mm. in 1907, the same in 1908, but 6 mm. in 1909 (the year in which no eggs were laid), and 2 mm. in 1910.

4. Geographical Distribution of Cape Crawfish.

The Cape Crawfish has a peculiar distribution, being confined to the West Coast so far, at least, as practical fishery purposes are concerned. A few were found as far East as Bird Islands, on the East Coast, during the trawling operations of the *Pieter Faure*. These were, however, of a small size, though specifically identical with the crawfish found so abundantly near Cape Town. Its place is taken in Natal by other and quite different kinds, which occur in no great abundance, chiefly amongst the rocks of the shore. It is found also at Hermanus, the specimens got at this locality being also of a small size. In False Bay it is occasionally met with, but so seldom that its capture is somewhat of a rarity. On rounding Cape Point and coming into the colder waters of the Atlantic it is found in great abundance, as for instance at the Kommetje, only a few miles from False Bay. From this point northwards it is very plentiful. How far north it extends has not been recorded, but it was found in abundance by the *Pieter Faure* as far north as Mercury Island.

Doubtless the distribution is determined directly or indirectly by the great difference in the character of the water of the West Coast northwards of Cape Point from that of the East and South Coast, the former, originating in the Antarctic Circle, being of a much lower temperature and specific gravity than the latter, which comes from the tropical regions of the Indian Ocean, and is of a higher temperature and specific gravity. This distribution is not peculiar to the

crawfish, but extends to many other marine invertebrates as well as fishes, as, for instance, the snoek. Some years ago some enterprising citizens of East London thought to remedy this unequal distribution of the gifts of Providence by importing a shipload of crawfish from Cape Town. The consignment arrived safely, and was placed in a suitable locality, but apparently the fish did not thrive, as they were never again seen.

There have been suggestions from time to time of the advisability of transporting a number of crawfish from Table Bay to False Bay, where they might breed and multiply. This seems a more feasible proposition than that just mentioned, but, for the reasons stated above, the success of the experiment is highly improbable.

The fact that the Cape Crawfish as a commercial asset has this comparatively limited range renders it all the more probable that the supply may be affected by indiscriminate fishing, and the more necessary that adequate means be taken for its preservation.

5. Sexual Differences in the Crawfish.

The difference between the male and female crawfish are at first sight not very striking, and this is of importance in connection with the practical difficulties in carrying out any legislative measures for the protection of the female.

The differences are chiefly the following :—

(1) The female is, as a rule, smaller than the male, and is never much over 4 inches in length measured from the base of the eye-stalk to the end of the carapace. Individual specimens have been known to measure between 5 and 6 inches, but these are exceptional. It follows from this that a size limit of 4 inches would form a very effective measure for the protection of the female, which, we will see when dealing with this question, is a very vital point in the protection of the industry.

(2) The female, as a rule, seems to differ in colour from the male, being generally somewhat darker.

(3) There is a difference in the relative breadth of the carapace, this being decidedly greater in the male.

(4) The tail shows marked differences, connected with the important function of carrying the eggs. Thus, in the female it is broader throughout its length than in the male, as will be shown by the following measurements (in millimeters) of the length and breadth of the carapace and the breadth of the several tail segments of three male and three female specimens :—

	Carapace.		Tail Segments.					
	Length.	Breadth.	First.	Second.	Third.	Fourth.	Fifth.	Sixth.
Females ..	97	68	55	62	62	62	58	54
	127	85	73	80	83	80	76	72
	115	85	65	75	77	74	70	66
Mean ..	113	76	64	72	74	72	68	64
Males ..	157	106	74	78	77	75	75	75
	83	59	43	44	43	42	43	43
	122	88	61	63	63	60	59	60
Mean	120	84	59	61	60	59	59	59

The relative breadth of carapace and of tail segments in the male and female may be more clearly shown by expressing them in the number of times they were contained in the length of the carapace, thus :—

	Measurements in length of carapace.							
Female ..	1	1·48	1·76	1·57	1·52	1·57	1·66	1·76
Male	1	1·43	2·03	1·96	2·00	2·03	2·03	2·03
Difference in favour of female	0	+·05	−·27	−·39	−·48	−·46	−·37	−·27

These figures show that the breadth of the carapace is contained 1·48 times in its length in the case of the female and 1·43 in the case of the male : that is, that the carapace of the female is relatively narrower than that of the male. In the case of the first segment its breadth is contained in the length of the carapace 1·76 times in the female and 2·03 in the male, a difference of ·27. This first segment is, therefore, narrower in the male and this is true also of the succeeding segments, the relative difference being expressed by the figures 39, 48, 46, 37, 27. This may be expressed in another and more direct way by taking the length of the carapace as 100 and

expressing the breadth of the carapace and tail segments in proportion, thus :—

Female, ..	100	67	56	63	65	63	60	56
Male, ..	100	70	41	50	50	49	49	49
Difference in favour of female	0	−3	+15	+13	+15	+14	+11	+7

Thus in a crawfish whose carapace measures 100 mm. (from the tip of the rostrum to the posterior border of the carapace) the carapace is 3 mm. narrower in the female, and the tail 15 mm. broader in the first and third segments, 13 in the second, 14 in the fifth, 11 in the fifth, and 7 in the sixth. A female and a male of equal length of carapace are therefore readily distinguished as there is a difference of 15 mm. in the greatest breadth of the tail. This is enough to be readily detected on a mere glance at the fish.

(5) Though the carapace is narrower as measured by its greatest breadth, the under side or sternum between the last pair of walking legs is broader in the female than in the male. This difference is well marked and is quite evident when pointed out. Thus, in the third female in the tables (115 mm. in length) the breadth of the sternum as measured by the distances between the points of articulation of the five pairs of walking legs were, as compared with those of the third male, (measuring 122 mm. in length) as follows :—

	Length of Carapace.	Distance between walking legs.				
		First	Second	Third	Fourth	Fifth
Male ..	122	13	27	38	42·5	26
Female	115	11	24	33	41	32

or taking the length of carapace as 100 :

Male ..	100	10	22	31	35	11
Female	100	9	20	28	35	27

The distinctly greater width between the bases of the last pair of walking legs in the case of the female is therefore a characteristic and easily-recognised feature, being 27 mm. in the female as compared with 11 in the male of a crawfish 100 mm. in length of carapace.

(6) Another marked difference between male and female crawfish, though not recognised without closer examination, is in the position of the genital openings, these being at the base of the last pair of walking legs in the male, while they are at the bases of the third pair in the female.

(7) Finally, there is a well-marked structural feature in the female not found in the male. This is a small pair of pincer-like claws (chelae) found at the end of the fifth pair of walking legs. These are not used for seizing prey, as is the case in the large claws of the lobster, but are used for arranging, cleaning and aerating the eggs.

The points of external difference between male and female are, therefore, numerous and well marked when analysed, and although they may not be apparent to a casual observer, are readily recognised by the experienced fishermen, so that, though he may not be able to express these differences specifically, he can pick out readily enough the males from the females in any lot of fish.

6. Early Stages of the Crawfish.

The various stages through which the crawfish passes after hatching from the egg have been investigated at the Marine Laboratory at St. James and by tow-nettings in and near Table Bay. The eggs have hatched out satisfactorily and some of the larval stages have been noted, while larvæ of about the same and older stages have been found in the sea. Three, or perhaps four, more or less distinct stages have been noted in all, but there are many gaps between these and the adult form, and it will be the object of further investigation to find these. On the results of such investigation will depend the feasibility of artificial hatching and rearing.

The following short summary, however, may be given of the results so far obtained.

There emerges from the egg a small form entirely unlike the adult.* Plate I shows the general appearance of the larva (enlarged about 84 times) in the living condition. The body is rounded or ovate and still contains some of the yellow yolk granules of the egg stage. The antennae are at this stage well developed. They have two branches and these are provided with long projecting setae. By means of these the animal swims about, rising first to the surface of

* A more detailed description of this larval form has been published in the Journal of the Linnæan Society, London.

the water. These are the only active locomotary appendages at this stage, all the others being more or less folded up under the body. The first two pairs of walking legs are branched, but the outer branch, though segmented, is not yet provided with swimming setae as in the next stage, and the inner branch is folded in itself. The last two pairs of walking legs are awanting.

When this larva moults it undergoes considerable change. The swimming setae of the antennae are thrown off and these appendages no longer perform the function of locomotion. This is now performed by the outer branch of the first two walking legs. Hitherto this has been a simple rounded organ, but on the shedding of the cuticle it expands into a feather-like structure with lateral projections or setae, which again are provided with smaller setæ, so that the whole forms an effective instrument for swimming purposes as the three walking legs, instead of being folded up under the body as in the previous stage, are now widely expanded. A change has taken place, too, in the body, which is no longer opaque, but is glassy and transparent. This stage (the typical "phyllosoma") has been procured in the aquarium at St. James and also by means of fine nets in Table Bay.

A single specimen has been found at a more advanced stage in which the third pair of walking legs has acquired a swimming outer branch and a fourth leg with the rudiments of the fifth pair appears.

Amongst other phyllosomas found in townettings a larger form (33 mm. in length) appears to be a still later stage of the crawfish. Fuller results of these investigations will be published with figures at a later date, when more data may be procured

7. Habits of the Larval Crawfish.

On hatching, the young crawfish in the first free stage casts off the cuticle of the previous stage. This cuticle may be seen lying alongside or partly protruding from the ruptured egg capsule. The large swimming antennæ are at once spread out, and apparently the larvæ cling to the surrounding eggs, or are retained in some way in their midst, until shaken off by the vigorous movement of the tail of the parent.

The larva then rises quickly to the surface by a series of rapid movements in a vertical direction. This is accomplished by the up and down movement of the antennæ with their long setæ. The exopodite projects towards the dorsal side of the animal, the endopodite being in the same plane but projecting laterally. The large wing-like or rather parachute-like structure formed by the rays is so constructed that, on the downward

stroke of the antennæ, they expand widely, and drive the animal upwards, while, on the upward stroke, they bend downwards at their tips and the body is only carried slightly lower. The final result is that the larva is carried upwards by a series of dancing movements (about 4 per second), which are continued with short periods of rest till the animal reaches the surface of the water.

The factor which determines the direction of movement is apparently the light, and once at the surface they rapidly congregate towards the most illuminated corner of the tank.

The rapidity with which they seek the light, and their power of discriminating between slight differences in illumination, were well illustrated by placing several in a glass dish in a room with two windows having slightly different outlooks. They quickly approached the more illuminated side, and, on this source of light being lessened, they as quickly moved towards the other source of illumination. In this lateral movement the main axis of the body is, of course, more or less changed in position.

Should movement cease for a short time in the ascent, the body sinks rapidly, as it is still laden with a certain amount of heavy yolk, lodged in the region of the large diverticula of the future liver, the anterior end of the alimentary tract and the thinner intestine. This yolk is apparently sufficient to tide over the interval between the first and second moult. Under the microscope the mouth appendages are seen to be in active movement, but their spines and denticulations are as yet covered by cuticle, and apparently the animal takes no food at this stage.

The duration of this stage is very short. A number of individuals on one occasion was observed given off from the parent in the morning and, by midday, they had all changed into the second stage.

The significance of this larval stage, of so short duration, and in which the animal may take no food, is doubtless connected with that fact that the larva changes into a second stage which procures its food at the surface of the water, and which is so organised that an upward movement is not easy. Though the duration of the first stage is only for a few hours, it is sufficiently long to enable the larva to ascend the few fathoms of water in which the parent lives.

In the second stage the legs become expanded and hang down on each side of the body, all except the last pair (the third walking leg) which are long and are trailed out behind. The body now assumes a horizontal position and progression is mostly parallel to and near the surface of the water. The

first and second walking legs hanging downwards ready to seize any food particle, draw it up to the body and hand it on to the maxilippedes maxillæ and mandibles, where it is crushed and mixed up before passing on to the stomach. The upper and lower lips are in active motion, they cover over the mandibles, thus forming a sort of cavity analogous to the "gastric mill" or grinding stomach of the adult.

The temporary outer branches of the second and third walking legs function as very active swimming legs in such a way as to direct the body forward. They do not appear to be at all directive.

The animal, however, is able to turn quickly, even to swim in short somersaults by means of the bending of the long rudder-like hind limbs (third walking legs). The body can also be rotated on its long axis by the movement of these limbs, as they are rather widely directed away from each other posteriorly.

This stage, like the first, swims rapidly towards the light. After about four days the larvæ were observed to be more scattered throughout the tank, often at a distance from the surface. On one or two occasions they were observed to descend to the floor of the tank and rise again. At other times they kept to the margin of the tank, where a number of copepods and small crustacea occurred, but, although these animals kept clear of the young crawfish, there was no attempt on the part of the latter to seize them.

About the fifth or sixth day the larvæ gradually disappeared. For better observation one was removed from the tank and placed in a bell jar containing clean sea water, which was renewed from time to time. This larvæ was very active, swimming about by vigorous movements of its swimming legs, though progression was in no case very rapid. Occasionally, however, there was a rapid turning movement ventrally, apparently for the purpose of seizing floating particles. About the seventh day the young crawfish was observed to be keeping almost exclusively to the bottom of the jar, occasionally examining small particles of debris, though a small quantity of boiled yolk of egg placed in the jar was apparently not touched. It was then observed that the animal had so changed its habits that it now avoided the light, instead of seeking it, and it could now be made to move from side to side of the tank, as in the case already mentioned, but in the opposite direction, keeping as far removed as possible from the source of light. The movement, however, was not so marked as in the previous stage. As this fact may prove of importance in elucidating the life history of the animal, the

experiment was repeated several times, so that there was no doubt about the actual fact. Provided that this was not brought about by the artificial surroundings or condition of the larvæ, it would seem to point to the reason why so few phyllosomas were found in townettings as they might have retreated to the darker or more shady parts.

It is to be noted that the crawfish in the swimming stage did not exhibit any great timidity in its movements but moved about rather slowly and apparently fearlessly. Most small crustaceans dart away rapidly on the approach of suspected danger, but these forms only moved off slowly, on being threatened by any object suddenly brought near them.

8. Age, Rate of Growth, etc., of Crawfish.

Very little is known with regard to this subject. The first free swimming stage, after hatching, lasts only a few hours as has been recorded, but how long the second stage lasts, and how many changes take place before the ground form is assumed is not known. This is of importance with regard to the question of the possibility of artificial rearing of the fish, and indicates a direction for future investigation of economic importance.

At what size or age the female reproduces is also of importance. If one can rely on statements of various observers this occurs at a very small size. Unfortunately these statements may be consciously or unconsciously influenced by ulterior considerations, and they have never been confirmed by producing the actual specimen. The smallest female carrying eggs which I have been able to procure was much larger than the sizes stated, and measured $2\frac{1}{2}$ inches in length of carapace.

The size of the largest female is of even greater importance. It is stated that at Hoetjes Bay Factory they have been got up to $5\frac{1}{2}$ inches, though very seldom, and always in deep water—perhaps such large specimens are old and past breeding. A female of between 5 and 6 inches has also been got at Hout Bay Factory, but this was considered a giant and very exceptional. As a rule, females do not usually much exceed 4 inches in length of carapace.

Males, on the other hand, grow to a much larger size, and have been seen about 9 inches in length of carapace. That these are probably very old males is indicated by the fact that they are generally covered with various growths, especially hydrozoa, which give them a hairy appearance—hence the idea among fishermen that old males grow hairs. The presence of these growths on the shell probably indicate old age, as, at this time of life the shell is not shed so frequently, if at all.

The bodies of these large fish are also not so well filled with " meat " it is stated by fishermen.

The usual size of males of the best marketable value is between this size down to about $3\frac{1}{2}$ or 4 inches. Smaller fish are not so useful at least for canning purposes.

It is not known as yet what relation exists between the age and size of the crawfish, and it may be useful to note that in the lobster of the Northern Hemisphere it has been found that those between 2 and 3 inches in total length may be considered to be about one year old, those about 10 inches four and a half to five years old.

9. Enemies of the Crawfish.

In considering any measures for the protection of the crawfish it is necessary to have some knowledge of what other enemies besides mankind the animal has. Thus, for instance, the Octopus is a serious enemy of the crawfish, when in its youngest crawling stages, and if one octopus devours a hundred young crawfish to one caught by fishermen there is not the amount of protection afforded to the animal as one would at first sight suppose by the prohibition of the catching of small crawfish. And from actual observation of the behaviour of the animals in the tanks of the Marine Station at St. James' there seems to be reason for believing that this is what actually happens. There it was observed that the healthy adult was well able to protect itself against the attacks of the octopus by means of its long antennæ, which are provided with strong and numerous spines, the points of which are directed forwards. On the approach of an enemy these tentacles are quickly brought forward, and, on contact with them, neither fish nor octopus care to advance further. It was only in the case of a " soft " crawfish (one which had just cast its shell) or a sickly one that the octopus was able to successfully attack its prey. It was different, however, with the small crawfish, which, like crabs and other small crustaceans, seem to constitute the chief source of food supply for the octopus. If it be borne in mind that every rocky coast is inhabited by numerous representatives of the octopus tribe, and that these are constantly searching every nook and cranny with their long arms for the small crustaceans on which they feed, it will be realized that the chief mortality in crawfish life probably occurs at the early rock frequenting stage. Reference is here made of course only to the very young crawfish, up to about 2 inches in length of carapace. There are many thousands of octopus to one fishermen engaged in the capture of these small crawfish, and the methods of

fishing is at any rate as effective in the case of the first mentioned, so that it is doubtful at least if the prohibition of the fisherman's operations really afford any material protection. It is different of course when the crawfish is large enough to escape the octopus. Another serious enemy of the young crawfish at this early stage of life is probably the "horse-fish" (*Agriopus*), which seems to live chiefly on small crustacea about the size of these small forms. This large toothless fish can extract crabs, etc., from their hiding places by the sudden protrusion of the mouth parts, which form a powerful suction tube.

The so-called "sea-snake" (*Bdellostoma*) is said by some to attack the crawfish. It is frequently found along with the crawfish in the fishermen's nets and certainly devours dead crawfish. It is the experience, however, of most fishermen that it is not a serious enemy of the crawfish, if one at all. Certainly there was no disposition observed on the part of these "snakes" to attack live crawfish when kept together in the same tanks at the Marine Laboratory at St. James'. Some of the more adventurous of the young crawfish indeed attacked these animals when first placed in the tanks with them. They were, however, very soon disconcerted by the slimy matter given out by the "snakes," and, in fact, had some difficulty in getting rid of it, as it clung to their tentacles and body and caused them great trouble for some time after their ill considered attack. The presence of the sea-snakes in the crawfish nets is therefore doubtless due to their being attracted by the fish bait.

Fish generally do not seem to be serious enemies of the crawfish. In the tanks they usually avoided it, and, when they happened to approach too closely, they at once started off as soon as they came in contact with the long spiny tentacles, which were thrust out in their direction.

Amongst sea birds the "Bank Duiker" (*Phalacrocorax*) is said to attack and devour crawfish.

While the adult crawfish is thus well provided with means of defence, it is different when the shell is cast and the animal is at the mercy of most of the other sea animals. It is then very wary and conceals itself as much as possible amongst rocks or in sand. It employs the same means of defence however, when approached, bringing forward its tentacles and keeping them projected towards the source of danger Of course they are then quite soft and flexible though in appearance in their normal condition. Apparently this is undetected by some of their enemies, as theyohave been observed to rapidly move off on the approach of the threaten-

ing though harmless tentacles. Dogfish readily attack the soft crawfish, however, as has been observed in the tanks, and is evident from the fact that the soft shells of crawfish have been found in the stomachs of these fish. The octopus also is not deceived by the apparently unchanged shell. Even a very small octopus has been observed in the tanks to attack a large soft crawfish and secure one of the large legs, of which it made a meal. Small crawfish also have been observed to attack and demolish large soft crawfish.

Apparently, however, man is the most serious enemy of the crawfish in its adult stage, and this would be sufficient to account for the rapid diminution in the supply, experienced as the result of the extensive operations of the factories. These adults occur in enormous numbers, and it was at first supposed that no fishing operations could dangerously affect the industry, but the explanation at once of their large numbers and the effect of fishing is probably to be found in the fact that they have comparatively few enemies in the adult stage. Another fact tends to confirm this, namely, that formerly, before this extensive fishing, very large old crawfish were frequently found, and these no longer or seldom occur in the nets of the fishermen, though still readily procurable in fishing grounds somewhat remote from those of the usual fishing operations as, for instance, at Dassen Island.

The following figures supplied by one of the Crawfish factories of the percentage of small and middle sized fish during four years, 1909-1911. afford more definite evidence pointing in the same direction : 35 per cent., 40 per cent., 40 per cent., 50 per cent.

There are, however, other stages previous to the early ground stage and the adult stage, as will be seen in the account of the life history of the crawfish. The egg stage, when carried about by the female, is not immune from hostile attacks. The eggs are very carefully guarded by the female, and they may be quite covered up by the strong flexure of the tail, but, from observation in captivity, it was seen that several small fish, such as Klip-fish, but particularly small Dasjes, are very fond of the eggs and take every opportunity of harassing the female ; darting under the tail, they frequently secure two or three, and their success leads to repeated attempts.

In some of the townettings made in Table Bay there was found a considerable number of unhatched but well-advanced eggs of crawfish. Whether or not this indicates that in nature the eggs may be prematurely detached or, what is more likely, that the females have been attacked for the sake of their eggs, which are thus scattered about, is not yet known. The fact

that these eggs were found in this way seems to indicate that there is some agent of destruction at this stage, for probably these eggs when they sink to the bottom of mud or sand could not hatch out.

The larva which is hatched out from the eggs seem to be much more liable to attacks of enemies, perhaps on account of the presence of the unconsumed yolk granules. By way of experiment some eggs and larvæ, some hatching and some just hatched, were put into a tank containing harders (mullet) and were at once attacked and devoured. In one case two or three female crawfish were kept in a large tank with several kinds of fish, and it was repeatedly observed that small fish, more especially Klip-fish (various species of *Clinus*), were concontinually on the watch during the hatching time, hovering round the female and devouring many of the larvæ as they were shaken off.

On the other hand, the larvæ when past their first stage and dispersed in the water do not seem to suffer from the attacks of fish. Thus when a few active transparent larvæ were placed in this tank they seemed to completely escape the notice of the fish or at least were unmolested. Two or three small gobies in the crawfish tank remained quite indifferent even when the larvæ scattered in hundreds throughout the tank almost touched their snouts. As noted under habits of the young crawfish at this stage, their behaviour also seem to indicate that they had little cause to fear the presence of enemies.

To sum up, the crawfish produces many thousands of eggs which may be devoured by fish. The early larvæ (still opaque) and eggs which are shaken off in clouds by the female are specially liable to attack and are probably destroyed in large numbers. At a later stage when the larvæ, now transparent, are widely scattered throughout the water, they would appear to be comparatively immune from attacks. At a later stage, however, when the larvæ take to the bottom, and become opaque and pigmented, they are again liable to the attacks of their enemies, notably the octopus.

Lastly, the adult stage seems again to be better able to defend itself and to have comparatively few enemies with the exception of man. For the depredations of the fish and the octopus nature has made provision by producing a surplus of progeny for these natural enemies, and on the whole the crawfish can maintain its own, but it has made no provision for the depredations of man at a stage when fewer natural enemies are present. Hence it is that this new drain in the supply so quickly upsets the balance, and, in spite of the

abundance of the adult forms, continual and extensive fishing operations very soon affect the supply.

10. Food of the Crawfish.

From observations made on the crawfish in captivity, its food seems to consist chiefly of any kind of animal matter that may happen to be present, such as dead fish, etc., and they act as scavengers in the life of the sea. They readily attack any disabled fish, but are quite incapable of doing any harm to a healthy normal specimen. They have frequently been observed to make sudden and rather clumsy attacks on resting fish, but these had no difficulty in escaping. It is stated by some that they live to a large extent on soles, and the suggestion has been made that the fewer crawfish the greater will be the supply of soles, so that the diminution of the crawfish supply is not without its compensation. This is founded chiefly, I believe, on the fact that crawfish are sometimes found in the fishermen's nets with a fresh sole tightly grasped in their legs. From what I have seen of the habits of the crawfish, however, this would appear to be the result of the special opportunities for the seizing of the sole in the narrow confines of the net in which both are captured. This plea, therefore, for the extermination of the crawfish can scarcely be justified and, in any case, is beside the point, as the regular habitat of the soles of commerce is in a region far removed from the haunts of the crawfish—a fact which, however, might be looked upon as a confirmation of the first position.

The stomachs of the captured crawfish frequently contain a substance like finely broken-up shells and they doubtless live to a large extent on various molluscs they find in the mud. In captivity they seldom pay any attention to such animals, but, on one or two occasions, they were observed to attack fairly large and strong shells, as, for instance, that of *Turbo*. The shell was taken up in the claws and turned round so that the edge could be firmly grasped between the powerful mandibles of the crawfish. The shell was then twisted to the side by the legs and the piece grasped by the mandibles broken off. The shell was so thick and strong that the noise of the breaking could be distinctly heard through the water and sides of the tank. This process was repeated until all the free edge of the shell was broken off, down to the very solid operculum, which was of course strongly drawn into the opening of the shell during the process. Further progress was more difficult, but, by inserting the sharp claws between the exposed operculum and the shell, the contents were finally exposed.

Crawfish have been observed in the tanks making attacks on sea urchins, but with little success. The animal was taken up in the claws of the crawfish as in the case of the *Turbo*, and the spines were bitten off one by one by means of the mandibles till the whole shell was quite bare. All attempts to penetrate the shell or the oral or aboral areas were, however, in vain, and the crawfish finally abandons its prey, which then fell a victim to the omnivorous starfish, which is provided with other and more effective means of attack, provided the spines are removed.

As regards food supply, the crawfish is very easily kept in captivity. It can survive for long intervals without food, and can be fed continuously on the same kind of food. It was never observed to feed on vegetable matter, though that it does so is shown by the stomach contents of captured fish.

11. Migration and Movements of the Crawfish.

Information is wanted on this subject in connection with the alleged difference in the spawning times of the crawfish at different localities and with reference to other questions. There does not seem to be any extensive migration along the coast, and it would appear that the animals are confined more or less to the bays or localities which they inhabit. A series of experiments with marked fish would be necessary to throw light on this point.

Within a restricted area, however, such as Table Bay, there seems to be a definite movement. Thus at times the animals are found in abundance at one spot for several days, and then suddenly hardly a single one will be found, the whole of them having moved off to some other locality, where they may be procured as abundantly as before. It has been stated that in Table Bay they move round the Bay in a circle, returning to the point from which they started. In the fishing operations of the Canning Factory it was found that large males were caught off Mouille Point from February to April or May (according to the weather). Mostly medium-sized males were caught off Milnerton and Blaauwberg in May and June. Medium-sized males and females were caught off Robben Island between June and October, and during the months of July and August a good proportion were females. Along the coast from Camps Bay to Oude Skip catches are made during March and April, these being nearly all large or medium-sized males. This, of course, does not point to an actual movement of the fish from Mouille Point, Milnerton, Blaauwberg and Robben Island, as the fish caught are apparently not the same kind, differing as they do in size and in sex.

The method of progression of the animal would seem to indicate that it can migrate to no great distance, as it can only crawl rather slowly by means of its walking legs or make rapid but spasmodic darts by the flexure of its large tail. That we cannot draw such conclusions, however, is rendered probable from the experiments with marked crabs and lobsters in Europe and America, and the interesting occurrence of crawfish apparently on a grand trek has been observed. This was at Stompneus Bay on the Malmesbury coast, and is recorded by Mr. MacLachlan who, on one occasion, observed the usual indications of the passage of a shoal of fish close inshore moving in the direction of Lambert's Bay. Steps were taken to put out the seine net for their capture, and this was successfully effected. Instead of fish, however, it was found that the take consisted of crawfish.

Definite movement from one place to another within a limited area therefore does certainly occur and possibly movements on a larger scale. The former is probably determined by a variety of causes. It is stated, for instance, that the large male crawfish found from February to April off Mouille Point will remain there sheltered from the prevailing south-east winds till the first strong north-west wind, when they all disappear from the locality and find shelter under the lee of Robben Island. Again, there must be definite movements in connection with the breeding season, when males and females come together, as, at other seasons, the males and females congregate by themselves in entirely different localities, as is seen in the account of the experimental hauls. Thirdly, there is a definite movement on the approach and after the period of the casting of the shell. This movement is said to be in some cases towards rocky ground, where shelter from enemies may be found in the nooks and crevices of the rocks ; in others towards a sandy shore, where the animals bury themselves up to the eyes in sand and there they remain until new hard shell is acquired.

12. Life History of the Crawfish.

The egg, still attached to the ventral side of the tail of the mother, is hatched in the spring of the year in shallow water.

From the egg emerges the first larval form already described, and this rapidly ascends to the surface of the water-remaining there probably without taking food.

It then, within a few hours, changes into another form (the Phyllosoma) provided with other and entirely different organs of locomotion, adapted for swimming chiefly in a

horizontal direction, and for the capture of minute floating particles of food, abundant during the summer months.

Later, free swimming stages succeed these, but whether they are numerous and last for weeks or months is not yet known. These free swimming forms are glassy and transparent and swim about rather slowly and without the timidity which characterises later stages. Probably their transparency helps them to avoid their enemies.

Ultimately, however, these free swimming forms settle down to the bottom, lose their swimming appendages, and seek refuge in seaweed and rocks in the shallow parts of the sea, avoiding as best they can the numerous enemies of this stage. It is no longer transparent and invisible to its enemies, and is timid and wary in its movements. The body becomes opaque and pigmented. The inner branches of the walking legs come into use for the first time as organs of locomotion, and it can crawl into crevices; the outer swimming branches are lost. The tail region increases very considerably in size and forms a powerful organ of locomotion, as, by its sudden flexure, it is capable of projecting the body backwards at a rapid rate, away from any suspected source of danger.

As it increases in size with succeeding moults the animal becomes better able to defend itself, and it may venture further afield.

The remaining stages of its life history differ according to whether it is a male or female.

During or towards the end of the winter months the female casts her shell and soon after has connection with the male, and lays the eggs which become attached to the underside of the tail.

The eggs are carried about in this way for some months and the female finds her way into shallow water, the male into deep water.

In the early summer months the eggs of the female, which is then in shallow water among seaweed, hatch out.

Meanwhile the males in the deeper water begin to cast their shells and gradually to build up a new one. They are then in poor condition, being described by the fishermen as "sick," and are unfit for food. This lasts till about the end of January or the beginning of February, when the fish have fully acquired the new shell, and the body fills up so that they are described as in "good condition" by the fishermen. During this sick condition they apparently do not eat much and are scarcely to be tempted by bait, finding shelter in crevices of the rocks or burying themselves in sand.

[C.P. 5—'13.]

13. Preservation of the Crawfish.

We have seen that the close season, which has been adopted with a view to the protection of the Cape Crawfish, corresponds to the months in which the males are in deep water engaged in casting their shell and in a sickly condition. They do not take the bait readily at this time and are unfit for commercial purposes. The females are at this time in shallow water, some still carrying their eggs, but most having got rid of them.

This is therefore the most favourable season for the fishermen and the factories to suspend their operations, but it is doubtful if the "protection" thus afforded by such a close season is of any considerable value. The males cannot readily be got. and are unfit for canning, so that fishing operations for the factories would be confined to females, but the females which have spawned in this season are just those which presumably could best be spared and the catching of which would do the least harm. As the females which have just given rise to progeny are of less value economically than those about to do so, the most effective close season would cover the months just previous to the time at which they get rid of their eggs.

However suitable this close season may be therefore for the fishermen it cannot be held to be the most effective for preventing overfishing and damage to the supply.

A second means adopted for the preservation of the industry was to impose a size limit of 3 inches (measured from the base of the eyestalk to the end of the carapace or shield). It was enacted that no crawfish below this size should be caught. This however protected, it is to be noted, three different classes of crawfish: first, the very small forms (males and females) such as were of commercial use as a delicacy; second, the adolescent and sexually mature males; and thirdly, the adolescent and secondly mature females. We have adduced reasons for believing that the first are particularly liable to the attacks of such natural enemies as the octopus, and nature has made special provision for a natural drain on these forms by their large numbers so that the damage caused by man is probably insignificant as compared with the normal mortality at this season. With regard to the second, the protection of young adolescent males, these it would appear are just the forms which can most readily be dispensed with, being the least valuable from the point of view of the preservation of the species. An analogous case is that of seals, where the young males or "bachelors" are found to be those that can be killed off with least damage to the industry. In both

cases the animal is polygamous, and there will probably always be a sufficient number of males to fertilise all the females. With regard to the third it would seem that the young female, reproducing, or about to reproduce its kind, should be the object of special care. Without doubt this protection does considerably safeguard the continuation and multiplication of the species, but it might be suggested that later stages, in which the female may be more fertile and capable of reproduction, should be the object of still more special care. A female at the zenith of its reproductive powers is the most valuable from the point of view of the preservation of the species. It would appear that as a matter of fact (though it is a point still to be investigated more fully) this period in the life of the female is between $2\frac{1}{2}$ and 4 inches, so that the strict preservation of these forms would be the best means of safeguarding the industry. It could not, however, perhaps be found practicable to enforce such a regulation. The fish are caught in nets and promptly tumbled into the boat, often in the dark of early morning, when there is neither time nor opportunity for readily separating out and throwing back into the sea females between $2\frac{1}{2}$ and 4 inches long. The difference between male and female are, however, as has been pointed out, well marked, and are seen by the experienced fishermen at a glance, and if any relaxation of the restrictive measures be contemplated in the future, in view of stricter protection of the females it might quite well be in allowing the capture of young males.

A third direction in which the protection of the crawfish has been sought is the protection of "berried" females or females carrying eggs externally. This is one of the most obvious methods of dealing with the problem, and regulations to this effect cannot but be very useful, though they have been avoided, it is said, by stripping the female of eggs before landing the catch. Females with the ovaries well-developed and with internal eggs demand protection, however, quite as much as those with external eggs, and the only fault with the regulation is that it implies the non-protection of such females.

A fourth method of ensuring the continuation of the supply of crawfish is one which has not yet been tried, but has been adopted for some time in the case of the lobster of the Northern Hemisphere. It is that of artificial hatching, which may be carried out by collecting the eggs and by a system of artificial aeration keeping them until the young hatch out. These young, free-swimming forms are then turned into the sea, having probably been tided over a dangerous period of their development. This method could probably be easily carried out in the case of the South African Crawfish.

Lastly, artificial hatching can be rendered still more effective by artificial rearing, namely by keeping the free-swimming forms in comparative security from the attacks of their natural enemies by rearing them in ponds or enclosures until they have passed the pelagic stage and have become ground-frequenting forms. It is possible, however, that this may not be easily accomplished in the case of the crawfish, as it apparently passes through a long free-swimming larval stage. Further investigation of this point is required.

With regard to the general question as to what steps should now be taken to modify or extend the present laws, with a view to preserving an industry which is apparently threatened by inadequate protection and by the prospect of much more extensive fishing operations in the immediate future, it would appear that the most effective means would be the protection of the female between $2\frac{1}{2}$ and $4\frac{1}{4}$ inches (new measurement). There does not appear to be the same need for protecting the very young forms, up to say $1\frac{1}{2}$ inches, nor the males of any size, but in view of the threatened decrease in the supply it may not be advisable to withdraw any of the present restrictions, (including four months close season as recommended by the Fisheries Advisory Board), which do not impose a very heavy burden on fishing operations and afford some protection however small and inadequate. The proposed alteration therefore would be the *raising of the size limit from 3 to 4 inches, measured from the base of the eyestalk to the end of the carapace (or four and one-fourth inches measured from the tip of the rostrum or beak).*

Still more effective measures would be the protection throughout the year of all female crawfish, and this may yet have to be seriously considered.

It is to be borne in mind in framing such regulations that the ordinary fishing operations of the Cape fishermen for the Cape market do not seem to have affected the supply so seriously as those of the canning companies for oversea markets, if indeed the former have affected it at all, and the question may therefore be raised as to whether a distinction should not be made between these two in framing restrictive regulations.

Whatever difficulty there may be in adjusting the difference between the immediate interests of the factories and the permanent preservation of the industry, there is no such trouble in the methods of preserving or augmenting the supply of crawfish by means of artificial hatching and rearing, and all agree as to the desirability of carrying on further investigation which may lead to a more adequate knowledge

of the life history of the crawfish and possible practical results of great economic importance. *Steps should at an early date be taken in the matter of artificial hatching.* In the emphatic words of the manager of the Hout Bay Factory "the sooner such a course is adopted the better; it is inadvisable to follow the example set in the Northern Hemisphere and wait until the fishing grounds are denuded before making the experiment."

Finally, the question of controling crawfish factories and the procuring of reliable returns of quantities and conditions of fish caught should receive careful consideration, and adequate means should be taken for inspection.

Note.—In carrying out these investigations on the Crawfish and Crawfish Industry I have been greatly assisted by the ready co-operation of the Managers of the Crawfish Factories, to whom I desire to express my obligations. The actual fishing operations mentioned on p. 5 were efficiently carried out by the Fishery Officer, Mr. Cripps.

[C.P. 5—'13.]

II. REVIEW OF THF SOUTH AFRICAN CLUPEIDÆ (HERRINGS) AND ALLIED FAMILIES OF FISHES.

Owing to a lack of definite descriptions and figures of South African fishes there has been considerable doubt as to what fish really occur in South African waters. This is well illustreated in the case of the Herring family, which contains so many fish of economic importance. Thus, in the early records of Van Riebeek, mention is made of Herring. In his Journal, under the date February 24th, 1654, he wrote :—" Caught on board the *Calff* half a boatful of fine herrings—about 1,000 were salted—making the finest pickled herring in the World. Never caught so many together ; generally only found three or four in a shoal of harders, which, when salted, were found to be very delicate, and will be a great treat for the officers of the return fleet." From time to time since this date discoveries of the existence of Herring in South African waters are recorded. Only a few years ago much was made in the local press of the Eastern Province of such a discovery, and hopes entertained of the possible development of a herring industry on lines rivalling that of the North Sea. The " Penny Mail " gave an emphatic assurance that these were " true Herring." Nothing further, however, in the way of more definite information or practical results followed.

In the year 1853 a fish called the Shad or Sardyn was described by Pappe as a new species of *Clupea*, and was given the name *Clupea ocellata*. The description is mainly of the colour of the fish, other characters of specific value unfortunately not being mentioned. It is as follows :—" Body compressed, elongated ; head flattened at top ; muzzle obtuse ; upper jaw with a central notch and a little projecting. *No teeth in either mandible ;* eyes and scales large. One dorsal only, tail deeply forked. Length, 6 to 7 inches. Head and back blue, changeable to green and shaded with purple, yellow and gold. Lower jaw and gill cover silvery, with a reflecting golden lustre ; sides above the lateral line crossed by a sky blue longitudinal stripe. A line of eight to fifteen round, black, eye-light (eyelike ?) spots extends from the edge of the operculum along the whole body. Belly silvery. Iris gilt."

In 1860 Bleeker, in his "Vische v. d. Kaap," mentions *C. ocellata* as a Cape fish but without further description, and in 1861 Castelnau ("Mémoire sur les Poissons de l'Afrique australe") gives a short description, again of colour only. He draws attention to its resemblance to the common Herring, without however adding any further details of importance. He says:—"Cette espece ressemble au Hareng commun mais s'en distingue par une série de points noires, espacés, assez grands et ocellés, qui suit le ligne latérale. Ils varient en nombre, de 5 à 12 de chaque coté du corps. Le dos et le dessus de la tete sont d'un beau bleu éclatant. Le reste d'un blanc argenté, un peu doré; nageoire dorsale jaune en avant.—Caudale cendrée, les autres nageoires blanches; l' iris jaune. Se peche en eté, mais assez rarement."

There is little doubt that Van Riebeek's "fine herring," the "Penny Mail's" "true herring," "Clupea ocellata, Sardyn or Shad" of Pappe, and Castelnau's fish resembling a "Hareng commun" are one and the same fish. A number of specimens of a fish corresponding to these descriptions have been recently captured alive and put into the tanks at the Marine Station, St. James, thus affording good material for a more definite determination as well as observations of the animal in the living state.

A second member of the family, not generally known to occur in South Africa, though abundant at times, is a species of Anchovy, almost identical with the European Anchovy. It is not distinguished from the Herring by Cape fishermen, who include both under the name "Sardine" It is first definitely mentioned by Pappe, who took it to be identical with the European Anchovy, *Engraulis encrasicholus*, L., and gave the common name as "Ansjovis or Anchovy" His description is as follows:—"Body slender; head and snout pointed; upper jaw projecting considerably. Mouth deeply and horizontally cleft far behind the eyes. Maxillaries and palate armed with small but sharp numerous teeth. Scales large and deciduous; tail deeply forked. Top of head and back blue, with a tinge of green; flanks and belly silvery. Fins greenish-white. Length, 4 to 5 inches."

Bleeker (l.c.p. 56) mentions *Engraulis encrasicholus* as a Cape fish, evidently quoting from Pappe, and Castelnau (l.c.p. 68) had some doubt as to the identity of the fish with the European form as identified by Pappe. "Ce n'est qu' avec beaucoup de doute que je rapporte ce petit poisson du Cap à l'espece européenne, mais je n'ai pas cette dernière à ma disposition et depuis, par conséquent, les comparer; je me range done à l'avis du docteur Pappe, en les réunissant

en une seule espèce." In spite of the apparent resemblance to the European Anchovy, this South African form, as will be shown later on, appears to be a different species, which I have named *Engraulis capensis*.

In 1900, young specimens of an Anchovy were found in some experimental netting in the Zwartkops River, and were described as a new species, *Engraulis holodon*, by Boulenger (Mar. Inv. in South Africa, Vol. I., p. 12). Those he took to be probably the fish referred to by Pappe and Castelnau, and pointed out that they were not the European species as these authors had supposed. He says: "The 'Ansjovis' of the Cape fishermen has hitherto been referred to *E. encrasicholus*, without having been compared with European specimens. These, as well as the Australian and Neo-zelandian *E. antipodum* differ in the narrower and shorter maxillary, the toothless mandible, and the dorsal fin entirely in advance of the anal."

In 1906 a new species of Herring (*Clupea durbanensis*) was described by Regan from the Coast of Natal (Ann. Nat. Gov. Museum, Vol. I, part I, p. 4).

In 1908 two new species were added to the South African Clupeidæ by Gilchrist and Thompson, viz.:—*Engraulis vitrirostus* and *Pellona* (*Ilisha*) *natalensis* (Ann. S. Afr. Museum, Vol. VI., part 3, p. 201) from the Coast of Natal.

In 1909 the same authors recorded and described another seven members of the family, also from the East Coast, viz: *Engraulis setirostis*, Brouss, *Etrumeus micropus*, Schleg, *Clupea sagax*, Jenyns, *Albula conorhynchus*, Bl. et Schn., (*A. vulpes* L), *Elopss saurus* L., *Megalops cyprinoides*, Brouss, and *Chanos salmoneus*, Forst.

The family *Clupeidæ* has been defined as fish with the margin of the upper jaw formed by the premaxillaries and the maxillaries. Body scaly; head, naked; abdomen, usually keeled; short dorsal fin; no adipose fin; respiratory mechanism well developed, the gill openings being usually wide, opercular pieces complete and pseudobranchiæ usually well developed. This definition includes a variety of groups which later authors have found it desirable to divide up into a number of distinct families. It includes the following South African forms: (1) *Elops saurus*, (2) *Megalops cyprinoides*, (3) *Albula conorhynchus*, (4) *Chanos salmoneus*, (5) *Etrumeus micropus*, (6) *Spratteloides æstuarius*, (7) *Clupea durbanensis*, (8) *Clupea sagax*, (9) *Engraulis holodon*, (10) *Engraulis capensis*, representing the families of the *Elopidæ* (1) and (2), *Albulidæ* (3), *Chanidæ* (4), *Clupeidæ* (5-8), *Engraulidæ* (9) and (10), as in the following table:—

CLASS PISCES.

SUB-CLASS TELEOSTOMI.

ORDER TELEOSTEI.

SUB-ORDER MALACOPTERYGII.

FAMILY 1: **ELOPIDÆ.**

1. **ELOPS,** *L.*
   1. **saurus,** *L.*
2. **MEGALOPS,** *Lacep.*
   1. **cyprinoides,** *Brouss.*

FAMILY 2: **ALBULIDÆ.**

1. **ALBULA,** *Gronov.*
   1. **vulpes,** *L.*

FAMILY 3: **CHANIDÆ.**

1. **CHANOS,** *Lacep.*
   1. **salmoneus,** *Forst.*

FAMILY 4: **CLUPEIDÆ.**

1. **ETRUMEUS,** *Blkr.*
   1. **micropus,** *Schleg.*
2. **SPRATELLOIDES,** *Blkr.*
   1. **æstuarius,** *Gilch.*
3. **CLUPEA,** *Cuv.*
   1. **sagax,** *Jenyns.*
   2. **durbanensis,** *Regan.*
4. **ILISHA,** *Gray.*
   1. **natalensis,** *Gilch & Thomp.*

FAMILY 5: **ENGRAULIDÆ.**

1. **ENGRAULIS,** *C. & V.*
   1. **holodon,** *Blgr.*
   2. **capensis,** *Gilch.*
   3. **vitrirostris,** *Gilch & Thomp.*
   4. **setirostris,** *Brouss.*

Key to Families.

1 Bony plate between branches of lower jaw .. .. ELOPIDÆ
2 No bony plate between branches of lower jaw
  1 Lateral line well developed
    1 Teeth present, no accessory branchial organ .. .. .. ALBULIDÆ.
    2. Teeth absent, an accessory branchial organ .. .. .. CHANIDÆ.
  2. Lateral line absent.
    1. Mouth terminal .. .. .. CLUPEIDÆ.
    2. Mouth inferior, long snout .. .. ENGRAULIDÆ.

FAMILY 1. ELOPIDÆ.

Margin of upper jaw formed of premaxillaries and maxillaries, which extend backwards beyond the eye, a bony plate between branches of lower jaw. Pharyngeal teeth . Branchiostegals numerous. Gill rakers rather long and slender. Body not keeled. Lateral line present. Parietal bones meet above head. Widely distributed in tropical and sub-tropical seas.

Key to Genera.

A. Scales, small; dorsal a little longer than anal. .. .. *Elops*, L.
B. Scales, large; dorsal a little shorter than anal, with last ray much produced .. *Magalops*, Lacep.

1. ELOPS, Linnaeus.

Linn. syst. Nat. Ed. XII, p. 518 (1766).
Mugilomorus, Lacep. Hist. Nat. Poiss. V, 398 (1803).
Body elongate with thin small scales. Lateral line straight, with simple tubes. Mouth very large, small teeth in premaxillaries and maxillaries, lower jaw, palatines, pterygoids, parasphenoid and tongue. Dorsal fin slightly behind ventrals, both depressible within a sheath. Pseudobranchiæ well developed. The young are ribbon-shaped, like young eels.

1. Elops saurus, Linn.

Linnæus, Syst. Nat. Ed. XII, p. 518 (1766); Bloch, Aust. Fische, VIII, p. 153, pl. CCCXCIII, fig. 1 (1794); Cuv. and Val. Hist. Poiss. XIX, p. 365 (1846); Günth. Cat. Fish, VII, p. 470 (1868); Steind Sitzb. b. ak. Wien, LXI,

i. p 571 (1870). Kleinz. Verh. Zool.—bot. Ges. Wien, XXI., p. 603 (1871); Bleek. Atl. Ich. VI., p. 84, pl. CCLVIII, fig. 3 (1872); Day, Fishes Ind. p. 649, pl. CXLVI, fig. (1878), &c.

Depth of body $4\frac{1}{2}$ to $5\frac{1}{2}$ times in total, length of head $3\frac{1}{2}$ to 4 times. Eye 4 to 5 times, about equal to snout and interorbital width. Lower jaw scarcely projecting beyond upper.

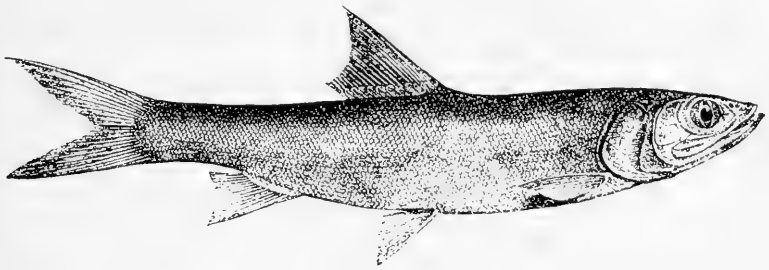
Scales about 100—120 in a longitudinal series, $\frac{1}{16}$—$\frac{1}{18}$ in in a transverse series, 9—10 between lateral line and scaly process above ventral, 28 round caudal pednule.

Dorsal 22—25, Anal 13—17.

Branchiategals 28—35.

Colour silvery.

This fish is abundantly distributed in tropical and subtropical seas, and may grow to a length of 3 feet.



Elops saurus. The "Springer" or "Salmon" of the East Coast (Blgr. after Day).

At certain seasons it ascends rivers and is known to fishermen on the East Coast as Cape Salmon, a name usually applied elsewhere in South Africa to the Geelbek (*Otolithus æquidens*). It affords excellent sport to anglers, and, in this respect, resembles its namesake the salmon more than the geel-bek. Though known by this name at Port Elizabeth and East London it is called the "Springer" in Natal, a name applied to a mullet, or "harder," in other parts of South Africa. The largest specimen recorded (Mr. Robinson, Natal) was 15 lb. in weight. He writes "The springer is related to the tarpon, which it resembles in the fire and speed of its movements when hooked and its frequent leaps out of the water when seeking to rid itself of the hook. It is a beautiful silvery fish with large scales, but, owing to its violent struggles when landed, it generally damages its skin, and it is not easy to get a perfect specimen. . . . . Its flesh is too pappy and full of bones to be edible. It will take most baits, but it is difficult to land owing to its soft mouth." Plate II. is from a photograph of two specimen caught at Delagoa Bay.

The young of the fish are ribbon shaped.

[C.P. 5—'13.]

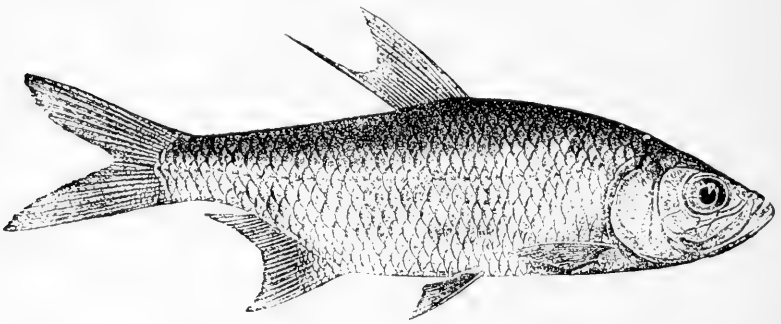
2. MEGALOPS, Lacep.

Lacep. Hist. Poiss. V, p. 289 (1803); Gunth. Cat. Fish VII, p. 471 (1868); Bleek. Atl. Ichth. VI, p. 85 (1872).
Tarpon, Jordan and Evem. Fish. N. Amer. I, p. 409 (1876).

Body not so elongated as in *Elops* and strongly compressed. Scales large; lateral line with branched tubes. Mouth large, small teeth in premaxillaries, maxillaries, vomer, palatine, pterygoid and tongue. Dorsal fin above or slightly behind ventrals, its last ray produced no pseudobranchiæ.

1. Megalops cyprinoides, Brouss.

Clupea cyprinoides, Brousson, Ichthyol, pl. IX (1782).
Megalops filamentosus, Lacep. Hist. Poiss. v. p. 290, pl. xiii, fig. 3 (1803); Bleek. Nederl. Tijdschr. Dierk. iii, 1866, p. 286, and Atl. Ichth., VI. p. 86, pl. cclxxiii, fig. 1 (1872).
Cyprinodon cundinga, Ham. Buchan. Fish. Ganges, p. 254 (1822).
Megalops setipinnis, Richards. Ann. N. H. xi, 1843, p. 493.



Megalops cyprinoides. A "Tarpon" of the East Coast (Blgr. after Day).

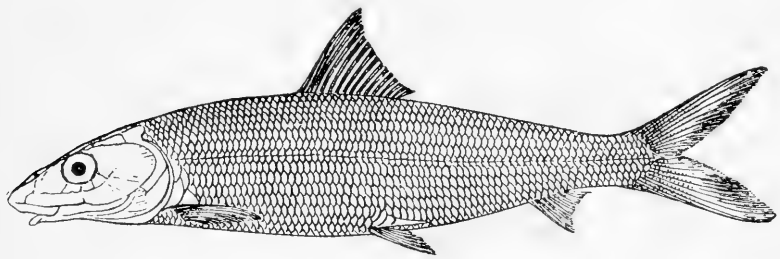
Megalops curtifilis, Richards. Ichth. China, p. 310, (1846).
Megalops indicus, Cuv. and Val. Hist. Poiss. xix, p. 388, pl. ccccexlii (1846); Bleek. Verh. Bat. Gen. xxiv, 1852, n. 7, p. 15.
Elops cundinga, Cantor, Cat. Mal. Fish., p. 289 (1850).
Megalops macrophthalmus, Bleek. Verh. Bat. Gen. xxiv. 1852, n. 7, p. 15.
Megalops macropterus, Bleek. Nederl. Tijdschr. Dierk. iii, 1866, p. 284, and Atl. t.c.p. 85, pl. cclxxiii, fig. 2.
Megalops kundinga, Bleek. tt. cc. pp. 288, 87, pl. cclxxiv, fig. 1.
Megalops cyprinoides, Bleek. t.c.p. 290; Günth. Cat. Fish. vii, p. 471 (1868); Bleek. Atl. t.c.p. 87, pl. cclxx, fig. 4; Day, Fish. Ind. p. 650, pl. clix, fig. 3 (1878); Sauv. Hist. Madag. Poiss. p. 497, pl. xlix, A. fig. 3 (1891); Pfeffer, Thierw. O.-Afr., Fische, p. 70 (1896).

Megalops oligolepis, Bleek. t.c.p. 292.
Elops apalike, Day, Fish. Malab., p. 228 (1865).
Elops cyprinoides, Playf. & Gunth. Fish. Zanzib. p. 122 (1866); Peters, Reise Mossamb. iv, p. 92 (1868).

Depth of body equal to or a little greater than length of head, 3 to 4 times in total length. Eye $2\frac{3}{5}$ to $3\frac{1}{2}$ times in length of head, greater than length of snout or interorbital width; lower jaw projecting beyond upper; maxillary extending to below posterior border of eye or a little beyond. Gill-rakers at least as long as gill-filaments, 25–35 on lower part of anterior arch. Dorsal 17–20, originating above base of ventral. Anal 24–28. Scales 37–42, $\frac{5}{7}$–$\frac{7}{8}$, 4–5 between lateral line and scaly process above ventral, 12–14 round caudal peduncle. Silvery, bluish green on the back.

Family 2. ALBULIDÆ.

Margin of upper jaw formed of maxillaries. Small teeth in jaws, vomer and palatine; patches of coarse flat teeth on tongue, sphenoid and pterygoid. Branchiostegels about



Albula vulpes.

14. Gillrakers, short. Body not keeled. No bony platse between jaws. Parietal bones meet above top of head. Young pass through a ribbon-like larval stage.

ALBULA, Gronov.

Gronov. Zoophyl, p. 102 (1763); Block & Schneider Syst. Ichth., p. 432 (1801)
Butrynus, Lacep. Hist. Nat. Poiss., v. p. 45 (1803).
Glossodus (Cuv.) Agassiz in Spix. Pisc. Brasil, p. 48 (1829).

Albula vulpes, L.

Jordan and Everman, Fishes of North America, p. 411. (see synonymy)

Albula conorhynchus, Gilch. & Thomps. Ann. S. Af. Museum. VI., p. 269 (Natal).

Depth of body nearly 4 times in total length, excluding caudal, length of head 3^{3}. Snout, $2\frac{4}{5}$ times diameter of eye, which is nearly $1\frac{1}{2}$ times in interorbital width and 6 times in

length of head. Maxillary reaches to vertical of about $\frac{4}{5}$ the distance between point of snout and anterior margin of eye. Profile from origin of dorsal to point of snout convex.

Dorsal 17, commences a little nearer to base of caudal than to point of snout, and $\frac{3}{4}$ of its base is situated in advance of the ventrals; anterior rays nearly $\frac{3}{4}$ length of head, posterior margin of fin slightly concave. Pectorals $\frac{2}{5}$ length of head. Ventrals over $\frac{1}{2}$ length of head, inserted below last $\frac{1}{4}$ of dorsal. Anal, 8; about $\frac{1}{2}$ length of dorsal and $\frac{1}{2}$ height. Caudal forked, upper lobe longest and about $\frac{9}{10}$ length of head. Lat. L. 70, nearly straight; lat. tr. $\frac{9}{13}$.

Colour (of preserved specimen), silvery, darker above.

(This description is of the Natal specimen).

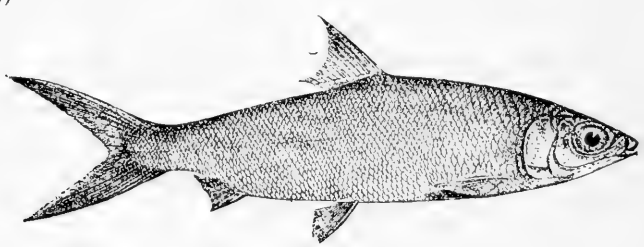
Family 3. **CHANIDÆ.**

Premaxillaries joined to anterior edge of maxillaries. No teeth. Branchiostegels, 4; pseudobranchiæ well developed. An accessory branchial organ. Lateral line well developed. Eye with adipose eyelid. Abdomen broad, flat.

CHANOS, Lacep.

Lacepede. Hist. Nat. Poiss. v. 395 (1803).

Lutodeira (Kuhl) Ruppel, Neue Wirbelthiere Abyssinia, 18, (1835).



Chanos salmoneus (After Day).

Ptycholepis, Gray, Dieffenbach's Travels in New Zealand, II, 218 (1842?).

The only genus in this family.

Chanos salmoneus, Forst.

Day, Fishes of India, p. 651 (see synonymy) Gilchrist & Thompson, Ann. S. Afr. Mus. VI. p. 271 (Natal).

Depth of body, $3\frac{3}{4}$ times in total length excluding caudal; length of head, $4\frac{2}{3}$ times. Snout, $\frac{3}{5}$ diameter of eye, which is $1\frac{1}{4}$ times in interorbital width and $3\frac{3}{10}$ times in length of head. Eyes, subcutaneous; upper surface of head flat; upper jaw overhangs lower, maxillary reaches almost to vertical of anterior margin of eye; opercle nearly twice as high as broad.

Dorsal 15 commences about midway between anterior margin of eye and base of caudal, highest in front, upper margin concave, 2 rows of scales at its base; longest rays nearly $\frac{6}{7}$ length of head. Pectorals pointed, $\frac{2}{3}$ length of head, with an elongated scaly appendage above the base. Ventrals $\frac{3}{5}$ length of head, inserted under middle of dorsal and with a long basal scale. Anal 9, small, lower margin concave, 2 rows of scales at base; anterior rays about $\frac{3}{7}$ height of longest ray of dorsal. Caudal deeply lobed, $1\frac{1}{2}$ times length of head, with two pointed laminæ of scales at its centre. Lat. l. 87, lat. tr. $\frac{12}{15}$.

Colour (of preserved specimen) bluish on top, silvery below; dorsal dark, and both it and anal and ventrals covered with minute dark specks, pectorals dark and also with minute specks. (This description is that of the Natal specimen).

Family 4. CLUPEIDÆ.

Mouth, large terminal; maxillaries forming margin of upper jaw, each of three pieces. Teeth, small, rudimentary, or wanting. Branchiostegels 6-15. Pseudobranchiæ present. No lateral line. Eyes with or without adipose eye-lids. Abdomen rounded or compressed and frequently armed with bony plates (includes the group Clupeina and Dussumieriina of Gunth., vi, 413-467).

Key to Genera.

Belly rounded, no abdominal scutes, a silvery band.
  Dorsal, 11-18 .. .. Spratteloides.
Belly rounded, no abdominal scutes, no silvery band.
  Dorsal, 18-20 .. .. .. Etrumeus.
Body compressed with scutes.
  Anal, 15-25 .. .. Clupea.
Body compressed, with scutes.
  Anal of more than 30 rays .. Ilisha.

SPRATELLOIDES, Bleeker.

Body elongate, slightly compressed, without abdominal scutes. Mouth terminal. Scales deciduous. Teeth minute or absent. Dorsal opposite or nearly opposite ventrals.

Spratelloides æstuarius, n. sp.

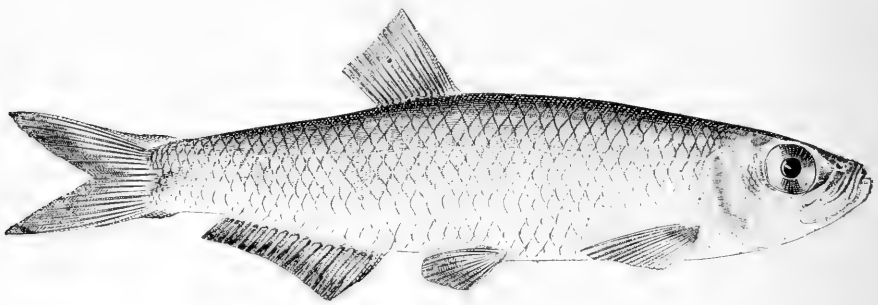
Depth of body, $4\frac{1}{5}$ in total length, excluding caudal; equals length of head. Snout $3\frac{1}{5}$ times in length of head, shorter than diameter of eye, which is four times in head; the lower jaw slightly projects beyond upper. Maxillary, broad; reaches to near vertical of anterior border of eye. Supplemental bone broad; slightly broader than maxillary. About 30 gill-rakers on the lower branch of the outer gill-arch.

[C.P. 5—'13.]

Dorsal 15, much nearer root of caudal than end of snout, these distances being in the proportion of 5 to 8. Anal 20, begins under the end of the dorsal. Ventrals inserted slightly in front of dorsal.

About 40 scales in a longitudinal and 10 in a transverse series. A patch of small teeth on the anterior end of premaxillary and mandible. The maxillary denticulate. There are no scutes on the abdominal margin between pectorals and ventrals nor behind ventrals, but there are three or four fused into a rather sharp and hard ridge on the thoracic region in front of pectorals.

This fish is common in the tidal portion of the Zwartkops River near Port Elizabeth, where it is known as "White-bait." It is found also in some of the tidal rivers near East London.



Spratelloides æstuarius, n. sp.

A fish apparently identical with it has been found by Mr. W. W. Thompson in Princess Vlei, a sheet of practically fresh water on the Cape Flats.

ETRUMEUS, Bleeker.

Bleeker, Verh. Bat. Gen. xxv., 48 (1853).

Body, elongate, slightly compressed; abdomen, rounded, without scutes; mouth, terminal; scales, cycloid, very deciduous; ventrals, entirely behind dorsals.

Dorsal fin long and low. No silvery lateral stripe.

Etrumeus micropus.

Clupea micropus, Schleg. Faun. Japon. Poiss, p. 236, pl. 107, fig. 2.

Etrumeus micropus, Bleeker, Verh. Bat. Gen. xxv, p. 48. Gilch. and Thomp. Ann. S. Afr. Mus. vi., p. 268 (1909).

Depth of body 6 times in total length excluding caudal, length of head $4\frac{1}{5}$ times. Snout $\frac{5}{6}$ diameter of eye, which is nearly $2\frac{9}{10}$ times in length of head and twice the interorbital width. Lower jaw slightly projecting beyond upper, maxillary reaches to vertical of anterior margin of eye.

Dorsal 18 ; originates nearer to point of snout than to base of caudal by about the length of the base of dorsal fin ; 2nd and 3rd rays $\frac{3}{5}$ length of head, remainder rapidly shortening, upper portion of fin slightly concave. Pectorals $\frac{7}{10}$ length of head, axillary scale very long. Ventrals about $\frac{1}{3}$ length of head. Anal 10, originates in posterior sixth of body, low. Caudal nearly $\frac{9}{10}$ length of head, forked. Scales 52-54. Lat. tr. 13.

Colour (of preserved specimen), dark on back above lateral line, sides and belly silvery.

This fish is recorded also from Japan. The above description is of a specimen from Natal.

CLUPEA (Artedi) Linn.

(Artedi) Linnaeus Syst. Nat. Ed. x, 317 (1853).

Rogeina, Cuvier & Valenciennes, Hist. Nat. Poiss., xx, 340 (1847).

Alosa, Cuv. Regne Anim. 2nd Ed. ii, p. 319 (1829).

Body compressed, with abdominal scutes, no lateral line. Maxillary of three pieces. Teeth present or absent. Dorsal fin short. Anal elongate. Ventrals with 6-9 rays.

Key to Species.

Depth of body about 5 times in total length : *C. sagax.*
Depth of body about $2\frac{1}{2}$ times in total length : *C. durbanensis.*

Clupea sagax, Jenyns.

Jenyns, Voyage of the Beagle, Fishes, p. 134, 1842 (Lima). Gilchrist & Thompson, Ann. S. Afr. Mus., Vol. vi, p. 269 (Natal).

Alosa fimbriata, Kner & Steindachner Sitzl. Akad. K. Wien 1886 (Chili).

Clupea ocellata, Pappe, Synopsis of the Edible Fishes of the Cape of Good Hope, p. 20, 1853 ; Bleeker, over eenige vischsorten van de Kaap de Goede Hoop. Nat. T. Ned. Ind. XXI, 1860, p. 56 ; Castelnau, Mémoire sur les Poissons de l' Afrique australe, p. 67, 1861.

Body elongate, compressed, depth slightly over 5 times in total length excluding caudal, length of head $3\frac{4}{5}$ times, greatest breadth of head about half its length. Snout $1\frac{1}{5}$ times the diameter of the eye, which is equal to the breadth of the interorbital space.

[C.P. 5—'13.]

Adipose eyelids present, each covering about $\frac{1}{3}$ of the diameter of the eye. Lower jaw scarcely projecting beyond upper, equal when completely closed. Maxillary extends to anterior third of eye. Lower branch of the outer branchial arch long, nearly straight, with about 115 gill-rakers, the longest of which is slightly longer than the diameter of the eye and slightly less than the length of snout.

Scales of the upper part of the body in front of dorsal striated and ciliated, those of the sides and belly smooth and slightly ciliated. They are regularly arranged and loose. Abdominal scutes in front (19) and behind (12) ventrals. Two of the anterior are in front of pectorals. About 54 scales in a longitudinal and 12 in a transverse row. Teeth absent in jaws and palate and tongue, which however has a sharp, rough, bony ridge.

Dorsal III 16, a little in front of middle of body, the distance between tip of snout and beginning of dorsal being $2\frac{1}{5}$ in total length. The longest ray a little more than the length of the

Clupea sagax. The Cape Herring or Sardine.

head and equal to the length of its base. Anal III 15. Beginning of ventral below posterior part of base of dorsal, its longest ray $1\frac{2}{3}$ in head. The length of pectoral is $\frac{1}{2}$ its distance from the ventral.

The colour of the fish when alive and observed swimming in the water appears of a silvery, slightly greenish shade. This uniform colour is only broken by the black spots along the side. These may be numerous, few or entirely absent. When removed from the water, and especially when the easily-detached scales fall off, the variety of colours recorded by Pappe and Castelman may be observed. The lower $\frac{2}{3}$ of the body is then of a bright silvery colour sharply marked off by a straight line from the upper third, which is of a vivid green or greenish blue tint. The line of demarcation follows the line of greatest diameter of the body, so that when viewed from above, the fish is of a dark blue or green colour, and when viewed from below of a bright silvery hue ; the sharp line of demarcation is

interrupted by the series of dark spots which has suggested the specific name of the fish. These range from about 20, extending from the head to the tail, to a few at the anterior end of the body and in some cases are absent. The position of each scale is marked on the upper part of the body by a small black dot and, in some cases, there are two or three larger black marks, symmetrically placed on each side at the base of the dorsal fin.

The ovaries were examined and were found to be not fully developed. In a specimen 40 mm. in length from snout to tip of caudal and weighing 84 grammes, the ovaries weighed 3 grammes. The largest ovum was ·63 mm. in diameter and was full of very small oil globules.

Pappe has compared this fish with the Shad of Europe and gives this apparently as the popular name in South Africa. This name is not now used, but "Sardine." The Shad of Europe —*Clupea finta*, the Allis Shad, and *C. alosa*, the Twaite Shad— differ from *C. ocellata* in deeper body, fewer number of gill-rakers, larger number of scales and other respects.

The fish does not seem to differ from *C. sagax* Jenyns recorded (from a single and somewhat imperfect specimen) by Gilchrist and Thompson from Natal. The type was found at Lima. *Alosa fimbriata*, Kner and Steindachner, from Chili, may also be the same species. It is very closely related to the European Pilchard (*C. pilchardus*) small tinned specimens of which are called "Sardines." It is sometimes preserved in salt or oil by the native fishers, and both in this and the fresh condition has an excellent flavour. It would probably make a valuable article of commerce if cured in sufficient quantities. The difficulty is to make a beginning and this might be arranged by offering a reward for the best preserved samples.

Clupea durbanensis, Regan.

Regan, Annals of the Natal Government Museum, Vol. 1, Part 1, p. 4, 1906. Gilchrist and Thompson, Annals of the South African Museum, Vol. VI, Part 3, p. 269, 1909.

Body comparatively short, deep and much compressed. Abdominal profile very convex. Depth $2\frac{2}{5}$ to $2\frac{2}{3}$ in length, length of head $3\frac{2}{3}$ to $3\frac{3}{4}$. Snout equals the diameter of eye, which is 4 to $4\frac{3}{4}$ times in length of head, interorbital width $3\frac{1}{2}$ to $3\frac{3}{4}$.

Eyes with adipose lids, each covering about $\frac{1}{2}$ of the eye. Lower jaw shut within upper; maxillary extends to below middle of eye or slightly beyond. Gill-rakers about 200 in the 2 sections of the lower branch of the outer arch, these two

sections forming nearly a straight line. The longest ray equals the breadth of the interorbital space. Post orbital portion of head longer than or about equal to remainder of head.

Scales regularly arranged, finely striated ciliated, 43-45 in a longitudinal, 14 in a transverse series ; 12 scuta behind and 15 before ventral.

Dorsal III 14, a little nearer end of base of caudal than end of snout, the longest ray equal to the length of its base and double the length of the last ray. Anal III 17-19. Pectoral $\frac{2}{3}$-$\frac{3}{4}$ length of head. Origin of ventral a little in advance of middle of dorsal. Caudal deeply forked.

Colour : Silvery, a dark spot on shoulder. Edge of dorsal blackish.

This description is drawn up from that of the authors referred to, and from a large specimen, forwarded by the Durban Museum, 240 mm. in length excluding caudal (which is 76 mm.) the body is deeper, being $2\frac{2}{5}$ in total, the head is longer ($3\frac{2}{5}$ in body), eyes smaller $4\frac{3}{4}$ in head, the post orbital position of the head, which, in the other specimen is equal or about equal to the rest of it, is here decidedly longer, being 1·3 times the rest of the head.

This East Coast Herring is a handsome and substantial-looking fish and may occasionally be seen as smoked fish in the inland cities. It is said, however, to be very bony. It is recorded as yet only from Natal waters.

ILISHA, Gray.

Platygaster, Swainson, Nat. Hist. ii, p. 294 (1839) name pre-occupied.

Ilisha, Gray in Richards. Ichth. China, p. 306 (1846) ; Bleek. Atl. Ichth. vi. p. 116 (1872).

Pellona, Cuv. & Val. Hist. Poiss. xx, p. 300 (1847) ; Gunth. Cat. Fish, vii. p. 454 (1868).

Ilisha natalensis (Gilch. & Thomp.).

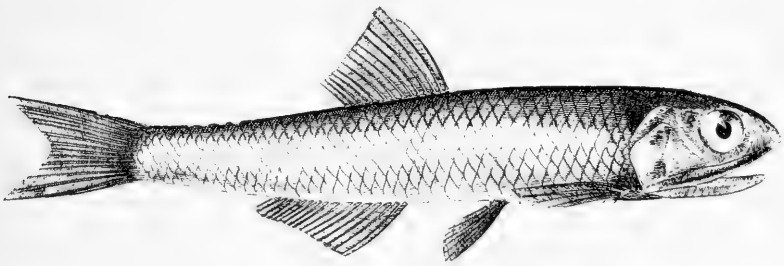
Pellona natalensis, Gilch. & Thomp. Ann. S. Afr. Mus. Vol. vi. Pt. ii, p. 202.

Teeth on jaws, palate, vomer, and tongue. Depth of body $2\frac{3}{4}$ times in total length excluding caudal, length of head $3\frac{2}{5}$ times. Snout nearly $\frac{4}{5}$ diameter of eye, which is $1\frac{7}{8}$ times interorbital width and $2\frac{2}{5}$ times in length of head. Ridges on occiput converge very slightly posteriorly and meet anteriorly ; mouth opens on superior side, lower jaw projects beyond upper ; maxillary reaches to vertical of posterior nostril ; eyes large and situated high up, occupying upper half of head. Dorsal profile almost straight, abdominal profile convex.

Dorsal 17 ; situated about midway between point of snout and base of caudal. Pectorals $\frac{3}{5}$ length of head. Ventrals situated just in front of vertical of origin of dorsal and very small, about $\frac{1}{2}$ diameter of eye in length. Anal 37 ; commences below posterior margin of dorsal, length of base $2\frac{1}{5}$ times in total length of body excluding caudal. Caudal forked, as long as the head. Scales, 16 scutes anterior to and 8 posterior to ventral fins.

Family 5 : ENGRAULIDÆ.

Mouth very large, upper jaw projecting beyond lower. Premaxillaries small, firmly joined to maxillaries, which are formed of three pieces and are long and slender, extending to beyond eye. Branchiostegels 7-14. Pseudobranchiæ present. No lateral line. No adipose eyelid. This family is closely allied to the Clupeidæ, from which it should perhaps not be separated.



Engraulis holodon. An East Coast Anchovy.

ENGRAULIS, Cuvier.

Conical snout projecting beyond very large mouth. Maxillary extending beyond eye, but not beyond gill opening. Teeth small but equal. Dorsals posterior to ventral, about middle of body. Pseudobranchiæ present. Branchiostegels 9-14. Gill-rakers long and slender. Vertebrae about 48.

Key to Species.

Anal begins below middle of dorsal ... ... *E. holodon.*
Anal begins behind dorsal ... ... *E. capensis.*
Anal begins about last ray of dorsal :
Maxillary extends to a little beyond base of pectoral ... ... *E. vitrirostris.*
Maxillary extends to end of ventral ... *E. setirostris.*

Engraulis holodon, Blgr.

Boulenger, Marine Investigations in South Africa, Vol. I, p. 12, 1900.
[C.P. 5—'13.]

Depth of body 5 to $5\frac{1}{2}$ times in total length, length of head 4 times. Snout pointed, strongly projecting, shorter than eye, the diameter of which is three times in the length of the head. Teeth present in both jaws, minute; maxillary tapering behind, extending to gill-opening. Gill-rakers long, 12 on the lower part of anterior arch. Dorsal with 14 rays, originating a little nearer root of caudal than end of snout. Anal with 19 or 20 rays, originating below middle of dorsal. Pectoral $\frac{2}{3}$ length of head. Spiny scales of abdomen 9 in number, extending between pectorals and ventrals. Caudal deeply forked. Caudal peduncle twice as long as deep, 40 to 42 scales in a longitudinal series, 9 in a transverse series. A silvery lateral stripe.

The specimens of which this description is given by Boulenger were young, the total length being 50 mm. The adults are not known. They are very abundant in the nettings carried on in the Zwartkops River near Port Elizabeth and are known as "White-bait," as are also other immature fish, such as *Clupea sagax* and *Spratteloides æstuarius*. The term "white bait" is in Europe applied to the young of the herring and other fish.

The Anchovies of warmer seas characterised by a fewer number of vertebrae and the possession of a silvery lateral stripe have been placed in a separate genus (*Slotephorus*, Lacépède) and the distinction would seem to be justified. *Engraulis holodon* and *E. capensis* occur in practically the same latitude in S. Africa, but the former in the warmer waters of the Indian Ocean and the latter in the colder waters of the Atlantic.

E. holodon has about 42 vertebrae and a silvery lateral band and, therefore, would be placed in the genus *Stolephorus* of Lacépède.

Engraulis capensis, n. sp.

Engraulis encrasicholus, Pappe (not L.), Synopsis of the Edible Fishes of the Cape of Good Hope, p. 21, 1853; Bleeker, Over eenige Vischsoorten van de Kaap de Goede Hoop. Nat. T. Ned. Ind. XXI, 1860, p. 21; Castelnau, Mémoire sur les Poissons de l'Afrique australe, p. 68.

Depth of body $6\frac{2}{5}$ in total length, excluding caudal, length of head $3\frac{3}{5}$. Snout pointed, strongly projecting, slightly shorter than diameter of eye which is $4\frac{2}{5}$ in length of head. Maxillary not tapering behind, ends in angle of jaw but does not extend to end of mandible. Gill-rakers 35 on lower branch of outer gill arch, the longest $1\frac{1}{3}$ in the diameter of the eye.

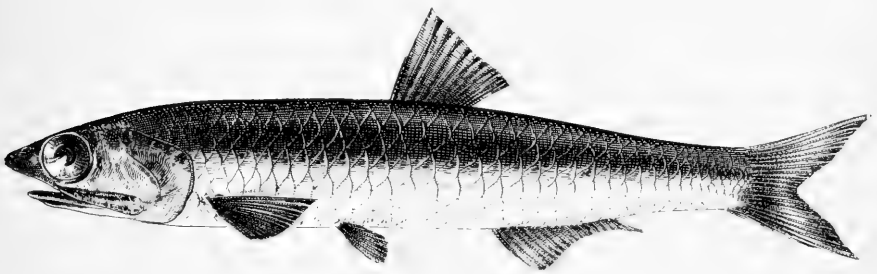
About 44 scales in a longitudinal series, 6 in a transverse series. Teeth present in both jaws, minute.

Dorsal with 15 rays, its origin half way between end of snout and root of caudal. Anal with 19 rays originating behind dorsal. Pectoral $2\frac{1}{10}$ in head. Vertebræ 46.

Colour: Dark above, silvery below.

This fish closely resembles the European Anchovy (*E. encrasicholus L.*), but differs from it in having teeth in the lower jaw and a fewer number of scales in the lateral line (44 as against 48). The number of vertebræ is the same—46 in one specimen examined—and the colour, general shape of body, etc., are very similar.

In referring to *E. antipodum* of the Australian regions, Günther states that "the only difference between European specimens and those from the Southern Hemisphere is a slightly increased number of anal rays, viz., 18-20." He regards it, therefore, as a variety of *E. encrasicholus*. The South African specimens resemble Günther's specimen from



Engraulis capensis. The Cape Anchovy.

Van Diemen's Land and New Zealand in having the additional rays, but differ from it in the same features which mark it off from *E. encrasicholus*. There seems little doubt as to the constancy of these differences. The scales have been counted in about half-a-dozen specimens, showing a possible difference of one or two scales, but nothing like 48. The teeth in the lower jaw are also well marked and rather numerous, but smaller and readily seen with a lens or under a low power of the microscope, the longest being about ·2 mm. in length.

This fish differs markedly from the only other South African Anchovy, which has been sufficiently described (*E. holodon*, Blgr.) most obviously in the length of the maxillary, which in that species reaches the gill opening, and in the position of the anal, which originates below the middle of dorsal.

It is not a point of great importance as to whether early authors, who described the South African Anchovy referred

to this or to the other species, but probably the reference was to the species near the Cape, not to the East Coast species, and to the one which most resembles the European form. I have therefore regarded Pappe's, Bleeker's, and Castelnau's *E. encrasicholus* as a synonym of the species which I have now described under the new name of *E. capensis*.

This fish is closely related to the European Anchovy, it resembles it also in its economic qualities, and there is here an opening for fishery entetprise. Difficulties, however, will present themselves in the ascertaining of its times and places of occurrence, its capture and preparation. The attention of fishermen and fishmerchants should be drawn to the fish, and an adequate reward offered for its introduction to the market.

Engraulis vitrirostris, Gilch. & Thomp.

Gilchrist & Thompson, Ann. S. Afr. Museum, Vol. VI., Part II., p. 201 (Natal).

Teeth, fine, a row on each jaw, two patches on vomer, band on palatines, and covering the tongue. Depth of body $3\frac{1}{2}$ to nearly $3\frac{3}{4}$ times in total length excluding caudal, length of head $4\frac{1}{3}$ times. Snout $\frac{7}{9}$ to $\frac{8}{9}$ diameter of eye, which equals or is slightly less than interorbital width and is $4\frac{1}{9}$ to $4\frac{3}{9}$ times in length of head. Eyes subcutaneous; snout obtuse and projects slightly beyond upper jaw; maxillary produced beyond gill-opening to a little beyond the base of the pectorals; opercle rather more than twice as high as broad; gill-rakers about $\frac{1}{2}$ diameter of eye in length, 21-24 in horizontal limb of outer branchial arch.

Dorsal i 12; commences nearly midway between base of caudal and point of snout; spine short and separate from soft rays. Pectorals $\frac{3}{4}$ to $\frac{4}{5}$ length of head, reach to origin of ventrals, which are very small, about $\frac{1}{3}$ length of head. Anal 41; commences behind vertical of last ray of dorsal. Caudal nearly as long as head, forked. Scales moderately large, cycloid; 16 scutes anterior to, 9 behind base of ventrals.

Colour (of preserved specimens), silvery, shot with gold, back a darker shade, venules on shoulder.

This description is that of the type.

Engraulis setirostris, Brouss.

Clupea setirostris, Broussonet, Ich. dec. i

Engraulis setirostris, Day, Fishes of India, p. 626. (See synonymy). Gilchrist and Thompson, Ann. S. Afr. Museum, Vol. VI., Part III., p. 267 (Natal).

Teeth minute, present on both jaws and on palatines and tongue. Depth of body $3\frac{4}{5}$ times in total length excluding caudal, length of head $4\frac{1}{5}$ times. Snout about $\frac{3}{4}$ diameter of

eye, which is slightly greater than interorbital width and a little more than $3\frac{1}{2}$ times in length of head. Snout obtuse, very slightly projecting beyond lower jaw; angle of mouth is beneath posterior edge of eye; maxillary much prolonged, extending to anus, lower edge finely serrated, and slightly enlarged or bulging at angle of mouth. 10 gill rakers on horizontal limb of outer branchial arch, rather widely separated from each other and the longest shorter than diameter of eye.

Dorsal i 14, originates midway between anterior third of eye and base of caudal; 4th ray about $\frac{9}{10}$ length of head, succeeding rays rapidly decrease giving the fin a triangular shape Pectorale nearly equal length of head. Ventrals nearly $\frac{3}{5}$ length of head. Anal 38, commences below or slightly behind last ray of dorsal; anterior rays about $\frac{3}{4}$ height of longest rays of dorsal, succeeding 12 or 13 decrease rapidly, remainder subequal. Caudal forked, $1\frac{1}{5}$ times length of head. Abdomen compressed; the spiny scutes extending forward to gill-openings, 14 before, 10 behind insertion of ventrals. Lat. l. 42.

Colour (of preserved specimen), darkish above, silvery on sides; black venules in scapular region.

This description is that of the Natal specimen.

The South African representatives of the Sub-order Malacopterygii may be completed by the addition of the families: Mormyridæ, Pantodontidæ, Kneriidæ, Chirocentridæ, Salmonidæ, Alepocephalidæ, Stomiatidæ, Gonorhynchidæ.

The Mormyridæ are peculiar fresh water fishes found in Africa, mostly in the Nile and Tropical Africa. The following are found in the Zambesi and East Africa: *Mormyrops deliciosus*, Leach; *Petrocephalus stuhlmanni*, Blgr., *Marcusenius discorhynchus*, Peters, *Gnathonemus macrolepidotus*, Peters, *Mormyrus anchietæ*, Guim.

The small family of the Pantodontidæ is represented by a single species, *Pantodon buchholzi*, Peters, a fresh water flying fish, and another small family, the Kneriidæ, by *Kneria angolensis*, Stdr., also a fresh water fish.

The family of the Chirocentridæ is represented by its single species, *Chirocentrus dorab*, Forsk. found in the Indian Ocean and Seas of China and Japan.

The Salmonidæ are represented in South Africa only by introduced species, *Salmo fario*, the brown trout, its variety *S. levenensis*, the Loch Leven Trout, and *Salmo irideus*, the Rainbow Trout.

The Alepocephalidæ are represented by a species of *Alepocephalus*, and *Xenodermichthys socialis*. These are deep sea fish allied to the Clupeidæ and Salmonidæ.

[C.P. 5—'13.]

The Stomiatidæ (including Sternoptychidæ) is also a deep sea family and is represented in South African seas by *Maurolicus amethysto-punctatus*, *Chauliodus sloanii*, *Astronesthes boulengeri*, *Cyclothone bathyphila*, *Argyropelecus hemigymnus*, *Sternoptyx diaphana*, *Neostomias filiferum* and *Idiacanthus ferox*.

Another small family, the Gonorhynchidæ, is represented by its single species, *Gonorhynchus greyi*, occasionally found by fishermen in their seine nets.

III. INTRODUCTION OF "MILLIONS."

The little fish known as "Millions" (*Lebistes poeciliodes*) on account of the rapidity with which it reproduces is found in Barbados. It lives in pools and thrives well in any small collection of water, such as tanks, garden fountains, etc., so that it abounds everywhere. It is a striking fact that the Island of Barbados enjoys an immunity from malaria, and as this little fish feeds to a large extent on the larvæ of mosquitoes, which occur in such collections of water, the conclusion has been drawn that the immunity of the island is due to the fact that the mosquitoes which convey the malarial parasite are kept in check by the presence of the fish, the malarial mosquito being unknown in Barbados, though other mosquitos are found. So far as the evidence goes it would seem that the conclusion is justified.

This being so, it was naturally suggested that the fish might with great advantage be introduced into the countries suffering from malaria. It was accordingly introduced into most of the other West Indian Islands, apparently with good results. In 1904 a "Citizen's Antimosquito Committee" was organised at Honolulu for the purpose of introducing mosquito larvæ-eating fish, and samples of various kinds (*Mollinisia*, *Adinia*, *Gambusia* and *Fundulus*) were successfully transported from the United States to Hawaii. No difficulty was experienced in transportation nor in the subsequent rearing of their progeny. The success of these experiments was doubtless due to the similarity of conditions, especially of temperature, in the two places.

It has proved otherwise, however, in attempts to introduce the fish into remoter and colder regions. A consignment was brought to London and throve fairly well in the Zoological Gardens, though they did not increase as rapidly as was hoped. They were kept in special tanks, as they would readily have perished from cold in open air tanks in the climate of England. As there were applications from several of the English Colonies for supplies of the fish, an arrangement was made through the Colonial Office with the Department of Agriculture of Brabados to keep a stock, from which the fish could be supplied, though the information obtained by the staff of the Zoological Gardens did not indicate that the importation of the fish would

lead to the desired result. In recent years, however, "Millions" have been sent to Australia, India, Burma, and some parts of Africa, but no success has attended these experiments. In cases where the fish survived the journey they did not thrive in the tanks specially prepared for their reception, and when set free rapidly disappeared.

No attempt has been made to introduce the fish into East Africa. In 1908, however, a consignment was brought out for the Uganda Protectorate, but, unfortunately, perished in the railway journey, owing, it was thought, to the excessive cold on the Mau Plateau (about 8,000 feet). The Administration of Rhodesia has considered the question of the importation of "Millions" into their territory, and it "does not propose, after due consideration of the value of such a step and the probabilities of success, to take any action in the matter."

There have been suggestions from time to time of the desirability of importing these fish into South Africa, and Mr. S. Goldreich recently brought the matter to the notice of the Provincial Secretary for Natal. It was then referred to the Cape Provincial Secretary for advice and assistance. In view of the risks attending the introduction of animals from other countries and the unlikelihood of any advantage to the Cape Province, it was not considered desirable that the Cape Provincial Government should take any active steps in the introduction of the new fish, but the facilities of the Trout Hatchery at Jonker's Hoek were offered for the experimental breeding of the fish.

Meanwhile the "South African Anti-malarial Association" took the matter up and ordered a consignment from the Department of Agriculture of Barbados to arrive about August to escape the South African winter. The consignment was shipped by the "Kenilworth Castle," which left Southampton on the 24th August, 1912. It consisted of seven tins, all of which arrived with their contents in a good healthy condition, some of the fish having given birth to young (the fish is viviparous) on the journey of six weeks' duration. The fish were at once distributed to the trout hatcheries of Jonker's Hoek in the Cape Province, to the Trout Hatchery at Potchefstroom, in the Transvaal, and to the Anti-Malarial Association in Johannesburg. At Jonker's Hoek the fish throve well in the open-air ponds during the summer months, but began to die off when the winter cold set in. Some were then placed under cover with an appliance for raising the temperature of the water and in this way a few have so far survived the winter. At Potchefstroom the fish were placed in a carefully prepared pond, but after a time they disappeared; the pond was

emptied, but no traces of them were to be found, and it was thought that they may have been devoured by the large frogs which were discovered at the bottom (more probably they perished from cold). The remaining lot of the imported fish, sent to the Pongola Rubber Estate Company's property in Zululand, has also disappeared.

It does not appear, therefore, from these experiments that the West Indian "Millions" can readily be acclimatised in South Africa, and attention may now be profitably directed to the finding of some native species of fish which may be as useful in the extermination of the mosquito larvæ.

It is also to be borne in mind, as I have already stated in a former report on the subject, that the introduction of animals not native to the country has already been the means directly or indirectly of injuring the native fauna, and this is an additional reason for thoroughly testing the country's own resources.

A small fish known in some districts as "Kurper" (*Tilapia*) has been observed (Howard) to clear the pools in which it lives of mosquito larvæ. It is a hardy little fish, stands transportation well, and appears to multiply quickly in favourable surroundings, so that further investigations into its habits may show that it can be utilized as a mosquito larvæ destroyer. A small species *T. philander* is abundant near Pretoria, and a few years ago I conveyed a few in a large glass vessel to Cape Town. They throve well at the Jonker's Hoek hatchery, though not reproducing rapidly, probably on account of the colder water. Plate III of this Report is from a photograph of these fish in the living condition. *Fundulus melanospilus* in German East Africa, Longo Bay, Seychelles, and two other species from Longo Bay and Zanzibar (*F. guentheri*) from Victoria Nyansa and Lake Tschaia (*F. taeniopygus*) may prove useful. Species of *Haplochilus* from Nyassa, Albert Nyansa, and probably in many other regions, are also deserving of further investigation in this connection. A small fish (*Galaxias*) found in the South West of the Cape Province may prove a useful mosquito destroyer though confined to the South Western districts of the Cape Province.

Some investigation in this direction has already been done in India; a number of fresh water cyprinodont fishes of India and Burma have been kept under observation, and it has been found that several species of *Haplochilus* in particular are as hardy as "Millions" and devour mosquito larvæ even more readily.

[C.P. 5—'13.]

The fresh water fishes of South Africa are imperfectly known and still less is known of their habits. The great benefits that would result from the discovery of some native fish of similar habits to that of the Barbados fish and suitable to this country are obvious, and such an investigation seems a matter of necessity if active steps are to be taken in combating malaria in this way.

This is a matter of course more for combined action among the different Provinces of the Union, and the Cape Province has less to gain than the others, though it would appear that malaria is endemic along the whole of the Orange River, the malarial mosquito being found at Kimberley, Barkly West, Vryburg, and Kuruman and "much of the disease known locally as 'camp fever' is in reality a mild type of Malaria" (Thornton).

The initiative in such an investigation might well be taken by the Cape Province, and, with the co-operation of the other Provinces might produce valuable results.

INDEX.

[C.P. 5—'13.]

THE CAPE CRAWFISH, JASUS LALANDII
(FIRST STAGE AFTER HATCHING.)

ELOPS SAURUS.
THE "SALMON" OR "SPRINGER" OF THE EAST COAST OF S. AFRICA
(The larger was 37 inches in length and weighed 7 lb.)

TILAPIA.

A SMALL SOUTH AFRICAN FISH WHICH MAY PROVE OF VALUE AS A MOSQUITO EXTERMINATOR.

(From a photograph of the living animal. About two-thirds natural size).