Tunny Investigations made in the North Sea on Col. E. T. Peel's Yacht, "St. George," Summer, 1933. Part I. Biometric Data.

By

F. S. Russell,

Naturalist at the Plymouth Laboratory.

With 8 Figures in the Text.

THE occurrence of the Tunny, *Thunnus thynnus* L., in the waters of the North Sea during the summer months has in recent years aroused considerable interest owing to the possibilities of sport afforded by this fish to big-game anglers. It would seem also that the majority of commercial fishermen have only recently become aware that the tunny is a regular visitor to northern waters. Our knowledge of the northern migrations of the tunny has been summarised in two publications by Le Gall (**5** and **6**), and it is evident that a careful study of the fish occurring in northern waters might do much to help in elucidating the general problem of its life-story.

In the summer of 1933, at the kind invitation of Col. E. T. Peel, D.S.O., M.C., I had the opportunity of making a preliminary survey into the occurrence of this interesting fish in the North Sea. At the same time, largely due to the reports by Mr. W. J. Clarke, F.Z.S., on the occurrence of tunny in North Sea waters, and to the successful attempts of Mr. L. Mitchell-Henry and Col. R. Stapleton-Cotton to capture them on a rod and line, there came into existence an angling club known as the "British Tunny Club." The formation of the club has attracted a number of big-game anglers to the North Sea and has given rise to further opportunities for the study of this fish, especially by the use of marked hooks.

It is a pleasure for me here to record my grateful thanks to Col. Peel for the facilities for research he afforded me and for his most generous hospitality during nearly two months' cruising on his yacht, *St. George* : I should like also to thank Col. R. Stapleton-Cotton for his great assistance in many ways and for his advice on a subject that he had already studied for several years in co-operation with well-known European biologists. To the Captain and crew of *St. George* I owe a debt of gratitude for much help willingly rendered. My thanks are also due to all members of the

British Tunny Club who have helped by marking their hooks and allowing me to have access to their fish, and especially to the Honorary Secretary, Mr. H. J. Hardy, for his help and advice. I have received also much courteous treatment from those engaged in the fishing industry and would express my feelings of gratitude to the captains and crews of the many Danish, Dutch, and British fishing vessels we boarded, and also to Mr. Bamford, Mr. Catchpole, and the Pure Ice Company at Scarborough, and Mr. Spinks and Mr. D. Buchan at Peterhead. Lastly I am deeply indebted to Mr. W. J. Clarke for much useful information he has passed on to me as a result of his many years' study of the natural history of the fishes of Scarborough. Acknowledgements are due to Mr. Victor Hey, press photographer of 1 York Place, Scarborough, for his kind permission to reproduce Figure 8.

The programme of research was divided into two main fields of enquiry :

1. A study of the fish themselves, (*a*) by marking of living fish so that if caught at a later date they might be identifiable ; and (*b*) by detailed measurements and examination of the fish caught.
2. A study of the distribution of the tunny in the North Sea in relation to hydrographical conditions.

The present report deals only with the first of these two aspects.

(*a*) *The Marking of Fish.*

It has been shown by Sella that the migrations of the tunny may be traced to some extent by a study of the occurrence of hooks in fish that have broken away from fishing-lines. On the formation of the British Tunny Club it was felt that an opportunity was afforded to help in this study by using marked hooks which could be identified again ; in this way hooks which the angler lost in fish through broken tackle might nevertheless incidentally prove of value to science if at some later date the fish in which they were fixed should be captured. Accordingly members of the club were asked to mark their hooks with three saw cuts or punch marks. This simple method was adopted as a preliminary trial to a more detailed system of marking that might be used in future years should the method prove successful.

During the fishing season of 1933 in August and September a large number of hooks have been lost in fish in the North Sea between the Dogger Bank and the Yorkshire coast. The actual number is not known but it must be at least a hundred. Many of these hooks were marked with the three saw cuts, and all are probably distinguishable by their shape and make.

I give below a list of the types of hooks that have been used and in

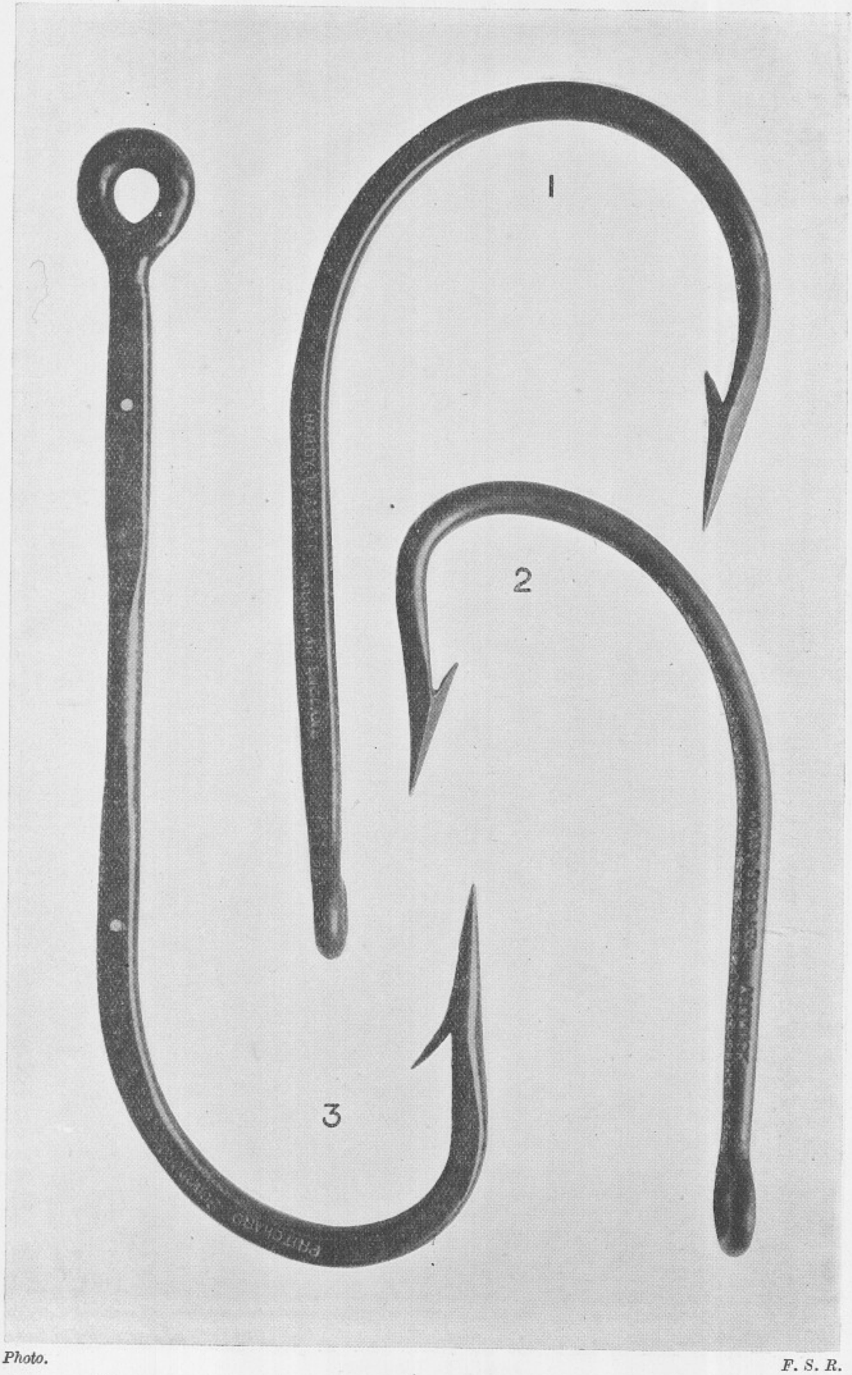


Photo. *F. S. R.*

Fig. 1.—Hooks used by anglers in the North Sea (natural size). 1. Hardy Zane-Grey; 2. Hardy Limerick; 3. Pritchard.

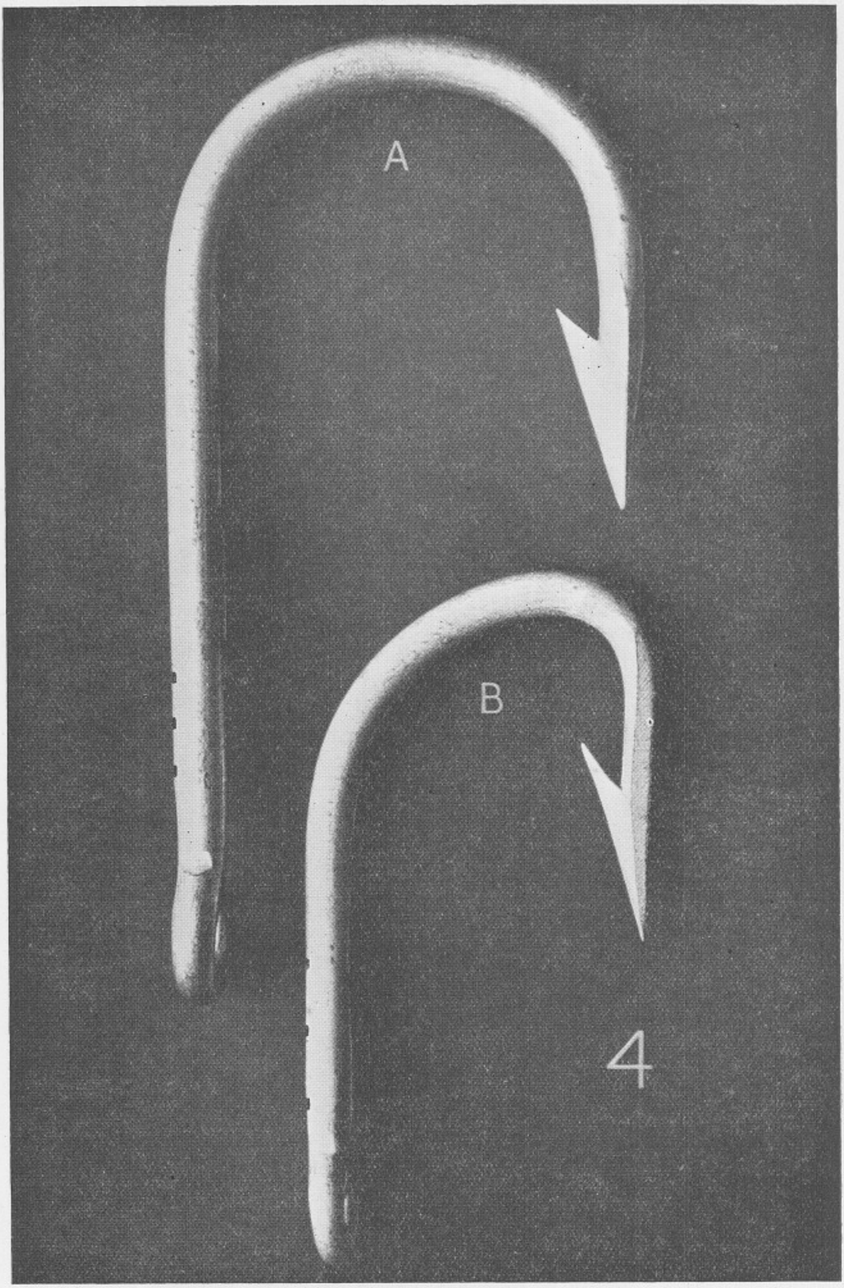


Photo. *F. S. R.*

Fig. 2.—Hooks used by anglers in the North Sea. 4. Norwegian Mustad: A, round bend; B, Limerick.

Figures 1 and 2 are given photographs of these hooks. Five kinds of hooks have been used and lost for certain.

1. Hardy Zane-Grey Hooks—Pfleuger type.
   Black hooks 4½ inches long, stamped " The Zane-Grey " on one side, and " Hardy Bros. Ltd., Alnwick, England " on the other side.
2. Hardy Limerick Hooks.
   Black hooks 4 inches long, stamped " Hardy Bros. Ltd. Alnwick " on one side, and " England " on the other side.
3. Pritchard's Hooks.
   Bronzed and steel hooks 6 inches long, with flattened sides and the name " Pritchard Scarboro " stamped on the bend on one side: there are two small holes through the shank about 1½ inches and 4¼ inches from the eye end respectively.
4. Norwegian Mustad Hooks: galvanized iron.
   A. Round Bend, 5 inches long.
   B. Limerick, 3½ inches long.

(b) Measurements of the Fish.

At a joint meeting of the International Council for the Exploration of the Sea and the International Commission for the Exploration of the Mediterranean in 1932 to discuss investigations into the biology of the tunny, a number of biometric measurements were agreed upon in the hope of obtaining information on the possibility of the occurrence of racial variations in the tunny. Some measurements of this nature had already been made by Heldt (**4**) on fish from Tunis and by Frade (**2**) on fish from Algarve on the south coast of Portugal. Frade's results showed that the fish he measured apparently differed significantly from those measured by Heldt, but the observations were insufficient to be conclusive. Both workers studied fish which were preparing to spawn.

This cruise afforded a good opportunity to make similar measurements on the migrating fish occurring in the North Sea, and great attention was paid to this side of the work to see whether either or both of the types of fish described by the above workers occurred. At the outset difficulty was experienced in deciding from the International Council Report which were the exact points of reference for some of the measurements, a matter of considerable importance in such large fish if a high degree of accuracy was to be obtained. Accordingly I give below a very detailed statement of the measurements I have made so that other workers may know to what extent their results are comparable. Measurements were made, as suggested by Frade (**2**, p. 93), with a ribbon tape that could be fixed by an awl or skewer into the centre point of the snout as a point of origin for the length measurements. The tape was graduated to half-centimetres.

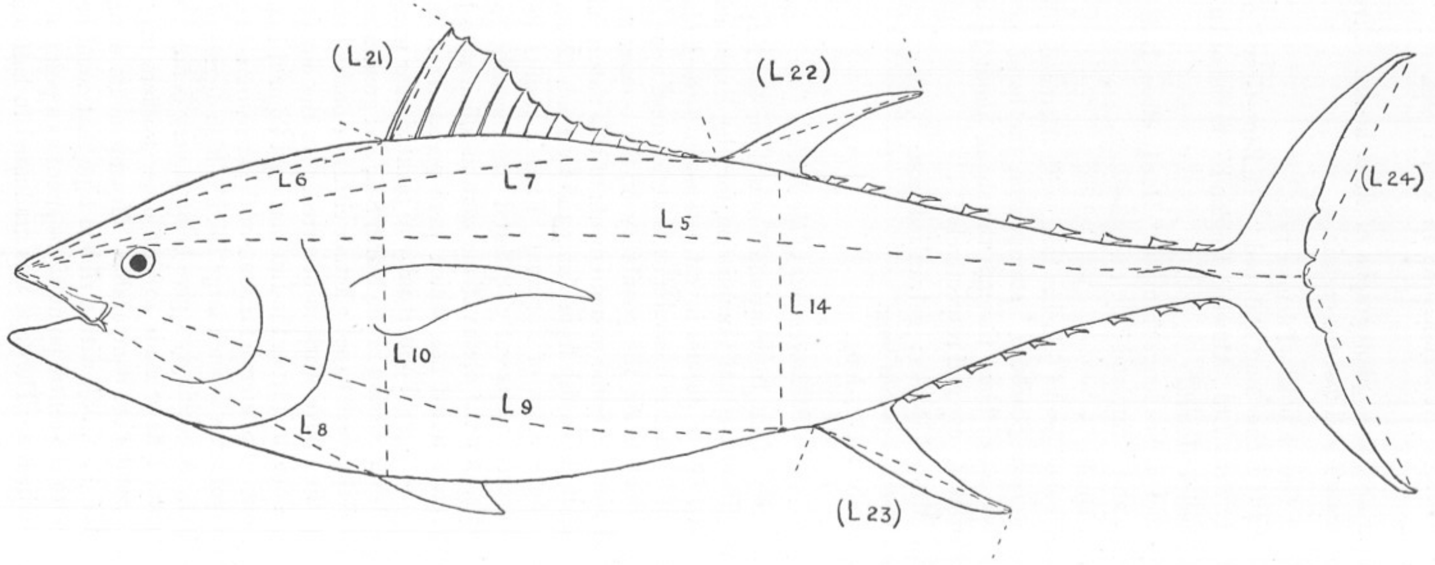


FIG. 3.—Diagram showing body measurements made on tunny.

The notations used below for the different measurements were those given in the International Council Reports (**1**). See Figures 3, 4, 5, 6 and 7.

In fixing the point of origin in the centre of the snout the skewer was inserted on the most anterior point of the nose immediately above the median groove which occurs in the front end of the roof of the mouth : this ensured that it was central.

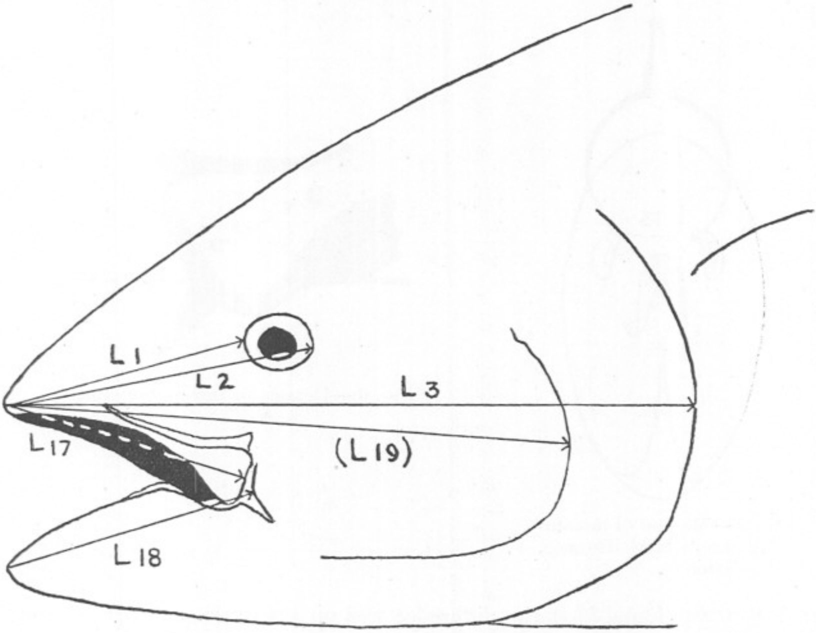


FIG. 4.—Diagram showing measurements on head.

L_1. From the origin to the anterior edge of the eye (preorbital distance).

L_2. From the origin to the posterior edge of the eye.

In the above two measurements the " eye " was taken to mean the actual eye-opening in the skin of the fish : if the eye be pushed inwards the hard edge of the skin can be clearly seen. Measurements were taken to the most anterior and most posterior points of this skin opening.

L_3. From the origin to the most distant point of the free edge of the operculum (length of the head).

In taking this measurement the soft flap of skin which extends beyond the edge of the bony operculum along its hinder margin was included ; it is usually about one centimetre in width. The hindermost point of the operculum generally lay below the middle line of the body.

L_4. From the origin to the upper point of the origin of the pectoral.

Difficulty was experienced in deciding which this latter point should be. When the fin is lying flat along the side of the fish it appears to start from the point indicated A in Figure 7; if however the fin be fully extended at right angles to the body, the point of articulation is found to be behind A, namely, at B, Figure 7. In the measurements of the earlier fish the point B was taken as being the origin of the pectoral since A is merely the front point of a flap of skin in continuation of the flattened groove into which the fin fits. But it appeared that this point of reference might easily be confused by other workers and therefore in later fish measurements were made both to A and

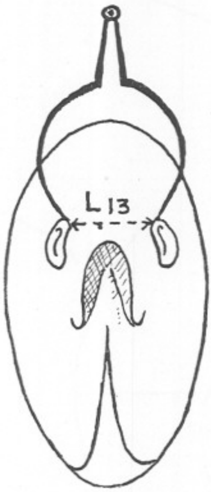


Fig. 5.—Method of measuring interorbital distance, L_{13} (after **1**).

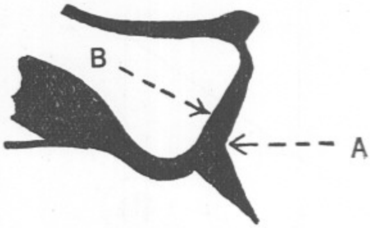


Fig. 6.—Details for jaw measurements, see Text.

to B: it was found that the difference was on the average about 1·5 centimetres.

L_5. From the origin to the centre of the caudal furca (length of the body).

This measurement was made by laying the tape along the body of the fish just above the eye and the pectoral fin and allowing it to lie along the body-surface and along the tail region above the lateral keel.

L_6. From the origin to the base of the first ray of the first dorsal fin.

This measurement was taken down the centre of the back to the front edge of the first spine of the first dorsal fin when fully erected, this being the shortest distance.

L_7. From the origin to the base of the first ray of the second dorsal fin.

L_8. From the origin to the base of the first ray of the ventral fin.

This measurement was made with the fin fully extended.

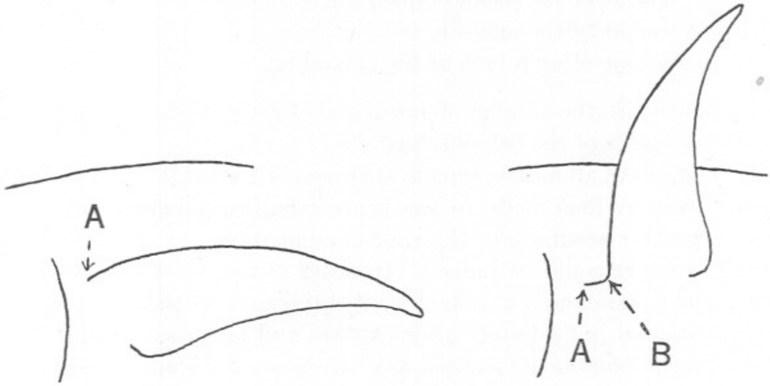
L_9. From the origin to the posterior edge of the anus.

L_{10}. Height of the body at the level of the first ray of the first dorsal.

Taken between upright boards.

L_{12}. Length of the pectoral fin.

This measurement presented the same difficulty as did L_4. It was decided that the fin proper started at the point B (Fig. 7); however, later a few measurements were also made from the point A with the fin pressed flat



(i) (ii)

FIG. 7.—Diagram showing points of reference for pectoral fin measurements (i) with fin flat along body of fish; (ii) with fin extended.

against the side of the body. The difference observed between the two measurements from A and from B was considerable, being about 5 to $5\frac{1}{2}$ cm.

L_{13}. Interorbital diameter (taken with calipers) (Fig. 5).

L_{14}. Height of body at level of anus (taken with calipers).

L_{15}. Interaxillary diameter.

Only a few measurements were made of this dimension owing to the difficulty of moving such heavy fish into the correct position.

L_{16}. Width of base of pectoral.

It was found that this dimension was rather unreliable as there was considerable shrinkage after a few hours due to drying.

L_{17}. Distance from the intermaxillary symphysis to the extremity of the upper jaw.

It was found that this measurement (taking the point A in Figure 6 as given in the International Commission Report Figure on p. 60) varied by as much as a centimetre between when the mouth was open and when it was shut. It seemed that the more constant point would be B, the centre point of the hind edge of the maxilla. Measurements were made in many fish both to the points A and B.

L_{18}. Distance from the mandibular symphysis to the buccal commissure.

In this measurement the point A in Figure 6 was taken as the point of reference for the buccal commissure.

(L_{19}.) From the origin to the most distant point of the edge of the preoperculum.
(L_{20}.) Length of the greatest transverse section of the lateral keels.
(L_{21}.) Height of the first dorsal fin (1st and 2nd rays).
(L_{22}.) Height of the second dorsal fin.
(L_{23}.) Height of the anal fin.
(L_{24}.) Height of each lobe of the caudal fin.

In all fish also the number of dorsal and of ventral pinnules was counted and the weights of the fish obtained.

Full details of all measurements are given in Table III, p. 521. Measurements were at first made to the nearest half-centimetre, and later, to ensure greater accuracy in the shorter dimensions, to the nearest millimetre as far as could be judged. In order to test whether a long period out of the water caused any significant shrinkage, two fish, Nos. 31 and 32, were measured immediately after capture and again several hours later. Only two measurements showed any alteration of significant magnitude, namely the length of the base of the pectoral fin which shrank by 2·5 and 1·5 cm. respectively, and the width of the lateral keels which shrank by 1·25 and 0·5 cm.: both were rather large shrinkages for such short measurements.

Biological Indices.

From the measurements obtained the following biological indices recommended in the International Reports were calculated :—

$$Oi_1=\frac{2L_3}{L_1+L_2} \qquad Oi_2=\frac{L_3}{L_2-L_1} \qquad (Oi_3)=\frac{L_3}{(L_{13})}$$

$$Ti=\frac{L_5}{L_3} \qquad (Hi)=\frac{L_5}{(L_{10})} \qquad Pi=\frac{L_5}{L_{12}}$$

$$\frac{Pi}{Ti}=\frac{L_3}{L_{12}} \qquad Di=\frac{L_5}{L_6} \qquad D^1i=\frac{L_5}{L_7}$$

$$Vi=\frac{L_5}{L_8} \qquad Ai=\frac{L_5}{L_9} \qquad H^1i=\frac{L_{10}}{L_{14}}$$

$$Ei=\frac{L_{10}}{L_{15}} \qquad P^1i=\frac{L_{12}}{L_{16}} \qquad M^1i=\frac{L_{17}}{L_{18}}$$

Comparison of North Sea Tunny with those Measured by Heldt at Tunis and Frade at Algarve.

In order that a strict comparison may be made between my results and those of Frade and Heldt the same statistical data have been calculated, viz.: average deviation, $\frac{\Sigma d}{n}$; probable error, $h=\pm 0{\cdot}6745\times\pm\sqrt{\frac{\Sigma d^2}{n}}$;

Probable error of the mean, $\frac{h}{\sqrt{n}}$; the practical error, $\frac{5h}{\sqrt{n}}$ and the probable and certain limits.

The full details are given in Table I, in which the data obtained by Frade and Heldt, on fish in the G_4 group (viz. 200 to 260 cm., **4**, p. 14), are also given for comparison. It will be convenient to compare each biological index in turn. All the 32 fish that I have measured were large fish between 223 and 271 cm. in length.

Oi_1 : for the North Sea fish this index lies midway between those for Tunis and Algarve and the certain limits almost exactly extend over the whole range for these limits in both Tunis and Algarve fish.

Oi_2 : for the North Sea fish this index is higher than in either the other two types but lies nearer that of those from Tunis and is very near that given by Heldt (**4**, p. 14) for fish 235 cm. in length.

Oi_3 : North Sea fish have a lower index than the Algarve but no comparable data are available for the Tunis fish.

Ti : for the North Sea fish this index lies between that of those from Algarve and from Tunis, but is considerably nearer that for those from Algarve.

Hi : for North Sea fish lies below that for Algarve ; no comparable data are available from Tunis.

Di : for the North Sea fish lies above both Algarve and Tunis fish, being nearer the Algarve type.

D^1i : lies above that for both Algarve and Tunis fish.

Vi : lies below that for both Algarve and Tunis fish, but approximates very closely to those from Algarve.

Ai : approximates very closely to that for Algarve and Tunis fish, but is very slightly lower.

The fish examined in the North Sea would thus appear to differ in body proportions both from those between 200 and 260 cm. in length measured by Frade at Algarve and by Heldt in the Mediterranean at Tunis. The first and second dorsal fins are set slightly further forward in the North Sea fish than in the Algarve and Tunis fish : the ventral fin and anus are approximately in the same position as in the Algarve fish: in the North Sea fish the head is smaller than those measured by Frade ; the eye is also considerably smaller and is slightly further forward on the head resembling the Tunis fish in these respects ; the interorbital width is greater.

In no respect, except in the index Oi_1, was the spread of the variations in the biological indices sufficient to cover both Algarve and Tunis fish, but it was always of the same order of those given by Frade and by Heldt.

It is useless to discuss the significance of the difference between my results and those of Frade and Heldt until far more measurements have been made of large tunny from different regions and at different times of the year. It should however be stressed that all the fish I measured lay in the upper half of Heldt's G_4 group, taken as being 200 to 260 cm.; it is possible that this may account for some of the differences observed. It is likely also that there will be slight differences in body proportions before and after spawning.

Many fish showed a tendency towards the concavity of the snout mentioned by Heldt (in **1**, p. 215): this consequent shortening of the preorbital distance is clearly shown in Figure 8 in the fish nearest the camera.

TABLE I.

COMPARISON OF BIOLOGICAL INDICES OF NORTH SEA TUNNY (223 to 271 CM. IN LENGTH) WITH THOSE OF FISH FROM ALGARVE (ATLANTIC) AND TUNIS (MEDITERRANEAN) BETWEEN 200 AND 260 CM. IN LENGTH.

		North Sea.	Algarve. (Frade.)	Tunis. (Heldt.)
Oi_1				
Mean (M)	=M.	2·42	2·406	2·443
Average deviation	$\left(\frac{\Sigma d}{n}\right)$=A.D.	0·044	0·053	0·049
Probable error	(h)=P.E.	±0·040	±0·049	±0·0452
Probable error of the mean	$\left(\frac{h}{\sqrt{n}}\right)$=P.E.M.	±0·007	±0·0049	±0·0045
Practical error	$\left(\frac{5h}{\sqrt{n}}\right)$=Pr.E.	±0·035	±0·024	±0·023
Probable limits	=P.L.	2·413–2·427	2·401–2·411	2·429–2·437
Certain limits	=C.L.	2·385–2·455	2·381–2·430	2·410–2·456
Oi_2	M.	11·42	9·726	10·98
	A.D.	0·470	0·623	0·73
	P.E.	±0·386	±0·553	±0·63
	P.E.M.	±0·068	—	—
	Pr.E.	±0·341	—	—
	P.L.	11·352–11·488	9·627– 9·825	10·87–11·09
	C.L.	11·079–11·762	9·231–10·221	10·42–11·54
(Oi_3)	M.	2·51	2·70	—
	A.D.	0·086	0·076	—
	P.E.	±0·073	±0·069	—
	P.E.M.	±0·013	—	—
	Pr.E.	±0·065	—	—
	P.L.	2·497–2·523	2·693–2·707	—
	C.L.	2·446–2·575	2·665–2·735	—
Ti	M.	3·74	3·713	3·87
	A.D.	0·068	0·070	0·088
	P.E.	±0·066	±0·061	±0·066
	P.E.M.	±0·012	—	—
	Pr.E.	±0·059	—	—
	P.L.	3·728–3·752	3·702–3·724	3·86–3·88
	C.L.	3·681–3·799	3·658–3·768	3·81–3·93

		North Sea.	Algarve. (Frade.)	Tunis. (Heldt.)
(**Hi**)	M.	4·21	4·410	—
	A.D.	0·138	0·095	—
	P.E.	±0·118	±0·086	—
	P.E.M.	±0·022	—	—
	Pr.E.	±0·120	—	—
	P.L.	4·188–4·233	4·395–4·425	—
	C.L.	4·090–4·330	4·335–4·485	—
Di	M.	3·62	3·555	3·518
	A.D.	0·085	0·063	0·077
	P.E.	±0·070	±0·048	±0·066
	P.E.M.	±0·012	—	—
	Pr.E.	±0·062	—	—
	P.L.	3·608–3·632	3·546–3·564	3·506–3·530
	C.L.	3·558–3·682	3·510–3·600	3·458–3·578
D[1]i	M.	1·93	1·886	1·887
	A.D.	0·026	0·029	—
	P.E.	±0·023	±0·029	—
	P.E.M.	±0·004	—	—
	Pr.E.	±0·021	—	—
	P.L.	1·926–1·934	1·883–1·889	1·881–1·893
	C.L.	1·909–1·951	1·871–1·901	1·858–1·916
Vi	M.	3·17	3·197	3·397
	A.D.	0·098	0·081	0·087
	P.E.	±0·084	±0·072	0·074
	P.E.M.	±0·015	—	—
	Pr.E.	±0·074	—	—
	P.L.	3·155–3·185	3·185–3·209	3·383–3·411
	C.L.	3·096–3·244	3·137–3·257	3·329–3·465
Ai	M.	1·64	1·660	1·657*
	A.D.	0·022	0·027	—
	P.E.	±0·019	±0·024	—
	P.E.M.	±0·004	—	—
	Pr.E.	±0·018	—	—
	P.L.	1·646–1·654	1·658–1·662	1·652–1·662*
	C.L.	1·632–1·668	1·648–1·672	1·634–1·680*

The biological index Pi has not been considered here owing to the doubt about the correct points of reference to take in measuring the pectoral fin. It was found that when measuring from the point B in Figure 7 the mean for Pi was 6·30, and the average of the four measurements made from the point A was 5·57.

The Length of the Fins.

In Table II are given the lengths of the 2nd dorsal, 1st dorsal, and anal fins, and upper caudal lobe, expressed as percentages of the total length of the fish (L_5). In this table the lengths of the second dorsal are arranged serially in order of size and there is a very distinct tendency for the fish with short second dorsals to have short first dorsal and anal fins and to a less extent narrower tails, and for fish with long second dorsals to have the

* For (G_3+G_4) fish, i.e. 160 to 260 cm.

other two fins long also and the tail wider. There is considerable variation in fin-length, the range covered by the different fins being :—

2nd Dorsal . . .	12·4–17·0%	of total length, L_5
1st Dorsal . . .	8·5–11·4%	,, ,, ,,
Anal	12·5–17·2%	,, ,, ,,
Upper Caudal Lobe . .	15·3–18·7%	,, ,, ,,

No correlation is shown between the length of the above fins and that of the pectoral fin which varies between 14·4 and 17·4% of the total length of the fish (L_5).

It is of interest also to note that the lengths of the 2nd dorsal fin show distinct bimodality, the two modes falling in the 13-cm. and the 15 to 16-cm. groups respectively. No such bimodality is however shown by other fins.

No correlation could be found between fin-length and other body proportions of the fish.

TABLE II.

LENGTHS OF SECOND DORSAL, FIRST DORSAL, ANAL AND CAUDAL FINS EXPRESSED AS PERCENTAGES OF BODY LENGTHS. (CAUDAL FIN BASED ON UPPER LOBE.)

Fish No.	2ND D.	1ST D.	A.	C.
24	12·4	8·9	13·0	16·3
31	12·9	9·8	12·5	16·3
3	13·0	9·5	13·4	17·3
4	13·0	9·4	13·5	16·4
28	13·4	10·7	14·4	18·0
29	13·4	10·5	14·9	17·9
7	13·5	8·6	14·8	17·6
22	13·6	9·0	13·2	16·8
19	13·8	9·8	13·6	16·6
21	13·8	9·7	13·1	16·4
2	13·8	9·1	14·6	17·8
10	13·9	10·5	13·1	15·3
11	14·1	10·7	13·7	16·7
12	14·6	11·4	13·0	17·5
5	15·0	10·0	14·6	17·9
13	15·0	10·0	13·7	17·2
16	15·0	11·1	15·8	17·4
23	15·3	9·2	13·4	17·1
8	15·6	11·2	16·4	18·0
14	15·8	10·0	14·1	18·7
15	15·9	11·3	14·9	16·9
27	15·9	11·1	14·9	18·1
1	16·0	10·4	16·8	17·6
26	16·0	10·6	14·8	17·0
18	16·2	10·0	15·5	17·0
6	16·3	8·5	15·4	16·7
9	16·3	10·0	15·5	17·5
17	16·3	10·7	17·2	17·0
31	16·5	10·4	14·0	18·7
32	16·5	11·2	15·3	17·8
20	16·7	9·7	15·7	17·5
25	17·0	10·0	15·3	18·5

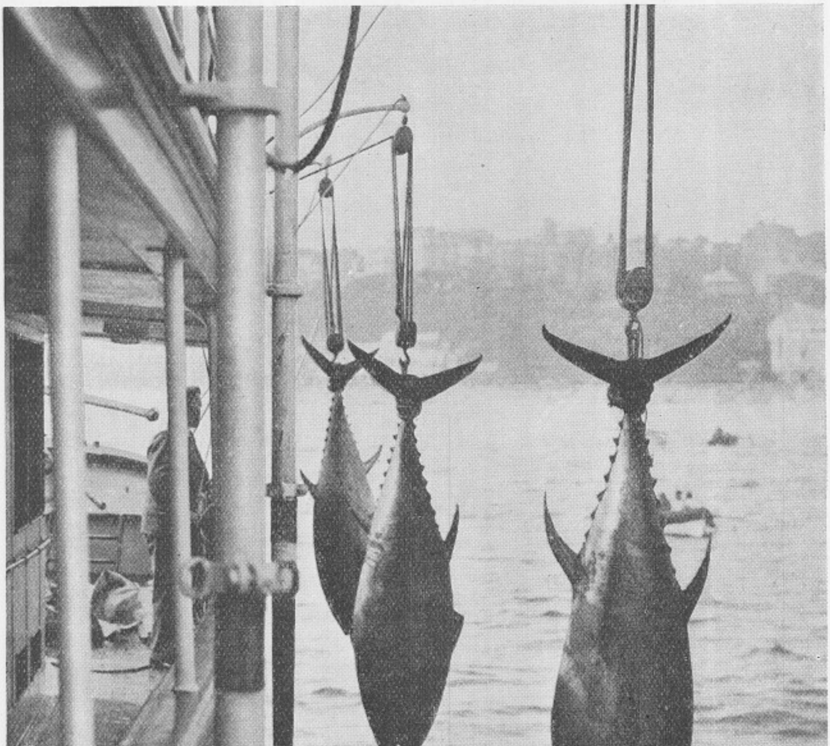


Photo *Victor Hey, Scarborough.*

Fig. 8.—Three tunny caught in North Sea, August 4th, 1933, hanging from side of M.Y. *St. George* (fishes 1, 2, and 3). Note the concavity of the snout in the fish nearest camera. (By kind permission of Mr. Victor Hey.)

Data on Condition of Fish.

An additional series of measurements was made on the last twelve fish to give some idea of their condition. It is not easy to make an accurate measurement of the girth of such heavy fish when lying on the deck of a ship : therefore it was decided to adopt a measurement equal to half the girth taken round one side of the fish from mid-dorsal to mid-ventral lines. Owing to the obvious variation in the shape of the fish a number of these semigirth measurements were made at different points : the points of reference chosen were as follows :—

1. In the region of the front end of the first dorsal fin by slipping the tape under the pectoral fin as far forward as it would go when this fin was flat along the side of the fish : this ensured a very constant position.
2. At the anterior insertion of the second dorsal fin.
3. At the anterior insertion of the anal fin.
4. At the eighth ventral pinnule counted from the caudal end.
5. At the sixth ventral pinnule from the caudal end.
6. At the fourth ventral pinnule from the caudal end.

I am indebted to Mr. F. Hannam for suggesting the latter of these measurements. These measurements are given in Table IV, p. 522.

SUMMARY.

1. Details are given of the types of hooks lost in tunny in the North Sea in the summer of 1933.

2. Data are given on the measurements made on thirty-two large migrating fish caught in the North Sea in August and September, 1933.

3. In certain body proportions the tunny measured differ from those in the G_4 Group (200 to 260 cm. in length) given by Heldt for fish from Tunis and by Frade for fish from Algarve on the south coast of Portugal, while in some characters they resemble the Tunis fish and in others the Algarve fish, but all the North Sea fish were between 232 and 271 cm. in length.

4. It was found that there was a tendency for fish with short second dorsal fins to have short first dorsal, anal, and caudal fins, and for those with long second dorsals to have these other three fins long.

5. Measurements were made to supply data on the condition of the fish.

REFERENCES.

1. CONSEIL INTERNATIONAL pour l'Exploration de la Mer (Comité du Plateau Continental Atlantique) et Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée. Conférence d'Experts pour l'examen des Méthodes Scientifiques et techniques à appliquer à l'étude des poissons de la famille des Thonidés. Comm. Int. Explor. Sci. Mer Médit. Rapp. Proc. Verb., Vol. VII (U.S.), 1932, pp. 47–90 ; and Cons. Perm. Int. Explor. Mer. Rapp. Proc. Verb. Rapport Atlantique, 1931, pp. 92–103, 1933.

2. FRADE, F. Données Biométriques pour l'Etude du Thon Rouge de l'Algarve (Côte méridionale du Portugal). Bull. de la Soc. Portugaise des Sc. Naturelles, T. XI, No. 7, pp. 89–130, 1931.

3. HELDT, H. Le Thon Rouge *Thunnus thynnus* L. Mise à jour de nos connaissances sur ce sujet. Stat. Océanogr. Salammbô. Bull. No. 7, pp. 1–24, 1927.

4. HELDT, H. Contribution à l'Étude des Races de Thons (*Thunnus thynnus* L.). Caractères Biométriques du Thon Tunisien et Considérations sur sa Croissance. Stat. Ocean. Salammbô. Annales No. IV, 1927, pp. 1–54.

5. LE GALL, J. Contribution à l'étude de la Biologie du Thon Rouge (*Thunnus thynnus* L.). Sur la présence de Thons Rouges en Mer du Nord et dans l'Atlantique Nord-Est. Cons. Perm. Int. Explor. Mer. Journ. du Cons., Vol. II, No. 3, pp. 309–331, 1927.

6. LE GALL, J. Le Thon Rouge (*Thunnus thynnus* L.) en Mer du Nord et dans l'Atlantique Nord-Est. *Ibid.*, Vol. IV, No. 2, pp. 200–206, 1929.

DATE AND PLACE OF CAPTURE, ETC., OF THE THIRTY-TWO TUNNY FROM THE NORTH SEA MEASURED SUMMER, 1933.

All fish were caught on a rod and line except when otherwise stated.

FISH No.	CAUGHT BY.	DATE OF CAPTURE.	POSITION.		DATE AND PLACE OF MEASURING.	
1	Col. Cotton	4.viii.33	55°34′N.	3°26′E.	5.viii.33 on board.	
2	On pellet (*St. George*)	,,	,,	,,	,,	,,
3	Col. Peel	,,	,,	,,	,,	,,
4	On pellet (*St. George*)	7.viii.33	55°18′N.	2°49′E.	8.viii.33	,,
5	Col. Cotton	,,	,,	,,		
6	Lady Broughton Lord Moyne	4.viii.33	55°19′N.	2°28′E.	9.viii.33 in Pure Ice Co. Factory.	
7	F. Hannam, Esq.	26.viii.33	54°51′N.	0°19′E.	26.viii.33 on board.	
8	L. Mitchell Henry, Esq.	,,	,,	,,	,,	,,
9	,, ,, ,,	,,	,,	,,	,,	,,
10	Col. Cotton	,,	,,	,,	,,	,,
11	Col. Peel	,,	,,	,,	,,	,,
12	On pellet (*St. George*)	,,	,,	,,	,,	,,
13	Col. Cotton	,,	,,	,,	,,	,,
14	Mrs. T. O. M. Sopwith	,,	55°05′N.	1°30′E.	28.viii.33 in fish market.	
15	T. O. M. Sopwith, Esq.	,,	55°10′N.	1°00′E.	,,	,,
16	Miss G. Yule	,,		—	,,	in Pure Ice Co. Factory.
17	S. V. Hine, Esq.	,,	54°51′N.	0°19′E.	,,	in Mr. Bamford's cellar.
18	David Leigh, Esq.	,,	,,	,,	,,	in exhibition room.
19	E. Leigh, Esq.	,,	,,	,,	,,	,, ,,
20	Col. Cotton	29.viii.33	54°57′N.	0°50′E.	29.viii.33 on board.	
21	,, ,,	,,	,,	,,	,,	,,
22	,, ,,	,,	,,	,,	,,	,,
23	On pellet (*St. George*)	,,	,,	,,	,,	,,
24	Col. Cotton	,,	,,	,,	,,	,,
25	,, ,,	30.viii.33	54°55′N.	0°25′E.	30.viii.33	,,
26	Col. Peel	,,	54°55′N.	,,	,,	,,
27	,, ,,	,,	,,	,,	,,	,,
28	On pellet (Col. Peel)	,,	,,	,,	,,	,,
29	Col. Peel	2.ix.33	54°48′N.	0°28′E.	2.ix.33	,,
30	,, ,,	,,	,,	,,	,,	,,
31	,, ,,	,,	,,	,,	,,	,,
32	Col. Cotton	,,	,,	,,	,,	,,

TABLE III.

MEASUREMENTS OF TUNNY FROM THE NORTH SEA: ALL MEASUREMENTS ARE IN CENTIMETRES.

No. of Fish.	1	2	3		5	6	7	8	9	10	11	12	13	14	15	16
L_1	25	27	22	21½	23½	25	27	24	24	22½	23	25	24	25	25	25
L_2	31	33	28	27	29	31	33	29½	29½	28	28½	31	30	31	30½	31
L_3	68	71	62·5	60	65	62	70½	66	65	62	63	67	68	69	67	68
L_4	69	73	64	62	66	70	75	67½	66½	65	65½	69	69	69½	69	71
L_5	250	253	231	223	240	246	266½	250	245	248	233½	246	256	241	252	253
L_6	67	73	65	61½	63½	71	72	66½	66½	63½	62	69	70	69	70	73
L_7	129	133	121	117	121	131	136	128	126	121	120	130	137	126	130	131½
L_8	82	81	73	69	79	81	90½	79	76	73½	76½	75½	76	81	79	81
L_9	154	151	139	135	144	152	166	154	147	143½	143	151	156	147	149½	154
L_{10}	59	64	56	48	56	62	68	63	58	57	56	54	60	60	61	60
L_{12}	40	42	38	36½	41	40	42	39	38½	40	34	41	40	40	38½	44
L_{13}	27	29	23	23½	25½	27	30	26	26½	24	24	26	26	25	25	28
L_{14}	45	46	45	41	45½	47	50½	50	45½	46	45½	43	50½	46½	51½	46½
L_{15}	40	42	39	40	40	41	–	43½	–	–	–	–	–	–	–	–
L_{16}	14	16	15	12½	13	13	15	14	14	13	12	14	13½	14	13½	13
L_{17}	26	27·5	23	23	26	27	27	25	24½	24	25	26	27	27	26	25
L_{18}	26	27	23	22	26	25	29	26	24½	23	24½	25	26	26	25	24½
(L_{19})	54·5	57	50	48	52½	55	58	54	51½	50	50	53½	56	54½	54½	55
(L_{20})	18	18	17	17½	18	17	20	**	17½	19	19	20	19	17½†	18½	18½
(L_{21})	26	23	22	21	24	21	23	28	24½	26	25	28	25½	24	28½	28
(L_{22})	40	35	30	29	36	40	36	39	40	34½	33	36	38½	38	40	38
(L_{23})	42	37	31	30	35	38	39½	41	38	32½	32	32	35	34	37½	40
(L_{24}) Upper	44	45	40	36½	43	41	47	45	43	38	39	43	44	45	42½	44
(L_{24}) Lower	44	45	40	36½	43	41	46	45	43½	38	39	43	42	45	42½	44
Fin formula																
Pinnules D.	10	10	10	10	10	10	10	–	–	10	11	5+3	10	10	10	10
Pinnules V.	9	9	9	9	9	9	9			10	10	9	9	9	9	9
Weight (lbs.)	524	542	459	–	461	532	705	532	514	511	476	434	616	505	575	561

No. of Fish.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
L_1	22	27½	23	26·4	26·9	24·3	26	24	27·5	24·5	24·75	25	26·5	25·2	26	24·8
L_2	28	33½	29	32·2	32·8	30·2	32·4	30	33·7	30·2	30·25	31	32·8	31	32	30·2
L_3	62	73½	63	71·7	71	66	69	64·7	73·2	67·5	66	68·8	71·5	69·5	68·5	64
L_4	63½	76	65	71·9* 73	72* 73	68* 69·5	70* 71·5	– 67	73·4* 75	68·5* 70	66* 67·5	69* 70·5	71·5* 73·2	69·5* 71	68·7* 70	64·5* 66
L_5	233	271	235	260·5	268	250·5	251	242	270·5	264	248	261	268	264*p*	257	236
L_6	66	73½	66½	74	73·25	71·5	70	68	75	72·3	70·25	72·5	75	71	71	66
L_7	123	140	123	134·5	139·5	128	132·5	125·5	141	135	129	137·5	139	134	133	124
L_8	71½	96	74	81·5	81	81	78	76·5	85·5	79	76·5	79	83·5	80	78·5	76
L_9	140	170	142	157	163	150	151	145	164	157·5	151	159	163	155	155	148
L_{10}	55	–	–	63	65	59	57	55	68	65			62	62	60	55
L_{12}	39	40	39	41·5	41·5	36	38·5	37·5	42·5	40·5	40	40	45·5* 40	46·5* 41	47* 41·5	45* 40
L_{13}	24½	29	25	29	29·5	26	28	27	31·2	26	26	28	27	27·5	28	27
L_{14}	44½	53	44½	48·5	49	45	41·5	46	54	52	47	52	51·5	51·5	51·5	49
L_{15}	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
L_{16}	12	15	13	14·75	14	14	12·5	13	15·3	14·5	14	15	16	15	15·5	13
L_{17}	24½	30½	25	27*o* 26*s*	28*o* 27*s*	27*o* 26*n*	26·5*s*	25·5*o* 25*n*	28*o* 27·5*n*	26*o* 25·5*n*	25·5*o* 25*n*	25*s* 25*n*	27·5*o* 27*n*	26·5*o* 26*n*	26·5*o* 26*n*	25·5*o* 24·5*n*
L_{18}	23½	29	24	26*o* 25·5*s*	26	26*o*	25	24	26·5	25	24·5	25	26	25·5	25	24
(L_{19})	49½	60½	52½	58	58	52·75	56	52·3	60	54·5	53	56	57	56	55·5	53
(L_{20})	17	½ missing	16	19	20	18	20·5	17·5	21·8	20·2	20	20	21·75	21·5	20	17
(L_{21})	25	27	23	25	26	22·5	23	21·5	27	28	27·5	28	28	26	26·75	26·5
(L_{22})	38	44	32½	43·5	37	34	38·5	30	46	42·3	39·4	35	36	34	42·5	39
(L_{23})	40	42	32	41	35	33	33·5	31·5	42	39	37	37·5	40	33	36	36
(L_{24}) Upper	39½	46	39	45·5	44	42	43	39·5	50	45	45	47	48	43	48	42
(L_{24}) Lower	40	46	39	45	44	42	44	39·5	50·5	45	45	47·5	48	43	48	42
Fin formula																
Pinnules D.	10	10	11	10	10	11	10	10	4+5	10	10	11	10	11?	10	10
Pinnules V.	9	9	9	9	9	9	9	9	9	9	9	10	9	9?	9	9
Weight (lbs.)	428	763	456	643	735	492	546	469	714	664	549	695	709	659	687	554

** One side missing. † damaged.

* With pectoral fin flat by side (to point A, Fig. 7); other measurements to point B (Fig. 7).

L_{17}, L_{18}: *o*: mouth open, *s*: mouth shut — to point A, Fig. 6; *n*: to point B, Fig. 6.

TABLE IV.

Body Measurements to Study Condition of Fish.

Fish No.	7	8	9	10	11	12	13	14	15	16	17	18	19
6th Pinnule	40	34½	38	35	36	32½	39	34	38	37	36	41	32½
4th Pinnule	27½	24	26	25	25½	25	27½	24	26	26	27	29	22½

Fish No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1st Dorsal	–	–	–	91	95	83	87	84	90	89	87	90·5	91·5	90·5	91	86
2nd ,,	–	–	–	77	87	69	73	70	80	79	72	79	80	78	83	75
Anal	–	–	–	67	72	59	62	62	69	71	62	69	70	70	72	64
8th Pinnule	–	–	–	55	62	44	50	50	51	52	48	56	58	54·5	55	50
6th ,,	36	41	32½	40	45	36	39	34	39·5	39	35	44	43½	40	41	39
4th ,,	27	29	22½	28	29	26	29	24	29	28	26	29	30	28·5	29·5	28