Conseil International pour l'Exploration
de la Mer

C. M. 1953
Shellfish Committee.
'43

SOME OBSERVATIONS ON THE DISTRIBUTION, BIOLOGY AND EXPLOITATION OF NEPHROPS NORVEGICUS IN SCOTTISH WATERS

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1. INTRODUCTION

The prawn[1] (Nephrops norvegicus, Leach) is of general occurence in British waters and is abundant in certain localities. On the other hand, the British market was formerly very limited and the stocks were not then exploited commercially to any significant extent. Of recent years a market has developed alongside a considerable increase in the landings of the prawn, which now constitutes a worthwhile part of the income of certain vessels (Table I). The total value of landings in Scotland during 1952 was over £ 2o,ooo.

TABLE I

The commercial landings (in cwt.) of Nephrops norvegicus in Scotland during 195o - 52.

	195o	1951	1952
South-east Scotland and Firth of Forth.....	1153	2199	2844
Moray Firth	1o95	1553	2738
Firth of Clyde	646	429	128
Others(approximate)....	1oo	1oo	12o
Total.....	2994	4281	583o
Average value per cwt..	37/-	54/-	72/-

Apart from the interest attaching to population investigations of a stock which is in transition of exploitation from the relatively unfished state, the possibility that landings will continue to increase makes it desirable that investigations should be carried out on this species.

Acknowledgement is due to the Fishery Officers of the Scottish Home Department for their generous co-operation in supplying details of landings etc.

2. MATERIALS AND METHODS

Data giving the landings of the prawn (Nephrops norvegicus)have been collected for all Scottish Fishery Districts through local Fishery Officers for the years 195o, 1951 and 1952. In addition, observations by the Fishery Research Ship "EXPLORER" on the composition of the stock and measurements of the overall length are available from certain grounds during the late twenties. The samples were obtained using the Otter trawl with small mesh attachment and thereby afford information on mesh selection.

The overall lengths and the corresponding carapace lengths have been measured in a sample of prawns taken in the Firth of Forth during June 1953 in order to constitute conversion data for overall length to carapace length, the latter being the more accurate and the conventionally accepted scientific standard. Information on the

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[1] The term "prawn" is used also, particularly in England, to designate Palaemon seratus and Pandalus spp.

distribution of the larvae are derived from analyses of research ship plankton hauls using 1 m. nets of mesh about 1 mm.

3. THE COMMERCIAL FISHERY

The commercial fishery for Nephrops norvegicus in Scotland is centred mainly in three areas; the Berwickshire coast and Firth of Forth, the Moray Firth and the Firth of Clyde (Fig.3). As will be seen in Table I, these areas constitute, by far, the greatest proportion of the total landings for Scotland.

(a) The Berwickshire coast and the Firth of Forth.

Table II shows the sum of the landings of Nephrops norvegicus for the ports of Eyemouth, Dunbar and Anstruther, by months, for the years 1950, 1951 and 1952.

TABLE II

The commercial landings of Nephrops norvegicus from the south-east coast of Scotland and Firth of Forth by months for years 1950, 1951 and 1952.

Month	1950 Weight cwt.	1951 Weight cwt.	1952 Weight cwt.
January	101	19	143
February	93	61	187
March	23	39	429
April	13	7	117
May	43	1	13
June	25	1	101
July	157	74	312
August	121	243	451
September	268	470	516
October	81	535	211
November	129	282	169
December	99	467	195
Total	1153	2199	2844

The principal fishing grounds extend in a belt about a mile and a half wide from about 6 1/2 miles north from Eyemouth along the coast to the outer reaches of the Firth of Forth. The fishery from Eyemouth extends as far as 3 1/2 to 4 miles north-east from Fastcastle Point. The focus of the Firth of Forth fishery is around the May Island, particularly to the south and east.

The capture of Nephrops norvegicus is mainly by smaller seine-net boats, up to 50 ft., and to a large extent is incidental to the capture of white fish, although seiners also shoot with the primary object of taking prawns. The net used is the standard Danish seine, the mesh being governed by regulations, which at present in the Eyemouth district permit a 70 mm. mesh, but around the May Island a minimum mesh of 100 mm. is in force.

(b) The Moray Firth.

The principal fishing grounds lie towards the south-east end of the Firth(Fig.3). The fishery is prosecuted by seine-net boats using a net of 70 mm. mesh and is in the main incidental to the capture of white fish. Certain smaller boats, however, frequently shoot with the prime object of capturing prawns.

In addition to the above, in 1952, 54 cwt. of prawns were landed at Fraserburgh from fishing grounds about 1o miles north from Aberdour. Landings at other Moray Firth ports were negligible.

The bulk of the prawns captured within the Moray Firth are landed at Lossiemouth. Table III gives details of these landings by months for the years 195o, 1951 and 1952.

TABLE III

The commercial landings of Nephrops norvegicus at Lossiemouth from the Moray Firth by months for the years 195o, 1951 and 1952.

Month	195o	1951	1952
	Weight cwt.	Weight cwt.	Weight cwt.
January	2o9	7o	138
February	111	38	21
March	162	241	187
April	59	152	111
May	13	-	76
June	23	56	468
July	-	1o2	3oo
August	42	138	354
September	44	232	314
October	78	2o7	159
November	155	134	211
December	194	183	345
Total	1o95	1553	2684

(c) The Firth of Clyde.

The main port at which prawns are landed from the fishing grounds of the Firth of Clyde is Ayr. The landings at this port are given in table IV, by months, for the years 195o, 1951 and 1952.

TABLE IV

The commercial landings of Nephrops norvegicus at Ayr from the Firth of Clyde, by months, for the years 195o, 1951 and 1952.

Month	195o	1951	1952
	Weight cwt.	Weight cwt.	Weight cwt.
January	-	16	-
February	-	29	3o
March	1oo	-	12
April	83	-	1c
May	1o5	3	1
June	9	2o	1c
July	-	29	-
August	-	2c	-
September	-	73	13
October	77	12o	13
November	217	119	29
December	55	-	1c
Total	646	429	128

The capture of prawns is incidental to seine-net fishing for white fish. The size of mesh employed is 7o mm. The principal prawn areas are the middle grounds of the lower Clyde, around Arran and south to beyond Ailsa Craig. Occasionally, landings from these grounds are also made at the adjacent ports of Stranraer, Portpatrick and Campbeltown, but the quantities landed at each of these ports during the whole of 1952 averaged only around 7 cwt.

(d) Other Areas.

Very occasional small landings of prawns were made during 1952 at most of the major Scottish ports. The largest were at Aberdeen, where Swedish motor trawlers marketed 29 cwt. from fishing grounds about 2oo miles out. Belgian trawlers landed 22 cwt. from Icelandic waters, and British trawlers landed 17 cwt. from North Sea grounds. In all cases the capture of prawns was completely incidental to that of white fish. Landings at Oban during 1952 totalled about 15 cwt., being taken by seine-net boats working in the Minch. About 1o cwt. were landed at Stornoway from the seine-net grounds in the northern Minch from Tiumpan to near the Butt of Lewis. Landings at Lerwick by Shetland seine-net vessels operating locally, mainly in the neigbourhood of Burra Voe, totalled about 1o cwt. It is unlikely that the total landings outside the main grounds of the Firth of Forth, Moray Firth and Firth of Clyde exceeded 12o cwt. in 1952, or 1oo cwt. in either 195o or 1951 (Table I).

4. THE COMPOSITION OF THE STOCKS

Table V (see page 8) shows the overall percentage composition of 16 samples of Nephrops norvegicus taken in the Firth of Clyde during September 1927. Whilst there may be overall annual variations in the stocks, these data may be expected to reflect the principal features of Nephrops populations in waters adjacent to Scotland.

The same data are reproduced in Fig. 1, (see page1o). The gear employed was an Otter trawl with a 7o mm. cod-end mesh fitted with a small mesh attachment. The catches from both cod-end and small mesh attachment have been summed. It will be observed that the minimum length for berried females is 7 - 8 cm., beyond which the porportion of berried females to total females increases up to about 15% at and above 12 cm. For lengths at which the female prawns are immature, the sex ratio shows a proponderance of females, but with the progressive increase in the proportion of berried females between lengths 8 and 12 cm. the overall sex ratio gradually becomes reversed and males predominate. The maximum recorded length for any female prawn was 18 cm., and the proportion above 15 cm. was insignificant. In this length group only o.7% of the stock were females. The males, on the other hand, were recorded up to an overall length of 24 cm. Whilst the possibility of migration cannot be excluded, the most likely explanation for the observed change in the sex ratio with increasing length is that with onset of maturity the moulting frequency (and consequently growth) amongst females is reduced to a level well below that for males. Other observations on the sex ratio are given by Barnes and Bagenal (1951).

Table VI (see page9) gives details of the escapes, by length groups for all classes of prawn, into the small mesh attachment from the cod-end of 7o mm. mesh in six hauls carried out in the Firth of Clyde during September 1927.

The same data are depicted in the graph Fig. 2, (see page 1o). It will be seen that the 5o% release point lies about overall length 9cm. At this length 8.8% of the female prawns were berried.

5. DISTRIBUTION

(a) Adults.

The adult stage of Nephrops norvegicus is of widespread occurence in the Scottish waters, mainly on bottoms of mud or muddy sand. The location of the commercial fishing grounds is shown in Fig. 3 (see page11), which also indicates stations at which the Fishery Research Ship "EXPLORER" has taken specific quantities of prawns in the Otter trawl during the period 1947 to 1952, inclusive, at all seasons. The intensity of sampling on the east of Scotland far exceeds that on the west. The data cannot necessarily be taken as covering the full distribution of Nephrops and, due to the limited research ship sampling, are not suitable for investigation of seasonal changes in distribution. Apart from the commercially exploited grounds, Nephrops norvegicus are relatively abundant in the area contred about 4o miles north-east from Buchan Ness. To the west of Scotland they are widely, though not densely distributed throughout the Minch, and a considerable concentration exists in the south of this area to the west and south of Barra. In addition to the commercially exploited grounds in the Firth of Clyde, the research ship records show a concentration of prawns in the Sounds of Islay and Jura. The majority of hauls were taken in depth ranging between 5o and 18o metres.

(b) Larval Stages.

The occurence of larvae of Nephrops norvegicus in the plankton hauls taken by F.R.S. "EXPLORER" during the years 1947 to 1952 inclusive, is shown in Fig. 3, (see page11). In the routine sorting, estimates have been made of the larvae of Nephrops, such as rare, fair, common, etc. These have been conservatively interpreted numerically as in the figure.

Table VII shows the seasonal fluctuation in numbers of larvae taken in the plankton hauls.

Table VII.

Approximate numbers of larval Nephrops norvegicus taken in plankton hauls by F.R.S. "EXPLORER" during the period 1947 to 1952, inclusive, by months.

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
-	-	4	9	148	82	18	-	3	6	-	-

The main hatching season appears to be in May, and tails off thereafter in June and July. In depths down to loo metres there was no noticeable regular variation in density with depth. The distribution of the larvae corresponds roughly with the observed distribution of the adults.

6. RELATIONSHIP OF OVERALL LENGTH TO CARAPACE LENGTH.

In view of the greater consistency in measurement of the carapace, it is customary to prefer this to the measurement of overall length. Fig. 4 (see page11) shows the relationship between the length from the hinder end of the eye socket to a point at the same level on the posterior end of carapace, and the overall length from the tip of the rostrum to the end of the telson, excluding the setae.

7. DISCUSSION

The increase in the market value of prawns in Scotland over the period 1950 to 1952 and the corresponding increase in landings suggest that the exploitation of this shellfish is likely to increase further. There appears to be scope for the extension of the fishery to populations not now exploited. The fishery, at present, is largely incidental to the capture by seine-net vessels of white fish, and any pronounced change in this relationship seems unlikely. On the other hand, given suitable gear, there should be the possibility of a profitable prawn fishery by small motor boats. Such a development might be of especial benefit on the west coast of Scotland where stocks at present unexploited are known to exist.

The regulations at present limit the seine-net to a minimum mesh of 70 mm. when used for the capture of white fish. The law also provides that persons fishing for shellfish only are excluded from the provisions. However, prawns are caught with these nets and a 70 mm. mesh corresponds to a 50% release of prawns of about 9 cm. overall length; this allows for a proportion of females reaching maturity. The introduction of an 80 mm. minimum mesh, as now proposed, would provide a further and adequate margin of safety in this respect. On the other hand, consideration of a minimum permissible mesh size specifically suitable for prawns may become necessary should a fishery be developed exclusively for them.

The stocks of Nephrops norvegicus in the Firth of Clyde were practically unexploited commercially in 1927. The data for length composition recorded for that year, therefore, relates to an almost natural population. The results suggest a relatively high natural mortality. This would, however, be decreased by commercial exploitation. Storrow (1912) describing the prawn fishery from North Shields, suggests that the absence of berried females in winter is due to a migratory habit whereby they are not taken in the trawl. Such a habit could account for the low percentage of berried females recorded in the present data. On the other hand, there appears to be no need for such a theory to account for the variation in sex ratio. The falling off in the proportion of total females to males with the onset of maturity could also be attributable to the probably lower frequency of casting in the mature female.

The numbers of larvae of Nephrops norvegicus taken in plankton hauls indicate May as being the peak period for hatching. The concentration of larvae falls off during June and July. Whilst a few larvae are taken in other months, it seems likely that normally not more than one brood is produced annually.

8. SUMMARY

(i) The commercial landings of Nephrops norvegicus in Scotland for the years 1950 - 1952 are detailed.

(ii) The composition in respect of size and sex of a relatively unexploited stock of prawns is given.

(iii) The 50% release point for prawns by a net of 70 mm. mesh is at about overall length 9 cm.

(iv) The distribution, as shown by research ship data, for both adults and larvae of Nephrops norvegicus in Scottish waters is outlined.

(v) The main period of hatching of eggs is May and June. The female produces not more than one brood annually.

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L e g e n d s

Fig. 1 The overall percentage composition, length amd sex of 16 samples of Nephrops norvegicus taken by Otter trawl with small mesh attachment in the Firth of Clyde during September 1927.

Fig. 2 The percentage escapes by each centimetre length group of Nephrops norvegicus through the 7o mm. codend mesh of an Otter trawl into the small mesh attachment in six hauls carried out in the Firth of Clyde during September 1927.

Fig. 3 The distribution and density of the adults and larvae of Nephrops norvegicus in Scottish waters. The commercial fishery relates to 1952; the circles represent the numbers of larvae taken per 15 minute plankton haul with 1 metre net over the period 1947-1952; numbers give landings of adult Nephrops norvegicus taken in the Otter trawl by F.R.S. "EXPLORER" over the same period.

Fig. 4 Nephrops norvegicus. Regression of carapace length on overall length.

Table V.

The percentage composition, length and sex, of 9,850 Nephrops norvegicus taken at 16 stations in the Firth of Clyde during September 1927.
Data for Otter trawl and small mesh attachment have been summed

Overall length in cm.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Males	-	0.26	0.22	0.42	1.36	3.42	8.58	11.64	10.83	9.36	7.21	5.38	4.36	3.67	2.82	2.33	1.90	1.20	0.90	0.27	0.04	0.02	76.19
Non-berried females	0.01	0.53	0.41	0.86	1.87	3.75	6.65	4.80	2.03	0.84	0.21	0.05	0.01	0.01	0.01	0.01	-	-	-	-	-	-	22.05
Berried females	-	-	-	-	0.01	0.08	0.63	0.53	0.25	0.17	0.03	0 01	0.02	-	-	-	-	-	-	-	-	-	1.73
All females	0.01	0.53	0.41	0.86	1.88	3.83	7.28	5.33	2.28	1.01	0.24	0.06	0.03	0.01	0.01	0.01	-	-	-	-	-	-	23.78
All classes	0.01	0.79	0.63	1.28	3.24	7.25	15.86	16.97	13.11	10.37	7.45	5.44	4.39	3.68	2.83	2.34	1.90	1.20	0.90	0.27	0.04	0.02	99.97
Percentage berried females of total females	-	-	-	-	0.53	2.09	8.65	9.94	10.96	16.83	12.50	16.67	-	-	-	-	-	-	-	-	-	-	99.97
Sex ratio: percentage of total females of all classes	-	67.09	65.08	67.19	58.02	52.83	45.90	31.41	17.39	9.74	3.22	1.10	0.68	-	-	-	-	-	-	-	-	-	-

TABLE VI

The escapes of Nephrops norvegicus from the 7o mm. mesh cod-end of an Otter trawl into the small mesh attachment. Data relates to all classes of prawns taken in six hauls carried out in the Firth of Clyde during September 1927.

Length in cm.	3		4		5		6		7		8		9		1o		11		12		13		14		15	
Escapes = Ex.) Retained= R.)	Ex.	R.	Ex.	R.	Ex.	R.	Ex.	R.	Ex.	R.	Ex.	R.	Ex.	R.	Ex.	R.	Ex.	R.	Ex.	R.	Ex.	R.	Ex.	R.	Ex.	R.
Haul No. 1	0	0	0	0	0	0	0	0	2	2	7	12	41	5o	48	68	3o	87	12	1o7	3	94	1	66	o	38
" " 2	0	0	0	0	6	2	10	0	34	9	74	46	227	130	202	123	84	83	24	64	3	43	2	33	2	21
" " 3	1	0	78	0	44	0	78	3	1o6	11	148	35	85	28	42	37	15	39	14	45	4	28	1	26	0	23
" " 4	0	0	0	0	4	0	0	0	18	2	22	7	11	20	8	14	2	20	0	14	0	13	0	5	0	3
" " 5	0	0	0	0	3	0	12	6	44	11	50	45	54	114	32	119	9	84	4	66	0	41	0	23	0	18
" " 6	0	0	0	0	0	0	0	0	1o	14	33	45	62	238	68	3o9	17	257	8	182	1	127	0	91	0	66
Totals	1	0	78	0	57	2	1oo	9	214	49	334	19o	48o	58o	4oo	67o	157	57o	6o	478	11	346	4	244	2	169
Percentage Escapes	1oo		1oo		96.6		91.7		81.4		63.7		45.3		37.4		21.6		11.1		3.1		1.6		1.2	

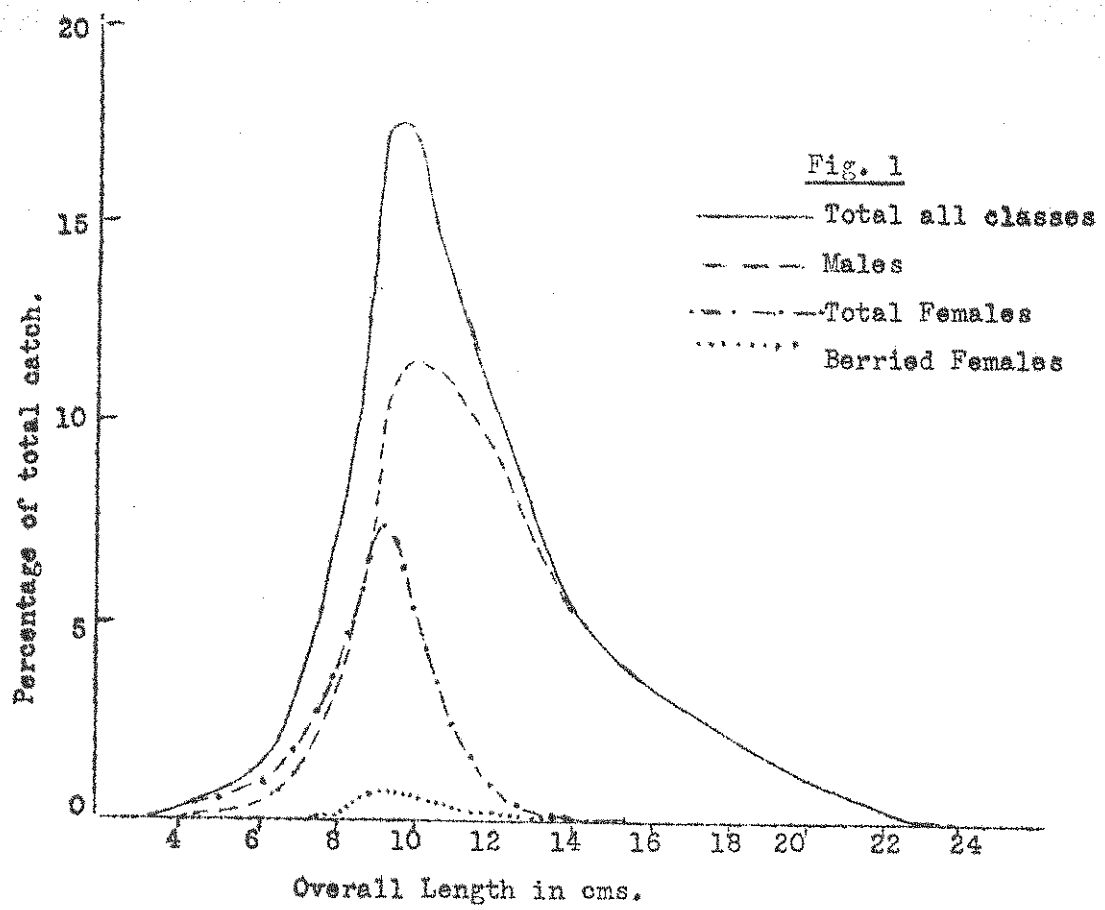

Fig. 1 The overall percentage composition, length and sex of 16 samples of Nephrops norvegicus taken by Otter trawl with small mesh attachment in the Firth of Clyde during September 1927.

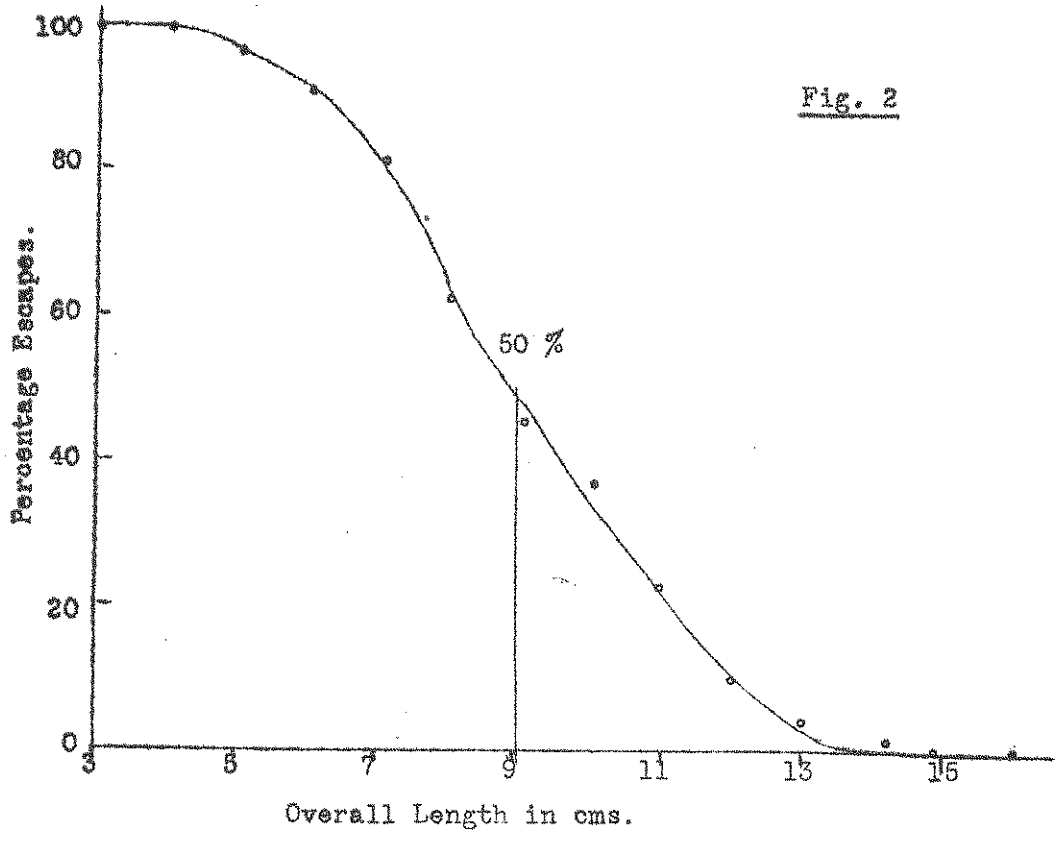

Fig. 2 The percentage escapes by each centimetre length group of Nephrops norvegicus through the 70 mm. codend mesh of an Otter trawl into the small mesh attachment in six hauls carried out in the Firth of Clyde during September 1927.

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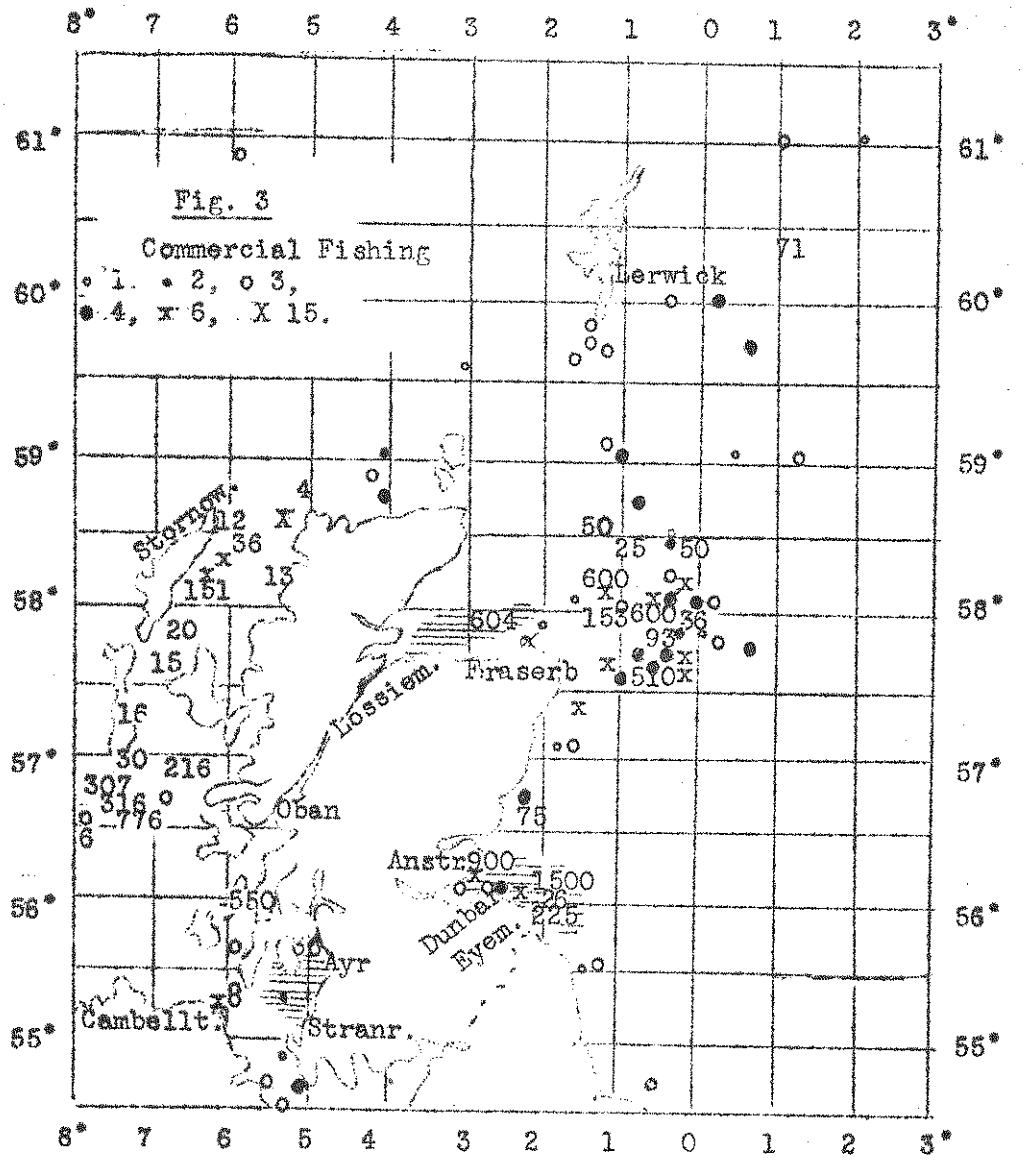

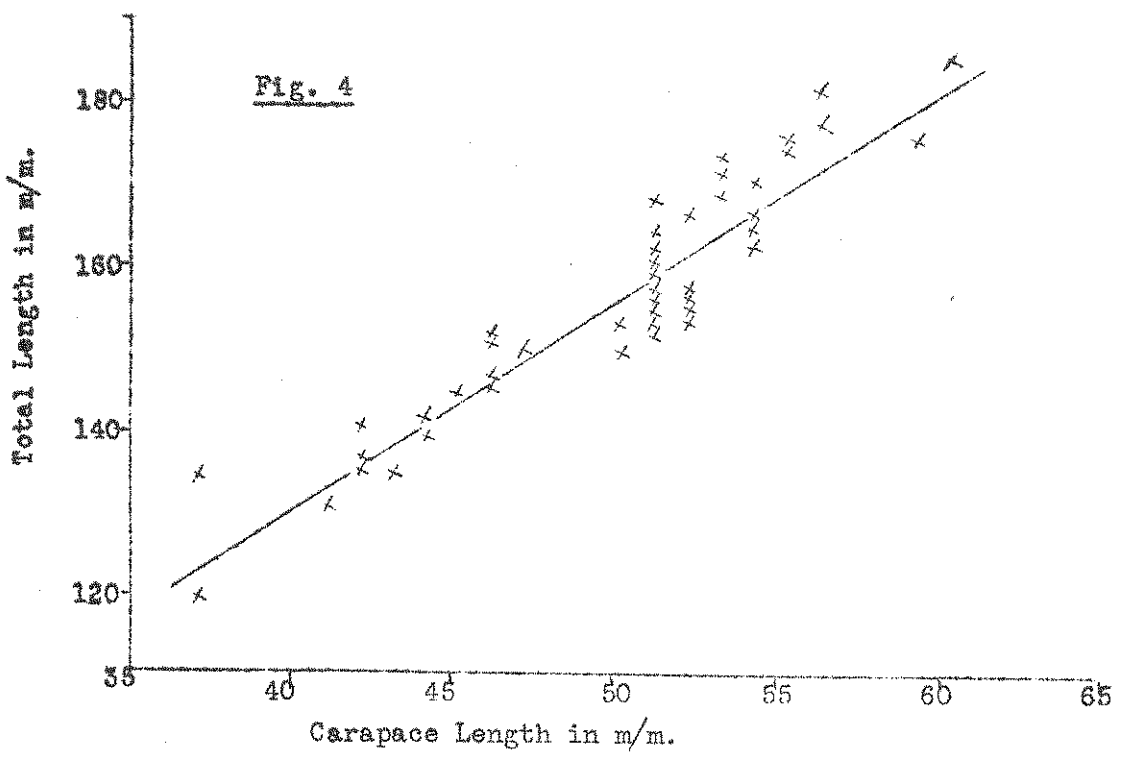

Fig. 4 Nephrops norvegicus. Regression of carapace length on overall length.