THE HERRING FISHERIES AT MILFORD HAVEN

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(Text-figs. 1–6)

CONTENTS

INTRODUCTION

Milford Haven is primarily a trawling port, with hake as its chief product, but it also has herring fisheries which are of interest because they last almost the whole year round. Though Milford ranks fourth or fifth among the herring ports of England and Wales, landing only some 2–4 % by weight of all the herrings landed, its herring fisheries have considerable local importance, and Watkin, whose two papers (1933*a*, 1933*b*) are the only ones dealing with these fisheries, shows that the summer trawl-caught herrings sold at a price twice as great as the contemporary average for the whole of England and Wales. Farran (1944) has very recently published the statistics of the herring fisheries in Eire, and his results are of interest in connexion with the present paper because at least one of the Irish herring fisheries may be based on shoals which contribute, at least in part, to the Milford herring fisheries.

Each year there are three herring fisheries. The spring fishery is a drift-net fishery, and, as Watkin shows, lasts from March to July and even August. The fishery in the summer and autumn is a trawl fishery, and lasts from June and July until November. Finally, the winter drift-net fishery lasts from December to February or March. It will be seen in Fig. 5 that, except for a gap in March and again in late November and early December, herrings are landed at Milford Haven in every month of the year.

Watkin states that the spring drift-net fishery began in 1925, but I am told that it was flourishing as early as 1900. The winter drift-net fishery is genuinely of recent date: it was started in 1933, when some drifters, disappointed by the

failure of the Plymouth winter season, broke their voyage north to Buncrana and Stornaway to have a shot off Dunmore. They got good results, and the fishery has been an annual event since. The trawl fishery for herrings in the summer and autumn is of long standing.

Watkin shows that, during the spring drift-net fishery, the herrings are mainly spent fish. They are feeding heavily on krill (euphausiids) and red feed (copepods). Towards the end of the season, however, in June, the roes show a considerable degree of recovery. Farran (1944) writes that, in the Irish fisheries of Waterford and East Cork 'the fish taken in April are at first in poor condition after spawning, but, owing to the rich feeding on the south coast, they rapidly improve and by the middle or end of May almost all are matties in first-class condition'. 'Fish taken in April, May and June have usually food in their stomachs, sometimes in large quantities. The main food is the copepod *Calanus*, but larval Crustacea and fish are also eaten at this time; in April, euphausians, small shrimp-like Crustacea, sometimes occur in large numbers.'

During the summer and autumn trawl fishery, the roes are in an advanced stage of development, but never 'mazy', or running with eggs. Watkin does not mention whether these fish are feeding or not, but Mr Hewett, one of the most consistent of trawl herring skippers at Milford, has told me that, at least off Kinsale, the herrings may have 'black-gut', that is, contain some food.

Finally, in the winter drift-net fishery, the beginning of the season in December and January, finds the fish 'full', and in good condition, but in February and March the fish become spent. Farran (1944) shows that in January 41 % of the fish are full and 40 % actually spawning. The stomachs are empty.

The herrings taken in these three fisheries, therefore, show a continuous change, with spawning in the winter, and recovery in the spring and summer; and until the contrary is proved, it is reasonable to believe that they are all of the same stock of herrings. Evidence will be given later in this paper in support of this. The fact that Watkin found differences between the spring drift-caught herrings and the summer trawl-caught herrings, in respect of the size of the fish, the age of the fish and the rate of growth, does not necessarily indicate different stocks, for the trawl takes all herrings without selection, whereas the drift-net, as Farran (1936) has shown, is very selective in its effect, picking out from the shoals of herring fish of the size and bodily condition appropriate to the size of mesh used. I have shown, in connexion with the pilchard (Hickling, 1939) that this net selection can change the apparent rate of growth.

Ships and Gear

The drift-net fisheries are carried on by steam drifters from the east coast, which make seasonal visits to the port. The trawl fisheries are carried on by local steam trawlers, usually of the largest type fishing from the port, namely,

'Castles', of 125 ft. length and about 270 gross tons. A special herring trawl is used; Davis (1936) gives a description of this trawl. It has ordinary wings, but the 'straight piece' is many feet longer than in the ordinary trawl and is braided of fine mesh throughout. The herring trawl must be towed as fast as possible, and so only the largest and most powerful trawlers usually take up this fishery. But in the autumn of 1939, owing to the uncertainty as to the course which the war might take, all trawlers were working on the herring grounds off Kinsale and the Smalls, and a comparison of the catches of herrings made by ships using the ordinary trawl and the herring trawl shows that the herring trawl catches about $2\frac{1}{2}$ times as much herring in unit fishing time as the ordinary trawl.

In 1940, the trawl fishery for herrings off the Old Head of Kinsale was the heaviest ever known. One trawler, the *Rudilais*, Skipper A. Riby, landed 1019 cwt. of herrings in a single voyage, an all-time record. Trawlers of all types took part, using the herring trawl, and this allows of a comparison between the performances of the different classes of trawler. The average weight of herrings caught, per 100 hr. of fishing time, was as follows:

Type	Average length	Average gross tonnage	Average catch per 100 hr.
Small trawlers	110 ft.	180	210 cwt.
Medium trawlers	115	220	254
Large trawlers	125	270	307

It is seen that the large 'Castle' type trawlers, which normally carry on the fishery, have a performance 50% greater than the small trawlers, and 20% greater than the trawlers of medium size. The performance, in fact, increases in direct proportion with the gross tonnage.

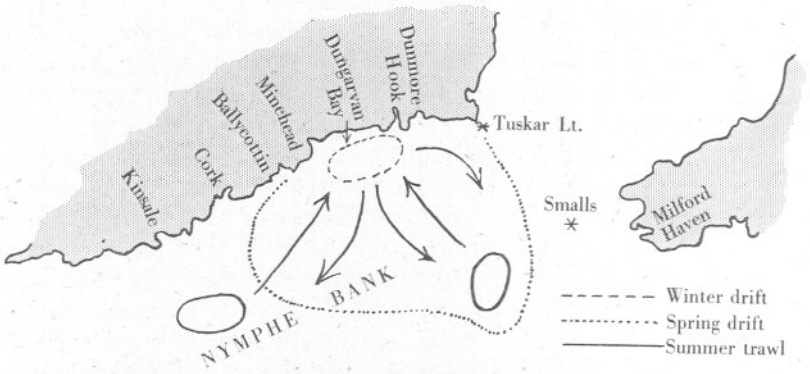


Fig. 1. The location of the herring fisheries; the arrows mark the suggested migrations.

The Location of the Fisheries

The localities in which the herring fisheries are carried on are shown in Fig. 1. The winter drift-net fishery takes place in a comparatively small area off the

south-east corner of Ireland, in Dungarvan Bay between Hook Point and Minehead, and occasionally as far west as Ballycottin.

The spring drift-net fishery covers a much wider area. Apart from small outlying catches, it extends from off Cork along the south coast of Ireland to the Tuskar, and to a considerable distance southwards into the St George's Channel and on to the Nymphe Bank.

Finally, the trawl herring fishery occurs in two well-defined and quite separate localities, namely, off the Smalls, and, again, some 90 miles farther west, off the Old Head of Kinsale.

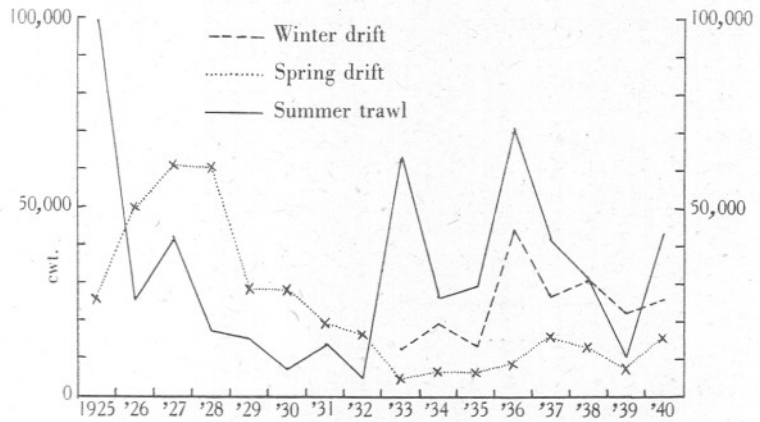


Fig. 2. The total catch of herrings in each year at Milford Haven.

The Yield of the Fisheries

In Fig. 2 are shown the total annual weights of herrings caught in each of the three fisheries from 1925 to 1940. There were no herring fisheries in the years 1941–4 because war conditions so hampered the operations of the drifters that they did not work from Milford, while the trawlers found herring trawling less profitable than trawling for hake.

Referring to Fig. 2, both the summer trawl fishery and the spring drift fishery showed a downward trend in the years 1927–32, after years of high yield in 1925 in the trawl fishery and 1926–8 in the drift fishery. From 1933 to 1937 the drift fishery showed some recovery, though not to the previous best levels; but the trawl fishery recovered very substantially, and the years 1933 and 1936 were good years. In 1936 the quality of the herrings was particularly good. The winter drift fishery showed an upward tendency throughout.

Fig. 2 shows the total yield, and this is affected quite as much by the fishing effort expended as by the abundance of herrings. A truer picture of the yearly variations in the fortunes of the fisheries is to be got by calculating the weight of herrings caught per voyage. Even this, however, leaves something to be desired, for the amount of fishing time may vary in each voyage. But, generally

speaking, the effect of this variation will be to exaggerate the goodness or poorness of the apparent catches per voyage, for when fishing is poor, a longer time is necessary on the fishing grounds to make a trip, whereas, when fishing is good, a satisfactory trip is made in a short time. But, in the case of herrings, which do not keep well, there is a limit to the length of any voyage, which may be put at about five days.

In Fig. 3 the average weight of herrings caught per voyage in each year is shown. The abundance of herrings, as measured by the catch per unit of fishing effort, declined from 1925 to 1932, but from 1933 to 1938 all three fisheries showed an increasingly high yield per unit of fishing effort. The trawl herring season of 1939 was apparently poor, but the outbreak of war occurred during

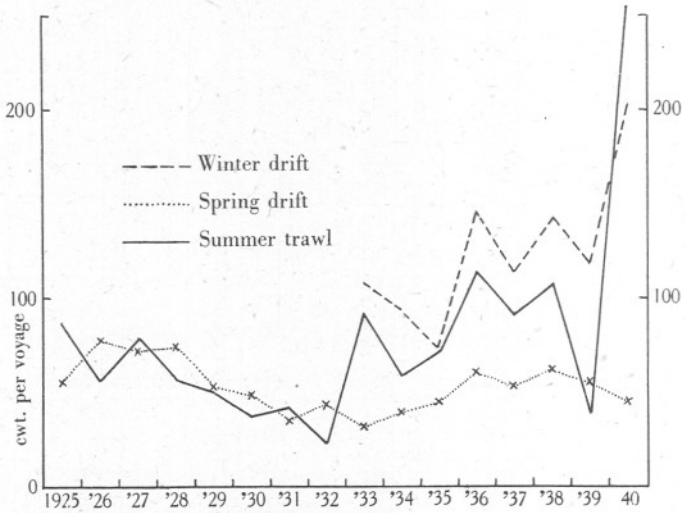


Fig. 3. The average weight of herrings per voyage in each year at Milford Haven.

the period which is normally most productive, and the large-scale requisitioning of trawlers, together with the general uncertainty as to the effect of the war at sea, so handicapped the fishing fleet that the apparent catch per unit of fishing effort is much lower than it would normally have been. The season would undoubtedly have been poorer than that of 1938, and I have estimated that it would have given an average weight of about 80 cwt. per voyage.

The Relations between the Fisheries

There is a considerable correspondence between the annual changes in the abundance of the herrings caught in the spring drift-net fishery, and those in the summer trawl fishery, especially from 1925 to 1932. But from 1933 to 1940 the herrings taken in the spring drift-net fishery, while increasing in abundance as did those in the trawl fishery, did not do so in the same relation

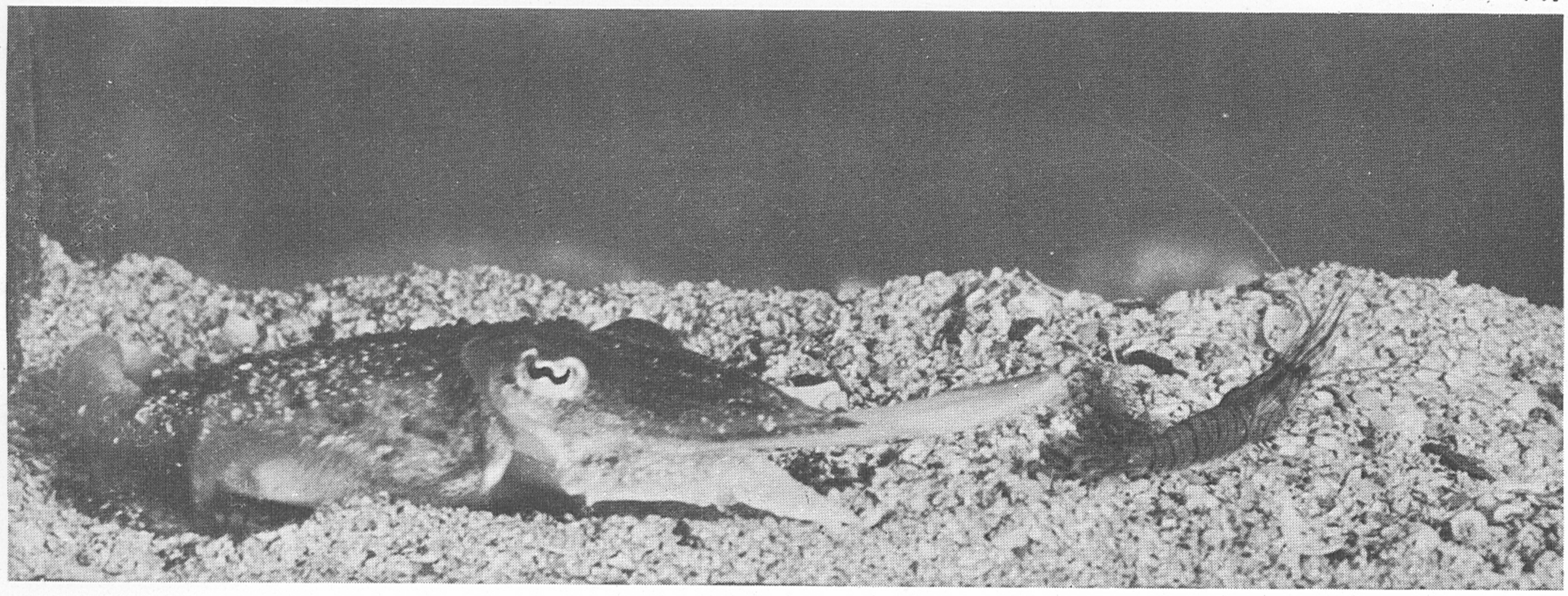
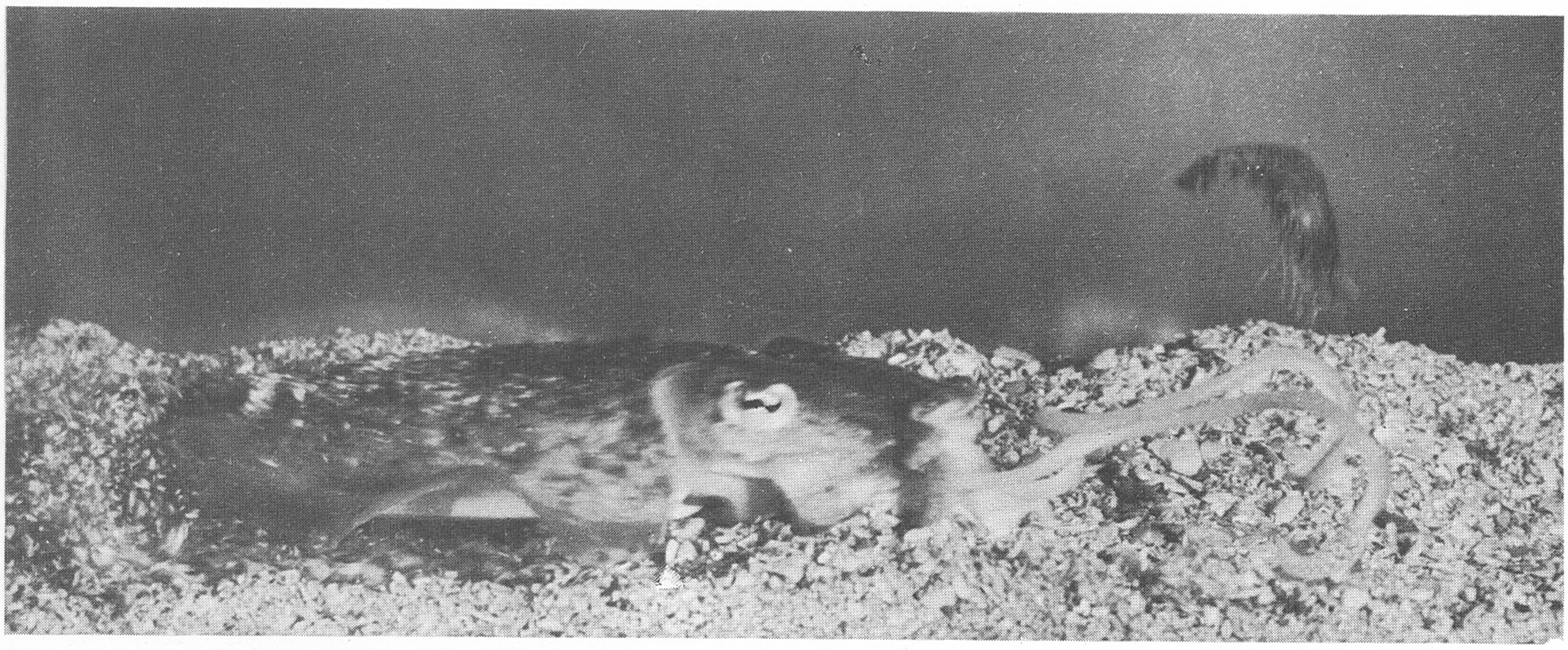


Fig. 1.



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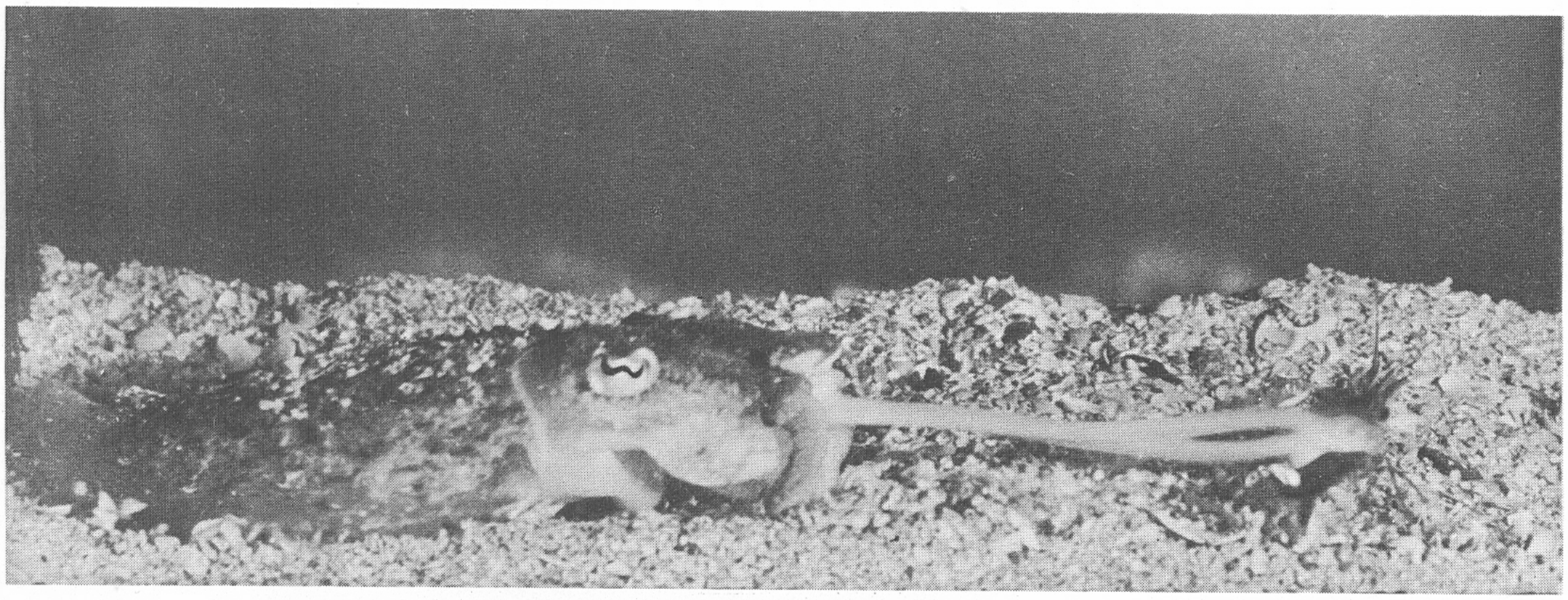

Fig. 3.

Sepia officinalis. Catching a prawn.

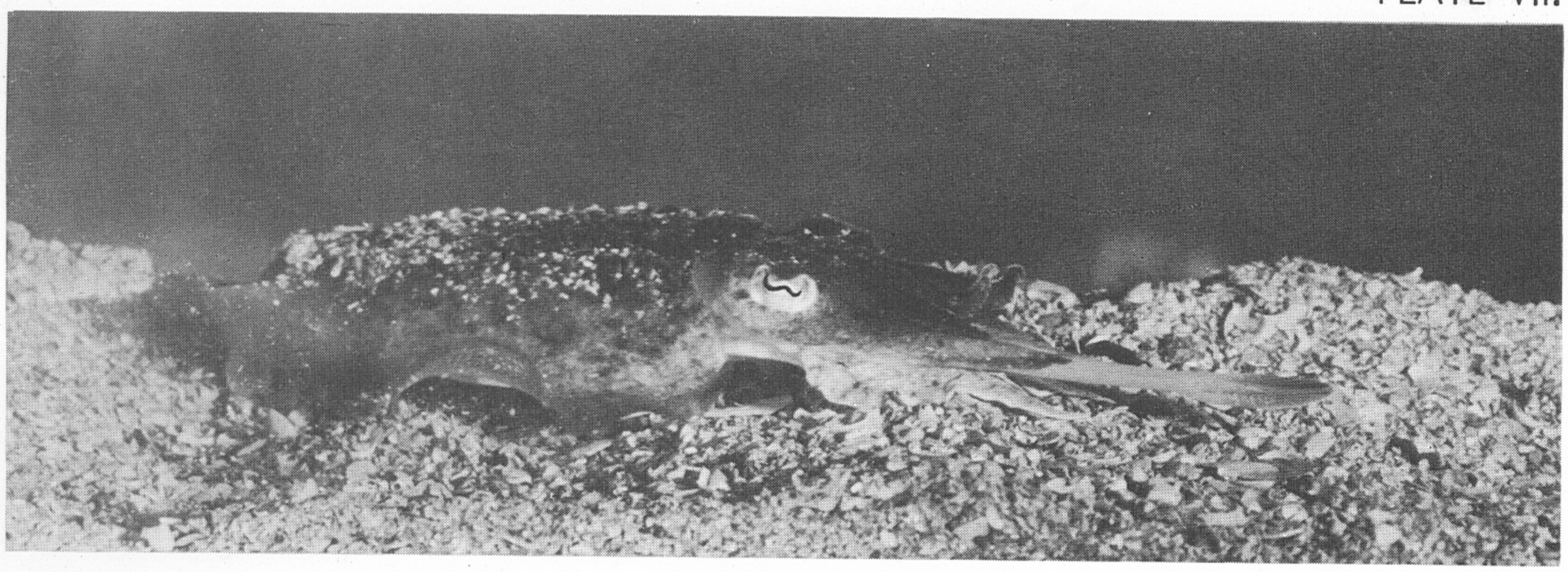

Fig. 1.

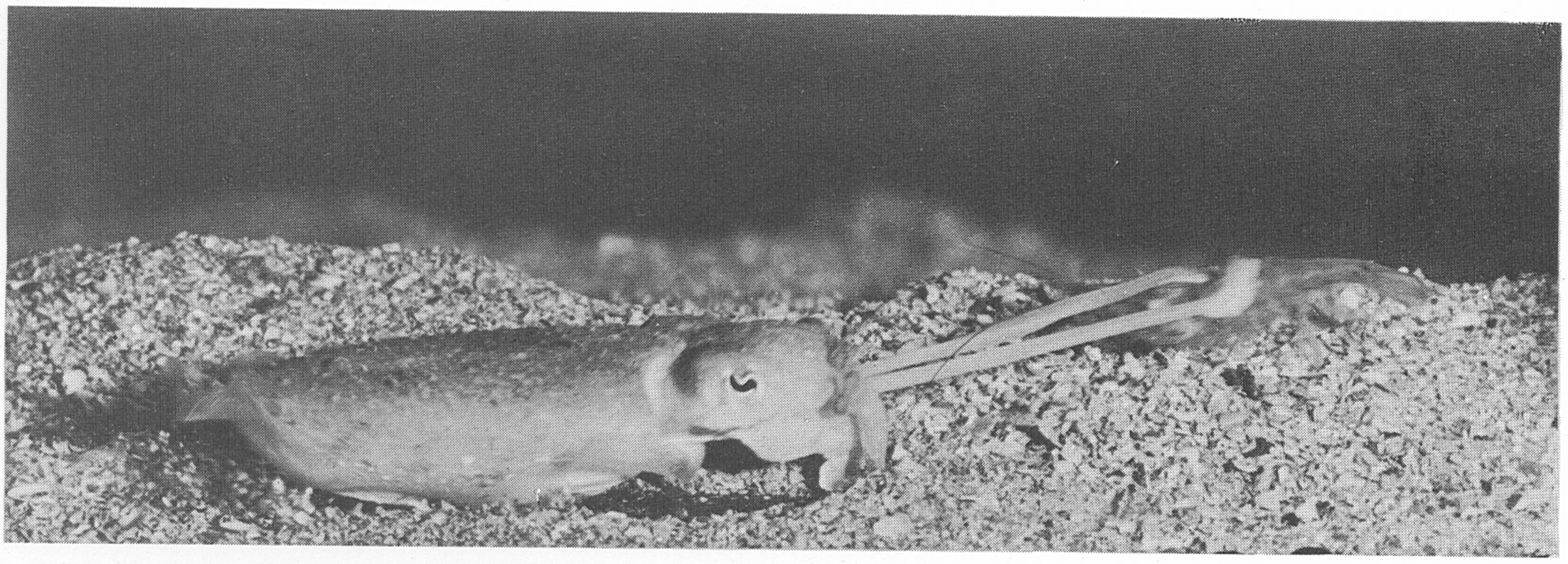

Fig. 2.

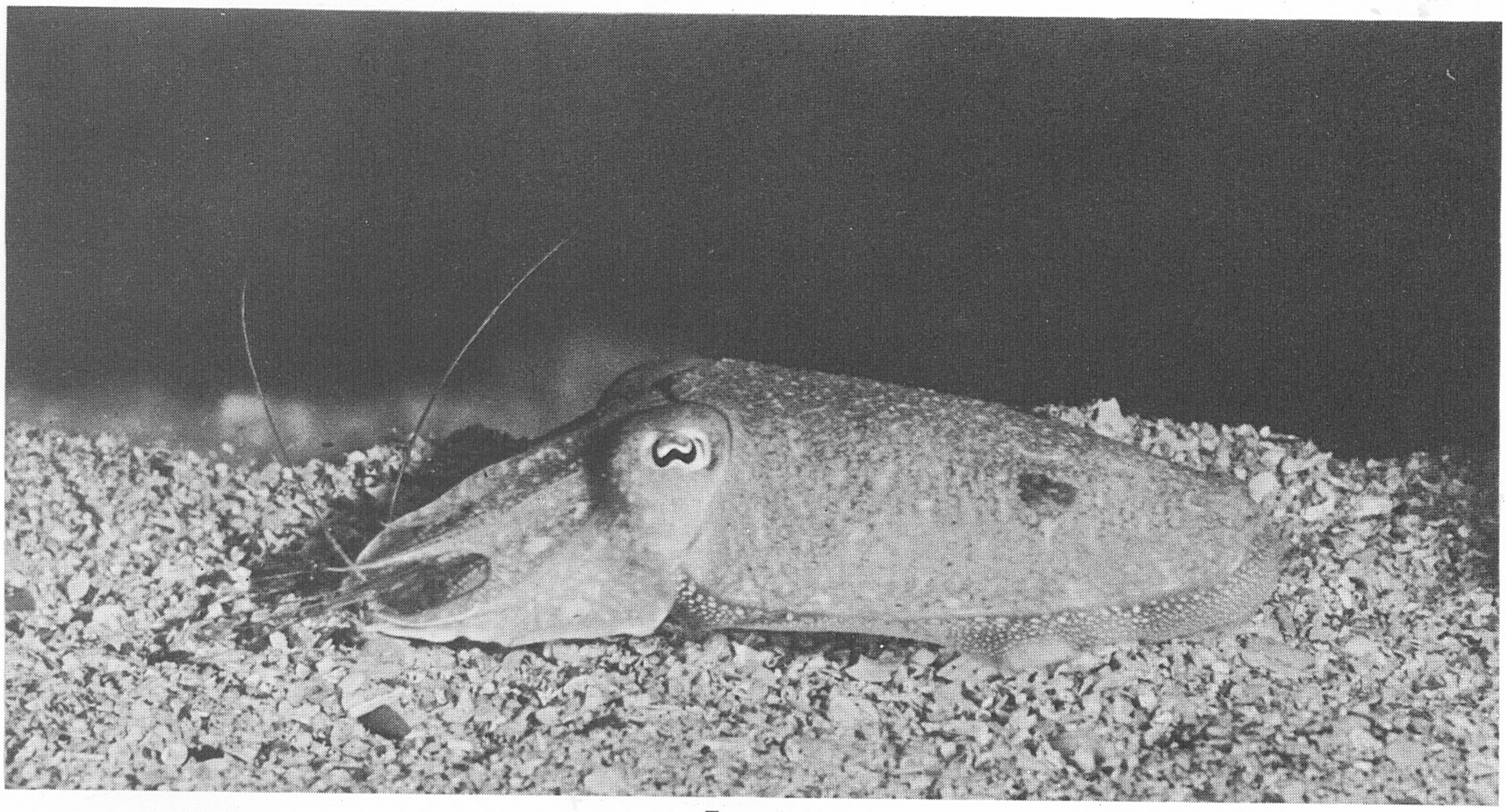

Fig. 3.

Sepia officinalis. Catching and eating a prawn.

to the latter as in the years 1925–32. The two average yields per voyage were, by a coincidence, of the same order of weight in the years 1925–42, but, from 1933 to 1940, the recovery in the drift-net fishery fell much below that of the trawl fishery. In 1933 the winter drift-net fishery began, and I think it very probable that the new fishery, by taking large quantities of herrings, has lowered the yield of the spring fishery. If this is so, it is a desirable development, for the winter-caught fish are in a good condition, at least during the earlier part of that season, while the spring-caught fish are spent and in poor condition until towards the end of the spring season.

There is a very close correlation, as Fig. 3 shows, between the catch per trip in the winter drift-net season and the subsequent trawl herring season. Using the estimated figure for 1939, the correlation between the eight pairs of average catches from 1933 to 1940 gives a coefficient of +0·908, a very significant figure which would be obtained by chance in uncorrelated material less than once in a hundred trials.

It follows that, by the end of the winter drift-net fishery, in March, an estimate may be made of the prospects in the trawl fishery which begins in June or July and ends in November. A good winter drift-net season is very likely to be followed by a good trawl season, while if the winter season is below the average, or a poor season, the prospects for the summer trawl season are likely to be poor. Where, as at present, no estimate whatever may be made as to the prospects of a herring season, which means a lot to the port's prosperity, the guide given by the correlation described above may be of help.

The correlation holds equally well whether the bulk of the trawl-caught herrings are taken off the Smalls or off Kinsale. In the table below are given the weights of herrings caught by the trawl at each of these grounds in each year:

Year	Kinsale	Smalls
1933	14,886	48,557
1934	8,457	19,861
1935	2,718	26,704
1936	13,986	50,077
1937	27,290	13,595
1938	25,638	5,892
1939	5,679	3,021
1940	43,059	Closed by minefield

The correlation shown in Fig. 3 holds as well for the years 1933 to 1936, when most of the herrings were caught off the Smalls, as for the years 1937–40, when the Kinsale fish provided most of the catches.

Evidence of Herring Migrations

It has already been shown that the changes in the roes of the herrings caught by the three fisheries show a continuous series, suggesting that the three fisheries are based on the same stock of herrings. Now it has been shown that the annual fluctuations in the abundance of the winter spawning herrings

off Dunmore are linked with those of the summer trawl-caught herrings, and that there also is a considerable amount of agreement between those of the widely scattered spring-spent herrings, and those of the trawl fisheries. The suggestion that all three fisheries are based on the same stock is reinforced.

As to the trawl-caught herring, it has been shown that both the Smalls and the Kinsale herrings are related to the same winter fishery at Dunmore, and further light on the connexion between the two trawl fisheries may be got by comparing the course of the seasons on each ground.

In Fig. 4 the weight of trawled herrings caught in each month from June to November is shown for each year from 1933 to 1940. The figure shows that,

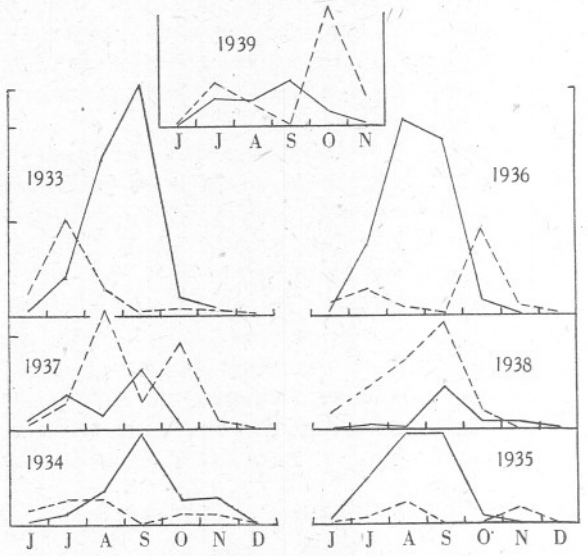

Fig. 4. The weight of trawl-caught herrings landed monthly at Milford Haven from the Smalls and the Kinsale grounds, 1933–40. Broken line—Kinsale, continuous line—Smalls.

in each year except 1938, the two fisheries tend to show an alternation. The fishery at Kinsale shows two peaks, in July or August, and again in October or November; between the peaks, in September, the weight of herrings caught at Kinsale falls, in some cases to zero. This is not because fishing ceases off Kinsale at that time: such data as I have show that fishing is still carried on there. So the decline in the abundance of herrings there is genuine. On the other hand, the fishery off the Smalls tends to rise to a single peak, usually in September, and falls at the time of the secondary peak at Kinsale. In 1938, however, both fisheries reached their maximum in September.

Therefore, though the two trawl fisheries are separated by some 90 miles of sea, they are related to one another by their common relation to the winter drift-net fishery, and by this alternation in the seasonal course of the fisheries.

But it is also well known that, during the trawl herring season, shoals of herring may be seen at the surface between the two trawl herring grounds: I have myself seen them. I think it probable that the herrings which are shoaling in preparation for spawning may be more or less continuously distributed between the Smalls and Kinsale, but that hydrographic or other conditions drive them to the sea-bed within reach of the trawl only at the two ends of their zone of distribution. An oscillation of these shoals from west to east and back again, would cause the seasonal variation in the abundance of herrings at the two ends of the zone.

Therefore in Fig. 1, I have sketched arrows to indicate what appear to be the movements of these herrings on which the three fisheries at Milford Haven are based. After spawning in winter off Dungarvan Bay, they scatter southwards on a feeding movement and are then caught in the spring drift-net fishery. Still later, in summer and autumn, they gather again in a zone, in two areas of which they are caught by the herring trawl, and finally they move back, in late autumn and winter, to Dungarvan Bay to spawn.

One notable feature about the shoaling of these herrings is the fact that, although the trawl fishery ends in October or November, and the winter drift-net fishery begins a few weeks later in December, during these few weeks there must be a reshuffling of the shoals. For, as Fig. 3 shows, the yield of the winter drift-net fishery is not in any way correlated with the yield of the summer trawl season which so recently ended, but with the trawl season still some seven months ahead.

Watkin (1933*a*) suggested that the herrings trawled off the Smalls later move south to the coast of Cornwall to spawn, but when he studied the subject the winter fishery off Dungarvan was unknown. I realize that these suggestions lack proof and that only further research, using biometrical methods, can establish whether the three Milford herring fisheries are in fact based on the same shoals. For example, the continuous cycle in the developing roes might be shown by distinct races of herrings which happen to spawn in the same season, and the observed correlation between abundance of the winter drift herrings and the summer trawled herrings may be due to some environmental factor common to both.

There is a fruitful field of work on the three herring fisheries for a study in the seasonal cycle of the herring, the relation between drift-caught and trawl-caught herring, and even in the behaviour of the herring shoals. In no other port, to my knowledge, are herrings available almost all the year round and possibly from the same stocks of fish.

The Influence of the Moon

Savage & Hodgson (1934) have shown that, in the great East Anglian autumn drift-net season for herrings, there is a relation between the phases of the moon and the catches of herrings, such that the best landings tended to occur at full moon. Further, the success of the herring season as a whole depends

to a large extent on the date of full moon. These authors say 'the best condition for a productive fishery appears to be when the October full moon occurs during the second week, for in this case it is found that the peak in the landings which accompanies this moon is approximately equal to the peak which appears at the time of the November full moon. Under these circumstances a period of about five weeks of good fishing can be expected'. This factor overrides the change in the age-composition of the herring shoals in its effect on the success of the season.

Fig. 2 and 3 show that the yield of the Milford drift-net and trawl seasons show great fluctuations from year to year. These can hardly be due to changes in the age composition of the shoals, for Watkin shows that, in the whole series of years 1923–8 (which included such good years as 1924, when the average weight of herrings per voyage was some 120 cwt., and such poor seasons as 1928 when the average per voyage was only some 56 cwt., or less than one-half) the mean length of the herrings varied only as between 29·2 and 28·4 cm., and the average age as between 6·3 and 6·8 years. These changes, as I have shown elsewhere for the herrings of the southern North Sea (Hickling, 1940), would represent only slight seasonal variations in the mean weight of the fish, of nothing like the order of magnitude of the variations in the yield per voyage. Some other factor, associated with shoaling, must thus account for the greater part of the observed variations from year to year in the abundance of herrings as judged by the catch per unit of fishing effort, as in the southern North Sea.

It is to be noted that Savage & Hodgson could find no regular relation between the moon's phases and the seasonal course of the drift-net fisheries for herring at North Shields and Grimsby.

In Fig. 5 the yield of the Milford drift-net and trawl fisheries, per unit of fishing effort, in each lunar week of each year from 1933 to 1940 is shown. The lunar weeks are the days centred about each phase of the moon, and may consist of 6, 7 or 8 days, according to the adjustment necessary to keep the moon's phase central.

Fig. 5 shows no sign of lunar periodicity in the winter drift-net fishery, and there appears to be no connexion between the date of full moon in January, at the height of the fishery, and the season's yield. Below are given the dates of full moon, and the average weight of herrings per landing in the appropriate full season:

Date in January	5	8	11	16	19	24	26	30
Year	1939	1936	1933	1938	1935	1940	1937	1934
Cwt. per landing	119	146	118	141	73	203	114	95

In the spring drift-net fishery there is a slightly better relation between the catches and the date of full moon. Thus, peaks in this fishery occurred at full moon twice in 1933, once in 1934, twice in 1935, and twice in 1936, once in 1938, and twice in 1940. But there are also many peaks not at full moon, and no definite relation can be stressed.

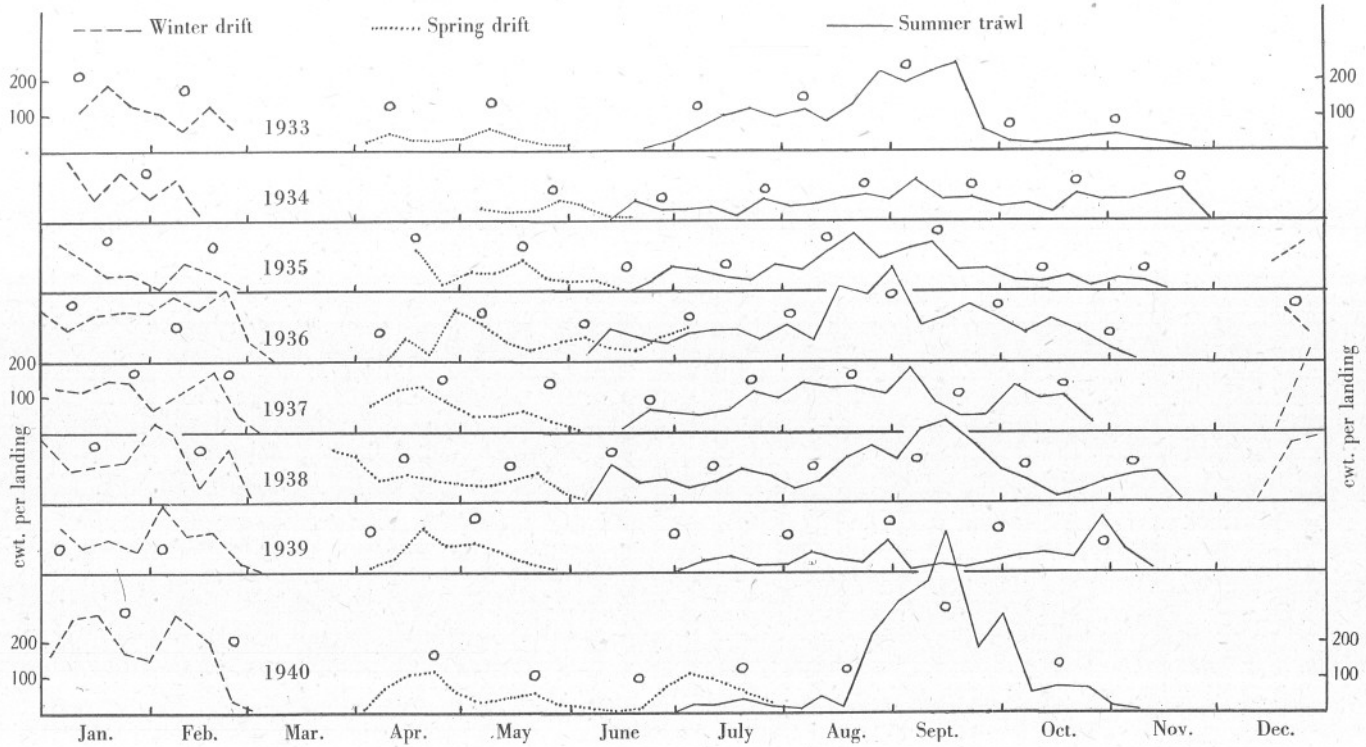

Fig. 5. The average weight of herrings per voyage in each year from 1933 to 1940, calculated by lunar weeks. Full moons inserted.

When the date of the full moon in May is compared with the average yield of the season per unit fishing effort, again, as in the winter drift-net fishery, there appears to be no relation between the two. I have divided this series into two, one series including the years 1925–32, and the second including the years 1933–40, when as I have shown earlier the advent of the winter drift-net fishery may have lowered the yield of the subsequent spring drift-net fishery:

Date in May	4	7	12	16	19	23	26	31
Year	1928	1925	1930	1927	1932	1929	1926	1931
Cwt. per landing	75	56	49	72	44	54	78	34
Date in May	3	6	9	14	18	21	25	28
Year	1939	1936	1933	1938	1935	1940	1937	1934
Cwt. per landing	57	60	31	61	44	46	53	39

Again there is no tendency apparent in these figures to suggest that the season may be a better one when the full moon occurs at any particular time in May.

Finally, in the summer trawl herring fishery there has been no regular and constant tendency for the fishery to improve at full moon. In two of the best seasons, namely, 1936 and 1940, the heaviest fishing did occur at full moon, but in the next best seasons, those of 1933 and 1938, the peaks occurred between full moons, and in all the other years an improvement in the catch was just as likely to occur at any other phase of the moon as at full moon.

If, in the whole series of years, the average weight of herrings per landing at each phase of the moon is calculated, it appears that full moon did produce the largest average catch, as may be seen below:

Full	Last	New	First
94·1	72·0	89·0	84·8

But when these means are tested, it is found that a difference as great as that observed between the lowest mean catch, at last quarter, and the highest mean catch, at full moon, would be found by chance twice in ten trials, and no significance can be attributed to them.

Finally, to compare the yield of the trawl herring seasons with the date of full moon in September, use can be made of the Sea-Fisheries Statistical Tables of the Ministry of Agriculture and Fisheries. From these can be extracted the average weight of herrings landed by steam-trawlers, per days absence from port, in Region VIIG–K, which includes both the Smalls and the Kinsale fishing grounds, in each year since 1907. Years in which fewer than 10,000 cwt. of herrings were landed have been omitted, as being so small a total that the fishery was not adequately sampled. The years omitted are 1909, 1915–19, and 1930.

In Fig. 6 the average weight of herrings per day's absence has been plotted, for each year, against the date of September full moon. The figure shows that all but one of the best seasons occurred when the moon was full in the first 16 days of September, and that all seasons in which full moon fell in

the last fourteen days of September, with that one exception, were poor seasons. The average weight of herrings per day's absence from port, when full moon fell in the first 16 days of September, was 25, whereas when full moon fell in the last fourteen days of September the average was 10. When these averages are tested statistically, they are found to be significant, since a difference in the averages as great as this would be found by chance less than once in a hundred trials.

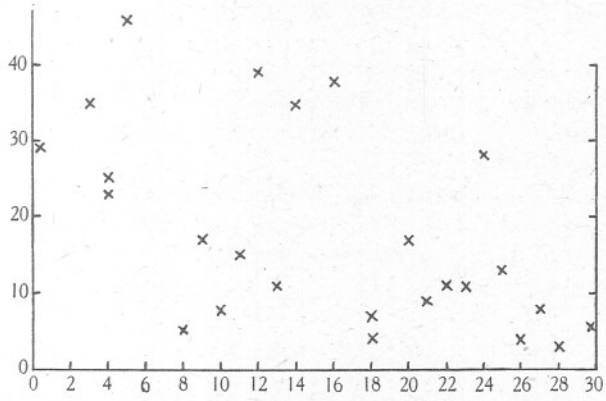

Fig. 6. The average weight of herrings (cwt. per day's absence) plotted against the date of full moon in September 1907–39.

The data may be further considered as a fourfold table. The average weight of herrings per day's absence from port over the whole 25 years was 18 cwt.:

	Season above average	Season below average
Full moon in the first 16 days	8	5
Full moon in the last 14 days	1	11

A statistical test again shows that these figures are significant. It appears, therefore, that when full moon falls in the first sixteen days of September, the trawl herring season may be either good or bad, with the odds slightly on the good; but when the moon is full in the last fourteen days of September the season is likely to be below the average.

The Daily Variation in the Catches

Lucas (1936) showed that, in the North Sea trawl herring fishery, the average catches increased from midnight to a maximum at midday, falling again to a minimum at midnight. I have no data as to the diurnal variations of the trawl fisheries in the Milford Haven area, but skippers are agreed that herring catches are best at night off the Smalls, and by day off Kinsale. On both occasions when I have been at sea on herring trawlers off the Smalls, the night gave the best catches, and the ship would steam away a few miles, when daylight came, to fish for mackerel.

Summary

1. There are three herring fisheries carried on from Milford Haven, namely, a winter drift-net fishery, a spring drift-net fishery, and a trawl fishery in the summer and autumn. These fisheries provide herrings nearly all the year round.

2. There is evidence that the three fisheries are based on the same stock of herrings, and the annual migrations of these herrings are deduced from statistical data.

3. There is a correlation between the results of the winter drift-net fishery and the following summer and autumn trawl fishery, so that it is possible to make an estimate of the prospects of the important trawled herring fishery some months in advance.

4. There is no evidence that the catches in any one season fluctuate with the moon's phases, but it is found that, in seasons when the moon was full in the last fourteen days of September, the result of the trawl herring fishery has almost always been poor.

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