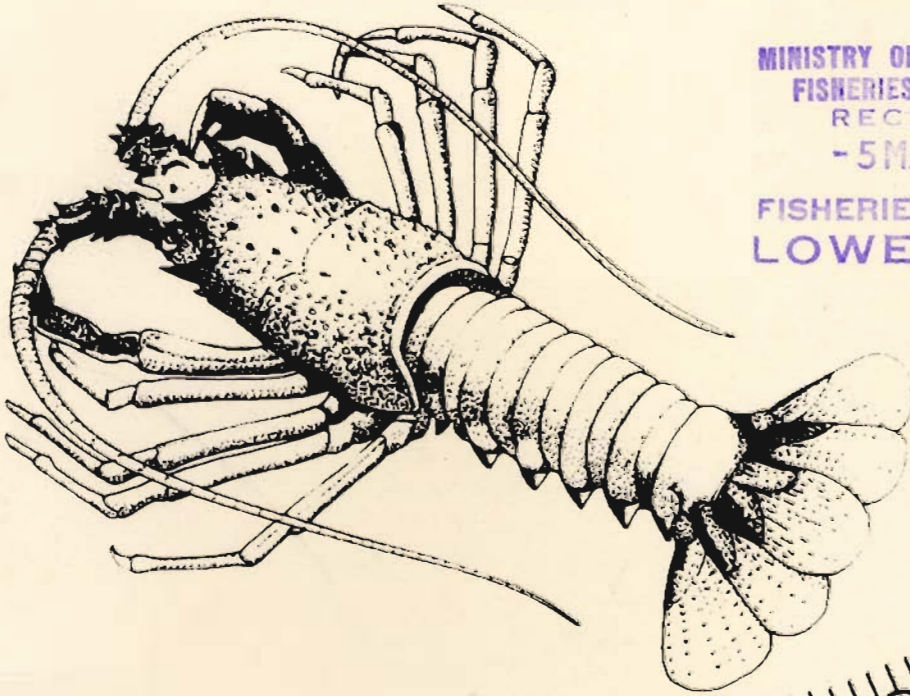
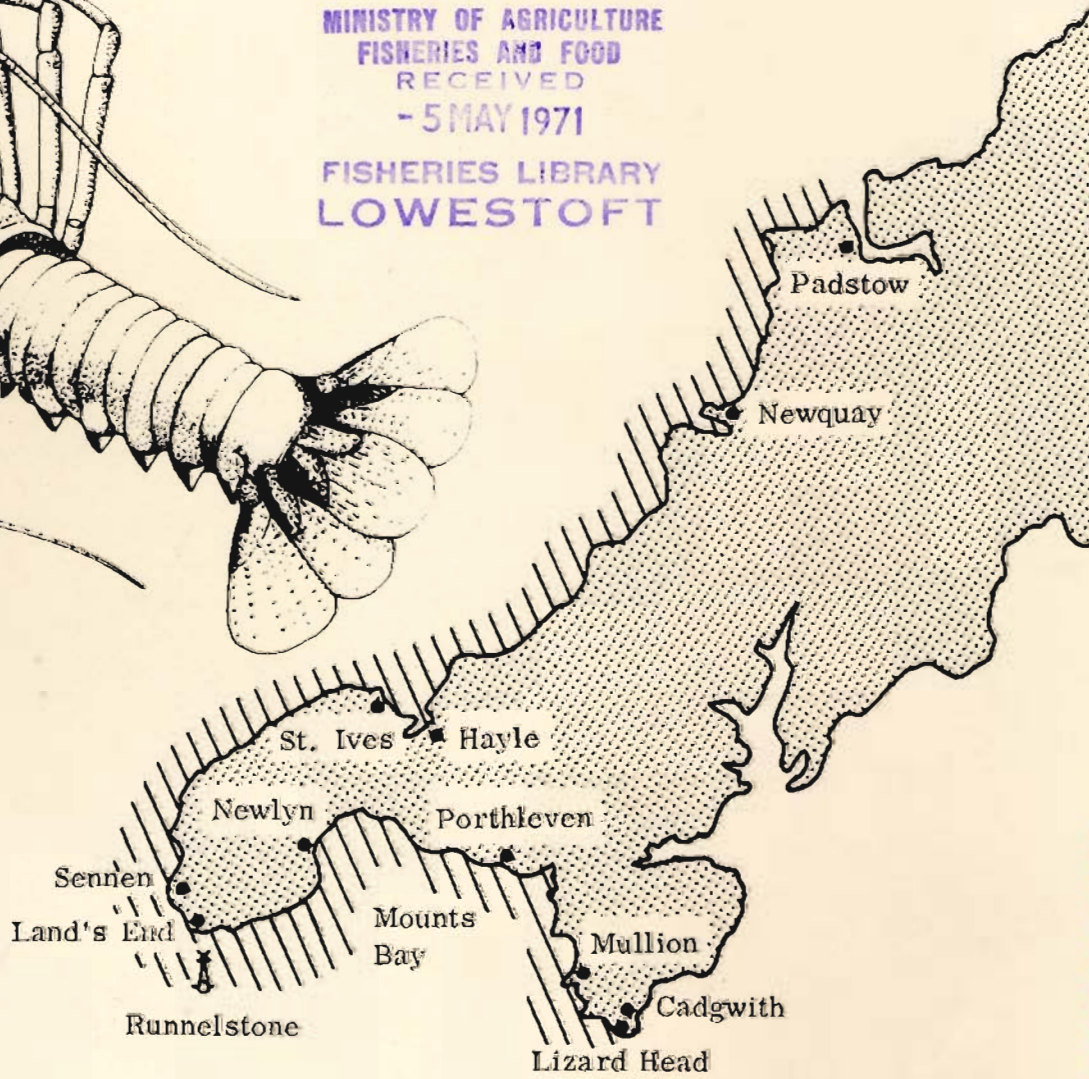


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# CORNISH CRAWFISH INVESTIGATIONS



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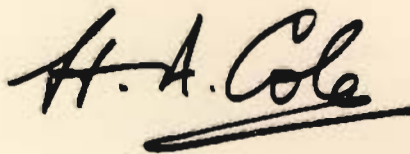


LABORATORY LEAFLET (NEW SERIES) No 22

BY B.T. HEPPER  
FISHERIES EXPERIMENT STATION  
CONWAY  
CAERNARVONSHIRE

MARCH 1971

In this report Basil Hepper summarizes our present knowledge of the fishery for crawfish off Cornwall and of the state of the stock of crawfish on which it is based. He considers the effects of the fishery for crawfish by diving on the stock as a whole and on the catches of the pot fishermen. On some grounds off north Cornwall the abundance of crawfish has been reduced in recent years, but not dangerously so. The fishery removes only the larger and older crawfish, and apparently takes only a small proportion of the stock in any year.

A handwritten signature in black ink, reading "H. A. Cole". The signature is written in a cursive style with a prominent loop on the "C" and a long horizontal stroke underneath the name.

H. A. Cole  
Director of Fishery Research

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## CORNISH CRAWFISH INVESTIGATIONS

### THE FISHERY

Crawfish are caught in quantity only in the area west of a line drawn through the Lizard Head and Padstow. Although caught over a relatively small area, they form an important part of the local fishing economy, and in recent years the total value of the crawfish landed has been, on average, intermediate between that of lobsters and crabs landed from the same area. The main crawfish fishing season is from about May/June to October or November, with the best landings usually occurring in September.

Crawfish are caught in pots, either the traditional Cornish 'inkwell' pot or the barrel-shaped French pot, or by tangle nets or by divers. The pots are also used to catch crabs and lobsters and are fished from the rugged coastline down to a depth of some 180 ft. Tangle nets were used extensively for catching crawfish before 1939 but were not much used afterwards until fairly recently, when the use of synthetic fibres has brought them back into favour. Some crabs and lobsters are also taken in tangle nets.

Diving for crawfish started in 1963 and built up to about 24 divers in 1967 and about 33 in 1969; it is largely done from Hayle, although the divers operate along most of the north coast west of Padstow, round Land's End to the Runnelstone and off the Lizard Head. Their operations are limited to depths of less than 120 ft. Divers fishing for crawfish rarely take lobsters or crabs.

The fishery and the biology of crawfish have been studied since 1962, and the study was intensified in 1965 after pot fishermen expressed fears that diving for crawfish might harm the stock. Several published papers give an outline of earlier results and these are listed in the References on page 20.

### RECENT CHANGES IN THE FISHERY

In order to understand the causes of changes in the quantities of crawfish landed from year to year and changes in the quantities caught by individual fishermen, it is necessary to have good information on the amount of fishing (fishing effort) in different areas and from year to year. Obtaining this information on fishing effort for the Cornish fishery for crawfish has proved extremely difficult and continues to be one of the main causes of uncertainty in determining the state of the fishery. It is our aim to receive from each fisherman each week details of the quantities of crawfish, crabs and lobsters caught and the number of pots he has

been using and on how many days he has lifted his pots during the week, or, for divers, the quantity of air used during the week.

Although information on the quantities of crawfish, crabs and lobsters landed is fairly complete, in only a few areas has it been possible to get matching data on the fishing effort. However, it would seem from the records available that during the 1950s there was a slightly larger fishing effort from the ports of Cadgwith, Mullion and Sennen than during the 1960s. It would also appear that the fishing effort from Porthleven, Newlyn and the Isles of Scilly built up during the 1950s, fell off again in the early 1960s and has risen again in recent years. On the north coast only a small fishing effort was expended from Padstow, Newquay, Hayle and St. Ives during the 1950s and until 1962, after which the effort in these areas increased substantially, although since 1967 there has been a reduction in effort from Newquay.

Much of the increased effort has been due to the entry of divers into the fishery. In 1963, when diving started, there were 6 divers operating, and in successive years their numbers increased to 14, 20, 20, 24, 30 and about 33 in 1969. There has also been a substantial increase in the number of tangle nets, which during the post-war years up to 1967 were used on only a small scale. It has been estimated that in 1969 there were 20-30 miles of these nets in use from St. Ives, and 30-40 miles in 1970. A few nets are also worked from Mounts Bay ports. In addition, on the north coast there is a much greater potting effort than was the case before 1962. Furthermore, it should be noted that there are now a number of well-boats, based at Padstow and Newlyn, engaged in crawfish fishing, and these boats range over a wide area.

## LANDINGS OF CRAWFISH

Information is available, from the published fishery statistics\*, on the total landings of crawfish in south-west England since 1920 and these landings are shown in Figure 1. It is seen that catches have varied very much in irregular cycles and that there were peak catches in the early 1920s, in 1933, 1947 and in 1959. Unfortunately, there is no satisfactory information on the numbers of boats fishing for crawfish each year between 1920 and 1970, so it is not possible to tell to what extent these variations in annual catch were due to changes in the number of boats fishing and how much to changes in abundance of crawfish, though the low catches between 1940 and 1946 were certainly at least partly due to reduced fishing during the 1939-45 war. Figure 1 also gives the landings of lobsters in Cornwall and the Isles of Scilly and these show an almost continuous decrease from 1921 to 1961, suggesting that the fishing effort had steadily declined or that there has been a steady decline in abundance of the lobsters, or both. As, in general terms, the same boats fish for crawfish as fish for lobsters, the more striking fluctuations in catches of crawfish are more likely to have been due to changes in their abundance or availability than to changes in the numbers of boats fishing specially for them.

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\*Sea Fisheries Statistical Tables (published by HMSO annually).

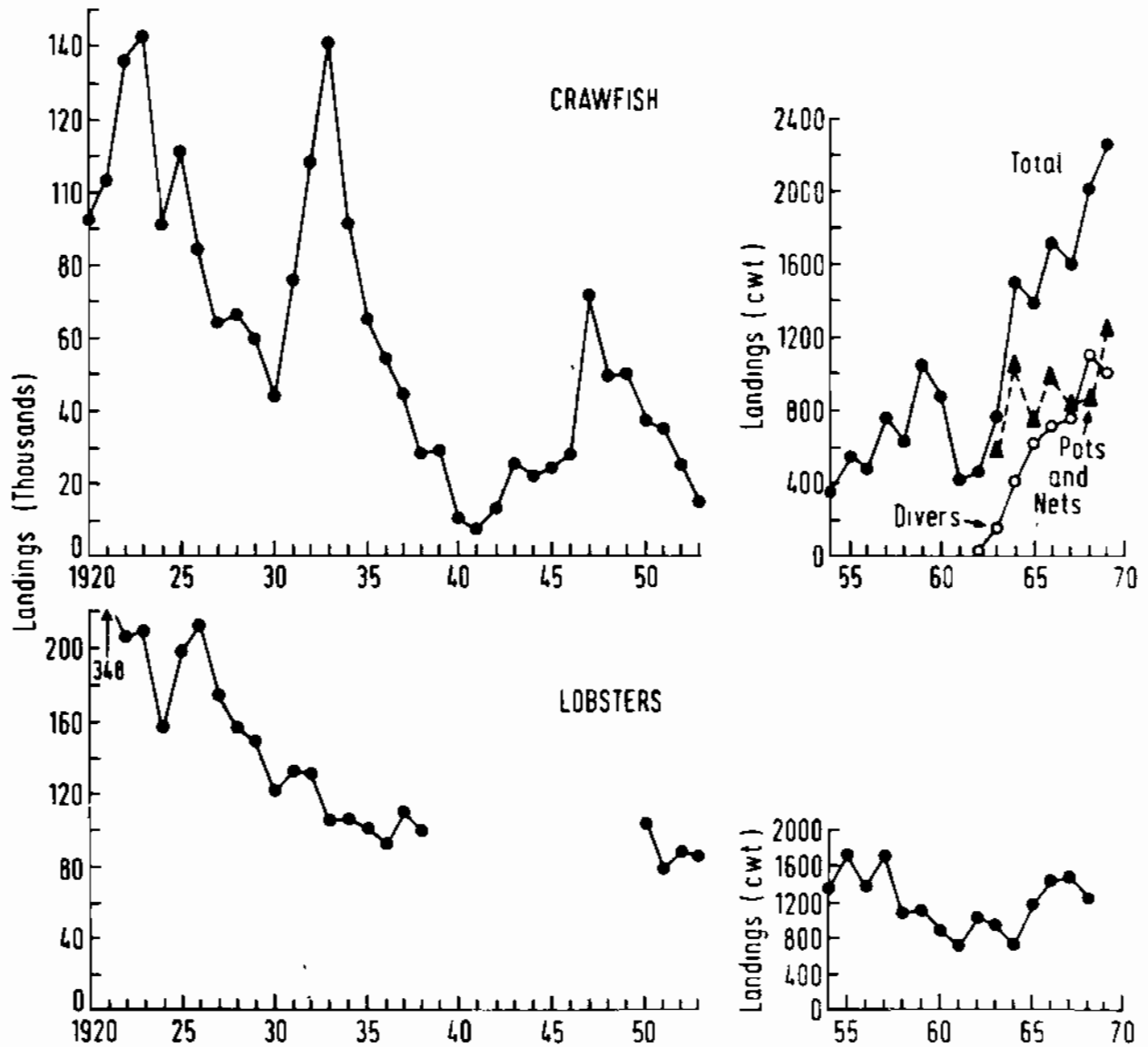


Figure 1 Landings of crawfish and lobsters in Cornwall and the Isles of Scilly since 1920.

Since 1963, when diving for crawfish started, the catches of lobsters have increased from around 9 000 cwt to 13 000 cwt in 1968. During these 5 years the landings of crawfish by potters have fluctuated around 900 cwt per annum, while those taken by divers have increased from practically nothing in 1963 to 1 100 cwt in 1968. The annual landings of lobsters and crawfish at the main places landing crawfish are shown in Figure 2.

Although we do not have any information on the actual size of the stocks of lobsters and crawfish on the north coast, they must have been substantial to produce a total of approximately 10 000 cwt landed at St. Ives, Hayle, Newquay and Padstow in the 7 years 1962-68, when only about 1 900 cwt had been landed at these ports in the previous 10 years, 1952-61. The average landings from these ports in 1962-68 were about 1 400 cwt per year, compared with about 190 cwt per year in the previous 10 years, an increase of over seven times. The stocks of

lobsters and crawfish had presumably built up over previous years when little fishing was done, and the increased landings in recent years are probably largely due to fishing on the accumulated stock. It should also be noted that there has recently been some extension of the range of operations of Cornish crawfish boats, and this probably contributes to the rise in total landings.

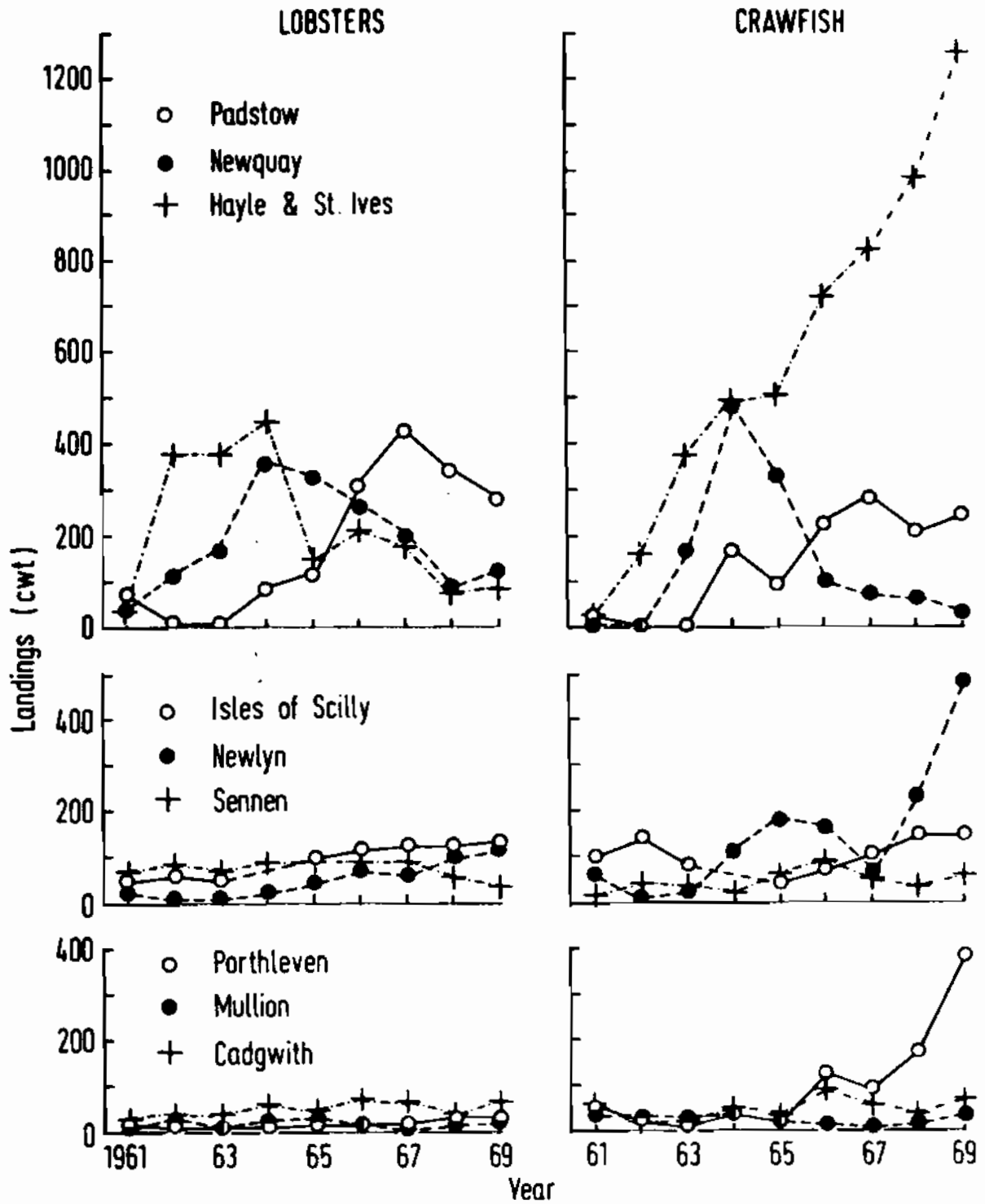


Figure 2 Annual landings of crawfish and lobsters at the nine major crawfish fishing ports, 1960 to 1969.

## CATCH PER UNIT OF EFFORT

Since total landings are markedly influenced by the amount of fishing, as well as by the abundance of the fished stock, they are not a good indicator of the state of a fishery. A better indication is given by the catch for a given fishing effort which, in the case of fisheries for crabs, lobsters and crawfish, is measured by the weight of fish caught for each 100 pots hauled or, in the case of diver-caught crawfish, the weight caught for each 100 cubic feet of air used. Unfortunately, we do not yet have enough data to relate catch per 100 cubic feet of air to catch per 100 pots, nor have we yet been able to work out a satisfactory unit of effort for tangle nets. A less satisfactory estimate of catch per unit of effort, but one which is usable, is given by catch per diver per day, a measure which can sometimes be employed where the quantity of air used is not known (e. g. for 1969).

Since 1961, MAFF collectors of statistics have recorded for five ports the number of pots worked by each boat, the number of days at sea, and the weights of crawfish landed. Using these data, the weekly or monthly mean catch per 100 pots has been calculated. The results are subject to error where fishermen have hauled their gear more than once a day, or have not hauled all their gear on a particular day, but even so this measure is a far better estimate of the state of the stock than are total quantities landed. Divers have kept log-books recording the quantity of crawfish landed and the amount of air used, so that their catch per unit effort can be measured.

Figure 3 shows the mean monthly catches of crawfish per 100 pots lifted for various ports from 1961 to 1969. It will be noticed that, in general, the catches by pot fishing tended to rise to a summer peak as the season progressed, and either remained high until the fishery finished or fell off sharply during the autumn. Such a pattern has been noted in previous years. In the case of the divers' catches, which are shown in Figure 4, the pattern is not the same as for potters; if anything, the divers' catches show a downward trend as the season progresses. The gradual seasonal increase in catches by the potters would suggest either that crawfish are moving into the fishery or that there is some behavioural change in summer which makes them more easily caught in pots. If the increase were due to immigration, one would expect this to be reflected in the divers' catches; this was not shown in the divers' records, and hence it would seem that the change in potters' catches is probably due to behaviour.

Figure 5 shows the mean annual catch of crawfish per 100 pots for various ports from 1961 to 1969, and may be taken as an indication of the abundance of the stock over the period, because seasonal behavioural changes will tend to be averaged out. It will be noticed that the figures from Hayle and St. Ives show a marked downward trend over the period. Such a trend is to be expected if, as has been suggested above, this area built up a large stock of crawfish during a period of little fishing; it represents the removal of the accumulated stocks. The figures for the mean annual catch per 100 pots from Porthleven, Mullion and Cadgwith do not show any marked trends and indicate that, even if the increase in fishing on the north coast has reduced the density in that area, there has been no significant thinning out between Porthleven and Cadgwith.

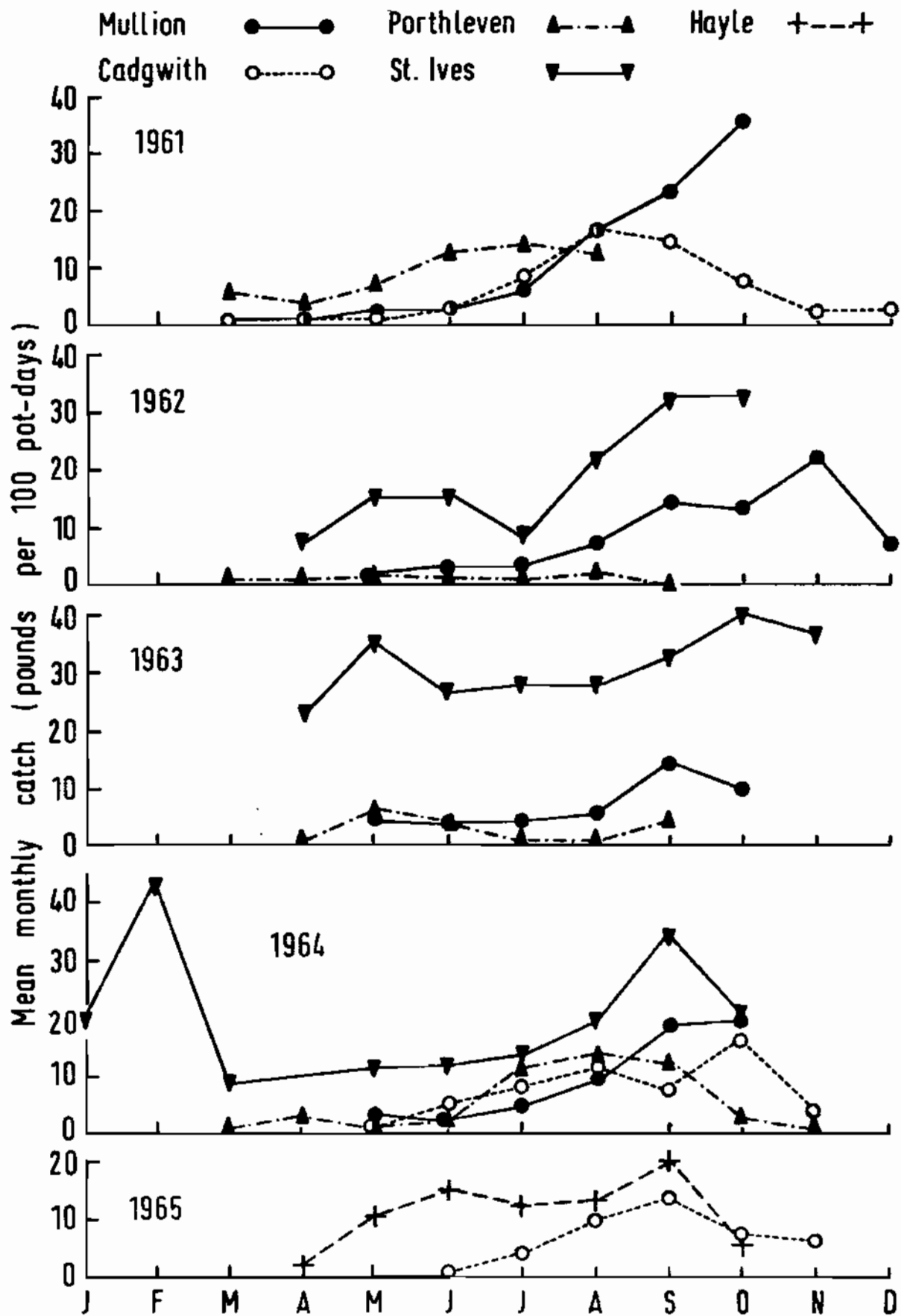


Figure 3 Mean monthly pot catches of crawfish, for various ports, from 1961 to 1969.

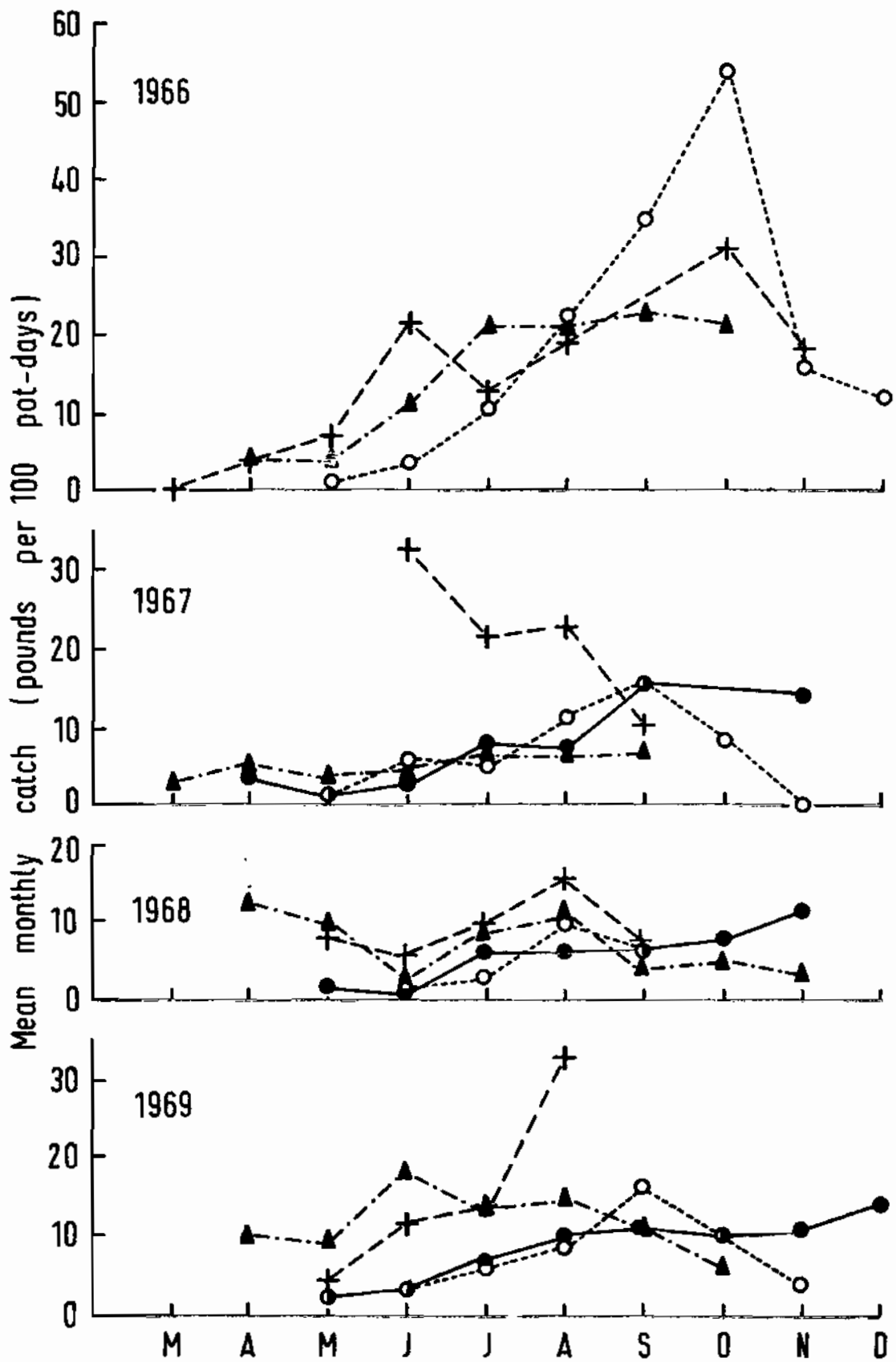


Figure 3 (continued)

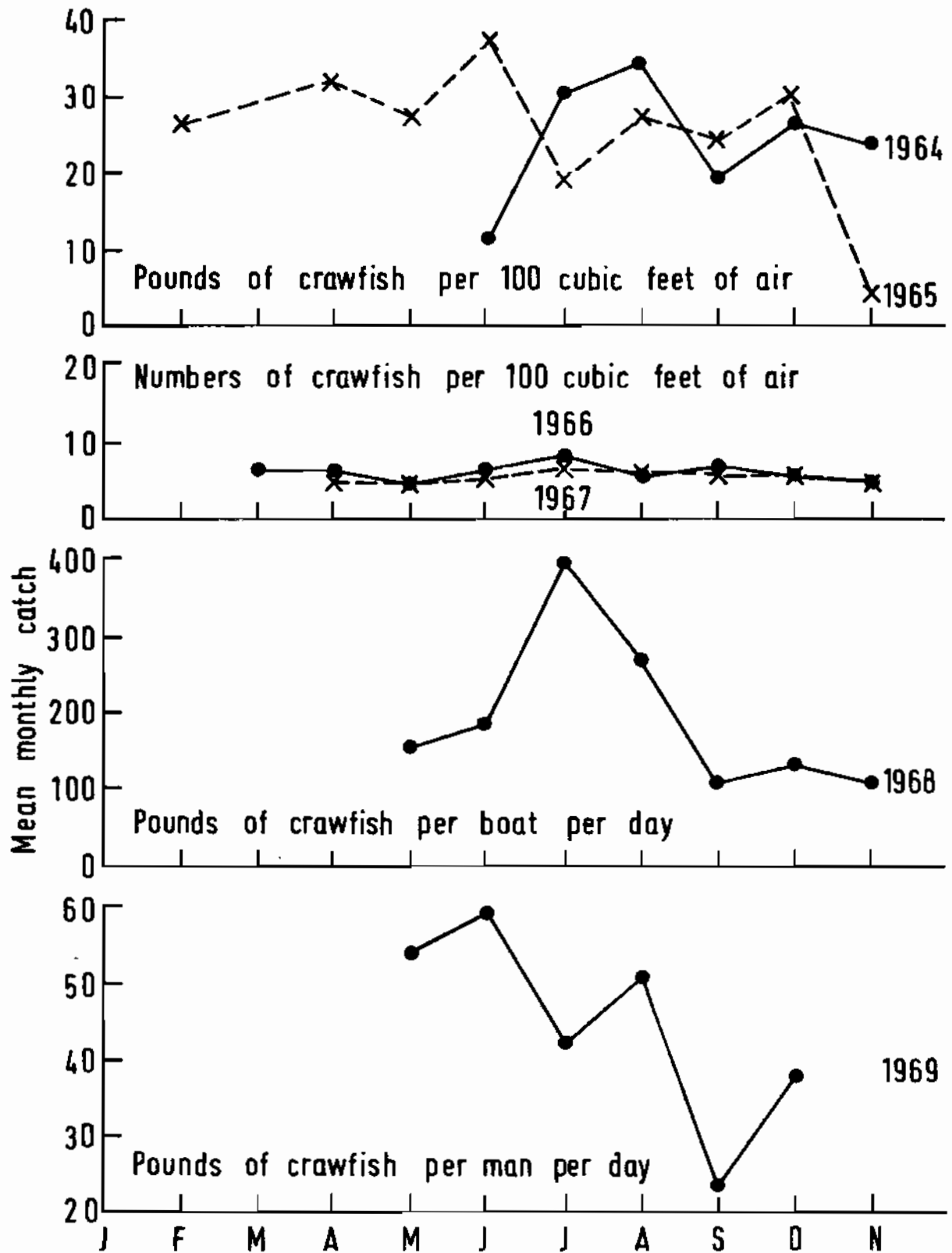


Figure 4 Mean monthly crawfish catches by divers in Cornwall from 1964 to 1969.

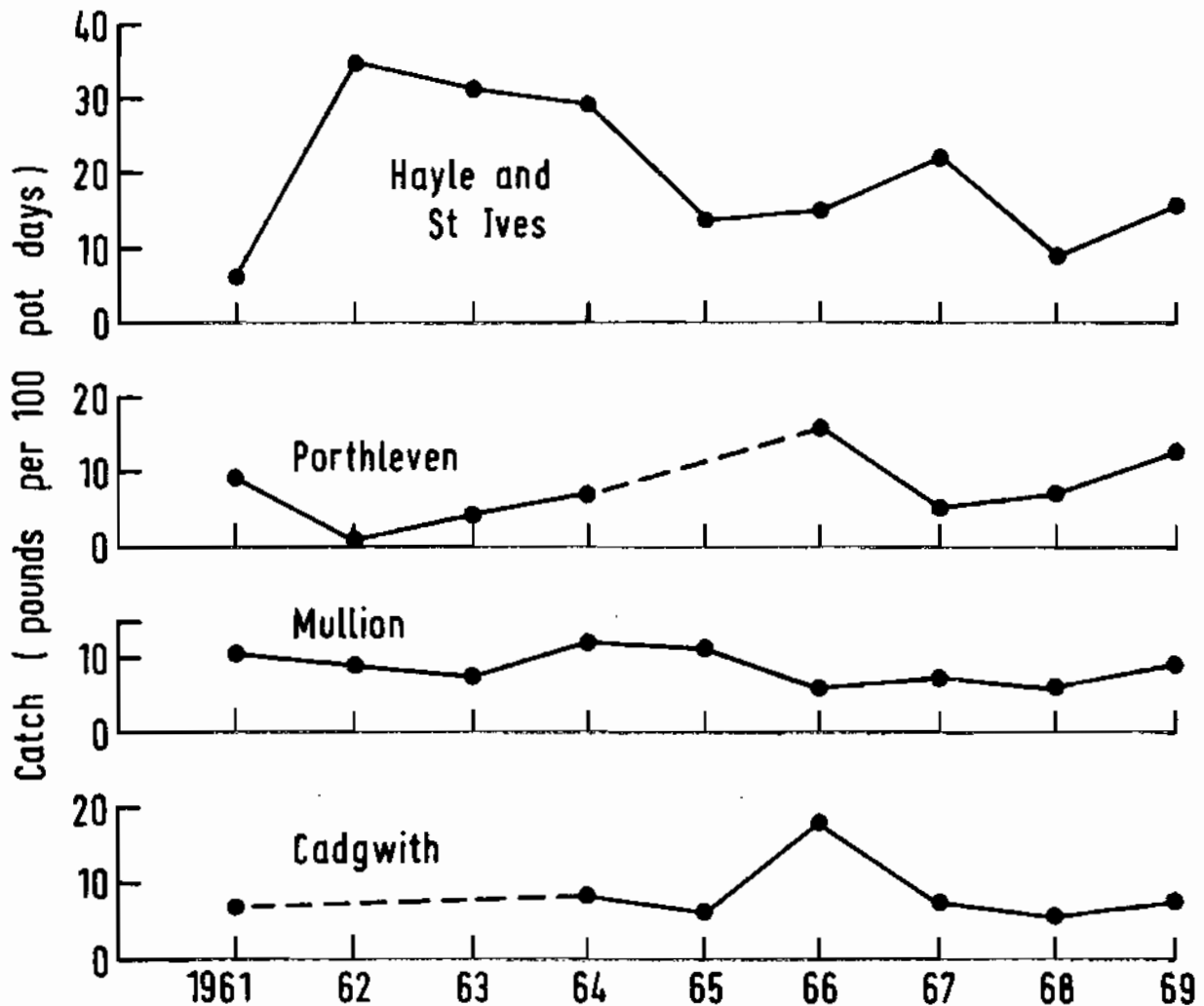


Figure 5 Mean annual catch of crawfish, for various ports in Cornwall, from 1961 to 1969.

#### MEASUREMENTS OF CRAWFISH

Samples of crawfish from the Cornish fishery have been measured for several years. It has been found that the largest ones are taken from the north coast, the smallest from the Lizard and Mounts Bay areas, and those from Land's End are intermediate in size. Crawfish from the Isles of Scilly are slightly smaller than those from the Mounts Bay area.

The crawfish caught by divers and tangle nets are slightly larger than those caught in pots. In view of these differences, in Figures 6-11 the measurements are shown according to the area of capture and method of fishing for 1967, 1968 and 1969, where adequate samples are available. Since seasonal changes in size composition of the catch have not been observed, the measurements for each year are grouped on one diagram.

The majority of crawfish fell into a fairly well-defined group between about 105 and 150 mm carapace length for females and about 140 and 180 mm carapace length for males, with a small proportion of the catch falling markedly below these

groups. In Table 1 are shown the mean lengths of the crawfish making up the bulk of the catch. The 'stragglers' lying outside this main group are excluded, since they are likely to influence the mean length out of proportion to their importance in the fishery. It will be noticed from Table 1 and from Figures 6-11 that over the last few years there have been only small changes in the size composition of the crawfish catch.

Table 1 Mean carapace length (mm) of crawfish measured in Cornwall. The means are derived from the main bulk of the sample, excluding the smaller crawfish; these did not comprise more than 12 per cent in any sample, and were usually much less

Area and fishing method			1969	1968	1967	1966	1965
North coast	Pot	Male	162.2	-	162.1	163.2	161.8
		Female	138.1	-	131.3	135.7	132.4
Land's End	Pot	Male	-	-	163.4	157.1	160.6
		Female	127.1	127.1	132.9	128.3	127.9
Land's End	Diver	Male	163.6	165.6	167.3	166.7	166.8
		Female	130.0	131.5	132.0	129.6	129.2
Mounts Bay	Pot	Male	154.2	155.3	151.0	149.9	148.0
		Female	126.5	123.8	124.5	123.5	123.6
Isles of Scilly	Pot	Male	146.3	146.7	146.3	-	149.2
		Female	119.6	121.7	120.1	-	122.7

- indicates an inadequate sample.

The only changes which may not be due to chance variations are that the diver-caught male crawfish from the Land's End area in 1969 appear to be significantly smaller than those measured in previous years, and diver- and pot-caught females from Land's End in 1967 and pot-caught females from Mounts Bay in 1969 appear to be significantly larger than those in earlier years. However, with samples taken over such a short period - 5 years - it would be unwise to make any generalization on these few small differences.

It should be noted that in a sample of net-caught crawfish from the Land's End area in 1969 the mean length of males was 168 mm, indicating that there is still a high proportion of large males in the population.

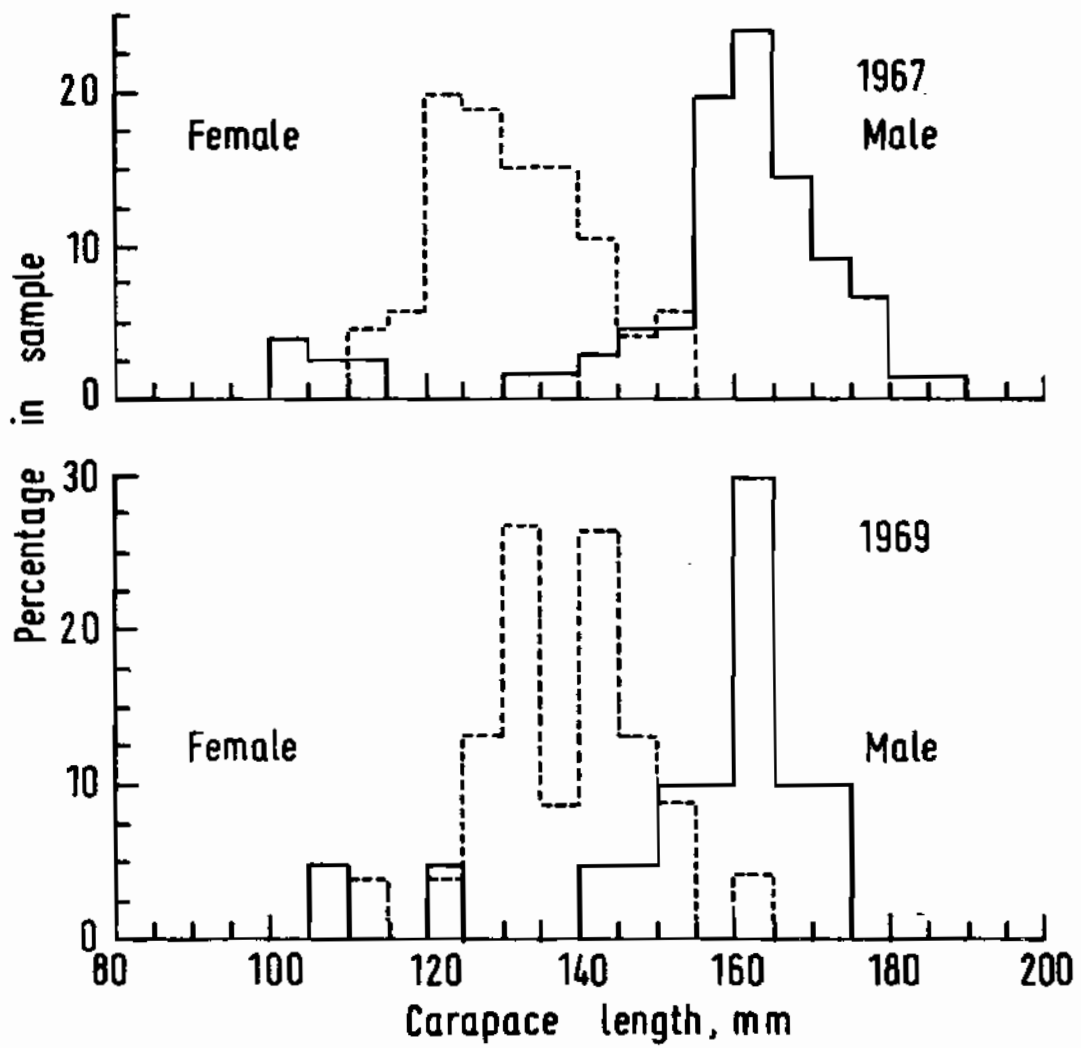


Figure 6 Measurements of pot-caught crawfish from the north coast of Cornwall in 1967 and 1969.

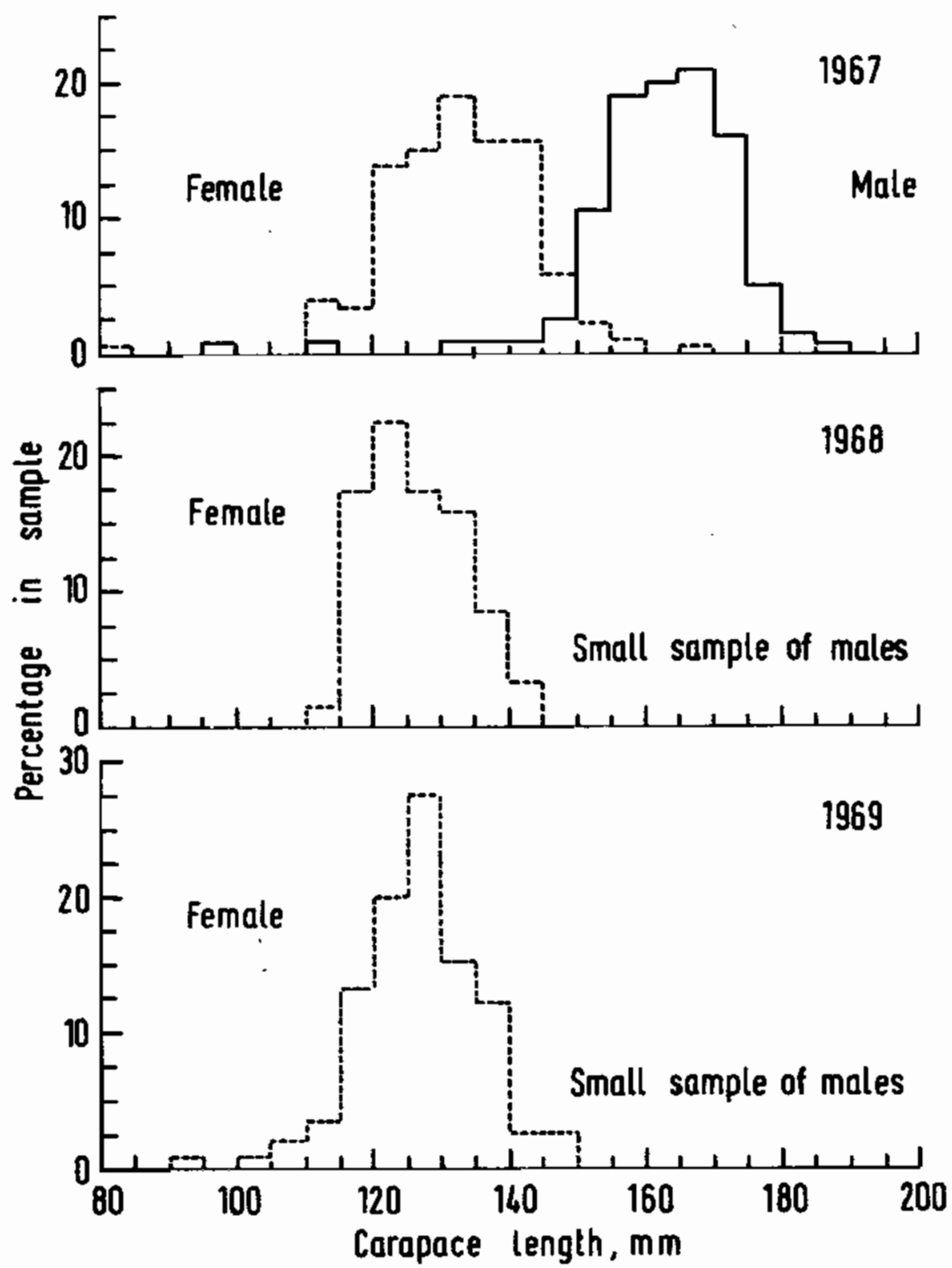


Figure 7 Measurements of pot-caught crawfish from the Land's End area of Cornwall, 1967 to 1969.

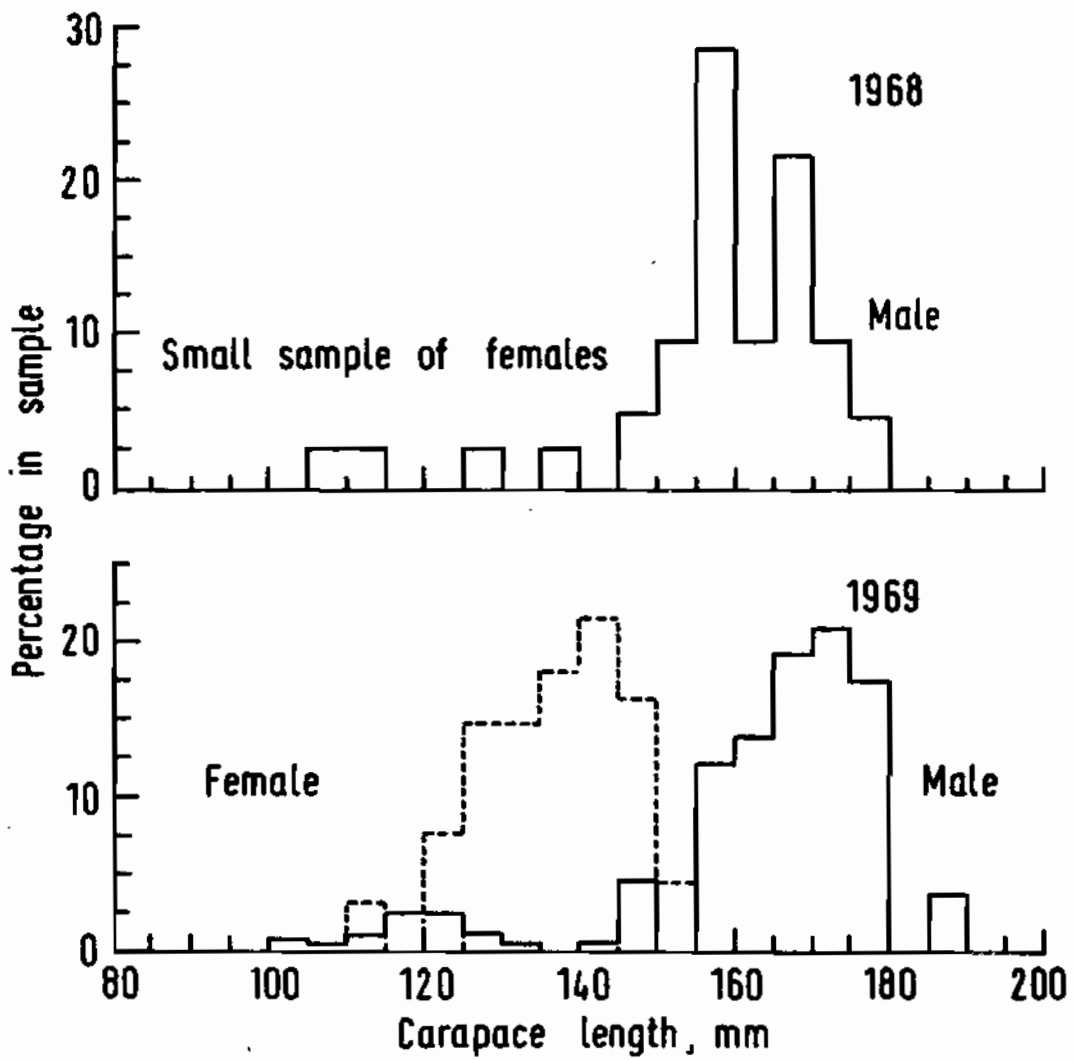


Figure 8 Measurements of net-caught crawfish from the Land's End area of Cornwall in 1968 and 1969.

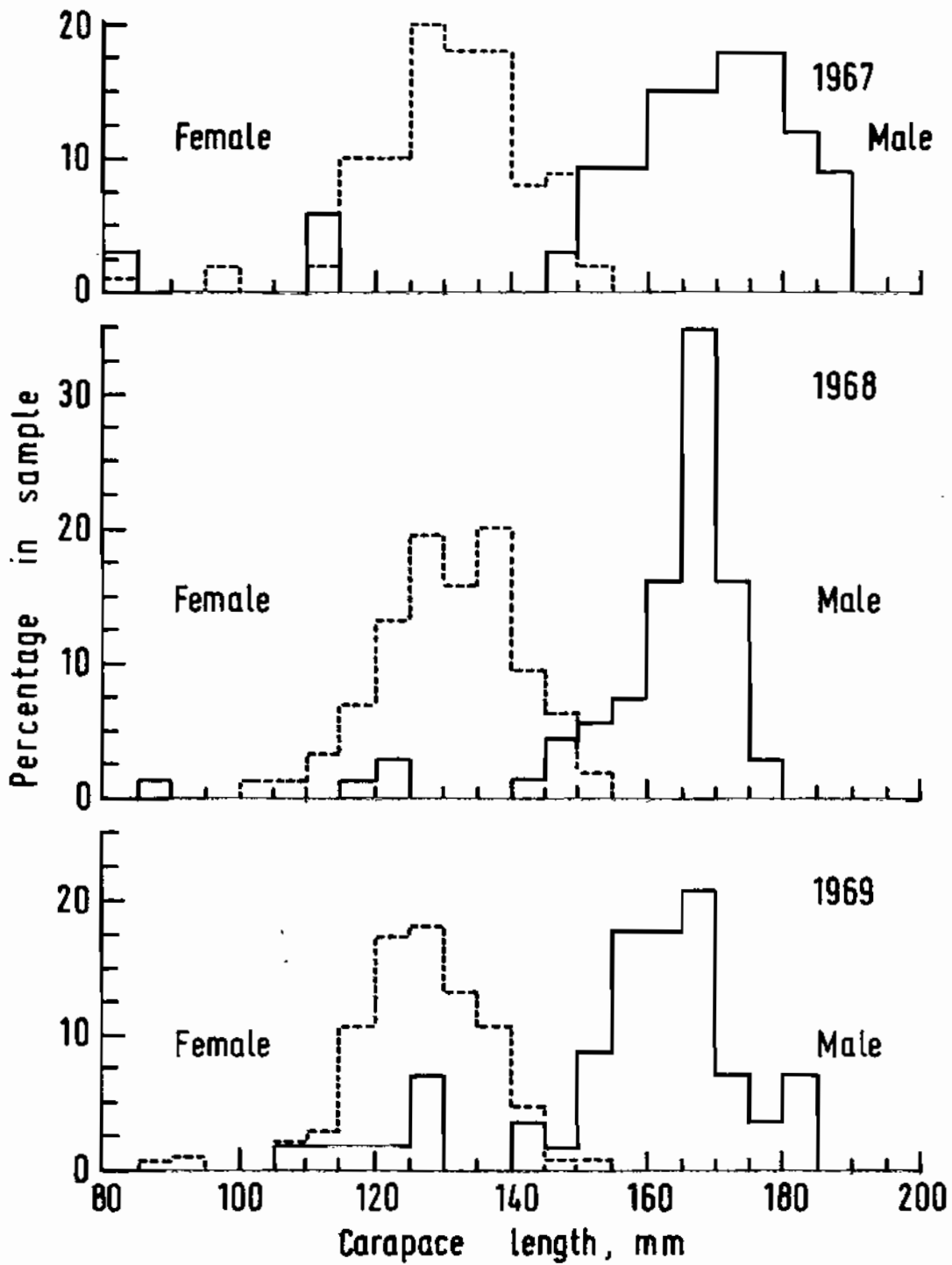


Figure 9 Measurements of diver-caught crawfish from the Land's End area of Cornwall, 1967 to 1969.

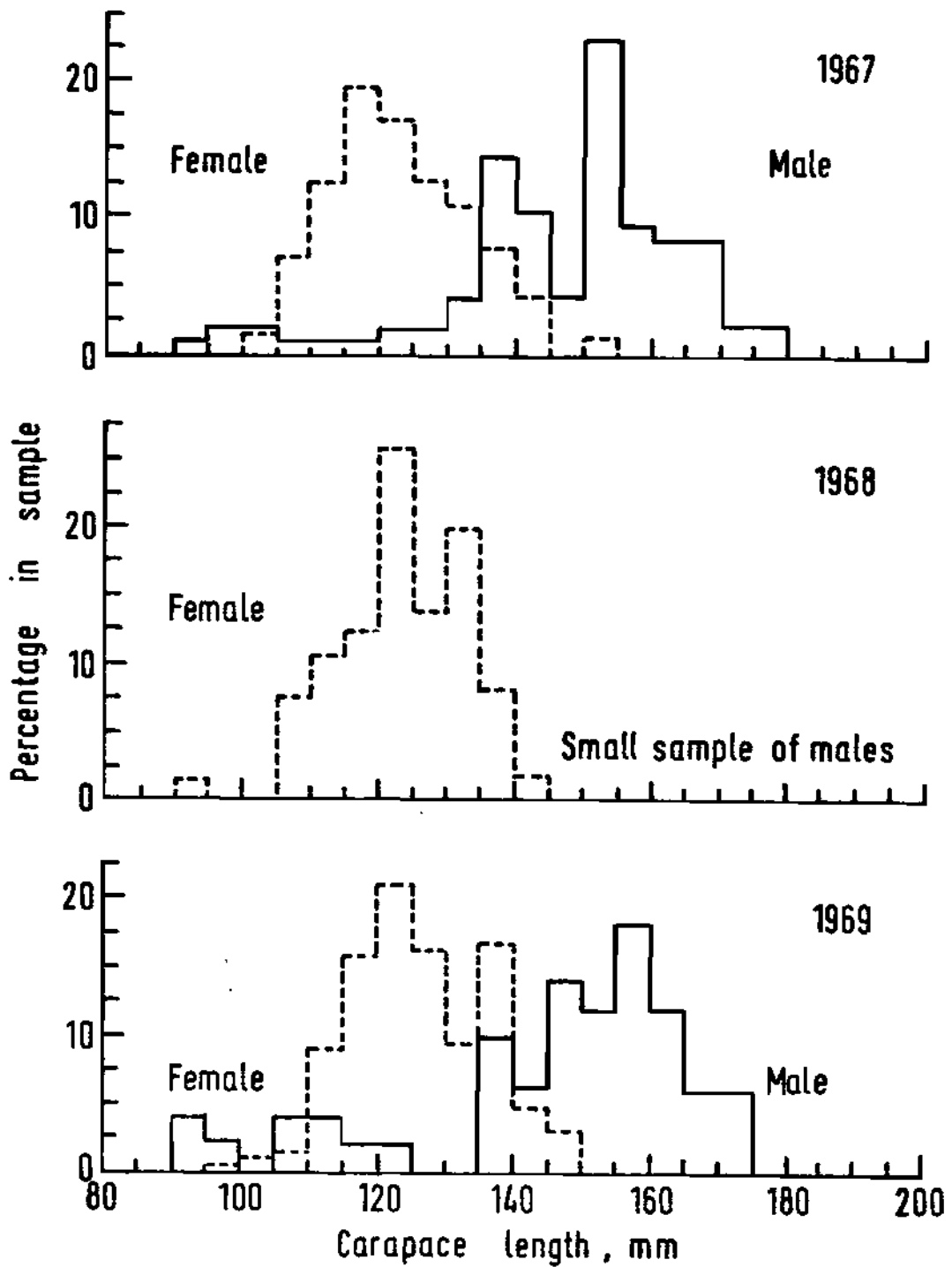


Figure 10 Measurements of pot-caught crawfish from the Mounts Bay area of Cornwall, 1967 to 1969.

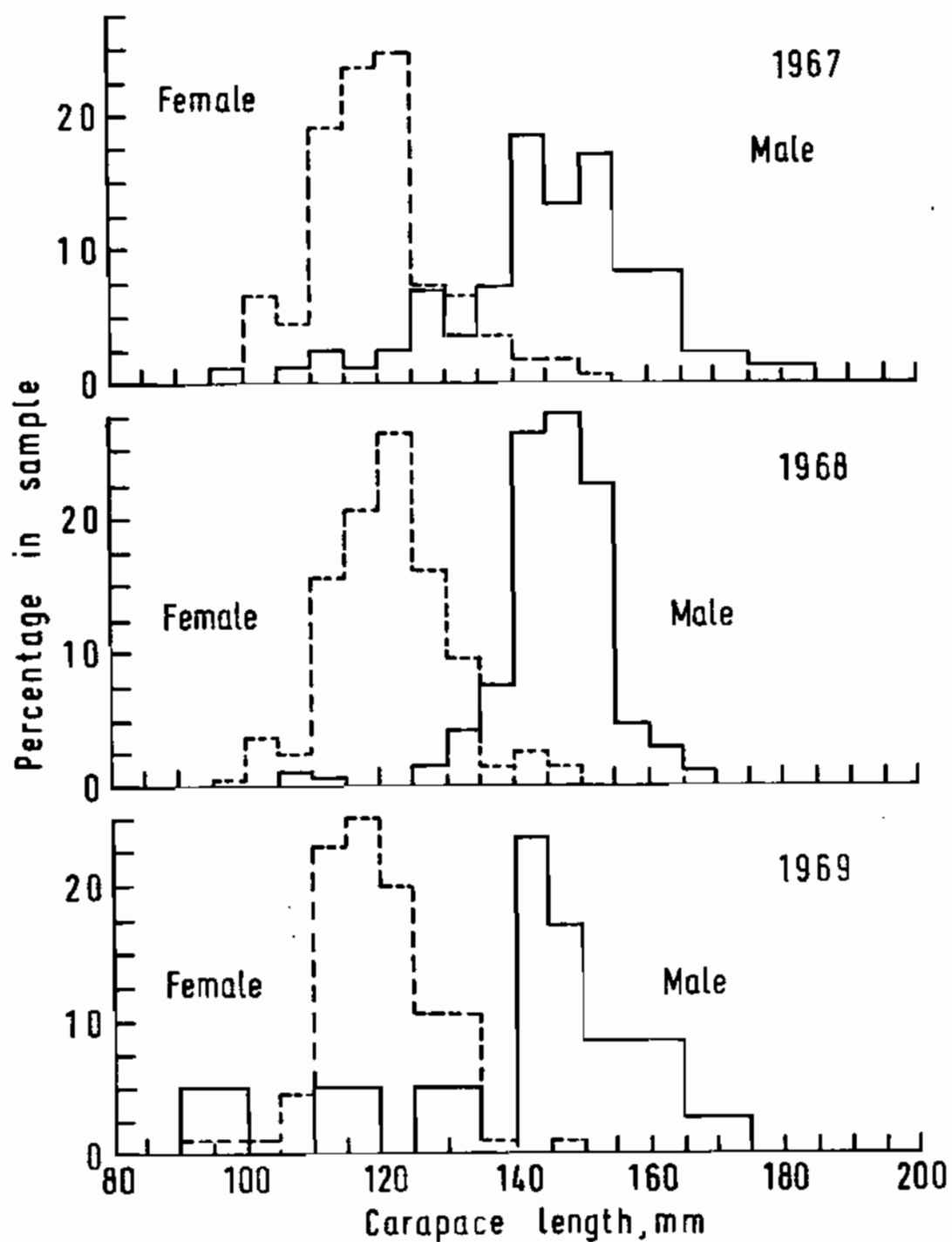


Figure 11 Measurements of pot-caught crawfish from the Isles of Scilly, 1967 to 1969.

## TAGGING EXPERIMENTS

In each year since 1966, tagged crawfish have been released off the south coast of Cornwall, round Land's End or in the Isles of Scilly. Table 2 shows the numbers released each year and the recaptures in the first, second and subsequent years after release.

The crawfish were tagged either with a numbered, white plastic disc attached with stainless steel wire to the base of an antenna, or with a numbered, flat arrow-shaped tag inserted between the joints of the tail; in some cases, both types of tag were used on the same fish. The disc tag has the advantage that it is unlikely to injure the crawfish, but has the disadvantage that it is lost at moulting. The arrow tag, being anchored beneath the shell, is retained in the animal when it moults and hence can be used for estimates of growth rate, but has the disadvantage that it may injure the animal. In tank experiments at Conway, crawfish were tagged by both these methods and in neither case did they seem to be harmed.

Table 2 Details of tagged crawfish released off the Cornish coast (excluding the Isles of Scilly)

Year in which released	Number released	Year in which recaptured				Remarks
		First	Second	Third	Fourth	
1966	292	14	5	5	2*	Disc + arrow tags
1967	137	3	3	1*	-	Arrow tags
	92	2	0	0*	-	Disc tags
1968	293	29	5*	-	-	Arrow tags
1969	101	5*	-	-	-	Arrow tags

\*10 months only of the year had elapsed at the time of writing.

## RESULTS OF TAGGING EXPERIMENTS

### 1 Migrations

Seventy-two tagged crawfish have been returned with details of their places of capture, and the distances they had moved are shown in Table 3; it will be seen that most of them were recaptured within a short distance of where they were released. However, because fishing is generally confined to a fairly narrow coastal strip, any appreciable offshore movement will not have been detected in this study. In view of the evidence available from studies elsewhere, it would be unwise to rule out the possibility of any such movement at this stage, but the evidence so far suggests that, although crawfish do not make substantial movements along the shore, they do move considerably more than lobsters.

Table 3 Movements of tagged crawfish, including those tagged off the Isles of Scilly

Distance (miles*)	Number moved	Distance (miles*)	Number moved
Up to 1	37	5- 6	0
1-2	12	6- 7	4
2-3	5	7- 8	3
3-4	5	8- 9	1
4-5	2	12-13	3

\*1 mile = 1.6 km approximately.

## 2 Fishing and natural mortality rates

The number of tag returns is too small to make a numerical estimate of mortality, but it will be seen from Table 2 that no more than 10 per cent of the tagged crawfish have been returned within a year of release. Since such a small proportion of the tags is being returned, it seems reasonable to suggest that only a small proportion of the crawfish population is being taken by fishing; hence fishing mortality would seem to be very low. It is not yet possible to make reliable estimates of total mortality (i. e. the mortality due to fishing and natural causes), nor is it yet possible to make any estimate of the total population.

## 3 Growth

The length of the crawfish is recorded at the time of tagging and at recapture, and any growth during the period of liberty can be calculated. So far, 2 males and 5 females have been recaptured after between 1 and 2 years at liberty and 4 females recaptured after between 2 and 3 years. The 2 males showed no growth, the 5 females after 1-2 years showed an average growth of 1.6 mm, and the 4 females free for 2-3 years showed an average increment of 1.25 mm (all measurements relate to carapace length). The maximum growth increment shown was 5 mm, and 4 of the females showed no measurable growth.

These results show unexpectedly low growth rates and, if correct, suggest that the large crawfish in this area are many years old. However, it is possible that the arrow tag is interfering with growth, resulting in considerable under-estimation of the rate of growth. Further work is required.

## DISCUSSION

It will be seen from Figure 2 that the yearly crawfish landings at Cadgwith, Mullion, Sennen and the Isles of Scilly, although fluctuating slightly, have not shown any marked changes since 1961, nor have the annual catches per 100 pot-days (Figure 5) from Cadgwith or Mullion shown any trends.

Landings at Porthleven and Newlyn have increased in recent years (Figure 2) and there is some indication (Figure 3) that the catch per 100 pot-days has increased slightly at Porthleven. It is thought that these increases have been brought about by a tendency in recent years for boats from these ports to fish grounds further away from their home ports.

The most dramatic changes in landings have occurred on the north coast of Cornwall, especially at St. Ives and Hayle. The increase in landings at Padstow since 1963 is attributable to an increased fishing effort in that area. At Newquay the rise in landings from 1962 to 1964 and the subsequent decline are also due to increased effort, both by pot fishermen and divers, followed by a decline in effort.

At Hayle and St. Ives the rise in annual landings from 1961 to the present high levels (Figure 2) is due to an increase of pot-fishing effort in the area starting in the early 1960s, followed by divers entering the fishery and increasing their effort from about 1964-65, followed in turn by the reintroduction of net fishing from about 1967. This rise in landings has been accompanied by a fall in catch per 100 pots worked, from about 30 lb of crawfish in the early 1960s to about 15 lb recently. Although this reduction undoubtedly indicates a reduction in the abundance of crawfish on the grounds, it is probable that the earlier figure of about 30 lb per 100 pot-days was a slight overestimate, and the figure of around 15 lb per 100 pot-days is still about 50 per cent above the comparable figure for ports from Cadgwith to Sennen.

If the fishing is on an accumulated stock then a fall in catch per 100 pots is to be expected as the stock is reduced by fishing. Further increases in fishing effort will continue this trend of falling catch per 100 pots, as the population is reduced.

Since we do not know what factors govern recruitment to the Cornish crawfish fishery, it is not possible to say what is the best level of fishing at this stage. In addition economic factors also play a part, in that they govern the return to the fishermen. However, it can be pointed out that a continued rise in fishing effort will result in a continued fall in catch per 100 pots. In fact some further reduction in catch per 100 pots may occur even if effort does not increase beyond present levels, because we cannot yet say that equilibrium has been reached.

Although it is clear that there has been a reduction in the abundance of crawfish on some of the grounds off Cornwall in recent years, it is not considered that this reduction is dangerous to the stock as a whole. The fishery continues to remove only the larger and presumably older members of the crawfish population, leaving the younger faster-growing ones almost untouched. It would also seem from our tagging experiments that the fishery takes only a small proportion of the stock in any year.

## REFERENCES

- HEPPER, B. T., 1963. The fishery for crawfish, Palinurus vulgaris Latr., in Cornwall. ICES Shellfish Committee C. M. 1963, No. 42, 4 pp. (mimeo).
- , 1965a. Interim Report on investigations into the fishery for crawfish (Palinurus vulgaris) in Cornwall. MAFF (Duplicated Report to Cornwall Sea Fisheries Committee and fishermen). 5 pp. (mimeo).
- , 1965b. Notes on the breeding of crawfish (Palinurus vulgaris) in Cornish waters. ICES Shellfish Committee C. M. 1965, No. 96, 2 pp. (mimeo).
- , 1966a. Measurement of carapace length and total length in the crawfish, Palinurus vulgaris. J. Cons. perm. int. Explor. Mer, 30, 316-323.
- , 1966b. Crawfish investigations in Cornwall. Report of investigations made in 1965. Shellfish Inf. Leafl. Fish. Lab. Conway, No. 5, 8 pp. (mimeo).
- , 1967. Observations on a crawfish (Palinurus vulgaris Latr.) tagging experiment off Cornwall in 1966. ICES C. M. 1967/K:13, 4 pp. (mimeo).
- , 1968. Cornish crawfish investigations 1966-67. Shellfish Inf. Leafl. Fish. Lab. Conway, No. 9, 8 pp. (mimeo).
- , 1970. Observations on the growth of crawfish, Palinurus vulgaris Latr., off the coast of Cornwall. ICES C. M. 1970/K:9, 5 pp. (mimeo).

## LABORATORY LEAFLETS (NEW SERIES)

- No. 1 Newfoundland Fishing. December 1962.
- No. 2 Spotlight on the American Whelk Tingle. December 1962.
- No. 3 Yorkshire Crab Investigations 1962. May 1963.
- No. 4 Trawling Prospects off West Norway. September 1963.
- No. 5 Notes on Escallops, and Details of the Baird Sledge Dredge and its Handling. February 1965.
- No. 6 Studies with the Woodhead Sea-bed Drifter in the Southern North Sea. February 1965.
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- No. 8 Future Prospects in the Distant-water Fisheries. May 1965.
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- No. 19 Oyster Pests and their Control. May 1969.
- No. 20 The Production of Clean Shellfish. September 1969.
- No. 21 Fishing for Sandeels. March 1970.
- No. 22 Cornish Crawfish Investigations. March 1971.
- No. 23 Mackerel of the South-west. (In preparation.)

### NOTE

Although the complete list of Laboratory Leaflets is given to show the scope of the series, it will be appreciated that many of these leaflets are topical and therefore of interest chiefly at the time when they are written. For this reason most of the earlier ones are being allowed to go out of print when present stocks are exhausted; few copies are available of those prior to No. 13.