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An apparent relationship between catch per unit of effort and temperature in the English lobster fishery

by

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For several years Ministry of Agriculture, Fisheries and Food collectors of statistics have recorded the number of pots being used in lobster fishing from certain ports and the lobster landings at these ports. Therefore there are available considerable data from which the catch per unit of effort in the lobster fishery can be calculated. These estimates of catch per unit of effort when plotted against the prevailing sea temperature commonly give significant correlations, suggesting that temperature plays an important role in determining the success of lobster fishing.

Collection of data

At the ports shown in Fig. 1 Ministry collectors of statistics record weekly for each boat the number of pots in the water, the number of days at sea, and the weight of lobsters landed (together with the weight of crawfish and crabs, which will not be considered here). It is not always possible to record these data for all boats, but usually the majority of boats in each port is recorded.

The number of pots worked by each boat is multiplied by the number of days at sea to give the number of pot-days as a measure of fishing effort. These values are summed for all boats in a port. The landings of lobsters x 100 are divided by the number of pot-days to give the catch per 100 pot-days as a measure of catch per unit of effort. Usually the catch per unit of effort is expressed as a monthly value for the port by dividing total landings from that port for the month by the total pot-days for the month. In practice this has proved a convenient unit to use.

The method of collecting the data has certain disadvantages. In particular it presupposes that the boats haul all their pots once on each day at sea. This is not always the case. In bad weather a boat may only be able to haul part of its gear, perhaps that shot in a sheltered area. At some ports the boats may haul some of their gear more than once in a day: it is common practice in Yorkshire, for instance, for the gear to be hauled twice or more daily in fine weather in late summer when lobsters are plentiful. However, although part- or multiple hauling will distort the figures, and although this distortion may at times be quite substantial, it is considered that to improve the data would be very onerous for the collectors.

Off the coast of north-east England, particularly off Yorkshire, lobsters normally moult during July or August and re-enter the fishery during September. At this time a stock of lobsters is built up which supports the fishery until the moulting period in July-August of the following year. It is therefore convenient to consider the year as starting at 1 September in this context. In some years a second moult may occur in the autumn, but this is not a regular feature and appears to affect less than 25 per cent of the lobsters present.

In September or October, depending to some extent on the season, catches are at their highest. There is a gradual fall in catches into the winter, followed by a rise in spring with a further fall in June or July as lobsters prepare for moulting, when they are apparently in hiding and not accessible to the fishery.

The low catches during the winter months appear to be due partly to colder water making the lobsters inactive and partly to the fishery moving offshore into deeper water. In the deep water the gear is safe from storm damage, but it seems that the offshore lobster population is less dense than that inshore. Hence some of the fall in winter catches is due to fishing on less productive grounds.

Fig. 2 shows a typical pattern of catches expressed as monthly catch per 100 pot-days, in which the fluctuations mentioned above may be seen. It will also be noticed from Fig. 2 that, except for the summer moulting season, the fluctuations in catch per unit effort generally follow the sea temperature changes, suggesting a connection between catch/effort and temperature.

In Fig. 3 the mean monthly catch/effort data for various ports are plotted against the corresponding monthly sea temperatures for the months September to May. June, July and August are not plotted because of the influence of the moulting season on catches. The catch/effort is calculated as outlined above, and the mean sea temperature is that for the nearest observing station and is taken from the Monthly Weather Report (Meteorological Office, London HMSO).

In addition to the data from individual ports, the mean monthly catch/effort data for the coast from Hartlepools to Scarborough are also shown plotted against the corresponding monthly temperatures ("whole area" in Fig. 3). In this case the mean monthly catch/effort is (1) the mean of the monthly catch/effort data for all ports within the area, and (2) the catch/effort obtained by dividing total catch by total effort for the area.

In Fig. 3 lines have been fitted where a correlation coefficient with a probability of 5 per cent or less is obtained. The significance of the correlation coefficient is shown on Fig. 3 as + = P5% or less, ++ = P1% or less, +++ = P0·1% or less. It will be noticed that in 48 of the 67 correlationsa correlation coefficient significant at better than the 5 per cent level was obtained. All the lines shown in Fig. 3 have slopes significantly greater than 0.

Discussion

It is generally accepted that the activity of lobsters is markedly affected by temperature. Dow (1964) has suggested that sea temperature may be the principal factor influencing the Maine lobster landings, and McLeese and Wilder (1958) have related catchability to temperature in the American lobster, Homarus americanus. The relationship noted is not, therefore, unexpected but does introduce various complications in the interpretation of data in analysing the population.

It is common practice in fisheries population dynamics to use the catch per unit of effort as an index of stock abundance, and to compare catches per unit of effort at different times to estimate mortalities. But such a procedure assumes that the catchability of the stock in question is the same at the various times. It is quite clear from the above results that temperature may have a very substantial influence on the catchability of lobsters off north-east England, and this must be taken into account when using catch/effort data in population analysis.

The above data cannot be used at present to estimate the effects of temperature on catchability, because the stock is being reduced by fishing and natural mortalities, whilst the temperature changes are taking place. It would therefore seem necessary to use partial correlation techniques in attempting to analyse a lobster population from catch/effort data. This will be dealt with more fully elsewhere.

References

DOW, R. L., 1964. A comparison among selected marine species of an association between sea temperature and relative abundance. J. Cons. perm. int. Explor. Mer, <u>28</u> (3), 425-431.

McLEESE, D. W. and WILDER, D. G., 1958. The activity and catchability of the lobster (*Homarus americanus*) in relation to temperature. J. Fish. Res. Bd Can., <u>15</u> (6), 1345-1354.

METEOROLOGICAL OFFICE 1962/63-1969/70. Monthly Weather Report, London HMSO. <u>79</u> to <u>86</u>.

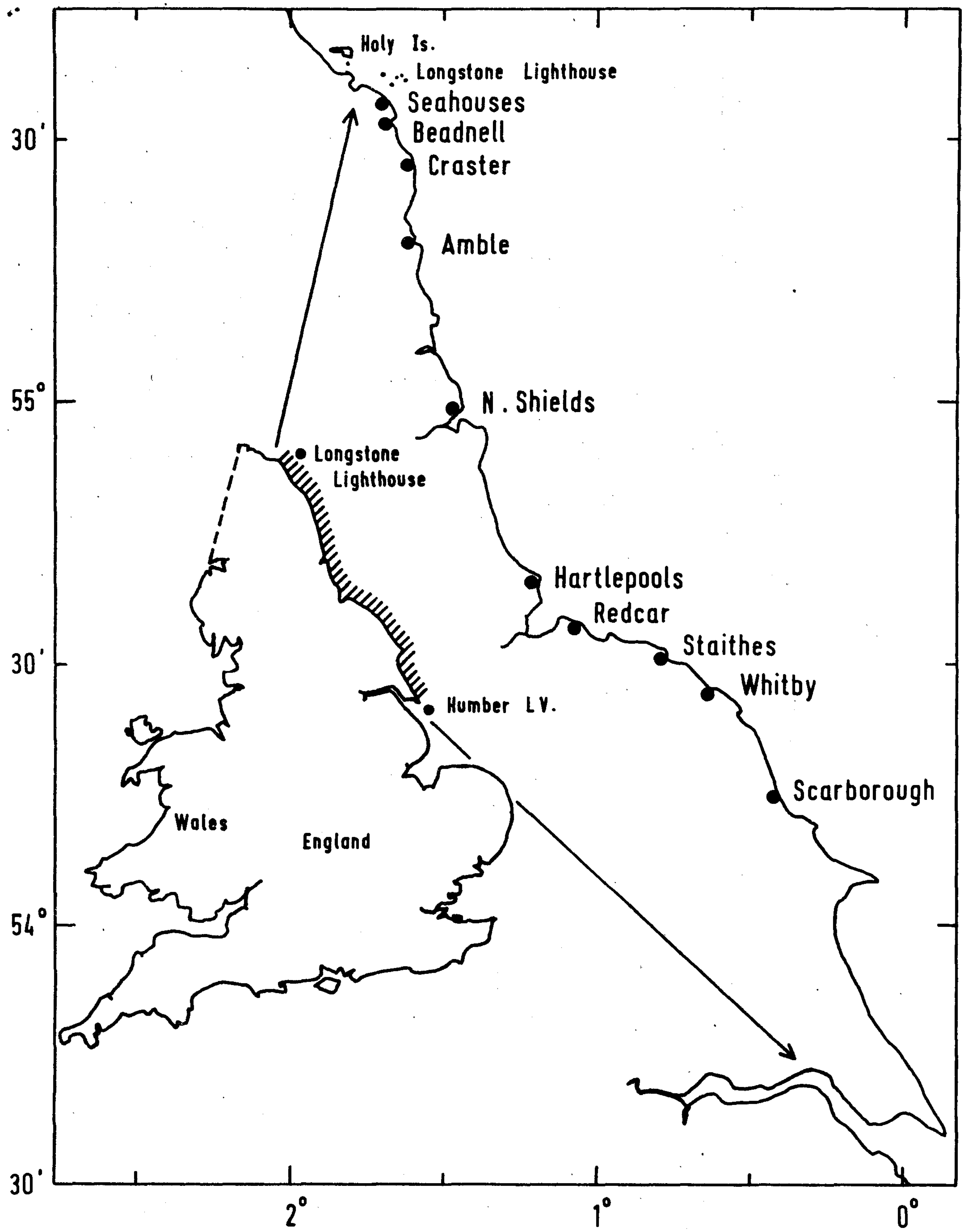

Fig. 1 Sketch map of north-east coast of England, showing ports mentioned in text.

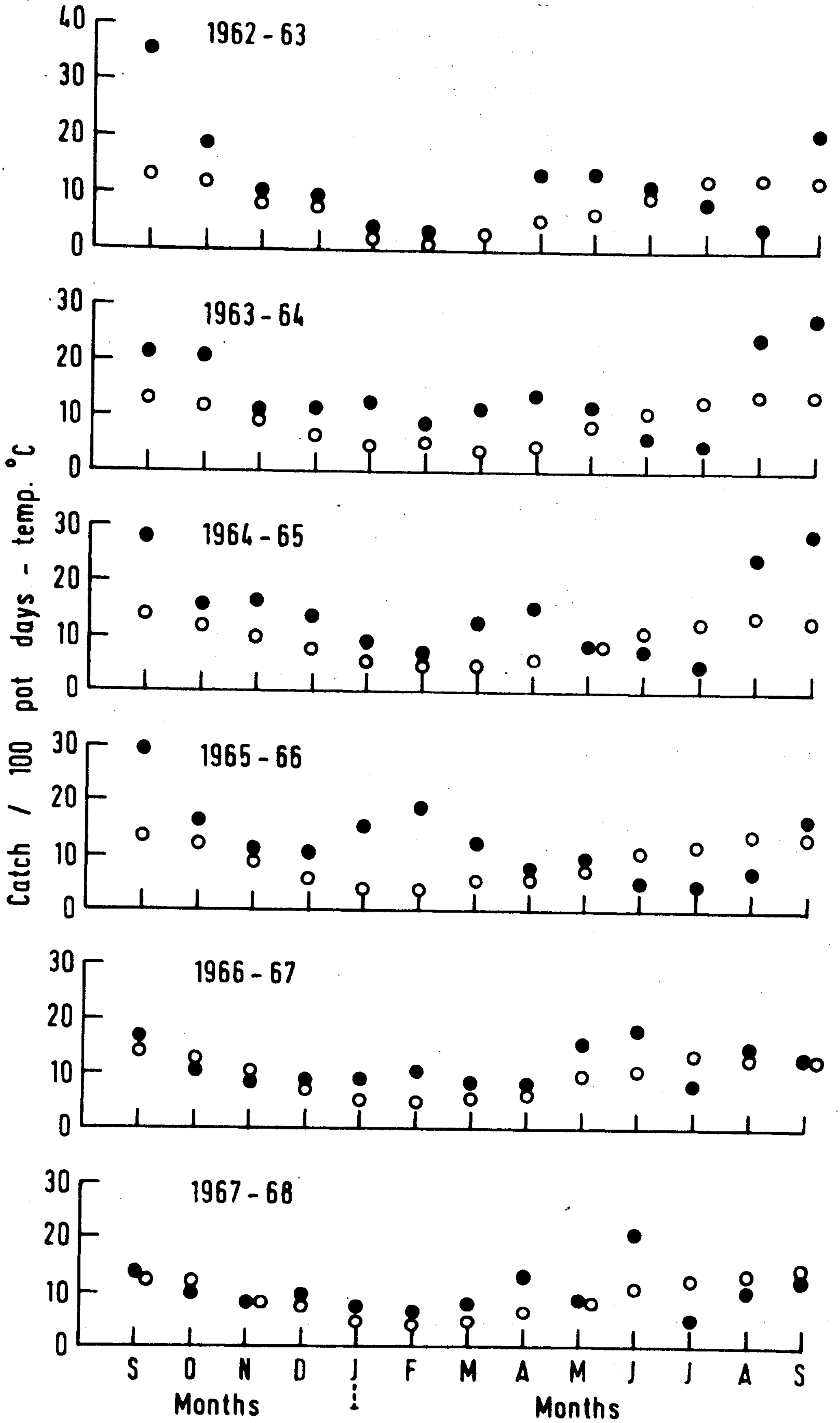

Fig. 2 Mean monthly lobster catch/100 pot-days at Whitby (solid circles) and mean monthly sea temperature in °C at Humber Lightvessel (hollow circles).

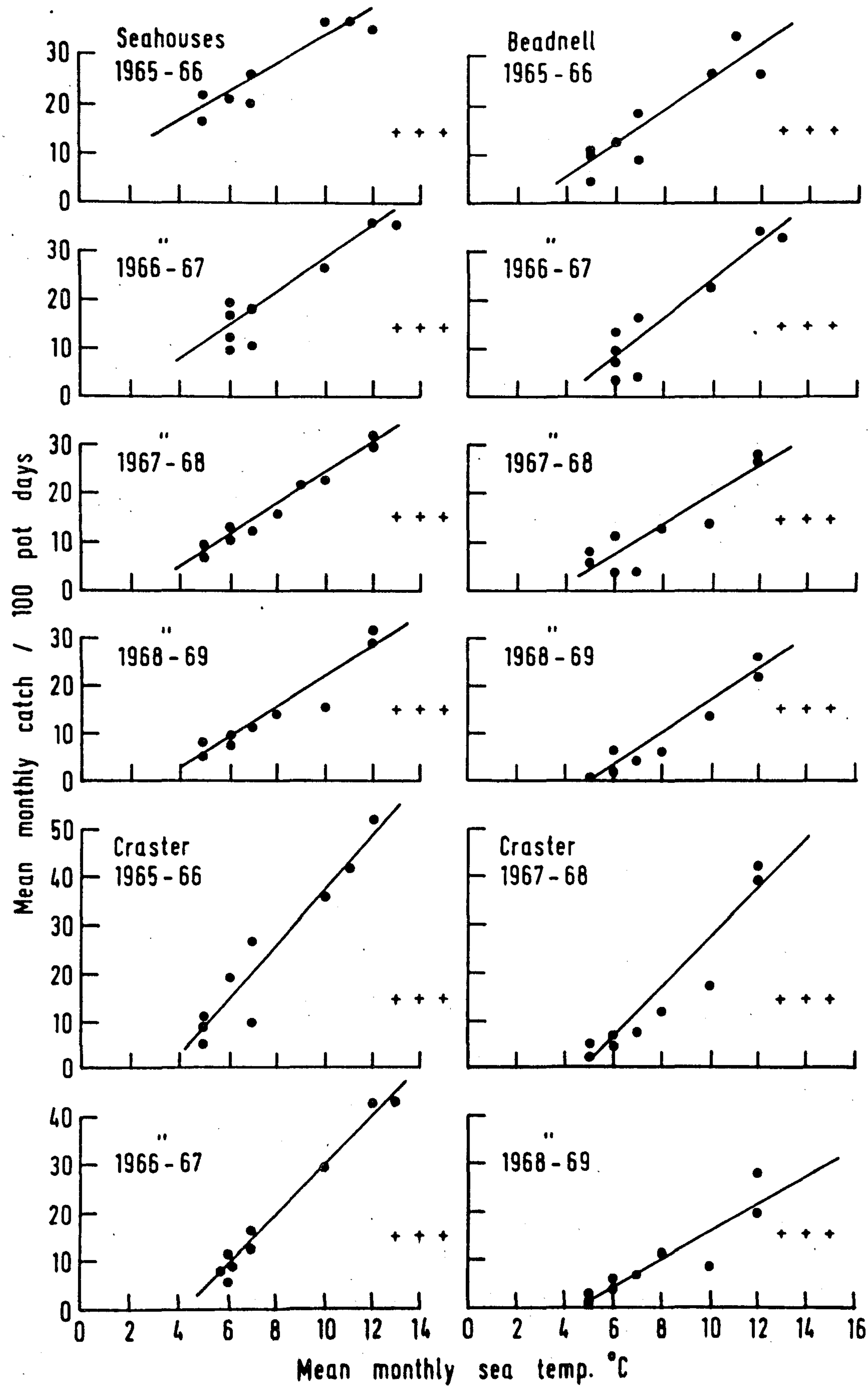

Fig. 3a Mean monthly lobster catch/100 pot-days for various ports, plotted against the mean monthly sea temperature at the Longstone Lighthouse. +++ indicate that P = 0.1% or less.

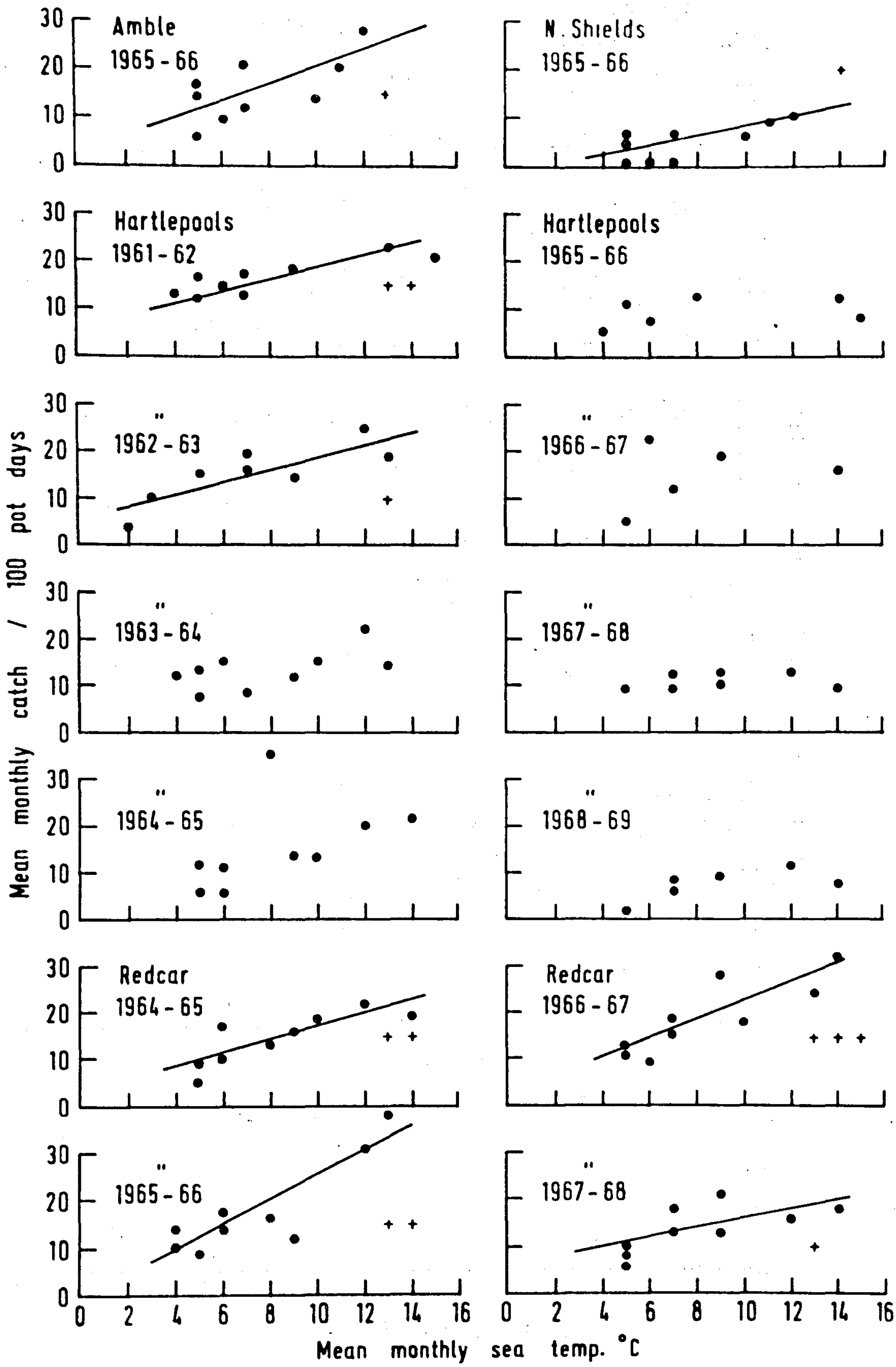

Fig. 3b Mean monthly lobster catch/100 pot-days for various ports, plotted against the mean monthly sea temperature at the Longstone Lighthouse (for Amble and North Shields) or the Humber Lightvessel (for Hartlepools and Redcar). + indicates that P = 5% or less; ++, P = 1% or less.

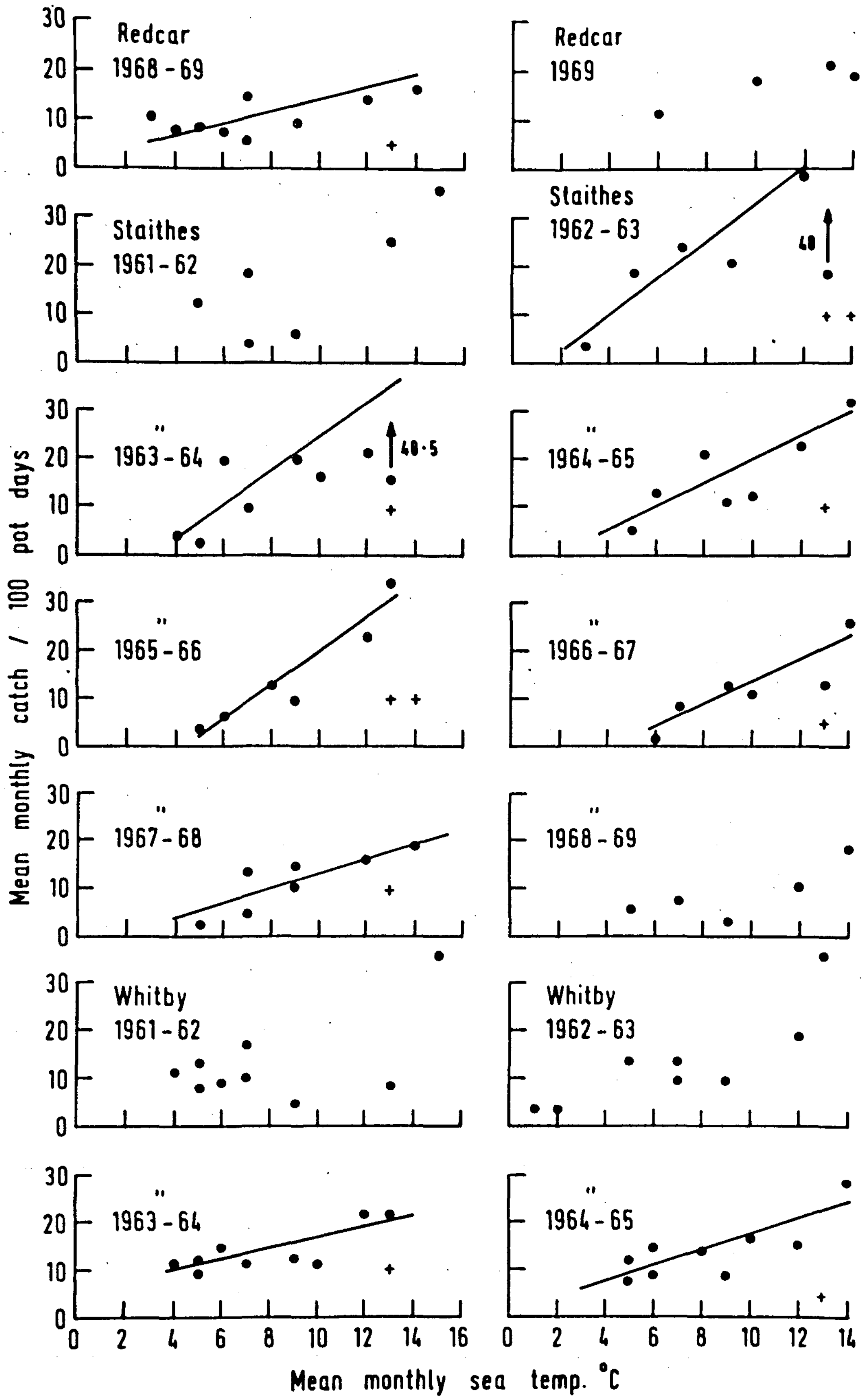

Fig. 3c Mean monthly lobster catch/100 pot-days for various ports, plotted against mean monthly sea temperature at the Humber Lightvessel. + indicates that P = 5% or less; ++, P = 1% or less.

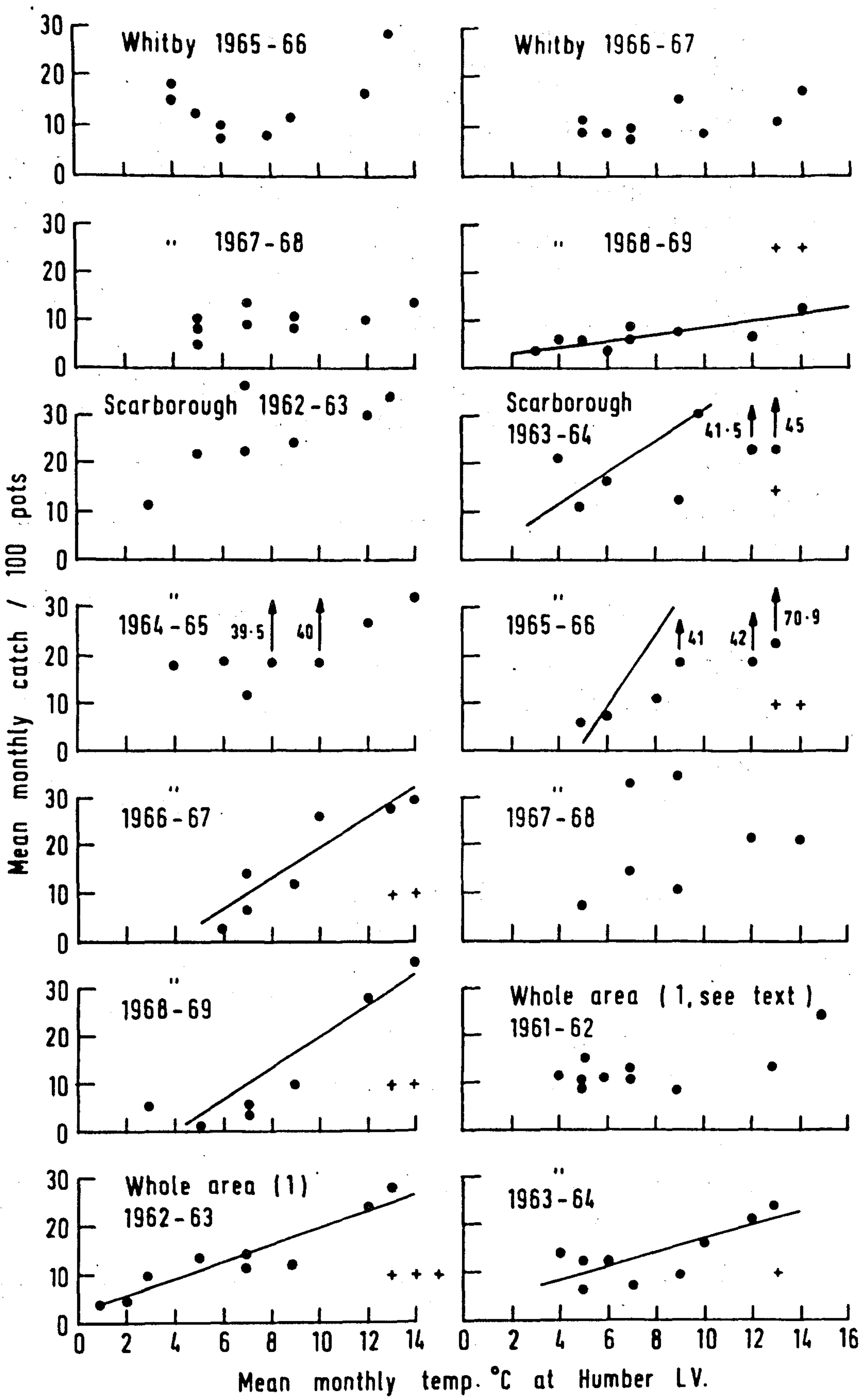

Fig. 3d Mean monthly lobster catch/100 pot-days for various ports, plotted against mean monthly sea temperature at the Humber Lightvessel. + indicates that P = 5% or less; ++, P = 1% or less; +++, P = 0.1% or less.

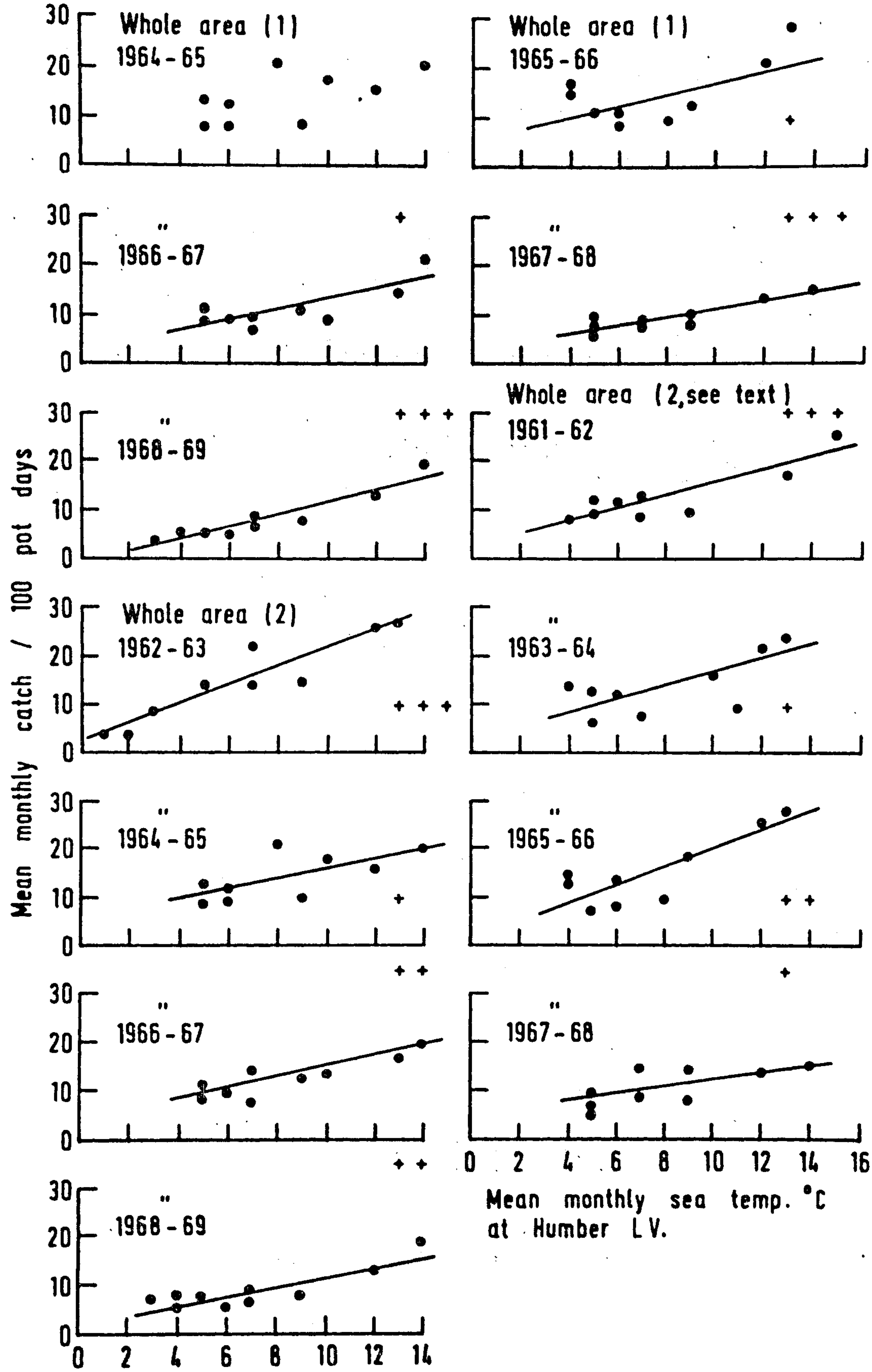

Fig. 3e Mean monthly lobster catch/100 pot-days for the whole area, plotted against mean monthly sea temperature. + indicates that P = 5% or less; ++, P = 1% or less; +++, P = 0.1% or less.