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SHELL GROWTH INCREMENTS IN SCALLOPS (PECTEN MAXIMUS) FROM THE ENGLISH CHANNEL

A. Franklin and G. D. Pickett

Ministry of Agriculture, Fisheries and Food, Directorate of Fisheries Research, Fisheries Laboratory, Burnham-on-Crouch, Essex CMO 8HA, England.

ABSTRACT

Size at age analysis of scallops from beds in the English Channel suggest that considerable variation in growth rates occur. The slowest growing scallops are found in the Western Channel, though in some of these populations macroscopic interpretation of annual rings has proved difficult. Where rings appear indistinct, microscopic examination of the small regular increments in shell growth, the striae, has proved valuable in confirming ring positions. Counts of numbers of striae per growth band suggest a possible daily relationship during the first one or two growth seasons, but there are significant differences in the number of striae per band between different populations. Contrary to expectations, scallops from the slow-growing Polperro (Cornwall) stock have a significantly higher number of striae than the faster-growing stocks examined, but the striae are smaller.

INTRODUCTION

There has recently been a considerable increase in fishing effort on scallops off the south coast of England. Research has been carried out on the suitability of available conservation measures, should the situation require some form of fisheries legislation. One such measure is the implementation of a national minimum size, but regular catch monitoring has indicated that the sizes of scallops landed varies greatly from port to port. Scallops generally exhibit an annual ring on the shell surface at the start of each year's band of growth. Preliminary analyses of shell banding indicated that this size difference between ports was a function of varying growth rates as well as differences in age-class structure. However, scallops from some populations had indistinct annual rings, with interpretation being made difficult by the presence of spurious rings caused by some form of disturbance to the animal.

Growth in scallops occurs mostly in the spring-autumn period and is achieved by the addition of small (0.05-0.20 mm) concentric ridges or striae of shell around the shell margin. This paper shows how microscopic examination and analysis of these striae has proved to be extremely useful in locating the true position of the annual rings.

Several species of bivalves have been shown to exhibit an apparent daily growth banding (Clark, 1974; Farrow, 1972; Wheeler *et al.*, 1975; Wrenn, 1972), and Antoine (1978) suggested a strong daily relationship in the formation of *Pecten* shell striae during the first two growth seasons. New data on this from experiments using captive scallops are presented here.

METHODS

Previous work on microscopic growth increments has often utilised shell sectioning to reveal the growth lines, e.g. Richardson, *et al.*, (1979) for *Cardium edule* and Antoine (1978) for *Pecten maximus*. The technique used here was simply to observe the shell surface with a binocular light microscope at x10-x40 magnification. Where shells required prior cleaning, this was done by gentle scrubbing after immersion in a strong detergent for 24 h. Such treatment was used as little as possible to avoid damaging the striae.

Samples of scallops examined were as follows (see Figure 1):

(i) from commercial catches taken from beds in the Rye, Plymouth and Polperro areas of the English Channel;

(ii) young scallops caught by divers off Lulworth;

(iii) young scallops caught by divers in Start Bay and transplanted to Salcombe;

(iv) first year scallops caught on artificial collectors and kept in captivity in Brighton Marina.

Once the positions of the annual rings had been verified (see below) counts of striae per growth band were carried out for all samples. The mean size of striae, i.e., the lateral inter-striae distance, was generally estimated by the simple division of band width by striae number. However, actual measurements of striae on some of the Lulworth scallops (selected because the striae were very distinctly formed) were carried out using an eyepiece graticule to assess variation in striae size over the growth season. Variations are found when striae numbers and size are measured at different parts of the shell. All counts and measurements in this paper refer to the area between the central ribs (i.e. the dorso-ventral axis) of the flat valve.

RESULTS

A) Identification of the position of the annual ring

Microscopic examination of 'difficult' shells revealed four distinct types of ring, any of which could be taken macroscopically to correspond to the annual ring:

(i) Pigmentation band. This is normally a band of darker colouration extending over the width of several striae. No difference in the formation of the striae is observed. Bands or groups of striae of lighter colouration (near-white) usually occur at the commencement of new spring growth.

(ii) Interference or disturbance ring. This is seen microscopically as a deep cleft between two striae with usually no difference in striae size on either side of the 'ring'. It is caused by short-term adverse conditions.

(iii) Ridge. This is a form of abnormal growth seen in some caged specimens and slow-growing wild stocks. The striae bunch closely together and form a protruding ridge around the shell. Since the ridge can be composed of more than twenty striae, the cause is probably longer-term environmental changes.

(iv) True annual ring. This is characterised by striae becoming closely grouped (smaller) before the ring and by a rapid increase in striae size after the ring, as is shown by the striae measurements for Lulworth scallops, two examples of which are presented in Figure 2. The actual ring is often composed of thin, pale, overlapping striae which occur at the commencement of the new season's growth.

Microscopic analysis of striae amplitude changes can therefore distinguish the true annual winter ring and allow size at age analysis to be undertaken, which was done for the range of samples to assess regional variation in growth rates.

B) <u>Growth variation</u>

Growth data obtained from dredge samples of scallops from three selected areas (Rye, Plymouth and Polperro) are presented in Table 1. Comparisons can be made, for the 1970 year-class, of breadth at age, annual breadth increments and number and size of striae for individual growth bands. It is immediately apparent that the western Channel (Plymouth and Polperro) samples have a much lower growth rate than those from Rye in the eastern Channel (Figure 3); this is most obvious in the early years, breadth increment differences being much less marked after the third growth season. The maximum sizes (B_∞) arrived at by Ford-Walford plot are 130mm for Rye, 98mm for Plymouth and 89mm for Polperro. Thus even local differences, e.g. between Plymouth and Polperro, may be important in any consideration of regulation by minimum size.

Striae analysis provides useful information on how the observed growth differences come about. The number of striae per growth band decreased progressively after the second year for all the populations studied, presumably because the energy available for shell growth decreases with size as metabolic requirements increase. However, the growth differences observed between populations in any one year are not the result of a reduction in striae number: in fact, Polperro scallops tend to have significantly more striae per growth band in the first two growth seasons. It is the size of the striae which is related to the growth rate; Polperro scallops, for example, have striae less than half the size of those from Rye in the early years.

C. Direct measurement of growth increment frequency

The annual growth season for scallops can very roughly be said to cover the seven month (~ 200 day) period April-October inclusive. The counts given in Table 1 indicate (allowing for variation in spat settlement time) that striae are laid down at roughly daily intervals during the first and second year and that the rate falls by about half by the fourth year. Experiments with captive animals were undertaken to confirm this.

(i) First year scallops (spat). Spat scallops obtained from artificial collectors in Start Bay in late summer 1979 were transferred to cages in Brighton Marina where they were left for a period of just under 10 weeks, when counts were made of the striae laid down subsequent to the growth check which occurred at transfer. In the 65-68 days available for growth (the exact period depending on when during the transfer the scallops began to grow) an average of 66 straie were laid down, appearing as fine, dark lines rather than the concentric ridges seen in subsequent growth bands.

(ii) Older scallops. A number of three-year-old scallops were obtained by diving in Start Bay in May 1979 and transferred to the nearby sheltered Salcombe Estuary. Some of these were recovered in September 1979 and counts made of the number of striae laid down subsequent to the growth check caused by the transfer. On average 56 striae were laid down for 110 days at liberty, i.e. roughly one per two days.

These experiments thus support the results obtained from the striae counts of commercial catches; they also suggest that the reduction in growth rate with age indicated in Table 1 is a result of reduced frequency of striae additions over the growing season rather than a shortening of the season itself.

DISCUSSION

Analysis of the striae pattern on scallop shells appears to be an extremely useful method of identifying the position of annual rings, especially in areas where the shells are characterised by the presence of disturbance rings. The use of this method has allowed confirmation of different growth rates found for three scallop populations in the English Channel. These growth differences appear to result mainly from differences in striae size rather than frequency. There is some evidence that the term 'daily banding' could be applied to the striae during their first and second growth seasons, but the frequency with which these are laid down falls markedly in later years. The method could prove useful in calculating instantaneous values of growth during the season; abnormalities may then be compared with physical parameters, e.g. temperature or salinity fluctuations.

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Table 1. Growth of 1970 year-class of scallops in three areas of the English Channel

Growth bands (≡Age in y)	1	2	3	4	5	6
(a) Measured annual breadth (mm)						
Rye	28.1	69.0	97.8	111.8	118.9	122.7
Plymouth	22.3	50.5	68.7	80.0	85.5	89.7
Polperro	19.7	44.3	62.3	75.7	81.5	83.8
(b) Annual breadth increments (mm)						
Rye	28.1	40.9	28.8	14.0	7.1	3.8
Plymouth	22.3	28.2	18.2	11.3	5.5	4.2
Polperro	19.7	24.6	18.0	13.4	5.8	2.3
(c) Number of striae per growth band						
Rye	141	200	167	124	65	36
Plymouth	153	199	133	105	70	48
Polperro	229	269	149	100	68	42
(d) Mean size of striae (mm)						
Rye	0.20	0.20	0.17	0.11	0.11	0.11
Plymouth	0.15	0.14	0.14	0.11	0.08	0.09
Polperro	0.09	0.09	0.12	0.13	0.09	0.05

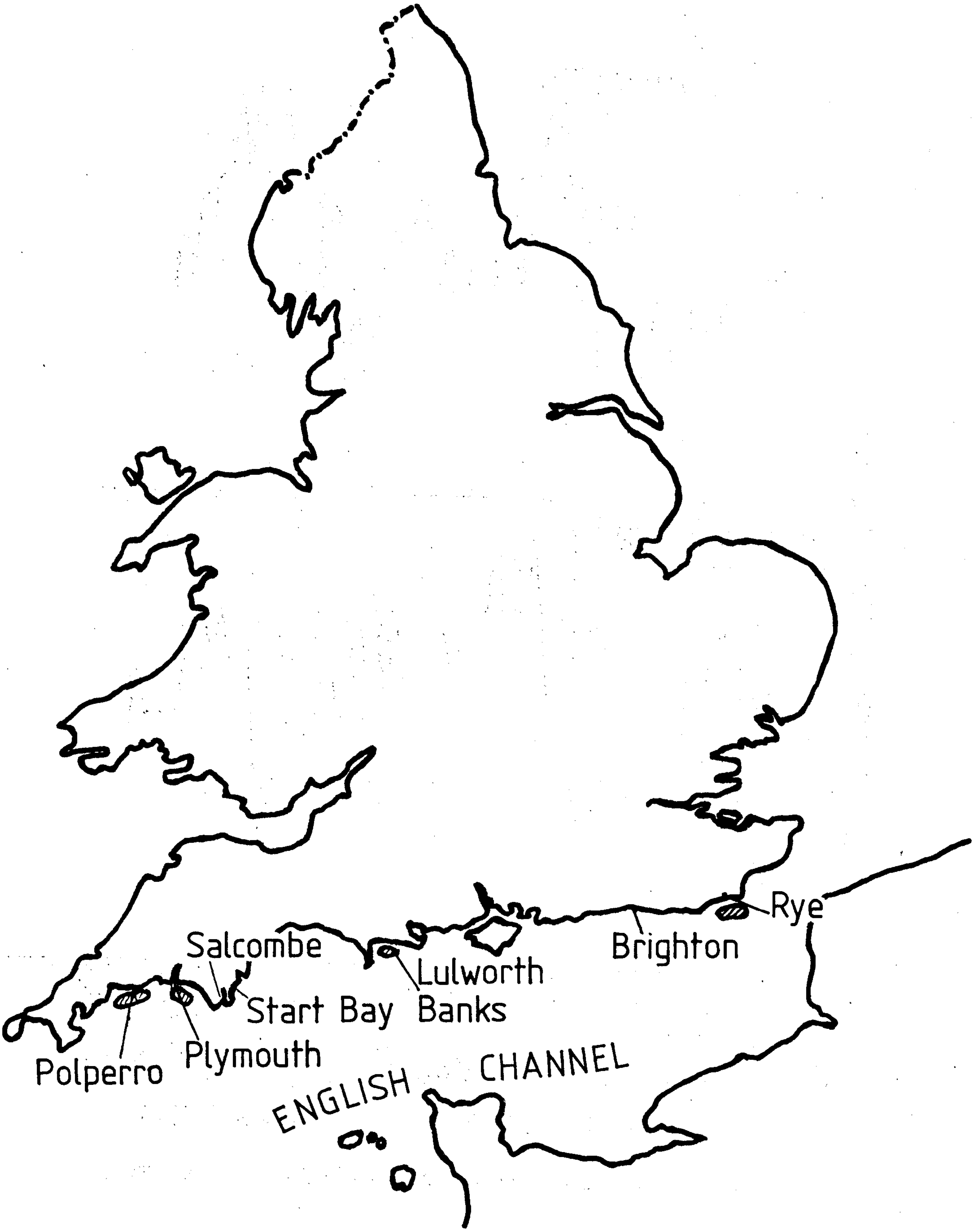

Figure 1 Origin of samples for striae analysis.

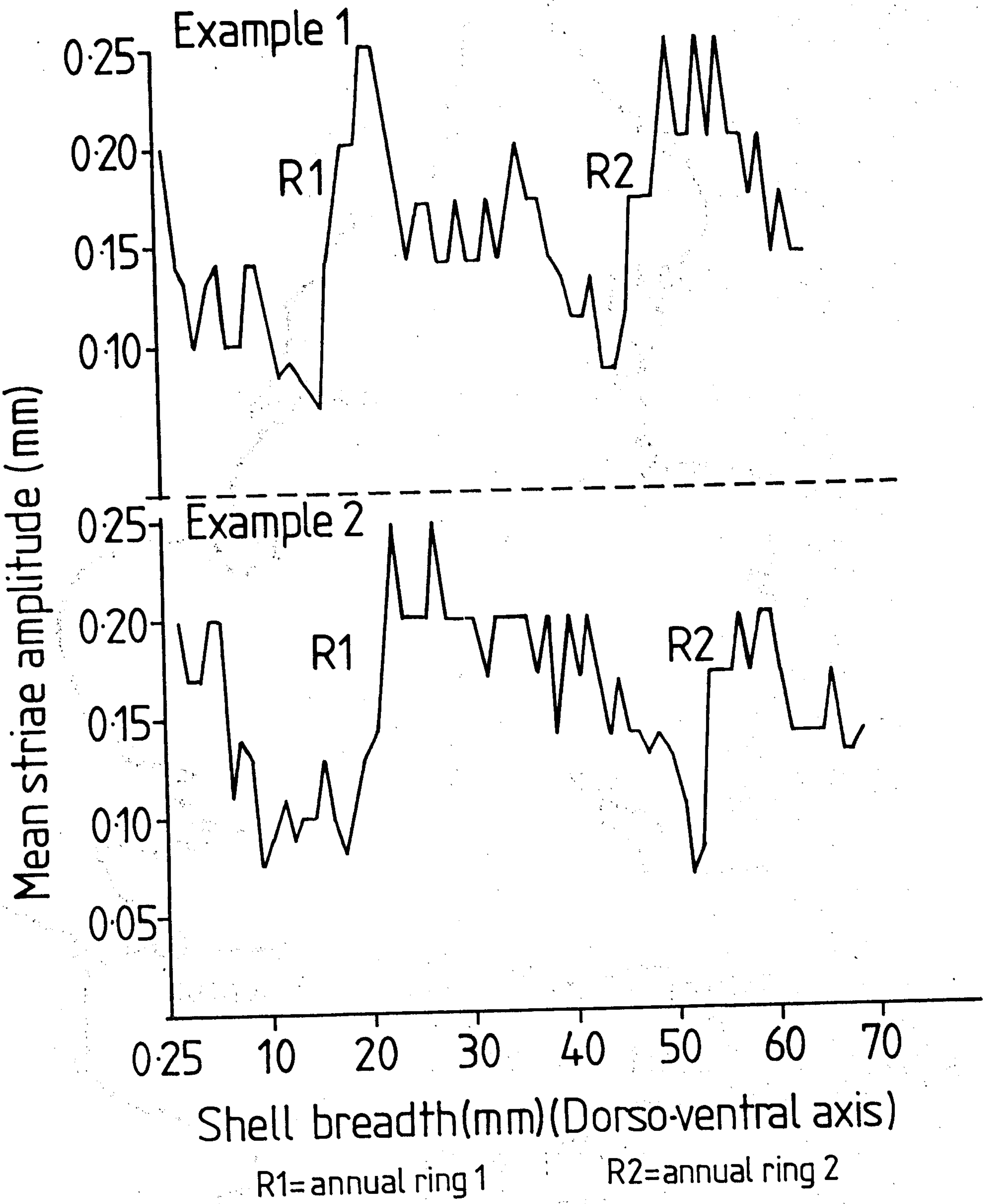

Figure 2 Variation in striae amplitude along the dorso-ventral axis.

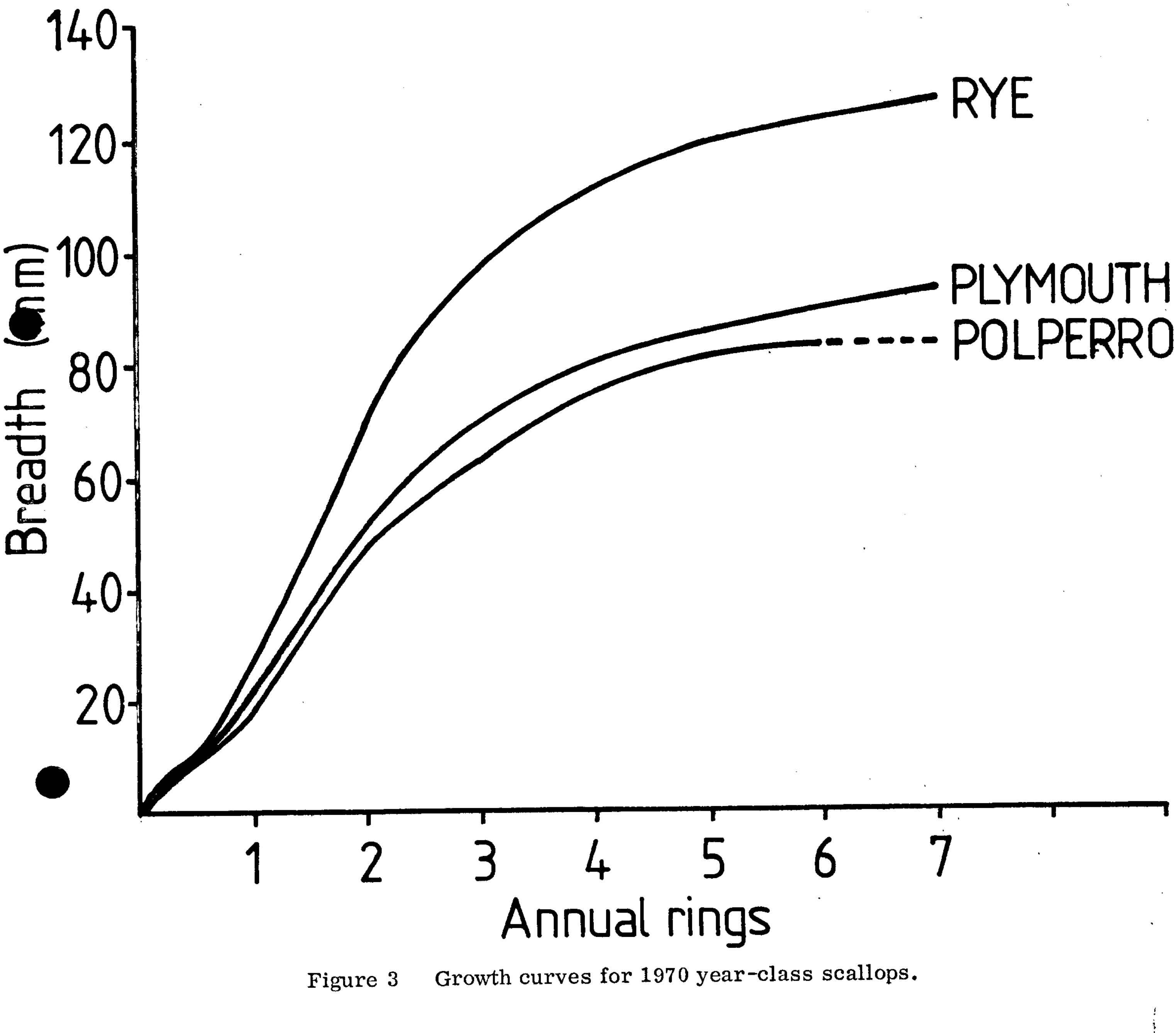

Figure 3   Growth curves for 1970 year-class scallops.