A survey of the age structure of beach populations of *Nephtys* spp. in the British Isles. The basis of population fluctuations

Nephtys spp.
British Isles
Age structure
Population fluctuations

Nephtys spp.
Grande-Bretagne
Structure en âge
Fluctuations de populations

Peter James William Olive, Peter John Morgan
Dove Marine Laboratory and Department of Zoology, University of Newcastle upon Tyne, Cullercoats, North Shields, Tyne and Wear, NE30 4PZ, UK.

ABSTRACT

A survey of the age structure of beach populations of *Nephtys* species in the British Isles. The basis of population fluctuations.
An earlier investigation on *Nephtys* populations in an estuarine beach has been extended to include other beaches. It has become apparent that periodic reproductive failure is a common phenomenon, and this explains why many populations are dominated by large, apparently old individuals which have numerous growth lines in the jaws. Reproductive failures are often the result of a failure to spawn, but may also be due to lack of recruitment.
The reproductive failures we have observed can have the effect of producing isolated year classes, the ages of which may be precisely known. This phenomena is providing an ideal opportunity for testing the hypothesis that growth rings in the jaws of Nephtyidae are laid down annually, and provide a record of an individuals age.

Oceanol. Acta, **1983.** Proceedings 17th European Marine Biology Symposium, Brest, France, 27 September-1 October, 1982, 141-145.

RÉSUMÉ

Une étude de la structure en âge des populations littorales des espèces de *Nephtys* en Grande-Bretagne : les causes des fluctuations dans les populations.

Après des recherches sur des populations de *Nephtys* dans une plage estuarienne, des populations de diverses plages ont été étudiées. Au cours de ces études, on a observé que des périodes d'absence presque totale de reproduction sont assez fréquentes, ce qui pourrait expliquer pourquoi tant de populations se composent de grands individus qui paraissent, d'après leurs mâchoires, être âgés de plusieurs années. De telles périodes d'absence de reproduction sont fréquemment causées par une absence de ponte, mais elles sont parfois aussi causées par un mauvais recrutement. De ces périodes d'absence de reproduction résultent des classes d'âge isolées dans la population, dont il est possible de connaître exactement les âges. Ce phénomène nous donne la possibilité d'éprouver l'hypothèse selon laquelle les anneaux de croissance dans les mâchoires se produisent annuellement et marquent l'âge d'un individu.

Oceanol. Acta, **1983.** Actes 17e Symposium Européen de Biologie Marine, Brest, 27 septembre-1er octobre 1982, 141-145.

INTRODUCTION

Marked changes in the relative abundance of two species of *Nephtys* in an estuarine beach, caused apparently by spawning failure, were described by Olive *et al.* (1981). Did these changes constitute a freak ecological event, or were they representative of more commonplace fluctuations ? This paper describes preliminary results from a continuation of this research which has now been extended to cover a range of

beaches. It also describes how the hypothesis that " rings in *Nephtys* jaws provide a record of age " is being critically assessed.

Four species of *Nephtys* occur in beaches around the British Isles : *N. caeca*, *N. cirrosa*, *N. hombergii* and *N. longosetosa*. *Nephtys caeca* and *N. longosetosa* are more northerly forms whose distribution extends to the Subarctic or Arctic (Kirkegaard, 1969) and which may be nearing their southern limits of distribution in the British Isles. Conversely, *N. cirrosa* is a more southerly form which appears to be nearing its northern limits of distribution.

METHODS AND MATERIALS

Nephtys have been collected from beaches using the two methods described by Olive (1977) and Olive *et al.* (1981) in which metre square quadrats are carefully dug for the older specimens but the density of 0^+ group individuals is estimated from replicate samples of 1/16th m^2 sieved through a 0.5 mm mesh.

Jaws were prepared according to Olive (1980). Samples from the sublittoral environment were obtained using a Van Veen grab operated from the R. V. "Bernicia ", and passed through a 0.5 mm sieve.

RESULTS

The relative numbers of each species in the beaches being investigated in detail is shown in Figure 1. It must be emphasized that the data here refers only to the relative numbers of each species at one time (autumn 1981). It should not be assumed that this represents the " normal " situation. To emphasize this a comparable figure for autumn 1975 is given for the Tynemouth population. Notice the drastic change in relative abundance.

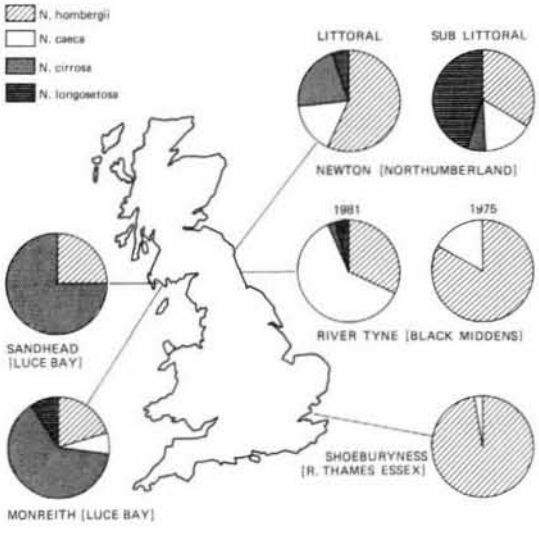


Figure 1

Examples of the relative abundances of Nephtys species *in some beach populations in Eastern England and South Western Scotland.*

A fundamental problem in attempting to study *Nephtys* populations is that of age determination. It is possible to recognise a 0^+ group by virtue of its size. It is also possible to follow an unusually strong year class for several years as it passes through the size/frequency distribution. However, while there is no doubt that a relationship between age and size exists, making the distinction between say populations dominated by either young or old individuals possible, it is *not* possible on the basis of size alone to allocate a precise age to specific individuals. Skeletal growth records can provide a means of determining the age of individuals more precisely, and growth lines have been described in the jaws of Nephtyidae which could make this possible. Growth lines can be seen in scanning electron micrographs of the jaw surface (*see* Fig. 2). Kirkegaard (1970) first described the rings in *Nephtys* jaws, and stated that they were annual. Retière (1976) and Olive (1977) also proposed that the rings were annual, finding this assumption to be in accord with the overall behaviour of the *Nephtys* populations studied. However, the hypothesis that the growth lines are annual has not been critically tested. If growth rings do represent a record of age, then there should be a correspondance between the ring number/frequency distribution and the observed history of reproductive performance (provided there is no significant influence from immigration). For instance, if year classes are known to be absent, there should exist corresponding hiatuses in the jaw ring number count.

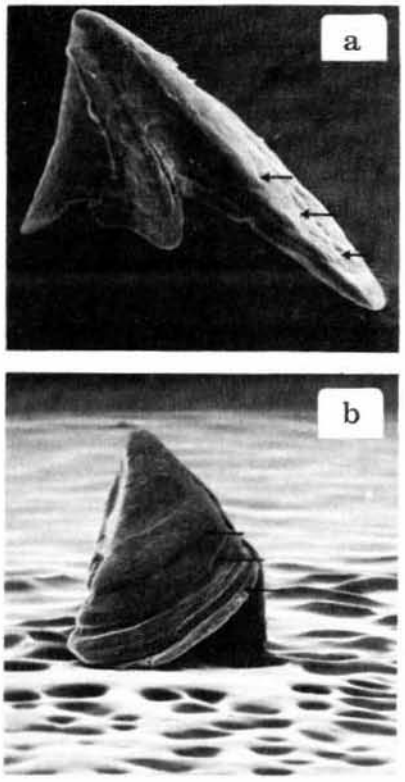


Figure 2

Scanning electron micrographs of a jaw taken from a specimen of N. hombergii *showing the general morphology and the annual growth lines which are particularly clear in this specimen : a) labial view ; b) posterior view. The major growth lines which are thought to be produced annually appear as steps on the surface of the jaw and are indicated by arrows. The inferred age of this specimen is 4^+ years since the first growth line corresponds to an age of 1^+.*

Our longest sequence of data relates to *Nephtys caeca* and *N. hombergii* in the River Tyne estuary. The recent history of spawning, recruitment and juvenile survivorship has been summarised in the Table. Figure 3 shows that the sequence of good recruitments of *N. caeca* had by 1980 established a population which was dominated by younger year classes. This is also indicated by the counts of the rings in the jaws. The relative survival of the 1980 and 1981 year classes up to August 1982 was poor and has led to a more flattened size/frequency distribution with a corresponding shift in the ring count number mode from zero rings to two rings. Hence it is clear that following a successful spawning, both recruitment and juvenile survivorship contribute to the eventual strength of a given year class.

The size/frequency and jaw ring number/frequency distributions for the population of *N. hombergii* are shown in Figure 4. By February/March 1982 the unsuccessful reproductions of 1978 and 1979 had caused a clear hiatus to develope in the size/frequency distribution. There also developed a corresponding paucity of counts of 1 and 2 in the jaw ring number/frequency distribution. The fact that these counts were not totally absent however, shows that the fidelity of the ring count method is not absolute. The 1980 year class survived reasonably well and forms the peak of smaller animals, the larger animals being those recruited prior to 1978.

The other beach populations of *N. hombergii* examined by us provide evidence of a recent history of poor recruitment. Figure 5 shows the structure of a population in the River Thames at Shoebury Ness. The population is composed primarily of older animals > 2.4 mm body width, with 2 or more rings in their jaws. A recruitment class, presumably that of a 1981 spawning, is present but has not yet shown any significant growth. Populations of *Nephtys hombergii* collected from Newton in Northumberland and from Monreith in Luce Bay, SW Scotland, are also composed predominantly of large, apparently old, individuals. The 1980 year class, which is now a prominent feature of the River Tyne population, is not present in these beaches.

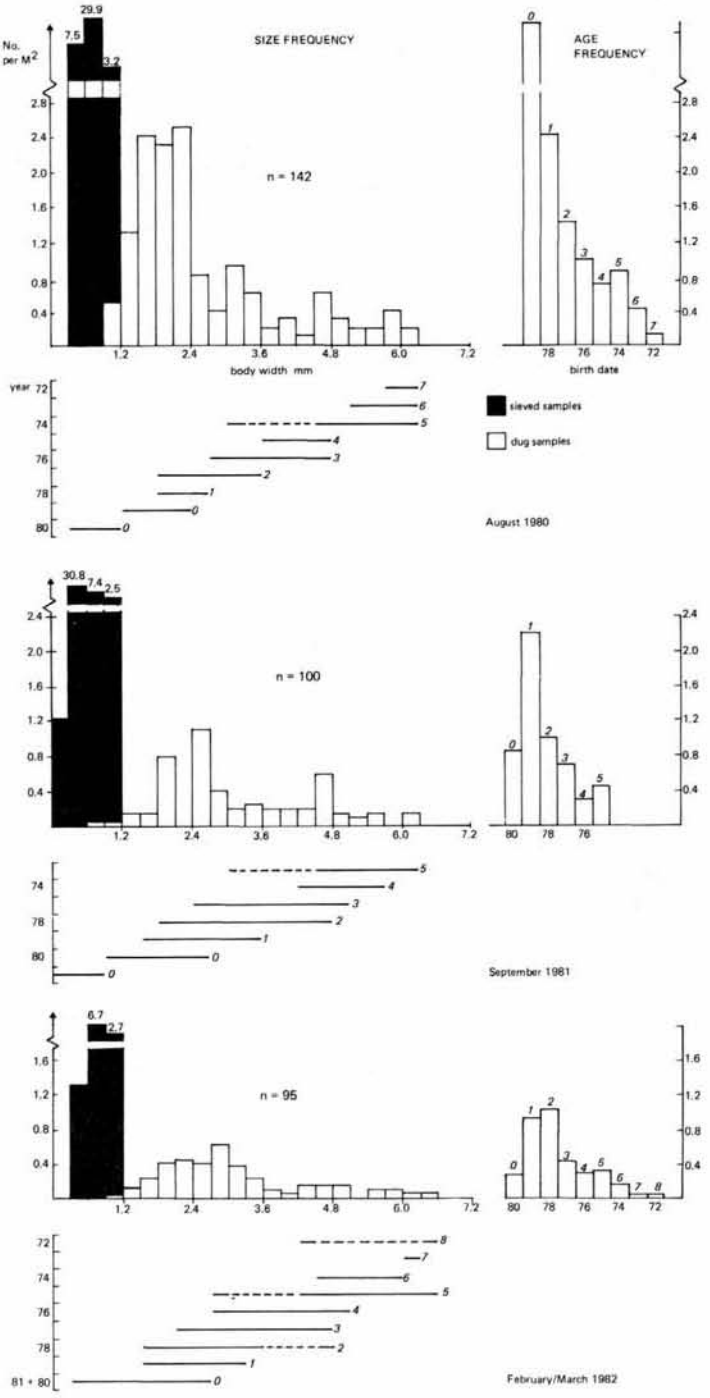


Figure 3

Size and age frequency of a population of Nephtys caeca *in the Black Middens beach in the River Tyne estuary. Samples taken in Auguts 1980, September 1981 and February/March 1982. The age frequency is based on a count of the number of rings in the jaws and does not include the 0⁺ group. The inferred birth date is given. The horizontal bars indicate the size range of each inferred year class. n = the number of animals in each sample.*

Table

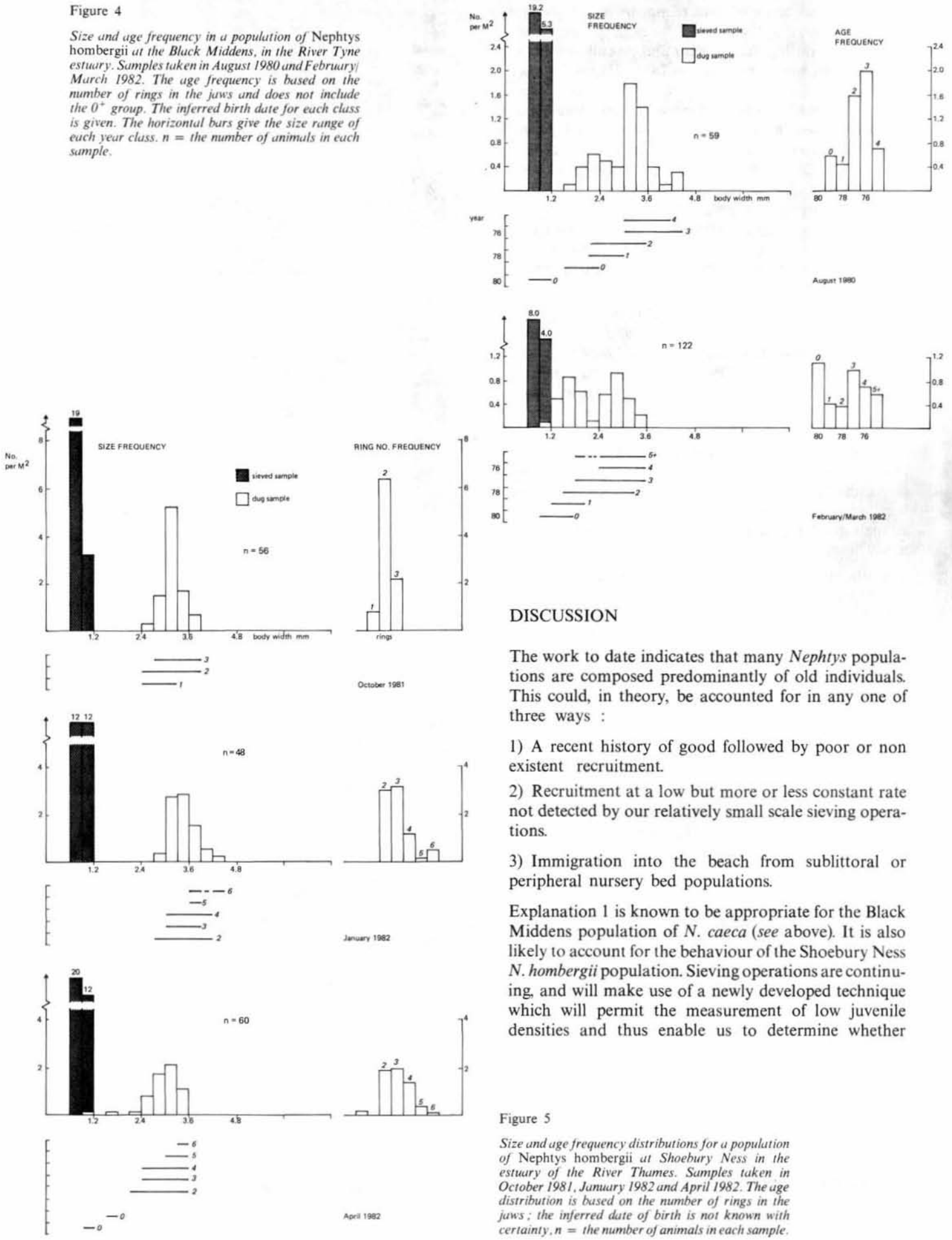
Recent recruitment and survivorship of Nephtys *in the River Tyne estuary. "Good" recruitment indicates a mean of > 2 individuals 1/16th m² area sieved. "Poor" recruitment represents anything less. "Good" 0⁺ group survivorship indicates that a clear cohort peak was still present twelve months after settlement.*

	N. caeca		*N. hombergii*	
Year	Recruitment	0 group survivorship	Recruitment	0 group survivorship
1975-1977	good	good	good	good
1978	good	good	poor	?
1979	good	good	nil	—
1980	good	poor	good	good
1981	good	poor	poor	?
1982	good	?	nil	—

Age distributions in which apparently older animals predominate have also been observed in populations of *Nephtys cirrosa* at Newton and Monreith (Fig. 6). An additional observation has been a marked difference in the spawning success of *N. cirrosa* at these two beaches. The impact of these events on future population structures will be monitored.

Figure 4

Size and age frequency in a population of Nephtys hombergii *at the Black Middens, in the River Tyne estuary. Samples taken in August 1980 and February/March 1982. The age frequency is based on the number of rings in the jaws and does not include the 0⁺ group. The inferred birth date for each class is given. The horizontal bars give the size range of each year class. n = the number of animals in each sample.*



DISCUSSION

The work to date indicates that many *Nephtys* populations are composed predominantly of old individuals. This could, in theory, be accounted for in any one of three ways :

1) A recent history of good followed by poor or non existent recruitment.

2) Recruitment at a low but more or less constant rate not detected by our relatively small scale sieving operations.

3) Immigration into the beach from sublittoral or peripheral nursery bed populations.

Explanation 1 is known to be appropriate for the Black Middens population of *N. caeca* (*see* above). It is also likely to account for the behaviour of the Shoebury Ness *N. hombergii* population. Sieving operations are continuing, and will make use of a newly developed technique which will permit the measurement of low juvenile densities and thus enable us to determine whether

Figure 5

Size and age frequency distributions for a population of Nephtys hombergii *at Shoebury Ness in the estuary of the River Thames. Samples taken in October 1981, January 1982 and April 1982. The age distribution is based on the number of rings in the jaws ; the inferred date of birth is not known with certainty, n = the number of animals in each sample.*

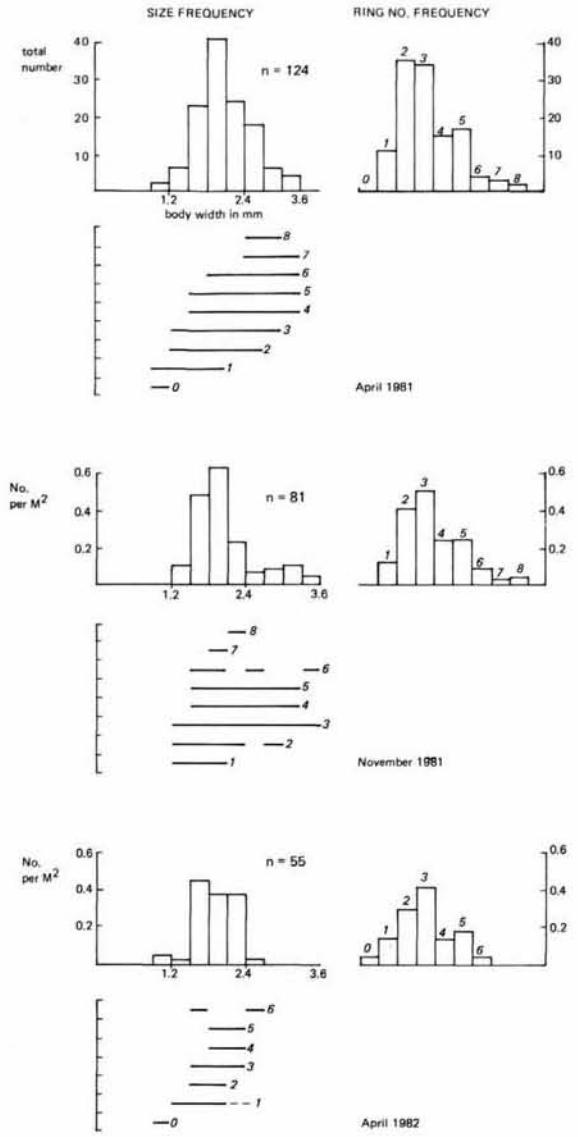


Figure 6

Size and age frequency distributions for a population of Nephtys cirrosa *at Monreith (Luce Bay, SW Scotland) in April 1981, November 1981 and April 1982. Horizontal bars show the size range of the year class groups but the inferred year of birth is not known with certainty. n = the number of animals in each sample.*

explanation 2 is exerting any appreciable influence. We have searched for a sublittoral nursery bed population at Newton, but have found no evidence — the sublittoral population being composed predominantly of *N. longosetosa* (Fig. 1). Examination of a beach at Sandhead, at the head of Luce Bay, suggested at first the possible existence of a nursery bed population since the *N. cirrosa* and *N. hombergii* found there were numerous, but smaller than the ones found nearby at Monreith. The jaws of the *N. cirrosa* collected here in April 1981 however (Fig. 7) had a ring number/frequency distribution similar to that of the Monreith population. Here estimates of age based on size and on jaw ring counts would differ markedly. If jaw ring analysis does indeed indicate age, the implication is that growth rates between adjacent populations can vary markedly. Conversely, if such small animals are in fact young, then the existence of many rings in their jaws is contrary to the " rings correspond to age " hypothesis.

An objective method to assess the validity of using jaw ring counts to determine the age of specimens of Nephtyidae, must be independant of a general relationship between size and ring number which may exist. It is necessary to demonstrate that size frequency peaks, representing cohorts of known age, are composed predominantly of animals with a predictable number of rings in their jaws. At present this has only been possible, to a limited degree, with the *Nephtys* populations at the Black Middens. The question of jaw ring analysis must therefore remain open until longer runs of data provide the necessary empirical proof. Work in this direction is continuing, as are attempts to improve the objectivity of ring counting, through the examination of jaw sections, rather than of jaw surface features.

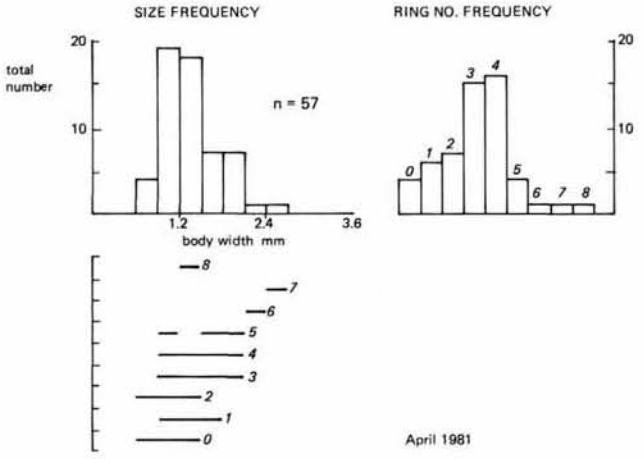


Figure 7

Size and age frequency distributions for a population of Nephtys cirrosa *at Sandhead (Luce Bay, SW Scotland) in April 1981. Horizontal bars show the size range of the year class groups but the inferred year of birth is not known with certainty. n = the number of animals in sample.*

REFERENCES

Kirkegaard J. B., 1969. A quantitative investigation of the central North Sea Polychaeta, *Spolia Zool. Mus. Haun.*, **29,** 1-284.

Kirkegaard J. B., 1970. Age determination of *Nephtys* (Polychaeta : Nephtyidae), *Ophelia*, **7,** 277-281.

Olive P. J. W., 1977. The life history and population structure of the polychaetes *Nephtys caeca* and *Nephtys hombergii* with special reference to the growth rings in the teeth, *J. Mar. Biol. Assoc. UK*, **57,** 133-150.

Olive P. J. W., 1980. Preparation of polychaete jaws for growth-line examination, in : *Skeletal growth of aquatic organisms*, edited by D. C. Rhoads and R. A. Lutz, Plenum, New York, 625-626.

Olive P. J. W., Garwood P. R., Bentley M. G., Wright N., 1981. Reproductive success, relative abundance and population structure of two species of *Nephtys* in an estuarine beach, *Mar. Biol.*, **63,** 189-196.

Retière Ch., 1976. Détermination des classes d'âge des populations de *Nephtys hombergii* (annélide polychète) par lecture des mâchoires en microscopie électronique à balayage, *C.R. Hebd. Séanc. Acad. Sci. Paris*, **289D,** 1553-1556.