POPULATION STRUCTURE OF *MYTILUS EDULIS* L. FROM LINDASPOLLENE, WESTERN NORWAY

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SUMMARY: The Mytilus edulis population at Bjornoy was found to have a bimodal frequency distribution. A study of growth rings, however, showed that modes are comprised of more than one year classes which overlap each other. Distribution of size frequencies was found to exhibit an almost similar pattern throughout the year. Juvenile mussels attached to the byssus occurred throughout the year with the exception of October 1977. Late plantigrades (or juvenile mussels) varying in length from 400 to 1000 μ were found attached to polythene bags at the end of July 1978. Seasonal changes in the population structure were not found useful in determining the time of recruitment.

Key Words: Mussels, growth rings, year classes, recruitment.

INTRODUCTION

TAlthough of fair amount of literature has accumulated on various aspects of biology of *Mytilus edulis*, surprisingly few studies have been made of its population structure. An investigation by Seed (1) is perhaps the only detailed study in which the changes in population structure and distribution of *M. edulis* from several exposed shores in England have been documented. Some information on size frequency distribution of cultured mussels was obtained by Boetius (2) and Theisen (3) from Copenhagen and Danish Wadden Sea, respectively. Recently Wallace (4) has presented data on length frequency distribution of five populations of adult *M. edulis* from northern Norway. The settlement and recruitment of juvenile mussels has been observed by a number of workers, reviewed by Seed (5), but publications of most importance in this field are those of Bayne (6,7), De Block and Geelen (8), Savage (9), Seed (1, 10) and Verwey (11).

An attempt has been made in the present investigation to obtain some information regarding changes in the population structure of *M. edulis* from Bjornoy, Lindaspollene by sampling at regular monthly intervals for a period of thirteen moths. Young mussels found entangled in the byssus of adult mussels were also taken into consideration to study the settlement pattern in this area.

MATERIALS AND METHODS

Samples of mussels for the study of population structure were collected from Bjornoy on a regular monthly basis from September 1977 to September 1978. As the mussels remain submerged under water most of the time, they were detatched from the rocks with the help of a mussel collector, which consists of a small rectangular Iron frame measuring 20 cm in length and 14 cm in width. The frame is provided with a cloth bag for the mussels and a long wooden stick for handling. The mussels so collected were thus considered to have been collected at random. All individuals of a sample were counted and their shell lengths (longest distance from the anterior to the posterior edge of the sheel) measured with a dial vernier calliper to the nearest tenth of millimeter. To obtain information about recruitment to the population, byssus of fifteen adult mussels from each months sample were removed by cutting and thoroughly searched under a microscope for juvenile mussels trapped between byssus threads.

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Since no difference in size class distribution of mussels were observed in the first five months of sampling (September 1977 to January 1978) at Byornoy it was decided to conduct simultaneous replicate mussel sampling on an additional site at a distance of about 50 meters from the original site just to see if any monthly difference in population structure could be detected. Replicate sampling was started in February 1978 and continued for eight months until September 1978.

RESULTS

Length frequency distribution of mussels collected at monthly intervals has been plotted for each 5 mm group of mussels (Plate 1). These histograms also include juvenile mussels trapped between the byssus threads of adult mussels.

Size frequency distribution of mussels from Bjornoy was found to exhibit an almost similar pattern throughout the year. The population could broadly be categorized as having a bimodal frequency distribution. The data however, indicate that the modes are comprised of more than one year class which overlap each other. For instance, the sample of September 1978 was found to include mussels of at least eight year classes as revealed by growth ring study (Barkati, unpublished data) but the size frequency histogram shown in Figure 13 (Plate 1) is unable to differentiate eight year classes in the sample.

Juvenile mussels found between the byssus threads of adult mussels formed a considerable portion of the sample in September 1977 (Figure 1, Plate 1) but they disappeared completely in the October sample. Moreover, the number of juvenile mussels of 0.5 to 1.0 cm was negligible in September 1977, through they increased considerably in October. This was interpreted as follows: juvenile mussels settled on the byssus had grown during the one month period from September to October, and had migrated to the mussel bed leaving their byssus attachments. At the same time high mortality might have occurred reducing their number considerably.

As mentioned above juvenile mussels attached to the byssus occurred throughout the year with the exception of October 1977. This may be taken as evidence for continuous recruitment to the mussel population (with bulk recruitment occurring in September and November) indicating a long spawning season. Results of other reproductive phenomena (Barkati and Ahmed in press) studied in the present investigation, however, do not support the above interpretation of long spawning season. The studies indicated the initiation of spawning in late April and its continuation until August. An alternative explanation which may be offered about the juvenile mussels settled on byssus threads is that although they were of small size, they may have settled here sometime earlier. They had remained small in size probably because of unfavorable conditions prevailing among the byssus threads.

During the period June-November, observations were also made on the growth of mussels suspended in net bags under water. This experiment provided on opportunity to record some observations on the settlement of mussel larvae. On June 27, 1978 the wire and ropes of the system were found to be covered over with filamentous algae, mainly *Enteromorpha*. When examined after one month, at the end of july, the algae had vanished and the small polythene bags, used for tagging the net bags, were found to be completely covered with newly settled juveniles which Carriker (1961, quoted by Seed (10) had earlier designated as "late plantigrades". The lengths of these plantigrades varied from 400 to 1000 μ.

DISCUSSION

The absence of distinct modes in the sire frequency distribution of *M. edulis* in the present study, has made it difficult to identify individual year classes. Variations in the growth rates of mussels may have resulted in this type of population structure. According to Seed (10), length frequency distributions of many bivalve populations are polymodal, each mode representing an individual year class. Seed (1,10) was, however, unable to recognize individual year classes in *M. edulis* from England, on the basis of length frequencies. This, in his opinion, was due to the presence of a large number of small mussels in the population at any one time. He, however, mentioned that in younger mussels polymondal length frequency distribution could be found. It was recently pointed out by Wallace (4) that as a result of differential growth of individuals of a year class, size distribution in the population may not correspond to the particular year class. Steady decline in growth rate was suggested as another important factor resulting in over-

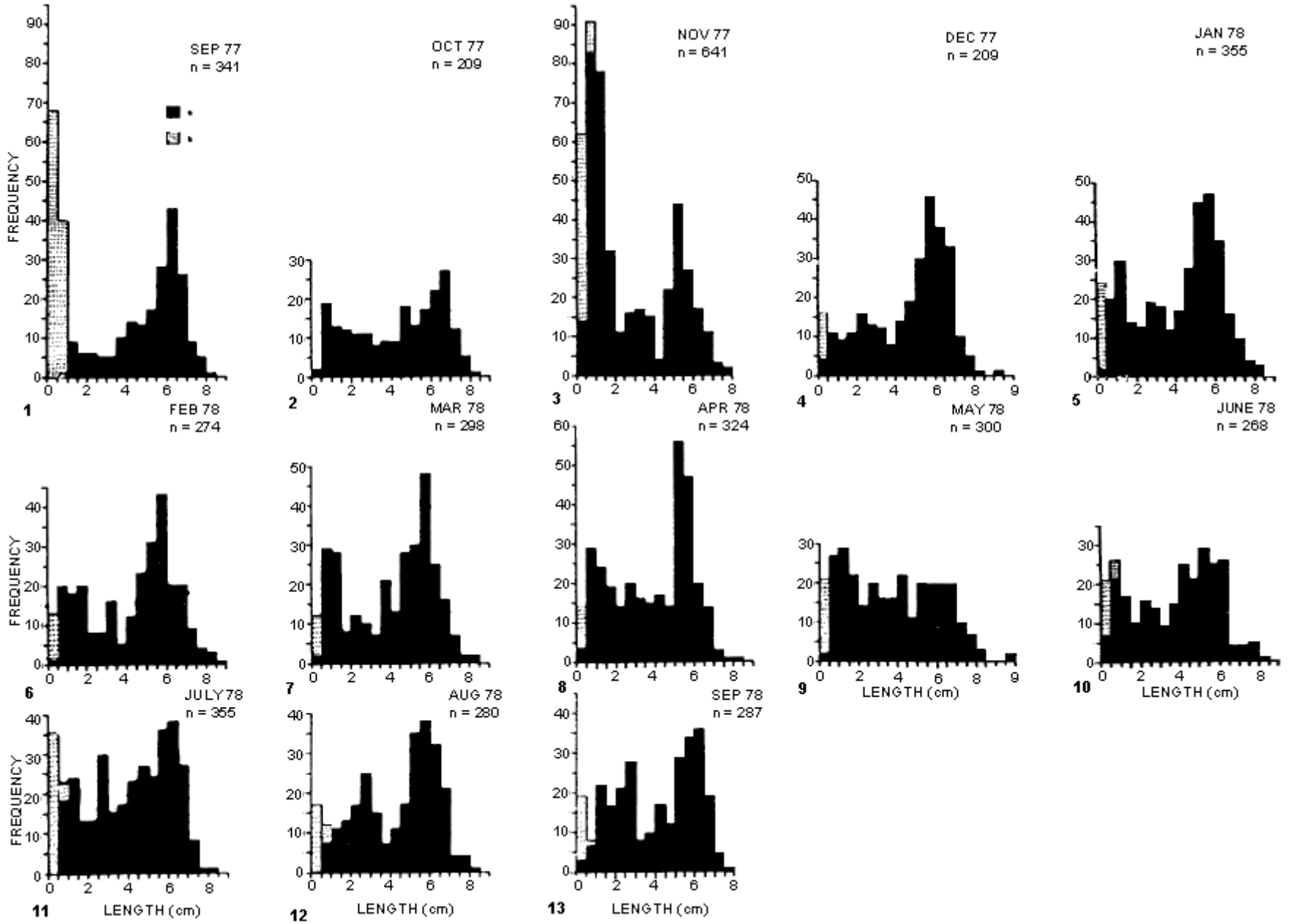

Figure 1 to 13: Length frequency distribution of *M. edulis* from Bjornoy; September 1977 to September 1978. Lightly stippled areas represent juvenile mussels collected from the byssus threads of adult mussels.

lap in size distribution (12, 13). During a study of growth in *M. edulis* from Norway, Wallace (4) presented data on population structure of five of its populations. He stated that separation of shore mussels into year classes, using size distribution, was difficult; mussels grown on floats and buoys were however, relatively easily separable into year classes. He further emphasized that sample of mussels which had grown on floats and which belonged to thin and less crowded populations were more easily interpretable. A similar situation has been reported in *Modiolus modiolus* which displays bimodal size frequency distribution (13, 14, 15). An investigation of this species based on annual disturbance rings on the shells, however, indicated that the larger size groups consisted of overlapping year classes.

Though quite a few attempts have been made in the past to study the patterns of settlement in + , εδυλισ, techniques employed to study the same may not have been entirely reliable. In previous studies, settlement periods were determined by taking into consideration the appearance of mussel spat on intertidal rocks or on the shells of adult mussels. Some authors, for instance Chipperifeld (16), also scrutinized the byssus threads for recently settled young mussels. Likewise, data regarding reproductive cycle and larval abundance in the sea was also used to make conclusions about the recruitment. Most of the studies on recruitment were, however, based on the settlement of mussels on collectors of various kinds suspended in water. This method is considered to provide more reliable information for determining the period of settlement. However, the presence of mussel spat on cultch can not be taken to mean that settlement has occurred on the shore. Dare (17) , working on mussels in Morecombe Bay, England, pointed out that spatfall appeared to be controlled more by a natural cycle of physical and biological events on the ground then by mere availability of spat in the sea. In the present study, settlement of mussels on the polythene bags suspended in water was first observed in the month of July. Bohle (18) reported larval settlement in Oslo fjord, Norway, to occur in June, which is contradictory to his pervious observation (19) mentioning that settlement occurred in October. This inconsistency, however, may have resulted due to annual variation in the timing of settlement.

Recruitment of juveniles to the mussel population may also be investigated through a study of seasonal changes in the population structure of mussels (5) as has been done in the present study. A marked increase in the number of small mussels may indicate the main period of settlement. However in the present study, the continued appearance of these juveniles in every monthly sample made it impossible to use the seasonal changes in population structure for recruitment studies. Reynold (20) also encountered difficulties in separating the small slow growing members of the population from the newly settled mussels. The same problem was faced in the present study since miniature continued to appear throughout the year. Dare (17) and Seed (5) mentioned that algal substrates act as reservoirs of temporary attachment for miniature mussels which may subsequently migrate to mussel beds at any time during the year.

Studies of gonadal development and spawning of *M. edulis* population from Bjornoy undertaken by the present author (Barkati, in press) do not suggest the same recruitment pattern of juvenile mussels as was actually observed in the field. This discrepancy can be explained by the observations of Seed (5) who indicated that recruitment of mussels can occur at almost any time of the year.

It is now a well established fact that larvae of *M. edulis* pass successively from plankton to sites of temporary attachment of filamentous algae (primary settlement) and then to sites of permanent attachment near or on a bed of adult mussels (secondary settlement). Bohle (18) mentions that a planktonic stage of *M. edulis* preceding a secondary settlement does not seem to exist in Norwegian waters. The size of spat at which migration from algae to experimental plates occurred, in Bohle's experiments, varied from 500-1500 μm. Bayne (6) has demonstrated a migration to the mussel bed at a size of 900-1500 μm in British waters. Juvenile mussels of this size have been recorded in plankton in English waters whereas very few juveniles larger than 300 μm were recorded in Norwegian waters (18).

Recruitment studies (5) have shown that spatfall can occur on any roughened stable substrate. Mussel beds, due to their surface texture and byssus thread of mussels provide suitable spots for mussel settlement (21). In the present study, though juvenile mussels were

found between byssus threads, no such settlement was seen on shell of adult mussels. Moreover settlement of mussels on rocks could not be detected since they remain submerged under water most of the time. The present observations seem to suggest that mussel larvae first settle on floating algae leading to primary settlement, and as the algae start decaying the juvenile mussels migrate to a site of permanent attachment such as byssus threads or plastic bags (used in the present experiment). This evidently constitutes secondary settlement. It is stated in the literature that mussel juveniles attach and detached themselves several times before finally settling on mussel beds (21). As the maximum size of juvenile mussels found between the byssus thread (in the present study) coincided with young mussels collected from the rocks, it is assumed here that juveniles after spending sometime among byssus threads of adult mussels acquire lengths of 5 to 9 mm and then migrate to the rocks where adult mussels attach. This settlement may be termed as "tertiary settlement".

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