REPRODUCTION OF PECTEN MAXIMUS FROM DIFFERENT FISHERIES AREAS : RADE DE BREST, BAIE DE ST BRIEUC, BAIE DE SEINE

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Abstract : *The baie de Seine, the baie de St–Brieuc and the rade de Brest are the three main fisheries in France. Measurements made on spawners issues from these areas allow now to consider two separate reproductive strategies, in these populations. Scallops from the baie de St–Brieuc spawn during a short period (july–august), a sexual rest stage being observed in autumn and winter and recovery occuring in spring. This seasonal recruitment is strongly dependant of external factors and remains aleatory.*
Populations from the rade de Brest and from the baie de Seine show similar reproductive cycle with a permanent annual sexual activity spawning being scattered from early spring to autumn. This reproductive strategy, more opportunistic and flexible could explain that recruitment in these fisheries are better than in the Baie of St–Brieuc. The origin of such differences is discussed, on the basis of transplantation experiments and genetic investigations. In all populations, the variations of the muscle and gonad index are opposite, the muscle acting as a storage organ releasing metabolites to cover the energy requirements for growth and reproduction. The contribution of the muscle glycogen content is discussed.

Keywords : *Pectinids, Scallops, Reproduction.*

INTRODUCTION

The aim of this work is to compare the reproductive strategies of scallop populations from the three main fisheries in France : rade de Brest, (Atlantic), baie de St–Brieuc et baie de Seine (Channel), in order to explain the differences in recruitment. This knowledge is important for managing the different stocks and establishing the legal ryles of exploitation.

MATERIAL AND METHODS

All these populations growth is shallow waters (10–35 m depth), the annual range of temperature and salinities being nearly similar for the three areas. Monthly samples have been dredged (and weekly during the period of reproduction) from october 1985 to june 1989 (baie de Seine), november 1984 to december 1987 (baie de St–Brieuc) and april 1989 to mai 1991 (rade de Brest).

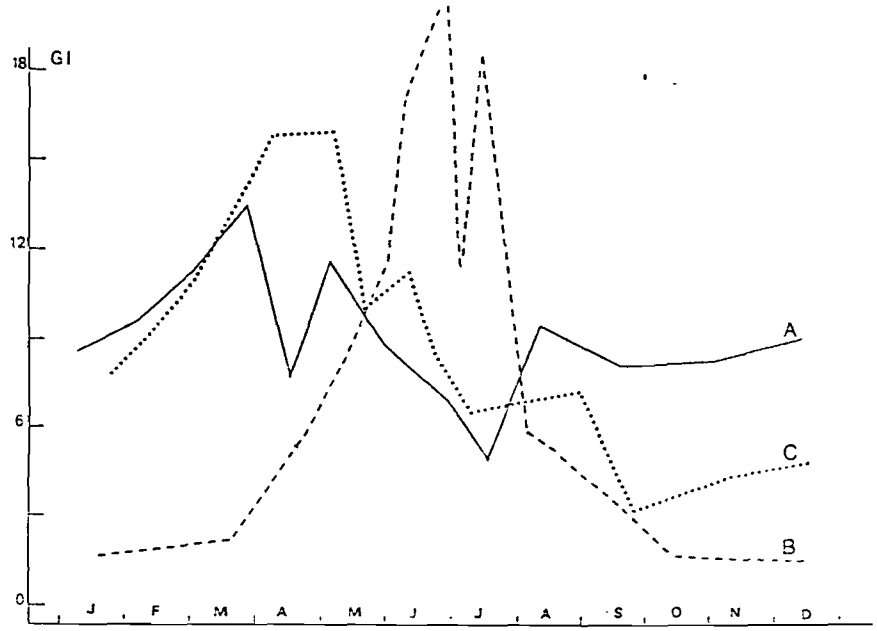

Figure 1. Annual variations of the gonad index (GI)

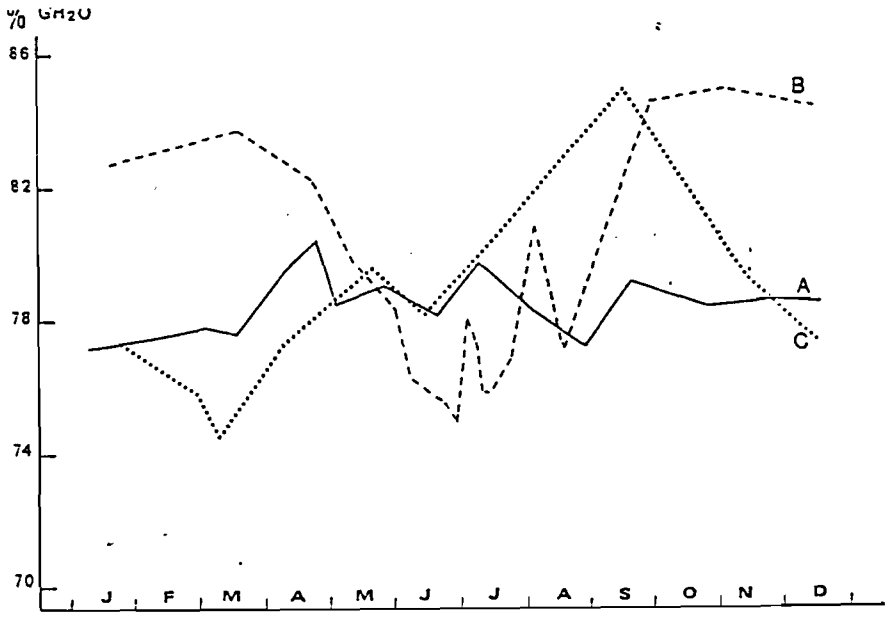

Figure 2. Annual variations of the gonad water content (% of the dry weight)
–A : Rade de Brest, –B : Baie de Saint Brieuc, –C : Baie de Seine

1) Animals of the 3 age group (3 winter rings) were selected for examinations. The sizes attained by the animals from the baie of Seine (10–11 cm height) are greater than those from other areas. For each measurement, 10 scallops or more have been studied (baie de Seine), 20 (rade de Brest) and 30 (baie de St–Brieuc).
The shells are measured (height from the umbo to the ventral area). After opening and dissection it has been calculated the following indexes.

Gonad index : gonad wet weight x 100/height 3

The interindividual variancy at the same time of this index gives a good estimation of the synchronism or asynchronism of the sexual stages especially for spawning in each fisherie.

muscle index : muscle wet weight x 100/Height 3

The muscle or gonad water content has been calculated after drying (48–96 h at 100 °C), the glycogen content estimated by the method of Gilbert and Bourdon (1968). The results are expressed as a percentage of the dry weight of the organ. For each parameter, the graphs are established as means of the results during the studied period because the variations in each fisheries are nearly similar from one year to another. It has been possible to draw a probable annual variation for each parameter.

1. Annual variations of the gonad index and the reproductive cycle (Fig.1)

Each area exhibits similar variations of the gonad index from one year to another, but differences appears between the different main fisheries.

1.1 – Baie de St–Brieuc

The annual variations of the G.I. are very important. This population shows a rest sexual stage (minimal values of the GI) from october to the next march recovery in april corresponds to a sudden increase of the G.I., the maximum values being observed each year at the end of june. Two successive and synchronic spawnings are generally observed in july.

1.2 – Rade de Brest

The reproductive activity is permanent throughout the year but he variations of the GI are irregular from one year to another. Nethertheless, it appears that the sexual rest stage seems absent and the maximal production of gametes attained during winter (G.I. maximum in march). Three main periods of spawning have been identified, on at the beginning of spring (march – april), very important and synchronic in the whole population, a second from may to the end of july (minimal values fo the G.I.) and depending on the year, the last one during autumn. After the first spawning individual asynchronism increases gradually in the population.

1.3 – Baie de Seine

The annual sexual cycle is continuous, but some years a short rest stage appears in october. A strong gametogenesis takes place in autumn and winter and the maximal values of the GI are observed in mars or april. Spawnings are scattered from may to the next september or october, the main ones occuring in july and august. According to the year synchronism or asynchronism have been noticed. Minimal values of the G.I. correspond to the end of the reproductive season.

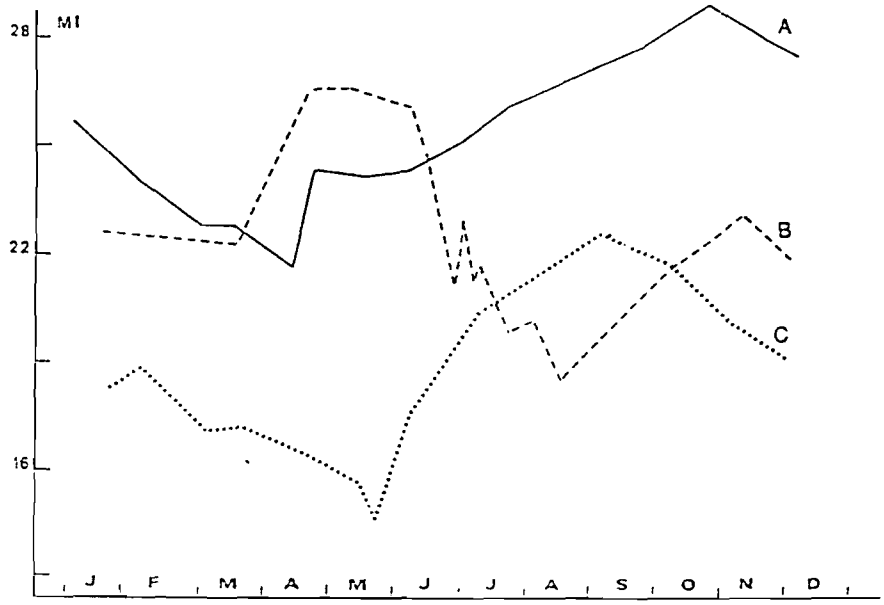

Figure 3. Annual variation of the muscle index (MI)

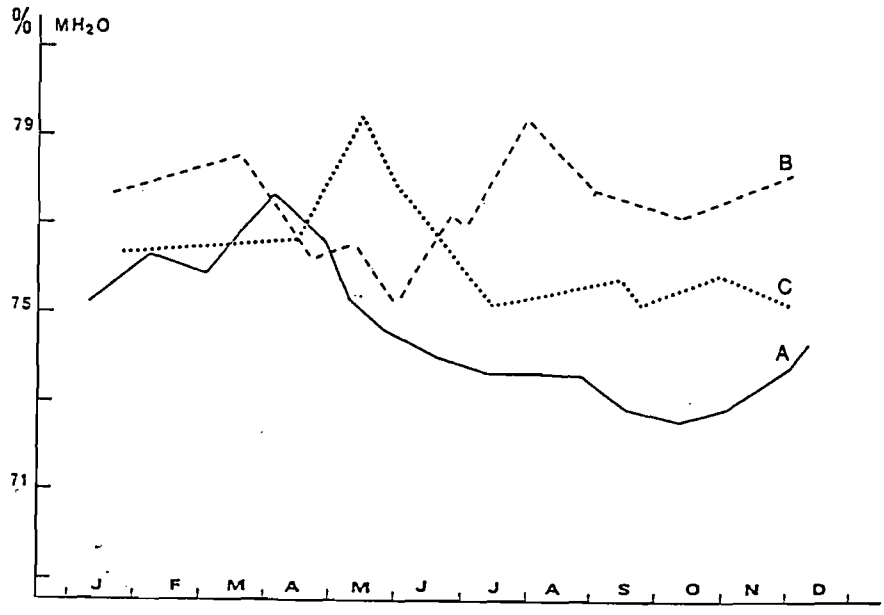

Figure 4. Annual variation of the muscle water content (% of the dry weight)
–A : Rade de Brest, –B : Baoe de Saint Brieuc, –C : Baie de Seine

2 – Annual variations of the water content of the gonad (figure 2)

A gross and synchronic spawning is followed by a sudden increase of this index, haemolymph taking the place of oocytes or sperm in the gonad tubules. A decrease indicates restoration, lower values being founded when animals are mature.

2.1 – The populations from the baie de St–Brieuc show two major periods of synchronic spawnings in july and august, maximal values of the gonad water content beeing observed during the winter rest stage.

2.2 – The gonad water content of scallops from the Rade de Brest shows low annual variations indicating asynchronic spawning scattered from spring to autumn. In the baie de Seine, the increase of the water content in september–october might indicate a short sexual rest period.

3 – Annual variations of the muscle index (M1) (figure 3)

3.1 – Baie de St–Brieuc : the maximal values are observed in april–may during the first phytoplancton bloom and when the gonad recovers (low values of the G.I.). The minimal values correspond to the end of the spaxning season, the muscle weight increasing in autumn.

3.2 – Rade de Brest and Baie de Seine : the annual variations are similar, the index values being lower in the populations from the baie de Seine. The minimal values have been noticed after winter, the muscular index increasing in spring and summer to maximal values in autumn.

4 – Annual variations of the muscle water content (figure 4)

In the rade de Brest and the baie de St–Brieuc, the variations of the muscle water content are opposite to those of the muscle index. In the baie de Seine, the water content increases after winter but remains nearly constant, throughout spring, summer and autumn.

5 – Annual variations of the muscle glycogen content (figure 5)

In the baie de Seine estimations of glycogen muscle content carried out during three years have shown that glycogen decreases in autumn and winter but recovers in spring, maximal values being observed in autumn.
These variations are similar to those of the muscle index and in spite of a restricted number of measurements it would be probable that in the rade de Brest and in the baie de St–Brieuc, the same relationship could be demonstrated.

DISCUSSION

1) In the three populations, the variations of the gonad and muscle index are opposite. The adductor muscle could play an important role as storage tissue in Pectinids (Ansell, 1974 ; Barber, 1983 ; Lubet et al., 1987–1989). The high values of the muscle index is depending on an increase fo muscle protein and lipid content (Faveris and Lubet, 1989). On the contrary the increase of the muscle water content would be the traduction of release periods of metabolites by the muscle.

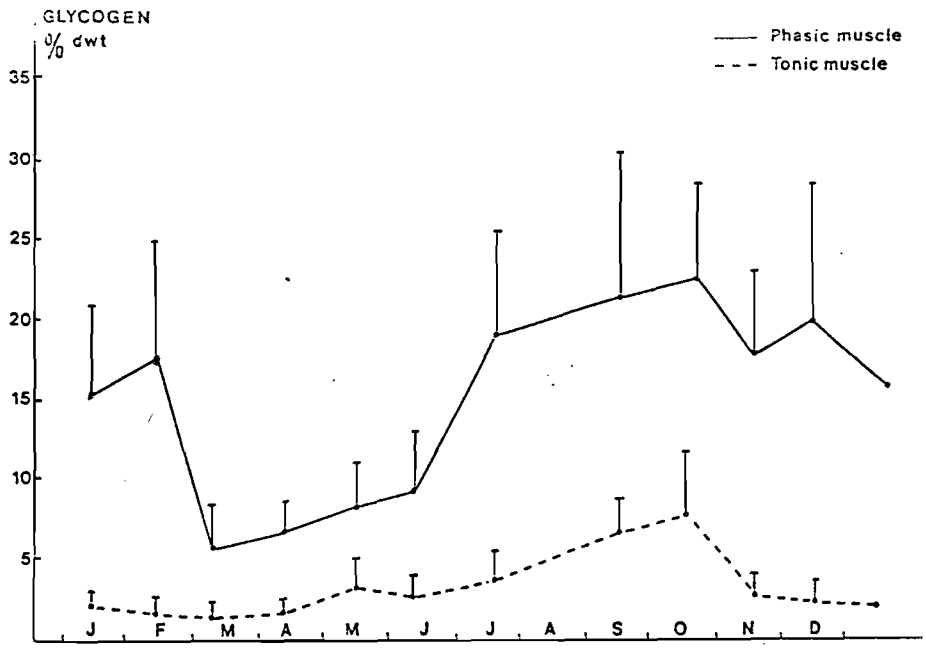

Figure 5. Annual variations of the adductor muscle glycogen content (Baie de Seine)

It is important to notice that in the same time, it has been found the lower values of the muscle glycogen content, as observed by EPP (1988) in Argopecten irradians for which the higher water content is linked with the degradation of glycogen liberating high quantities of water. Faveris and Lubet (1989) have shown that the variations of muscle glycogen content are similar to those of lipids and proteins muscle content.
The contribution of glycogen catabolism for reproduction and growth energy could be less important than it has been found in oysters and muscles ; fatty and amino-acids could play an important role in the needs requirements as it has been suggested by EPP (1988).
The decrease of glycogen could be in connection with the energy requiremnts involved in lipid and protein metabolism in the adductor muscle, amino and fatty acids being certainly an energy substrate in pectinids (Lubet et al., 1989).

2) The sexual cycle of the scallops from the rade de Brest and the baie de Seine shows great similarities : i) it is continuous throughout the year, ii) the maximum of the gonad index is observed at he beginning of the spring, iii) the spawning period lasts from spring to the end of summer. The same pattern has been described in all populations from Scotland, Ireland and Wales (rev. in Mason, 1983). However, the synchronic emissions of the end of spring seem to be the more favourable for a good recruitment. This "spreading out of the risks", obtained by numerous spawnings during the course of the year, will tend to diminish the probability of very low recruitments. This strategy must be considered as an opportunistic one.
Population from the bay of St-Brieuc being the exception (Paulet *et al.*, 1988), the gonad activity remains very low during autumn and winter, recovery occuring from march and maximum values of the gonad index being observed before the spawning period in july. The population spawns during a period which lasts from a few days up to three weeks. This "single trial" reproduction may lead to a highly variable recruitment. A similar annual sexual cycle has been described (Lubet, 1959) for *Chlamys varial L.*
The differences in reproductive activities can be the adaptive responses to different environmental factors and (or) the expression of genetic patterns.
Transplantation experiments of spat from rade de Brest to baie of St-Brieuc (Bueste et al., 1987) have shown that scallops when mature have the same reproductive cycle as found on the original site, that may be the expression of genetic differences. Moreover, Huelvan (1985) working on enzymatic polymorphism in Pecten maximus showed some characteristics specific to each population. Nevertheless, the maximal values of the gonad index of transplanted scallops are lower than those of animals from rade de Brest (Ansell *et al.,* 1988). These differences observed in this paper appeared to be a combination of genetic characteristics and of responses to environmental parameters, principally trophic ones. Such features might be taken in account in fishery management and aquaculture development strategy ; for example, the choice of strains for a restocking programm would prefer animal with an opportunistic reproductive type to ensure the most regular recruitment, also the analysis of the reproductive behaviour of experimental transplants can be an accurate source fo information for the qualification of potential sites for aquaculture.

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