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GONAD DEVELOPMENT AND FECUNDITY OF WHITEFISH, *COREGONUS LAVARETUS* (L. 1758) FROM THE POMERANIAN BAY

ROZWÓJ GONAD I PŁODNOŚĆ SIEI *COREGONUS LAVARETUS* (L. 1758) ZATOKI POMORSKIEJ

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The Pomeranian Bay whitefish migrate to the Szczecin Lagoon to spawn. Gonads begin to develop strongly a month before spawning. After spawning in late November – early December, gonad development is very slow; the gonads do not gain weight until the end of May next year. The absolute fecundity was found to range from 23.650 to 131.418 eggs. The absolute fecundity was observed to increase considerably with fish length, age and weight. The average relative fecundity was 45.721 eggs per kg body weight (including viscera).

INTRODUCTION

The first detailed studies on the Pomeranian Bay whitefish were made in 1956–1958 (Pęczalska, 1962). The rapid environmental deterioration and growing eutrophication constitute a serious threat to the whitefish and related species. For these reasons, an increasing attention has recently been focused on those fishes.

The recent (1983–1985) studies on the Pomeranian Bay whitefish morphology have suggested that the population consists of two plastic forms (Heese, 1987, 1990), which was confirmed by a 1988 study (Heese, unpubl.). On the other hand, growth rate and food analyses (Heese, 1988, 1989) failed to demonstrate any biological differences between the two forms.

The Pomeranian Bay is an area strongly affected by pollution brought in by the River

Odra via the Szczecin Lagoon. The latter is strongly eutrophic, but, owing to some special hydrological relationships between the Lagoon and the Bay, the whitefish is able to spawn in autumn – winter in the north-eastern part of the Lagoon. Observations on growth and food of the spawning whitefish allow to conclude on a possibility of an intensive culture of this valuable species in the area. At present, the annual harvest is about 3 tonnes and consists mostly of the spawning migrants.

In this context, detailed data on gonad development and fecundity of the Pomeranian Bay whitefish seem indispensable.

MATERIALS AND METHODS

The whitefish individuals examined were obtained from commercial catches made in the Pomeranian Bay and in the Szczecin Lagoon. A total of 252 females and males were examined between October 1983 and April 1985.

The extent of gonad development was assessed from the gonad maturity index (G):

$$G = \frac{W_g \cdot 100\%}{W_t}$$

where: W_g – gonad weight
W_t – total fish weight

The absolute fecundity was calculated for 73 females caught in autumn seasons of 1983 and 1984. Dried eggs, previously preserved in Gilson's fluid, were weighed to 0.1 g, a 300-egg sample being weighed to 0.0001 g. In the relative fecundity (no. of eggs per kg female body weight) calculations the total fish weight was used.

RESULTS

The data on fecundity and gonad maturation do not demonstrate any perceptible differences between the platic forms described in earlier works.

Fig. 1 shows changes in the gonad maturity index over two spawning seasons of 1983 and 1984. The lack of a complete year-round data set is related to the seasonality in whitefish fishing, although data collected before and after spawning clearly illustrate the nature of changes in the index.

In females, the index starts growing rapidly a month before spawning and continues to do so until the spawning begins (late November – early December), to decrease thereafter and remain unchanged until May. Presumably the index grows slowly throughout the remaining part of the year and increases rapidly again before spawning. A similar pattern is observed in males. The difference between females and males is seen during the pre-spawning season; the female index still grows at that time as opposed to that of males,

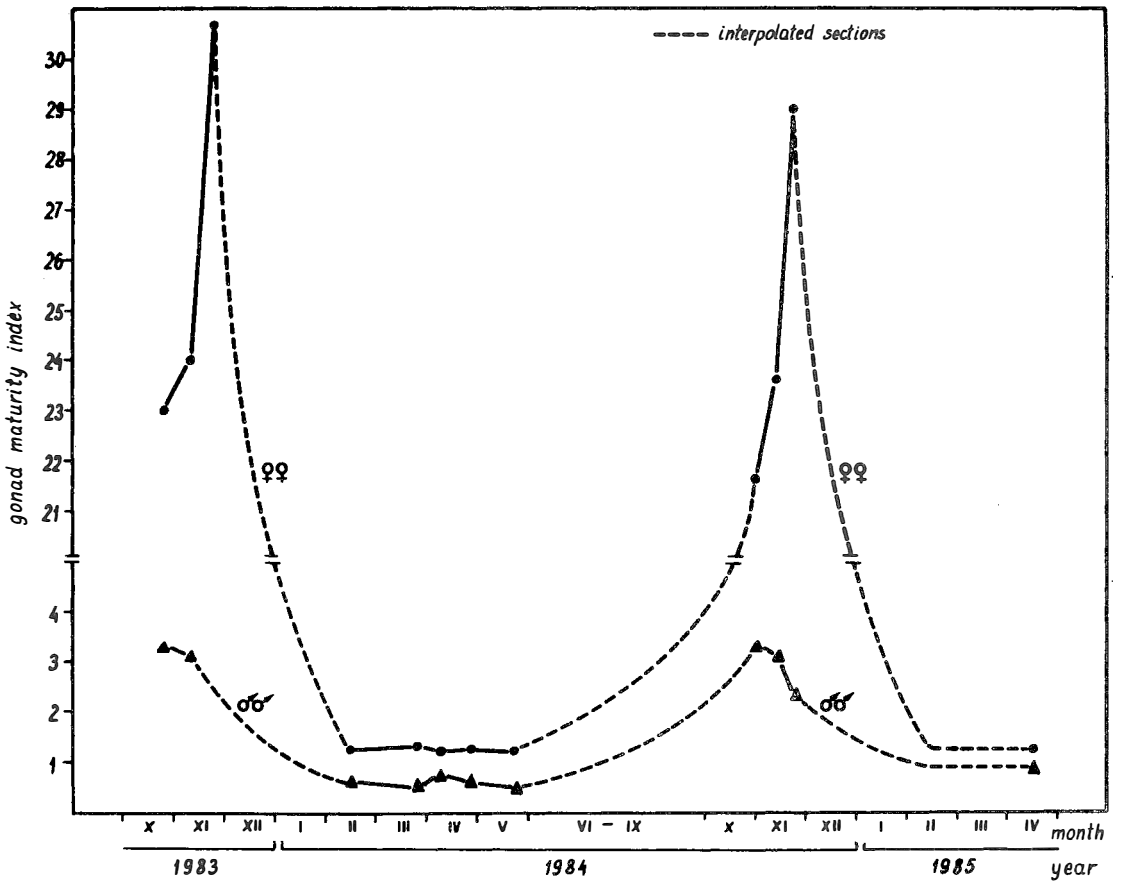

Fig. 1. Dynamics of gonad maturity index in whitefish-males and females

already decreasing. This is confirmed by the fact that the males caught at that time were already releasing sperm.

Asymmetry between the left and right lobes of the female gonad was frequently observed during the pre-spawning period. Usually the left lobe was shorter by about 15–20%. Spring samples (March, April) contained full or partly spent females and – less frequently – males at a similar stage. The partly spent females had regenerated ovaries the morphology of which was typical of the whitefish. One full female caught on 6 April 1984 measured (total length) 64.3 cm its gonads weighing 529 g.

The sample (n = 73) taken for fecundity calculations contained mostly females aged 2+; less numerous were age groups 3+ and 4+. The youngest and oldest females were aged 1+ and 10+, respectively. The fecundity data are presented in Table 1.

The absolute fecundity was found to correlate directly with the total length, age, and weight of fish. The respective relationships are shown in Figs. 2, 3, and 4. However, the oldest (10+) female was much less fecund than the 7+, 8+, and even 6+ females (Fig. 3).

The relative fecundity expressed as number of eggs per kg total female body weight ranged rather widely from 29.012 to 63.468. The changes, however, are neither total weight – nor fish length-dependent, but result from individual variability only. The gonad weight shows an exponential relationship with the total length (Fig. 5) and is directly proportional to the total fish weight (Fig. 6).

Table 1

Fecundity of the Pomeranian Bay whitefish

Character	Range	M	S
Weight (g)	765–2582	1409.9	457.8
Total length (cm)	39.5–59.2	47.9	4.6
Absolute fecundity (no. of eggs)	23650–131418	64945.6	24238.6
Relative fecundity (no. od eggs)	29012–63468	45721.2	6606.0

M – arithmetic mean
S – standard deviation

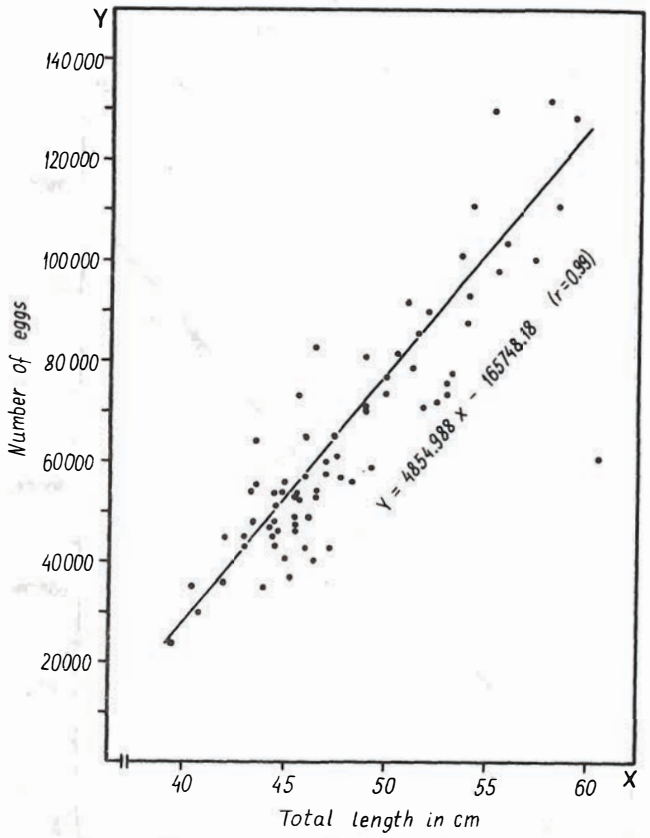

Fig. 2. Absolute fecundity vs. female total length relationship

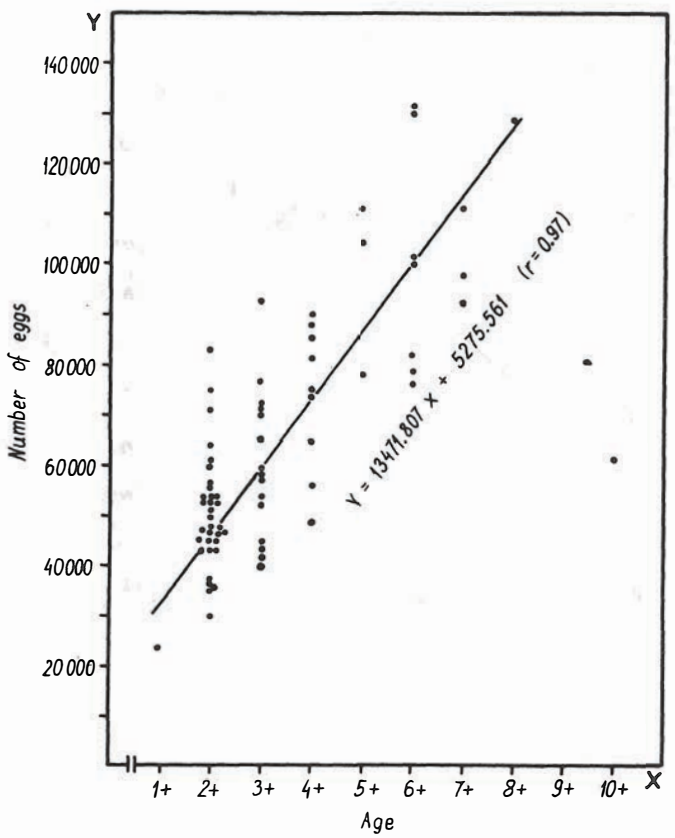

Fig. 3. Absolute fecundity vs. female age relationship

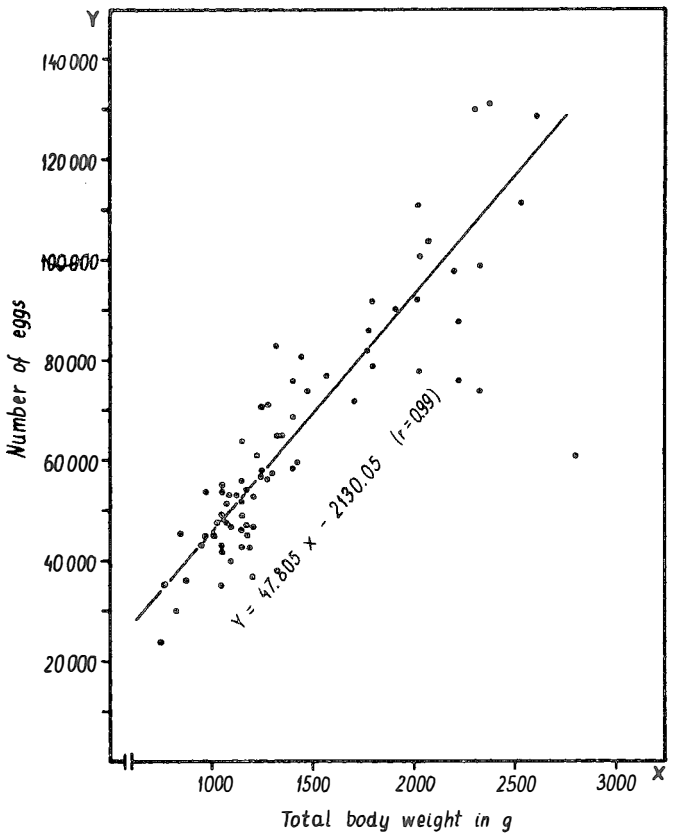

Fig. 4. Absolute fecundity vs. female total weight relationship

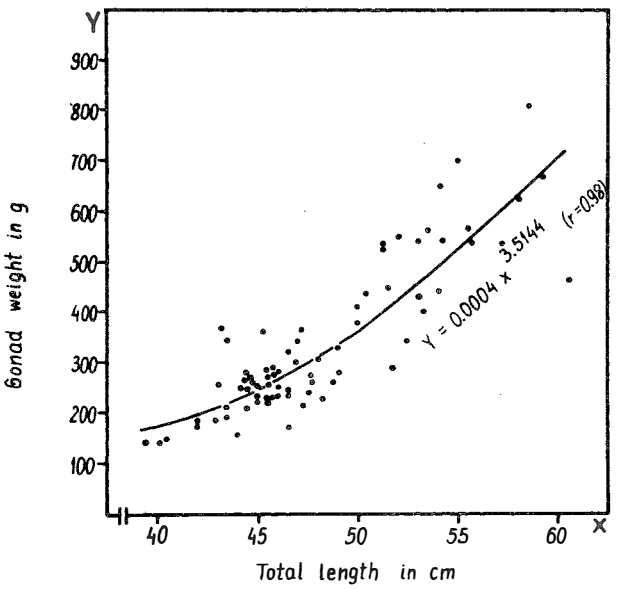

Fig. 5. Gonad weight vs female total length relationship

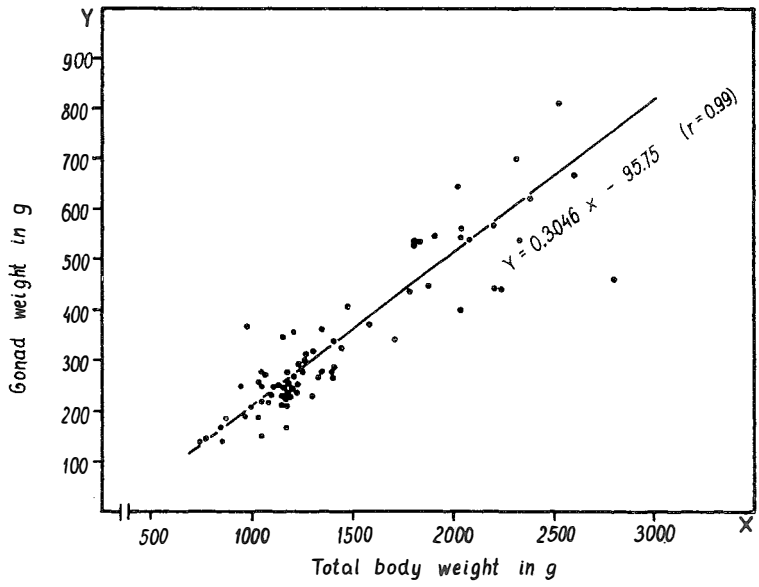

Fig. 6. Gonad weight vs. female total weight relationship

DISCUSSION

The fastest gonad growth begins just before spawning, in October and November, when mature whitefish aggregate in the Pomeranian Bay. After spawning in the Szczecin Lagoon, the gonads were basically resting until April or May. Their development starts anew, slowly at fisr, after the fish have returned to the sea, and intensifies again during the spawning migration. Similar observations were reported by Wilson and Pitcher (1983) who found the gonad maturity index of the whitefish in North Irish lakes to remain on a stable level within February – June. Subsequently, the index was growing slowly until October and increased rapidly in November and December, i.e., before spawning. The Lake Chun whitefish females (Rešetnikov, 1980) show a fast increase in their gonad maturity index to begin as eraly as in July, males displaying a similar timing of the increase in the index.

The Pomeranian Bay whitefish absolute fecundity is demonstrated to depend closely on fish length, age, and weight. All the three variables considerably affect fecundity. Usually, older females play a lesser role in reproduction of the species. The data obtained indicate an increase in fecundity until the age of 8+, reduced fecundity being observed in the oldest (10+) female only. Fecundity is presumed to decrease rapidly in the oldest females.

Very large differences between the present data and those of Pęczalska (1966) are evident (Fig. 7). One of the mechanisms underlying the pronounced increase in fecundity

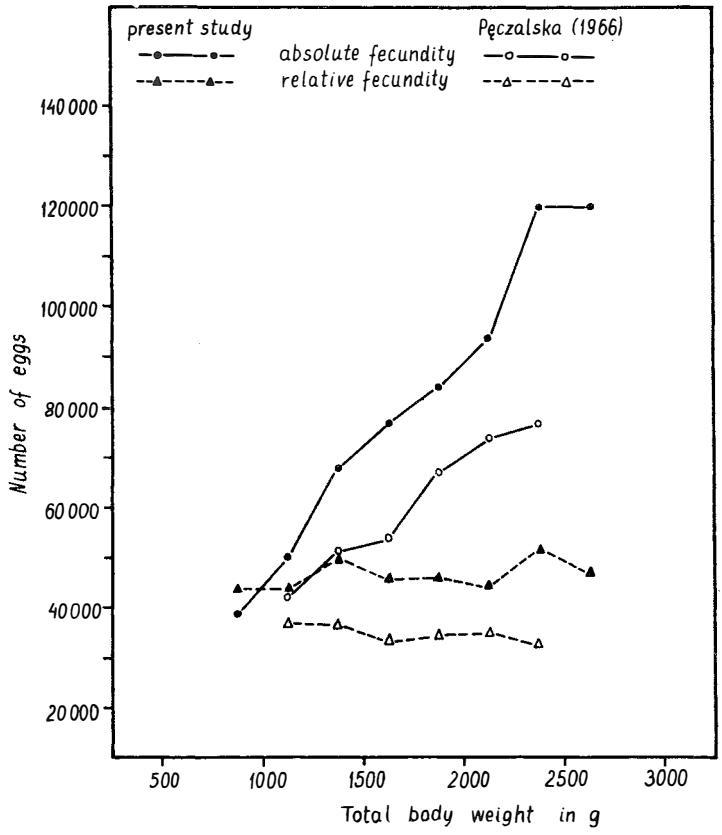

Fig. 7. Relationships between absolute and relative fecundities and fish total weight in the present study and in Pęczalska (1966)

of the whitefish studied here may be sought in the reduced abundance of the stock or increased food resources. In other animal groups, fecundity frequently increases as a result of reduced population abundance or environmental changes (Allee et al., 1958).

Based on the literature data and results obtained in this work, the relative fecundity of the Baltic Sea drainage whitefish is estimated at 20.000–45.000 (Kaj, 1955; Lindroth, 1957; Pęczalska, 1966; Gajgalas, 1972; Lehtonen, 1981). The highest relative fecundity was recorded in the Pomeranian Bay whitefish.

Environmental changes brought about by fast eutrophication have adverse effects on coregonid reproduction, which results in a reduced abundance of populations. This trend can be reversed by stocking only. On the other hand, increased fertility of a water body and larger food resources in it may have some advantages, too. Compared with data obtained 20 years ago (Pęczalska, 1962, 1966), the present-day Pomeranian Bay whitefish grow much faster (Heese, 1988) and feed intensively in the Szczecin Lagoon after spawning on attractive food such as small fish and chironomid larvae (Hesse, 1989).

These factors must have been involved in the increased fecundity discussed in this work. A comparison with earlier data provides insights into adaptive capabilities of the whitefish with respect to changing environment.

CONCLUSIONS

1. The Pomeranian Bay whitefish gonad development is strongly related to the migratory habits of the species.
2. The gonads grow at the fastest rate a month before spawning, during the fish migration from the Baltic Sea into the Szczecin Lagoon.
3. The gonads remain resting when the whitefish stay in the Lagoon after spawning.
4. The Pomeranian Bay whitefish absolute fecundity depends closely on fish total length, age, and weight.
5. Compared to other Baltic Sea drainage whitefish populations, the whitefish studied show very high absolute and relative fecundities.
6. Environmental changes recorded over the last 20 years and related to growing eutrophication adversely affect whitefish reproduction under natural conditions. Indirectty, however, the changes have enhanced fecundity by increasing food resources available to the whitefish.

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STRESZCZENIE

Badane sieje pochodziły z połowów gospodarczych prowadzonych na Zatoce Pomorskiej i Zalewie Szczecińskim (miejsce tarła). Ocenę rozwoju gonad, stosując współczynnik dojrzałości gonad, opracowano dla 252 sztuk samic i samców, pobranych w kolejnych próbach od października 1983 do kwietnia 1985. Płodność siei obliczono metodą wagową (n = 73) dla ikry konserwowanej w płynie Gilsona i wysuszonej.

Najszybszy wzrost gonad, jak się ocenia, następuje na miesiąc przed terminem tarła w czasie wędrówki z morza do zalewu. Z kolei w czasie pobytu siei, po tarle, w wodach zalewowych gonady znajdują się w stanie spoczynku i trwa to prawdopodobnie do maja.

Płodność absolutna siei Zatoki Pomorskiej wynosi około 24 000 do 131 000 sztuk jaj. Płodność względna obliczona dla masy ryb z wnętrznościami wynosi średnio około 46 000 i należy, według danych literaturowych, do najwyższej w zlewisku Morza Bałtyckiego.

W porównaniu z wcześniejszymi, 20 lat temu, badaniami nad płodnością siei Zatoki Pomorskiej zauważa się jej wyraźny wzrost. Obecnie sieje mają jednak większe przyrosty masy i długości. Cechy te zdecydowanie wpływają na płodność.

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