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RECRUTATION AND SETTLEMENT OF YOUNG FLOUNDER (*PLATICHTHYS FLESUS*) IN THE WESTERN PART OF THE GULF OF GDAŃSK (BALTIC)

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Key words: fish, inshore shallow waters, spatial and temporal distribution

Abstract

On a basis of whole year monthly sampling, the abundance of the flounder in inshore shallow waters of the western part of the Gulf of Gdańsk was established. Flounders were observed almost all year. Only in winter, when sea ice forming processes occurred, they disappeared from the investigated zone. The highest abundance of the flounder was noticed in Hel vicinity. No flounders were observed in inshore waters of the Puck Lagoon.

Young flounders occurred in the highest number in July (average for all investigated area amounted to 2.81 individuals×100 m^{-2}). In that month, this-year-born flounders settle in the inshore shallow water zone. The highest biomass was noticed in August (average 4.98 g×100 m^{-2}) when older bigger flounders more frequently inhabited inshore zone.

Body proportions of young flounders during their growth in inshore shallow waters of the Gulf of Gdańsk are stable. All measured distances were increasing linearly with the growth of flounder length.

INTRODUCTION

First two years of life of the flounder, when young individuals occur in an inshore zone, play the key role in their ontogenesis and importantly influence the structure of whole population (Berghahn 1987). The inshore zone is an area of intensive growth and a region of the biggest variability of environmental factors. During recent decades, anthropogenic factors have been added to natural

environmental diversity of the Gulf of Gdańsk (Pliński and Wiktor 1987). One of the important symptoms of these changes is the decrease in total fish biomass and the increasing role of flounder in biocenosis (Skóra 1993).

This study was aimed at answering some basic questions concerning the flounder from inshore shallow waters of the Gulf of Gdańsk:

- How big is the recruitment of young flounders in the western part of the Gulf of Gdańsk?
- Where are the main areas of settlement?
- How big flounders occur in the investigated area?
- How abundant are flounders compared to other fish species?

MATERIAL AND METHODS

The seasonal changes of abundance of the young flounder in inshore shallow waters of the Gulf of Gdańsk were recorded by regular sampling at 8 stations located along the shore of the Gulf of Gdańsk from Hel to Gdańsk (Fig. 1).

The sampling area is divided into two parts by under water sandy bar: inner shallow waters of the Puck Lagoon (with two sampling stations: Puck and Chałupy) and outer waters widely opened to the rest of the western part of the Gulf of Gdańsk. There is only one narrow, deeper connection between both parts (the Głębinka Deep near Rewa). The Puck Lagoon hydrology differs from that in the rest of the Gulf of Gdańsk. Salinity is there a bit lower (especially in early spring after snowy and icy winter). Bigger year amplitudes of temperature are observed. Temperature is lower in winter and higher in summer than in other parts of the Gulf (Nowacki 1993). Compared to other regions of the investigated area, sea ice is forming more often in winter (Szefler 1993).

Samples were collected monthly, during night (22.00-4.00) when, according to migratory behaviour, young flounder migrate to shore (Draganik and Kuczyński 1985, Malorny 1990). Two meters wide trawl with mesh size 6 mm and 1 mm mesh in the cod end was towed parallel to the shore, approximately at 1 meter izobath, on the distance from 150 to 400 meters. Additional samples were collected at Hel (the place of the highest flounder abundance in the investigated area). Two meter beam trawl (Kuipers 1975) with mesh size 6 mm was used in this case.

Collected material was preserved in 4% buffered formaldehyde, except for flatfish, which were preserved in 70% ethanol for future investigations of otoliths. After establishing taxonomy, all specimens were measured (L_t down to the nearest mm) and weighed (with 0.1 g accuracy). The abundance of each taxon for each sampling site in every studied month was calculated. The average numbers and biomasses for each month and the year averages for each station were determined.

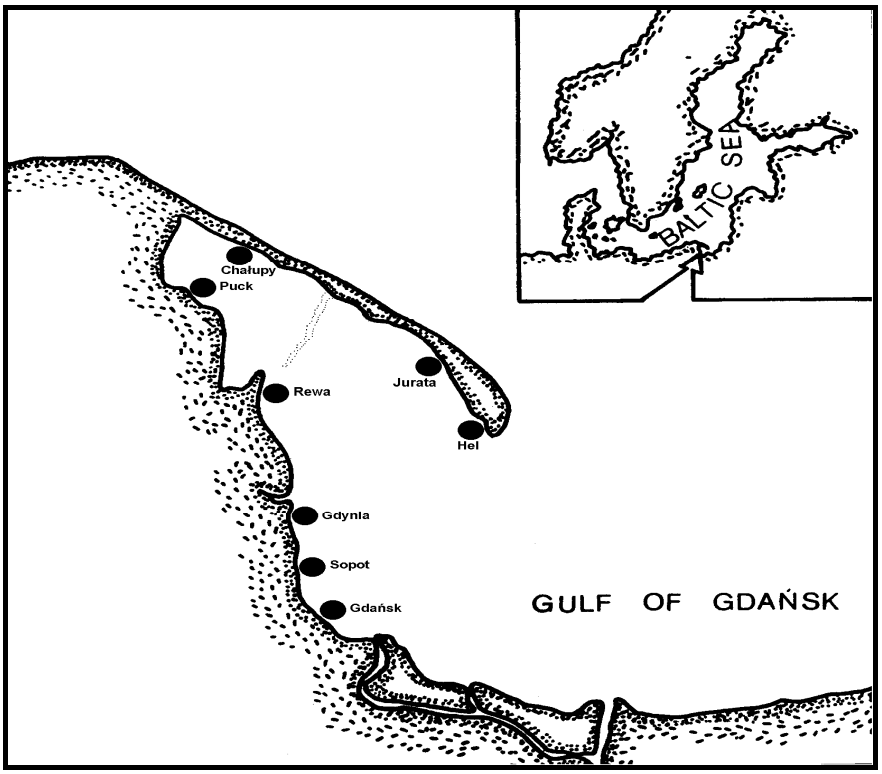

Fig. 1. Location of sampling stations

Totally 1005 flounders were fished. For 758 flounders additional morphological measurements were done (Fig. 2).

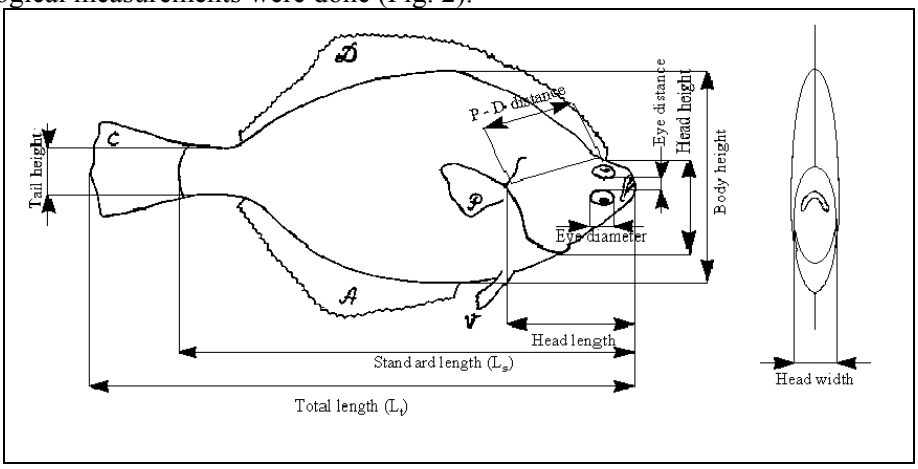

Fig. 2. Scheme of morphometric analysis of the flounder

Based on the collected material, spatial and temporal distribution of the flounder in the investigated area was established. Length and biomass distributions, as well as the correlation between these two variables and body proportions were also calculated.

RESULTS

SPATIAL DISTRIBUTION

The flounder occurred in all sampling stations except for those located in the Puck Lagoon (Fig. 3). The highest number and biomass of flounders were noticed at Hel (year average 1.88 individuals×100 m^{-2} and 4.83 g×100 m^{-2}, respectively). The highest percentage of the flounder was recorded also at Hel (the average yearly percentages amounted to 1.92% of number and 5.5% of biomass - Fig. 4).

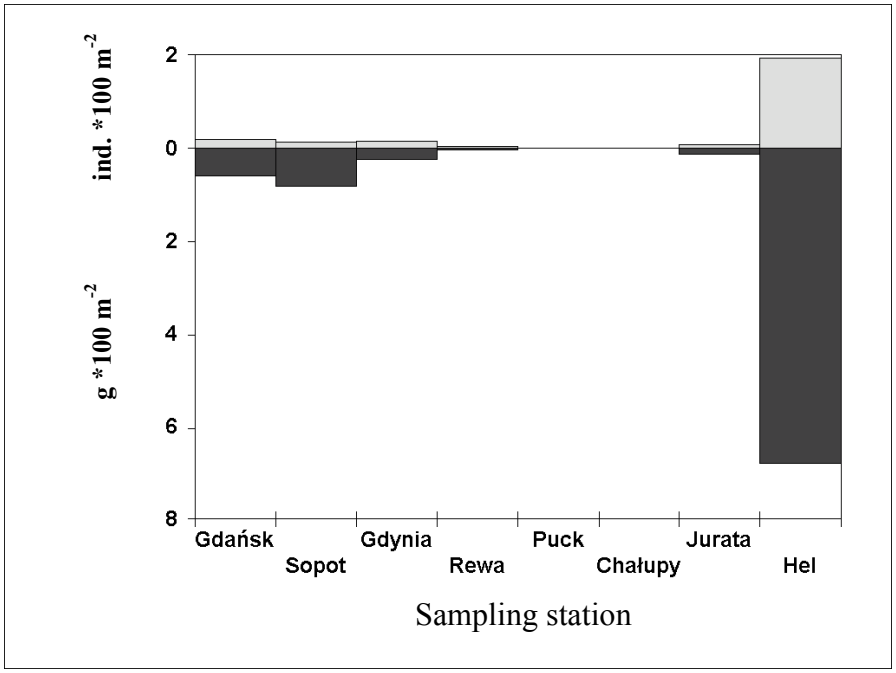

Fig. 3. Spatial distribution of young flounders in shallow inshore waters of the Gulf of Gdańsk

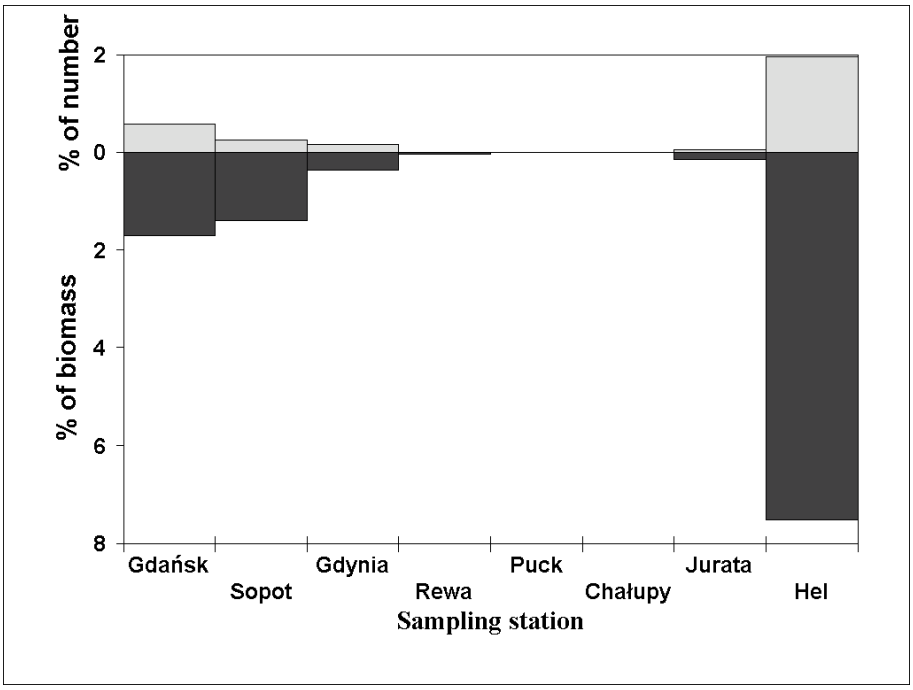

Fig. 4. Comparison of the flounder and the total fish number and biomass (spatial distribution)

TEMPORAL DISTRIBUTION

Flatfish occurred in the investigated zone almost all year (Fig. 5). Only in December and January, when sea ice forming processes were observed close to the shore, not a single flatfish was caught. The greatest abundance was noticed in June (averages for the investigated area were 2.81 individuals×100 m^{-2} and 4.4 g×100 m^{-2}). The maximum biomass was reached in September (4.98 g×100 m^{-2}). The temporal distribution of the percentage of young flounders in the investigated zone was similar to the distribution of this fish number (Fig. 6).

LENGTH

In the investigated material, flounders from 8.85 to 220 mm of the total length were found. The average length amounted to 46.2 mm (S.D. 26.8 mm). The greatest abundance was noticed in the case of 25 - 30 mm length class (18.01%, Fig. 7). The smallest individuals were observed in June (Fig. 8). In earlier months, individuals of 40 - 60 mm of the total length were caught. Distinct shift of maximum frequency of the smallest flounders, one length class per month, was observed. It was possible to observe this shift up to 35 mm of the total length, then interference from lengths of older flounders occurred.

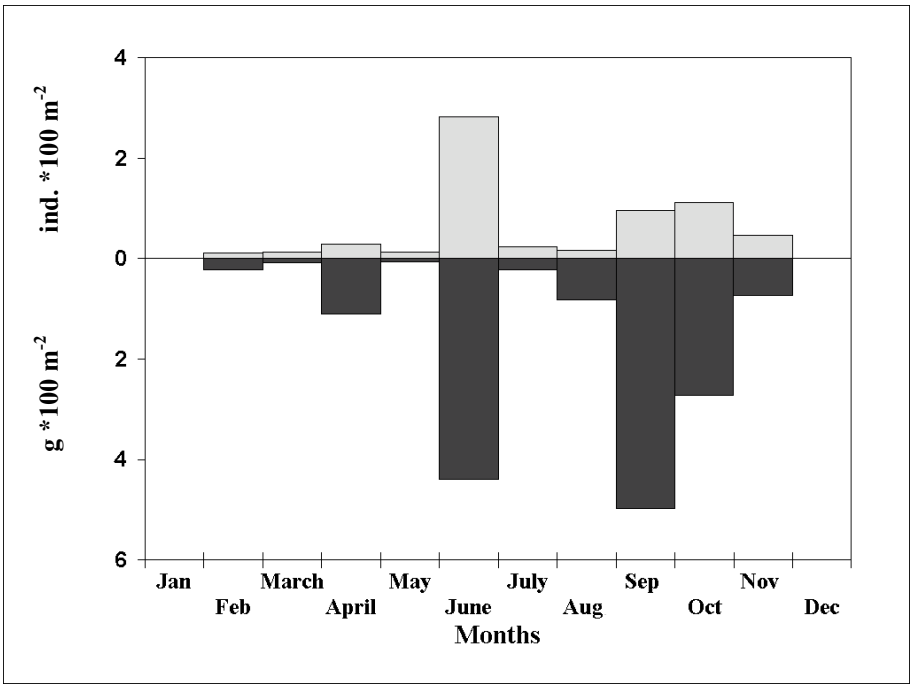

Fig. 5. Temporal distribution of the young flounder in shallow inshore waters of the Gulf of Gdańsk

Flounders of 35 - 75 mm of the total length were present in all samples collected from May to October.

WEIGHT

The collected flounders weighed from 0.01 to 101.6 g (Fig. 9). The average weight was 2.6 g (S.D. 7.35 g). The most abundant was the flounder of weight below 0.5 g. The highest frequency occurred in the case of 0.2 - 0.25 g class.

CORRELATION BETWEEN WEIGHT AND LENGTH

The strong exponential correlation between weight and length was observed (Fig. 10).

BODY PROPORTIONS

Relations between all measured distances of flatfish body were statistically significant (correlation > 0.9) and all of them displayed linear character. Total and standard lengths turned out to be the best correlated variables. Eye parameters were related closer to body weight than to other distances. The distance between eyes was a variable whose correlation with other parameters was the lowest (Fig. 11).

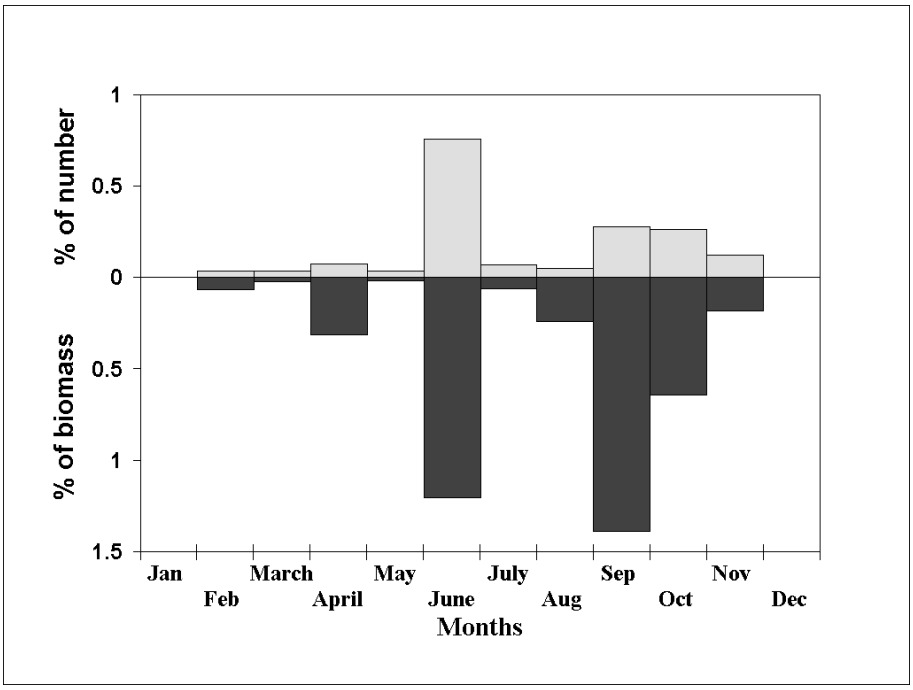

Fig. 6. Comparison of the flounder and the total fish number and biomass (temporal distribution)

DISCUSSION

The character of bottom sediment plays an important role in spatial distribution of the young flounder. In the Puck Lagoon, mud and organic sediments cover about 25% of the bottom area (Musielak 1984). Flounders prefer another type of sediment, that is hard sands. Such sediments occur mostly in Hel vicinity, the place of the highest flounder abundance in the investigated region. Among the investigated stations, Hel represents the most open sea character. At this point, the distance from flounder spawning places is the smallest. All these factors result in the highest flatfish abundance around Hel. Similar observations were made in the Gulf of Gdańsk previously (Malorny 1990). In 1948-53, the big concentrations of young flounders around the entrance to the Puck Lagoon (Rewa) were noticed (Mulicki 1955).

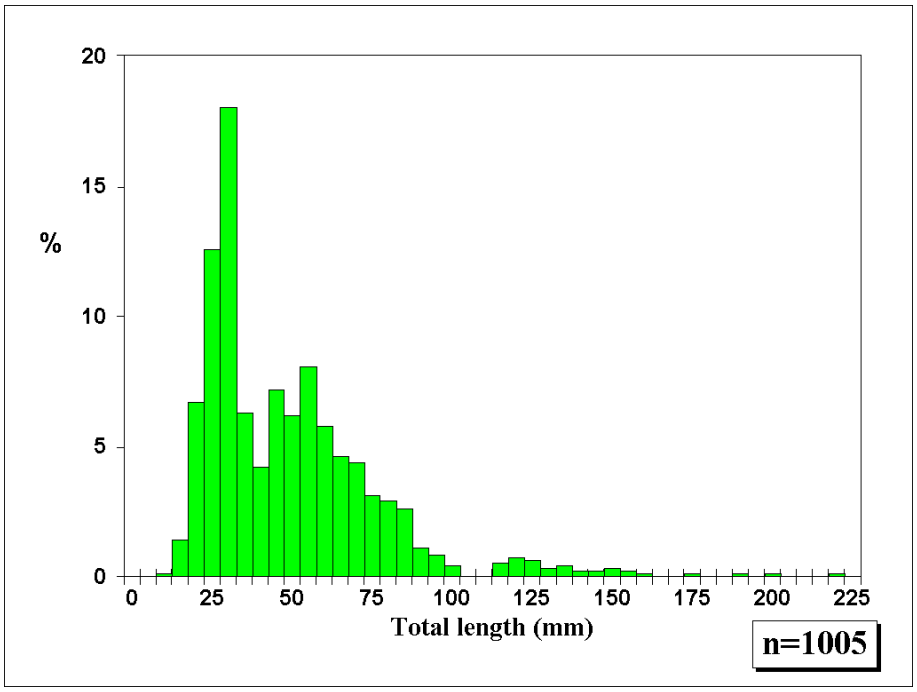

Fig. 7. Frequency, in length classes, of flounder from shallow inshore waters of the Gulf of Gdańsk

The highest abundance of flounder in the investigated zone was recorded in June. In this month, small this-year-born individuals enter the shallow inshore waters of the Gulf of Gdańsk. In June, young flounders were appearing at all sampling stations except for those located in the Puck Lagoon. The highest biomass was noticed in September. The increase in number was not so distinct. At that time, older heavier individuals migrate to warm shallow waters of the Gulf of Gdańsk.

Disappearance of the flounders in winter months was correlated with sea ice forming processes in the inshore zone. Generally, the amount of fish during winter time was very low (Sapota and Skóra 1996). However, it must be stressed that occurrence of the flounders in inshore shallow waters is strongly influenced by weather conditions. Even small sea raffles can push young flounders away from the shoreline (Mulicki 1955). Therefore, during collection of samples special care was taken to do all sampling in similar weather conditions.

The total length of flounders collected up till June/July exceeded 40 mm. According to observations on growth and age of flounders in the southern Baltic (Cięglewicz *et al*. 1969, Draganik and, Kuczyński 1985), specimens of such length are 1 year old. Metamorphoses in the flounder take place in individuals 15 - 18 mm long (Russel 1976). Such flounders are observed in the beginning of

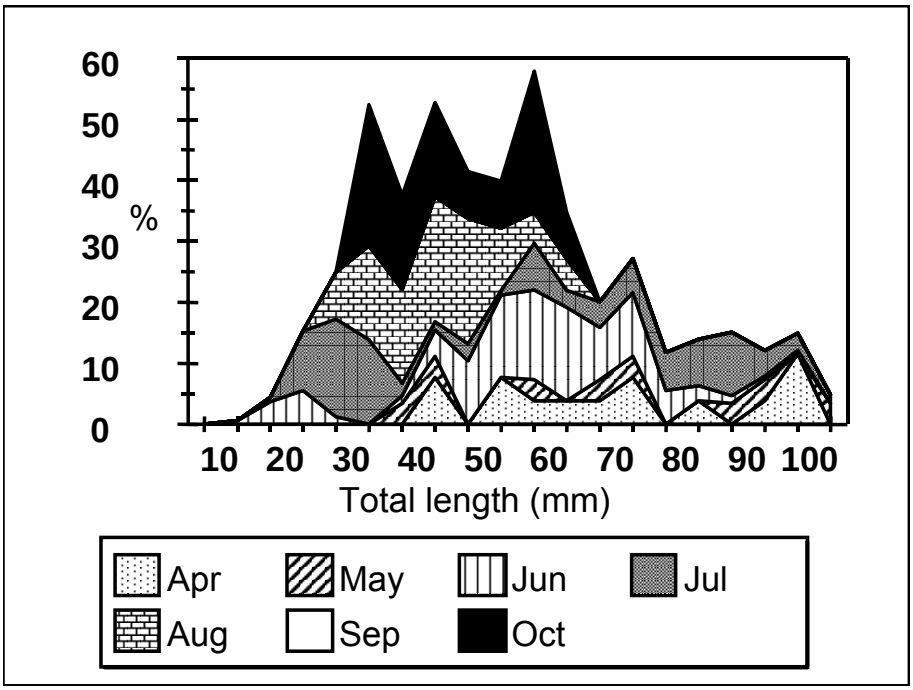

Fig. 8. Monthly frequencies, in length classes (up to 100 mm), of the flounder from shallow inshore waters of the Gulf of Gdańsk

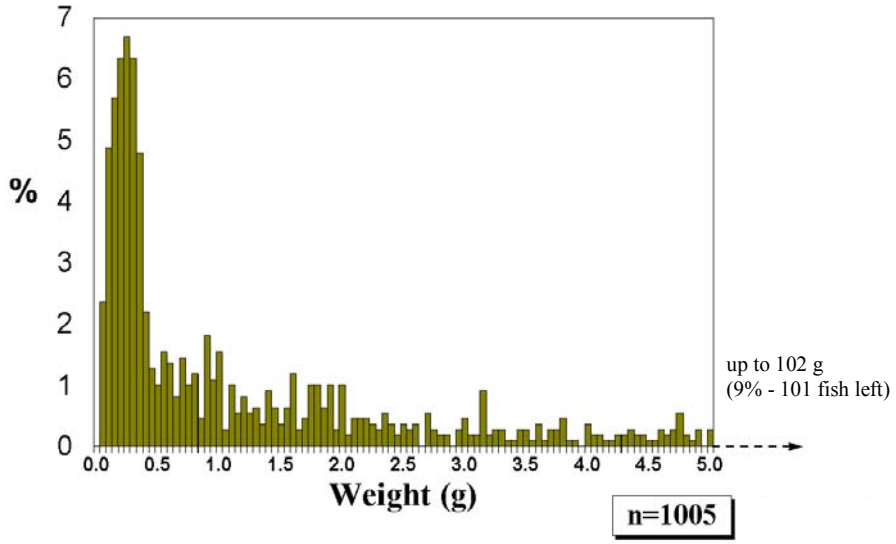

Fig. 9. Frequency, in weight classes, of the flounder from shallow inshore waters of the Gulf of Gdańsk

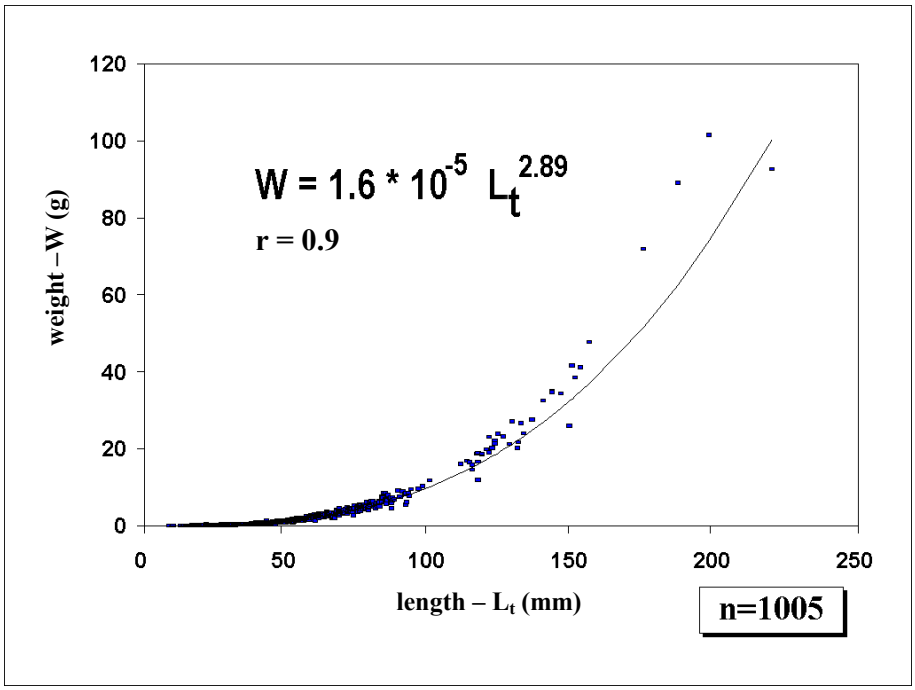

Fig. 10. Correlation between length and weight of the flounder from shallow inshore waters of the Gulf of Gdańsk

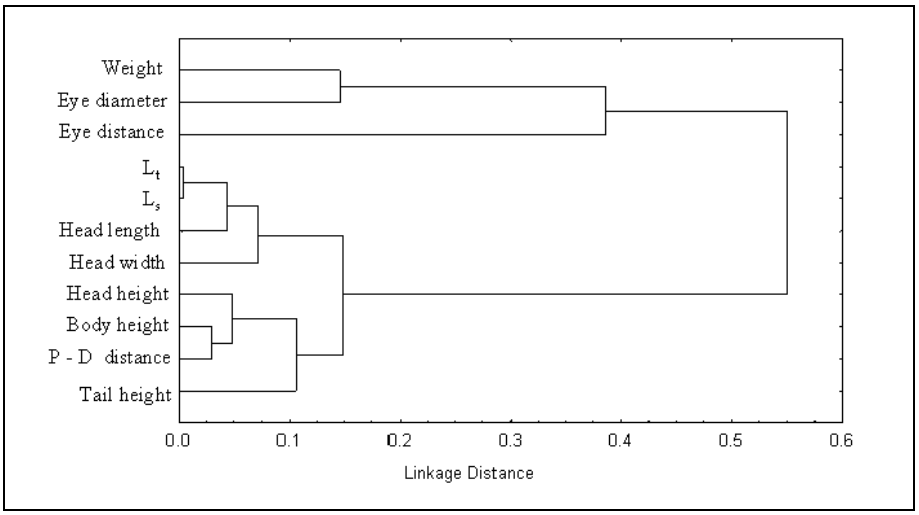

Fig. 11. Statistical connections between measured parameters of flounder body

summer. In inshore shallow waters of the Gulf of Gdańsk, they appear in greater numbers, when they reach 25 - 35 mm in length.

The observed big differences in length among flounders of the same age could be explained by a long period of flounders spawn in the Baltic and very big differences in individual rate of growth among young flounders (Draganik, Kuczyński 1985). Because of that, it is difficult to determine young flounder age based only on length measurements.

The rate of growth may differ considerably from year to year depending on weather conditions. The main factor influencing the growth of young flatfish in shallow water zones is water temperature (Kuipers *et al*. 1986). Comparing the data obtained during this study with results from about ten years ago (Malorny 1990), no important differences in growth rate could be seen.

The calculated exponential coefficient of correlation between length and weight is similar to that obtained for the young (0-year age group) plaice from Wadden Sea (Kuipers 1977). Ten years earlier, higher coefficient for the flounder from the same age group was computed (Draganik and Kuczyński 1985, Malorny 1990). The higher coefficient is characteristic also for the young flounder from the central part of the Polish coast (Szypuła and Załachowski 1975). Similarly to the plaice from Wadden Sea (Kuipers 1977), for older flounders from the Gulf of Gdańsk higher exponential coefficient (Cięglewicz *et al*. 1969) was obtained.

In the investigated groups of flounders, the total length and other measured distances grow linearly. No changes of obtained characteristics with flounder growth are observed. The lowest linkage distance between the total length and standard length is the confirmation of their very close relation. Very characteristic is the lack of relationship between parameters connected with eyes from other variables.

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