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Research Article

DO TWO SIMILAR LOOKING GOBIDAE OCCURRING IN THE GULF OF GDAŃSK DIFFER IN BIOLOGICAL CHARACTERISTIC? COMPARISON OF TWO SPECIES – *POMATOSCHISTUS MINUTUS* AND *POMATOSCHISTUS MICROPS*

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Abstract

In the Polish costal zone of the Baltic Sea two similar looking gobies – sand goby and common goby occur. In quantitative investigation both species are often taken as an one, because of difficulties in distinguish them. There are a few methods to differentiate sand goby and common goby - body pigmentation, shape of head and pigmentation of a spleen (Ławacz 1965). During the investigation it was proofed that compared species differ from each other also in biological characteristic. In the Gulf of Gdańsk spawning-season starts for sand goby in March and ends in September, for common goby it lasts from March to August. They have different sex ratio, but they have similar range of a HSI and GSI coefficients. Those differences and similarities are important for future investigations because they show that sand goby and common goby should be separated in studies.

INTRODUCTION

In the Polish zone of the Baltic Sea, six representatives of Gobiidae family occur (Żmudziński 1990; Gąsowska 1962; Horackiewicz, Skóra 1998). They are: sand goby - *Pomatoschistus minutus* (Pallas 1770), common goby - *Pomatoschistus microps* (Kröyer 1840), black goby – *Gobius niger* (Linaeus 1758), two-spot goby - *Gobiusculus flavescens* (Fabricius 1779), transparent goby – *Aphya minuta* (Risso 1810) and round goby – *Neogobius melanostomus* (Pallas 1811). Generally sand goby and common goby are the most abundant gobies in costal waters. They prefer expose sandy, exceptionally muddy or overgrown by marine plants bottom (Żmudziński 1990). Sand goby and common goby are euryhaline organisms. They occur in costal zone of the Baltic Sea, the North Sea, European costal water of the Atlantic and the Mediterranean Sea, common goby exist also in Ponto-Caspian region (Gąsowska 1962). Both species are often taken as one taxon in quantitative investigations because of similar appearance and the same place of existence (Morawski 1977; Morawski 1979; Horackiewicz, Skóra 1998). Exact taxonomic identification is possible after the ichthyologic analyses, when the spleen pigmentation is examinated. Sand goby has pigmented spleen (Ławacz 1965). Those species can also be recognizing by their characteristic pigmentation of body. *P. minutus* has five dark marks on the side and the last of them has shape of lying letter "T", but recognizing this could be difficult because this is not always visible (Żmudziński 1990). Moreover, common goby can be recognized by the shape of the head, which is elongated with rounded mouth. Another feature is that common goby has smooth edge of sucker while sand goby has a fuzz sucker (Gąsowska 1962).

Both sand goby and common goby are protected species in Polish waters of the Baltic Sea.

The seasonal migrations are characteristic for both species. In spring and summer they occupy shallow waters, down to a few meters depth, where temperature is higher. In autumn and winter they move into deeper part of the Baltic Sea to about 50 meters depth, where temperature is about 4^0C and is higher than on a surface (Hesthangen 1977, Morawski 1977). Reason for the other, not so far, migration is spawning. It takes place from March to September. Gobies migrate to deeper (few meters) waters to protect their eggs off waves impact. Sand goby and common goby lead active way of life, often changing place of their stay (Żmudziński 1990). *P.minutus* and *P.microps* feed on similar nourishment, mainly consisting of Harpacticoida, Ampipoda, Gammaridae and Isopoda. Their diet could be different in other regions were sand goby and common goby exist.

The aim of this study is to compare and contrast some of the biological aspects (length, weight, condition, reproduction) of two similar looking species. It could influence on future studies because sand goby and common goby have been identified to the genus level in most quantitative investigations. This analysis is made to prove that the differences between sand goby and common goby are considerable once.

MATERIAL AND METHODS

The investigated material was taken from the Gulf of Gdańsk (region of Sopot and Chałupy). Sand goby and common goby almost always occur in those regions together. Samples were taken from July 2001 to October 2002 excluding winter months when they were not collected because of stormy weather and ice cover. Fish were collected on 1 meter depth, on a distance of 100 meters, using towing-net (mesh size 6 mm, 1 mm in cod end) with 2 meters wide opening. Caught fish were preserved in 4% buffered formaldehyde.

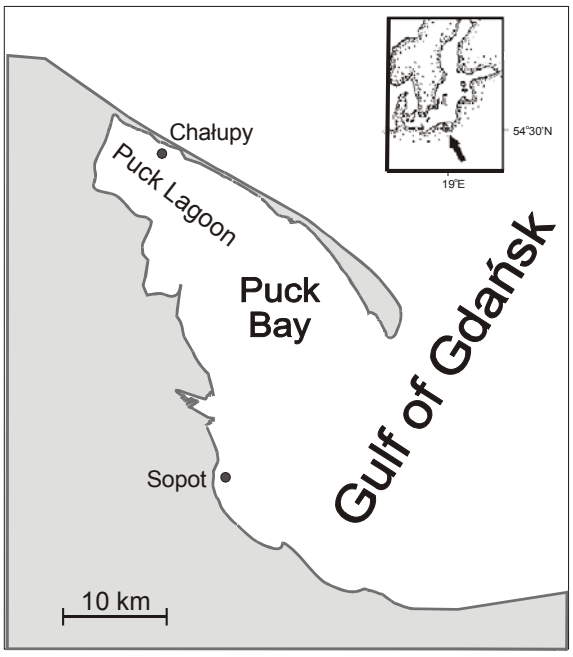

Fig. 1. Location of sampling sites

They were identified taxonomically, measured with 1 mm precision, weighted with and without viscera with 0.0001 g precision, sex was recognized by the shape of urogenitall papilla or by the appearance of their gonads. The

gonad development was specified in 5 stages of Nikolski's scale (Opuszyński 1979). Gonads and liver were weighted with 0.0001 g precision. Numbers of eggs in female gonads were counted using quantitative-gravimetric method (Ricker 1975). Subsequently the absolute and relative fecundity was calculated. Gonadosomatic index – GSI was determinated to estimate the ratio of gonad weight to weight of whole fish. In the case of the hepatosomatic index – HSI, the liver weight was related to the total fish weight. Moreover, condition factor K (Fulton), condition factor C (Clark) and relation between length and fish weight were calculated (Ricker 1975).

RESULTS

Both species were collected in the same time and in the same places, because they almost always occur together. The longest fish among *Pomatoschistus minutus* achieved 65 mm while *Pomatoschistus microps* 62 mm. The smallest caught fish had 17 mm for common goby and 10 mm for sand goby (Tab. 1). The Fulton condition factor for common goby is almost constant and there is no considerable change related to fish length. It is on a stable level of approximately 0.0008 for fish which total length is above 22 mm. Similarly, for sand goby there are stable values of Fulton condition factor for individuals with length greater than 25 mm. For common goby it decreases from August to September and than it is on a stable level to June. The most diverse values are in August and September: from 0.0005 to 0.0011. Sand goby has the biggest span of Fulton factor in September and its values range from 0.0005 to 0.0010. From March to August condition factor is on a stable level (Fig. 2).

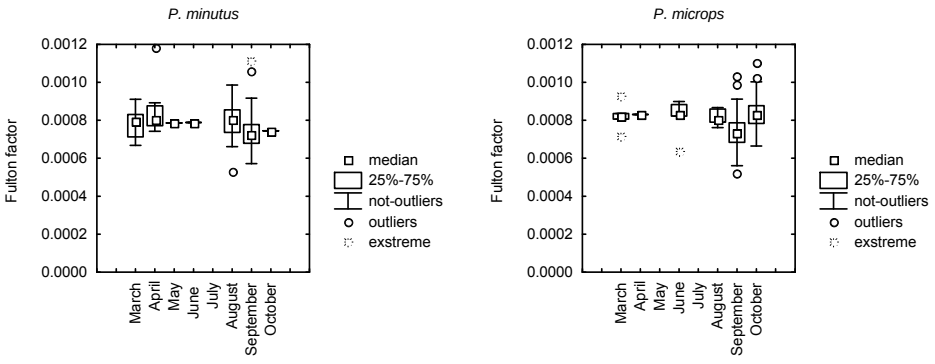

Fig. 2. Seasonal changes of Fulton condition factor

For both species the value of Clark condition factor is not depending on total fish length. Value of this factor is on approximately constant level from 0.0006 to 0.0007 for common goby and between 0.0005 and 0.0008 for sand goby. Values of Clark factor decrease from October to September for *P.microps*. There is no such relation for *P.minutus*. (Fig. 3).

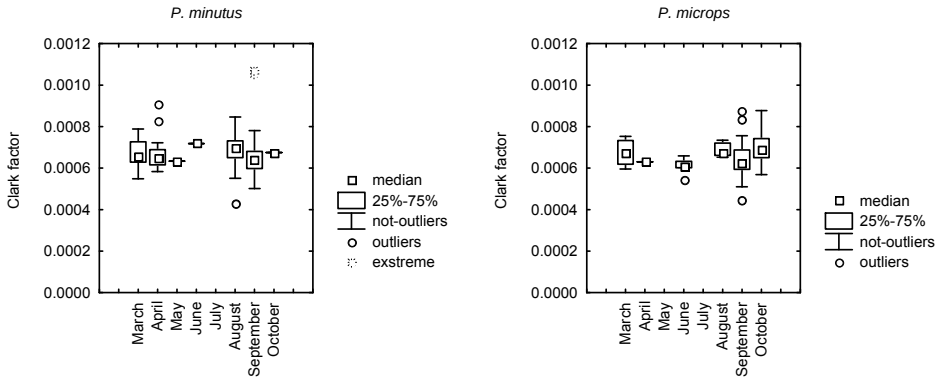

Fig. 3. Seasonal changes of Clark condition factor

Table 1

Comparison of biology attributes of *P. minutus* and *P. microps* from the Gulf of Gdańsk

variables	*P.minutus*			*P.microps*		
	Female	Male	Undefined	Female	Male	undefined
maximum total length minimum total length (of caught fish)	65 mm 30 mm	58 mm 31 mm	10 mm	62 mm 38 mm	54 mm 29 mm	17 mm
dependence between mass and length (values of Lagler expotential coefficient)	female and male female male		3.25 3.08 3.28	female and male female male		3.10 3.11 3.01
dependence between mass without viscera and length (values of Lagler expotential coefficient)	female and male female male		3.10 2.98 3.28	female and male female male		3.05 3.08 3.13
spawning period	March - September			March -August (Ławacz 1965)		
relative fecundity	722 – 3955 41 < Lt < 65			716 – 3885 52 < Lt < 62		
absolute fecundity	422 – 4990 41 < Lt < 65			1425 – 4482 52 < Lt < 62		
males : females sex ratio	1.7 : 1			2.3 : 1		

Values of hepatosomatic index for sand goby males are decreasing from March to June. In August index has the biggest values – from 1.12 to 4.41. Females have higher values of HSI in April and August, smaller in March and September. Common goby males have the higher values of hepatosomatic index in August, about 4. For females decrease of values are not perceptible. In March and April, they are similar, in June rapid increase of HSI index (for one individual) to 11 is observed. In September it decreases to 3 (Fig. 4).

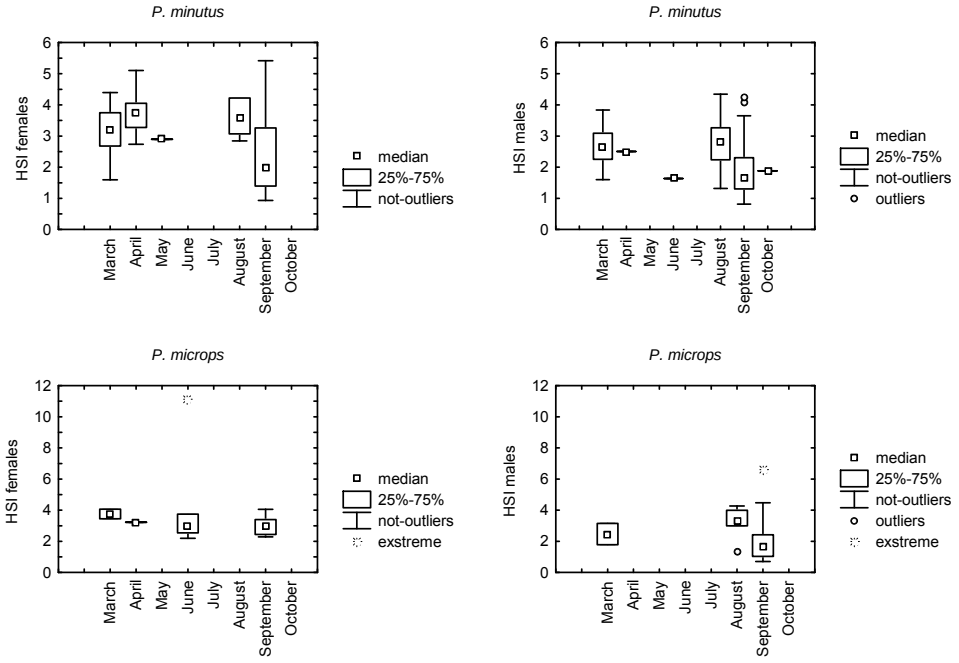

Fig. 4. The HSI index values in months of investigation

The gonadosomatic index for *P.minutus* is increasing from March to April, then it decreases in September. This situation is the same for males and females. For *P.microps* it is difficult to interpret the relation because of lack of mature fish (hard to recognize the sex)(Fig. 5).

For sand goby gonads are in last stage of development from March to May and in September, for common goby it is in March and April. *P. minutus* has also gonad in "4" stage of development in October (Tab. 2).

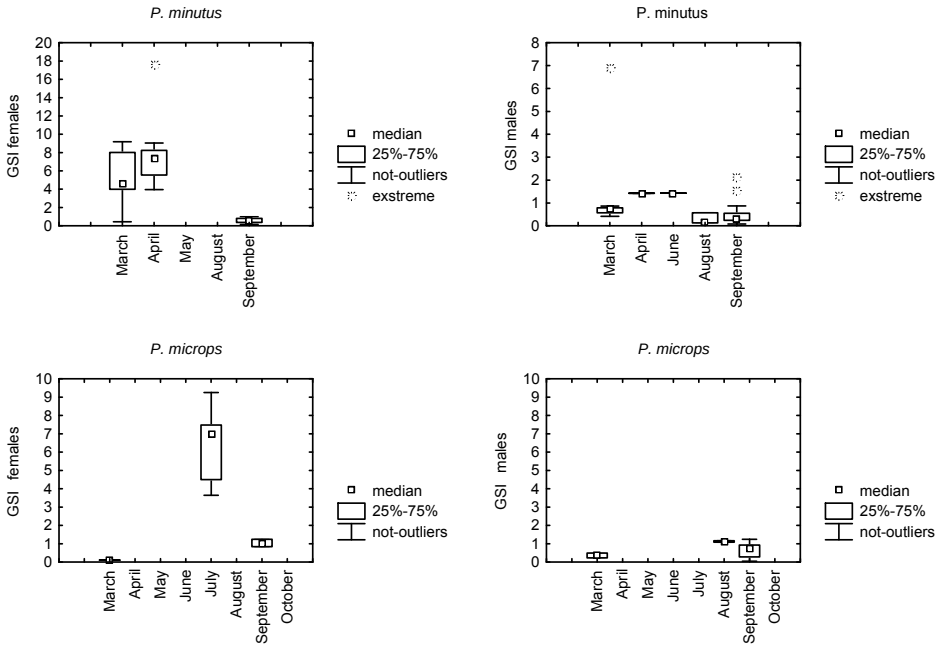

Fig. 5. The GSI index values in months of investigation.

Table 2

Seasonal changes of gonad development stage in Nikolski scale for *P. minutus* and *P. microps*

months	*Pomatoschistus minutus* stage of gonad development (Nikolski scale)					*Pomatoschistus microps* stage of gonad development (Nikolski scale)				
	„1"	„2"	„3"	„4"	„5"	„1"	„2"	„3"	„4"	„5"
March			**X**	**X**	**X**			**X**	**X**	**X**
April				**X**	**X**					**X**
May					**X**					
July				**X**				**X**		
August		**X**	**X**		**X**		**X**			
September		**X**	**X**	**X**			**X**	**X**		
October				**X**						

DISCUSSION

Individuals of both species where caught in shallow waters from 0 to 1 meter depth using the same towing-net. They almost always occur in the same time. There were only few exceptions when one of the species was present and another absent in the sample.

In earlier studies often both species were taken as one. Some of scientists considered them to be the same species, but *Pomatoschistus microps* was treated as the younger stage of *Pomatoschistus minutus*, because individuals of common goby are smaller than those of sand goby (Ławacz 1965).

In the Gulf of Gdańsk the major difference between sand goby and common goby is the size. *P. minutus* achieve bigger average lengths then *P. microps*.

For sand goby males the expotential Lagler coefficient has the same value independently if total fish weight or fish weight without viscera was taken into account. For males weight increases faster than length. For females dependence is slightly different because there is a distinction between expotential Lagler coefficients, when total weight and fish weight without viscera is taken into account. This could be caused by the weight of female gonads, which is meaningful especially before spawning time, when gonads are filling whole fish abdominal cavity. The difference between both coefficients is rather small and relationship is closed to isometric one. For common goby the biggest differences are visible for dependence between total weight and length for males and females (Wendt 2004). In contrasting to sand goby, the weight of common goby females increases faster than length. The reason could be that individuals from common goby are adapt to higher temperature and in the Gulf of Gdańsk they have to cumulate energy substances in bigger body mass in proportion to length (Morawski 1977).

Fulton condition factor for sand goby from length range between 10 and 25 mm achieve diverse values, but generally it increases with fish length. In realize analysis it is not state, for both sand goby and common goby that general regularity exists in changes of Fulton condition factor with increasing total length of investigated fishes. For older common goby individuals, bigger than 20 mm, this factor maintains on stable level. Similar situation takes place for sand goby, but the factor remains on stable level for organisms larger than 25 mm. For shorter fish, increase of Fulton factor with length is observed. Common goby achieve both the largest and the smallest values of the factor when fish length is small. This is a consequence of the most diversed growth during the first part of their life (Waligóra-Borek 2004). Values of Fulton factor for sand goby and common goby differ from each other in particular months.

August for *P.minutus* and September for *P.microps* are months when the range of Fulton coefficient is the widest. This is a consequence of coexistence of fish from generation I and generation II. Individuals born as a result of spawning-season in year 2001 will be named as generation I, while individuals from spawning-season in year 2002 – generation II. Individual which body length is short has higher value of condition coefficient. Those are fish, which hatch recently and use all energy for growth. Growth must be fast because of coming wintertime. After this period of time fish would not have much time to prepare to spawning-season, which starts in April and May (Gąsowska 1962). In winter, when they go to the deeper part of the Gulf of Gdańsk, their metabolism will slow down because of lower temperature. This will cause slower grown in wintertime – from November to February. Fish from generation I are not growing, it is connected with their biology – soon after the spawning-season they die. The largest values of Fulton factor for sand and common goby are observed from June to September, when young individuals of generation II occur.

Another way of checking condition is Clark factor, which takes into account the fish weight without viscera. Condition factor values for sand and common goby do not change in any characteristic way with the fish size. The widest range of values are noticed in August and September for sand goby and in September and October for common goby. This could be a consequence of existing in environment both generations - II (with higher values of Clark coefficient) and generation I (with lower condition).

The HSI index indicates if organism is cumulating energy before spawning or winter time, or it is using the energy (values are low during the reproduction time). The hepatosomatic index has wider range for sand goby males than for common goby males. For females situation is different because for common goby the lowest and highest values are bigger then for sand goby. For males from both species the biggest values are observed in March when spawning starts. Males cumulate energy because during the spawning they are guarding nests. They have no opportunity to regular feeding in this period. Females from both species can feed all the time during whole year including spawning-season. Males have smaller values of HSI in September when the spawning is ending, it is noticed for both species.

The values of gonadosomatic index indicate that both species are multi spawning organisms. The GSI values are decreasing gradually during the reproductive time. The maximum GSI values for common goby are much lower than those for sand goby, and the largest value was noticed in September when spawning ends. This is a male, which might not take part in spawning. Among both species there are individuals that behave as a sneaking males. They are

usually smaller and less likely to defend a nest and attract a female successfully. They interfere with spawning pairs, fertilize some of the eggs and leave (Svensson et al. 1998). Generally the GSI index has the biggest values in March when spawning starts. The GSI index lets to delimit when spawning starts and ends. For *P. minutus* gonads ready to spawn are recorded in March for the first time. They do not remain at this stage during all the spawning season. The last time when gonads are in "4" stage is September and this is a month when reproduction ends. In October one individual has gonads at "3" stage of gonad development, but this fish probably was not going to spawn because of the unfavorable environmental conditions (low temperature). *P. microps* also start spawning in March. It is confirmed by "4" stage of gonads development. Time of ending the reproduction is hard to recognize because of lack of individuals in August and September, but earlier studies place it in August (Ławacz 1965). In prior investigations it was found that sand goby starts reproduction in March and ends in August and common goby starts in March and ends in late August (Ławacz 1965).

Observation of gonads confirms that both species are multi spawners, because in gonads are eggs which have different sizes (Waligóra-Borek 2004, Wendt 2004).

In the investigated zone of the Gulf of Gdańsk, sex ratio is different for both species. There are almost two times more sand goby males than females and common goby males are more than two times abundant than females. For both species, April is a month when much more females than males are observed. They consists 93% (sand goby) and 100% (common goby) of individuals. Males are in deeper parts of water where they are guarding nests.

Absolute fecundity has different values for both species. For sand goby it is increasing with length and for common goby an opposite relation was observed, but for both species the absolute fecundity reach almost the same maximum values. In Atlantic area *P. microps* fecundity is lower then this observed in the Gulf of Gdańsk, while *P. minutus* presented an opposite relation (Bouchereau, Guelorget 1997). This comparison showed that those species have different reproductive preferences, which could be caused by different salinity and temperature regimes. Relative fecundity has similar values for both species and there is no correlation with fish length in the Gulf of Gdańsk region (Waligóra-Borek 2004). There is a large variability in biology for fishes belonging to this genus. In Atlantic area the maximum values are five times lower for sand goby and almost three times lower for common goby (Bouchereau, Guelorget 1997) in comparison to those of the Gulf of Gdańsk. Gobies reached larger sizes in Atlantic area, this could be a cause of smaller values of relative fecundity, because it expresses the dependence between a number of eggs and fish weight.

Individuals in that region are heavier, but they can have the same or similar number of eggs in gonads.

CONCLUSIONS

There are differences in biological characteristic between sand goby and common goby occurring in the Gulf of Gdańsk. They reach similar sizes – sand goby up to 65 mm while common goby up to 62 mm, but mean values of length are larger for *Pomatoschistus minutus*. They present a differnt sex ratio (females to males) – sand goby 1:1.7 and common goby 1:2.3. For common goby females the increase of total weight to length is larger, they also showed more diversed growth in first part of their life. Both species are multi spawners, they start spawning in the same month - March. For sand goby reproduction ends in September while for common goby spawning is finishing in August. The results confirm that those species should not be taken as a one group in future investigations because of the significant differences in their biology and possibly a slightly different role in the environment.

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