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Feeding activity and diet composition of round goby (*Neogobius melanostomus*, Pallas 1814) in the coastal waters of SE Baltic Sea

by

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Abstract

Feeding activity and diet composition of round goby were investigated in the south-eastern Baltic Sea, the Lithuanian coastal waters during May-October 2012 in order to determine main feeding objects and seasonal periods when native fauna could be most affected by predation of this highly invasive species. In total, prey represented by 18 taxa was found in the gut contents of dissected fish. Feeding activity of round goby varied depending on the body size, sex and stage of the reproduction period. The gut contents of <50 mm specimens were dominated by zooplanktonic and meiobenthic organisms, whereas larger individuals (50-99 mm) shifted to amphipods and mollusks. Individuals of the intermediate 100-200 mm length had a variable diet, changing depending on the season; in spring they mostly preyed on *Macoma balthica*, in summer – on polychaetes, while in autumn the contribution of *Mytilus trossulus* and fish considerably increased in their diet. Diet composition of individuals ≥200 mm was relatively constant in the course of the study with substantial preference to *M. balthica*. These findings imply that benthic fauna, particularly a newly settled generation of epibenthic mollusks in autumn is under strong predatory pressure of the round goby.

Key words: invasive species, food composition, seasonal variability, reproductive cycle

Introduction

The round goby (*Neogobius melanostomus*, Pallas 1814) is a small bottom-dwelling fish species, originating from the Ponto-Caspian region: the Black Sea, the Caspian Sea, the Sea of Azov and the Sea of Marmara. During the last 15 years, this fish colonized Laurentian Great Lakes (Jude et al. 1992), some of their tributaries (Phillips et al. 2003; Krakowiak & Pennuto 2008; Pennuto et al. 2010), the Baltic Sea (Corkum et al. 2004) and many Eurasian rivers (Copp et al. 2005). In the Baltic Sea, round gobies were first reported in 1990 from the Gulf of Gdańsk, near the harbors of Hel and Gdynia. Several years later their population significantly increased in numbers and began to spread to the other parts of the Gulf of Gdańsk, mouth of the Vistula River, adjacent canals, the Vistula Lagoon (Sapota & Skóra 2005) and successfully expanded to the south-eastern and northern Baltic coastal areas (Sapota 2004; Ojaveer 2006; Björklund & Almqvist 2010). The first specimen of round goby in the Lithuanian coastal waters of the Baltic Sea was captured in the vicinity of Klaipėda harbor in 2002 (Zolubas 2003). Within a decade from initial introduction, abundance of round goby increased dramatically, allowing this fish to become a key component of ichthyofauna in the Lithuanian aquatory, including adjacent waters of the Curonian Lagoon (Rakauskas et al. 2013).

Expanding population of round goby has a great potential to change invaded ecosystem reducing diversity and abundance of its feeding objects (Barton et al. 2005; Krakowiak & Pennuto 2008), competing for various resources with native demersal fish species (Balshine et al. 2005; Karlson et al. 2007) or becoming an important component in the diet of piscivorous fish (Almqvist et al. 2010; Płąchocki et al. 2012), birds (Bzoma 1998; Pūtys & Zarankaitė 2010) and mammals (Lundström et al. 2010). Round goby is a typical benthophagous fish, feeding predominantly on mollusks at the size of >100 mm (Skóra & Rzeznik 2001; Brush et al 2012), while individuals <100 mm consume mainly zooplankton and other soft-bodied prey (Walsh et al. 2007; Hayden & Miner 2009; Thompson & Simon 2014). Feeding habits of this species are opportunistic and flexible, reflected in highly variable prey composition, depending on the body size, the type of inhabited waterbody, biotope, diurnal and seasonal changes in the environment (Kornis et al. 2012).

Recently many researches on feeding ecology of round goby in European riverine (Kakareko et al. 2005; Borza et al. 2009; Polačik et al. 2009; Borcherding et al. 2013; Brandner et al. 2013; Vašek et al. 2014), estuarine (Rakauskas et al. 2008, 2013) and marine (Skóra & Rzeznik 2001; Wandzel 2003) ecosystems have been conducted. Only several of them, performed in lotic waterbodies, were focused on seasonal changes in feeding activity and diet composition (Borcherding et al. 2013; Vašek et al. 2014). No comprehensive research on the variation of seasonal feeding patterns in relation to the reproductive cycle has been performed in the Baltic Sea yet, which makes accurate evaluation of round goby impact on native zoobenthic communities difficult.

The goal of this study was to examine feeding patterns of round goby in the exposed coastal soft bottom area of SE Baltic Sea with an adjacent fragment of artificial hard substrate. The main objectives were:

(1) to determine changes in the feeding activity of female and male round gobies during different months and stages of the reproduction period;

(2) to evaluate seasonal and ontogenetic variation in the diet of differently sized individuals applying gut content analysis.

Materials and methods

Study site and sampling

This study was conducted in the south-eastern Baltic Sea, the Lithuanian coastal waters, close to the Klaipėda strait and harbor (56°43‘34“N, 21°04‘37“E). Seabed at the sampling site is dominated by soft and sandy sediments, strongly affected by wave action (Olenin & Daunys 2004), however, underwater harbor constructions and breakwater provide shelter and hard substrate for fish and invertebrates. Specific and variable environmental conditions determine high diversity and abundance of potential feeding objects for round gobies: soft sediments are inhabited by burrowing infaunal and actively swimming nectobenthic organisms (Olenin & Daunys 2004), whereas hard artificial substrates are colonized by sessile epifauna and seasonal algae (Olenin et al. 1996), used as refugia by mobile macroinvertebrates and fish fry.

Sampling was performed at 2-3 week intervals in May-October 2012, while in the other months, round gobies were absent at the study site. Fish were collected using multi mesh gill nets (mesh size = 17.5, 20, 38 mm) at depths ranging from 6 to 11 m within 12 h. Small round gobies usually inhabit shallower waters compared to large specimens (Kornis et al. 2012) and cannot be caught with gill nets, therefore baited minnow trap (70 cm length, 25 cm height and 2.5 mm mesh size) was placed at a depth of 2-3 m to collect <100 mm specimens. Dead Baltic herrings (*Clupea harengus membras*) were used as a bait. Trapping was possible only during low waving and was conducted daily under suitable environmental conditions by checking the trap, taking out all captured animals and changing the bait. Individuals <100 mm did not occur in the trap until late summer and were found in catches only in August-October (Table 1). All fish, selected for dietary analysis, were immediately frozen at a temperature of -20°C for further examination.

Laboratory analysis

After thawing, round gobies were measured to a total length (TL, nearest mm), weighted with an accuracy of ±0.01 g and sorted according 50 mm size groups (Taraborelli & Schaner 2002; Barton et al. 2005): TL <50 mm, 50-99 mm, 100-149 mm, 150-199 mm and ≥200 mm. If available, 10-15 randomly selected individuals were analyzed in each size group during a month period.

The alimentary tract from esophagus to anus of each examined specimen was removed, weighed while full and re-weighed when empty (±0.001 g) to obtain wet weight of the gut content. Feeding objects were identified to the lowest possible taxon, measured and counted under a stereomicroscope. Crushed mollusk shells and hulls of crustaceans were reconstructed from the particles whenever possible to gather taxonomically identifiable and measurable

Table 1

The total number of analyzed female (F), male (M) and juvenile (J) fish, percentage of empty guts and gonad maturity stages of matured round gobies captured during different months of the study

Month	Sex	No. of specimens	Empty guts		Gonad maturity stages (%)				
			No.	%	I	II	III	IV	V
May	F	40	3	7.5	-	-	40	60	-
	M	4	2	50	-	-	75	25	-
	J	-	-	-	-	-	-	-	-
June	F	27	2	5.4	-	-	44.4	55.6	-
	M	8	3	37.5	-	-	62.5	37.5	-
	J	-	-	-	-	-	-	-	-
July	F	35	4	12.1	-	8.6	11.4	20	60
	M	8	3	37.5	-	-	37.5	50	12.5
	J	-	-	-	-	-	-	-	-
August	F	20	4	20	-	55	15	-	30
	M	32	1	3.1	-	21.9	3.1	-	75
	J	26	1	3.8	-	-	-	-	-
September	F	8	2	25	-	100	-	-	-
	M	18	2	11.1	-	66.7	-	-	33.3
	J	22	2	9.5	-	-	-	-	-
October	F	13	2	15.4	-	100	-	-	-
	M	27	4	14.8	-	100	-	-	-
	J	24	1	4.2	-	-	-	-	-

parts of the ingested prey. In the case of a high digestion level, the number of consumed soft-bodied organisms found in posterior guts was determined based on characteristic structural elements such as mandibles and chaetae of polychaetes or telsons, legs and eyes of crustaceans (Skóra & Rzeznik 2001), considering their body length as an average length from all measured individuals of certain prey taxa found in the gut contents of dissected fish. Wet weight of each feeding object was determined using length-weight regression functions (Rumohr et al. 1987). A total of 312 round gobies were analyzed and 36 individuals with empty guts were excluded from the data analysis.

Variation in gonad maturity stages was examined monthly in order to follow the reproduction cycle. Sex of round gobies was determined visually according to the shape of urogenital papilae (Charlebois et al. 1997) and dissected gonads, while small individuals with indeterminable sex were considered as juveniles. Gonads were weighed (±0.001 g) and their maturity was evaluated under a stereomicroscope using the following descriptive five-stage scale (Tomczak & Sapota 2006).

Gonads of male round gobies were described according the following maturity scale:

I. Juvenile;
II. Clearly visible, light beige or slightly grey, not too supple;
III. Clearly visible, light beige color, but darker than in stage 2, supple;
IV. Clearly visible, darker than in stage 3, beige, grey-beige to grey with possible red staining on the edges, supple, engorged;
V. Spent (gonad empty).

Since female round gobies are batch spawners and their gonads contain eggs at higher and earlier developmental stages, maturity was determined according to the fraction of eggs at a higher developmental stage. Evaluation of female eggs' maturity was performed using classification suggested by Tomczak & Sapota 2006:

I. Poorly developed, yellow or pink, not clearly visible, sometimes difficult to determine the sex;
II. Small, grains visible, ovaries transparent;
III. Ovaries yellow or reddish, eggs not transparent, first hydrated oocytes;
IV. Very well-developed grains, eggs transparent, ovaries yellow or reddish, leakage stage;
V. Ovary almost empty with single egg grains, ovaries flabby, reddish.

Calculations and statistical analysis

The index of stomach fullness (*ISF*) (Hyslop 1980) was calculated for individuals >100 mm using the following formulas:

$$W_{prey} = W_{stomach\ \ full} - W_{stomach\ \ empty} \tag{1}$$

where: W_{prey} = weight of the prey items (g), $W_{stomach\ full}$ = weight of the full stomach (g) and $W_{stomach\ empty}$ = weight of the stomach without prey items (g) and

$$ISF = \frac{W_{prey}}{W} \times 100 \tag{2}$$

where: W = weight of the fish (g).

Contribution of each taxon in the diet of differently sized round gobies was determined using the Index of Relative Importance (*IRI*) (Pinkas 1971):

$$IRI = (\%N + \%W) \times \%F \tag{3}$$

where: $\%N$ = relative abundance; $\%W$ = weight; $\%F$ = frequency of occurrence of feeding objects in all examined alimentary tracts.

For multivariate data analysis and graphical presentation, feeding objects were classified into 12 prey categories: *Macoma balthica*, *Mytilus trossulus*, Cladocera, Copepoda, Ostracoda, Amphipoda (*Gammarus* sp. and *Corophium volutator* combined), *Crangon crangon*, *Saduria entomon*, *Balanus improvisus*, Polychaeta and Pisces. Rarely occurring food items such as *Cerastoderma lamarcki*, *Mya arenaria*, *Hydrobia ulvae* and *Neomysis integer* were pooled and considered as other prey. Non-metric multidimensional scaling (NMDS) analysis was employed to demonstrate dissimilarities in the diet composition among round gobies belonging to different size groups. Permutational one-factorial ANOVA (PERMANOVA) (Anderson 2001) with a random subset of 999 permutations was used to test the influence of season on the diet of each size group individually. Prior to the statistical analyses, the data on biomass of all 12 major prey categories found in the examined alimentary tracts were standardized by total gut content biomass and square root-transformed to reduce the effects of outliers. Similarity matrices were conducted using the Bray-Curtis similarity coefficient. Multivariate analyses were performed using PRIMER v. 6 software (Clarke & Gorley 2006). Seasonal variation in the diet of round goby was analyzed further by using weight percentage (%*W*) contribution of different prey taxa (Hyslop 1980). All samples were combined according to spring (May), summer (June-August) and autumn (September-October) seasons.

Results

Feeding activity

Three reproduction periods were distinguished according to the dominant gonad maturity stages: pre-spawning (III and IV maturity stages) took place in May and June, the peak of spawning event (V maturity stage) was recorded in July and August, while September and October (II maturity stage) were considered as a post-spawning period (Table 1). The reproduction period had a major impact on feeding activity of male round gobies, while females were less affected. Feeding activity increased from pre-spawning (May) to post-spawning (September) four times in females, whereas it was more constant in males. The lowest values of the stomach fullness index for male round gobies were recorded in July, before and during the spawning (Fig. 1).

Seasonal and ontogenetic variation of the diet composition

The NMDS analysis demonstrated that diet composition of <50 mm and 50-99 mm round gobies considerably differed from the ration of larger fish (Fig. 2). The most important feeding objects for <100 mm round gobies were ostracods, cladocerans, copepods, amphipods and small specimens of *M. trossulus*. Larger (≥100 mm) individuals consumed mainly bivalve mollusks *M. balthica* and *M. trossulus*, polychaetes and fish with a secondary importance of crustaceans: amphipods, brown shrimps (*C. crangon*), barnacles (*B. improvisus*), isopods (*S. entomon*) and mysids (*N. integer*) (Table 2).

As indicated by PERMANOVA, prey composition of <50 mm, 50-99 mm and ≥200 mm round gobies was relatively constant in time, while 100-149 mm and 150-199 mm individuals had more variable

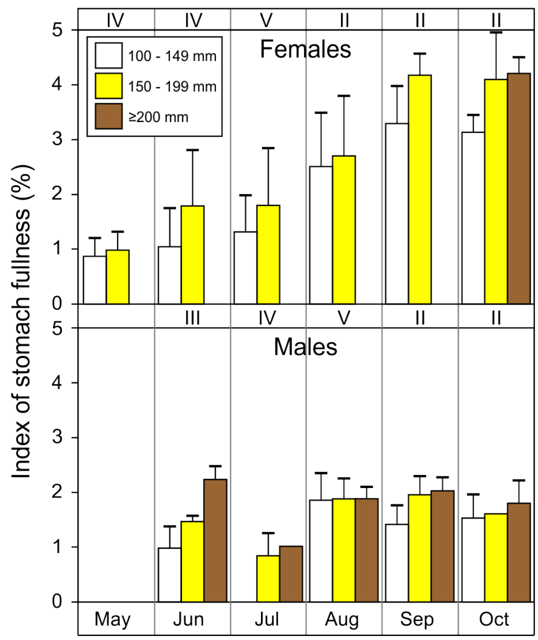

Figure 1

Changes in the index of stomach fullness (mean ± standard deviation) values and dominant gonad maturity stages of differently sized female and male round gobies during May-October

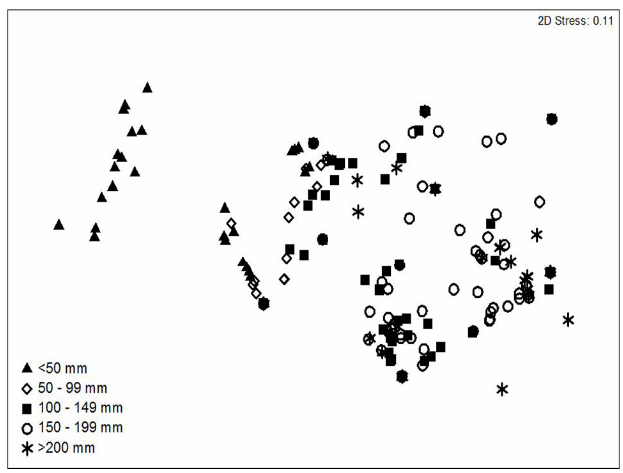

Figure 2

NMDS ordination plot of biomass of prey items, found in the gut contents of differently sized round gobies

Table 2

Diet composition (%*IRI*) of differently sized round gobies according to relative abundance (%*N*), weight (%*W*) and frequency of occurrence (%*F*) of consumed prey items. Values are derived from pooled data of the whole May-October period; n - the number of individuals with non-empty guts, analyzed within each size group.

Prey items	Size groups of round goby (TL)																			
	<50 mm				50-99 mm				100-149 mm				150-199 mm				≥200 mm			
	n=42				n=27				n=90				n=86				n=31			
	%*N*	%*W*	%*F*	%*IRI*	%*N*	%*W*	%*F*	%*IRI*	%*N*	%*W*	%*F*	%*IRI*	%*N*	%*W*	%*F*	%*IRI*	%*N*	%*W*	%*F*	%*IRI*
Mollusks	1.9	47.0	6.1	7.2	17.3	24.7	20.1	12.3	43.9	33	28.4	38.8	45.9	50.9	33.8	55.1	64.9	84.5	47.2	77.3
Macoma balthica	0	0	0	0	0	0	0	0	6.7	17.4	7.8	9.5	17.8	46.2	19.8	38.7	36.7	78.5	32.3	67.2
Mytilus trossulus	1.9	47.0	6.1	7.2	14.0	17.9	14.5	5.6	35.7	9.3	17.4	29.2	27.6	1.8	12.8	16.4	28.2	6.0	14.9	10.1
Cerastoderma lamarcki	0	0	0	0	0	0	0	0	1.2	4.6	2.8	<0.1	0.4	1.3	0.9	<0.1	0	0	0	0
Mya arenaria	0	0	0	0	0	0	0	0	0.3	1.7	0.4	0.1	0.1	1.6	0.3	<0.1	0	0	0	0
Hydrobia ulvae	0	0	0	0	3.3	6.8	5.6	6.7	0	0	0	0	0	0	0	0	0	0	0	0
Crustaceans	98.1	53	93.9	92.8	81.6	48.6	77.1	78.3	31.1	25.3	46.6	24.3	28.3	26.1	36.3	18.2	23.7	9.8	29.9	9.9
Cladocera	33.2	13.4	23.3	26.0	9.6	0.1	8.1	17.3	0	0	0	0	0	0	0	0	0	0	0	0
Copepoda	25.4	9.6	29.7	25.9	19.2	0.3	14.7	1.1	0	0	0	0	0	0	0	0	0	0	0	0
Ostracoda	35.5	14.1	29.5	30.6	15.2	0.2	9.9	0.4	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus sp.	4.0	15.9	11.4	10.3	34.9	45.7	38.1	58.9	7.2	0.7	8.4	7.4	4.9	0.5	6.6	1.4	2.6	0.2	5.3	1.0
Corophium volutator	0	0	0	0	0	0	0	0	8.2	1.0	10.3	4.2	1.5	0.2	2.1	0.5	0.3	<0.1	2.9	0.6
Crangon crangon	0	0	0	0	0	0	0	0	2.9	16.1	5.5	6.5	2.6	14.1	6.4	3.1	0	0	0	0
Neomysis integer	0	0	0	0	0	0	0	0	3.9	0.3	7.9	1.5	0.2	<0.1	0.3	<0.1	0.5	<0.1	1.3	<0.1
Saduria entomon	0	0	0	0	0	0	0	0	0.2	4.0	0.4	0.1	0.4	8.9	2.0	1.2	1.0	7.9	3.0	1.0
Balanus improvisus	0	0	0	0	2.7	2.3	6.3	0.6	8.7	3.2	14.1	4.6	18.7	2.4	18.9	12.0	19.3	1.7	17.4	7.4
Polychaetes	0	0	0	0	1.1	26.7	2.8	9.4	23.9	31.8	20.4	34.4	21.5	12.0	16.5	21.3	8.7	3.3	15.0	11.8
Pisces	0	0	0	0	0	0	0	0	1.1	9.9	4.6	2.5	4.3	11	13.4	5.4	2.7	2.4	7.9	1.0
Osmerus eperlanus	0	0	0	0	0	0	0	0	0.2	2.3	0.9	2.2	2.9	8.5	8.7	1.2	1.6	1.7	4.8	0.7
Gasterosteus aculeatus	0	0	0	0	0	0	0	0	0.7	7.1	2.8	0.2	1.1	2.3	2.8	4.0	0.6	0.6	1.8	0.3
N. melanostomus	0	0	0	0	0	0	0	0	0.2	0.5	0.9	0.1	0.3	0.2	1.9	0.2	0.5	0.1	1.3	0

diet, which used to change depending on the season (Table 3).

In spring, diet composition of round gobies was the least diverse and consisted mainly of mollusks and crustaceans. Importance of mollusks increased with a fish size and represented 56.2% and 72.5% relative contribution by weight in the diet of individuals from 100-149 mm and 150-199 mm size groups, respectively; the rest of the diet consisted of amphipods (2.0% and 1.6%), brown shrimps (34.8% and 13.4%), polychaetes (6.3% and 2.4%), barnacles (0.7% and 1.6%) and fish (0.0% and 8.5%). The largest round gobies (≥200 mm) fed exclusively on bivalves *M. balthica* (90.9%) and *M. trossulus* (9.1%) (Fig. 3A).

In summer, <50 mm round gobies consumed *M. trossulus* (43.0%), amphipods (22.1%), cladocerans (13.4%), ostracods (10.8%) and copepods (10.7%), while larger individuals (50-99 mm) preyed mainly on amphipods (60.9%), polychaetes (23.3%) and bivalve mollusks (10.2%) with negligible contribution of barnacles (1.4%), copepods (0.5%), cladocerans (<0.1%), ostracods (<0.1%) and other prey items (3.5%) in their diet (Fig. 3B). Bivalve mollusks (51.0%), ostracods (17.4%), cladocerans

(13.5%), barnacles (9.7%) and copepods (8.4%) were the most important feeding objects in the diet of <50 mm round gobies in autumn, while the bulk of 50-99 mm fish ration was composed of amphipods (70.4%), bivalve mollusks (25.6%) and barnacles (3.2%) with a minor contribution of ostracods (0.5%), cladocerans (0.2%) and copepods (<0.1%) (Fig. 3C).

Diet composition of intermediately sized (100-200 mm) individuals was different in summer compared to the spring. Importance of mollusks and crustaceans declined, whereas importance of polychaetes increased sharply. In June-August, polychaetes represented 65.7% and 26.0% in the diet of fish from 100-149 mm and 150-199 mm size groups, while in autumn consumption rates of polychaetes declined to 23.6% and 7.5%, respectively. Contribution of bivalve mollusks (8.7% and 41.7%), crustaceans (20.6% and 25%) and other prey items (5.0% and 4.8%) was also significant, while fish prey was less important (0.0% and 2.5%) (Fig. 3B).

Table 3

PERMANOVA of season effect on round goby diet composition (by weight contribution of 12 prey categories) within each size group

Size group (mm)	Source	df	SS	MS	Pseudo-F	P
<50	Season	1	2894.5	2884.1		
	Residual	42	59312	2478.5	1.137	0.304
	Total	43	65217			
50-99	Season	1	2531	2272		
	Residual	27	38420	2089.7	1.132	0.270
	Total	28	41021			
100-149	Season	2	15324	8270.5		
	Residual	90	<0.001	3221.8	2.457	**0.012**
	Total	92	<0.001			
150-199	Season	2	11314	6246.5		
	Residual	86	<0.001	2987.2	2.146	**0.047**
	Total	88	<0.001			
≥200	Season	2	10951	5641.3		
	Residual	31	<0.001	3147.5	1.691	0.183
	Total	33	<0.001			

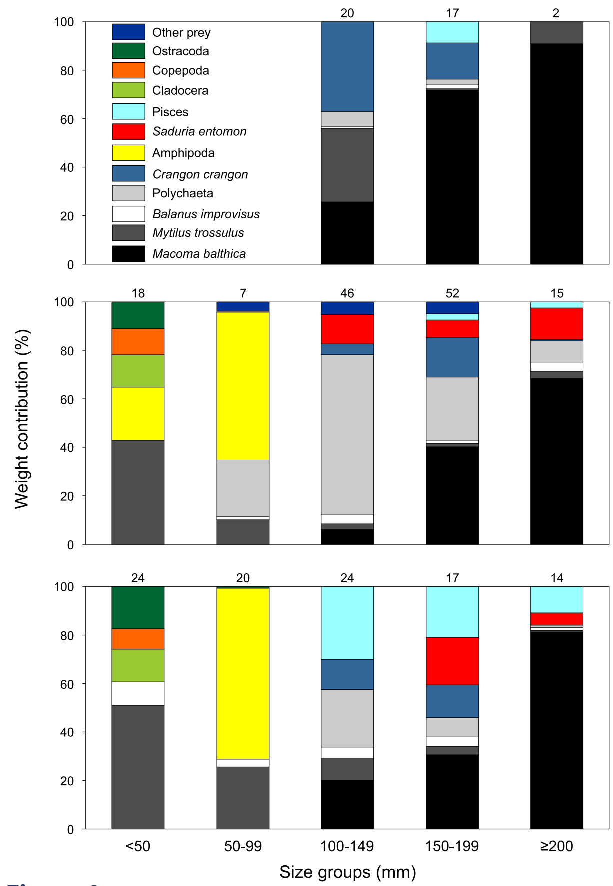

Figure 3

Mass percentage diet composition of the round goby during spring (A), summer (B) and autumn (C) seasons. Presented weight contributions (%) are averages of pooled values of female and male individuals during each season. The numbers above columns indicate sample sizes.

Changes in the diet composition of intermediately sized round gobies in autumn were mostly induced by lowered consumption of polychaetes and increased importance of *M. trossulus* (8.9% and 3.3%) and fish (30.0% and 21.0%). The overall consumption rates of mollusks (29.0% and 34.1%) and crustaceans (17.3% and 37.4%) remained almost the same as those determined during summer season (Fig. 3C).

The most common prey item for round gobies ≥200 mm was infaunal bivalve mollusk *M. balthica*, which constituted 90.9%, 68.4% and 81.2% in the diet during spring, summer and autumn, respectively. Other prey items, including epibenthic bivalves, crustaceans and fish were consumed less actively (Figs. 3A-C).

Discussion

Feeding activity of round gobies varied in relation to the reproductive cycle. Values of the stomach fullness index for females were relatively low from May to July, because before and during the spawning they usually spend most of the time near the nests, protected by males or spawn (MacInnis & Corkum 2000), resulting in suppressed foraging at that time. After spawning, females immediately leave reproduction sites (Meunier et al. 2009) and begin to feed actively, reaching the highest values of feeding activity during the post-spawning period. Such behavioral adaptation allows females to accumulate sufficient amounts of energy to produce large quantities of eggs for multiple batch spawnings. Males had lower gut fullness compared to females. Contrary to females, males are sedentary and guard their nests from the beginning of reproduction (Corkum et al. 1998). During the breeding, male round gobies do not feed or their diet is very poor, composed of eggs from their own or nearby located nests and organisms found in a very close vicinity of the nesting site. In July, during the peak of spawning, feeding activity of male round gobies was the lowest due to their immobility induced by nest guarding and parental care behavior. Feeding activity between male and female individuals varies at different sites, e.g. Thompson and Simon (2014) reported females feeding less actively than males in Lake Erie, while in the Black Sea, feeding activity was higher for females (Rosca & Surugiu 2010). Our findings revealed that feeding activity for both female and male round gobies reaches the peak during the post-spawning period, suggesting that benthic fauna is under particular pressure at that time, specifically September-October.

Many studies emphasize the impact of round goby in the food web through predation on mollusks. The contribution of mollusks in the diet typically increases with increasing fish size (Skora & Rzeznik 2001; Raby et al. 2010; Brush et al. 2012), because gape height and width are the main limiting factors, determining the type and size of consumed prey (Ray & Corkum 1997). Gape limited juvenile individuals prefer soft-bodied prey, such as zooplanktonic or meiobenthic organisms and small amphipods, and avoid hardly digestible mollusks (Phillips et al. 2003; Hayden & Miner 2009). Our study proves the consistency of these patterns. The most important feeding object, ingested by >100 mm individuals was *M. balthica*, however, we also determined seasonal variability of prey taxa consumed by differently sized round gobies. The lack of new data on prey availability makes the comprehensive evaluation of round goby feeding preferences difficult. According to previous studies from the round goby pre-invasion period, the infaunal soft bottom benthic community was dominated by mollusks (79% of the total zoobenthos biomass), crustaceans (11%) and polychaetes (9.8%) in the near-shore (4-9 m) zone, representing our study site (Bubinas & Repečka 2003). Availability of epifaunal mollusks in the study area changes seasonally, as there is no permanent population of *M. trossulus* on the hydrotechnical constructions of harbor moles. Abundance of *M. trossulus* at the study site reaches the peak during autumn season, after recruitment of mussel spat (Kautsky 1982). Increment of juvenile (2-3 mm) blue mussel abundance was particularly reflected in the diet of 100-200 mm fish; likely round gobies of this size prefer epifaunal mollusks, while soft bottom species, burrowed deeply into the sediments are of limited access. We also determined relatively high weight contribution of *M. trossulus* in the diet of juvenile individuals, however, it occurred only in negligible number of analyzed stomachs. In contrast, the largest individuals (≥200 mm) were less dependent on seasonal variation in the availability of small epibenthic mollusks and preferred *M. balthica* even in autumn. Results from previously conducted studies (French & Jude 2001; Raby et al. 2010; Brush et al. 2012) also showed that the ration of large gobies is the least variable and mainly consists of bivalve mollusks. Moreover, large fish are capable of ingesting bivalves of a wider size range by swallowing entire mollusks or crushing them with pharyngeal teeth (Ghedotti et al. 1995).

Round gobies are known to forage on the most abundant components of benthic community, which may change seasonally (Skora & Rzeznik 2001; Banaru & Harmelin-Vivien 2009). Diet composition of intermediately sized round gobies was the most variable during the course of present research. In spring, round gobies 100-200 mm fed mainly on mollusks and barnacles, with a large portion of brown shrimps in the gut contents. The highest relative importance of *C. crangon* in the diet was observed during spring season, because brown shrimps migrate from deeper areas and accumulate in the coastal waters at that time (Lapinska & Szaniawska 2006). During summer season, intermediately sized round gobies shifted their diet from mollusks to polychaetes. The highest abundance of polychaetes in the guts of analyzed fish was recorded in midsummer, when the population of *Hediste diversicolor* was dominated by small, newly hatched individuals that stay close to the sediment surface (Marty & Retiere 1999) and represent easily accessible prey for benthivorous fish. In autumn, relative importance of polychaetes declined considerably in the diet of 100-200 mm individuals, whereas importance of juvenile *M. trossulus* and fish increased. In September and October, round gobies preyed on fish more frequently compared to spring or summer and their main fish prey was represented by juvenile smelts, that are concentrating in the coastal waters of the Baltic Sea in autumn (Ustups et al. 2003). Small juvenile round gobies also occurred occasionally in the guts of large specimens and these findings confirmed cannibalistic feeding habits of the species, previously determined by French and Jude (2001) and Carman et al. (2006).

The presented study demonstrated ability of round goby to change feeding patterns depending on the body size, sex, stage of the reproduction cycle and changing seasonal availability of preferred prey items. Constantly increasing abundance of this invasive fish is a serious threat to the Baltic Sea, which may cause significant abundance reduction or even extinction of various native invertebrate species (Kuhns & Berg 1999; Barton et al. 2005; Krakowiak & Pennuto 2008). Abundance of epifaunal bivalve *M. trossulus* and other benthic invertebrates, living in association with its colonies in the Lithuanian coastal waters of the Baltic Sea declined dramatically after round goby invasion (Stupelytė 2014). Round goby predation on newly settled blue mussels has significant potential to reduce its recruitment success, especially in areas where space on suitable hard substrates is limited. Further, more comprehensive field researches and laboratory experiments are necessary to prove negative effects of this invader on both infaunal and epifaunal zoobenthic communities.

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