Species diversity and catch per unit effort (CPUE) of Gobiidae in Salmanshahr, coastal area of the southern Caspian Sea

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Abstract

The gobies are non-commercial fishes in the Iranian waters of the Caspian Sea for which population dynamics and stock status are poorly known. In this survey, we tried to define species diversity and catch per unit effort (CPUE) of Gobiidae by using beach seine nets in Salmanshahr, the southern Caspian Sea. From March 2011 to April 2012, 224 specimens representing 4 gobiid species, belonging to genus *Ponticola* and *Neogobius*, were caught. The deepwater Goby, *Ponticola bathybius* (Kessler, 1877), was the most abundant species with 92.8% frequency. The highest catch per unit effort of gobiid fishes was obtained in spring. The species diversity was highest in spring according to Shannon's index.

Keywords: Gobiid fishes, CPUE, Species diversity, Salmanshahr, Caspian Sea

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Introduction

The family Gobiidae is a very large family of about 210 genera and estimated 2000 species, distributed worldwide, and found mostly in tropical coastal waters (Coad, 2007; Kottelat and Freyhof, 2007). Of this family, 13 species were indicated in the ichthyofauna of the Southern Caspian Sea (Kiabi *et al*., 1999; Abdoli and Naderi, 2008). The genus *Neogobius*, belonging to Gobiidae, is native to the Ponto-Caspian region where there are about 14 species (Coad, 2007). *Ponticola* is another genus of this family that contains 13 species in the Black and Caspian Sea basins (Freyhof and Brooke, 2011) with 4 species in Iranian waters (Coad, 2007). The deepwater Goby, *Ponticola bathybius* (Kessler, 1877) is a marine species of the gobies endemic to the Caspian Sea. It inhabits sandy and shelly bottoms and, in smaller numbers, firm silt down to 75 m (Miller, 2003).

Because the gobiid fishes are not economically important in Iran, very limited information exists on stock status and ecological characteristics of their species. The gobies, however, play a crucial role in the Caspian Sea ecosystem as food resources and competitors for many commercially important species. Ghelichi (1999) showed that in the Myankaleh coastal waters, the Bighead Goby, *Ponticola gorlap*, was the most abundant species caught using beach seine nets and the catch per unit effort of gobiid fishes was highest in spring.

The purpose of the present research was to determine species diversity and to assess the catch rates of gobiid species caught by beach seining in the south central Caspian Sea. Moreover, we tended to shed more light on details of stock status of this family in new conditions of this habitat. The abundance of gobiid species may be significantly affected by the decreasing abundance of some species in recent years, such as acipenserids as their main predators and *Clupeonella* as a prey item (Fazli *et al*., 2007; Abdoli and Naderi, 2008). The lack of surveys on ecological characteristics of the gobies during the last decade emphasizes the seriousness of new studies.

Materials and methods

The gobies were collected as by-catch of beach seine fishing in Salmanshahr (36°42’N, 51°11’E). Sampling was conducted between March 2011 to April 2011 and October 2011 to April 2012 using a 1000 m long beach seine (mesh size 33 mm). Species were identified, enumerated, and recorded separately for each seine haul. Water temperature at the fishing site was recorded on each sampling day using a mercury thermometer. Linear regression analysis was fit to the relationship between water temperature and catch per unit effort data. The specimens were fixed and preserved in 10% formaldehyde during transport to the laboratory. In the laboratory, the total length (TL to the nearest mm), body weight (W, to the nearest 0.1 g),

and sex of each specimen were recorded (Table 1). For fish species identification, the number of first dorsal fin rays, head sensory papillae patterns and otoliths were used. To determine the age of specimens, otoliths were extracted, cleaned, polished, and clarified in glycerine. These structures were viewed under a stereo microscope and their images were taken with camera and Dino capture software for counting the annual rings. Catch per unit effort (CPUE) was calculated as total weight in kg or number of the gobies captured per seine haul. To compare the catch rate of Gobiidae with economically important fishes seined from Salmanshahr, CPUE data of major target species were also recorded as consistently as possible with more accuracy. Throughout the sample period, the target and by-catch species of 10 seine hauls per month were considered and one net was randomly visited on each fishing day. Because beach seine fishing is banned from late April to late October, we could not collect any sample in this time. To define the species diversity of gobiid fishes, the Shannon index (*H*) was calculated in all the months of the study period, as described by Krebs (1998):

$$H = -\sum p_i \, Ln \, p_i$$

Where p_i is the numerical abundance of the *i*th species. *H* values equal or close to zero indicate that the species diversity is narrow, whereas high values indicate that the species diversity is wide.

Results

A total of 224 gobies representing 4 species and 2 genera were collected from Salmanshahr beach. During the sampling period, by-catches were dominated by the deepwater Goby, *Ponticola bathybius*. It was the most abundant species constituting 92.8% of the total catch of the gobies. *Neogobius fluviatilis* (Pallas, 1814), *Neogobius caspius* (Eichwald, 1831), and *Ponticola gorlap* (Gunther, 1861) were captured infrequently (Table 1). The target species for beach seining in Salmanshahr were *Rutilus kutum*, *Lisa* sp, *Alosa* sp., *Cyprinus carpio*, and *Sander marinum*. Age determination of gobiid fishes indicated that *P. bathybius* was classified in four age groups (5+, 6+, 7+, and 8+). The ages of gobiid species are given in Table 1. Catch per unit effort (CPUE) data of gobiid fishes were obtained considering 87 seine hauls (average; 10 seine hauls per month). Variation in monthly CPUE indicated that catches of the gobies increased considerably in March and April (Fig. 1). The catch rate of these fishes was very low in autumn and winter as in October and November the CPUE was zero. The highest catch per unit effort of gobiid fishes occurred in April 2011. There was a significant, but weak positive linear relationship between water temperature and gobiid CPUE (a=2.25, r^2=0.19, p= 0.01).

Table 1: Number of specimens (N), total length (TL), weight (W) with the standard deviation (S.D) and the age of gobiid species seined from Salmanshahr.

Species	Sex	N	TL (mm)	W (g)	Age
Ponticola bathybius	Male	211	242 ± 16	156 ± 48	5+ to 8+
Neogobius fluviatilis	Male	2	153 ± 13	43 ± 11	2+
Neogobius caspius	Male	7	152 ± 10	44 ± 20	2+, 3+
	Female	1	178	76	3+
Ponticola gorlap	Female	3	262 ± 5	215 ± 26	1+, 2+

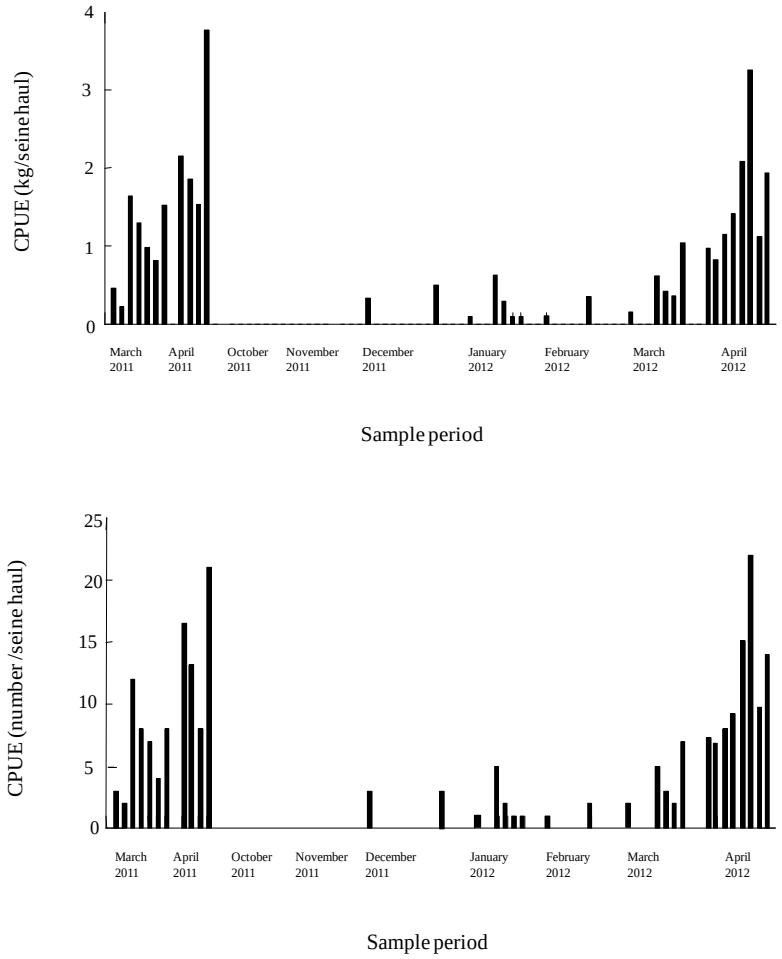

Figure 1: CPUE analysis of gobiid fishes in Salmanshahr, the southern Caspian Sea.

The Shannon index showed the highest species diversity of the gobies seined in April 2012. Low H values in all seasons illustrated that the species diversity is narrow, but in spring 2012, this value was high compared with the other seasons of the sample period (Fig. 2). *Rutilus kutum* was the most abundant species constituting 48.31% of the total catch (Table 2).

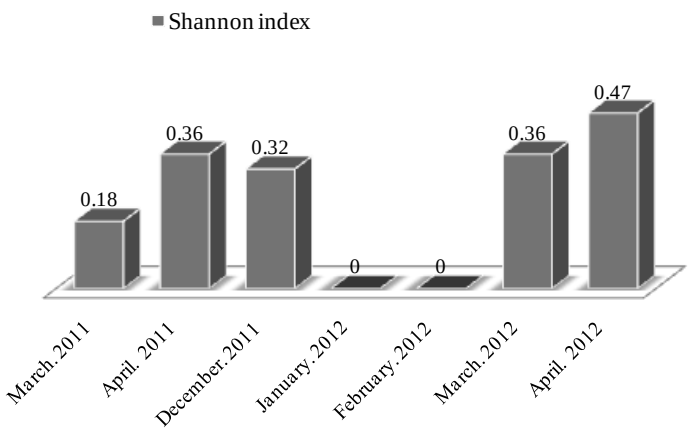

Figure 2: Shannon index for species diversity of the gobies in Salmanshahr, the southern Caspian Sea.

Table 2: The catch rate of fish species captured in Salmanshahr from October 2011 to April 2012.

Species	**Gobiidae**	***Rutilus kutum***	***Liza* sp.**	***Alosa* sp.**	***Cyprinus carpio***	**Other fishes**	**Total**
Catch per 70 seine hauls (kg)	16.32	4072.25	3743	547	15.2	35.25	8429
Catch per seine haul (CPUE) (kg)	0.23	58.17	53.47	7.81	0.21	0.5	120.41
Species abundance %)	0.19	48.31	44.4	6.48	0.18	0.41	100

Discussion

The objective of the present study was to provide some information on population dynamics of Gobiidae, one of many non-commercial fishes in Iran about which exceedingly little is known. The results of this survey showed that the abundance and species diversity of gobiid fishes seined from Salmanshahr was highest in spring. Four gobiid species could be identified in the specimens collected and *P. bathybius* was the most abundant species. Ghelichi (1999) showed that in the Myankaleh Wetland the catch rate of the gobies was highest in March and April, while the highest species diversity occurred in February. *P. gorlap* was the most abundant goby caught using beach seine nets. The other species which were observed in his survey were *P. bathybius*, *Benthophilus stellatus*, *N. fluviatilis*, and *Neogobius* sp. The results of the current study are consistent with the observations of Ghelichi (1999) who found that the abundance of the gobies increased in shallow waters in March and April. A consideration of literature reviews showed that the major reason of this increase seems to depend on their breeding seasons. Ragimov (1967, 1968) indicated that in the western, central and south Caspian Sea, spawning period of *P. gorlap* occurred in April and May and they approached the coast during their spawning phase. He also showed that mature males of *P.*

bathybius begin approaching the coast in March or April.

In this research a significant relationship between water temperature and gobiid CPUE was observed. This suggests that temperature may play a role in the gobies distribution in coastal waters, but this relationship would need further examination. The differences in the species diversity and the abundance of the gobies found in our study and in Ghelichi (1999) research may have been affected by characteristics of the studied areas. In comparison with the south central coast, the western and eastern coasts of the southern Caspian Sea are characterized by gentle slopes and higher sedimentation rates (Lahijani *et al*., 2007). In our survey we sampled fish in an area with sandy bottom and steep slopes. The results of Ghelichi (1999), however, were reported in the south-eastern part of the Caspian Sea, with a muddy substrate, gentle slopes and stable conditions. Different kinds of marine organisms have adapted to different substrates. The type of organisms present also affects the establishment of others (Castro and Huber, 2008). The differences may also reflect temporal changes of the Caspian Sea. The decreasing abundance of some species such as *Clupeonella*, invasive species, sea-level fluctuations, and variation in sedimentation rate have impacted on conditions of the ecosystem during the past decade (Fazli *et al*., 2007; Lahijani *et al*., 2007; Abdoli and Naderi, 2008). In the survey by Ghelichi (1999), the catch rate of the gobies was reported as 155.67 kg per 27 seine hauls (CPUE: 5.76 kg per seine haul) from October to April, but in this research it was calculated as 16.32 kg per 70 seine hauls (CPUE: 0.23 kg per seine haul) over the same period. This suggests that the stocks of gobiid fishes may have decreased in recent years. As mentioned previously, this decrease may have been affected by temporal and spatial changes of the habitat. During the past decade, passive introduction of alien species caused a rapid impact on the Caspian Sea. Due to an invasive jellyfish Ctenophora, *Mnemiopsis leidyi*, which appeared in 1999 and affected all components of this habitat (Bagheri *et al*., 2012; Sarvi *et al*., 2014), the biomass of anchovy kilka, *Clupeonella engrauliformis*, that is a prey item for the gobies, greatly declined (Fazli *et al*., 2007). Moreover, cannibalism which was found in some species of Gobiidae due to insufficient food supply (Lissåker, 2007; Semenov, 2009; Kalantarian *et al*., 2013) may be a significant factor responsible for changing the abundance of gobies. Construction of dams and canalization of rivers in recent years reduced freshwater flow and the amounts of sediments entering the sea. It caused considerable changes in dynamics of coastal waters, wetlands and estuaries. River and marine pollution and algal blooms have also had drastic impacts on the habitat. Little information about gobiid species and interactions among them and other marine organisms in the Caspian Sea prevents us from definitively explaining the reasons for

these changes. We hope that further studies on the ecological and biological features of this family and the other fish reveal more details about that structure and function of this marine ecosystem.

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