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None-Indigenous Fishes of Alma-Gol, Adji-Gol and Ala-Gol Wetlands (Golestan Province); Implications for Conservation and Management Programs of Wetlands

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Abstract
The study was conducted to explore fish species composition of the international wetlands of Golestan province, which represent a series of the small and rather isolated freshwater lakes during September 2000 to August 2002. The results revealed that non-indigenous fish species are dominant in the wetlands. Of 10 sampled species, four including Sharp Belly *Hemiculter leucisculus*, Silevr Crucian Carp *Carassius auratus*, Top mouth Gudgeon *Pseudorasbora parva*, Mosquito fish *Gambusia holbrooki*, were non-indigenous. Alma-Gol and Ala-Gol contained 89.80% and 79.57% (of total frequency of fishes) of none-indigenous species respectively, indicating decreasing of native fish fauna. The most frequent none-indigenous species were *H. leucisculus* in Alma-Gol (58%), *C. auratus* in Ala-Gol (77.6%) and *H. leucisculus* in Adji-Gol (16.82%). As numerical abundance, two none-indigenous species *H. leucisculus* and *C. auratus* had the highest biomass in the Alma-Gol and Ala-Gol respectively. This situation highlights the importance of conservation and protection measures. Therefore, if greater emphasis is not placed on the conservation of native fishes with no direct economic values, these species could face continuous decline or might be completely lost.

Keywords: none-indigenous fish species, Iran, conservation, wetland.

گونه‌های غیر بومی تالاب‌های آلماگل، آجی گل و آلاگل (استان گلستان)؛ اشاراتی برای برنامه‌های حفاظتی و مدیریتی تالاب‌ها

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چکیده
جهت بررسی ترکیب گونه‌ائی ماهیان تالابهای بین المللی استان گلستان که یک سری از دریاچه های تقریباً ایزوله آب شیرین میباشند، از شهریور ۱۳۷۹ تا مرداد ۱۳۸۱ مطالعه انجام شد. نتایج نشان داد که گونه های غیربومی در تالابها غالب میباشند. از ۱۰ گونه نمونه برداری شده، چهار گونه شامل تیزه کولی(Hemiculter leucisculus)، کاراس(Carassius auratus)، آمورچه(Pseudorasbora parva) و گامبوزیا (Gambusia holbrooki) غیربومی بودند. تالابهای آلماگل و آلاگل به ترتیب دربرگیرنده ۸۹,۸۰٪ و ۷۹,۵۷٪ (از کل فراوانی ماهیان) گونه های غیر بومی بوده که نشان دهنده کاهش گونه های ماهیان بومی میباشد. فراوان ترین گونه های غیربومی شامل H. leucisculus در آلماگل (۵۸٪)، C. auratus در آلاگل (۷۷,۶٪) و H. leucisculus در آجی گل (۱۶,۸۲٪) بود. همانند فراوانی عددی، دو گونه غیربومی Hemiculter leucisculus و Carassius auratus بیشترین بیومس را به ترتیب در تالابهای آلماگل و آلاگل داشتند. این وضعیت اهمیت حفاظت و نگهداری را بیشتر نشان میدهد. بنابراین اگر تاکید بیشتر بر حفاظت ماهیان بومی بدون در نظر گرفتن ارزشهای اقتصادی انجام نپذیرد این گونه ها با کاهش مداوم مواجه شده و یا حتی ممکن است بطور کامل از بین بروند.

کلیدواژه‌ها: ماهیان غیربومی، حفاظت، تالاب، ایران.

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Introduction

Many none-indigenous fish species often appear in natural waters where they were unknown before. This could be the result of purposeful introduction for food, sport, research, ornamentation, weed control, or health reasons (Coad and Abdoli, 1993), and of accidental introduction such as the careless release of live specimens from aquaria or escapee from nearby aquaculture units, the negligent transfer of fertilized eggs of unknown species during stocking or undocumented stocking. (Cowx, 1998). Introduced fish species may directly impact native fish by predation, resource competition, interference with reproduction and/or the introduction of parasite and diseases (Kennard *et al*., 2005). Introduced fish may therefore represent a symptom and a cause of decline in ecosystem health (Rapport *et al*., 1998). The apparently strong relationship between none-indigenous species and degraded ecosystem conditions, and their potential impact on native species, has led to the frequent use of none-indigenous fish as indicator of biological integrity and ecosystem health (Kennard *et al*., 2005). The presence, richness, relative abundance and/or relative biomass of none-indigenous species are often incorporated as component metrics in application of index of biotic integrity. (Karr, 1981; Karr *et al*., 1986).

Throughout the world, the rate of none-indigenous species introduction in freshwater is continuously increasing (Rosechi et al., 2001). Occurrence and frequency of none-indigenous fish species in natural waters from south Caspian Sea regions has been increased in recent years in Iran (Abdoli, 2000; Kiabi *et al*., 1999a), but almost no exclusive attempts have been devoted to determine their distribution and impact on native biota. Therefore, the goal of this paper is to describe, quantity, and compare the abundance of none-indigenous fish species in the wetlands. Moreover, in an effort to establish conservation measures for the native species, possible consequence of presence of none-indigenous species and annotation of their ecological impacts on native fish species are discussed.

Material and Methods

The study was performed in three international wetlands (Alma-Gol, Adji-Gol and Ala-Gol) which are situated on the Turkmen steppes near the border with Turkmenistan in the Golestan Province, in north of Iran (Figure.1). These wetlands differ in size, depth, salinity, and type of aquatic vegetation. Ala-Gol is the largest wetland, having a surface area of 2500 ha and a maximum depth of 2.0-2.5 meter. Adji-Gol is of intermediate size (320ha and maximum depth of 1.5-2.5 meter) and Alma-Gol is the smallest (207ha and maximum depth of 1.2-2.0 meter).The wetlands, especially Ala-Gol, were subjected to extensive fluctuation in water level, although rarely it dried up during periods of drought. The bed formation consists of soft clay and mud. Alma-Gol and Adji-Gol are slightly more eutrophic than Ala-Gol. Aquatic macrophyts include *Myriophyllum spicatum* and *Phragmites australis* in Alma-Gol, *M. spicatum*, *Potamogeton pectinatus*, *P. australis*, *Juncus* spp. and *Typha angustifulia* in Adji-Gol, and *P. australis*, *T. angustifulia*, *Zanichella palustris*, *Juncus* spp. in Ala-Gol (Kiabi *et al*., 1999a and 1999b; Scott, 1995).

Fieldwork was carried out from September 2000 to August 2002 on the basis of twice per season and overall 16 samples were collected in each study area. At each wetland, fish were captured using gillnets (20m long and 2 meter height) with various mesh size (16, 18, 20, 22, 24, 26, 28, 32, 36, 40, 45, 50, 55mm knot to knot), which were set perpendicularly from the shoreline in random order, maintaining a spacing of 3m and beach seine (50m long by 2m deep with a mesh size of 3 mm). Each unit of effort consisted of 16 overnight gillnet sets which consisted of two gillnet of each mesh-size with equal lengths and heights, and 5 hauled seines. Fish specimens were preserved in 10% formaldehyde and taken to laboratory. All specimens were enumerated and identified to the species level using Berg (1949).

Frequency of occurrence was expressed as percent of total number for each species. The species diversity indices including diversity index, richness index and evenness index were calculated according to Ludwig and Reynolds (1988) to compare fish species structure among the wetlands as richness index ($R1=\frac{S-1}{\ln(n)}$); diversity index ($H'=-\sum_{i=1}^{s}(pi \cdot \ln pi)$) and evenness index ($E1=\frac{H'}{\ln(S)}$), where S is number of species, n total number of specimens and p_i the proportional abundance of the ith species, to compare fish species structure among the wetlands.

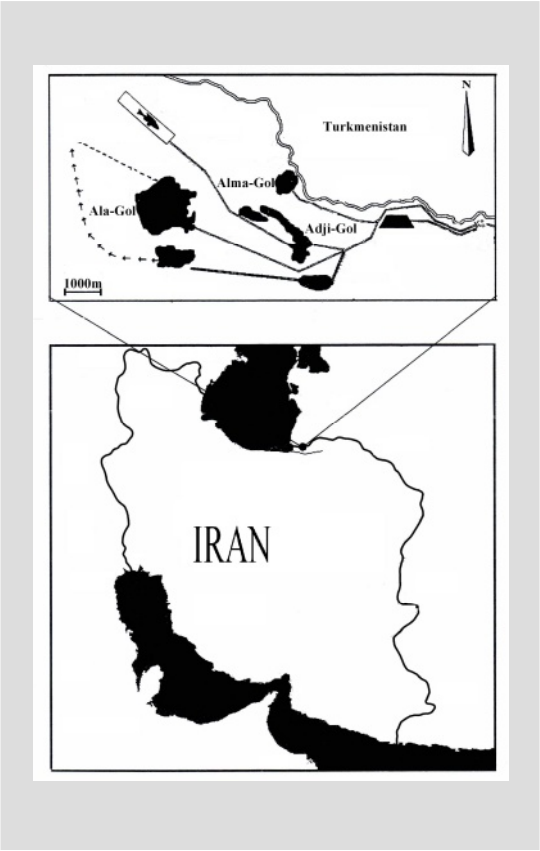

Figure.1 Location of the Alma-Gol, Adji-Gol and Ala-Gol wetlands in the South Caspian Sea, Iran

Results

During the 2 successive years of study period, a total of 1780, 766 and 2659 specimens were sampled in Alma-Gol, Adji-Gol and Ala-Gol wetlands respectively. Fish species composition varied slightly among wetlands. Total of 10 taxa of fish were sampled belonging to three families, Cyprinidae, Atherinidae and Poeciliidae in these wetlands. Four species *Carassius auratus*, *Pseudorasbora parva*, *Hemiculter leucisculus*, *Gambusia holbrooki* were none-indigenous species. Observation of *P. parva* and *H. leucisculus* represent the first record of these species in these wetlands. *H. leucisculus*, *C. capoeta gracilis* and *C. auratus* numerically dominated the Alma-Gol, Adji-Gol and Ala-Gol wetlands respectively (Figure. 2). In addition, general view of the total catch during 16 sampling efforts in the wetlands is given in figure 3. The total catch of species varied in the wetlands significantly. The major part of the catches was *H. leucisculus* in Alma-Gol, *Cyprinus carpio* in Adji-Gol and *C. auratus* in Ala-Gol. As numerical abundance, two none-indigenous species *H. leucisculus* and *C. auratus* had the highest biomass in the Alma-Gol and Ala-Gol respectively. The majority number of species belonged to the Cyprinidae. Five of the ten collected species including three native species *Rutilus rutilus caspicus*, *Capoeta capoeta gracilis*, *C. carpio* and two none-indigenous species *H. leucisculus*, *C. auratus* occurred in all wetlands. Endemicism was highest in Adji-Gol (52.90% native), and much lower in Alma-Gol (10.20%) and Ala-Gol (20.43%) which contained 89.80% and 79.57% none-indigenous species (of total frequency of fishes) respectively. The species richness, diversity and evenness were highest in Adji-Gol and lowest in Ala-Gol (Table 1).

Table1. Species diversity indices for the International wetlands, Golestan Province, Iran, 2000-2002

Wetland	Alma-Gol	Adji-Gol	Ala-Gol
No of species	7	7	6
R1	0.69	0.78	0.67
H’	1.12	1.77	0.73
E1	0.66	0.98	0.40

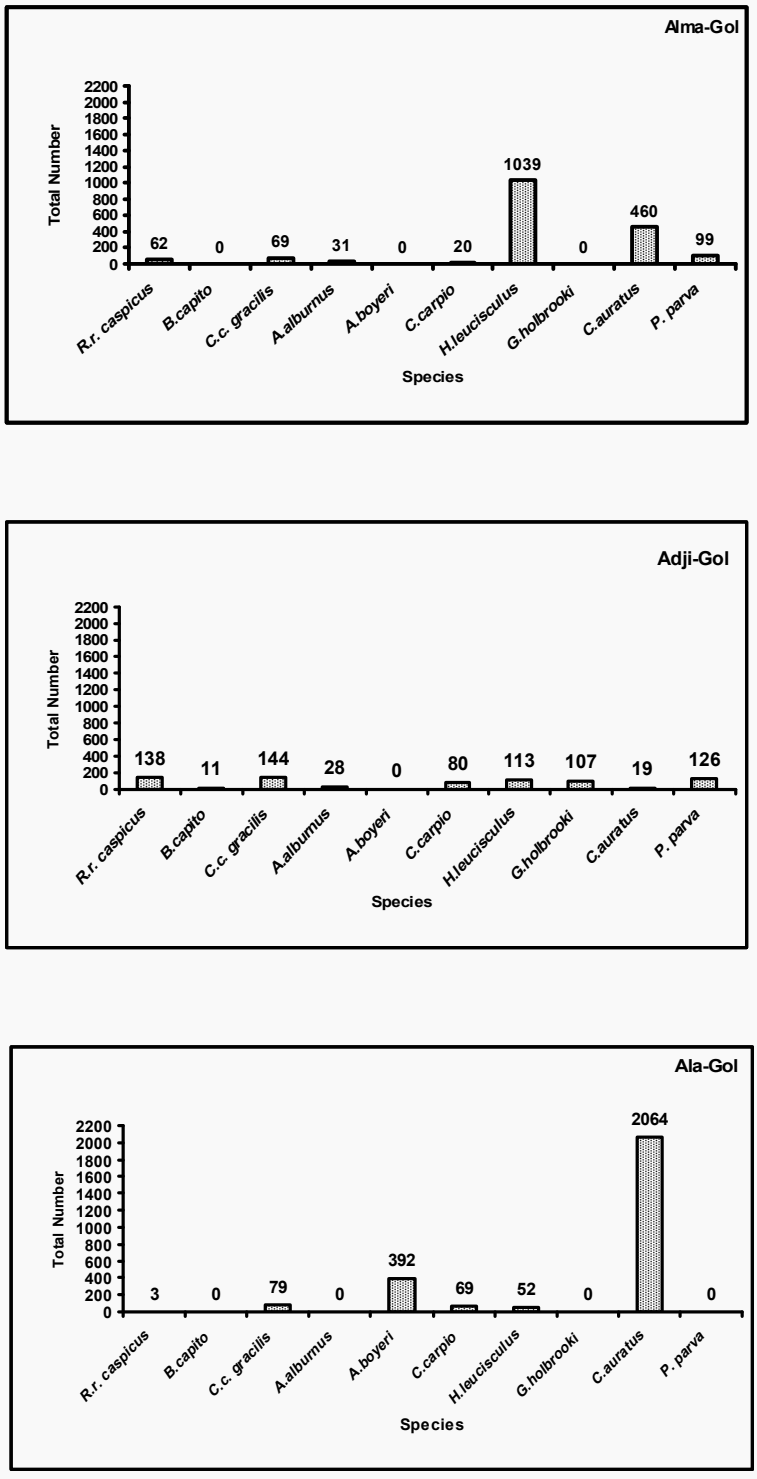

Figure. 2. Total numerical abundance (%) of fish species sampled during 16 efforts in the International wetlands, Golestan Province, Iran, 2000-2002

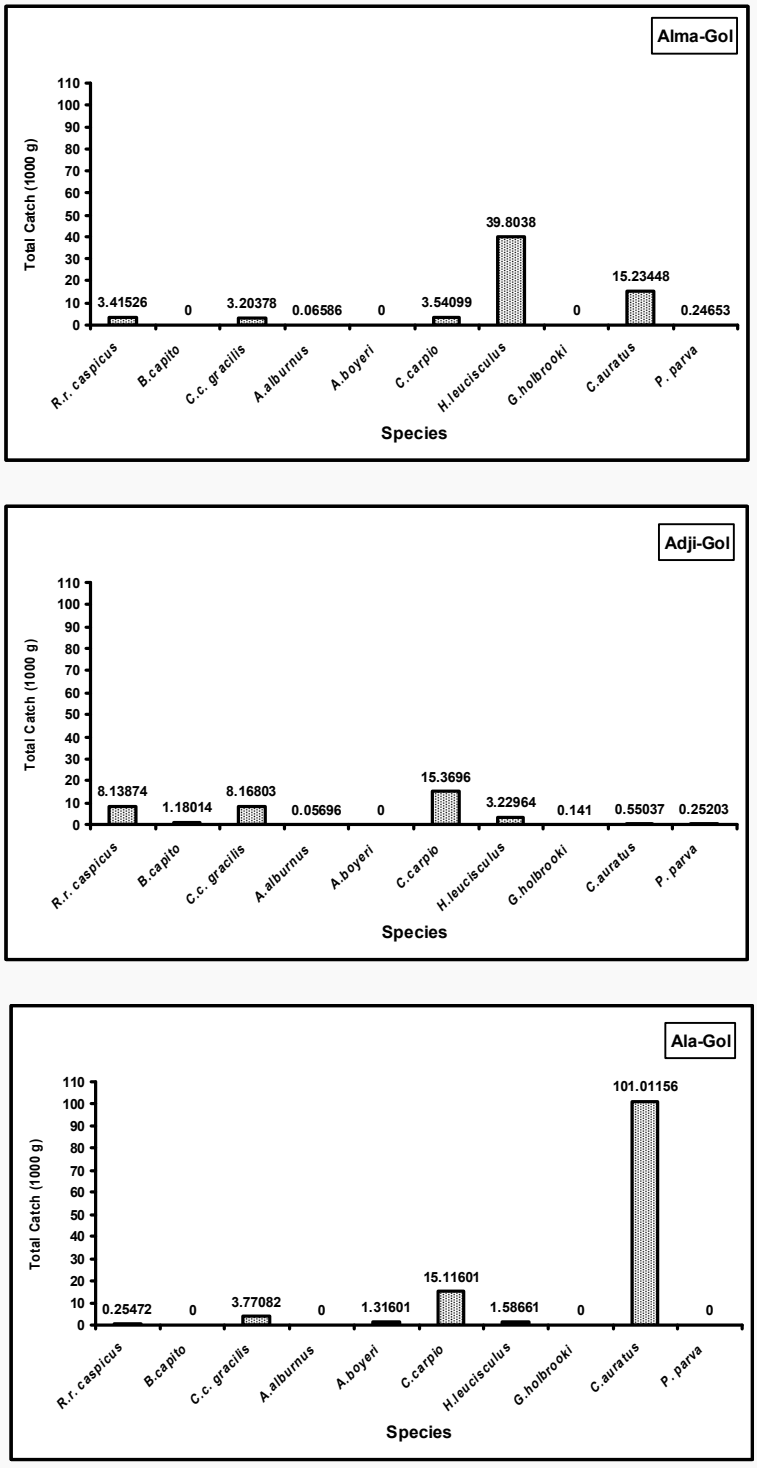

Figure. 3. Total catch (×1000 g) of fish species sampled during 16 efforts in the International wetlands, Golestan Province, Iran, 2000-2002

Discussion

The results revealed that the fish fauna of the wetlands, composed of 10 species, was dominated by none-indigenous species, suggesting limited area for the distribution of native species. Previously reported native species *Silurus galnis* (in Alma-Gol and Ala-Gol) and *Neogobius* sp. (in Alma-Gol) (Abdoli, 2000; Kiabi *et al*., 1999b) were not observed in the present study. Furthermore, another native species the *B. capito*, which belongs to the " Least Concern" category of IUCN with the widest distribution range in the Caspian basin (Abdoli, 2000), was recorded only occasionally and in small number in Adji-Gol. It can be concluded that degradation has occurred in native fish species communities. The reason for their decline could be habitat degradation due to appearance of none-indigenous species in high frequency. In many cases it has been shown that that variation in abundance of native species in the isolated ecosystems is clearly associated with abundance of none-indigenous species, their ability to utilize available food resources and high reproduction, *e.g. H. leucisculus* and *C. auratus* (Kukuradze and Mariash, 1975; Holcik and Razavi, 1992). Coad and Abdoli (1993) pointed out that none-indigenous fishes can lead to serious decline in populations or to rendering commercial species unfit for human consumption. They may compete for food, for space, for spawning sites, or may simply be aggressive and limit the success of indigenous fishes, displace one or more native species and alter an entire ecosystem.

H. leucisculus is a none-indigenous fish for the Caspian basin and Iran as well. Its original distribution includes the rivers of China, Korea and Vietnam, and also the Amur River basin (Holcik and Razavi, 1992). Its presence was reported in Anzali lagoon (Holcik and Razavi, 1992; Abbasi *et al*., 1998), It is supposed that this species is more spread in Iran. Concerning the *H. leucisculus* the situation is rather ambiguous in these areas and needs special investigations. Borisova (1972) blamed this species for the partial displacement of the native species and also indicated that in new environmental conditions its role is rather negative. This species had high frequency in the wetlands that might be a serious competitor for food and space with the juveniles and adults of native fishes.

According to Abdoli (2000), *P. parva* was observed in fish farms and some water bodies of the Golestan province. However, *P. parva* has never been recorded in these wetlands. It is widely distributed as native species in China, Korea and Japan. In addition, it has been introduced from China into central Asia and Kazakhstan (Makeeva and Zakimohamed, 1982). Although some potential hazards of *P. parva* mentioned by Abdoli (2000) but there is no confirmed reports of its damage on native species in the Caspian basin.

One of the most frequent species in the wetlands is *C. auratus*. It is well known as aggressive species in inland waters, which counted for decrease of native fish stocks (Kukuradze and Mariash, 1975). Hence, the relatively high number of this species in the wetlands could be a major limiting biotic factor of the frequency of the native fish taxa.

G. holbrooki is a small and more frequent none-indigenous species in the water bodies of the south Caspian Sea (Abdoli, 2000; Kiabi *et al*., 1999a). This has a variety of biological attributes typical of successful invaders and has expanded their distribution range to include a diversity of habitats of worldwide (Harmer *et al*., 2002). Fortunately, this none-indigenous species has been observed only in Adji-Gol with a low frequency.

The comparison of results indicated an increase in dominance of few species in Ala-Gol, while abundance of all species in Adji-Gol is relatively equal. The major reason for reduced diversity of fish species in Ala-Gol and Alma-Gol could be higher frequency of none-indigenous species.

In Iran, unfortunately, there is no updated information about threatened fish species in the wetlands and no global assessment of this kind has been done so far. A few wetlands were investigated, but the results are generally non-specific, and more

importantly, they are sometimes incomplete for fish species. Furthermore, we cannot directly qualify the magnitude of the effects of none-indigenous species on the native fish assemblage in the wetlands. However, the decreased frequency of native species, coupled with increased frequency of none-indigenous species, implies that none-indigenous species had great effect on native fishes.

None-indigenous species are indicator of biological integrity in two fundamental respects. First, their presence represents a deviation from the historical natural condition of fish community (i.e. the pre-introduction condition), Secondly, none-indigenous fish species have been associated with decline in, or extirpation of native fish in arrange of systems because of predation, competition and/or transmission of diseases. (Kennard et al., 2005). Therefore, the domination of none-indigenous species can be used as an indicator of degraded ecosystem condition and these area must be given appropriate attention for remediation. In practice, however, once a species has become established and spread from its point of introduction, eradication is almost impossible, therefore, it is believe that prevention remains better than cure especially in vulnerable recipient community such as wetlands where the chance of none-indigenous species becoming invasive is so high. The results revealed that the wetlands had a substantially higher relative abundance of none-indigenous fishes. The reasons for the high frequency of none-indigenous fishes are unclear, but presumably include a combination of proximity to source of invasion, susceptibility of the native communities to invasion and habitat characteristics amenable to the invading taxa.

An out come of this study is that appearance of none-indigenous species (e.g. *H. leucisculus* in Alma-Gol and *C.auratus* in Ala-Gol) had serious effect on native fish fauna, but more-in-depth studies are required in order to assess the impact of none-indigenous species on the native fish fauna. Although the fish fauna of these wetlands is not very rich, protection measures and management of biological diversity is recommended for wetlands in all aspects.

Ultimately, a combination based on presence, abundance and biomass of none-indigenous species could be a good indicator of wetland health and function because of its practical (i.e. relative ease of sampling, identification and analysis) and conceptual simplicity (it is easy to communicate results to manager and the wider community).

References

Abbasi, K. *et al.* (1998). *Atlas of Fishes of Iran, Inland water of Guilan Province*. Rasht: Novin Press Co.

Abdoli, A. (2000): *The Inland water fishes of Iran*. Tehran: Natural and Wild life Museum of Iran.

Berg, L. S. (1949). *Freshwater fishes of the U.S.S.R and adjacent countries*. Jerusalem, Israel program for scientific translations.

Borisova, A.T. (1972). *Sluchainie vselentsi v vodoemakh Uzbekistana. (Accidental settlements in the reservoirs of Uzbekstan).* (In Russian) Voprosi Ikhtiologii, 12: 49-53.

Coad, B.W and A. Abdoli (1993). Exotic fish species in the fresh waters of Iran. *Zoology in the Middle East,* 9: 65-80.

Cowx, I. G. (1998). *Stocking and introduction of fish*. Oxford: Fishing News Book, Blackwell Science.

Harmer *et al.* (2002). The role of introduced mosquitofish (Gambusia holbrooki) in excluding the native green and golden bell frog (Litoria aurea) from original habitats in south.

Holcik, J. and V. A. Razavi (1992). On some new or little known freshwater fishes from the Iranian coast of Caspian Sea. *Folia Zoologica,* 41(3): 271-280.

Karr, J. R. (1981). Assessment of biotic integrity using fish communities. *Fisheries,* 6:21-27.

Karr, J. R. (1986). *Assessing biological integrity in running waters: A method and its rationale*. Illinois Natural History Survey Publication 5, Champaign.

Kennard, M. J. (2005). Are alien fish a reliable indicator of river health?. *Freshwater Biology,* 50:174-193.

Kiabi, (1999a). Status of the fish fauna in the south Caspian Basin of Iran. *Zoology in the Middle East,* 18:57-65.

Kiabi, H. B. (1999b). *Wetland and riverian ecosystems of Golestan province*. Department of the Environment, Golestan Province, Gorgan: Office of D.O.E.

Kukuradze, A. M. and L. F. Mariash (1975). Materiali k ekologii serebrianogo karasia *Carassius auratus gibelio* (Bloch) nizovia Dunaia. (Materials on ecology of silver caras *Carasius auratus gibelio* (Bloch) in the lower parts of Dun river). (In Russian) *Voprosi Ikhtiologii,* 15(3):456-462.

Ludwig, J. A. and J. F. Reynolds (1988). *Statistical Ecology, A primer on methods and computing*. New York: John Wiley & Sons Inc.

Makeeva, A. P. and M. I. Zakimohamad (1982). Razmnozhenie i razvitie psevdorasbori (*Pseudorasbora parva*) v vodoemakh Srednoi Azii. (Reproduction and development of *Pseudorasbora parva*). (In Russian) *Voprosi Ikhtiologii,* 22(1): 80-92.

Rapport (1998). Assessing ecosystem health. *Trends in Ecology and Evolution,* 13: 397-402.

Rosechi (2001). Can life-history traits predict the fate of introduced species? A case study on two cyprinid fish in southern France. *Freshwater Biology,* 46: 845-853.

Scott, D.A. (1995). *A directory of wetlands in the Middle East*. IUCN: the World Conservation Union.