Iranian Journal of Animal Biosystematics (IJAB)
Vol. 1, No. 1, 1-13, 2006
ISSN: 1735-434X

Endemicity in the Freshwater Fishes of Iran

BRIAN W. COAD*

Canadian Museum of Nature,P. O. Box 3443, Station D,Ottawa, Ontario, Canada K1P 6P4

Iran contains 33 named endemic fish species, which together with undescribed taxa, approximates one-third of the ichthyofauna. Endemism in relatively large species such as fishes, which are better known systematically than other taxa, can often serve to indicate areas in need conservation. An analysis of endemicity is given in terms of systematics, distribution and ecology.

Key words: Iran, freshwater fishes, endemics, systematics, distribution, ecology

INTRODUCTION

Endemic fishes are an important part of the natural heritage of a country. Their conservation has implications on a world-wide basis since, by definition, an endemic taxon is one found nowhere else. Areas with significant numbers of endemics and/or systematically significant endemics are prime candidates for conservation. Fishes are generally better known then many other, smaller, aquatic organisms, particularly in large and geographically diverse areas without an extensive history of systematic research like Iran. On this basis they can be useful indicators of areas of concern for management decisions about biodiversity conservation priorities.

Iran lacks an annual surplus of water and seasonal surpluses are only important in the Zagros and Elburz mountain chains. As a consequence, springs and artificial means of water abstraction and storage are very important over much of Iran, while rivers and streams show wide variations in flow and are often dry over much of their length (Coad, 1996b). Lakes are rare and mostly very small; most lakes visible on maps of Iran are salty and fishless. Fish habitats are therefore limited and many are small and isolated, and the potential for endemism is high.

Endemic fishes are under a particular threat through population growth; the number of people in Iran has doubled over the last 20 years to about 70 million. This growth causes heavy demands on water resources for domestic purposes, for industry, and for agriculture. Growth also causes increased pollution, a continuing problem which is difficult to control. Additionally, growth in population has resulted in a policy of large scale transfers of fishes, both native and exotic, to increase protein production. These exotic species threaten native fishes, competing for habitat and food, consuming native species and introducing parasites and diseases (Coad, 1980a; 1996c; Coad and Abdoli, 1993).

This paper records the endemic fishes of Iran and analyses their endemicity in terms of systematics, distribution and ecology.

MATERIALS AND METHODS

The source materials on which this paper is based are the accumulated knowledge listed briefly in Coad (1995, 1998), extensive collections housed at the Canadian Museum of Nature, Ottawa and those examined at other museums, field studies carried out at various times and localities in Iran by me and by others who have shared their knowledge from 1976 until the present, and literature such

* bcoad@mus-nature.ca

as Nalbant and Bianco (1998). A complete bibliography on the Iranian ichthyofauna is given in Coad (2002).

An endemic is here defined as any species found solely in Iran. Some species are known only from endorheic basins within the political boundaries of Iran or have a very restricted distribution within an exorheic basin. Others are recorded from basins shared with neighbouring countries and may eventually be found there but as yet are known only from Iran. Exotic and transplanted species are not included in the analysis.

RESULTS

SYSTEMATICS

The endemic fish species are listed in Table 1 and a selection of species, showing variation in body form, is shown in Figure 1. They comprise 33 named species in 20 genera and 6 families. This represents 20.5% of the native ichthyofauna of 161 species recognised for this study. The related families Cyprinidae and Balitoridae together dominate with 26 species (or 78.5%) of the endemic fauna and 16.1% of the total freshwater ichthyofauna. The family Cyprinidae is comprised of 20.0% endemic species and the family Balitioridae of 52.4% endemics. Both these families also dominate the non-endemic fauna with 75 species (or 46.6%) and 21 species (or 13.0%) of the total fish species respectively. The only other speciose families are the Gobiidae (18 species or 11.2% of the total ichthyofanua) and the Clupeidae (9 species or 5.6%), both with distributions centred in the Caspian Sea, but no Iranian endemics. The family Cyprinodontidae is an unusual case where endemism is very high, 4 out of 6 described species and several more undescribed endemics.

The earliest described endemic species is *Capoeta aculeata* in 1844, with 12 other species from the 19th century. More than a third (13 species or 39.4%) of the species have been described in the last 25 years of the 20th century. This is to be expected as new discoveries are mostly of species with restricted distributions and in groups which need taxonomic revision. Systematically significant endemics include a cichlid, two cave fishes, and a hot spring fish. The cichlid (*Iranocichla hormuzensis*) is the only member of its family in Iran, is an endemic genus too and is geographically remote from related species. Its relationships lie with the Levant and Africa and have been reviewed by Coad (1982). The two fishes from a single cave system (see Figure 3) at Kaaje-ru in the Tigris River drainage of Lorestan Province are a cyprinid (*Iranocypris typhlops*) and a balitorid (*Paracobitis smithi*). Their relationships to surface taxa with normal eyes and pigmentation are unknown. They are important in studies of evolution in unique environments and as potential aquarium fishes (Coad, 1996d). The hot spring fish is a tooth-carp or cyprinodontid, *Aphanius ginaonis*, found in the Ab Garm-e Ganow (or Genu) near Bandar Abbas in southern Iran (see Figure 4). Morphologically distinct from *A. dispar* of neighbouring waters (Coad, 1980b), it is regarded as conspecific by some authors. Berg (1949) places this species in the synonymy of *Aphanius dispar* and Villwock *et al.* (1983) regard it tentatively as a synonym of *Aphanius dispar*. Wildekamp (1993) is of the opinion that it may be a subspecies of *Aphanius dispar*. Hrbek and Meyer (2003) using mtDNA found this species to be deeply nested within the *A. dispar* clade. Villwock (2004) has used cross-breeding experiments that demonstrate this taxon and *A. dispar* are comparable to intraspecific crosses in other taxa. Evidently this taxon, and probably others, requires further work to be fully resolved. Other populations of tooth-carps in hot springs in southern Iran show less morphological distinctions and this population is valuable in lending itself to studies of speciation, adaptation and variation in response to high temperatures.

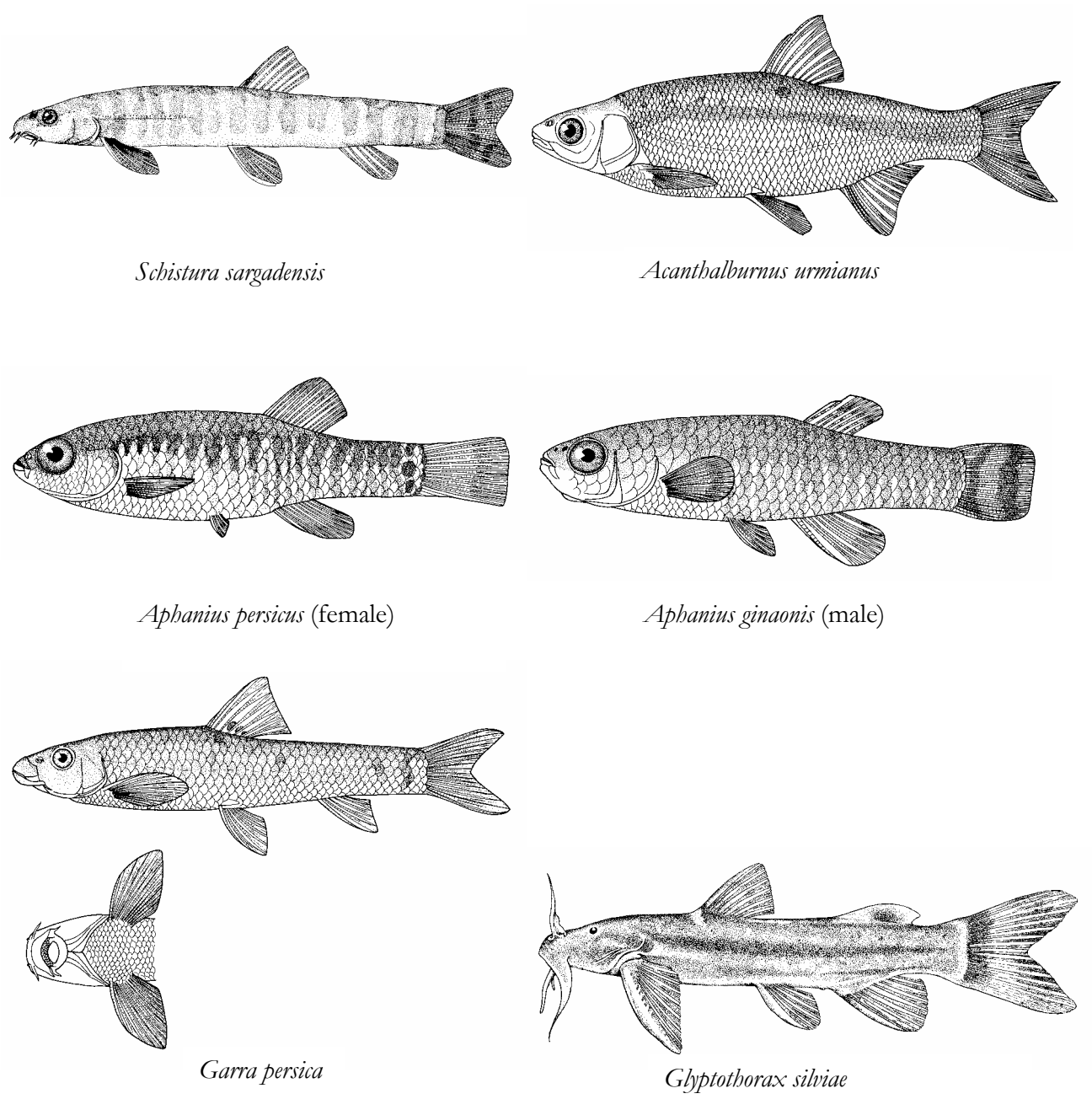

FIG. 1.– Selected endemic species, showing variation in body form

The proportion of endemics is expected to rise as further studies on this ichthyofauna are carried out. New species are usually described from one or a few localities and are consequently often endemic. Some of these taxa are listed in Table 2 and commented on below. As some are actively being worked on, or are in press, their names cannot be cited to avoid *nomina nuda*.

Populations of *Alburnoides cf. bipunctatus* occur in the Lake Orumiyeh (= Urmia), Namak Lake, Kor River, Esfahan and Tigris River basins and their distinction from *A. bipunctatus* of the Caspian Sea basin or European waters remains to be resolved. They could be part of a species complex,

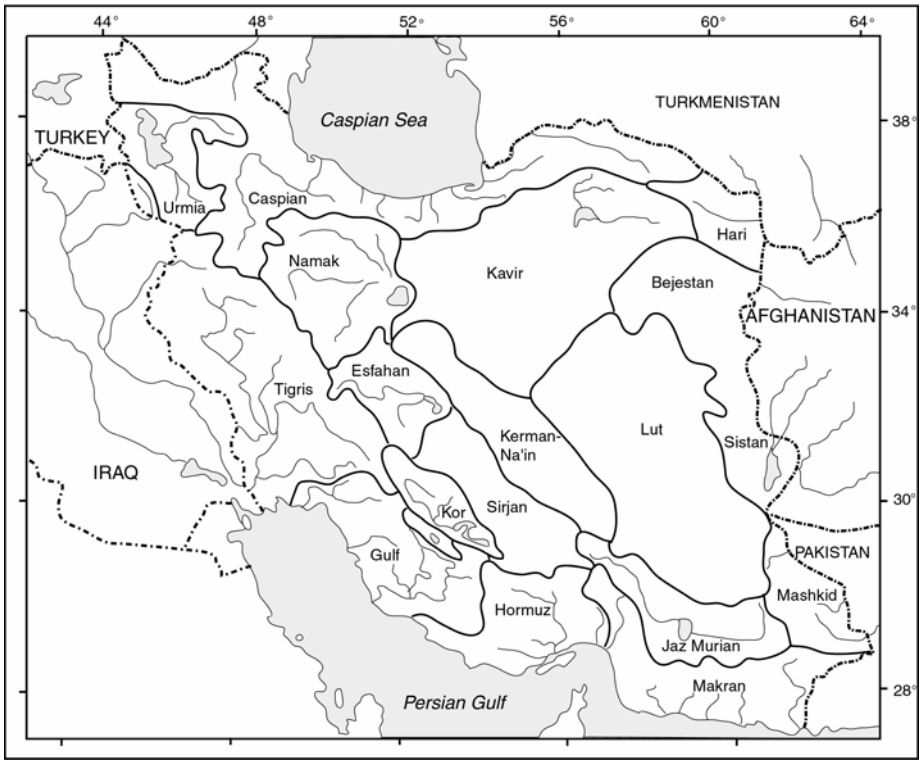

FIG. 2.– Drainage basins of Iran

subspecies or distinct species of this widespread and variable taxon. Interpretation of the available data will depend on the species philosophy followed (Kottelat, 1997), and may require molecular work to resolve questions on distinctiveness. The balitorid *Paracobitis malapterura* is a parallel case. This also applies to populations of other species with wide distributions which show some differences in morphology between isolated basins and/or have an extensive synonymy but still require further work to tease out possible distinct taxa, e.g. the cyprinids *Barbus lacerta*, *Capoeta damascina, Chalcalburnus mossulensis* and *Cyprinion watsoni*.

The cyprinodont genus *Aphanius* has named taxa which are Iranian endemics and also populations isolated in other basins which show different colour patterns. These patterns are recognised in reproduction and are isolating mechanisms. Morphology is conservative and distinction on this basis is not always possible. Molecular evidence has demonstrated that some of these basins harbour new species, currently under investigation.

The trout, *Salmo trutta*, has a population in the Liqvanchai, a stream of the Lake Orumiyeh basin in northwest Iran. The colour pattern is distinctive and this may be a new subspecies or species. There are some other named subspecies in Iran which require further detailed work to determine their status. If they are elevated to species, then they would be endemics, e.g. the cyprinids *Capoeta barroisi persica* from the Tigris River basin and *C. b. mandica* from the Gulf basin. Other taxa with named subspecies, potentially species on the pragmatic species concept after Kottelat (1997), have been found to show populational or clinal variation, e.g. see Coad (1996a) on *Chalcalburnus chalcoides* in the Iranian Caspian Sea basin. These taxa are omitted from consideration here.

Resolution of many of these systematic problems will depend on the collection of large series of adults from varied localities, some remote and hard of access or, of necessity, type localities, comparative material from other countries, and the application of modern, molecular techniques (see also Coad (1998) for further comments on this problem).

TABLE 1.– List of the endemic freshwater fishes of Iran (# = potentially occurring in neighbouring countries as waters are contiguous).

Family 1. Cyprinidae
1. *Acanthalburnus urmianus* (Günther, 1899)
2. *Barbus miliaris* De Filippi, 1863
3. #*Capoeta aculeata* (Valenciennes in Cuvier and Valenciennes, 1844)
4. *Capoeta buhsei* Kessler, 1877
5. #*Capoeta fusca* Nikol'skii, 1897
6. *Chalcalburnus atropatenae* (Berg, 1925)
7. *Chondrostoma orientalis* Bianco and Banarescu, 1982
8. *Cyprinion tenuiradius* Heckel, 1849
9. *Garra persica* Berg, 1913
10. *Iranocypris typhlops* Bruun and Kaiser, 1944
11. *Kosswigobarbus sublimus* (Coad and Najafpour, 1997)
12. *Petroleuciscus persidis* (Coad, 1981)
13. *Petroleuciscus ulanus* (Günther, 1899)
14. *Romanogobio persus* (Günther, 1899)
15. #*Schizocypris altidorsalis* Bianco and Banarescu, 1982

Family 2. Cobitidae
1. *Cobitis linea* (Heckel, 1849)

Family 3. Balitoridae
1. *Barbatula bergiana* (Derzhavin, 1934)
2. *Barbatula farsica* (Nalbant and Bianco, 1998)
3. *Barbatula kermanshahensis* (Bănărescu and Nalbant, 1967)
4. *Barbatula persa* (Heckel, 1849)
5. *Paracobitis iranica* Nalbant and Bianco, 1998
6. *Paracobitis smithi* (Greenwood, 1976)
7. #*Paracobitis vignai* Nalbant and Bianco, 1998
8. #*Schistura bampurensis* (Nikol'skii, 1899)
9. *Schistura nielseni* Nalbant and Bianco, 1998
10. #*Schistura sargadensis* (Nikol'skii, 1899)
11. *Seminemacheilus tongiorgii* Nalbant and Bianco, 1998

Family 4. Sisoridae
1. *Glyptothorax silviae* Coad, 1981

Family 5. Cyprinodontidae
1. *Aphanius ginaonis* (Holly, 1929)
2. *Aphanius persicus* (Jenkins, 1910)
3. *Aphanius sophiae* (Heckel, 1849)
4. *Aphanius vladykovi* Coad, 1988

Family 6. Cichlidae
1. *Iranocichla hormuzensis* Coad, 1982

DISTRIBUTION

The endemics are distributed in 18 of 19 drainage basins considered here, of which 7 are also shared with other countries (Figure 2).

Unequivocal endemics as presently understood number 27 or 81.8% of the total endemics. In Table 1, those species which may also occur in neighbouring countries are marked with an octothorpe.

Table 2 shows the distribution of endemics within Iran. Those basins shared with neighbouring countries and the Iranian species that may eventually be found there, are indicated, although there are no confirmed records. Some species within an Iranian basin shared with a neighbouring country have a known and limited distribution (caves, rivers remote from the main basin) and are true Iranian endemics. Large basins such as the Caspian Sea, Tigris River and Sistan have a wide variety of endemics that are not yet, or are unlikely, to be found in Iran and this potentially shared endemic fauna is not reported on here. Their survival, management and conservation would not be solely under Iranian jurisdiction, e.g. endemicity is not reported from three speciose families, the Clupeidae, Cyprinidae and Gobiidae in the Caspian Sea, an area which is not wholly encompassed within the political boundaries of Iran and which consequently has free contact with extraterritorial waters.

Endemicity in the Caspian Sea basin of Iran is low (1 out of 76 species or 1.3%) but high for the whole basin (50 out 134 or 37.3%) indicating that the Iranian fauna is a subset of that for the whole basin, comprising almost exclusively the commoner, non-endemic species. A similar situation is found in the Tigris River basin where there are a fewer Iranian endemics (8, two of which are in a single cave locality) while for the whole basin there are 64 species with 33 endemics (51.6%). The Sistan basin has 22 species total, 10 endemic (45.5%) and the Iranian endemics listed are doubtless found in Afghanistan too as they are described from the Sistan lowlands where the *hamuns* or freshwater marshes are contiguous. Other transboundary basins have a more restricted fauna with 0-1 endemics (Makran: 19 species, 1 endemic; Mashkid: 13 species, 1 endemic; Bejestan: 3 species, 0 endemics; Hari River 13 species, 1 endemic).

There are three types of endemic distribution in Iran, dealt with below:

a) Highly localised

These are species known only from a single point locality. Point localities are constrained by an unusual environment. The two species of cave fishes in the Tigris River basin and a hot spring species in the Hormuz basin are highly localised taxa as mentioned above. Some new taxa are known only from a single locality but this may be an artefact of collecting as there are no immediate geographical or ecological restrictions to them being more widespread within their drainage basin. Some endemics are restricted to a single river, e.g. *Kosswigobarbus sublimus* known only from a stream in the Tigris River basin.

b) Single basin

Seventeen endemics are known only from a single basin, although they may occur in a wide range of localities within that basin (excludes the single basin, highly localised species above).

c) Multi-basin

One species, the cyprinid *Capoeta aculeata*, is recorded from 6 basins and is the most widespread Iranian endemic. Two species, the cyprinid *Capoeta fusca* and the balitorid *Schistura bampurensis* are found from 4 basins, 2 species are found in 3 basins, and 8 species in 2 basins.

The basins with the most endemics are in descending order the Tigris and Kor River basins (both with 8 species), and the Gulf and Namak Lake basins (both with 6 species). The Hormuz basin has 5 species and Lake Orumiyeh 4 species. The remaining basins have 0-3 species. The basins with most endemics restricted to that basin are the Tigris River basin with 5 species, the Orumiyeh basin with 4 species, and the Hormuz and Namak Lake basins, both with 3 species. Other basins have 0-2 restricted endemics. Although the Gulf basin has 6 endemics, all are shared with other basins.

TABLE 2.– Distribution of endemics within Iranian basins.

* = endemic to this basin alone or narrowly confined to Iran within a shared basin, # = basin shared with neighbouring countries and species potentially shared too. Species without an asterisk (*) superscript are endemics found in more than one basin.

Basin	Total fauna	% basin endemics	% total endemics	Species
#Caspian Sea	76	1.3	1.3	*Barbatula bergiana*
Lake Orumiyeh (= Urmia)	11	36.4	36.4	**Acanthalburnus urmianus, *Chalcalburnus atropatenae, *Romanogobio persus, *Petroleuciscus ulanus*
#Tigris River	49	12.2	16.3	*#Capoeta aculeata, *Iranocypris typhlops, *Kosswigobarbus sublimus *Barbatula kermanshahensis, Schistura nielseni, *Paracobitis smithi, Glyptothorax silviae, *Aphanius vladykovi*
Namak Lake	13	23.1	46.2	**Barbus miliaris, *Capoeta buhsei, Capoeta aculeata, Barbatula bergiana, Barbatula farsica, *Paracobitis iranica*
Esfahan	6	0	16.7	*Capoeta aculeata*
Kor River	16	12.5	50.0	*Capoeta aculeata, *Chondrostoma orientalis, Cyprinion tenuiradius, Petroleuciscus persidis, Cobitis linea, Barbatula farsica, Barbatula persa, *Aphanius sophiae*
Lake Maharlu	7	14.3	28.6	*Barbatula persa, *Aphanius persicus*
Gulf	21	0	28.6	*Cyprinion tenuiradius, Petroleuciscus persidis, Cobitis linea, Barbatula farsica, Schistura nielseni, Glyptothorax silviae*
Hormuz	21	14.3	23.8	*Garra persica, Petroleuciscus persidis, *Seminemacheilus tongiorgii, *Aphanius ginaonis, *Iranocichla hormuzensis*
Kerman-Na'in	2	0	50.0	*Capoeta aculeata*
Sirjan	2	0	0	None
Jaz Murian	9	0	22.2	*Garra persica, Schistura bampurensis, Schistura sargadensis*
#Makran	13	7.7	0	*#Schistura bampurensis*
#Mashkid	8	25.0	0	*#Schistura bampurensis, #Schistura sargadensis*
Lut	5	40.0	0	*Capoeta fusca, Schistura bampurensis*
#Sistan	14	21.4	0-14.3	*#Capoeta fusca, *#Schizocypris altidorsalis, *#Paracobitis vignai*
#Bejestan	3	33.3	0	*#Capoeta fusca*
Kavir	3	33.3	0	*Capoeta aculeata*
#Hari River	12	8.3	0	*#Capoeta fusca*

The Tigris River basin is large and diverse such that a high number of endemics and of endemics restricted to it are to be expected. Much smaller basins have significant numbers of endemics, such as the Kor River, Namak Lake and Lake Orumiyeh basins but these are all endorheic and have been isolated from neighbouring basins for varying lengths of geological time (Coad and Holčík, 1999). A variety of endemics (mainly Balitoridae) are described from rivers in the Sistan basin in Afghanistan but have no records for the lowland marshes and river affluents in Iran. The large Caspian Sea basin contains a number of endemic species but none are restricted solely to Iranian waters.

ECOLOGY

Ecological interactions of endemic taxa have been little studied in Iran and their environmental requirements are poorly known. Diet, reproductive modes and preferred habitats are also unknown or based on a few anecdotal notes. Statements must be of a general nature based more on the family and genus characters than on specific studies of the species.

The habitats of endemic species are similar to those of related, non-endemic species with the obvious exception of the cave fishes and the hot spring cyprinodontid. Even streams and rivers not fed by subterranean waters have temperatures in the high 30sºC in southern Iran where some of these endemic species are found. Lakes and ponds are rare and most habitats are streams and rivers, often with little riparian vegetation and no shade, with pebble, rock and stone bottoms. The available foods are aufwuchs (encrusting algae and associated invertebrates) and filamentous algae with its associated invertebrates. Most fish are therefore grazers or feed on invertebrates under rocks or among pebbles. None are piscivores

The cyprinids are predominately bottom feeders as evidenced by ventral mouths in more than two-thirds of the species and for those with known diets.The cobitids and balitorids are small and cryptic fishes, usually found under stones or in gravel or mud and feed principally on small invertebrates. The sisorid catfish is also found under rocks and stones in rivers and has a similar diet. The cyprinodontids are found in springs and streams where temperatures and salinity can be very high. Competition with other native species is limited under the more extreme conditions where these fishes are found, although the introduced mosquitofish (*Gambusia holbrooki*) is a competitor. The diet of cyprinodontids is filamentous algae and associated invertebrates despite the upturned mouth which might suggest surface feeding. Maturity in these fish is attained in one year so they can quickly replace their numbers. The cichlid feeds on filamentous algae, diatoms and associated invertebrates. The cichlid builds and defends nests and is a mouth brooder so young are well-protected in the open waters of the streams where it is found.

Coad (2000) assessed the conservation status of the Iranian ichthyofauna. Endemic species that scored high on the system used include, as might be expected, the two cave fishes and the hot spring cyprindontid which have highly restricted distributions susceptible to one time events eliminating the species, such as pollution. Other species generally have a fairly wide distribution in more than one water body, albeit within a single basin in some cases. Threats to these species are similar to non-endemics, water abstraction, pollution and habitat alteration. None are food fishes or taken incidentally in commercial catches. There is a possibility that the cave fishes and the cyprinodontids may come under threat from collecting for aquaria, as these are unusual and visually attractive fishes respectively. The cave site and the hot spring should be monitored more closely although they are both under some form of legal protection (Coad, 2002).

Endemic species were compared with non-endemics for total length. The mean length of non-endemics was 60.4 mm and for endemics 11.8 mm, significantly different ($p<0.001$). Within the family Cyprinidae this relationship held too (means 49.9 mm and 15.9 mm, $p<0.001$) but not within the Balitoridae (means11.6 mm and 7.9 mm, $p>0.05$). Generally, endemic species are smaller than

TABLE 3.– Some new taxa from Iran (in press and potential)

Family Cyprinidae
1. *Alburnoides cf. bipunctatus*
2. *Chalcalburnus* sp. by J. Holčík
3. *Leuciscus* sp. Esfahan
4. *Leuciscus* sp. Tigris River
Family Salmonidae
1. *Salmo trutta* Liqvanchai
Family Cobitidae
1. *Cobitis* sp. Tigris River
Family Balitoridae
1. *Paracobitis cf. malapterura* Kor River
2. *Paracobitis cf. malapterura* Tigris River
3. *Nov. gen. et sp.* Tigris River
Family Cyprinodontidae
1. *Aphanius* sp. Namak Lake
2. *Aphanius* sp. Damghan
3. *Aphanius* sp. Esfahan
4. *Aphanius* sp. Tigris River

non-endemics, although this relationship does not hold within the Balitoridae which are mostly small and cryptic species. The generally small size of endemics is a function of discovery, smaller species being less obvious and discovered later than the larger and more easily observed species. Date of scientific description plotted against size of fish has a significant Pearson correlation coefficient of 0.79, indicating that endemics are later discoveries than more widespread species.

CONCLUSIONS

The Iranian endemic ichthyofauna forms a significant part of the total species known from that country. It is estimated that about one-third of the fauna will prove to be endemic once poorly-known groups such as the balitorids are fully documented. Most species have a fairly wide distribution, even those known from within a single basin and are not under immediate threat. Certain species with restricted distributions do require enhanced conservation efforts and some of the rarer species could be developed for the aquarium trade. This would ensure their continued survival assuming that the capture of wild specimens is carefully controlled.

ACKNOWLEDGEMENTS

I am indebted to Noel Alfonso and Krystal Lapierre, Canadian Museum of Nature (CMN) for statistical analyses and image manipulation. Dr. Alison Murray, CMN, re-drew the map electronically from a print original.

LITERATURE CITED

BERG, L. S. 1949. Presnovodnye ryby Irana i sopredel'nykh stran [Freshwater fishes of Iran and adjacent countries]. Trudy Zoologicheskogo Instituta Akademii Nauk SSSR, 8:783-858.

COAD, B. W. 1980a. Environmental change and its impact on the freshwater fishes of Iran. Biological Conservation, 19(1):51-80.

COAD, B. W. 1980b. A re-description of *Aphanius ginaonis* (Holly, 1929) from southern Iran (Osteichthyes: Cyprinodontiformes). Journal of Natural History, 14(1):33-40.

COAD, B. W. 1982. A new genus and species of cichlid endemic to southern Iran. Copeia, 1982(1):28-37.

COAD, B. W. 1995. Freshwater Fishes of Iran. Acta Scientiarum Naturalium Academiae Scientiarum Bohemicae, Brno, 29(1):1-64.

COAD, B. W. 1996a. Systematics of the shah mahi, Chalcalburnus chalcoides (Güldenstädt, 1772), in the southern Caspian Sea basin (Actinopterygii: Cyprinidae). Zoology in the Middle East, 12:65-70.

COAD, B. W. 1996b. Fishes from the qanats of Iran. Publicaciones Especiales Instituto Español de Oceanografía, 21:63-79.

COAD, B. W. 1996c. Exotic and transplanted fishes in Southwest Asia. Publicaciones Especiales Instituto Español de Oceanografía, 21:81-106.

COAD, B. W. 1996d. Threatened fishes of the world: *Iranocypris typhlops* Bruun and Kaiser, 1944 (Cyprinidae). Environmental Biology of Fishes, 46(4):374.

COAD, B. W. 1998. Systematic biodiversity in the freshwater fishes of Iran. Italian Journal of Zoology, 65 (Supplement):101-108.

COAD, B. W. 2000. Criteria for assessing the conservation status of taxa (as applied to Iranian freshwater fishes). Biologia, Bratislava, 55(5):539-557.

COAD, B. W. 2002. Freshwater Fishes of Iran. First posted 26 February 2002 at www.briancoad.com, maintained by Brian W. Coad and Nicholas P. Coad, Pure Throttle Technologies Inc., Ottawa, Ontario.

COAD, B. W. AND ABDOLI, A. 1993. Exotic Fish Species in the Fresh Waters of Iran. Zoology in the Middle East, 9:65-80.

COAD, B. W. AND HOLČÍK, J. 1999. Systematics of the cyprinid fish *Chalcalburnus atropatenae* (Berg, 1925) from the Lake Orumiyeh basin in northwest Iran. Biologia, Bratislava, 54(2):179-186.
Hrbek, T. and Meyer, A. 2003. Closing of the Tethys Sea and the phylogeny of Eurasian killifishes (Cyprinodontiformes: Cyprinodontidae). Journal of Evolutionary Biology, 16(1):17-36.

KOTTELAT, M. 1997. European freshwater fishes. An heuristic checklist of the freshwater fishes of Europe (exclusive of former USSR), with an introduction for non-systematists and comments on nomenclature and conservation. Biologia, Bratislava, 52 (Supplement 5):1-271.

NALBANT, T. T. AND BIANCO, P. G. 1998. The loaches of Iran and adjacent regions with description of six new species (Cobitoidea). *Italian Journal of Zoology*, 65 (Supplement):109-123. (Proceedings of the Ninth Congress of European Ichthyologists (CEI-9) "Fish Biodiversity" organised in Naples at the University Federico II and held in Trieste - Italy, 24-30 August 1997).

VILLWOCK, W. 2004. Synopsis of classic and molecular investigations of Old Word (*sic*) cyprinodontids of the genus *Aphanius* Nardo, 1827 (Teleostei: Cyprinodontidae), with special concern of the Anatolian species, their speciation phenomena and their probable historic development. Mitteilungen aus dem hamburgischen zoologischen Museum und Institut, 101:35-46.

VILLWOCK, W., SCHOLL, A. AND KRUPP, F. 1983. Zur Taxonomie, Verbreitung und Speziation des Formenkreises *Aphanius dispar* (Rüppell, 1828) und Beschreibung von *Aphanius sirhani* n. sp. (Pisces: Cyprinodontidae). Mitteilungen aus dem hamburgischen zoologischen Museum und Institut, 80:251-277.

WILDEKAMP, R. H. 1993. A world of killies. Atlas of the oviparous cyprinodontiform fishes of the world. Volume 1. The genera *Adamas*, *Adinia*, *Aphanius*, *Aphyoplatys* and *Aphyosemion*. Edited by B. R. Watters. American Killifish Association, Mishawaka, Indiana. 311 pp.

FIG. 3. – The cave habitat of Kaaj-ru at 33°04'N, 48°37'E in the Dez River drainage, Lorestan, with R. Mehrani

FIG. 4. – The hot spring Ab Garm-e Ganow at 27°27'N, 56°19'E. View downstream just above the fault line which isolates the fish in the spring

FIG. 5. – A'la River at Pol-e Tighen, Khuzestan, type locality of *Kosswigobarbus sublimes*

FIG. 6. – *Iranocichla hormuzensis*, breeding male, aquarium specimen courtesy of Thomas Schulz.

FIG. 7. – *Kosswigobarbus sublimus*, from the type locality, A'la River at Pol-e Tighen, Khuzestan.

FIG. 8. – *Iranocypris typhlops*, from the type locality, Kaaj-ru, courtesy of R. Mehrani.

FIG. 9. – *Salmo trutta* from the Liqvanchai, courtesy of A . Asghar.