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Does the river blenny *Salaria fluviatilis* (Asso, 1801) (Actinopterygii: Perciformes) still survive on the Mediterranean island of Cyprus?

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The river blenny (*Salaria fluviatilis*) is rarely mentioned in the natural history literature of Cyprus. This has led to doubts about its existence there. Mistakes with mismatched fish collections have occurred in the past, so it is worth asking whether the recorded specimens are actually from Cyprus and whether the species survives there today. Archived correspondence from the original specimen collector confirms that the record of *S. fluviatilis* on Cyprus is genuine, yet our extensive surveys there during the last 4 years have failed to locate the fish. A review of the species' Mediterranean island distribution shows that it exists on 10 islands that are either close to the mainland or are relatively very large in areal extent. Although the mystery of *S. fluviatilis* survival on Cyprus lingers, efforts must be made to survey all potential habitats and consider planning a re-introduction project if the population is confirmed as extinct.

Keywords: *Salaria fluviatilis*; conservation; island populations; extinction; Cyprus

Introduction

The river blenny (*Salaria fluviatilis* Asso, 1801) is very rarely mentioned in the natural history literature of Cyprus. This has led to doubts about the species' presence on the island. Mistakes with misplaced and mismatched fish collections have occurred in the past, so it is worth confirming that the species really exists in Cyprus (Zogaris et al. 2012a).

The uncertain status of *S. fluviatilis* on Cyprus is an obstacle for conservation. Even during a policy-relevant review of taxa of importance for conservation when Cyprus entered the European Union in 2004, the existence of the species was not presented in official species lists and therefore no special conservation measures were granted to this taxon or its habitat (Hadjisterikotis pers. comm.). Some researchers do not trust that the species was ever found on the island and the species is not given in inland-water fish lists or literature reviews (Charalambidou and Gücel 2009). Also during a recent phylogenetic survey of the species across the Mediterranean, the Cyprus population was not referred to (Almada et al. 2009); although other insular populations, and especially populations on the edge of the species' distribution, which are of increased phylogenetic interest, have been actively investigated (Perdices et al. 2000; Kottelat 2004). Cyprus lies near the eastern edge of the species' potential distribution. Here we review the status of the species' occurrence on Cyprus and,

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with respect to other Mediterranean islands, we consider local conservation requirements.

Salaria fluviatilis has a near circum-Mediterranean distribution, but is known from just 10 Mediterranean islands. In the Eastern Mediterranean it is found on the islands of Ikaria, Lesvos, Kerkyra, Crete, Rhodes and Euboea (Bianco et al. 1996 ; Koutsikos et al. 2012) and it is also recorded from Cyprus (Bath 2003). In the western Mediterranean it is found on Sicily, Sardinia and Corsica but is absent from many islands where perennial streams are not well developed, such as in Dalmatia or the smaller western Mediterranean islands (Kottelat and Freyhof 2007; Froese and Pauly 2012). *Salaria fluviatilis* is mainly a riverine species but can also be found in brackish river mouths, lakes and reservoirs (Changeux and Pont 1995; Neat et al. 2003); it will seasonally tolerate brackish conditions but has fully adapted to survive and reproduce in freshwaters (Plaut 1998). It prefers cobble and gravel substrate usually in streams with moderate to high current velocity; it is often found in the deeper parts of streams (Freeman et al. 1990) and also quite high and far from the river mouths, sometimes even above 500 m elevation (Alp and Kara 2007). The males make a nest under large stones and the larvae are pelagic, so areas with still waters in the streams are also required (Vinyoles and de Sostoa 2007). This small fish is sometimes difficult to catch or to observe; consequently it is often difficult to know its status, and new distributional records have come to light (e.g. El-Absy and Mir 1986; Crivelli 2006; Alp and Kara 2007). *Salaria fluviatilis* is of considerable biogeographical interest because it is the only freshwater representative the Blenniidae to reproduce in freshwaters in the Mediterranean (Cote et al. 1999) and it is often one of the few fish occurring year-round in very small Mediterranean island and peninsular streams. This species is of high conservation interest because its marginal populations in the Eastern Mediterranean have been shown to have significant genetic divergence from the main lineage within this species (Almada et al. 2009). Some *S. fluviatilis* populations may represent cryptic species, as was recently found in Lake Trichonis, Greece (Kottelat 2004). Populations of *S. fluviatilis* are generally highly localized (Cote et al. 1999) and there is evidence of a decline in response to certain anthropogenic pressures (Vinyoles and de Sostoa 2007). Mediterranean islands may hold evolutionarily significant populations of this species and their lotic habitats are particularly susceptible to long droughts, anthropogenic river diversions engineered barriers to dispersal and pollution, so these island populations need careful monitoring (Crivelli 2006).

Material and methods

We reviewed the existence of the species in Cyprus in the literature and in the collection of The Natural History Museum, London, UK. We also reviewed records of an extensive fish survey recently carried out on Cyprus (partially published in Zogaris et al. 2012a). The survey explored streams and wetlands using two sets of battery-powered backpack electrofishing equipment (SR-L24 and a Bulgarian custom-made unit), a fry net, and interviews during the spring–summer periods of 2009, 2010, 2011 and 2012. Within a total field work period of 64 field days, 170 sites were sampled (155 were electrofished) in 31 independent river basins primarily on the western and southern parts of the island. Seventy-eight sites (46%) had no fish (Figure 1) and native fishes were remarkably scarce (Zogaris et al. 2012a). Using a simple two-page questionnaire, interviews referring to the presence of fishes

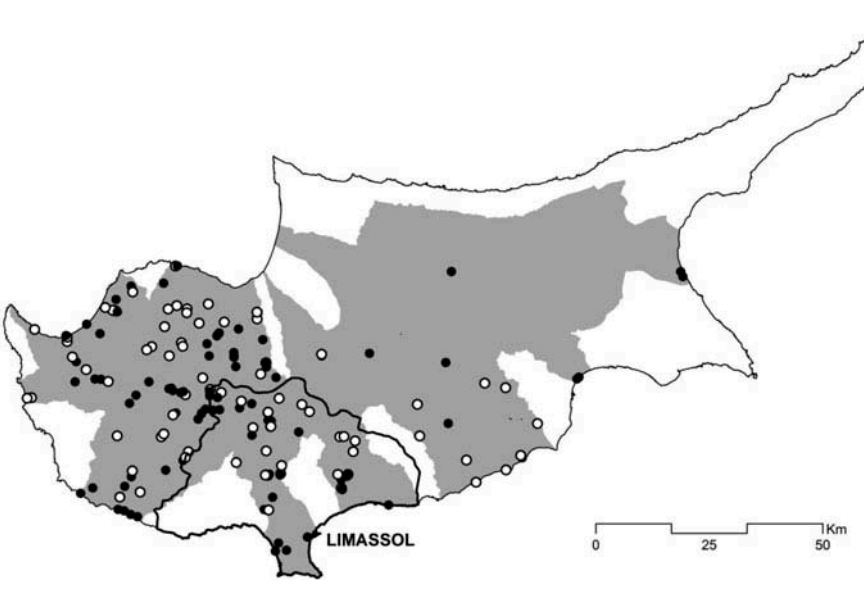

Figure 1. Map of all sampled sites (n = 170); black dots represent sites with fish present; white dot sites had no fish present during the survey. Grey areas show the river basins (n = 31) that were explored. The outline shows the legislative boundaries of the District of Limassol (were the presence of the *S. fluviatilis* was confirmed in 1909).

(especially the eel *Anguilla anguilla*) in particular reaches were undertaken with 149 local inhabitants and experts on Cyprus. This questionnaire was administered primarily to natural resource experts, villagers and naturalists, including knowledgeable government officials and wildlife resource users primarily in the southern part of the island; these data will soon be published in a review, but are partially available in the grey literature (Zogaris et al. 2012b). Finally, data on the presence of *S. fluviatilis* on other Mediterranean islands were collected, where knowledge exists of their complete freshwater ichthyofaunas (as reviewed in Crivelli 2006 and Kottelat and Freyhof 2007). A principal components analysis (PCA) ordination was employed to test whether the presence of *S. fluviatilis* on Mediterranean islands can be interpreted by key abiotic descriptors, such as an island's area, the shortest distance from the mainland, the highest peak of the island, and the mean annual precipitation. Given that the species is fairly widespread in freshwater streams along the Mediterranean coastline for validation of the abiotic descriptors, two more factors were employed, the longitude and the latitude. All data were log-transformed and analysis used the PRIMER 6β Statistical Package.

Results and discussion

Sampling and interviews

The sampling and questionnaire survey failed to find *S. fluviatilis* on Cyprus. Most of the researched sites were in the western and southern parts of the island so there may be potential for the species to exist in isolated areas of freshwater in the east

and north of Cyprus, however perennial lotic reaches are extremely scarce in that part of Cyprus. Of course there is also a possibility that the species is still present even in some inland waters that were checked using the methods employed in the present research. This may be due to: (1) the weakness of the particular sampling technique, (2) seasonal variability of species presence and habitat conditions, and/or (3) incomplete survey coverage (i.e. the entire volume/surface of the habitat could not be checked so the scarce species escaped detection). Of the 31 river basins explored; a representative sample of areas was surveyed presumably hosting adequate habitat conditions for fish survival (particularly in spring). Unfortunately, several sites with deeper water, or high-conductivity waters were not adequately surveyed and it is very difficult to report on the percentage of available appropriate habitat that was sampled. The last 3 years were climatically favourable with rather strong flows from winter to late spring throughout most of the surveyed basins.

The interviews also gave no concrete evidence concerning the species or its habitats; not a single individual who lived on the island was aware of the species, including scientists in relevant fisheries and wildlife conservation positions.

The museum specimens

To our knowledge the only preserved specimens of *S. fluviatilis* from Cyprus were collected by Roland L.N. Michell a British national, over a hundred years ago. R. L.N. Michell was not a naturalist or ichthyologist but we know he lived on Cyprus for a period and has written on Cypriot ethnography (Michell 1908). Michell's three existing samples are labelled *Blennius varus* (junior synonym of *Salaria fluviatilis*) and arrived at the museum in 1909. A letter produced by the collector of the three specimens of *S. fluviatilis* deposited in the Natural History Museum, London, shows that they were in fact collected in streams in the District of Limmasol, Cyprus (BMNH 1909.2.25.2-4). In his letter to Dr G.A. Boulenger, (28 January 1909) Michell states: "It [*S. fluviatilis*] is found in 2 or 3 of the torrents of this District [Limmasol]. Nearly all of these run dry (or very nearly dry) during the hottest months of summer. I have been trying for 4–5 years to obtain specimens without success, and have only recently succeeded in getting a few". The archived letter of Michell shows that the species was found in the southern part of Cyprus and that locals were probably aware of its presence, because locals finally brought the fish to him. In fact, our questionnaire showed that many of the older respondents frequently collected food items from streams (especially eel and freshwater crabs), so it should have been possible to know whether other fish species were present. Since this archived letter was found, there can be little doubt that these specimens are from Cyprus (see Appendix for a transcript of the full letter).

The three museum samples were re-checked and all morphologically match *S. fluviatilis*, and the diagnostic characteristics are evident. The best preserved specimen, an adult male (Figure 2) shows all the major distinguishing features as given in modern identification keys (Kottelat and Freyhof 2007). These specimens are preserved in 70% alcohol solution, they are partially shrivelled and meristic measurements need to be taken with care. However, DNA extraction may be possible for future phylogenetic investigations.

Figure 2. Recent photograph of adult male *S. fluviatilis* specimen deposited in 1909 from Cyprus. Natural History Museum, London, UK.

The Mediterranean island distribution of S. fluviatilis

It may be instructive to explore key environmental attributes of other Mediterranean islands that host *S. fluviatilis*. After data were gathered from an assortment of 12 islands that do not have *S. fluviatilis* and 10 that do, a PCA analysis was performed for four axes for the 22 islands (Table 1, Figure 3). The cumulative variation of the first two axes was 84.4% (Table 1), so it can be inferred that a plot based on these axes represents a sound ordination of the samples (islands). According to the results of the PCA, geographical location given by longitude and latitude factors is not important for the interpretation of the variation in the first two axes. The measure of areal extent that an island occupies is the most important descriptor for the first axis and the shortest distance from the mainland is the most important descriptor for the second axis (Table 1). Most of the islands inhabited by the *S. fluviatilis* are fairly close to the mainland and most are fairly large islands; only the largest islands away from the mainland host *S. fluviatilis*.

Why is S. fluviatilis *absent from Cyprus?*

Cyprus, being the third largest Mediterranean island, has adequate stream habitats with perennial flow and many irrigation reservoirs where *S. fluviatilis* could survive.

Table 1. The eigenvalues and the variation explained by the axes in the principal components (PC) analysis.

PC	Eigenvalues	%Variation	Cum. % variation
1	4.29	48.9	48.9
2	3.11	35.5	84.4
3	0.898	10.2	94.6
4	0.368	4.2	98.8

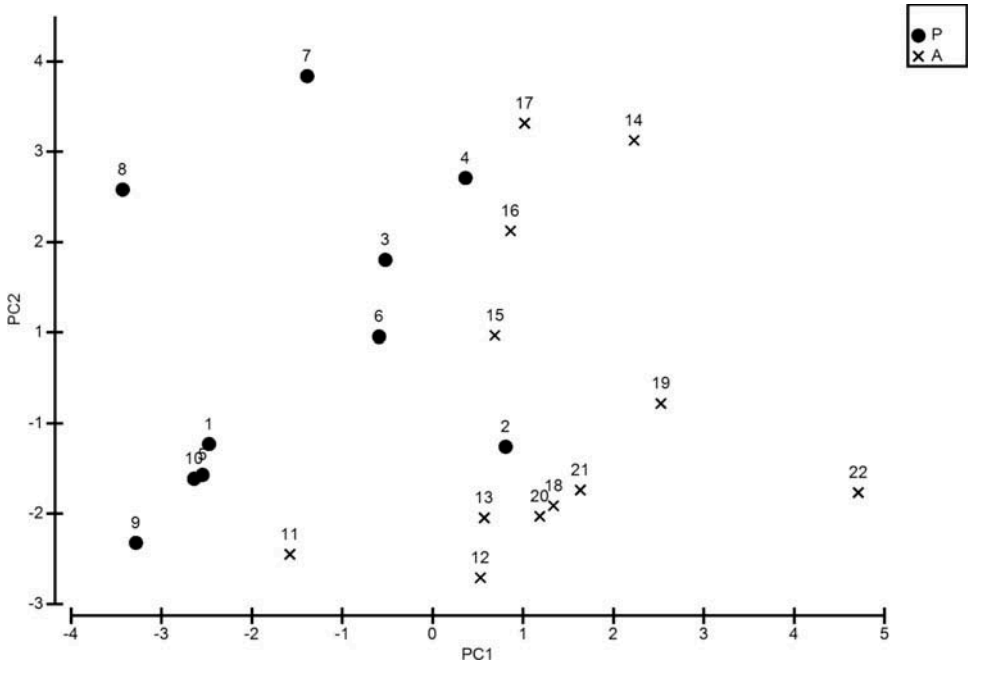

Figure 3. Principal components analysis ordination on the abiotic descriptors of 22 Mediterranean islands, including the 10 islands where *Salaria fluviatilis* is present (P) with black dots. The axes refer to island areal size and distance to mainland; and the numbers refer to the island numbers as in Table 2.

In fact, approximately 341 km of streams are considered as flowing perennially according to preliminary water body maps by the Water Development Department (unpublished data, G. Dörflinger pers. comm.). Although most of these are high-gradient mountain streams unsuitable for *S. fluviatilis*, we estimate that at least 20% of the perennial or partially perennial streams could host the species. Furthermore many perennial streams are connected to older dams that store water for irrigation, often below 500-m elevation; therefore, the species could have survived in at least a few of the older reservoirs. It is our opinion that extinction caused solely by natural forces (such as stream desiccation due to drought) is unlikely to have caused a total population collapse with respect to this species, on one of the Mediterranean's largest islands. The apparent scarcity of *S. fluviatilis* on Cyprus is unusual and may point to a recent anthropogenic extinction.

Many of the local respondents to interviews point to the widespread use of DDT for an intensive government anti-malarial campaign, which began in 1946 and ended in 1978. Questionnaire respondents frequently mentioned a "remarkable absence of freshwater crabs, semi-aquatic grass snakes, amphibians and fish", which they attributed to the prolonged and widespread DDT poisoning before the late 1970s (Zogaris et al. 2012b). During the DDT poisoning some aquatic species may have become remarkably range-restricted and/or have gone extinct from the island; the spraying coincides with the time of the extinction of the dipper (*Cinclus cinclus*), an obligate river bird (Flint and Stewart 1983). Other anthropogenic pressures that may have

Table 2. Investigated Mediterranean islands' characteristics and the presence (P) or confirmed absence (A) of *Salaria fluviatilis*.

A/A	Island	Area (km^2)	Max. altitude (m)	Distance from mainland (km)	Average precipitation (mm)	Latitude	Longitude	Presence of *S. fluviatilis*
1	Cyprus	9251	1952	70	498	35	33	P
2	Ikaria	255	1037	57	603	38	26	P
3	Lesvos	1633	968	7	750	39	26	P
4	Kerkyra	614	911	2	1089.7	40	20	P
5	Crete	8336	2456	96	497.84	35	25	P
6	Rhodes	1408	1216	18	687	36	28	P
7	Euboea	3684	1745	0.04	506	39	24	P
8	Sicily	25711	3326	3	611	38	14	P
9	Sardinia	24090	1834	187	426.72	40	9	P
10	Corsica	8680	2706	90	645.7	42	9	P
11	Majorca	3640	1364	167	427	40	3	A
12	Minorca	694	358	200	599	40	4	A
13	Ibiza	572	475	87	439	40	1	A
14	Djerba	514	52	0.4	219	34	10	A
15	Zakynthos	408	758	16	950	38	21	A
16	Cres	406	648	4	1064	45	14	A
17	Krk	406	568	0.5	1100	45	15	A
18	Milos	160	748	103	412	37	24	A
19	Leros	74	320	31	591.8	37	27	A
20	Paros	196	724	117	375.9	37	25	A
21	Malta	246	253	81	553.3	36	15	A
22	Pantelleria	83	5	65	484.6	37	12	A

Table 3. The coefficients in the linear combinations of variables making up the principal components (PC) (axes).

Variable	PC1	PC2	PC3	PC4
Area	−0.809	0.052	0.515	−0.253
Altitude	−0.584	0.039	−0.706	0.352
Distance	−0.066	−0.985	−0.078	−0.113
Precipitation	−0.007	0.076	−0.179	0.128
Latitude	−0.003	0.008	−0.005	0.075
Longitude	0.006	0.139	−0.446	−0.882

affected or synergistically precipitated the presumed *S. fluviatilis* decline/extinction are the widespread water abstraction points that have proliferated in Cyprus, especially since the 1960s. Cyprus currently has 108 dams, and many of the streams of the island are artificially intermittent or ephemeral in their flow below the major dams (Zogaris et al. 2012a). *Salaria fluviatilis* is vulnerable to habitat degradation and connectivity changes (Cote et al. 1999; Benejam et al. 2010) so the increased water exploitation has destroyed much suitable habitat. One may implicate alien species invasion as a problem for the species on Cyprus, as the number of carnivorous fish has increased in reservoirs and associated perennial streams (i.e. catfish, big-mouth bass, etc). However, in Spain, where *S. fluviatilis* was found in reservoirs almost as often as in rivers, the species showed an ability to coexist with invasive species both in lotic (e.g. Blanco-Garrido et al. 2009) and lentic (e.g. Garcıa-Berthou and Moreno-Amich 2000) environments. This coexistence has been related to the cryptic coloration and benthic habits of the species that would allow a lower predation pressure than that suffered by native cyprinids (Garcıa-Berthou and Moreno-Amich 2000). The species is tolerant of brackish or seawater salinity levels (Plaut 1998), which means that it could survive in isolated river-mouth pools or other pooling water during periods of extreme drought. Further research on the effects of widespread pesticide spraying may be the key to the presumed demise of this and other aquatic species, and this requires meticulous historical research.

From a conservation standpoint, the freshwaters of Cyprus are unique – they have a high degree of isolation from neighbouring Levantine and Anatolian lands (Por 1975; Abell et al. 2008; Plötner et al. 2012). There are very few ways in which Cyprus could be re-colonized by a freshwater fish if a species is lost. The island has been almost completely isolated from the mainland save for a relatively short period – during the Messinian Salinity Crisis (approx. 5.59–5.33 million years ago) (Baier et al. 2009). The ancestor of *S. fluviatilis*, a relative of the marine peacock blenny, *Salaria pavo*, is said to have been a euryhaline species, perhaps allowing incursions into freshwater and subsequent dispersal via the sea (Almada et al. 2009). The biogeographically confined and range-restricted Mediterranean island populations of *S. fluviatilis* point to the possibility that the species' distribution may have its origins in the different sea levels and salinity conditions following important geological events (such as glacial period sea-level fluctuations or older salinity fluctuations) and not in long pelagic migrations through current seawater conditions. Today, *S. fluviatilis* does not usually enter the sea and it reproduces solely in freshwater, but the almost circum-Mediterranean distribution of this species shows that it once somehow

reached offshore islands; and this explains its existence in several very small river basins on islands and peninsulas around the Mediterranean (Plaut 1998).

Risk of extinction of freshwater species due to long-term anthropogenic pressures is highly increased by natural vulnerabilities and biogeographical pressures that raise extinction rates of freshwater species on islands. Obviously the extinction pressures on seasonally semi-arid Mediterranean islands are heightened within restricted aquatic habitats, especially where small isolated river basins exist, such as on Cyprus. One would expect certain poor-dispersers, such as freshwater fish, to be particularly vulnerable to extinction on Cyprus. Island biogeographic constraints as well as increased climatic aridity have been shown to increase extinction rates of northern temperate reptile species on several Mediterranean islands (Foufopoulos et al. 2011). Cyprus's freshwater fauna is susceptible to a combination of climatic and long-term anthropogenic pressures (Davis et al. 1998; Hadjisterikotis et al. 2000).

Conservation implications

Current knowledge of Cyprus's inland waters suggests that the island's *S. fluviatilis* population may be extinct. Verification of local conservation status needs to be reached as soon as possible because this population is potentially of outstanding evolutionary interest, within a species that is known to harbour endemic cryptic taxa at the geographic margins of its range (Kottelat 2004; Almada et al. 2009). In the Greek Islands and along the coast of the Hellenic Peninsula it should be noted that *S. fluviatilis* was found in extremely short reaches of insular and peninsular river basins and some were partially intermittent; so the species can survive in restricted water bodies. It is imperative that a full exploration of all Cyprus's water bodies be executed before the species' local extinction is confirmed. The rarity or loss of *S. fluviatilis* from Cyprus is testament to the fact that Cyprus has witnessed a widespread degradation of large areas of unique and critical natural inland waters. However, adequate habitat for *S. fluviatilis* exists today on both upland areas and near reservoirs (and within some reservoirs), so the real problem is re-colonization. If the island's populations are extinct, human-assisted re-colonization through a scientific stocking programme should be implemented. A carefully planned re-introduction scheme may help fill a vacant niche, to restore the only freshwater-reproducing fish in Cyprus's streams.

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References

Abell R, Thieme ML, Revenga C, Bryer M, Kottelat M, Bogutskaya N, Coad B, Mandrak N, Contreras-Balderas S, Bussing W, et al. 2008. Freshwater ecoregions of the world: a new map of biogeographic units for freshwater biodiversity conservation. BioScience. 58:403–414.

Almada VC, Robalo JI, Levy A, Freyhof J, Bernardi G, Doadrio I. 2009. Phylogenetic analysis of peri-Mediterranean blennies of the genus *Salaria*: molecular insights on the colonization of freshwaters. Mol Phylogenet Evol. 52:424–431.

Alp A, Kara C. 2007. Distribution pattern and morphological differences between the sexes of River Blenny, *Salaria fluviatilis* (Asso, 1801), in the Ceyhan River Basin, Turkey. Turk J Zool. 31:113–120.

Baier F, Sparrow DJ, Wiedl HJ. 2009. The amphibians and reptiles of Cyprus. Edition Chimaira: Frankfurt am Main.

Bath H. 2003. The European freshwater blenny (Salaria fluviatilis). In: Miller PJ, editor. The freshwater fishes of Europe, Vol. 8/I, Mugilidae, Atherinidae, Atherinopsidae, Blenniidae, Odontobutidea, Gobiidae. Wiesbaden: AULA-Verlag.

Benejam L, Angermeier PL, Munné A, García-Berthou E. 2010. Assessing effects of water abstraction on fish assemblages in Mediterranean streams. Freshwater Biol. 55:628–642.

Bianco PG, Ahnlet H, Economidis PS. 1996. The freshwater fishes from eastern, and large Mediterranean islands with comments on their safety status. Acta Univ Carol Biol. 40:45–60.

Blanco-Garrido F, Clavero M, Prenda J. 2009. Jarabugo (*Anaecypris hispanica*) and freshwater blenny (*Salaria fluviatilis*): habitat preferences and relationship with exotic fish species in the middle Guadiana basin. Limnetica. 28:139–148.

Changeux T, Pont D. 1995. Current status of the riverine fishes of the French Mediterranean basin. Biol Conserv. 72:137–158.

Charalambidou I, Gücel S. 2009. Bibliographic index of flora, fauna, biodiversity and nature conservation in Cyprus. Nicosia (Cyprus): UES-CCEIA/ESI/TCBA/GAG/. Unit of Environmental Studies (Cyprus Center of European and International Affairs).

Cote IM, Vinyoles D, Reynolds JD, Doadrioc I, Perdices A. 1999. Potential impacts of gravel extraction on Spanish populations of river blennies Salaria fuviatilis (Pisces, Blenniidae). Biol Conserv. 87:359–367.

Crivelli AJ. 2006. *Salaria fluviatilis*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2

Davis AJ, Jenkinson LS, Lawton JL, Shorrocks B, Wood S. 1998. Making mistakes when predicting shifts in species range in response to global warming. Nature. 391:783–786.

El-Absy AH, Mir S. 1986. A new record of *Blennius fluviatilis* from Jordan. Zool Middle East. 1:114–116.

Flint PR, Stewart PF. 1983. The birds of Cyprus: an annotated check-list. B.O.U. Check-List No. 6. London: British Ornithologists' Union.

Foufopoulos J, Kilpatrick AM, Ives AR. 2011. Climate change and elevated extinction rates of reptiles from Mediterranean Islands. Am Nat. 177:119–129.

Freeman MC, Vinyoles D, Grossman GD, de Sostoa A. 1990. Microhabitat use by *Salaria fluviatilis* in the Rio Matarrana, Spain. Freshwater Biol. 24:335–345.

Froese R, Pauly D. 2012. "FishBase", World Wide Web electronic publication, version; [cited 2012 Aug]. Available from: www.fishbase.org

García-Berthou E, Moreno-Amich R. 2000. Introduction of exotic fish into a Mediterranean lake over a 90-year period. Arch Hydrobiol. 149:271–284.

Hadjisterikotis E, Masala B, Reese DS. 2000. The origin and extinction of the large endemic Pleistocene mammals of Cyprus. Biogeographia. 21:593–606.

Kottelat M. 2004. *Salaria economidisi*, a new species of freshwater fish from Lake Trichonis, Greece, with comments on variation in *S. fluviatilis* (Teleostei: Blenniidae). Rev Suisse Zool. 111:121–137.

Kottelat M, Freyhof J. 2007. Handbook of European freshwater fishes. Cornol (Switzerland): M. Kottelat.

Koutsikos N, Zogaris S, Vardakas L, Tachos V, Kalogianni E, Šanda R, Chatzinikolaou Y, Giakoumi S, Economidis PS, Economou AN. 2012. Recent contributions to the distribution of the freshwater ichthyofauna in Greece. Mediterr Mar Sci. 13:268–277.

Michell RLN. 1908 May. A Muslim-Christian sect in Cyprus. The Nineteenth Century. 63:751–762.

Neat FC, Lengkeek W, Westerbeek EP, Laarhoven B, Videler JJ. 2003. Behavioural and morphological differences between lake and river populations of *Salaria fluviatilis*. J Fish Biol. 63:374–387.

Perdices A, Doadrio I, Cote IM, Machordom A, Economidis PS, Reynolds JD. 2000. Genetic divergence and origin of Mediterranean populations of the river blenny *Salaria fluviatilis* (Teleostei: Blenniidae). Copeia. 3:723–731.

Plaut I. 1998. Comparison of salinity tolerance and osmoregulation in two closely related species of blennies from different habitats. Fish Phys Biochem. 19:181–188.

Plötner J, Baier F, Akın C, Mazepa G, Schreiber R, Beerli P, Litvinchuk SN, Bilgin CC, Borkin L, Uzzell T. 2012. Genetic data reveal that water frogs of Cyprus (genus Pelophylax) are an endemic species of Messinian origin. Zoosyst Evol. 88:261–283.

Por FD. 1975. An outline of the zoogeography of the Levant. Zool Scr. 4:5–20.

Vinyoles D, de Sostoa A. 2007. Life history traits of the endangered river blenny *Salaria fluviatilis* (Asso) and their implications for conservation. J Fish Biol. 70:1088–1108.

Zogaris S, Chatzinikolaou Y, Koutsikos N, Economou AN, Oikonomou E, Michaelides G, Hadjisterikotis E, Beaumont WRC, Ferreira MT. 2012a. Freshwater fish assemblages in Cyprus with emphasis on the effects of dams. Acta Ichthyol Piscat. 42:165–175.

Zogaris S, Chatzinikolaou Y, Koutsikos N, Oikonomou E, Giakoumi S, Economou AN, Vardakas L, Segurado P, Ferreira MT. 2012b. Assessment of fish assemblages in Cyprus Rivers for the implementation of Directive 2000/60/EC. Specialized Consultancy Services for the Assessment of Fish Assemblages in Cyprus Rivers – Implementation of the Directive 2000/60/EC. Final Report of Second Phase of the Project. Hellenic Center for Marine Research – Institute of Marine Biological Resources and Inland Waters/Instituto Superior de Agronomia, Universidade Técnica de Lisboa, pp. 153 plus Appendixes.

Appendix

Letter by Roland L.N. Michell courtesy of Natural History Museum Archives DF235/1/12/72, Department of Zoology, Departmental Correspondence, 1909. By permission of the Trustees of The Natural History Museum.

To Dr.G.A. Boulenger, Jan 28th .09

Dear Sir,

I venture to write a few lines regarding a small fish that is found in some of the torrents of Cyprus. When last in England I called on Prof. Ray Lankester (Nov.07) who advised me, in case of finding any new (or to me unknown) species, to apply to you. As I was leaving England the following day I was unable to have the pleasure of calling on you.

I am sending by today's post specimens of the little fish to which I refer. It is found in 2 or 3 of the torrents of this District [Limmasol]. Nearly all of these run dry (or very nearly dry) during the hottest months of summer. I have been trying for 4–5 years to obtain specimens without success, and have only recently succeeded in getting a few. I have been told by a Cypriot who has been to Greece that an exactly similar fish is found in some of the streams there (I have not the name he gave me at hand but will find it).

But this is contradicted by others.

I should be greatly obliged if you would examine the specimens (should this be convenient to you) and kindly let me know the name if known. In the event of you desiring to have more specimens I would find you some more.

Apologizing for thus troubling you, yours truly,

Roland L.N. Michell