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AGGIORNAMENTO SISTEMATICO DEI PESCI D' ACQUA DOLCE AUTOCTONI ITALIANI: PROPOSTA DI UN WORKSHOP

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Riassunto
Dalla monografia di Gandolfi et al. (1991) sui pesci d'acqua dolce italiani, tuttora in uso dalla maggior parte degli ittiologi e con l'avvento, a partire soprattutto dagli anni novanta, delle moderne indagini biomolecolari, e delle ipotesi biogeografiche sulla origini degli endemismi peri-mediterranei, molti aspetti tassonomici riguardanti le specie europee sono cambiati. Una sintesi di tutte queste novità è riportata nel recente manuale dei pesci d'acqua dolce europei di Kottelat & Freyhof (2007), dove vengono elencate circa 108 specie per l'Italia di cui 51 autoctone, 43 introdotte e 14 di origini marine o occasionali. Per quanto riguarda le autoctone, tra le 51 riportate circa 15 hanno subito cambiamento di specie, ovvero, riconosciute come endemismi italiani piuttosto che specie d'oltralpe. La precedente confusione, purtroppo ha portato in Italia molti esotici congenerici molto competitivi ai danni degli autoctoni. Alcune novità tassonomiche proposte sono da rivedere come la riabilitazione della specie *Squalius albus* del Trasimeno, praticamente fatta a tavolino, ignorando che la fauna di questo lago deriva dal Tevere (terra tipica di *Squalius squalus*, ovvero la specie di cavedano data per endemica in Italia). Molti generi sono cambiati come ad esempio *Chondrostoma* ora scomposto in 6 generi. La riabilitazione e la descrizione di altri generi e specie devono essere riviste. In sintesi, si propone una lista aggiornata e ragionata delle nostre specie ittiche condensando i dati morfologici e biomolecolari e le considerazioni oggettive dei collaboratori.

Abstract. We provide an updated checklist of freshwater fishes of Italy (including both native and established alien species) based on available molecular, morphological and biogeographical data. About 15 native species, reported as conspecific with transalpine species in the official Italian ichthylogical literature, are in fact endemics. Because of the previous taxonomic confusion, several alien species have been brought into Italy, either introduced in official stockings or mixed in as impurities. Rehabilitated species include the cyprinids *Scardinius hesperidicus* and *S. scardafa*, *Telestes savigny* from northern Italy and *T. comes* from southern Italy, and *Squalius ruffoi* from southern Italy. *Squalius albus* is a junior synonym of *S. squalus*. The endemic gudgeon, previously assigned to the genus *Romanogobio*, is returned to the genus *Gobio* (*G. benacensis)*. *Phoxinus lumaireul* is a junior synonym of *P. phoxinus.* Among Salmonidae, *Salmo cenerinus* is a junior synonym of *S. marmoratus*, while *Salmo farioides* represents the trout species of the Adriatic lineage and a neotype is designated. The esocid *Esox cisalpinus* is an endemic species of pike in Italy. Among sculpins, *Cottus scaturigo* and *C. ferrugineus* are regarded as potential junior synonyms of *C. gobio*. At present, there are 49 native living freshwater fish species, and 2 extinct (*Acipenser sturio* and *Huso huso*). Among the 51 introduced species, 4 are recent established (*Oreochromis niloticus, Poecilia reticulata, Amatitlania nigrofasciatus, Hemichromis* sp.), 39 are known to be established, 6 are probably established and 2 non-established Chinese carp, maintained in the wild by intensive stockings.

Introduction

Many taxonomic aspects of European and Italian freshwater fishes have changed since the monographs on the Italian species by Gandolfi et al. (1991) and Zerunian (2004), still in use

by most ichthyologists, and the advent in the 1990s of modern biomolecular investigations and biogeographical theories on the origin of peri-Mediterranean endemisms. In Italy, the nomenclatural confusion and lack of taxonomic updating of Italian endemic species, still considered of Danubian or transalpine origin, have allowed the legal introduction of central European fish stocks, mainly under the name barbels and chubs, as well as various genera of carps and crucian carps, with all the consequences of the introduction of alien species. This has reduced the Po basin to a branch of the Danube and the Tuscany-Latium basin to a dominant complex of Po and Danube species (Bianco & Ketmaier, 2001). Therefore, an updating of the taxa is necessary to determine the conservation status of native species, especially where genetic analyses have revealed unique haplotypes.

Here we provide a taxonomic summary of these novelties, largely reported in the recent European handbook (Kottelat & Freyhof, 2007). However, these authors applying the "Evolutionary Species Concept" in their allopatric species identification. The result seems an over-estimation of taxa. Moreover, except in rare cases, they did not consider genetic, phylogenetic and molecular phylogeographical studies.

The rehabilitation of certain species is not merely an exercise in taxonomy. As in the case of the genus *Telestes*, it is aimed at attracting attention to the small natural fish patrimony of Italy, demonstrated mainly by molecular analyses, in the hope that this will prompt appropriate interventions for their conservation.

For Italy, Kottelat & Freyhof (2007) listed ca. 108 species of which 51 native, 43 introduced and 14 of marine or occasional origin. However, some proposed taxonomic novelties must be revised, and recent introduced species added.

Methods

We report all the native species described for Italy by Kottelat & Freyhof (2007) and compare them with those reported by the current Italian ichthyological reference works (Gandolfi et al., 1991; Zerunian, 2004). An updated checklist is provided in Table I. For species subjected to taxonomic changes, we provide a comment on the reasons for such changes, based mainly on recent molecular genetic studies. While we agree with Kottelat & Freyhof (2007) on most species, we have doubts about the validity of others and we add other species as well. For the introduced species, we give an updated summary of their distribution, including the most recent records (Tab. II), interactions with the native species and eventual comments on their presence in Italy. We do not consider the occasional species: 1) those of marine origin but which do not breed in fresh water, such as the mullets, seabasses, some species of gobies, etc., with the exception of the eel, traditionally considered a freshwater fish; 2) those which have not had reproductive success in the wild except for the two species of herbivorous carps (*Ctenopharingodon idellus* and *Hypophtalmichthys molitrix*), whose density is maintained by massive introductions; 3) temporary records of non-established exotic fishes released in interior waters as tropical aquarium fish released by amateurs or escaped from farms.The categories of threat are those reported in IUCN (2010). Synonymies mentioned in the text are those relative to species described by Kottelat & Freyhof (2007). The authors of the species are reported when taxonomic aspects are discussed and in the tables listing the native and introduced species.

The diagnostic characters provided for several species are based on the analysis of materials conserved in the collections of the Zoology Section, Department of Biology, University of Naples Federico II : acronym: IZA.

Native species

Petromyzontidae

Lampetra zanandreai: According to the IUCN (2010) red list, the risk category is "Least Concern" (LC), although because of the progressive numerical decline the species it should pass at least to "Nearly Threatened" (NT).

In regard to the other species, the sea, and river lampreys, considered extinct by Bianco & Ketmaier (2001), actually both still form breeding communities at least in the Magra River (Ciuffardi et al., 2007; Ciuffardi et al., 2010).

The brook lamprey *Lampetra planeri* is still widespread in many rivers. Recent molecular investigation carried on lampreys of the Bussento and Mingardo rivers, the southernmost population among the range of the species, revealed genetic characters unique, when compared with the brook lamprey from European countries (Bianco et al., 2011). These should be regarded as independent conservation unit in agreement with the directory of the Convention of Biological Diversity (CBD) as they present independent aplotypes from the rest of Italy and Europe. They are extremely vulnerable and particular action urged to prevent extinctions.

Clupeidae

Alosa agone (Scopoli, 1786): Described for Lake Lugano, this is the correct species name of the endemic shads of subalpine lakes. Regarding the taxonomic entity, it is the senior synonym of *Alosa fallax* (La Cepède, 1803) described for the Seine River in France, as underlined by Kottelat (1997). According to Kottelat & Freyhof (2007), the twait shad represents a separate species *Alosa fallax*. However, the same authors cited *A. algeriensis* for Sardinian lakes, unaware that these fish were migratory populations of *A. fallax* relegated to interior waters by artificial obstructions. Bianco (2002) considered the agone and the twait shad ecotypes of the single species *A. agone* in view of their high variability. However, recent molecular analyses by Chiesa et al. (2010) showed a substantial genetic distance between agones and twait shads. Therefore, the agones of the Lombard lakes represent a valid species, well differentiated by biological and morphological characters from the migratory twait shad, *Alosa fallax*.

Salmonidae

Salmo cettii Rafinesque Schmaltz, 1810: Is the senior synonym of *S. macrostigma* and thus the correct species to cite. *S. macrostigma* is considered a possibly endemic trout to the Maghreb area (Kottelat & Freyhof, 2007).

Salmo marmoratus Cuvier, 1829
Synonym*: Salmo cenerinus* Chiereghin, 1847

Remark on synonym: according to Kottelat & Freyhof (2007), the brown trour of the Padany-Venetian district are not attributable to *Salmo trutta*. They propose the species *Salmo cenerinus* Chiereghini, 1847 (although the correct author is Chiereghin) described for the Chioggia area. According to Gridelli (1935), only the marble trout, *Salmo marmoratus*, occurred in the Friuli area, frequenting the lower reaches of rivers. The brown trout, also, originally did not occurs in the upper Adriatic rivers and never was recorded in the sea (Gibertoni, 2010). The monumental work by Abbot Chiereghin (1745-1820) was published only in 2001 (Chiereghin, 2001), while some species, including *S. cenerinus*, were briefly redescribed and thus rendered valid by Nardo (1847), the description of *S. cenerinus* provided by Chiereghin (2001) was very detailed and the figure (Fig. 1) illustrated it clearly. In short, according to him, this is a species of trout found in the sea or brackish waters of the Chioggia municipality (upper Adriatic area), which migrate upstream to reproduce. The colouration is

uniformly grey with reddish lateral spots. This description conforms exactly to the one given by Tortonese (1970) for the marble trout in brackish or marine habitats were it looses the marble pigmentation. Hence, it is clear that the name *S. cenerinus* is a junior synonym of *S. marmoratus*.

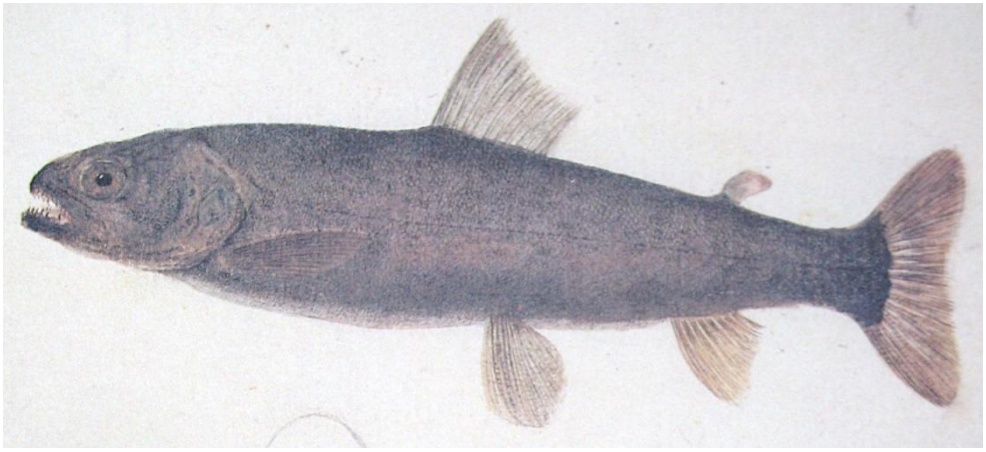

Fig 1 – *Salmo cenerinus* Chiereghin, 1847 (From Chiereghin, 2001)

Again according to Kottelat & Freyhof (2007), there are no other taxa described for Italy that represent the Adriatic lineage. Nevertheless, various taxa have been described for the eastern coast of the middle and upper Adriatic Sea. Gridelli (1935) considered the existence of three distinct species of brown trout in Italy under the name *Salmo trutta*. One was the "Sagittario River trout", very different from the Danubian *Salmo trutta*, especially by the number and conformation of the vertebrae (Henking & Altnoeder, 1931); it was subsequently described by Pomini (1941) as a separate species, *Salmo ghigii*. Gridelli (1935) also found affinity between the Sagittario River trout and the trout of Dalmatia. Three species have been described in these rivers of the Padany-Venetian district: *Salmo farioides* Karaman 1938, from the Krka River, described before *Salmo zrmanjensis* Karaman, 1938, from the Zrmanje River (Karaman, 1838), and *Salmo visovacensis* Taler, 1850 from the Visovacic River, a tributary of the Krka. These basins include numeürous primary or primary-like representatives (Bianco & Nordlie, 2008) of the Padany-Venetian district: *Padogobius bonellii*, *Alburnus arborella*, *Squalius squalus*, *Pomatoschistus canestrini*, *Barbus plebejus*. Also for palaeogeographic history, a dispersal events occurred during the last Würm glaciation, about 10-15.000 years ago, when the Po extended basin reached the meso-Adriatic ditch in central Adriatic sea (Bianco, 1990), joining rivers of the two Adriatic slopes. Hence, the Dalmatian trout can be considered conspecific with the brown trout of the Padany-Venetian area. From the colour photographs in Mrakovčić et al. (2006) and Kottelat & Freyhof (2007), as well as from material deposited in IZA, *S. farioides* and *S. zrmanjensis* present a habitus typical of Italian stream trout, with faint vertical bands, especially in small to middle sized specimens, as in larger one they may disappear, red spots sometimes encircled by a witheish area,scattered along the flanks of the body and a fairly extensive opercular spot, characters similar to those of *Salmo ghigii*.

Documented introductions of trout from central Europe to northern Italy are dated back at least on 1860 (Pavesi, 1881). Moreover more than a century of introductions (see Tab. III), have now cancelled almost any trace of the original Italian salmonid populations and range, as underlined by the many genetic studies of Italian trout. The type locality of *Salmo ghigii*, the Gizio and Sagittario rivers (Aterno-Pescara basin) (Pomini, 1841), has been polluted by decades of massive introductions of alien trout. In fact, molecular studies on trout from the

Sagittario (Ketmaier & Bianco, 2004) showed that they largely belong to the Atlantic lineage. A small, fairly well-structured and perhaps native population exists in a small stream of the upper Aterno River (Bianco pers. observ.). Croatian rivers probably still conserve native populations of the Adriatic strain, which could represent comparative material with which to try to resolve the other problems related to the genetics and taxonomy of Mediterranean salmonids.

The first of these four species to be described was *S. farioides* Karaman, 1938, and it characterizes the native populations of the Adriatic trout lineage, and we consider the nominal species *Salmo zrmanjensis* Karaman, 1938; *Salmo visovacensis* Taler, 1850 (geographically very closed) and *Salmo ghigii* Pomini, 1941 as potential junior synonyms.

Neotype designation for *Salmo farioides* Karaman, 1938: The species was described by Karaman (1938) from several rivers: Krka, Neretva, an others minor basins including tributary of Lake Skadar. The whole Stanko Karaman's fish collection wos lost (Dimovski A. & Grupce R., Skoplje Museum, FYROM, pers. comm. on 1987).

For the stability of nomenclature, on the light of the very confused taxonomy of *Salmo*, especially in the peri-Mediterranean regions, a neotype is here selected in accordance with the requirements of art. 75.3 of the ICZN (1999).

The characters which differentiate *S. farioides* from related Italian species, are: in respect of *Salmo marmoratus*, did not presents marble pigmentation on flanks an the dorsum; in respect of *S. carpio*, for geographical position as *S. carpio* is endemic of Lake Garda; in respect of *S. fibreni*, geographical position as *S. fibreni* is endemic of Lake Posta Fibreno in Central Italy; in respect of representative of Tyrrhenian lineage, *S. cetti*, either for geographical positions, genetics and general colour patterns. I designate the specimen 145 mm SL, 177 TL, collected in Croatia, River Krka near the town of Knin, on 20 august 1988, preserved in the Museo Civico di Storia Naturale di Carmagnola (To), Italy (available on request, for any examination) bearing the catalogue number MCCI/P/5001, as neotype of *Salmo farioides* Karaman, 1838, type locality, River Krka near the town of Knin (Fig 2).

Fig 2 – Neotype of *Salmo farioides* Karaman, 1938. River Krka near the town of Knin, Croatia, 145 mm SL, MCCI/P/5001

The neotype show a colour pattern formed by faint vertical bands, residual of mark parrs, as in larger, red spots sometimes encircled by a whiteish area, scattered along the flanks of the body (the red lack in the neotype following preservation), and a fairly extensive opercular spot. The dorsum, also presents scattered blacks spot encircled by a whiteish area. It can be identified by the following combination of proportional measurements, expressed as % SL. Mouth length, 20%; preorbital distance, 8%; eye diameter, 8%; interorbital wide, 9%; head depts., 19%; head length, 28%; body depth, 26%; caudal peduncle depth, 11%; caudal

peduncle length; 17%; predorsal distance, 50%; preventral distance, 57%; dorsal fin height, 19%; anal fin height, 16%; pectoral fin length, 19%; pelvic fin length, 15%; pectoral to pelvic distance, 34%; pelvic to anal fin distance, 20%. About 130 pored lateral line scales. To note that the propercular more or less enlarged dark spot seems a character common in most species of the Mediterranean brown trout lineage.

The neotype designation did not solve the general main problem of taxonomy of Mediterranean trout. In fact, about 17 taxa has been reported by Kottelat & Frehyof (2007) to live in the northern Mediterranean areas, a probable overestimation as the present-day non-migratory populations of the Mediterranean area are largely derived from expansion into the Mediterranean by migratory Atlantic populations during the phases of low salinity during deglaciations, particularly that of the last Würm glaciation ca. 15,000 years ago (Garcia-Marin et al., 1999).

Other marine derivates such as the river blenny (*Blennius fluviatilis*) and the three-spined stickleback (*Gasterosteus aculeatus*), now relegated to favourable circum-Mediterranean habitats, were subjected to waves of recolonizations in the various interglacial phases (Mäkinen et al., 2006; Perdices et al., 2000). Therefore, for Mediterranean brown trout, we are dealing with recent isolations, as shown by all the molecular genetic studies conducted in Italy in the attempt to characterize the species and clarify their taxonomic positions. For instance, according to Schoffmann & Susnik (2007), the Mediterranean brown trout, *Salmo cettii*, from the Anapo, Tellesimo and Irminio rivers in Sicily present Atlantic-type haplotypes. However, if we exclude an allochthonous origin, they could confirm the hypothesis of a recent Atlantic derivation of *Salmo trutta* during the recolonization in the last glaciation.

Salmo fibreni has a genotype practically identical to that of trout from the Bussento River (Ketmaier & Bianco, 2004). Studies on Italian trout (Lorenzoni et al., 2004; Bernatchez 2001; Caputo, 2003; Giuffra et al., 1994, 1996; Lucentini et al., 2006; etc.) have demonstrated the existence of alien strains mixed with native ones, with cases of hybridization, but have not been able to unequivocally characterize the species.

Finally, Gibertoni et al. (2010) assigned all the Mediterranean taxa to the species "Salmo mediterraneus", assigning the Italian taxa to five subspecies. However, this is a "nomen nudum", not applicable in taxonomy. Instead, we agree with Gibertoni et al. (2010) that the Mediterranean fario trout have very recent origins and are better referred to subspecies than to valid species. Instead of "mediterraneus", a subspecific nomenclature of a *Salmo farioides* complex could be used. However, it must be kept in mind that, according to the "Evolutionary Species Concept" adopted by Kottelat & Freyhof (2007), subspecies do not exist in ichthyology. Yet, subspecies are accepted by the Code of Zoological Nomenclature and are used to describe poorly distinguishable allopatric taxa of the same species. The concept proposed by the two authors should be re-examined because it induces the description of new taxa based on minimal morphological differences.

In addition to being of recent Atlantic origin, derived from post-glacial recolonizations, the Mediterranean trout taxa represent a complex of ecophenotypes recurring in similar environmental situations with variable biology, not unequivocally separable from one another. A further complication is that even the trout relegated to rivers tend to present homing behaviour, forming populations that assume habitat-dependent colour pattern, and tending to form reproductively isolated populations. Finally, we cannot exclude penetrations of transalpine populations since trout, like other frigophylic species, are able to exploit stream captures between the two sides of the Alps, as hypothesized by Bianco (1995a) and demonstrated by Slechtova et al. (2004) for bullhead (*Cottus gobio*).

Cyprinidae

The genus *Squalius* Bonaparte 1832, adopted by different authors in the past but then considered a subgenus of *Leuciscus*, has been rehabilitated. We will refrain from discussing this, even though we do not consider this genus very well definable with respect to *Leuciscus*.
Squalius lucumonis. The morphological characters of this species are well identifiable with respect to the similar *S. squalus* (for those who accept that species). Moreover, genetic analyses conducted on *Squalius lucumonis* have always underlined its full validity, unlike what occurs for any trout species (Ketmaier et al., 1998; Durand et al., 1999; 2000). The unproductive disputes triggered by some ichthyologists have certainly not favoured the survival of this species, already included in the Habitat Directive of 1982, currently in strong decline and on the global list of species threatened with extinction (Bianco & Ketmaier, 2003). It is an obligate rheophylic species that cohabits with the congener *S. squalus* – a rare case of sympatry of representatives of the same genus.

Squalius squalus (Bonaparte, 1837)
Synonym: *Squalius albus* (Bonaparte, 1838)

The Italian chub was indicated as an endemic species by Kottelat & Freyhof (2007). Bianco (1995b) distinguished the Italian chubs as *Leuciscus cephalus squalus* because of a character which, albeit labile, differentiated Italian chubs from the transalpine ones: on average, 9 branched rays in the anal fin versus 8 in the transalpine populations (Bianco, 1983; Bianco, 1988a; Bianco & Recchia, 1983; Bianco & Knezevic, 1987). Subsequent genetic studies of this species demonstrated that it belonged to a distinct Adriatic lineage (Ketmaier, et al., 1998; Durand et al., 1999; 2000).
Previously, the Italian chub was classified as *Leuciscus cephalus cabeda* Risso 1826 (Tortonese, 1970), but there is no mention of this taxon in Kottelat & Freyohf (2007).
Remark on synonym: *Squalius albus* from Lake Trasimeno, rehabilitated on the basis of introduction material (Kottelat & Frehyof, 2007), is clearly a synonym of *S. squalus* since the fish fauna of this lake derives from repeated connections with the Tiber basin (via the Caina and Nestore streams), the type locality of *S. squalus*, and there has never been any evidence of the contemporary existence of the two species in the lake. In addition, alien populations of chub were repeatedly introduced in the lake since the year 1934 (Bianco & Taraborelli, 1984).
Lectotype designation for *Squalius squalus* (Bonaparte, 1837). During a stay in the Academy of Natural Science of Philaelphia (ANSP), in 1985, all the Bonaparte cyprind's collections, already reported by Böhlke (1984), were examined. For each species a potential holotype or a lectotype has been selected and then photographed either in black and white or in colour slides. About five species of chub were originally described by Bonaparte. One of these is *S. squalus* (original cat. number in the jar, 441, type locality reported on the label: River Tiber). The series is represented by 36 specimens, (and not 37, as reported by Böhlke, 1984, and Kottelat, 1997), 65-380 mm TL(55-330 SL), but two species were mixed: *S. squalus*, (27 specimens: ANSP 6273-6300) and *S. lucumonis* (9 specimens: ANSP 6301-6309). This fact allows the selection of a name-bearing type according to the recommendation of the art. 74.3 ICZN (1999), as the inclusion of two species in the type series may cause taxonomic instability. In the "Indice distributivo del Tomo terzo, pesci", (Bonaparte, 1832-1841) the same species is reported also as *Squalius tyberinus* which clearly represents an indication to and a junior synonym of *S. squalus.*
The original description of S. *squalus* was mainly based on single specimen from the River Tiber. But in the description (Bonaparte, 1837), it seems that more than one specimens was involved especially for the plural description of fin colour pattern: "the colours of the fins are sometimes pales or tinged by red or greyish" and also for the localities "River Tiber, River

Arno and in all others rivers of Tuscany and Latium regions" and also because two specimens were illustrated. The specimen used and illustrated in the original description was of "7 inches and four lines" of length (no mention of which kind of length was reported by Bonaparte, but it is assumed that it was the total length), which corresponds to about 185 mm. Only one specimens of the whole 441 original series fit with this length. It corresponds for meristic counts and general outline resemblance with the Figure 1 of Plate 111 rather than the specimen illustrate in Figure 2 of Plate 112., given by Bonaparte (1837), in the original description. The specimens was not well preserved, but it posses the complete squamation making possible meristic counts. The specimens ANSP 6273, 186 mm SL, is designate as lectotype rather than holotype in accord to the art. 73 recommendation 73F of the ICZN (1999), of *Leuciscus squalus* (Fig. 3).

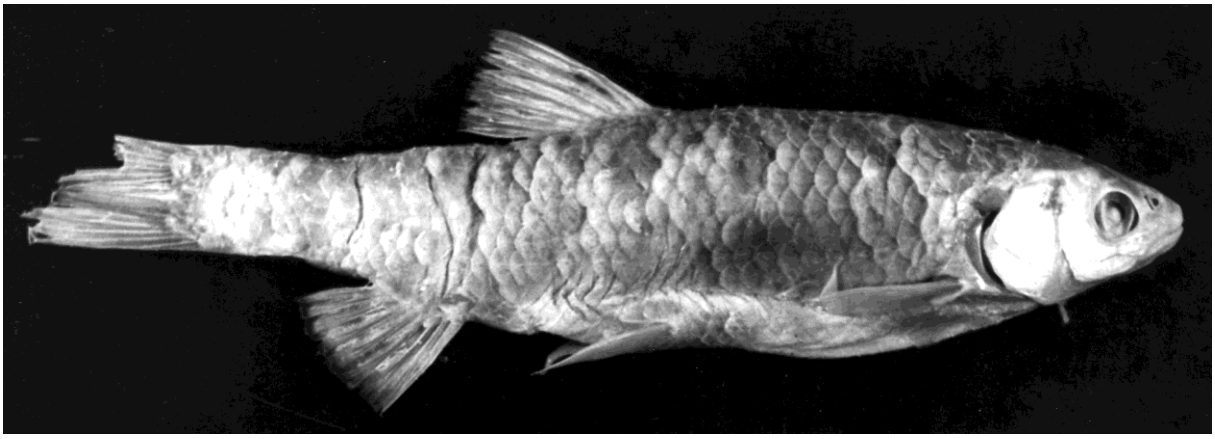

Fig 3 – Lectotype of *Squalius squalus* (Bonaparte, 1838). ANSP 6273, 186 mm SL, River Tiber.

It has 44 total pored scales on lateral line (LL); 7.5 above and 3.5 below LL; 8 branched rays in Dorsal and 9 in Anal fins; 14 circumpeduncular scales; 9 total gill rakers; 5.2-2-5 pharyngeal teeth. In 26 paralectotypes (ANSP 6274-6300): 42-46 scales on LL; 7.5 row of scales above and 3.5 belove LL; constantly 8 branched rays in dorsal and modally 9 in Anal fins (8 in two cases and 10 in one case). The second species, ANSP 6301-9309, 55-125 mm SL, are *Squalius lucumonis*: they posses 38-42 scales on LL; 7.5 rows of scales above and 3.5 below LL; 7 branched rays in D and 8 in A (Fig 4); 16 circumpeduncular scales; this diagnosis correspond to *Squalius lucumonis* described by (Bianco, 1983).

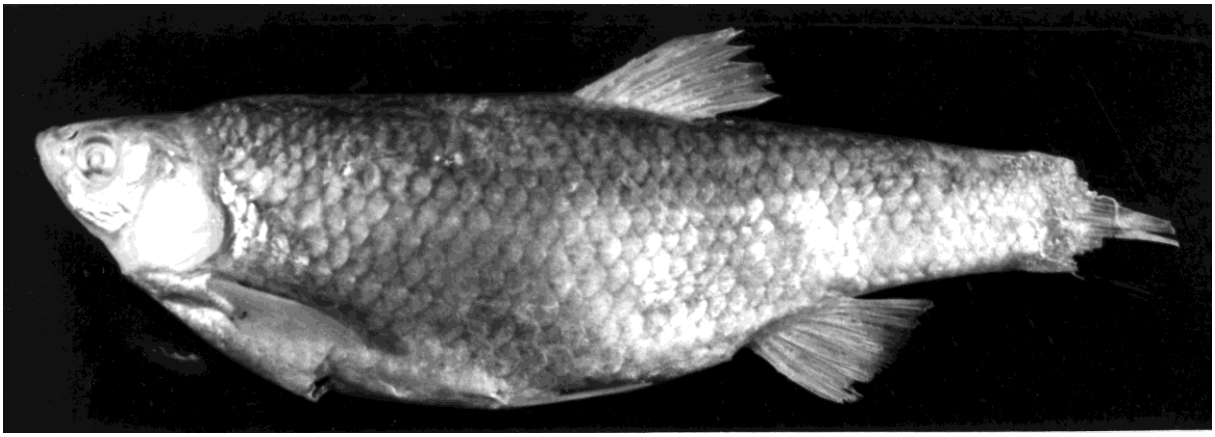

Fig 4 – *Squalius lucumonis* (Bianco, 1983). ANSP 6301, 135 mm SL, (ex syntype of *S. squalus*).

Squalius ruffoi (Bianco & Recchia, 1983)

This taxon has not been considered after its description and is tacitly considered synonymous with *Squalius cephalus*. Nevertheless, this subspecies is distinguished from the European and Italian chub by having on average one additional branched ray in the dorsal fin (mode 9 instead of 8), one less in the pelvic fin (7 instead of 8) and normally 16 circumpeduncular scales instead of 14 (Bianco & Recchia, 1983). Therefore, according to the "Evolutionary Species Concept" adopted by Kottelat & Freyhof (2007), it represents a good species.

Squalius lapacinus (Stefani, Serra, Loffredo and Fossa, 1987)

This taxon represents the hybrid *Squalius squalus x Alburnus arborella* (Bianco, 1988b).

A district of southern Italy was recently identified on the basis of molecular studies of genus *Telestes*, the presence of endemism such as *Cobitis zanandreai* and *Alburnus albidus* (Ketmaier et al., 2004), and the uniqueness of the southern haplotypes found in brook lampreys (Bianco et al., 2011). This allows the rehabilitation of this endemic taxon of the Savuto River in the southern district that we will call "Apulia-Campania" (Fig. 5), (since these endemic taxa are mainly found in the rivers of these two regions), whose extension matches the distribution of *Alburnus albidus*.

Fig 5 – The approximate delimitation of Italian ichthyogeographyc districts: PV: Padany-Venetian; TA; Tuscany-Latium; AC; Apulia-Campania.

Genus *Telestes*: The question of the vairone species belonging to the genus *Telestes* and its specific identity have been dealt with in numerous papers (Bianco & Ketmaier 1998; Stefani

et al., 2004; Gilles et al., 2010). Molecular analyses have shown a strong genetic divergence of the Padany-Venetian, Tuscany-Latium and Apulia-Campania populations based on cytochrome *b* (Ketmaier et al., 2004) (Fig. 6), and microsatellite markers (Marchetto et al., 2011). The latter identified a further group of independent populations in rivers of the Marches region. In conclusion, the marked genetic divergence among the vairone populations of the various Italian districts, particularly those of the Volturno-Calore Irpino complex, suggest the existence of three distinct species. Indeed, Bonaparte (1832-1841) distinguished a northern Italian form from a central one, while Costa (1829-1851) described a vairone from southern Italy. Therefore:

Telestes savigny Bonaparte, 1840
This taxon, described for the Piedmontese lakes and Lake Lugano, represents the endemic species of the Padany-Venetian district. Common name: vairone.

Telestes muticellus (Bonaparte, 1837)
The endemic species of Tuscany-Latium district, and Liguria. Common name: mozzella.

Telestes comes (Costa, 1838)
The endemic species of the Apulia-Campania district (Volturno and Sele basins). Its IUCN category should be "Vulnerable" (VU). In fact, the species is localized with a patchy distribution and only rarely forms well-structured populations. Common name: compagno.

The Po species is distinguished from the Tuscany-Latium one mainly by the number of lateral line scales, i.e. on average 45-50 (examined in 93 specimens IZA 0240; 86469; 85471; 88118), versus 42-47 (examined in 77 specimens IZA 8486; 8399; 8547; 8549; 882) while the southern species presents 38-44. *T. comes* is also differentiated from *T. muticellus* by having a proportionally larger eye, the more rounded distal margin of the preoperculum, the less marked longitudinal dark band and lack of nuptial tubercles on snout (in 234 specimen examined, IZA 02191).

Telestes souffia was introduced into eastern Italy as the result of introductions in Slovenia. With respect to the Italian species, it presents a longer head, the snout sharp instead of blunt, and a higher number of lateral line scales: 50-55 (examined in 8 specimens from Tagliamento river, IZA 8423).

Protochondrostoma genei: The genus *Chondrostoma* was divided into five genera by Robalo et al. (2007). The South European nase was assigned to the genus *Protochondrostoma*, endemic to the Padany-Venetian area with the single species *P. genei*.

Scardinius hesperidicus: Morphological and Genetic studies (Bianco et al. 2001; Ketmaier et al., 2004) revealed morphological differences and high genetic divergence between the common rudd, *S. erythrophthalmus*, of central Europe and the Italian specimens (Fig. 6). The correct name for the endemic Italian species of the Padany-Venetian area is *S. hesperidicus*, described for the Piedmontese lakes.

Scardinius scardafa: It represented, like *Squalius lucumonis*, the endemic species of the Tuscany-Latium district. Molecular analyses have shown a genetic distance between *S. hesperidicus* and *S. scardafa* equivalent to that between *S. squalus* and *S. lucumonis*, indicating similar times of dispersion and vicariance. Moreover, the analysed populations from central Italy all belong to *S. hesperidicus* (Ketmaier et al., 2004) (Fig. 6) and they indicate the extinction of *S. scardafa* due to possible introduction of the padany rudd. *S. scardafa* survives in Lake Scanno, to which it was introduced from Lake Fucino before the reclamation, and perhaps also in Lake Piediluco (Bianco pers. observ.). *S. scardafa* is included in the IUCN red list in the category "Critical Endangered" (Crivelli, 2006a) and is

among the global species threatened with extinction (Bianco, 2004). A simple diagnostic method for the three species is counts of the number of branched rays of the anal fin: mode 9 in *S. scardafa*, 10-11 in *S. hesperidicus*, 12-14 or more in *S. erythrophthalmus*.

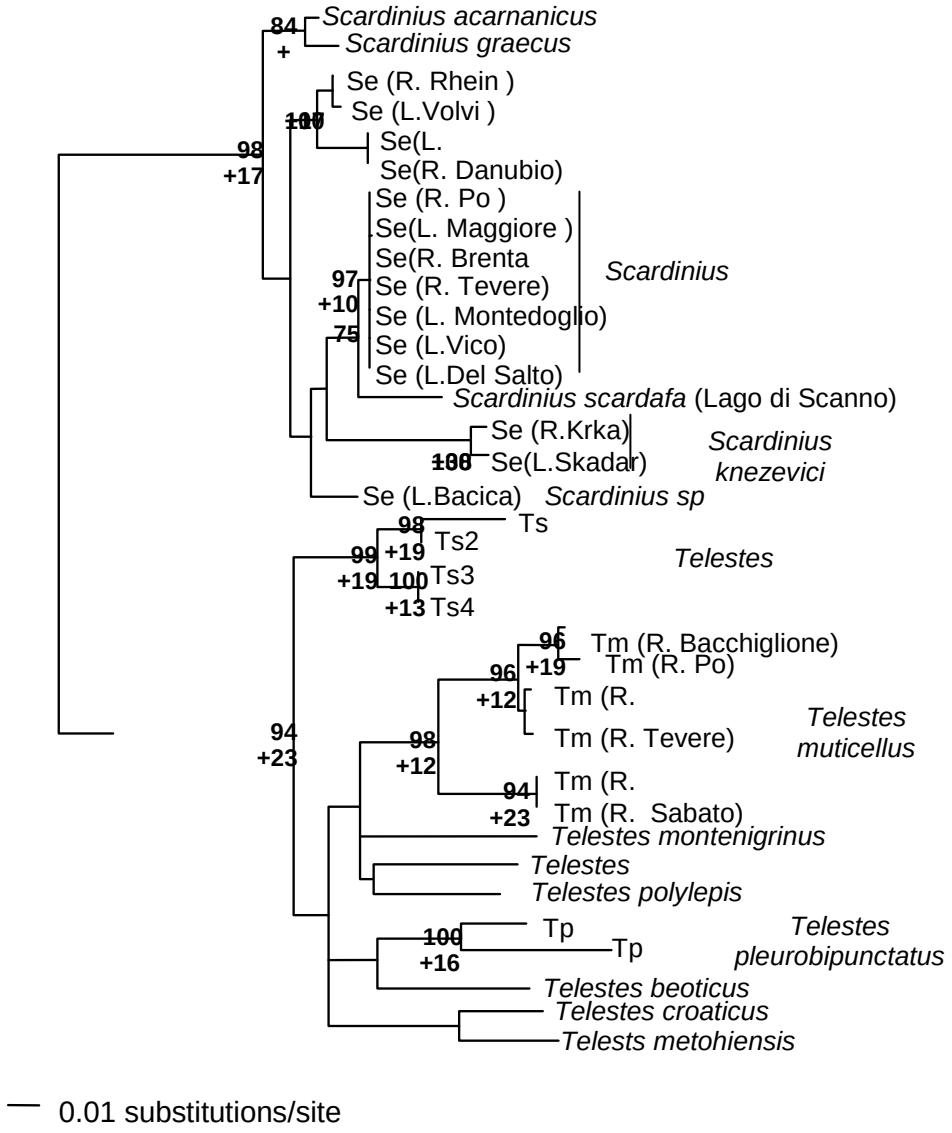

Fig 6 - Phylogenetic relationship among *Scardinius* and *Telestes* species in Europe based on cytochrome *b* (modified from Ketmaier et al., 2004).

Gobio benacensis Pollini, 1816
New combination: *Romanogobio benacensis* (Pollini, 1816)

This is an Italian endemic species now relegated to very few habitats and largely extinct in the Padany-Venetian area. The cause of its extinction is mainly due to introduction of the gudgeon, *Gobio gobio*. The two species are differentiated by bio/ecological and genetic characters. In addition to reaching larger sizes (14-15 cm SL versus 80-110 in *G. benacensis*), the gudgeon is gregarious, forming very large communities in stream environments, while *G. benacensis* is less invasive and less numerous. It is genetically well differentiated from the gudgeon (Fig. 7).

River code	n	SL (mm) Range	N sq a-A Range
Meletta (MEL)	6	62–106	5–7
Tagliamento (TAG)	14	34–74	2–3
Assino (ASS)	7	74–102	4–5
Ombrone (OMB)	5	36–71	2–3
Badolato (BAD)	6	54–86	4–6

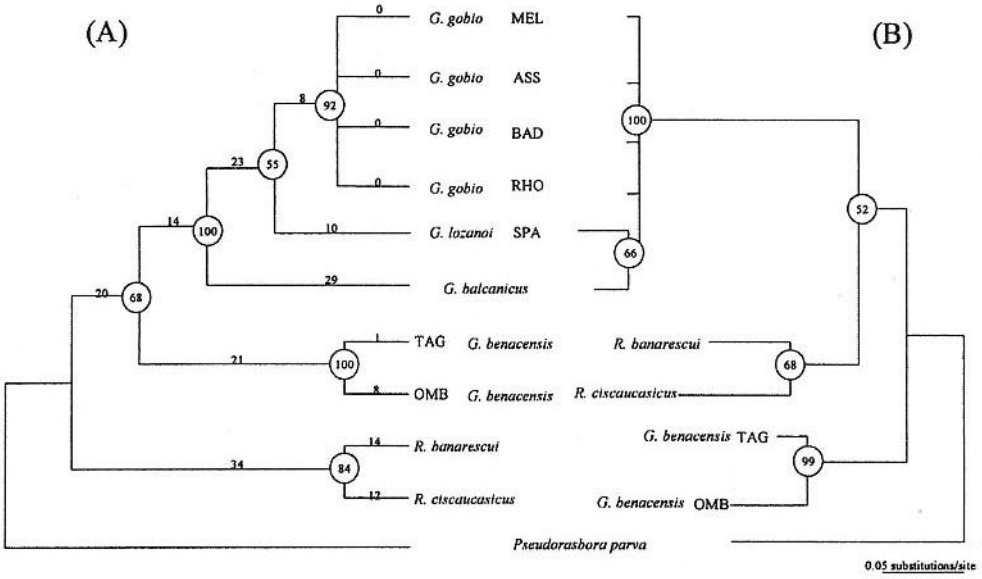

Fig 7 – Phylogenetic relationship of populations of *Gobio gobio* (introduced) and *G. benacensis* (endemic) in Italy. Phylogenetic trees constructed on the basis of PCR and DNA sequences with the "Maximum Parsimony" (A) and "Neighbour-Joining" (B) methods. The table above shows the difference in number of scales between the cloacal opening and the origin of the anal fin (N sq a-A), a diagnosis character for the two species (Bianco & Ketmaier, 2006).

Remarks on new combination:Kottelat & Freyhof (2007) included the species in the genus *Romanogobio*. However, molecular analyses (Bianco & Ketmaier, 2006)(Fig. 7) were not in accordance with this attribution. The morphological characters that distinguish the genus, i.e. "presence of dorsal epithelial scales crested" were not observed at least in 22 specimens from Tagliamento River, north-eastern Italy (IZA 0480). Moreover, the neighbouring species are *Gobio gobio* and *Gobio obtusirostris*, while the genus *Romanogobio* is central European. Hence, attribution to *Romanogobio* is a biogeographical absurdity. Therefore, the species is reassigned to the genus *Gobio*.
A practical and unequivocal character for identification of the two species in Italy is the number of scales in series between the origin of the anal fin and the cloacal opening: 2-3 scales in *G. benacensis* and 4-7 in *G. gobio* (Bianco & Taraborelli, 1986). The unproductive arguments by some ichthyologist on the validity of this endemic species have certainly not favoured its survival. *G. benacensis* is included in the IUCN red list as "Endangered" (Crivelli, 2006b) and is among the global species threatened with extinction (Bianco, 2009).

Phoxinus phoxinus (L., 1758)
Synonym: *Phoxinus lumaireul* Schinz, 1840

Remark on synonym: The Italian common minnows, previously reported as *Phoxinus phoxinus*, were attributed to the species *P. lumaireul* Schinz, 1840 by Kottelat (2007). Indeed,

the characters that differentiate this species from the seven reported by Kottelat are extremely labile. I try to identify specimens of the species in my collection coming from Northern Italy, Croatia and Montenegro (86 fishes, IZA 00299, 00314, 02263, 83134, 87103, 8223), using the key fishes proposed by Kottelat, but I was unable to identify , unequivocally, the Italian *Phoxinus* as a distinct specie from *P. phoxinus*. Apparently there are no extensive molecular studies on this species complex. Minnows are frigophylic species able to exploit mountain stream captures and probably should not differ at the molecular level from populations on the northern side of the Alps, as seen for bullheads (Slechtova et al., 2004). The distinguishing characters do not even seem applicable at the subspecies level. Barring more extensive studies on this species, we will maintain it as *P. Phoxinus*

The specific identity of *Barbus caninus* was demonstrated some time ago (Berrebi, 1995), as was that of *B. tyberinus* (Bianco, 2003), easily distinguished from *B. plebejus* in the zones where the latter has been introduced. The very detailed paper by Lorenzoni et al. (2006) described the four species living in Italy and in the Tiber basin.

Alburnus arborella (Bonaparte, 1841). The northern bleak is an Italian endemic species distinguished by genetic and morphological characters from the central European bleaks (Ketmaier et al., 2009). The correct name of the species is *Alburnus arborella* (Bonaparte, 1841) (Kottelat & Bianco, 2005)

The Danube roach, *Rutilus pigus*, is an Italian endemic species very well differentiated genetically (Ketmaier et al., 2008) and morphologically (Kottelat & Freyhof, 2007) from the similar *Rutilus virgo*. This species is seriously threatened by interaction especially with *Rutilus rutilus*, with which it also tends to interbreed. The current IUCN category of LC (low concern), attributed by Kottelat and Freyhof (compilers of this species for the IUCN red list), should be revised and it should be assigned to EN (endangered).

Cobitidae

Both *Cobitis bilineata* and *Cobitis zanandreai* have been recognized as endemic species, respectively of the Padany-Venetian area and the Apulia-Campania district (Perdices & Doadrio, 2001; Bohlen & Rab, 2001; Buj et al., 2008). A distinguishing character is the number of spots at the base of the caudal fin: usually two in *C. bilineata*, one in *C. taenia* and none in *C. zanandreai*. The last species also presents a rather deep caudal peduncle, a character that makes it similar to the genus *Sabanejewia*; hence, a hybrid origin has been hypothesized for it (*C. bilineata* x *S. larvata*)(Bianco, pers. Observ.).

Gobiidae

Padogobius bonellii is the senior synonym of *P. martensii* (Kottelat, 1997). Ethological mechanisms of competition and elimination by *P. bonellii* against *P. nigricans* at introduction sites have recently been shown (Mecatti et al, 2010). In fact, *P. nigricans* is becoming extremely rare on account of the introduction of *P. bonellii*. The current IUCN 2010 category, LC, should be changed to EN.

Lotidae

Lota lota is the only species present in Europe. It is a similar primary, obligate limnophilic, thermophilic species. Therefore, the Italian populations could be distinct from the European ones or introduced. Two subspecies are recognized in America (Elmer et al., 2006), while two phylogeographical lineages have been found in Europe: an Atlantic and a Danubian (Barluenga et al., 2006). Therefore, a molecular analysis would be important to determine a possible Adriatic lineage or the allochthonous origins of the Italian populations. Lota lota, apparently native il Lake Major, was transplanted in Lake Como and L. Garda (Pavesi, 1898).

Gasterosteidae

Gastrosteus gymnurus: On the basis of molecular studies, Mäkinen et al. (2006) distinguished the migratory populations of the European area from the freshwater populations of the Mediterranean area and placed their separation around the Pleistocene. Nevertheless, they found significant genetic divergences among the various freshwater populations due to the effects of dispersion and vicariance owing to post-glacial recolonization processes. Hence, there are good reasons to differentiate the migratory populations of northern Europe, *Gasterosteus aculeatus*, from those relegated to Mediterranean fresh waters, *G. gymnurus*. This nomenclature was used in the past by some ichthyologists, such as Ninni (1907) for the sticklebacks in the water bodies of Veneto.

Cottidae

Cottus gobio L., 1758

? Synonyms: *Cottus scaturigo* Freyhof, Kottelat, Nolte, 2005 - *C. ferrugineus* Heckel & Kner, 1858

Genetic analyses conducted on bullheads on the Italian and central European sides of the Alps showed marked genetic uniformity, supporting the existence of a single species, *Cottus gobio* (Slechtova et al., 2006). The conspecificity of populations on the two sides of the Alps indicates recent episodes of dispersion, confirming the theory that frigophilic species like the bullhead can use stream captures from high-mountain valleys to migrate from one side to the other (Bianco, 1995a).

Remarks on potential synonyms: *C. scaturigo*, described for the Timavo River near Monfalcone (Freyhof et al., 2005), was differentiated from *C. gobio* mainly by the colour patterns. These authors erroneously considered their record of the bullhead for this river as new, as it had already been reported by Brunelli & Chiappi (1931: p. 483 Plate I), who recorded the species in almost all the basins of the Jurisdiction of the Royal Fish Farm of Brescia, and by Pomini (1935: Timavo River near Duino, cited by Stammer, Zool. Jahrbucher, 1912, p. 651), who remarked on the marked variability of colour pattern of the Friuli bullheads. The Timavo basin belongs to the Padany-Venetian district and it is difficult to imagine long-term isolation or an adaptation to karst resurgences (the species is frequent in resurgences) considering the recent connections of the Timavo with the Po basin during the last Würm glaciation ca. 5-6000 years ago (Bianco, 1990). Tellini (1895) also cited the species as widely distributed in water bodies of the Alpine foothills and plains and especially in resurgences in 49 municipalities in Friuli. Finally, a typical Padany-Venetian fauna lives or lived in the Timavo including (according to the updated taxonomy here reported): *Lampetra zanandreai*, *Barbus plebejus*, *Protochondrostoma genei*, *Squalius squalus*, *Gobio benacensis*, *Cottus gobio* and *Aphanius fasciatus* (Brunelli & Chiappi, 1931). Therefore, it is difficult to accept the validity of *C. scaturigo* also because if the Veneto and Friuli populations represent a distinct species it would have to be called *C. ferrugineus*: this species regarded as the Italian endemic bullhead by Kottelat (1997), was missed or not intentionally reported in the book of Kottelat & Frehyof (2007). Finally, I compared my materials (104 specimens coming from northern and central Italy, IZA 00390, 00394,00402,02156,8961,8983,8984,9212), with the description given for *C. scaturigo*, and I was unable to identify it as a distinct species.

Esocidae

Esox cisalpinus Bianco and Delmastro, 2011 (Fig. 8): The cisalpine pike is an Italian endemic species of the Padany-Venetian and Tuscany-Latium districts. Despite the marked geographical variability found in *Esox lucius*, such as to consider it a single species (Nilsson et al., 2008), pan-European molecular analyses (Nicod et al., 2004) have identified unique

characters for the pike populations of Lake Maggiore and Lake Trasimeno, suggesting an at least Pleistocene isolation of the Italian populations from the transalpine ones. Subsequently, Lucentini et al. (2010) related the molecular divergences to pigmentation patterns. The Italian species, has flanks adorned with several trasversal bands, very well marked in juveniles, which tend to anastomose in adults, giving a vermiculated or marbled appearance, the unpaired fins are dotted by rare dark spots, in contrast to the transalpine populations with colouration prevalently of oval spots on the flanks and dorsal, anal and caudal fins marked by well developed dark vermiculation. The "banded populations" are typical of the native Italian pikes. For all these reasons, they have been considered as belonging to a new species by Bianco & Delmastro (2011). Regarding others characters, *E. cisalpinus* presents 92-107 total scales in lateral series versus 105-148 of the European species. The number of sub-mandibular pores is quite variable and size dependent. The holotype posses 4-4 pores, but in larger paratypes they are 5-5 as in *E. Lucius.*

Fig 8 – Holotype of *Esox cisalpinus*, 218 mm SL, IZA 111, Cercenasco (Turin), Bealera Bassa (Po basin).

Transfaunations

Almost all the native species have suffered alterations of their distribution areas, sometimes concealed ones. As an example, we report documented cases of transfaunations carried out by the Rome and Brescia fish farms in five years of activity (Tab. III). Since these farms have been operating for over 80 years, the reported values should be multiplied by at least x 15. Later, starting from the 1980s, the management passed to the provinces and information about introductions, especially those carried out with specimens of Danubian origin, remained concealed or fragmentary. However, many other institutions and fishing associations have conducted introductions, at times with specimens of doubtful origin. At present 33 species on 47 living ones, marked by an asterisk in Tab. I, were subjected to transfaunations.

Introduced species

Table III reports the list of introduced species (updated with respect to the one reported by Bianco & Ketmaier, 2001), with their distributions, types of harmful interactions with native species, and notes on novelties.

Among European and in general, in developed countries, Italy show the higher percentage of alien fish species, 51%, followed by France with, 43%, and Spain (Tab IV). And this reflect the general Italian disinterest in native freshwater fish care, and biodiversity conservation.

Special remarks on *Messinobarbus graellsi*, the Ebro Barbel: This species, introduced in Italy (Bianco & Ketmaier, 2001), was previously included in the genus *Messinobarbus* by Bianco (1998). This genus, later on was silently considered junior synonym of the genus *Luciobarbus* Heckel 1843.

Several authors, in an attempt to solve the generic position of Mediterranean Barbinae, re-actualized the genus or sub-genus *Luciobarbus* as a perimediterranean taxon from which several species of Iberian Penisnsula are related (Doadrio, 1994). Machodorm & Doadrio (2001a, 2001b) and Doadrio et al., (2002) provided molecular data to confirm the presence of this genus in the Mediterranean, but while they used topotypic materials for the peri-Mediterranean species, they did not include specimens of *Luciobarbus esocinus* Heckel, 1843, type species of the genus by subsequent designation by Jordan (1919), described from the Tigris river basin in Syria. Finally, later on the species was included in the molecular analyses of Tsigenopolus et al., (2003). These authors, considering the relationships between various genetic groups, conclude that: "the only relatively well-supported group clustering within *Luciobarbus* was that between north-western Africa and the Middle East". And this is in contrast with assumption of previous authors.

The name of the genus *Luciobarbus* described by Heckel (1843), for species inhabiting Syria, Egypt, Caspian Sea and Palestina, derived from the shape of the head similar to *Esox lucius* "Lucio-barbus". This surely implies significant osteological differentiations between *L. esocinus* and the "*Luciobarbus*" species reported in Europe. Osteology of the head in several cases is used for genera descriptions (Bogutskaya, 2002). According to Tsigenopoulos'et al. (2003) results, and applying the same molecular genetics criteria used by Robalo et al., (2007), to split the former genus *Chondrostoma* in 5 genera, *Luciobarbus* should be considered as and endemic genus of the Mesopotamic region, one of the most reach of fish endemism of western Asia (Bnarescu, 1977).

Finally, the following reasons may preclude the existence of *Luciobarbus* in southern Europe:

1) Type locality of L. *esocinus* is Tigris river near Mossul in Syria which belong to the Mesopotamia, part of WESCANA bio-region, very different from the Mediterranean one, and the species is unknown in the Mediterranean Turkey (Balik, 1988).
2) *L. esocinus* is a giant barb which can reach 2.2 m of length and 200 k in weight. Size unknown in European barbs.
3) One of the characters of the European genus *Messinobarbus* Bianco, 1998, was the presence of horny tubercles on the snout especially in males in spawning condition. *L. esocinus* apparently, did not show horny tubercles on snout (Brian W. Coad, Personal Communication).

By all these reasons the Ebro barbel introduced in Italy, and possibly all species included in *Luciobarbus* by Kottelat & Frehyof (2007), should be placed in the Mediterranean genus *Messinobarbus.*

Conclusions

In Italy, there are 51 native species of which two extinct (*A. sturio* and *H. huso*). 22 of the species cited by Gandolfi et al. (1991) and Zerunian (2004), and 11 of those listed by Kottelat & Freyhof (2007), have been updated. The introduced and established species (without considering transfaunations) number 51, of which 15 of extra-European origin, 29 of European origin, 6 of probable presence and at least 2 species of herbivorous carps which, because of massive introductions, are frequently found and interact with native cyprinids.

In regard to the previous official nomenclature and conservation status, seven species considered to be of Danubian or Po origin by Gandolfi et al. (1991) and Zerunian (2004), included in the IUCN (2010) category "Low Concern", have proven to be Italian endemic species, some for at least 15-20 years. The IUCN (2010) red list classified *Scardinius scardafa* as "Critically Endangered", *Gobio benacensis* as "Endangered", *Squalius lucumonis* as "Vulnerable" (*Telestes comes* must be assigned to the same category since it has become very rare in southern Tyrrhenian basins), *Barbus tyberinus* and *Squalius ruffoi* as "Nearly

Threatened". Without national recognition and protection of these endemisms, they are clearly destined to decline even more.

Fig. 9 reports the updated general trend of native and alien fishes in Italy. There are six more native species with respect to the situation observed in 2007. The sea lamprey and the river lamprey, previously considered extinct, have been recorded in the Magra River, and are rehabilitated. Genetic analyses have confirmed the existence of three species of Telestes instead of one. A species of chub described for a river in southern Italy has been rehabilitated, as has the loach *C. zanandreai*, endemic to the Volturno basin, and the new species of pike. Recent studies on the alien species have confirmed the establishment of four new tropical species found in thermal water bodies, while six are potentially present in Italy.

Table I – Updated checklist of freshwater species compared with the ones reported in the handbooks of European (Kottelat & Freyhof, 2007) and Italian fishes (Gandolfi et al., 1991; Zerunian, 2004). An a asterisk indicates species that have suffered transfaunations.

Updated species	**Native species in Italy (Kottelat & Freyhof, 2007)**	**IUCN category**	**Corresponding species (Gandolfi et al., 1991; Zerunian, 2004)**	**Origin of the corresponding species**	**IUCN Category**
Lampetra zanandreai (Vladikov, 1955)	*Lampetra zanandreai*	NT	*Lampetra zanandreai*	Po	NT
Lampetra planeri (Bloch, 1784)	*Lampetra planeri*	LC	*Lampetra planeri*	European	LC
Lampetra fluviatilis (L., 1758)	*Lampetra* ***fluvitilis (?)***	LC(CR)	*Lampetra* ***fluviuatilis (?)***	European	LC
Petromyzon marinus L., 1758	*Petromyzon marinus*	LC(CR)	*Petromyzon marinus*	Mid. Atlantic	LC
Acipenser naccari Bonaparte, 1836*	*Acipenser* ***naccarii (?)***	CR	*Acipenser naccari*	Adriatic	CR
Acipenser sturio L., 1758	*Acipenser sturio*	EX	*Acipenser sturio*	Europe	EX
Huso huso (L., 1758)	*Huso huso*	EX	*Huso huso*	Europe	EX
Anguilla anguilla (L., 1758)*	*Anguilla* ***Anguilla (?)***	LC	*Anguilla anguilla*	European	LC
Alosa agone (Scopoli, 1786)*	*Alosa agone*	LC	*Alosa fallax* (Lacépède, 1803)	Mid. Atlantic	LC
Alosa fallax (La Cepéde, 1803)*	*Alosa algeriensis* Regan, 1916 (Sardinia)	LC	*Alosa fallax*	Mediterranean	LC
Atherina boyeri Risso, 1810*	*Atherina boyeri*	LC	*Atherina boyeri*	Mediterranean	LC
Salmo cettii Rafinesque Schmaltz, 1810*	*Salmo cettii*	NT	*Salmo(trutta) macrostigma*	North African	DD
Salmo farioides Karaman, 1938*	*Salmo cenerinus*	LC	*Salmo(trutta) trutta*	Danubian	LC

Salmo fibreni Zerunian & Gandolfi ,1990	*Salmo fibreni*	VU	*Salmo fibreni*	L. Posta Fibreno	VU
Salmo marmoratus Cuvier, 1829*	*Salmo marmoratus*	LC	*Salmo (trutta) marmoratus*	Po	LC
Salmo carpio L., 1758	*Salmo carpio*	CE	*Salmo carpio*	L. Garda	CE
Thymallus thymallus (L., 1758)*	*Thymallus thymallus*	LC	*Thymallus thymallus*	Palaearctic	LC
Squalius lucumonis (Bianco, 1983)	*Squalius lucumonis*	EN	*Leuciscus cephalus*	Danubian	LC
Squalius squalus (Bonaparte, 1837)*	*Squalius albus*	LC	*Leuciscus cephalus*	Danubian	LC
Squalius squalus	*Squalius squalus*	LC	*Leuciscus cephalus*	Danubian	LC
Squalius ruffoi (Bianco & Recchia, 1983)	*Squalius squalus*	NT	*Leuciscus cephalus*	Europe	LC
Telestes savigny Bonaparte, 1840*	*Telestes muticellus*	LC	*Leuciscus souffia muticellus*	Italy	LC
Telestes muticellus (Bonaparte, 1837)*	*Telestes muticellus*	LC	*Leuciscus souffia muticellus*	Italy	LC
Telestes comes (Costa, 1838)	*Telestes muticellus*	VU	*Leuciscus souffia muticellus*	Italy	LC
Protochondrostoma genei (Bonaparte, 1839)*	*Protochondrostoma genei*	LC	*Chondrostoma genei*	Po	LC
Chondrostoma soetta Bonaparte, 1840*	*Chondrostoma soetta*	EN	*Chondrostoma soetta*	Po	EN
Scardinius hesperidicus Bonaparte, 1845*	*Scardinius hesperidicus*	LC	*Scardinius erythrophthalmus*	Danubian	LC
Scardinius scardafa (Bonaparte, 1837)*	*Scardinius scardafa*	CR	*Scardinius erythrophthalmus*	Danubian	LC
Gobio benacensis Pollini, 1816*	*Romanogobio benacensis*	EN	*Gobio gobio*	Danubian	LC
Phoxinus phoxinus (L., 1758)*	*Phoxinus lumaireul*	LC	*Phoxinus phoxinus*	Danubian	LC
Barbus tyberinus Bonaparte, 1839*	*Barbus tyberinus*	NT	*Barbus plebejus*	Po	LC
Barbus plebejus Bonaparte, 1839*	*Barbus plebejus*	LC	*Barbus plebejus*	Po	LC
Barbus caninus Bonaparte, 1839*	*Barbus caninus*	EN	*Barbus meridionalis caninus*	Po	EN

Alburnus arborella (Bonaparte, 1841)*	*Alburnus arborella*	LC	*Alburnus alburnus alborella* (De Filippi, 1844)	Po	LC
Alburnus albidus (Costa, 1838)*	*Alburnus* ***abidus (?)***	EN	*Alburnus albidus*	Southern Italy	EN
Rutilus aula (Bonaparte, 1841)*	*Rutilus aula*	LC	*Rutilus erythrophthalmus* Zerunian, 1982	Po	LC
Rutilus rubilio (Bonaparte, 1837)*	*Rutilus rubilio*	LC	*Rutilus rubilio*	Tuscany-Latium	LC
Rutilus pigus (La Cepéde, 1803)*	*Rutilus pigus*	NT	*Rutilus pigus*	Po	NT
Cobitis zanandreai Cavicchioli, 1965	*Cobitis zanandreai*	VU	*Cobitis taenia bilineata*	Po	LC
Cobitis bilineata Canestrini, 1866*	*Cobitis bilineata*	LC	*Cobitis taenia bilineata*	Po	LC
Sabanejewia larvata (De Filippi, 1859)*	*Sabanejewia larvata*	LC	*Sabanejewia larvata*	Po	LC
Barbatula barbatula (L., 1758)	*Barbatula barbatula*	LC	*Barbatula barbatula*	European	LC
Padogobius bonelli (Bonaparte, 1846)*	*Padogobius bonelli*	LC	*Padogobius martensii*	Po	LC
Padogobius nigricans (Canestrini, 1867)	*Padogobius nigricans*	VU	*Gobius nigricans*	Tuscany-Latium	VU
Knipowitschia panizzae (Verga, 1841)*	*Knipowitschia panizzae*	NT	*Knipowitschia panizzae*	Adriatic-Ionian	NT
Knipowitschia punctatissima (Canestrini, 1864)	*Knipowitschia punctatissima*	NT	*Knipowitschia punctatissima*	Upper Adriatic	NT
Esox cisalpinus n.sp.*	*Esox lucius*	NT	*Esox lucius*	Peninsular Italy	LC
Aphanius fasciatus (Valenciennes, 1821)*	*Aphanius fasciatus*	LC	*Aphanius fasciatus*	Mediterranean	LC
Gasterosteus gymnurus Cuvier, 1829*	*Gasterosteus gymnurus*	LC	*Gasterosteus aculeatus*	Euro-Mediterranean	LC
Cottus gobio L., 1758	*Cottus scaturigo*	LC	*Cottus gobio*	Euro-Mediterranean	LC
Cottus gobio	*Cottus ferrugineus*	LC	*Cottus gobio*	European	LC
Lota lota (Linnaeus, 1758) ? (Introduced?)*	*Lota lota*	LC	*Lota lota*	Palaearctic	LC
Salaria fluviatilis Asso, 1801	*Salaria fluviatilis*	LC	*Salaria fluviatilis*	Mediterranean	LC

Table II – Established alien species with comments on their origin, interactions with native species and other information

Species	**Distribution**	**Type of interaction with native species and other information**
Odonthestes bonariensis (Valenciennes, 1835	Lake Nemi	No interference
Salmo trutta L., 1758	Pan-Italian	Interbreeds and competes with *Salmo farioides*
Onchorhynchus mykiss (Walbaum, 1792)	Pan-Italian	Interbreeds and competes with native salmonids
Salvelinus alpinus (L., 1758)	Alpine lakes and rivers of north-eastern Italy	Unknown
Salvelinus fontinalis (Mitchill, 1814)	Alpine lakes and upper reaches of rivers	Unknown
Coregonus lavaretus (L., 1758)	Lakes of northern and central Italy	Kottelat & Freyhof (2007) reported only one species for Italy, *C. macrophthalmus*. Hence, we follow Gandolfi et al. (1991), who cited two well-differentiated and sympatric species in Italy.
Coregonus oxyrhynchus (L., 1758)	Introduced into prealpine lakes and those of northern, central and southern Italy	Interferes with the other *Coregonus* species
Thymallus thymallus	Northern and central Italy	Interferes with native strains
Squalius cephalus (L., 1758)	Introduced at least into the Ombrone basin, but probably into many other places	Interferes with native chubs
Telestes souffia (Risso, 1827)	Introduced into rivers of north-eastern Italy	Interferes with and tends to eliminate the endemic *T. savigny*
Barbus barbus (L., 1758)	Introduced to northern and central Italy	Interferes with native barbel species, especially in the lower reaches of rivers
Barbus balcanicus Kotlik et al., 2002.	Introduced into rivers of north-eastern Italy	Interferes with and tends to eliminate the endemic *B. caninus*
Massinobarbus graellsii (Steindachner, 1866)	Found in some central Italian rivers, probably established elsewhere	Interferes with and tends to eliminate the endemic *B. tyberinus*, especially in the lower reaches of rivers
Gobio gobio (L., 1758)	Now dominant in rivers of the Padano-Veneto area, with cases in central and southern Italy	Interferes with and tends to eliminate the endemic *G. benacensis*.
Pseudorasbora parva (Temminck & Schlegel, 1846)	Found throughout peninsular Italy and now also in Sardinia (Orrù et al., 2010).	Interferes with native cyprinids
Carassius auratus (L., 1758)	Italian peninsula and islands	It is difficult to follow Kottelat & Freyhof (2007), who

		distinguish as valid species the red form *C. auratus* and the gold form *C. gibelio* (Bloch 1872), even though all other characters are the same
? *Carassius carassius* (L., 1758)	Species assumed for Italy, although there are no documented cases of its presence	Unknown
Cyprinus carpio L., 1758	Italian peninsula and islands	Indirectly interferes with all the native species by altering the habitat
Tinca tinca (L., 1758)	Italian peninsula and islands	According to Lajbner et al. (2011), in Italy this species has post-glacial origins. This contrasts with its ecological category: primary, thermophilic, obligate limnophilic. Therefore, the species must be considered introduced into Italy.
Rhodeus amarus (Bloch, 1872)	North-eastern Italy. Locally dominant along with the topomouth gudgeon and gambusia	*Rhodeus sericeus* (Pallas, 1776), cited by Nocita & Zerunian (2007), is distributed in the Amur River (Kottelat, 1997)
Rutilus rutilus (L., 1758)	Padano-Veneto area and central Italy	In subalpine lakes, and elsewhere, it directly interferes with native cyprinids and tends to eliminate and interbreed with the Danube roach
?*Rutilus basak* (Heckel, 1843)	Sport fishing lakes	Some managers of sport fishing private ponds intend to or already have introduced the Croatian roach to forage predators because it is more resistant than the Italian roaches
?Alburnus alburnus (L. 1758)	Presence to be determined	Interferes with and probably interbreeds with native congeners
Pachychilon pictum (Heckel & Kner, 1858)	Serchio River. There is also a good-sized population in Lake Massaciuccoli (specimens donated by N.E. Baldaccini) and perhaps elsewhere	Competes with the rovella. In Lake Massaciuccoli, the species is confused with *R. rubilio.*
Chondrostoma nasus (L., 1758)	Padano-Veneto area	Directly interferes with and tends to eliminate the Italian nase and the South European nase
Abramis brama (L., 1758)	Padano-Veneto area	Interferes with native cyprinids
Blicca bjoerkna (L., 1758)	Padano-Veneto area	Interferes with native cyprinids
Aspius aspius (L., 1758)	Padano-Veneto area	Unknown
?Scardinius erythrophthalmus (L. 1758)	Presence to be determined	Interferes with native rudds
Misgurnus anguillicaudatus (Cantor, 1842)	Ticino. Erroneously cited as *Misgurnus fossilis* (L., 1758)	Unknown
Ameiurus melas (Rafinesque,	Italian peninsula and islands	Interferes by predation on the native species

1820)		
Ameiurus nebulosus (Leseur, 1819)	Italian peninsula and islands	Interferes by predation on the native species
Ictalurus punctatus (Rafinesque, 1818)	Certainly established in Tuscany	Unknown
Silurus glanis L., 1758	Padano-Veneto and Tuscany-Latium area	Eliminates the native communities by predation
Perca fluviatilis L., 1758	Pan-Italian	The genotype is identical to that of the populations of Poland and western Europe (Nesbø et al., 1999), which supports the alien origins of the species also in northern Italy
Lepomis gibbosus (L. 1758)	Pan-Italian	Interferes with the native species
? Lepomis auritus (L. 1758)	According to Besana (1908), the species imported from America was *L. auritus*	The possible presence of this species must be verified; perhaps it is locally confused with *L. gibbosus*
Micropterus salmoides (La Cepéde, 1802).	Pan-Italian	Strong predator of all species, especially cyprinids in limnophilic habitats
Sander lucioperca (L. 1758)	Northern and central Italy. Difficult to become established	Predation on cyprinids and other smaller forms
? Percottus glenii Dybowski, 1877	Originally from East Asia. Presence to be determined in Italy. Invasive species	Present as an impurity in stockings with official species, recorded in many European countries. Strong predator of juveniles
Gasterosteus aculeatus L. 1758	Toce River	Presence must be determined. The report is from 1975 (Bianco, 1980) and must be verified.
Gambusia holbrooki Girard, 1859	Pan-Italian	Interferes with *Aphanius* and the three-spined stickleback
Poecilia reticulata Peters, 1860	Central Italy	Establishment widely documented in thermal canals of the Viterbo area (E. Spada & L. Giuliani, www.repubblica.it) starting from 1996
Oreochromis niloticus (L. 1758)	Fossa Calda, Tuscany (Piazzini et al., 2010), Lake Lesina, Menona and Rialto Canals, Veneto	Euryoecious, invasive species. Interferes with the native species. Its progressive adaptation to low temperatures cannot be excluded (Bianco & Turin, 2010).
Amatitlania nigrofasciatus (Gunther, 1866).	Fossa Calda, Tuscany (Piazzini et al., 2010)	Unknown
Hemichromis sp.	Fossa Calda, Tuscany (Piazzini et al., 2010)	Unknown

Table III - Species and numbers of specimens of native reshwater fishes and crayfish transfaunated by the Brescia and Rome fish farms in 5 years (1926 to 1930).

Species	**Brescia**	**Rome**
Alborella	75,000	0
Agone	3,800,000	11,300,000
Eel	76,632,000	90,007,000
Barbel	13,445,000	401,000
Chub	5,834,000	0
Crayfish	52,000	101,000
Nase	2,200,000	0
Pigo	630,000	0
Rudd	400,000	0
Grayling	193,000	20,000
Triotto	4,380,000	0
Brown trout	16,973,000	6,528,000
Macrostigma trout	0	51,000
Vairone	3,700,000	0

Table IV – Percentage of alien species on total fish assemblages in developed countries (data combined from Copp et al.,2006; Froese & Pauly, 2010; and Bianco, 2005).

Country	**Native**	**Aliens**	**% Aliens**
Austria	**59**	**27**	**32**
Czeck Republic	**59**	**30**	**34**
England	**41**	**21**	**34**
France	**46**	**36**	**44**
Germany	**88**	**18**	**17**
Hungary	**62**	**19**	**20**
Italy	**50**	**54**	**52**
Poland	**58**	**23**	**28**
Portugal	**33**	**12**	**27**

Romania	**93**	**28**	**23**
Slovakia	**57**	**28**	**33**
Slovenia	**66**	**16**	**19**
Spain	**40**	**29**	**37**
Japan	**224**	**34**	**14**
Singapore	**67**	**38**	**36**
Hong Kong	**40**	**12**	**23**
Taiwan	**123**	**32**	**21**
Canada	**210**	**21**	**9**
Australia	**345**	**86**	**2**
USA	**796**	**61**	**8**

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