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THE LIST OF ALIEN SPECIES IN THE ICHTHYOFAUNA OF THE CZECH REPUBLIC

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In this paper, we record the introduction or invasion of 41 non-indigenous fish species into natural ecosystems of the Czech Republic over the past two centuries. Of these, only 12 species have survived to the present day. Fully naturalised species that have established natural populations include *Ameirus nebulosus, Carassius auratus gibelio, Gasterosteus aculeatus, Pseurorasbora parva* and *Neogobius melanostomus. Oncorhynchus mykiss* and *Salvelinus fontinalis* form occasional and locally stable populations. The occurrence of the remaining species *(Coregonus maraena, Coregonus peled, Ctenopharyngodon idella, Aristichthys nobilis* and *Hypophthalmichthys molitrix)* is reliant upon aquaculture, including hand-stripping. The six-year annual average of total production of alien species in the Czech Republic for 2001–2006 reached 2,054 tonnes. Of these alien species, only *C. auratus gibelio* has been shown to have a significantly negative impact upon native ichthyofauna. At present, apart from *Mylopharyngodon piceus*, no further officially sanctioned imports of alien species are under consideration.

Key words: allochthonous fish species, production, negative impact, significance.

Introductions of alien fish species have a long-standing tradition, both worldwide and in Europe. Both local and continental reviews of introduction activities contain, in addition to lists of alien fish species, examples of either the risk or confirmed influence of such species on local ichthyofauna, and their potential for devastating populations [Welcomme, 1988; Allendorf, 1991; Holčík, 1991; Efford et al., 1997; Bogutskaya, Naseka, 2002; Copp et al., 2005; Riberio et al., 2008; among others]. In recent years, there has been increased attention paid to so-called invasive alien species; particularly as regards the negative influence such non-native species may have on native biodiversity [Lusk, Lusková, 2005]. In view of the present connections existing between European hydrological systems, the time has come to consider the potential for incidental introductions and their possible risks, based upon unified pan-European criteria. A review of the present situation as regards occurrence, significance, and influence of alien species in individual countries should form an essential part of European endeavours to protect native ichthyofauna.

In the Czech Republic, the transfer of certain fish species *(e.g. Cyprinus carpio, Sander lucioperca, Salvelinus alpinus, Coregonus maraena)* has been performed for centuries in connection with fishpond aquaculture [Heinrich, 1856; Teplý, 1937]. Such transfers tend to take place over short distances, from one drainage area to another and, as such, they can be denoted as "translocations". In the 19th and 20th centuries, attempts at introductions in Central Europe had already led to their inadvertent release into neighbouring countries [Holčík, 1991].

As a continuation to our earlier preliminary reports [Lusk, 1988; Lusk et al., 1998], we present here a complete review of attempts at introduction and of the occurrence of non-native fish species in waters of the Czech Republic. We evaluate both the positive assets to fish production and the negative impacts on aquaculture and natural ecosystems connected with the acclimatisation and naturalisation of non-native species.

Material and Methods

The hydrological system of the Czech Republic consists of the headwaters of a

number of major European rivers (i.e. the Labe, Vltava, and Ohře – draining into the North Sea; the Morava and Dyje – draining into the Black Sea; and the Odra – draining into the Baltic Sea). Aside from *Carassius auratus* and *Neogobiusa melanostomus*, therefore, the occurrence of alien species is the result of human introductions. At this time, there is no central register of introduced fish species in the Czech Republic. In compiling the present review, therefore, we have mainly based our results on our own investigations on non-native species carried out over the past 30 years and on historical literary data. In addition, data were obtained from several non-specific studies focussed on the problems of non-native species [Čihař, 1968; Kálal, 1987; Adámek, Kouřil, 1996; Lusk et al., 1998) and on personal information provided by persons engaged in practical fisheries and ichthyological research.

Results and Discussion

Within the borders of the present Czech Republic, both *C. carpio* and *S. lucioperca* have been introduced from the drainage area of the Danube into that of the Labe (where the species are not native) and attempts to introduce *Salvelinus alpinus* are known to have occurred as early as the Middle Ages [Frič, 1859; Teplý, 1937; Andreska, 1987]. Subsequent introduction attempts took place in periodic waves. For example, fish species of North American origin were introduced in the late 19th century. A further wave of experimental introductions took place after 1950, connected with introduction activities in the then Soviet Union (Table 1).

Table 1. List of species introduced into the Czech Republic. Actual occurrence (Y-yes, N-no, E-experimental, Ar-artificial reproduction, Nr-natural reproduction). Importance (P-production, F-sport fishing, Bi-bioamelioration, Np-natural population, I-invasive species), *unintentional introduction, ** spontaneous immigration.

Species	Year of 1st introduction	Actual occurrence	Importance
ACIPENSERIDAE			
Acipenser nudiventris Lovetzky, 1828	1994	Y, E	
Acipenser gueldenstaedti Brant, 1833	1996	Y, E	
Acipeser stellatus Pallas,1771	1994	Y, E	
Acipenser baerii Brandt, 1869	1982	Y,E	
POLYODONTIDAE			
Polyodon spathula (Walbaum, 1792)	1995	Y,E	
CYPRINIDAE			
Ctenopharyngodon idellus (Valenciennes, 1844)	1961	Y, Ar	P, F, Bi,
Pseudorasbora parva /Schlegel, 1842)	1981, 1982*	Y, Nr	Np, I
Carassius auratus (Linnaeus, 1758)	1975-76**	Y, Nr	F, P, Np, I
Hypophthalmichthys molitrix (Valenciennes, 1844)	1964	Y, Ar	P
Aristichthys nobilis (Richardson, 1845)	1964	Y, Ar	P
Mylopharyngodon piceus (Richardson, 1845)	1999, 2000	Y, E	
CATOSTOMIDAE			
Ictiobus cyprinellus (Valenciennes, 1844)	1985	Y, E	
Ictiobus niger (Rafinesque, 1920)	1985	Y, E	
CLARIIDAE			
Clarias gariepinus (Burchell, 1822)	1986	Y	
ICTALURIDAE			
Ameirus nebulosus (LeSueur, 1819)	1890	Y, Nr	F, Np, I
Ameirus melas (Rafinesque, 1818)	2003*	Y	
Ictalurus punctatus (Rafinesque, 1818)	1985	N	

SALMONIDAE			
Salmo dentex (Heckel, 1851)	1901?	N	
Oncorhynchus mykiss (Walbaum, 1792)	1888	Y, Ar, Nr	P, F, Np?
Salvelinus fontinalis (Mitchill, 1814)	1885	Y, Ar, Nr	P, F, Np?
Salvelinus alpinus (Linnaeus, 1758)	1579, 1883	N	
Salvelinus namaycush (Walbaum, 1792)	1972, 1976	N	
Coregonus albula (Linnaeus, 1758)	1892?,1951	N	
Coregonus autumnalis (Georgi, 1775)	1959	N	
Coregonus peled (Gmelin, 1788)	1970	Y, Ar	P
Coregonus maraena (Bloch, 1779)	1882	Y, Ar	P
Coregonus wartmanni (Bloch, 1784*)*	?	N	
Coregonus fera Jurina, 1825	?	N	
THYMALLIDAE			
Thymallus arcticus (Dybowski, 1874)	1959, 1960	N	
GASTEROSTEIDAE			
Gasterosteus aculeatus Linnaeus, 1758	?	Y, Nr	Np
OPHICEPHALIDAE			
Channa argus (Cantor, 1842)	1956, 1960	N	
CENTRARCHIDAE			
Micropterus dolomieui (Lacépede, 1802)	1889	N	
Lepomis gibbosus (Linnaeus, 1758)	1929	N	
Lepomis auritus (Linnaeus, 1758)	1913	N	
Ambloplites rupestris (Rafinesque, 1758)	1892?, 1911	N	
CICHLIDAE			
Oreochromis aureus (Steindachner, 1864)	?	E,N	
Oreochromis mossambicus (Peters, 1852)	?	E,N	
Oreochromis niloticus (Linnaeus, 1758)	1985	Y, Ar	
Oreochromis urolepis hornorum (Trewavas, 1966)	?	E,N	
GOBIIDAE			
Neogobius melanostomus Pallas, 1814	2008**	Y	Np

Though introductions of around 41 fish species can be considered as proven in the Czech Republic (see Table1), positive identification of some species is doubtful in some cases, such as where a few individuals of a species were imported just once over a century ago or were only mentioned in magazine articles *(e.g. Salmo dentex, Coregonus fera, C. wartmani)*. Two non-native species, *Carassius auratus gibelio* and *Neogobius melanostomus,* invaded waters of the Czech Republic from the River Danube via their own migration activity. *C. a. gibelio* continued to expand its distribution, aided by man, and has now become naturalised [Lusk, 1986; Lusk et al., 1998b; Lusková et al., 2004]. Over the last two years, *N. melanostomus* has occupied the area around the confluence of the Rivers Morava and Dyje and is presently successfully reproducing there [Lusk et al., 2008; unpublished data). Of all the experimental introductions of alien fish species, positive results have only been obtained for *Ctenopharyngodon idella, Pseudorasbora parva, Hypophthalmichthys molitrix, Aristichthys nobilis, Ameirus nebulosus, Oncorhynchus mykiss, Salvelinus fontinalis, Coregonus peled, C. maraena,* and *Gasterosteus aculeatus.* Of these, only *C. a. gibelio, P. parva* and *A. nebulosus,* and localised populations of *G. aculeatus,* have produced stable populations in natural habitats, maintaining themselves by natural reproduction. The occurrence and aquaculture of *C. idella, H. molitrix* and *A. nobilis* depends exclusively on artificial reproduction. The remaining species occur primarily in connection with fishery activities, both natural reproduction and/or

populations in natural conditions tending to be unstable and non-permanent.

In recent years (2001–2006), alien fish species accounted for only a small part (8.36%) of annual total fish production in the Czech Republic (24,570 tonnes). Of this *H. molitrix* and *A. nobilis* accounted for 742 tonnes, *C. idella* 384 t, *O. mykiss* 695 t, *S. fontinalis* 116 t, *C. maraena* and *C. peled* 33 t, and *C. a. gibelio* 84 t. Most of this production comes from fishponds and intensive aquaculture, with only a small part being obtained from natural habitats by angling, e.g. *C. auratus* (50%), *C. idella* (23%) and *O. mykiss* (7%). The above data are based on annual statistics compiled by the Ministry of Agriculture [Ženíšková ,Gall, 2007].

Alien species characterised as "invasive" represent the greatest risk to native fish species. In the Czech Republic, *C. auratus* forma *gibelio* displays all the signs of a typical invasive fish [Lusk, Lusková, 2005]. Around 1975, it migrated from the Danube into the drainage area of the Rivers Morava and Dyje [Lusk et al., 1977]. Subsequently, helped by humans, it invaded all suitable water bodies, producing numerous stable populations. The original monosexual populations, consisting of triploid females, have been transforming over the past decade into so-called mixed type populations. Besides triploid and diploid females, these also contain diploid and, occasionally, even triploid males. These populations show both sexual and asexual forms of reproduction [Halačka et al., 2003; Lusková et al., 2004]. In a number of habitats in the floodplains of major rivers (the Morava, Dyje, Labe and Odra), *C. auratus* has become the dominant species, strongly competing for food and space with native species and, consequently, strongly limiting the numbers of their populations. A further negative effect caused by the presence of *C. auratus* in natural habitats is its sexual parasitism and hybridisation, especially with *Cyprinus carpio* and *Carassius carassius*. *C. auratus* has significantly suppressed and limited the occurrence of native *C. carassius* and *Tinca tinca* [Lusk et al., 1998; 1998a; Lusková et al., 2002; Papoušek et al., 2008; unpublished observations]. *C. auratus* is a serious problem in fishponds that specialise in carp production as it markedly limits carp production and its own production is of distinctly lower value (Lusk 1986, unpublished data). Certain less distinct characteristics of invasive species can also be observed in *A. nebulosus* and, to a certain extent, also in *P. parva*.

With the exception of *Mylopharyngodon piceus*, no further introductions of alien species are under consideration in this country. The risk remains, however, of undesirable alien species being introduced with imported fish stocks from abroad. A classic example is the dispersal of *Perccottus glenii* over Eastern and Central Europe [Koščo et al., 2003]. Also of importance is the phenomenon of "non-native populations" that present a serious risk for native genetic (intraspecific) diversity [Lusk et al., 2002]. This occurs in the case of transfers of stocking material of "native species" from different drainage areas, or even different sea basins that seriously endanger the indigenous intraspecific (population and intrapopulation) genetic diversity.

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