ПРИКЛАДНАЯ ЭКОЛОГИЯ

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THE NECESSITY OF THE REARING OF NON-COMERCIAL AQUATIC SPECIES IN AUSTRIA, AND PREREQUISITES FOR THE SIMILAR SITUATION IN RUSSIA

The general dramatic decline of biodiversity is progressing even faster in aquatic habitats. Highly specialized species living in a narrow ecological niche are on the edge of extinction or have already died out. But not only species with a complex life-cycle that often depend on host species, or animals and plants that need a pristine environment are at risk. In Austria and other European countries, even species that used to be common and abundant until recently have turned out to be endangered or even on the edge of extinction when subject of thorough investigation. This development has sped up in the past few decades because of various reasons. In most cases, there is not just a single reason for the decline, it is rather the combination of habitat loss, climate change and intensified utilization of the catchment areas that leads to combined effects that often actually intensify each other.

In Austria the decline of freshwater mussels, all native crayfish species, lampreys and several small fish species is so dramatic that artificial rearing is required to prevent their extinction. In Russia such measures are not realized yet in most cases, though similar processes of environmental degradation and intensification of land use are taking place. The awareness of the latter has led to the knowledge that certain prominent and well-surveyed species like the freshwater pearl mussel do need serious conservation measures regardless of their still large numbers. The bigger part of the endangered species, however, still remain unexplored in the context of conservation biology. This paper presents a review of recent studies in this field. Refs 26.

Keywords: population decline, species extinction, conservation, non-commercial species.

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НЕОБХОДИМОСТЬ РАЗВЕДЕНИЯ НЕКОММЕРЧЕСКИХ ВОДНЫХ ВИДОВ В АВСТРИИ И ПРЕДПОСЫЛКИ К АНАЛОГИЧНОЙ СИТУАЦИИ В РОССИИ

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Общее ухудшение состояния биоразнообразия все больше и больше ускоряется в водных биотопах. Популяции многих специализированных видов, имеющих сложные экологические ниши, пребывают на грани исчезновения. Однако не только виды со сложным жизненным циклом и требующие мало нарушенной антропогенным воздействием среды пребывают под угрозой. В Австрии и других европейских странах даже те виды, которые считались обычными и многочисленными, оказались сильно уязвимыми, что обнаружилось недавно при выполнении специальных исследований. Это явление наблюдается все чаще на протяжении последних

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десятилетий по разным причинам. Обычно оно вызвано не одним, а комбинацией нескольких факторов — разрушением биотопов, климатическими изменениями и интенсивным природопользованием. В Австрии падение численности пресноводных жемчужниц, всех местных видов раков, миног и некоторых мелких рыб настолько драматично, что для предотвращения их вымирания необходимо искусственное разведение. В России необходимость такой работы обычно не осознается, однако сходные процессы деградации окружающей среды и интенсификации хозяйственной деятельности происходят. По крайней мере, пресноводные жемчужницы уже требуют серьезных мер по сохранению, несмотря на то что в некоторых реках они еще многочисленны. Большая часть упомянутых видов в России остается неисследованной в контексте природоохранной биологии. В статье представлен обзор недавних работ в этой области. Библиогр. 26 назв.

Ключевые слова: падение численности, вымирание видов, сохранение, некоммерческие виды.

Introduction

The major causes of decline of aquatic species in Austria are anthropogenic activities. Several decades ago, mainly direct impacts as a result of riverine works, e.g. channelization and river regulation works, had massively negative consequences for the aquatic community and the sediment-situation. Additionally, hydropower plants totally transformed the character of many rivers and turned them into big lakes with abiotic conditions differing significantly from the original situation.

Migrating pathways have been disrupted, leading to severe consequences e.g. on the reproduction of migrating species, most prominently of sturgeons and salmons. Not only long distance migrators are affected by the thousands of migration barriers, but nearly every potamodromous species and species depending on them. In the River Aist for example, a river known for its large remnant freshwater pearl mussel population, impassable barriers occur every 240 m on average, blocking the migration routes of the mussel's essential host fish species, the brown trout (*Salmo trutta* f. *fario*) [1].

All these developments have fatal consequences for the biological cycles in rivers. Many highly specialized species were deprived of their necessary living conditions and died out. The extinction of certain plants and animals has changed the food web significantly and, consequently, the ecosystem all the more. A vivid example of these changes is the turbidity cleaning effect of filtering organisms like mussels and its benefit for the respective watercourse; when vast numbers of such filter feeders disappear, clear watercourses inevitably turn turbid.

Every single species, actually every organism has its position and necessity in the ecological context. We hardly know how things may change over a long period of time when a whole species disappears. During the past decades we had to recognize that not only highly specialized species with high environmental requirements are affected. Even species that were common and abundant turned out to be on the edge of extinction in Austria and other European countries within a few decades. The nase (*Chondrostoma nasus*), for example, was the most common fish in the River Danube and was caught in masses in the main river and its tributaries in the past century [2] but is nowadays only found in scarce remnant populations.

People in Central Europe usually have a very blurred picture of the natural situation of watercourses, since most rivers have been impaired over hundreds of years. In several regions Russia offers the last chance to get an imagination of natural rivers. In Russia the increasing decline of biodiversity is not to be found yet, but similar processes of environment degradation are taking place like they did some decades ago in Central Europe.

This paper focuses on the review of recent studies in this field. We believe the results indicate the promising perspectives of the work on the protection of the environment.

1. Examples from Austria

1.1. The freshwater pearl mussel (*Margaritifera margaritifera*)

Pearl mussels used to be very abundant in Austria in former times. It is known that practically all brooks and rivers to the north of the River Danube were inhabited by these mussels in millions and millions of specimens [3]. According to historical notations in monasteries and castles, they were even used as food for pigs. At the end of the 19th century an area-wide loss of mussel populations started, in the course of which more than 98% of the original stocks have vanished to date [4]. The same situation is to be attested all over Europe [5].

The reasons for the decline are manifold. It started with pearl fishing, which is a direct physical damage. When this activity came into vogue, millions of mussels were killed. Due to this over-exploitation many populations were destroyed and the commercial value dropped with the decreasing number of mussels.

Later on, the alteration and utilization of rivers (e.g. hydropower plants) and the various changes in agriculture and forestry in the catchments sped up the loss of mussel habitats and mussel populations. One of the most crucial problems nowadays is the colmation of the hyporheic interstitial, the habitat of juvenile mussels. As this colmation leads to oxygen depletion in the interstitials, most young mussels die at this stage.

Nowadays there are only about 7,000 mussels left in the original Austrian distribution area (pers. comm. Scheder) of what used to be millions in former times.

The drastic decline — to the edge of extinction — led to the decision that pearl mussels should be reared by captive breeding, at least until river restoration and sanitation measurements will have brought back adequate mussel habitats. Thus, an extensive and long-term project (ten years minimum) was launched in which both mussels are bred and their habitats restored [6, 7].

Nevertheless, many mussel populations in several rivers have already died out, and their genetic variability can never be brought back again.

1.2. Thick-shelled mussel (*Unio crassus*)

The thick-shelled mussel *Unio crassus* has much in common with the freshwater pearl mussel. It also lives in small clean rivers. Though shick-shelled mussels do not produce pearls, their shells can be used for jewelry. In the past these mussels were common in Austria, but recent studies have shown a catastrophic decline [8, 9]. Nowadays this species is to be classified as "regionally extinct". Like the freshwater pearl mussel, the thick-shelled mussel suffers from a degradation of the riverine environment, i. e. siltation, pollution, soil erosion and a washout of ground. The studies and conservation activities concerning *Unio crassus* resemble the efforts taken for the pearl mussel. The necessity of artificial rearing arises as well.

1.3. Brook Lamprey (*Lampetra planeri*)

As for *Lampetra planeri*, the situation is similarly alarming, albeit not as widely advanced as with the mussel species. This lamprey species has a similar geographical range

as the freshwater pearl mussel in Austria, formerly having covered all regions to the north of the River Danube. Currently, stocks are declining rapidly. But — assumedly due to the much shorter life span and the much shorter reproductive cycles — this species is still more abundant.

In some rivers the brook lamprey has died out in upper stretches, demonstrably due to critical incidents caused by toxic substances in the past, as it was proven for a river called Kleiner Kamp; a recolonization from lower reaches seems likely in these cases. However, it has turned out that any recolonization of lampreys is prohibited by even small weirs, let alone hydropower plants. In the case of the mentioned river, there is a migration barrier equipped with a fishway — which, however, does not work for weak swimmers like the brook lamprey, as it sports 15 cm high overflowing sections.

If fishways are not adapted for lampreys in the near future and there is any more calamity, a total loss of the lamprey population in the respective river is highly probable.

1.4. Weatherfish (*Misgurnus fossilis*)

One more example is the situation of the non-game fish species *Misgurnus fossilis* in Upper Austria. This small fish is highly adapted to small ponds in alluvial floodplains. Its adaptation even allows surviving several days if not weeks in waterless pools, buried in the mud, breathing atmospheric oxygen [10]. The species used to be so common in former days that anglers frequently used it as a bait for predators.

Due to massive melioration works in the floodplains of big rivers in Austria, the habitats of this specialized fish species vanished in most cases — only a few habitats have remained.

Therefore, a project currently aims at establishing a sufficient number of weatherfish populations to avoid its becoming extinct. As there are only two to three locations with dense enough populations for taking parent animals out for breeding, artificial breeding turned out to be inevitable [11].

The breeding experiments have lasted for five years now, with very unequal results. The bottom line is, there is no sufficient annual number of juveniles; several reproduction cycles even had to be cancelled without any breeding success. The breeding of this specialized animal has turned out to be too complicated to guarantee enough juveniles every year to definitely keep the species from extinction.

Again — the loss of genetic integrity cannot be estimated in its whole dimension.

1.4. Stone crayfish (*Austropotamobius torrentium*)

The last example deals with the native crayfish species *Austropotamobius torrentium,* the stone crayfish. It is reported that this crayfish species formerly inhabited nearly all small brooks up to 800 m above sea level all over the country. In order to find out about its current geographic distribution in Upper Austria, we studied more than 360 locations — mostly in small brooks, the preferred habitat of the stone crayfish [12, 13].

During this investigation we had to witness five cases of an outbreak of the crayfish plague, a highly infectious disease, brought to Europe by imported North American crayfish species like the signal crayfish, *Pacifastacus leniusculus*. These non-indigenous species are immune towards this disease, but they carry the pathogen against which native crayfish have no power of resistance.

The crayfish plague is not only distributed by crayfish, but also by wild animals and people crossing different rivers and brooks.

Currently we have to face the extinction of population after population without any idea how to stop it. If there is no solution in the near future, we will have to breed this species artificially, simultaneously losing genetic diversity and special adaptation.

2. Evidence of the similar processes in Russia

1. In Russia at least the freshwater pearl mussel already indicates a similar situation. Most of the populations have remained unexplored. More than 20 populations have become extinct, eight populations are very scarce in numbers that still decrease perpetually [14, 15]. In the north the pearl mussel is still abundant in some rivers [16]. However, they are not as numerous as they were in the past. The decline of some northern populations was noted at least since 1930s [17]. Analogously, in Western Europe the mussels had also been numerous before, but disappeared very rapidly within a few decades.

As for other freshwater bivalves, lampreys, small riverine fish and crayfish species, they remain unexplored in most of the Russian territory in the context of conservation biology. They seem more resistant than pearl mussels, but their decline is also probable — evidence is already available for some Russian territories. The noble crayfish *Astacus astacus*, for example, has declined in the water bodies of the Baltic Sea basin [18]. The thick-shelled mussel *Unio crassus* could be found in some rivers [14, 15], but are abundant in none of them. In the past they were used as a raw material for jewelry and as a food source for domestic animals, meaning that their populations consisted of millions of individuals. Nowadays there is a maximum of several hundred or thousand per river.

Studies on pearl mussels have indicated some positive aspects of land management in Russia: Pearl mussels have survived even in densely populated territories, nevertheless having decreased in number. Their survival had become possible as the natural arboreal vegetation were preserved at the river banks [15]. In such a situation the washing out of banks, drift of sand, acidification and other negative influences originating from the surrounding territory are attenuated. Maintenance of arboreal vegetation had become possible because of particularities of land and river use. Rivers and their banks cannot be private property in Russia. Even if a private plot of land is located close to a river, free access to the bank must be enabled. Some exceptions and violations occur, but the main part of the banks is still no man's land — a situation that has resulted in "disorder" along the river banks: nobody cleans them from seemingly unnecessary vegetation. At least small strips of natural vegetation have remained there. Since the rivers are public property, the state can impose bans on their use. According to the "Water code of Russia" (03.02.2006. № 74-FZ, www.pravo.gov.ru) "water protective zones" and "coastal defensive strips" exist along the banks of all water bodies. These notions point out different patterns of bans at different distances from the bank line. "Coastal defensive strips" are usually 30–50 m in width, the "water protective zone" 30–200 m. In the water protective zone the following activities are prohibited: 1) use of drainage water for fertilizing soil; 2) allocation of cemeteries, burial grounds for animal refuse, waste burials; 3) aerial pest control; 4) movement and parking of transport outside of the roads and especially arranged places. In the water defensive strips ploughing up, allocation of ground and pasture are not allowed.

Forestry management also contributed to the conservation of riverine environment, as forests cannot be private property in Russia either — they can just be rented. This has resulted in numerous restrictions on their use and in the fact that they are used rather extensively than intensively. Tree branches, stumps, leafs, small trees are not used usually. Hence, a big organic mass remains in a forest after clearing (although European technologies of the intensive use of woodland have developed since recently). Usually the forests renovate by themselves; transformation from forests into tree plantations does not take place, hence natural drainage into the rivers persists.

However, initiatives to introduce a "European order" in nature are continuously progressing. Even scientific institutions support this, although usually these activities take place spontaneously without any scientific base. For example, in the 2000s the managers of a sanctuary Gladyshevsky at the city of Saint-Petersburg cut trees lying across the river and tried to clean it from wood during several years. Scientific studies in this field are scarce, that is why it is difficult to stop such activities that originate from the natural human desire for order [19].

Discussion

Biodiversity is decreasing all over the world, mainly in densely populated areas like Western and Central Europe. Lots of people lead to lots of different measures with manifold impacts on our environment. One of the most unknown environments are our rivers.

As the above examples show, we have to deal with many problems, starting with the lack of common knowledge concerning the biology and ecological processes in our rivers. We lose so many specially adapted and genetically equipped animal and plant species by intervening into natural cycles and ecologically stable situations without any idea about possible outcomes. Many contributions to the loss of biodiversity could be prevented with more thoughtfulness before starting projects that go along with use and consumption of natural resources.

The above-mentioned examples from Austria demonstrate the typical situation for Europe [20]. Several special institutions dealing with the artificial rearing of pearl mussels were established recently in many European countries [21]. (Meanwhile the production of pearls is out of question because of the low number of mussels, the rearing exclusively aims at saving the species). Similar activities concerning other non-commercial aquatic species are required to prevent their extinction. At least *Unio crassus* is already considered an endangered species [22].

These cases reflect the process of a "current mass extinction" or the "sixth mass extinction" after the five mass extinctions of the remote past [23, 24]. It is especially dramatic as, unlike after the previous extinctions, presumably no new rich fauna and flora will arise to replace the extinct one. The study of this phenomenon indicates the necessity of the active use of gap-analysis methodology in modern biology — the revealing of the most significant gaps in our knowledge. Many species disappear even before they have time to be investigated by scientists. Among the species discussed above only the pearl mussel ever attracted attention, because it was kind of a commercial species in the past. The other ones are not as "charismatic" at least. There is still not enough information on their distribution and state of the populations. These species either have not been studied at all, or studied without any relation to conservation biology. For example, for some decades a discussion

about pair-species in lampreys has taken place, namely whether the small brook lampreys and the big migratory river lampreys belong to different species or represent morphs of the same species [25]. However, this discussion can turn out to be meaningless in the near future, because lampreys are probable to soon become extinct. In Russia some taxonomists still try to continue the old discussion on the number of species of the European pearl mussel [26], although it is also meaningless. In some rivers, being the source of this discussion, pearl mussels are already on the edge of extinction, the collection of big series of samples is not possible there. This means that conservation biology of this species is a more significant gap in our knowledge than details of taxonomy. The filling of such gaps is the most urgent task of biology. Otherwise the number of possible objects for biological research will decrease rapidly and with them biodiversity will decline incredibly fast.

The study of the aquatic species discussed above and more and more of them is especially urgent, because they represent an interest not only by themselves. These species are sensitive indicators of environmental changes on a global scale. The decline of their populations indicates the shallowing of the rivers, which means the desertification and loss of freshwater.

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Conclusion

The combination of Russian and European experiences would help to save the riverine environment nature: "natural disorder" in water bodies and along their banks, research and artificial rearing of endangered species in a case of need. However, the progress of the European scenario in Russia is more probable at the moment.

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