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Loaches and the environment in two provinces in Northern Vietnam

Miloslav PETRTÝL[1]*, Jörg BOHLEN[2], Lukáš KALOUS[1], Anh THE BUI[3] and Petra CHALOUPKOVÁ[4]

[1] *Faculty of Agrobiology Food and Natural Resources, Czech University of Life Science Prague, Czech Republic; e-mail: petrtyl@af.czu.cz*
[2] *Institute of Animal Physiology and Genetics, Academy of Sciences of the Czech Republic, v.v.i, Czech Republic; e-mail: bohlen@iapg.cas.cz*
[3] *Research Institute for Aquaculture No. 1, Vietnam; e-mail: atbu@ria1.org*
[4] *Institute of Tropics and Subtropics, Czech University of Life Sciences Prague, Czech Republic; e-mail: chaloupkova@its.czu.cz*

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Abstract. During the last decades, agriculture activities in the mountainous northern provinces of Vietnam intensified drastically, and today rice fields occupy the complete valleys of local streams and rivers. Upstream of the fields, many dams were built mainly for irrigation purposes; sometimes stopping the flow through the lower courses of the creek completely. Illegal fishing with electro-fishing gears is a common way to improve food supply for local villagers. Larger rivers are impacted by non-selective fishing, gravel mining and pollution. These factors represent threats to the local fish communities, which typically include one or several species of loaches.With usage of electro-fishing gear and hand net we surveyed 16 localities of the river basins of the River Ky Cung and the River Bang Giang. Both rivers belong to the drainage area of the River Pearl in the provinces Lang Son and Cao Bang in Northern Vietnam. We focused on getting maximum number of fish species with special attention to loaches at each locality. Ten species of loaches were found; at least two of them represent undescribed species. The main conclusion is that the ichthyofauna of Northern Vietnam still holds a hidden diversity, but at the same time is under strong anthropogenic pressure, so that parts of the diversity may be lost soon.

Key words: biodiversity, the River Pearl, *Schistura*, *Leptobotia*, *Traccatichthys*, *Cobitis*, *Misgurnus*

Introduction

Southeast Asia is one of the major biodiversity hotspots on earth, covering only 4 % of the global land area, but containing 20-25 % of all plant and animal species (Myers et al. 2000, Sodhi et al. 2004, Mittermeier et al. 2005, Woodruff 2010). Freshwater biodiversity is also extraordinary; the region has the second richest freshwater fauna in the world with many of local endemics (Kottelat 2002, Dudgeon 2005, Dudgeon et al. 2006, Froese & Pauly 2010). This rich terrestrial and freshwater biota are threatened by human population growth, deforestation and habitat lost, over-exploitation, invasive species, pollution and climate changes (Sodhi & Brook 2006, Sodhi et al. 2007, Koh & Wilcove 2009, Peh 2010, Woodruff 2010). Sodhi & Brook (2006) estimated that habitat destruction achieves twice the rate of other humid tropical areas, and overexploitation is six times higher than the sustainable rate. This results in an increased extinction risk for many vertebrate animals in Southeast Asia (Hoffman et al. 2010).

Freshwater biodiversity is experiencing higher rates of extinction than terrestrial biota (Dudgeon et al. 2006). Rivers and wetlands in South-East Asia have been severely degraded by erosion, pollution, overfishing, introduction of alien species, and by the construction of dams (Sodhi et al. 2007). These hydrologic changes influence the structure and dynamics of biological communities living in the rivers and may lead in many cases to species

* *Corresponding Author*

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extinction (Petts 1996, Cowx & Welcomme 1998, Dudgeon 2000, Bunn & Arthington 2002).

In Vietnam, the change of the environment is mainly caused by population and economical growth. Vietnam population grew drastically in 20th century, from 15 million in 1921 to more than 89 million people living nowadays in the region; the average density is six times the world mean of 46 people/km^2 (CIA factbook 2009, General statistic office of Vietnam 2010). In the second half of the 20th century, government- sponsor relocation projects shifted large numbers of people from the densely populated agricultural lowlands to highland regions. Conversion of forest to agricultural fields followed (Sterling et al. 2006). In late 1960 the forest covered 55 % of the land area of Vietnam, but was reduced within 20 years to 17 % (Koninck 1999). The loss of forest cover has important implications for river conservation since it results in reduces of available food, erosion, and siltation (Welcomme 1979).

If there is a need to protect biodiversity, to monitor changes and human influences, first it is necessary to explore and to document the diversity. The northern parts of Vietnam have only superficially been studied ichthyologically, but the high diversity in the neighbouring areas (southern China, central Vietnam and northern Laos; Kottelat 2000, Myers et al. 2000, Freyhof & Serov 2001) suggests that also here a high diversity is hidden. The fast changes in the environment in northern Vietnam makes it necessary to explore this diversity fast, otherwise many species might disappear before they have been recognised by science and by conservation biologists. Here we report about the loach species recorded during an ichthyological survey in two provinces of Northern Vietnam.

Material and Methods

Field survey was conducted in the basins of the River Ky Cung (Lang Son province) and the River Bang Giang (Cao Bang province), both in the drainage area of the River Pearl (Fig. 1). Lang Son and Cao Bang provinces have mainly hilly terrain covered by forests (average altitude 252 m a.s.l., range 20 to 1540 m). Summer temperature can reach 32 °C, while during winter occasionally freezing occurs.

Coordinates of particular localities were obtained in the field using a Garmin Colorado 3000 GPS (Table 1). Sampling was done during two field works in March and September 2009.

Sampling at all sites were provided by two trained researchers. We used portable electroshocker SEN (Radomír Bednář, Czech Republic) and hand net. To standardize the catch at each site we sampled 50 m long segment of river. We sampled all types of microhabitats occurring at each site to get maximum number of fish species with special focus on loaches. In total eight sites in Lang Son and eight sites in Cao Bang provinces were sampled. In addition, diversity of fishes on the local markets in Lang Son and Cao Bang cities was checked.

Fish were photographed, preserved in 5 % formaldehyde and then stored in 70 % Ethanol. Identification of loach species follows Kottelat (2001) and Freyhof & Serov (2000, 2001).

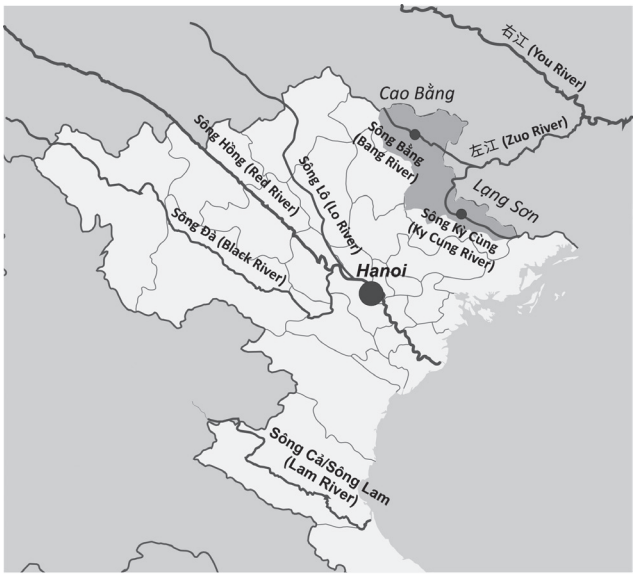


Fig. 1. *Map of Northern Vietnam. All 16 localities are situated in darker area in Lang Son and Cao Bang provinces.*

Results

In total, more than 600 specimens of fishes were sampled belonging to at least 50 species including 10 loach species. Among the loaches, the study identified three species of Balitoridae (*Sinohomaloptera kweichangensis*, *Beaufortia* sp., *Liniparhomaloptera* sp.) two species of Botiidae (*Leptobotia* cf. *elongata*, *Sinibotia pulchra*), two species of Cobitidae (*Cobitis laoensis*, *Misgurnus anguillicaudatus*) and four species of Nemacheilidae (*Schistura hingi*, *Schistura chapaensis*, *Schistura* sp. 1, *Traccatichthys taeniatus*). Because the identification of the species from family Balitoridae is preliminary, we do not include these species into the analysis.

In all visited localities at least one species of loach was present. Maximum number of species per locality was six. Most common were specimens of the genus *Schistura*, which occurred at each locality.

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Table 1. *List of sampled localities with occurrence of particular loach species. CB – Cao Bang; LS – Lang Son. Spec. 1* Leptobotia *cf.* elongata*; Spec. 2* Sinibotia pulchra*; Spec. 3* Cobitis laoensis*; Spec. 4* Misgurnus anguillicaudatus*; Spec. 5* Schistura hingi*; Spec. 6* Schistura chapaensis*; Spec. 7* Schistura *sp. 1; Spec. 8* Traccatichthys taeniatus.

Locality	GPS coordinates	river width (m)	Botiidae		Cobitidae		Nemacheilidae			
			Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6	Spec. 7	Spec. 8
CB1	N22 39.904 E106 10.420	3-5	-	<°))><	-	-	<°))><	-	-	-
CB2	N22 43.618 E106 11.007	3-5	-	-	-	-	<°))><	-	-	-
CB3	N22 43.064 E106 10.623	3-5	-	-	-	-	<°))><	-	-	-
CB4	N22 41.980 E106 11.997	3-5	-	-	-	-	<°))><	-	-	-
CB5	N22 39.931 E106 15.764	10-20	-	-	-	-	<°))><	-	<°))><	<°))><
CB6	N22 49.395 E106 06.305	5-10	-	-	-	-	<°))><	-	-	-
CB7	N22 44.337 E106 08.886	30-40	-	-	-	-	-	-	-	-
CB8	N22 44.434 E106 11.872	3-5	-	-	-	-	-	-	-	-
CBm	market in Cao Bang city	-	-	<°))><	<°))><	<°))><	<°))><	-	-	<°))><
LS1	N21 44.829 E106 56.088	40-50	-	-	-	-	<°))><	-	-	-
LS2	N21 47.517 E106 53.467	3-5	-	-	-	<°))><	<°))><	-	-	-
LS3	N21 51.112 E106 30.765	5-10	-	-	<°))><	-	<°))><	-	-	<°))><
LS4	N21 52.856 E106 39.287	15-30	-	-	-	-	-	-	<°))><	<°))><
LS5	N22 14.685 E106 29.169	3-5	<°))><	-	-	-	<°))><	-	<°))><	<°))><
LS6	N21 51.063 E106 45.451	50-80	-	-	-	-	-	-	-	-
LS7	N22 08.150 E106 34.713	reservoir	-	-	-	-	-	-	-	-
LS8	N22 08.280 E106 34.827	15-20	-	-	-	-	-	<°))><	-	-
LSm	market in Lang Son city	-	-	-	-	-	-	-	-	-

"<°))><" presence or "-" absence of species on locality.

Discussion

Despite a recent increase of studies about Vietnamese fishes, very few information about the fish fauna of the provinces Lang Son and Cao Bang have been published. Basing on own observations, Mai (1978) and Kottelat (2001) record 2 and 3 species of Cobitidae; 1 and 1 species of Botiidae; and 7 and 11 species of Nemacheilidae, respectively. Both authors base their information on records from the River Red and the River Ma and do not mention records from the provinces Lang Son and Cao Bang or the River Pearl basin. More loaches have been recorded from the River Pearl basin by Nguyen (2005) and several Chinese authors, but these records or descriptions do not give enough diagnostic characters to decide about the actual identity of the recorded fishes and cannot be considered here. All studies that have been carried out up to now in northern Vietnam revealed the existence of several undescribed species; and also the present study reports at least two undescribed species of loach. This frequent finding of undescribed species indicates the presence of a larger diversity of loaches in the area than is presently believed. A similar development was before observed in Laos, where a 3-year period of intense ichthyological surveys increased the number of known fish species from 210 to 481 (Kottelat 2000). In general, new taxa of loaches can be expected to occur in all less studied mountainous areas of Southeast Asia (Bohlen & Šlechtová 2011). Definitely there is a big need to study northern Vietnam in more detail, collect properly preserved voucher material and compare the material with existing material from central Vietnam, southern China and Laos.

As result of our survey we can add some information about the freshwater fishes of the provinces Lang Son and Cao Bang (Fig. 2).

Leptobotia cf. *elongata* has been described and reported from the middle River Yangtse basin in China, but recently, Kottelat (2001) and Nguyen (2005) reported one specimen each from the upper River Red basin in northern Vietnam. The specimen reported here is the third specimen for Vietnam and the first for the River Pearl basin. However, since all three Vietnamese specimens were juveniles and the

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identification of species of the genus *Leptobotia* is difficult, the identification of the species occurring in northern Vietnam is tentative. *Sinibotia pulchra* is known from the River Pearl basin in southern China. A figure that probably shows this species has been published by Mai (1978), but without giving the geographic origin of the fish (Kottelat 2001). Nguyen (2005) lists it from Lang Son and Cao Bang. Loaches of the family Botiidae are generally hideous and often occur in deeper water between stones, making them difficult to collect and consequently details about the distribution of many species are not known.

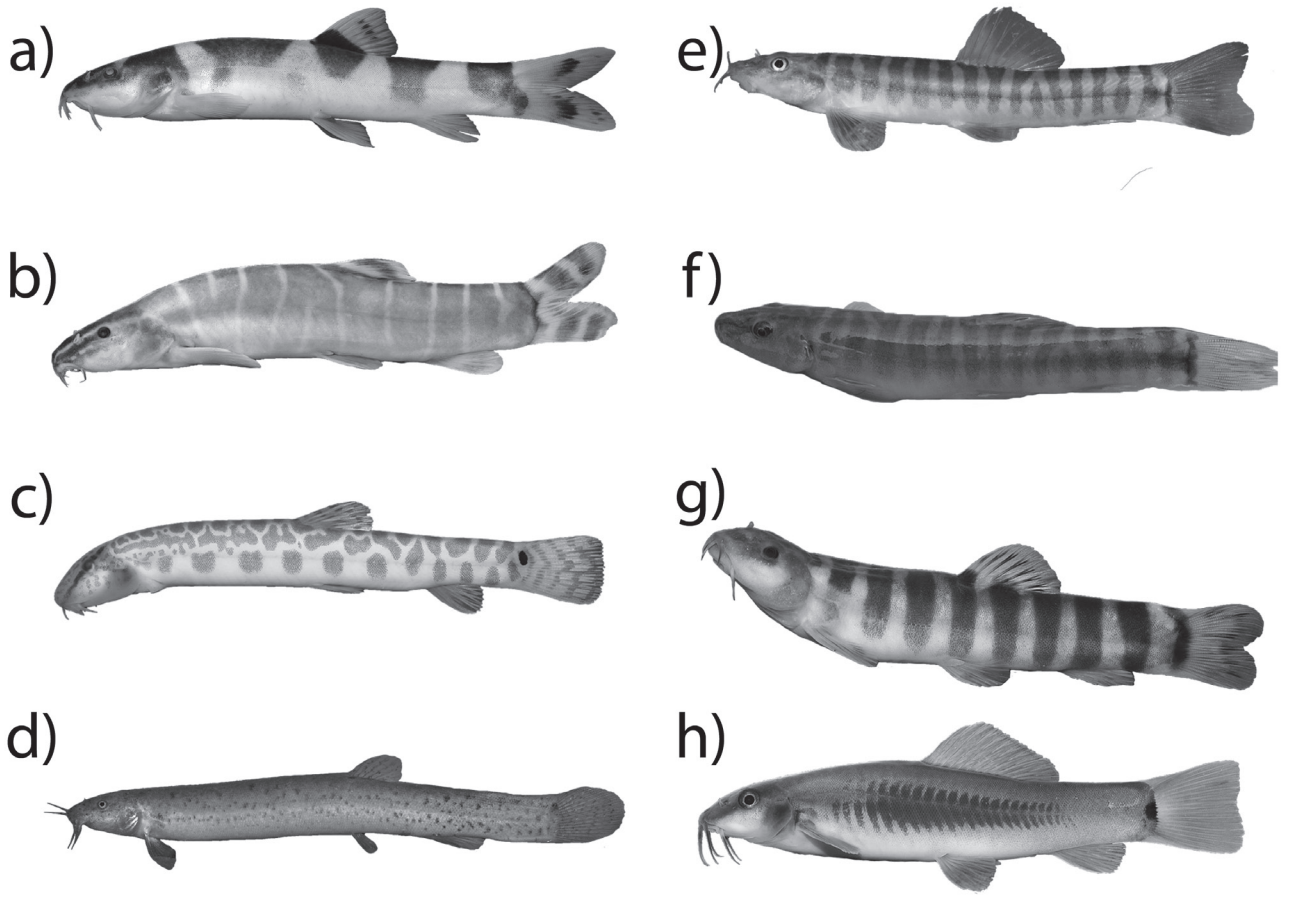


Fig. 2. *Photos of the eight loach species found in Lang Son and Cao Bang sites. a)* Leptobotia *cf.* elongata*; b)* Sinibotia pulchra*; c)* Cobitis laoensis*; d)* Misgurnus anguillicaudatus*; e)* Schistura hingi*; f)* Schistura chapaensis*; g)* Schistura *sp. 1; h)* Traccatichthys taeniatus.

Cobitis laoensis is endemic to Vietnam, but widespread in central and northern Vietnam. The present records are the northernmost one for the species and the first in the River Pearl basin. From the present records it can be expected that the species occurs also in the Chinese part of the River Pearl basin. Like most species of *Cobitis*, *C. laoensis* is found on sandy bottom in slow flowing waters. *Misgurnus anguillicaudatus* is one of the very widespread loach species, ranging nowadays from northern Burma through most of China to Japan and southwards into northern Laos and Vietnam. It is a valuable food fish and has been introduced by man to numerous places. The species is nowadays common throughout northern Vietnam and can be found in nearly each river, especially in the slow to moderately flowing streams in lowland areas.

Schistura hingi was previously reported from southeast China (Hong Kong and Lipu County in the province Guangxi, the River Pearl basin) and from central Vietnam (provinces Quang Binh, Ha Tinh and Nghe An) (Freyhof & Serov 2001). The present records from the River Pearl basin in northern Vietnam indicate that it occurs also in the area between these formerly known and that it can be expected for the whole the River Pearl basin. Like all species of Nemacheilidae in Lang Son and Cao Bang provinces, it is object of indiscriminate fishing but not particularly searched for. *S. hingi* occurs in small fast flowing streams between boulders. We found the species on ten sites (63 %) and on the market in

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Cao Bang city. According to these findings *S. hingi* seems to be most widespread species of *Schistura* in the area. *Schistura chapaensis* has formerly been reported from two localities in the River Red basin in northern Vietnam (Rendahl 1944, Kottelat 2001). Like *Schistura* sp. 1 it belongs to the group of species with complete lateral line, no sexual dimorphism, regular bands on body and moderately emarginated caudal fin. There seems to be a number of species of this group in northern Vietnam and southern China, and the poor informative value of many original descriptions and the lack of comparative material hampers a qualified identification. Both species have been collected in fast flowing clear streams between boulders. While *S.* sp. 1 was found on three distant localities (20 %) and seems to be a common and widespread species in the investigated area, *S. chapaensis* was found only on one locality. Thus, the later species seem to have a more restricted geographic distribution or different habitat requirements than *S. hingi* and *S.* sp. 1. *Traccatichthys taeniatus* is one of the most common loach in both provinces. It occurred on four (25 %) of all visited places. Juvenile specimens were found between detritus in the slow moving, shallow marginal waters, but with increasing body length the specimens inhabited deeper and faster flowing waters. *T. taeniatus* was regularly observed on local wet markets; according to local villagers the species is object of indiscriminate fishing but not particularly searched for.

According to the General Statistics Office of the Government of Vietnam, the population of Cao Bang province in 2008 was 528100 with a density of 79 persons per km^2. Lang Son and Cao Bang are rated as provinces with high ratio of poverty within rural communities (Minot et al. 2003). Consequently considerable part of population is using local natural recourses. That includes indispensable pressure for freshwater fauna. Local villagers commonly fish by a combination of non-selecting methods including traps, gill nets, hand nets and homemade electroshockers. Fishes of all size and age categories are usually taken. This was often observed directly in the field and it is also notable according to daily supply of fresh fish in local markets. In smaller streams, this pressure can reduce the fish population drastically.

Gravel mining became an important disturbance of river habitats since 1986, when the new economic politics in Vietnam enabled citizens to earn money and finally build new solid houses. By 2000, more than three quarters of all houses have been built new and this construction boom caused a dramatic increase in the gravel and sand mining activity in the rivers. Mining primarily destroys gravel beds, which are important habitats for juvenile fishes (Rinaldi et al. 2005). It may lead to changes in the flow pattern of the river (Kondolf & Swanson 1993), an effect that was visible in both provinces. Moreover, it causes a high sedimentation rate downstream of the mining place, preventing development of fish eggs and embryos.

Growth of human population density together with fast improvement of living standards resulted in a increase of the discharge of untreated sewage water, uncontrolled waste deposit in the alluvial areas, land degradation, deforestation and overfishing.

Another important factor that is influencing the ichthyofauna in the area is the change of the hydroregime of the rivers by building of water reservoirs. According to data from provincial statistics of Lang Son and Cao Bang, total number of reservoirs in the province of Lang Son is about 98 with total area of 7374.6 ha (average size 79.3 ha). The largest reservoir has 800 ha. Dams change the water flow regime in a way that the lower stretch of the stream is nearly or completely dry during the dry season. Moreover, the dam with its stagnating water is a physical as well as ecological migration barrier for riverine fishes and hampers the colonisation of disturbed stretches during periods with suited conditions.

In general, the loach diversity in Lang Son and Cao Bang provinces is larger than presently known, but under strong anthropogenic influence that threaten this diversity. The management of freshwater systems should consider these effects and find more environmentally friendly ways to deal with the streams. Additionally, more surveys of the loach diversity in northern Vietnam and a proper taxonomic analysis of the occurring species are needed.

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