What Do the Occurrences of Migratory Fishes in the Upper Mekong Mean?

Bin Kang

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Abstract This paper examines the recent appearance of four migratory species in the Upper Mekong: *Dasyatis laosensis*, *Anguilla bicolor*, *Anguilla marmorata*, and *Chitala ornata*. Since 2006 these species have been continually sampled in an area below Jinghong Dam in Xishuangbanna, China. This region is far beyond their historical upstream distribution, and the reasons for these appearances and their subsequent impact on river ecosystem are considered.

Keywords Dam · Invasion · Sediment · Habitat degradation

The Mekong, originating in the Tibetan Plateau, flows from north to south through six countries. It is the second richest waterway for biodiversity and the largest inland fishery in the world (Dugan et al. 2010). It supports over 60 million people and is central for the economy and food security of the region, yet there are plans for large scale exploitation of the abundant water resources of the Mekong. In total 32 dams are planned on the Mekong mainstream alone. Among these, four are already in operation, seven are in construction and all are subjected to great concern worldwide (Stone 2011).

The characteristics of a particular species determine its spatio-temporal distribution, behavior, and position within an ecosystem (Wolf and Weissing 2012). Fishes confine their movements to specific areas within certain time frames in order to make the best use of available habitats and food resources. This is especially true for migratory species (Lucas and Baras 2001). About 39 % of the Mekong fish yield, i.e., about 800 000 tons each year, consists of migratory species (ICEM 2010). Generally, scientists consider that the most significant threat to

Mekong fish consists of dams blocking migration routes, altering river flows and resulting in a loss of migratory triggers and of flood-plain area that support abundant fisheries (Dudgeon et al. 2006).

Thus, the closure of the first Mekong mainstream dam (Manwan Dam) in 1987 resulted in the creation of a reservoir with an area of 26.6 km² and a capacity of 922.6 million cubic meters. Since then the local fish fauna has changed gradually, showing an increased presence of species that thrive in still water, and even the dominance of the icefish *Neosalanx tangkahkeii*, originally transplanted for aquaculture. In total, 48 % of the local species have disappeared in this area in 20 years from 1987 to 2007 (Kang et al. 2009). Moreover, Manwan Dam trapped about 60 % of sediments into its reservoir (Fu et al. 2008), and Kummur and Varis (2010) predict the sediment trapping efficiency would reach as much as 94 % for the whole cascade of eight dams, which would dramatically reduce the amount of nutrients flowing to the Lower Mekong, further affecting fish biodiversity (Osmundson et al. 2002).

In the Upper Mekong, since 2006 and the closure of the fourth dam (Jinghong Dam), four ‘new’ fish species, which had never been met so far upstream in the past, were sampled downstream of Jinghong Dam. Thus the eel *Anguilla bicolor* McClelland 1844 was sampled in Jinghong (21°59′56″N, 100°47′13″E) in August 2006 (Chen et al. 2010a) but before that had only been found in Cambodia (Roberts and Warren 1994; MRC 2003). Another eel *Anguilla marmorata* Quoy & Gaimard 1824, was collected in Ganlanba (21°51′06″N, 100°55′20″E) in August 2009. Historically, it had been recorded in the Lower Mekong up to northern Laos (Dubeau 2004; Baird 2011). A freshwater stingray species *Dasyatis laosensis* Roberts & Karnasuta 1987, with a distribution range in the Lower Mekong up to northern Laos (Dubeau 2004), was

found some 150 km upstream in Guanlei Port (21°41'35"N, 101°07'16"E) in April 2008 (Chen et al. 2010b). Last the featherback *Chitala ornata* (Gray 1831), formerly known up to Chiang Khong (MRC 2003) then found in Northern Laos (Dubeau 2004), was found in Menglun (21°56'20"N,

101°15'18"E) in May 2007 (Fig. 1). The appearance of these species in the Upper Mekong during the past decade was confirmed by local fishermen I talked to. These fish are all endemic species with limited populations in the Mekong basin and *D. laosensis* was even evaluated as endangered

Fig. 1 Mekong basin. Jinghong Dam is the nearest dam to estuary in operation. Xayaburi Dam would be the first dam in Lower Mekong mainstream. The *alphabet* refers to the historical activity sites for *Anguilla bicolor* (a), *Anguilla marmorata* (b), *Dasyatis laosensis* (c), and *Chitala ornata* (d). The sampling area is the place where appearances have been noted of the four migratory fish species

(Vidthayanon 2011). Though belonging to different taxonomic groups, these fish all display similar biological and ecological characteristics:

- long-distance migration patterns
- carnivorous eating habits, feeding mostly on other fish and macroinvertebrates
- preference for sandy substrate at night and deep rocky pools in the daytime.

Generally, species have to change habitat only when they are facing threats such as environmental degradation or food shortage, and vulnerable migratory species with good swimming abilities can be pioneers in searching for new sites for survival (Daufresne and Boët 2007). I hypothesize that, due to the cascade of newly built dams, the running water converted into still water, coarse material being deposited in the reservoir and downstream sediment load reduced to fine grain sediments such as mud. Thus, the upstream sediment load reduction and associated loss of nutrients reduce the availability of sandy substrate habitats in the lower reaches (Sullivan and Watzin 2010; Baker et al. 2011). I also hypothesize that the reduction of fish sizes and resource due to intensive fishing (van Zalinge et al. 2001) led to a lack of food for predatory species. These factors may contribute to the appearances of long-distance migratory fish in the upper Mekong via the extension of migration ranges among Lower Mekong migratory species.

The extension of migration ranges may pose a threat to the Mekong fish biodiversity as a whole: a specific fish may be a mesopredator in a former habitat and become a top predator or an ‘invasive species’ in a new habitat, ultimately reorganizing the local food web by competing for food and living space with local fish (Rooney and McCann 2012). Throughout this process, local species as a target of invasive fish may become threatened, and species with a high position in the food web may fail to effectively compete with invasive species and ultimately have to seek new habitats as a new ‘invader’, probably resulting in fish redistribution, fauna homogenization and eventually species loss in the end.

On the 6th November 2012 the Government of Laos with support from Thailand announced its decision to proceed with the construction of Xayaburi Dam (Vaidyanathan 2011). The operations of this dam will shrink further habitats available to migratory fish. Considering the combined effects of connectivity loss, climate change, environmental degradation, and human growth, where will the Mekong fish ultimately be able to go?

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AUTHOR BIOGRAPHY

Bin Kang (✉) is a Professor at Fishery College, Jimei University, and Asian International Rivers Center, Yunnan University. His research interests include fish biogeography, fisheries, aquaculture and their changes corresponding to environmental factors.
Address: Fisheries College, Jimei University, No. 43, Yindou Road, Jimei District, Xiamen 361021, China.
 e-mail: binkang@163.com