

Helminth richness in Arunachal Pradesh fishes: A forgotten component of biodiversity

Biological diversity (or biodiversity), defined as the number and variety of living organisms within a specific geographical region, is essential for the stability of ecosystems, protection of overall environmental quality and understanding the intrinsic value of all species on earth (Ehrlich and Wilson 1991). Parasites, constituting more than half of all biodiversity (Toft 1986), are the integrative core of biodiversity survey and inventory, conservation and environmental integrity and ecosystem function (United States Department of Agriculture 2009). This article highlights the need for studies researching biodiversity of fish helminths, the largest and the most important group of fish parasites, with special reference to monogenoids occurring in Arunachal Pradesh waters.

The state of Arunachal Pradesh (29°30' N; 97°30' E) is recognized as the 25th biodiversity hotspot in the world (Chowdhery 1999), among the 200 globally important ecoregions (Olson and Dinerstein 1998) and is also one of the hotspots of freshwater fish biodiversity in the world (Kottelat and Whitten 1996). The state has no less than 213 recorded fish species (Bagra *et al.* 2009) having elements of Indo-Gangetic, Myanmarese and south Chinese regions (Yadava and Chandra 1994). Not only do these fish provide nutritious food, but they also part of an unbreakable relationship with the culture, religion and traditions of the region (Vishwanath 2002). Recognizing the future potential of fishery culture, the state government initiated the 'state fisheries programme' from as early as 1958, which is now regarded as one of the most important sectors involved in the socioeconomic upliftment of the tribal population of the state (Government of Arunachal Pradesh 2011a).

Disease, and much of it due to parasites, is the single most important factor threatening the fishery industry worldwide, particularly in the tropics (Schmidt and Roberts 2000). Among the parasites that infect freshwater fishes, helminths – represented by 5 well characterised taxonomic units, Monogenoidea,¹ Trematoda (comprising Digenea and Aspidogastrea), Cestoda, Nematoda and Acanthocephala – form a major group and often cause veterinary problems worldwide (Williams and Jones 1994). Helminth parasites are important not only because they cause fish diseases but also because they are an essential component of global biodiversity (Poulin and Morand 2004). As much as 30000 helminth species have been estimated to be parasites of fish (Williams and Jones 1994).

Monogenoidean parasites are the most ubiquitous and abundant parasites in the aquatic environment (Ivona 2004). These are mainly ectoparasitic on gills and/or external surfaces of freshwater and marine fishes (Bychowsky 1957); a few species become endoparasitic by inhabiting the pallial cavity of cephalopods and urinary bladder and rectum of amphibians and reptiles (*see* Euzet and Combes 1998 and the references therein). These worms feed on blood (Hayward *et al.* 2007) and/or epithelial cells and mucus of fish (Buchmann and Bresciani 2006), causing direct loss due to mortality, usually to younger fish and those in intensive culture/captive conditions (Thoney and Hargis 1991). Damage is frequently indirect when these worms degrade the mucous layer, making the host fish susceptible to secondary pathogens such as bacteria and fungi (Grimes *et al.* 1985). The economic effects of infestation include a decrease in and/or rejection of otherwise edible fish products leading to subsequent loss of interest in the aquaculture industries (Jones 2001). Chemicals and freshwater/marine baths are often used to control monogenoids but these methods can be very expensive (Whittington *et al.* 2001).

Keywords. Arunachal Pradesh; biodiversity; fish; helminths; Monogenoidea

¹ There has long been controversy regarding the use of the epithet Monogenea or Monogenoidea (*see* Wheeler and Chisholm (1995) and Boeger and Kritsky (2001) for discussions).

In addition to direct economic losses due to reduced fish production, several helminth parasites remain a subject matter of major public health concern, especially in Asia, since they can be transmitted to humans and domestic animals only through fish (Chai *et al.* 2005). At least 50 species of helminth parasites have been implicated as producing zoonotic infections (infections of animals that also infect man) resulting from eating raw or under-cooked aquatic food, including fish (Deardorff 1991).

In India, the biodiversity studies on helminths (excluding monogenoids) were started from the middle of the 19th century by some workers who came here on medical or military assignments from foreign countries (Gupta 1984). Since then, their diversity has been documented from different parts of the country by the pioneer helminthologists including particularly: GD Bhalerao (1930 to 1940s); GS Thapar (1930 to 1950s); MN Datta (1930 to 1960s); BS Chauhan (1940 to 1950s); TD Soota (1950 to 1980s); PD Gupta (1960 to 1980s); CB Srivastava (1960 to 1990s); KC Pandey (1968 to present); Y Chaturvedi (1970 to 1980s); M Hafeezullah (1970 to 1990s); QH Baqri (1970 to 1990s); RK Ghosh (1980s) and MS Jayrajpur (1980 to present). Most of these studies comprise descriptions of new taxa, while a few publications deal with the ecological aspects, the locomotion and mode of attachment, the life cycle, and pathology or, more recently, their molecular aspects. The biodiversity studies on Indian monogenoids in particular are rather recent and stem from papers of the 1940s and 1950s by BS Chauhan, GS Thapar, SL Jain, RV Unnithan, K Ramalingam and YR Tripathi. However, no complete list of the helminth fauna of Indian fish has been published to date. Pandey and Agrawal (2008) have determined the known nominal species of Monogenoidea to be about 300.

Surprisingly, while the literature is replete with information on diversity of fish helminths from the rest of India, little information exists on those of northeast India and, more specifically, on those of Arunachal Pradesh (Tondon *et al.* 2005; Tondon and Tondon 2009). Approximately 4000 species of Monogenoidea have been formally described worldwide but up to 25000 species are predicted to exist (Whittington 1988). This prediction is based on a rational assumption that each of approximately 25000 known fish species around the world harbours a minimum of one species of Monogenoidea. By this analogy, 167 species of Arunachal fishes could host a similar number of species of Monogenoidea, but there is no published record of them to date. Evidently, the entire taxa of monogenoidean parasites from Arunachal Pradesh are awaiting their discovery and formal description in biodiversity studies. This paucity of helminth studies in Arunachal Pradesh means there is a lack of baseline data about the levels of parasitism on fish populations, and this could possibly be assigned to a host of reasons, notably, the remoteness of the region, difficult terrain and, most importantly, 'taxonomic impediment' – the lack of helminth taxonomists and systematists – in the region.

The state of Arunachal Pradesh is predominantly characterized by topographical constraints such as altitudinal and geographical variations, mountain slopes and infertile soil that are not suited for high level of agricultural production (Government of Arunachal Pradesh 2011b). This imbalance can be removed by adequate research and development support in the fishery sector as the state has innumerable fishery resources (reviewed above). The success of various fishery development programmes, however, depends to a certain extent on the intensification of fish parasitological research, since improvements in fish yields can be achieved from healthy fish stock alone. Thus, there is a strong and urgent need to bring the state fisheries to focus attention on and manage fish parasitologists and, above all, helminthologists. The successful production of fishery resources in the state may supplement protein requirement for the poor (food security), add to their income (via food fishes and ornamental fishes) and may also promote sport tourism (via game fish), making the 'state fisheries programme' a success story.

Acknowledgements

This study was supported by a major project grant from the University Grant Commission, New Delhi [39-603/2010 (SR)].

References

- Bagra K, Kadu K, Sharma KN, Laskar BA, Sarkar UA and Das D N 2009 Ichthyological survey and review of the checklist of fish fauna of Arunachal Pradesh, India. *Check List* 5 330–350
- Boeger WA and Kritsky DC 2001 Phylogenetic relationships of the Monogenoidea; in *Interrelationships of the Platyhelminthes* (eds) DTJ Littlewood and RA Bray (London: Taylor and Francis) pp 92–102

- Buchmann K and Bresciani J 2006 Monogenea (Phylum Platyhelminthes); in *Fish diseases and disorders Vol. 1: Protozoan and metazoan infections* 2nd edition (ed) PTK Woo (London: CAB International) pp 297–344
- Bychowsky BE 1957 *Monogenetic trematodes, their systematic and phylogeny* (English translation) (Washington: American Institute of Biological Science) p 509
- Chai JY, Murrell KD and Lymbery AJ 2005 Fish borne parasitic zoonoses: status and issues. *Int.J. Parasitol.* **35** 1233–1254
- Chowdhery HJ 1999 Arunachal Pradesh; in *Floristic diversity and conservation strategies in India, Vol. II: In the context of states and Union Territories* (eds) V Mudgal and PK Hajra (Kolkata: Botanical Survey of India) p 1059
- Deardorff TL 1991 Epidemiology of marine fish-borne parasitic zoonoses. *SE Asia. J. Trop. Med. Public Health* **22** 146–149
- Ehrlich PR and Wilson EO 1991 Biodiversity studies: Science and policy. *Science* **253** 758–762
- Euzet L and Combes C 1998 The selection of habitats among the Monogenea. *Int. J. Parasitol.* **28** 1645–1652
- Government of Arunachal Pradesh 2011a Lower Subansiri district (<http://www.arunachalpradesh.nic.in/otherlinks.htm>)
- Government of Arunachal Pradesh 2011b New agricultural policy (<http://www.arunachalpradesh.nic.in/nnap.htm>)
- Grimes DJ, Gruber SH and May EB 1985 Experimental infection of lemon sharks, *Negaprion brevirostris* (Poey), with *Vibrio* species. *J. Fish Dis.* **8** 173–180
- Gupta PD 1984 Helminthology in India in 18th-19th centuries with some remarks on its recent progress. *Indian J History Sci.* **19** 109–117
- Hayward CJ, Bott NJ, Naoki I, Iwashita M, Okihiro M and Nowak BF 2007. Three species of parasites emerging on the gills of mullet, *Argyrosomus japonicus* (Temminck and Schlegel, 1843), cultured in Australia. *Aquaculture* **265** 27–40
- Ivona M 2004 Monogenean parasites in Adriatic cage-reared fish. *Acta Adriat.* **45** 65–73
- Jones SR 2001 The occurrence and mechanism of innate immunity against parasites in fish. *Dev. Comp. Immunol.* **25** 841–852
- Kottelat M and Whitten T 1996 Freshwater biodiversity in Asia with special reference to fish; in World Bank Technical Paper No. 343 (Washington, DC: The World Bank) pp 17–22
- Olson DM and Dinerstein E 1998 The global 200: A representation approach to conserving the earth's most biologically valuable ecoregions. *Conserv. Biol.* **12** 502–515
- Pandey KC and Agrawal N 2008 An encyclopaedia of Indian Monogenoidea (New Delhi: Vitasta Publishing Pvt Ltd) p 552
- Poulin R and Morand S 2004 *Parasite biodiversity* (Washington, DC: Smithsonian Institution Books) p 216
- Schmidt GD and Roberts LS 2000 *Foundations of parasitology* (Boston: McGraw-Hill) p 173
- Thoney DA and Hargis WHJ 1991 Monogenea (Platyhelminthes) as hazards for fish in confinement. *Annu. Rev. Fish Dis.* **1** 133–153
- Toft CA 1986 Communities of parasites with parasitic life-styles; in *Community ecology* (eds) JM Diamond and TJ Case (Harper & Row) pp 445–463
- Tondon V, Kar PK, Das B, Sharma B and Dorjee J 2005 Preliminary survey of gastro-intestinal helminth infection in herbivorous livestock of mountainous regions of Bhutan and Arunachal Pradesh. *Zoos Print J.* **20** 1867–1868
- Tondon P and Tondon V 2009 Helminth parasite spectrum in North-East India (<http://www.nehu.ac.in/BIC/Databases.htm>)
- United States Department of Agriculture 2009 National parasite collection (<http://www.ars.usda.gov/Main/docs.htm?docid=12004&page=1>)
- Vishwanath W 2002 *Fishes of North East India: A field guide to species identification* (Imphal: Manipur University) p 198
- Wheeler TA and Chisholm LA 1995 Monogenea versus Monogenoidea: the case for stability in nomenclature. *Syst. Parasitol.* **30** 159–164
- Whittington ID 1988 Diversity 'down under': monogeneans in the Antipodes (Australia) with a prediction of monogenean biodiversity world-wide. *Int. J. Parasitol.* **28** 1481–1493
- Whittington ID, Ernst I, Corneillie S and Talbot C 2001 Sushi, fish, and parasites. *Australas. Sci.* **22** 33–36
- Williams HH and Jones A 1994 *Parasitic worms of fish* (London: Taylor and Francis) p 593
- Yadava YS and Chandra R 1994 Some threatened carps and cat fishes of Brahmaputra river system; in *Threatened fishes of India* (eds) PV Dehadrai, P Das and SR Verma (Muzaffarnagar: Natcon Publication) pp 45–55

AMIT TRIPATHI

Department of Zoology, Rajiv Gandhi (Central) University
Itanagar 791 112, Arunachal Pradesh, India
(Email, tripathi_amit02@yahoo.co.in)

ePublication: 16 August 2011