A genetic survey of the genus *Garra* (Cyprinidae: Labeoninae) in Western Bhutan

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Photo credit: Karma Wangchuk

Introduction

Garra is a genus of predominantly rheophilic and benthic cyprinids ranging through Africa and Asia. Recent taxonomic work has described multiple new species in the eastern Himalayan region, largely on the basis of unique oral morphologies and diversity in the shape and form of proboscis.

Nebeshwar & Vishwanath (2013) *Ichthyol. Explor. Freshwaters*, 24(2): 97-120

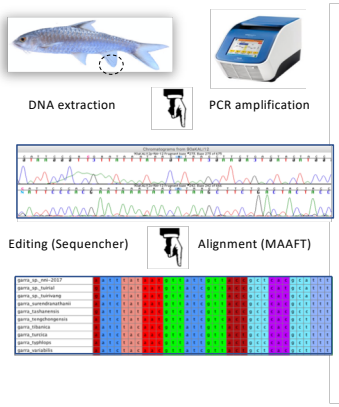
There are currently ~10 species reported in Bhutan, although with taxonomic ambiguity and possible species-level divergence causing confusion. We apply a genetic perspective using mtDNA and nuclear SNPs to resolve relationships and examine evolutionary patterns in *Garra*.

Thoni, Gurung, & Mayden (2016) *Zootaxa*, 4169(1): 115-132

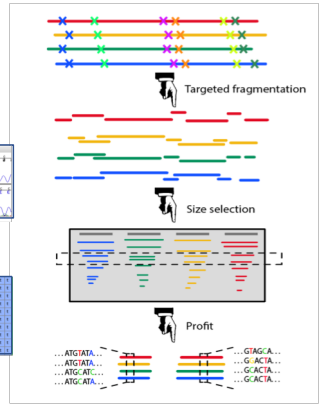
Methods

We sequenced 661 bases of the mitochondrial COI gene for N=314 individuals across 6 species. To examine potential hybridization, we also genotyped N=48 individuals at 21,290 nuclear SNP loci using ddRADseq. We examined mtDNA sequences within a phylogenetic context of 1457 cypriniform species from NCBI GenBank. We then applied a molecular clock analysis in TreePL so as to date divergences within *Garra* and examined diversification in BAMM.

mtDNA



ddRADseq



Population structure and distribution

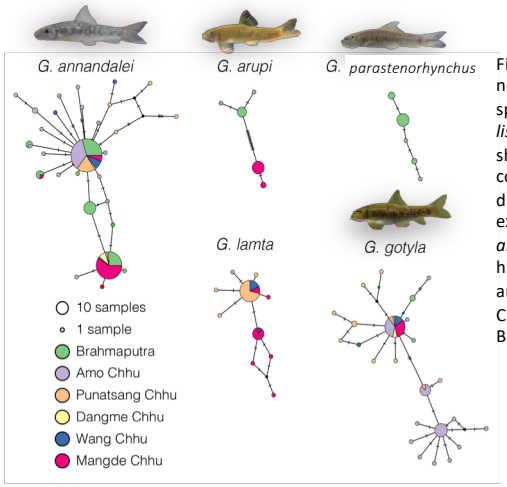
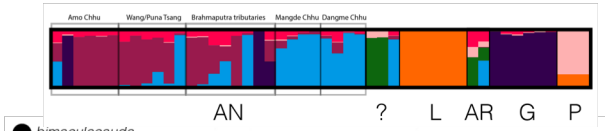


Fig. 1: Haplotype networks for each species (excluding *lissorhynchus*), showing high connectivity among drainages, with the exception of *G. arupi* which shows high divergence among Mangde Chhu and Brahmaputra sites.

Photo credit: Karma Wangchuk

Fig. 2: ADMIXTURE results based on >20k nuclear SNP loci, showing 'gene pools' as different colors, and bars showing individual samples assigned to gene pools. Three potential *gotyla* x *annandalei* hybrids were identified.



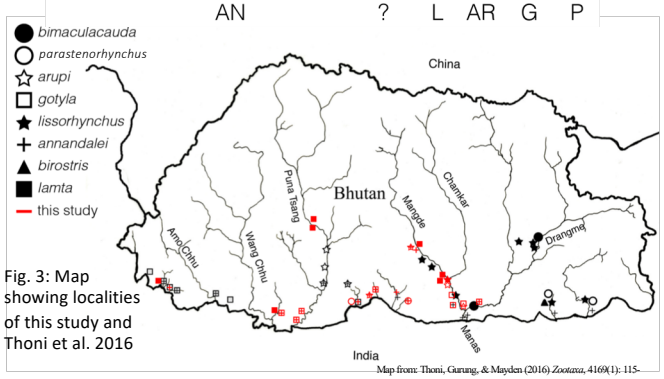
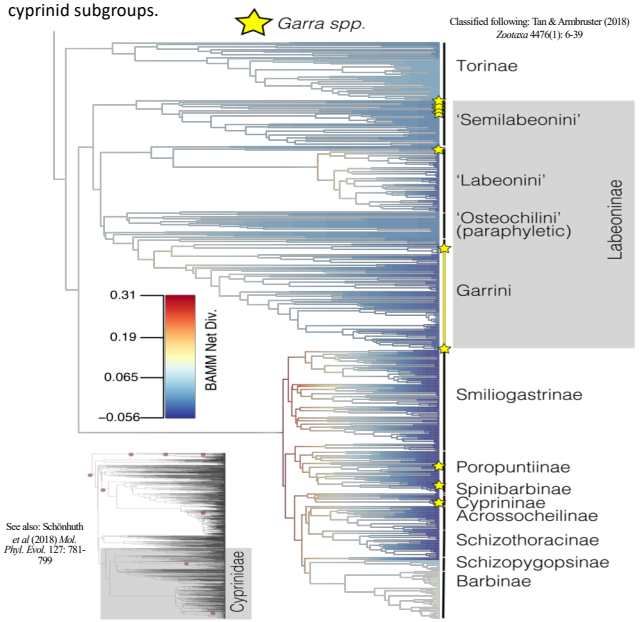


Fig. 3: Map showing localities of this study and Thoni et al. 2016

Map from: Thoni, Gurung, & Mayden (2016) *Zootaxa*, 4169(1): 115-132. Thanks to Ryan Thoni for permission to reproduce

Phylogeny and Taxonomy

Fig. 4: Time-calibrated COI phylogeny of Cyprinidae, showing polyphyly in *Garra*, paraphyly of the labeonin tribe 'Osteochilini', and diversification rate shifts in 2 cyprinid subgroups.



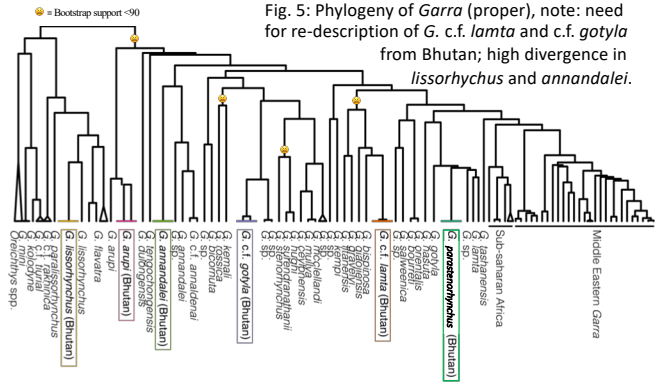


Fig. 5: Phylogeny of *Garra* (proper), note: need for re-description of *G.* c.f. *lamta* and c.f. *gotyla* from Bhutan; high divergence in *lissorhychus* and *annandalei*.