Fishes of Nepal: Mapping distributions based on voucher specimens

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Most prior accounts of the distribution of fishes in Nepal have not been validated with voucher specimens. We used specimens collected during a 1996 fish survey of Nepal, archived at the University of Kansas Natural History Museum and Biodiversity Institute (KU), to map the distribution of 141 fish species. Collections (131) spanned Himalaya Mountains to subtropical lowlands in 3 major river drainages (Karnali, Gandaki, Koshi) across 32 of Nepal’s 75 districts, and fishes from 111 samples are preserved in 1046 lots at KU. Collections comprised 10 orders and 30 families, including 76 species from 5 families of Cypriniformes, 41 species from 9 families of Siluriformes, 15 species from 8 families of Perciformes, 3 species from 2 families of Synbranchiformes, and 1 species each from Osteoglossiformes, Anguilliformes, Clupeiformes, Beloniformes, Cyprinodontiformes, and Tetraodontiformes. For each species, we provide a species account with scientific name, common name, a specimen photo with KU lot number, names of the districts in which the species was collected during the survey, a district dot map, and information on the species’ habitat use, feeding habits, and reproduction. Our maps provide a more extensive plotting of the distribution of fishes in Nepal than previously available, and we substantiate these records with museum voucher specimens. Results of this work will be useful to ichthyologists and others studying South Asian fishes, as well as to managers responsible for conserving this fauna.

Keywords: Nepal, fish, distribution, South Asia, Himalaya, mapping, KU, museum, voucher, Karnali, Gandaki, Koshi.

INTRODUCTION

Much remains to be learned about the distribution and ecology of fishes in many Asian countries (Dudgeon 1999). Nepal’s location at the intersection of the Palearctic and Oriental biogeographical realms, plus varied topography that generates a wide variety of aquatic habitats, yields a rich diversity of fishes (Rajbanshi 2005), with 232 species reported (T.K. Shrestha 2008), including 14 endemic species. However, documentation of the distribution of fish species across Nepal (J. Shrestha 1981, Rajbanshi 1982, 2003; T.K. Shrestha 2008) has been limited in scope, consisting mostly of checklists of species by river drainage or remarks on general habitats or regions of occurrence.

J. Shrestha (1981) included maps of the distribution of some fishes in Nepal, but these maps delineated fishes only to the family level, and included only 26 of the 37 fish families now reported from the country (T.K. Shrestha 2008). Furthermore, Shrestha (1981) mapped only to the zonal level (Nepal has 14 administrative zones which encompass 75 administrative districts), analogous to mapping fishes of India or the United States only to the state level. Placing a single dot in a zone for a fish species that may occur in a very limited area or throughout much of a zone can incompletely or imprecisely represent the distribution of that species. This is especially true in Nepal where a single zone can extend from snow-capped, 8,000-meter Himalayan peaks to Middle Hills, to lowland, subtropical jungles, known as the Terai, 50 meters above sea level (Fig. 1). J. Shrestha (1995) enumerated 185 fish species believed to occur in Nepal, and included maps with an indication of these species’ approximate distribution in the country. However, those accounts and most of the other aforementioned distributional narratives of the fishes of Nepal were not validated with museum voucher specimens. Voucher specimens are critical for scientists who seek to confirm identifications and are essential for taxonomists and systematists in the naming of organisms and the study of their evolutionary relationships.

Figure 1. Map illustrating the physiography of Nepal.
From February to December 1996, one of us (DE) made 131 fish samples in 32 of Nepal’s 75 districts (Fig. 2; Table 1) and collected 141 fish species belonging to 10 orders and 30 families (Table 2). Parts of these preserved collections were deposited in Nepal at the Natural History Museum at Swayambhu, Fisheries Development Division at Balaju, Chitwan National Park headquarters at Kasara, and Central Department of Zoology, Tribhuvan University, Kirtipur. Representative specimens of the 141 species from 111 collections were also deposited in 1046 lots at the University of Kansas Natural History Museum and Biodiversity Institute, Lawrence, Kansas, USA (KU). Herein, we map the distributions of those specimens vouched at KU. Our objective was to use these KU records to map Nepalese fish distributions to the district level, while also referencing specific museum voucher specimens to substantiate our conclusions.

**METHODOLOGY**

**Fish collection**

Fishes had been captured in 1996 by seine, cast net, gill net, trotline, hook and line, or electrofisher, preserved in 10% formalin solution in the field (Edds 2007), and then transferred to 70% ethanol at KU. Methods employed at each site are recorded in Edds’ field notebook, a copy of which is deposited at KU. For each lot, KU’s online catalog (ichthyology.biodiversity.ku.edu) provides range of sizes, field collection number, date, district, locality, approximate latitude/longitude, and number of specimens.

**Fish classification**

Classification and nomenclature used in this study follows the Catalog of Fishes (Eschmeyer 2012). All species included here are in Class Actinopterygii. Subfamilies are given for Cyprinidae, Cobitidae, Sisoridae, Gobiidae, and Osphronemidae, following the Catalog of Fishes (Eschmeyer and Fong 2012). Arrangement within family or subfamily is alphabetical by genus and species. Common names were taken from FishBase (Froese and Pauly 2012) when available, giving preference to the FAO (Food and Agriculture Organization of the United Nations), Nepalese, or Indian accepted English common name, respectively. For 25 of the 141 species, no common name was available from FishBase. For 17 of these 25, common names were taken from T.K. Shrestha (2008); for the other 8, no common names were available from the literature so we used a Nepalese local name.

**Fish photographs**

We photographed a selected specimen of each species at KU with a Canon digital EOS Rebel XT camera and EF-S 60 mm 1:2.8 macro lens, and measured the specimen’s standard length (SL) to the nearest 0.1 mm with a dial caliper. Specimens were photographed submersed in alcohol in a wet box made of glass and situated under a photographic light stand. Fish images were processed by using Canon Digital Photo Professional software. All specimens photographed were from the 1996 Nepalese collections made by D. Edds except for Gudusia chapra, Labeo calbasu, Wallago attu, and Channa marulius, for which KU specimens from India were used because the corresponding Nepalese specimens had been damaged. All fish photographs were taken by us except for species out on loan, including Balitora brucei, Psilorhynchus balitora, P. gracilis, P. nepalensis, P. pseudencheneis, and P. sucatio, which were photographed by Kevin Conway, and Turcinoemacheilus himalaya, which was photographed by Gary Lange.
We used geographic information system (GIS) software (ArcGIS 9.3, ESRI, Redlands, CA) to develop a template map of Nepal. Shape files of Nepal’s districts (1:250,000) were downloaded from Mountain GeoPortal (geoportal.icimod.org) (Fig. 2). Nepal’s three major river systems (Karnali, Gandaki, Koshi; Fig. 3) were digitized from Nepal Vista (nepalvista.com/features/rivers-images/nepal-map-rivers.gif), and district and river layers were blended together. Upon this template, for each species a solid circle (dot) was placed at the center of a district to indicate occurrence of that species in that district; species collected on the border of two districts were plotted in both districts.

### RESULTS

The following accounts for each of the 141 species provide scientific name, authority and year, common name, order, family, a specimen photo with KU catalog number and standard length.

<table>
<thead>
<tr>
<th>District</th>
<th>Region</th>
<th>Lots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karnali River Drainage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achham</td>
<td>H</td>
<td>5</td>
</tr>
<tr>
<td>Bajura</td>
<td>H</td>
<td>10</td>
</tr>
<tr>
<td>Banke</td>
<td>T</td>
<td>9</td>
</tr>
<tr>
<td>Bardiya</td>
<td>T</td>
<td>90</td>
</tr>
<tr>
<td>Dang Deokhuri</td>
<td>T</td>
<td>7</td>
</tr>
<tr>
<td>Kailali</td>
<td>T</td>
<td>86</td>
</tr>
<tr>
<td>Kancharpur</td>
<td>T</td>
<td>65</td>
</tr>
<tr>
<td>Mugu</td>
<td>M</td>
<td>24</td>
</tr>
<tr>
<td>Surkhet</td>
<td>H</td>
<td>8</td>
</tr>
<tr>
<td>Gandaki River Drainage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baglung</td>
<td>H</td>
<td>4</td>
</tr>
<tr>
<td>Chitwan</td>
<td>T</td>
<td>76</td>
</tr>
<tr>
<td>Gulmi</td>
<td>H</td>
<td>16</td>
</tr>
<tr>
<td>Mustang</td>
<td>M</td>
<td>2</td>
</tr>
<tr>
<td>Myagdi</td>
<td>H</td>
<td>13</td>
</tr>
<tr>
<td>Nawalparasi</td>
<td>T</td>
<td>175</td>
</tr>
<tr>
<td>Palpa</td>
<td>H</td>
<td>16</td>
</tr>
<tr>
<td>Parbat</td>
<td>H</td>
<td>15</td>
</tr>
<tr>
<td>Syangja</td>
<td>H</td>
<td>27</td>
</tr>
<tr>
<td>Tanahun</td>
<td>H</td>
<td>36</td>
</tr>
<tr>
<td>Koshi River Drainage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bhojpur</td>
<td>H</td>
<td>15</td>
</tr>
<tr>
<td>Dhankuta</td>
<td>H</td>
<td>9</td>
</tr>
<tr>
<td>Dhanusa</td>
<td>T</td>
<td>7</td>
</tr>
<tr>
<td>Ilam</td>
<td>H</td>
<td>11</td>
</tr>
<tr>
<td>Jhapa</td>
<td>T</td>
<td>51</td>
</tr>
<tr>
<td>Morang</td>
<td>T</td>
<td>29</td>
</tr>
<tr>
<td>Rautahat</td>
<td>T</td>
<td>7</td>
</tr>
<tr>
<td>Sankhuwasabha</td>
<td>M</td>
<td>22</td>
</tr>
<tr>
<td>Saptari</td>
<td>T</td>
<td>122</td>
</tr>
<tr>
<td>Sarlahi</td>
<td>T</td>
<td>7</td>
</tr>
<tr>
<td>Siraha</td>
<td>T</td>
<td>6</td>
</tr>
<tr>
<td>Sunsari</td>
<td>T</td>
<td>168</td>
</tr>
<tr>
<td>Udaypur</td>
<td>H</td>
<td>31</td>
</tr>
</tbody>
</table>

Table 1 (left). Number of fish lots archived at the University of Kansas Natural History Museum and Biodiversity Institute (KU) from collections made by D. Edds in Nepal in 1996, by district. Collections made and fish species occurrences recorded on the border between two districts are tallied for both districts. Districts are arranged by major river drainage, and predominant physiographic region is listed for each (M = mountains, H = hills, T = Terai).

Table 2 (below). Number of families, genera, and species in Nepalese fish orders collected by D. Edds in 1996 and archived at the University of Kansas Natural History Museum and Biodiversity Institute (KU). For detailed species descriptions, see Appendices I and II.

<table>
<thead>
<tr>
<th>Order</th>
<th>Families</th>
<th>Genera</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteoglossiformes</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Anguilliformes</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Clupeiformes</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cypriniformes</td>
<td>5</td>
<td>37</td>
<td>76</td>
</tr>
<tr>
<td>Siluriformes</td>
<td>9</td>
<td>24</td>
<td>41</td>
</tr>
<tr>
<td>Cyprinodontiformes</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Beloniformes</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Synbranchiiformes</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Perciformes</td>
<td>8</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Tetraodontiformes</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>30</td>
<td>80</td>
<td>141</td>
</tr>
</tbody>
</table>

### Mapping

We used geographic information system (GIS) software (ArcGIS 9.3, ESRI, Redlands, CA) to develop a template map of Nepal. Shape files of Nepal’s districts (1:250,000) were downloaded from Mountain GeoPortal (geoportal.icimod.org) (Fig. 2). Nepal’s three major river systems (Karnali, Gandaki, Koshi; Fig. 3) were digitized from Nepal Vista (nepalvista.com/features/rivers-images/nepal-map-rivers.gif), and district and river layers were blended together. Upon this template, for each species a solid circle (dot) was placed at the center of a district to indicate occurrence of that species in that district; species collected on the border of two districts were plotted in both districts.
discuss

These species accounts provide a district-wise and more extensive plotting of the distribution of fish species in Nepal than previously available, and substantiate these records with photographs of museum voucher specimens. Results of this study will be useful to ichthyologists and others studying South Asian fishes, as well as to managers responsible for conserving this fauna. The Himalayas are one of the world’s biodiversity hotspots (Myers et al. 2000), and Nepal’s fishes are threatened by environmental degradation from human population growth, industrial development, deforestation, road construction, pollution, overfishing, and fragmentation from water diversion and dam construction (Edds 1993, 2007; Edds et al. 2002). Our plotting of species’ distributions will facilitate conservation of Nepal’s fishes via potential predictive modeling of where a species should exist based on where it has been documented. Analysis of data on aggregations of species in key habitats and ecosystems will assist future estimation of the potential impact of environmental change on the distribution and sustainability of biodiversity of fishes.

Voucher specimens of Nepalese fishes housed in museums around the world should be accessed to add to the records here and to increase our knowledge of species’ distributions. Other collections of Nepal fishes include approximately 2000 lots at Oklahoma State University, Stillwater (OSUS) from collections made in 1984-86. KU has additional Nepalese fish holdings — more than 300 lots collected by R. Mayden and K. Conway in 2008 and deposited in the museum after we completed data collection for the current project. Other collections housing Nepalese fishes include, but are not limited to, the American Museum of Natural History, New York (AMNH); Academy of Natural Sciences, Philadelphia (ANSP); Auburn University Natural History Museum, Auburn, Alabama (AUM); Natural History Museum, London (BMNH); California Academy of Sciences, San Francisco (CAS); Field Museum of Natural History, Chicago (FMNH); Harvard Museum of Comparative Zoology, Cambridge, MA (MCZ); Natural History Museum Tribhuvan University, Swayambhu, Nepal (NHMTU); National Science Museum Tokyo (NSMT); Tribhuvan University Zoology Collection, Kirtipur, Nepal (TZC); University of Michigan Museum of Zoology, Ann Arbor (UMMZ); National Museum of Natural History, Washington, DC (USNM); Yale Peabody Museum of Natural History, New Haven, CT (YPM); Zoological Institute and Museum Hamburg, Germany (ZMH); and Zoological Survey of India, Kolkata (ZSI).

There is great need for renovation and financial support of Nepal’s Tribhuvan University Natural History Museum (NHMTU; Swayambhu, Nepal; nhmnepal.org/index.php) and for modernizing its collections. Just as voucher specimens from D. Edds’ 1996 fish survey were deposited at NHMTU and elsewhere in Nepal, so were vouchers from collections made...
by D. Edds in 1984-86. However, by 1996 most of the 1984-86 specimens had been ruined through dessication (D. Edds, personal observation). Until Nepal’s natural history museums have sufficient support, it is vital that selected voucher specimens continue to be sent to legitimate museums around the world. Without adequate funding for staff, equipment, and materials to enable suitable curation, the NHMTU collections, which also include valuable fungi, plant, insect, amphibian, reptile, bird, and mammal specimens, will continue to deteriorate. Such natural history collections are crucial for the study of life on earth, and are indispensable for scientists who attempt to document and preserve biodiversity.

Much work remains to document the occurrence, distribution, ecology, reproductive biology, genetic structure, health, abundance, and conservation status of Nepal’s fishes. In many of the accounts provided here, it is noted that there is "no available primary literature" on part or all of the species’ biology, and these provide outstanding potential research opportunities. Anthropogenic impacts on fishes, such as overfishing, pollution, and the effects of hydroelectric dams on breeding migrations, await investigation. Additionally, studies on the habitat use, feeding habits, and reproductive biology of Nepal’s fishes are needed, particularly of the indigenous mountain and hill fishes. The distributional records included here reflect only collections made by D. Edds in 1996, and that survey encompassed only 32 of Nepal’s 75 districts. Many districts and drainages are insufficiently sampled and, almost certainly, new fish species await description. Given the rugged terrain, dearth of transportation, and difficult living conditions, fieldwork in Nepal can be extremely challenging; thus, works such as ours that use existing natural history collections are important for study of the country’s fishes.

ACKNOWLEDGMENTS

We thank Andrew Bentley, KU Ichthyology Collection Manager, and Dr. Edward Wiley, KU Ichthyology Curator Emeritus, for support and assistance, including use of the camera and photo editing software, Kyle Edds for hospitality and lodging in Lawrence, Dr. Richard Sleezer and Dr. James Aber, Emporia State Research Studies, for editing and assistance with layout; all errors are ours alone. This project was funded by an ESU Graduate Student Research Grant to OHS and an ESU Faculty Research and Creativity grant to DRE. Field research in Nepal was funded by grants to DRE from the National Geographic Society Committee for Research and Exploration, the Fulbright program, and the University of Kansas Natural History Museum. Assistance in Nepal from staffs of the Department of National Parks and Wildlife Conservation, Department of Agriculture Fisheries Development Division, Tribhuvan University Department of Zoology, and U.S. Educational Foundation is greatly appreciated. Special thanks to Dr. Jiwan Shrestha, Amar Bahadur Gurung, Purna Parityar, Doug Biggs, Corinne Edds, Kyle Edds, Dr. Tracy Hirata-Edds, Dr. Penny Walker, Dr. D.B. Swar, K.G. Rajbanshi, and the late Dr. Tirtha Maskey for assistance in Nepal. Nepal’s Department of National Parks and Wildlife Conservation provided permits to collect fishes and export voucher specimens.

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