Conclusions And Recommendations

1. The Arun River Basin is a convenient natural unit for examining the complexity of mountain environments in the Himalaya. The basin may be divided into two distinct zones for developing management strategies, i.e., the northern zone and the southern zone.

   The northern zone consists of the great Himalaya and the fore Himalaya. The valley is narrow and steep, with slopes exceeding 40° angle: rainfall is very high, exceeding 3000 mm per year. The population is sparse, and ekes out a precarious living on marginal lands. This region should be managed as a protection zone not only for the conservation of its rich biological diversity and challenging mountain peaks but also as ecological support to the hydropower along the Arun River.

   The southern zone consists of midlands and Mahabharata, with wider valleys formed under a matured topography with moderate slopes. This region is heavily terraced and functions as a typical mountain farming system, where agriculture, forestry, and livestock are closely interlinked to maintain a subsistence system. Present trends of declining productivity against a growing population need to be examined vis-a-vis depletion of natural resources. Any attempt to provide management guidelines on environmental issues would need a focus on increasing the productivity of land without encroaching into vegetated areas.

2. Any environment poses a unique problem within the context of a specific area. In a mountainous ecosystem, identification of homogenous or homologous areas become a problem in the absence of adequate data on biological as well as physical factors. However, it should be possible to identify "isopotential" areas on the basis of plants, animals and vegetation distribution. For example, potential areas for cardamom cultivation are indicated by the occurrence of aldar trees; for pineapple and banana, Sal trees are the indicators. Farmers of the Arun Basin are actually following such indicators to introduce fruits and cash crops in their field. Similarly, a climax forest indicates a matured and stable slope while deformed, bent, or curled trees indicate soil creeps and similar other phenomena operative on a slope.

3. The functioning of rural societies and their farming systems has acquired an equilibrium through ages of trial and error. To externalize decision in order to exert influence or to intervene in their system one would need careful thought based on the following key questions :

   (a) How, where, and when the peasant works in his field, forest, and grassland ?

   (b) What factors determine his choice of technology, preference of sites, and adoption of crops ?

   (c) What is his calendar of activities and how is his pattern of movements and migration, within and outside the basin fixed ?

4. Water resource development in the basin is dominated by a large power plan of 400 MW, the Arun III Hydro-electric Project, which is going to be the most significant element to be added in the ecosystem. Its impact on the biophysical as well as socio-economical environment has to be considered adequately, in order to maintain a balance between water discharge and sediment transportation. This would need certain slopes along the river to be repaired and restored, especially in the Num-Chepua sector. This sector receives the heaviest downpour of monsoon and any unattended or abandoned slopes give way to rapid erosion and slope failures. Productivity of the area should be enhanced rapidly by supplying high-yielding varieties of potatoes, maize, and millet, with necessary agronomic support.

The approach road of about 170 km will exert unprecedented pressure on forest produce of economic importance, such as medicinal herbs, fibre plants, orchids, and animal produce such as bear bile, musk pods, and animal skins. Township development along the road is drawing more people into the ecosystem. This is surely going to exert more pressure on the resource base of the basin. The development of water resources along the Arun Valley should have as a component a recycling mechanism, where the output of the project from its seat of production reaches directly to the site of origin for its maintenance and development.

5. Our knowledge on mountain ecology is still very incomplete. Therefore, a programme has to be developed to generate minimum essential data on some key factors, such as weather systems and climate, hydrological regime, geomorphological features and soil characteristics, forest ecosystem, agricultural system, and the human response to those factors.

6. A diagnostic study on the present state of ecology could be based on the assessment of quality and quantity of climax forests and natural vegetation as against transformed ecosystems, such as cultivated land, grazing land, and abandoned slopes. Such studies should be tied up with modern methods of remote sensing for monitoring and evaluating environmental conditions.

7. In such an area, where massive interference on the environment due to hydropower development, road construction, mountain tourism and mountaineering is anticipated, it becomes necessary to formulate an Action Plan for the development of the basin in harmony with its environment.

8. A legal framework, administrative procedures, economic sanctions, etc., are some of the important tools in implementing management plans. However, the remoteness of mountain districts weakens implementation and accelerates the misuse of legislations and sanctions. Thus the need for a Management Authority emerges. Such an authority should not only co- ordinate development activities with environmental issues but should also be able to locate responsibilities of various implementing bodies.

Appendix I: Commercially important medicinal plants occuring in the Arun Basin

Botanical Name	Local Name
Achyranthus aspera	Datiwan
Aegle marmelos	Bel
Aconitum spicatum	Bikh
A. heterophyllum	Atis
Berberis sps.	Chutro
Cinnamomum tamala	Tej-pat, Dalchini
Dioscorea deltoidea	Vyakur
Elaeocarpus sphaericus	Rudrakshya
Holarrhena antidysenterica	Indra Jau
Lichens	Jhyau
Mesua ferra	Nag Keshar
Nardostachys jatamansi	Jatamasi
Orchis incarnata	Panch Aunle
Lycopodium clavatum	Nagbeli Pitho
Picrorhiza scrophulariiflora	Kutki
Rubia manjith	Majitha
Rheum emodi	Padamchal, chulthi
Swertia sps.	Chiraita
Valeriana wallichii	Sugandhawal
Zanthoxylum armatum	Timur

Appendix II : Birds spotted in the Arun Basin during 1986 August/September (Courtesy H.S. Nepali)

Ciconiidae

01. White-necked Stork

Accipitridae

02. Honey Kite
03. Dark Kite
04. Sparrow Hawk
05. Upland Buteo
06. Crested Serpent Eagle
07. Changeable Hawk Eagle
08. Black Eagle
09. Cinereous Vulture
10. Bearded Vulture
11. King Vulture
12. White-backed Vulture

Falcoidae

13. Red thighed Falconet
14. Peregrine Falcon
15. Oriental Hobby
16. Lesser Kestrel
17. Eurasian Kestrel

Phasianidae

18. Tibetan Snow Cock
19. Common Hill Partridge
20. Blood Pheasant
21. Impeyan Pheasant
22. Kalij Pheasant

Charadriidae

23. Green-Shank
24. Common Sandpiper
25. Pin-tail Snipe
26. Solitary Snipe

Laridae

27. Great Black headed Gull

Columbidae

28. Wedge-tailed green Pigeon
29. Bengal Green Pigeon
30. Snow Pigeon
31. Black Rock Pigeon
32. Long tailed Cuckoo Dove
33. Rufous Turtle Dove
34. Spotted Dove

Psittacidae

35. Blossom-headed Parakeet

Cuculidae

36. Banded-Bay Cuckoo
37. Plantive Cuckoo
38. Large green-billed Malkoha
39. Koel Cuckoo
40. Sirkeer Cuckoo

Strigidae

41. Spotted Scops Owl
42. Barred Owlet

Trogonidae

43. Red-headed Trogon

Coraciidae

44. Indian Roller

Upupidae

45. Hoopoe

Alcedinidae

46. Eurasian Kingfisher
47. White-breasted Kingfisher

Meropidae

48. Small Green Bee-eater

Caspitonidae

49. Great Himalayan Barbet
50. Golden-throated Barbet
51. Blue-throated Barbet
52. Crimson-breasted Barbet

Picidae

53. L. yellow-naped Woodpecker
54. S. yellow-naped Woodpecker
55. Himalayan pied Woodpecker
56. Darjeeling pied Woodpecker
57. Fulvous-breasted. p. Woodpecker

Apodidae

58. White-rumped Needle tail
59. House Swift
60. Edible Nest Swiftlet

Hirundinidae

61. Sand Martin
62. Crag Martin
63. Barn Swallow
64. Striated Swallow
65. Nepal house Martin

Linidae

66. Black-headed Shrike
67. Gray-backed Shrike

Dicruridae

68. S. Racquet-railed Drongo
69. Ashy Drongo
70. Black Drongo

Sturnidae

71. Brahminy Myna
72. Gray-headed Myna
73. Commom Myna

Corvidae

74. Yellow-billed Blue Magpie
75. Red-billed Blue Magpie
76. Himalayan Tree Pie
77. Nut Cracker
78. Red-billed Chough
79. House Crow
80. Jungle Crow
81. Raven

Campepnagidae

82. Large-cuckoo Shrike
83. Dark-cuckoo Shrike
84. Long-tailed Minivet
85. Scarlet Minivet

Irenidae

86. Iora
87. Orange-bellied Leaf Bird

Pycononotidae

88. White-cheeked Bulbul
89. Striated Bulbul
90. Red-vented Bulbul
91. Rufous-bellied Bulbul
92. Brown-eared Bulbul

Timilliidae

93. Slaty-headed Scimitar Babbler
94. Rufous-necked Scimitar Babbler
95. Rusty-cheeked Scimitar Babbler
96. Scaly-breasted Wren Babbler
97. Red-headed Babbler
98. Black-chinned Babbler
99. Jungle Babbler
100. Spiny Babbler
101. Spotted Babbler
102. Striated Laughing Thrush
103. White-crested Laughing Thrush
104. White-spotted Laughing-Thrush
105. Rufous-chinned LaughingThrush
106. Gray-sided Laughing-Thrush
107. Red-headed Laughing-Thrush
108. Black-faced Laughin-Thrush
109. Red-billed Leiothrix
110. Chestnut-throated Shrike
111. Spectacled Barwing

112. Bar-throated Minla
113. Blue-winged Minla
114. Yellow-napped Yuhina
115. Stripe-throated Yuhina
116. White-bellied Yuhina
117. Chestnut-headed Tit Babbler
118. White-browned Tit Babbler
119. Black-capped Sibia

Muscipidae

120. Sooty Flycatcher
121. Verditer Flycatcher
122. Paradise Flycatcher
123. Rufous-breasted Blue Flycatcher
124. Gray-headed Flycatcher
125. White-throated Fan-tailed Flycatcher
126. Pale-Blue Flycatcher
127. Ferrunginous Flycatcher
128. Orange-gorgetted Flycatcher

Sylviidae

129. Olive Ground Warbler
130. Chestnut-headed Ground-Warbler
131. Blanford's Bush Warbler
132. Rufous-capped Bush Warbler
133. Hodgson's Prinia
134. Brown-hill Prinia
135. Tailor Bird
136. Tickell's Leaf Warbler
137. Plain-Leaf Warbler
138. Orange-barred Leaf Warbler
139. Dull-Green Leaf Warbler
140. Yellow-rumped Leaf Warbler
141. Yellow-eyed Leaf Warbler
142. Gray-headed Warbler
143. Goldcrest
144. Broad-billed Flycatcher Warbler
145. Smoky Leaf Warbler

Turdidae

146. Blue Chat
147. White-browed Bush Robin
148. Orange-flanked Bush Robin
149. Golden Bush Robin
150. Rufous-bellied Bush Robin
151. Magpie Robin
152. Blue-fronted Redsart
153. White-capped River Chat
154. Little Forktail
155. Slaty-backed Forktail
156. Collared Bush Chat
157. Dark-gray Bush Chat
158. Pied Bush Chat
159. Blue-head rock Thrush
160. Chestnut-bellied Rock Thrush
161. Pied Ground Thrush
162. Orange-headed Ground Thrush
163. Whistling Thrush
164. Tickell's Thrush

Troglodytidae

165. Wren

Cinclidae

166. Brown Dipper

Prunellidae

167. Altai Accentor
168. Alpine Accentor

Paridae

169. Gray Tit
170. Green-backed Tit
171. Yellow-cheeked tit
172. Coal Tit
173. Sikkim Black Tit
174. Crested Brown Tit
175. Red-headed Tit
176. Rufous-fronted Tit

Sittidae

177. Chestnut-bellied Nuthatch
178. White-tailed Nuthatch

Certhiidae

179. Sikkim Tree Creeper

Motacillidae

180. Hodgson's Tree Pipit
181. Paddyfield Pipit
182. Richard's Pipit
183. Rose-breasted Pipit
184. Gray Wagtail
185. Pied Wagtail
186. Large-pied Wagtail

Dicaeidae

187. Thick-billed Flower-pecker
188. Plain-colored Flower-pecker
189. Fire-breasted Flower-pecker

Nectariniidae

190. Fire-tailed Sunbird
191. Nepal Sunbird
192. Black-breasted Sunbird
193. Scarled-breasted Sunbird
194. Streaded Spiderhunter

Zosteropidae

195. White-Eye

Ploceidae

196. Tree Sparrow
197. House Sparrow
198. Sharp-tailed Muniya
199. Spotted Muniya

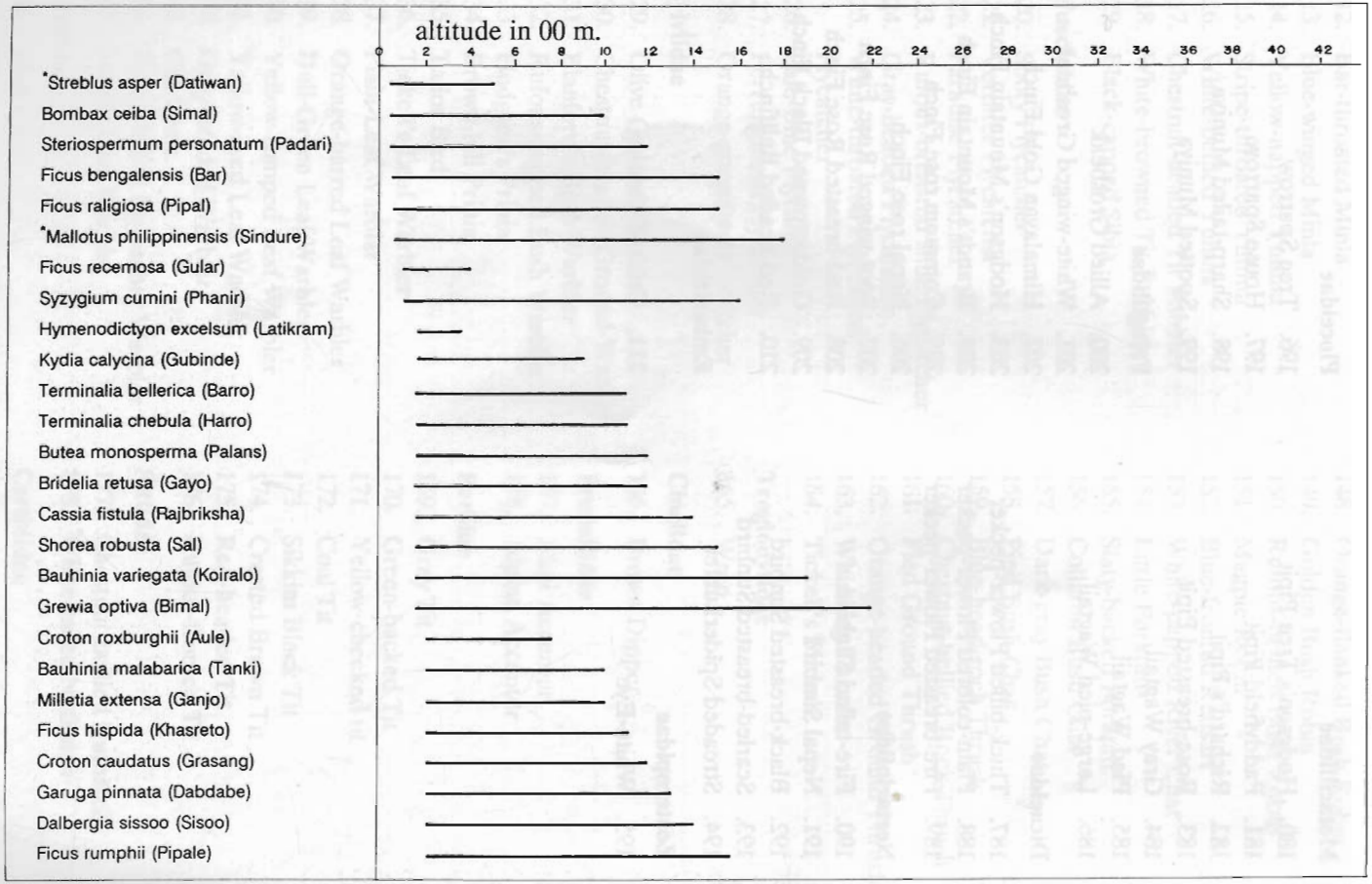
Fringillidae

200. Allied Grosbeak
201. White-winged Grosbeak
202. Himalayan Gold Finch
203. Hodgson's Mountain Finch
204. Brandt's Mountain Finch
205. Commom rose Finch
206. Nepal rose Finch
207. Spot-winged Rose Finch
208. Red-breasted Rose Finch
209. Gold-crowned Black Finch
210. Red-headed Bullfinch

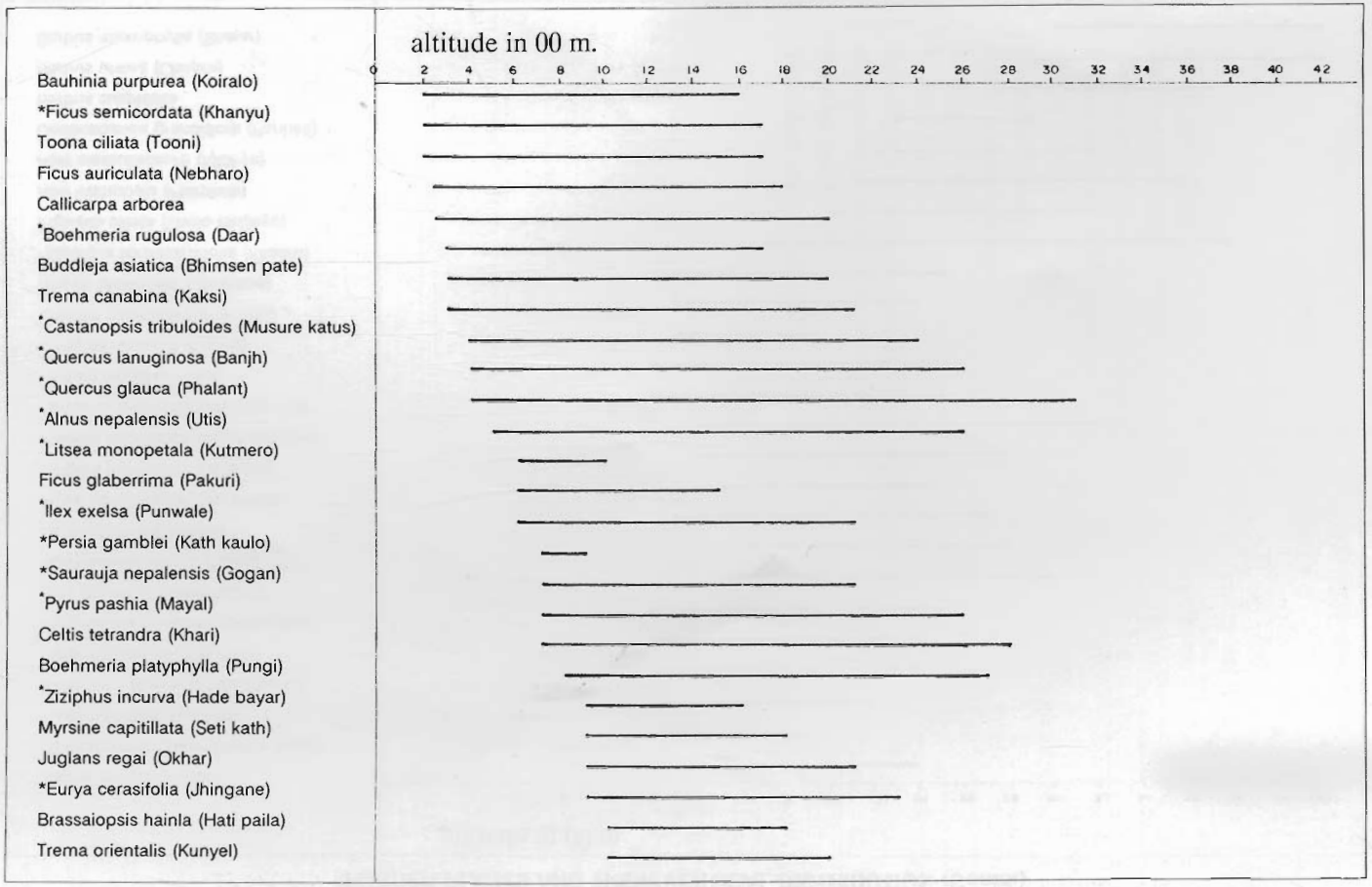
Emberizidae

211. Crested Bunting

APPENDIX III : FODDER PLANTS AND THEIR VERTICAL DISTRIBUTION



FODDER PLANTS AND THEIR VERTICAL DISTRIBUTION (Contd.)



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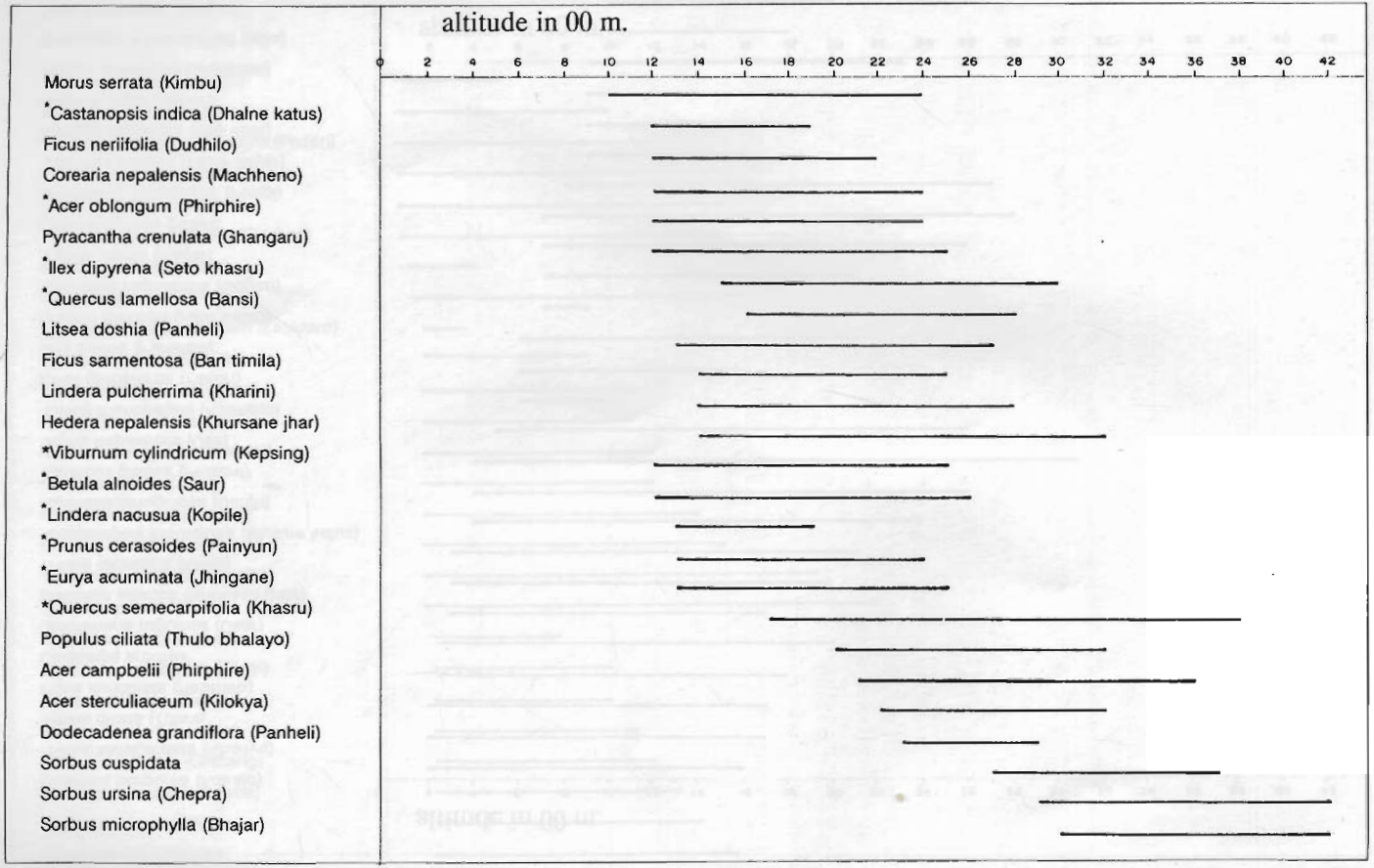

*First grade species having more than 30% dry matter and less than 10% total ash. (D. Bajracharya et. al. (1985)

Appendix IV : Fish which is special to Kosi System
(Courtesy K.G. Rajbansi)

1. Chela gora (Ham)
2. Barilius jalkapoori (Shrestha)
3. Danio acquipinnatus (McClelland)
4. Putius clavalus (McClelland)
5. Garra annadalai (Hora)
6. G. goiyla (Gray)
7. Labio angora (Ham)
8. L. Boga (Ham)
9. L. bata (Ham)
10. Psilorhynchys pseudocheneis (Menon & Dutta)
11. Pseudocheneis sulcatus (McClelland)
12. Sciaena coiter (Ham)
13. Tetradon cutcutia (Ham)