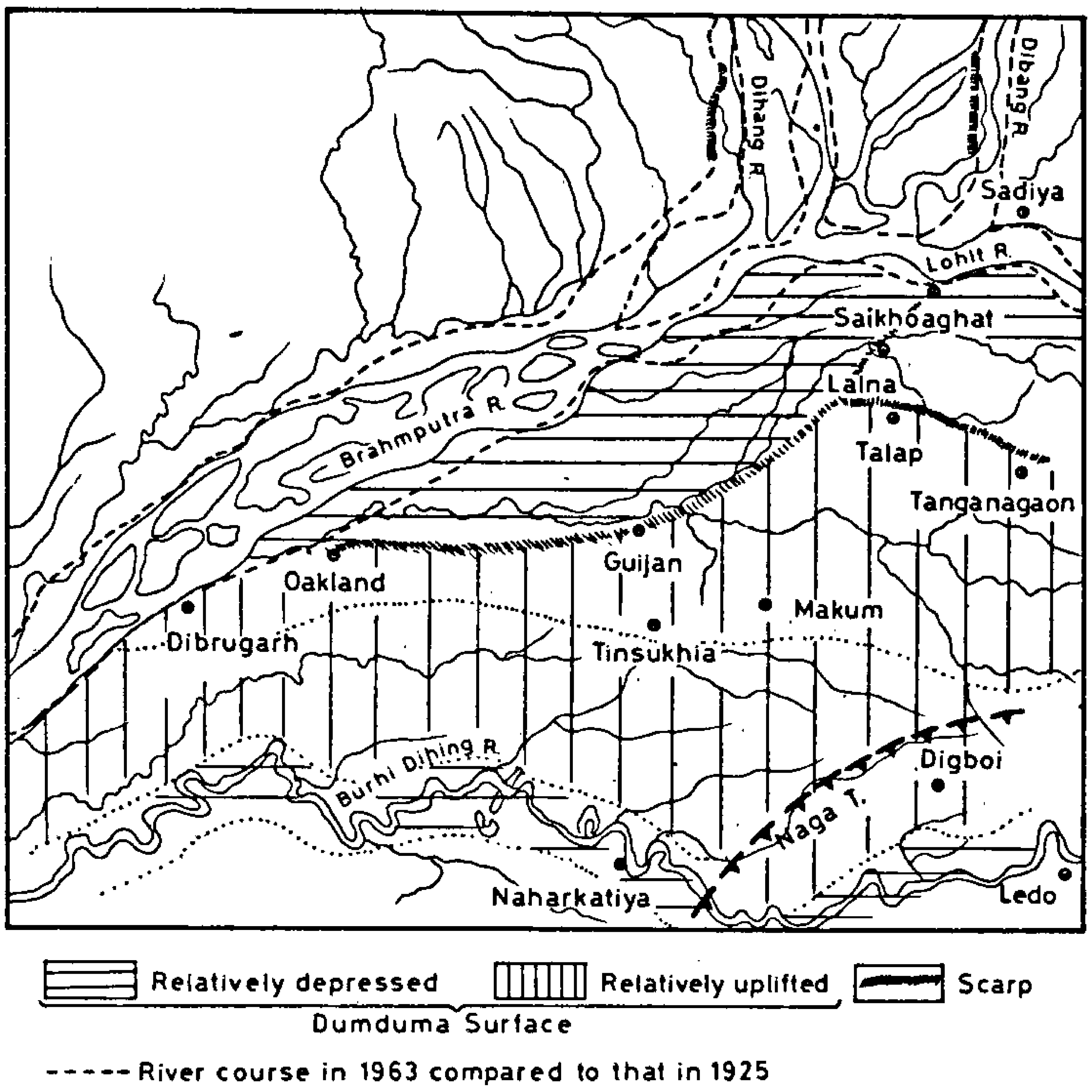

Figure 5. The 15 August 1950 earthquake of magnitude 8.7 drastically affected the gradient of the Brahmaputra in upper Assam. The Talap–Guijan–Oakland scarp is an expression of the uplift of the downstream block. This must have temporarily ponded the Brahmaputra[13].

inundation of the flood plain. In my opinion, this is what is happening today. It will therefore be advisable to embark on a comprehensive multidisciplinary investigation of the Brahmaputra valley in Assam to provide a rational knowledge-based perspective for the design of flood resilient mitigation measures.

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Avifauna of Mouling National Park, Arunachal Pradesh, India

Arunachal Pradesh includes a major portion of the eastern Himalayas, which has been recognized as one of the 18 biodiversity hotspots of the world[1]. Climatic features of this region have created a natural boundary making it an abode for a number of endemic species both flora and fauna[2]. Earlier works[3–6] on the avifauna of Arunachal Pradesh mainly covered Pakhui Wildlife Sanctuary, D'Ering Memorial Wildlife Sanctuary, Mehao Wildlife Sanctuary and its adjacent Mishmi Hills and Namdapha National Park. This is the first attempt to make a check-list of birds of Mouling National Park from the birdwatchers' viewpoint. The long list indicates physical as well as biological richness of the habitat; such diverse avian species assemblages have also been recorded from the Western Ghats, another biodiversity hotspot[5,6]. The Mouling Hills harbour varied forest types; there are tropical wet evergreen, semievergreen subtropical broad-leaved hill forests, montane wet temperate forests while the wet hollows are occupied by cane brakes and the wet ground along the margins of the streams and rapids are covered with wet bamboo brakes. Such a variation in the vegetation of the locality has attracted a variety of bird species; a number of lotic habitats and chain pools are an added advantage to study the water-dependent birds of this region.

Mouling was declared a National Park in 1986 but little is known about its floral and faunal diversity. This park (lat. 28°33′N, long. 94°46′E) covers an area of 483 sq km and the configuration is gentle to very steep and rugged mountainous land. Steep slopes of these mountains are covered with dense evergreen and semi-evergreen vegetation. The whole national park is irrigated by a number of perennial brooks and streams. Thirteen major perennial streams flow down the slopes of Mouling ranges and all voids in the mighty Siang River. This fast-flowing river system gives a special local topographical feature with much higher rainfall; greater atmospheric humidity and a reduced temperature range prevail in the lower elevations which give the area a climate different from that of other lowland tracts. Such a special condition is distinguished as 'montane climate', a class by itself. Very thick cane and bamboo brakes along the wet banks of the streams at lower altitudes and high water current and unpredictable drainage load in these lotic situations are a source of major hindrance in approaching the park. Notable plant species in the areas surveyed are *Terminalia myriocarpa*, *T. bellirica*, *T. citrina*, *Altingia excelsa*, *Canarium strictum*, *Castanopsis indica*, *C. hystrix*, *Albizia sapium*, *Amoora wallichii*, *Chukrasia tabularis*, *Tooan ciliata*, *Duabanga grandiflora*, *Cinnamomum glanduliferum*, *Michelia excelsa*, *M. montana*, *M. kisopa*, *Musa* spp., *Dillenia pentagyna*, *Quercus* spp., *Betula alnoides*, *Arundinaria maling*, *Dendrocalamus hamiltoni*, *Bambusa pallida*, *Calamus erectus* and *C. floribunda*. Luxuriant growth and high density of tree ferns and screw pines are also noted. Thick growth of epiphytic plants is mainly constituted by a variety of mosses, ferns and orchids. Creepers, climbers and herbaceous flora are also abundant; at places different herbaceous species of the families Rosaceae, Acanthaceae, and Hypericaceae are densely grown.

Month-long expeditions with short visits were organized during winter (October to end of January) from 1995 to 1998. Due to hostile climatic conditions, it is very difficult to approach this forest with limited infrastructure except between November and March. This period maintains a uniform weather condition and appears to be excellent to study the passage migrants and winter visitors along with the resident bird species of the region. Observations were made in the altitude range of 460–1620 m. Lower altitudes (460–650 m) were selected for observation in 1995–1996 while higher elevations (840–1620 m) were studied in 1997–1998 to record the diversity and abundance of the avian species. Species were recorded during extensive trekking (about 65 km) through the difficult terrain, covering all the salient forest types of this region. Nine different locations were selected and at each of these locations keeping the camp at the centre, an area encompassing 1 km radius was surveyed. Three to five survey treks (numbers varied with the approachability/ruggedness of the terrain) were made at each location towards different directions (selected randomly) from the camp between 4.00 and 16.00 h. At normal strolling speed the linear treks from the camp and back were performed to cover a 2 km (up and down) trail within a two-hour period. A Barigo (Germany) walking pedometer measured trekking distance. Results of independent observations following belt transect method[7] were later compared, consolidated and averaged, where necessary, to comment on the abundance and status of the species. Belt transects involved noting of the avian species sighted within 50 m on either side, both in front and above. Mist-net was also employed for closer observation and identification of smaller bird species. Species abundance is categorized by numbers in the text as follows: (1) Rare – Observed (singly or in pair or in party/groupings for gregarious species) or call heard only once during the study period; (2) Uncommon – Seen or call heard not more than thrice during the study period; (3) Regular – Seen or call heard not more than five times during the study period; and (4) Common – Seen and/or call heard more than five times during the study period.

Birds were observed in the field using NIKON (9 × 25) field binoculars. Information on their microhabitat and floral-avian affinity, if any, were also noted. Description of the study sites and the codes used in the text for the study locations are follows: RmC – Ramsingh Forest Rest House camp; altitude 680 m; 55 km drive from Jenging Divisional Forest Office; montane semi-evergreen biotope, SiC – Siyor camp; altitude 460 m; 5 km south-west of Ramsingh tribal village; montane semi-evergreen biotope, NgC – Nguri camp; altitude 500 m; 3 km trek to south of Siyor camp; montane climate semievergreen forests; Siring rivulet sides bordered by sparingly distributed bamboo brakes, KeC – Kebung camp; altitude 560 m; 6 km south of Nguri camp; montane climate evergreen forests; thick bamboo brakes alongside Siring rivulet, KuC – Kubsef camp; altitude 650 m; 4 km farther south of Kebung camp; Siring rivulet gorge with steep rise of the walls on either side; right bank with thick growth of bamboo and cane brakes while the left wall was completely denuded by heavy land slips, BvC – Bomdo village camp; altitude 840 m; 30 km from Ramsingh FRH; a small *adi* tribal hamlet, lightly inhabited; montane subtropical broadleaved hill forest, EpR – Epong ridge; altitude 1450 m; 2.5 km south-west of Bomdo village; montane wet temperate broadleaved forest with predominant evergreen species, EgC – Egong camp; altitude 1400 m; 2 km east of Epong ridge site; on the bank of fast flowing Sidi rivulet; montane wet evergreen biotope, and AnR – Angong ridge; altitude 1620 m; 5 km west of Egong camp; wet temperate broadleaved forest with predominant evergreen species.

For scientific nomenclature and arrangement order of the bird species, the book by King *et al.*[8], was followed in general. However, where we differed, especially for scientific names of the species, Ali[5,9] and Schavensee[10] were followed. Different indices to comment on the community structure were calculated following Odum[11].

One hundred and fourteen bird species under 38 families were recorded from 9 different study locations and are listed below along with location and abundance codex.

Phalacrocorax carbo 1SiC; *Mergus mergan* 1SiC; *Pernis apivorus* (*ptilorhynchus*) 3BvC; 2EpR; *Accipiter nisus* 2BvC; 1NgC; 2AnR; *Circus melanoleucos* 1SiC; *Spizaetus nipalensis* 1BvC; 1EpR; *Microhierax melanoleucos* 1KeC; *Falco tinnunculus* 1NgC; *Treron bicincta* 2EpR; 1AnR; *Ducula badia* 1EpR; 1AnR; *Columba hodgsonii* 1RmC; 1AnR; *Streptopelia orientalis* 1RmC; 2BvC; 1EpR; *Psittacula finschii* 1BvC; 2AnR; *Otus spilocephalus* 1RmC; 2EgC; *Athene brama* 3RmC; 2BvC; *Stryx aluco* 2EgC; *Harpactes erythrocephalus* 1SiC; *H. wardi* 1EgC; *Ceryle lugubris* 3SiC; 3NgC; 2KeC; 3KuC; *Halcyon coromanda* 1EgC; *Ceyx erithacus* 1KeC; *Megalaima virens* 3BvC; 2NgC; 2KeC; *M. franklinii* 2AnR; *M. australis* (*duvauceli*) 1NgC; 1KeC; BvC; EpR; *Sasia ochracea* 1RmC; 1BvC; *Picus canus* 1RmC;

1EgC; 1AnR; *P. flavinucha* 2EpR; 2AnR; *Picoides cathpharius* 1BvC; 2EgC; *Psarisomus dalhousiae* 2EpR; *Delichon urbica* 3RmC; 2SiC; 2NgC; 2KeC; 2KuC; 2BvC; *Hemipus picatus* 2SiC; 3AnR; *Tephrodornis virgatus (gularis)* 2BvC; 1EpR; 2EgC; *Coracina novaehollandiae (javensis)* 2EpR; *Pericrocotus flammeus (speciosus)* 4NgC; 2BvC; 2EpR; 2AnR; *P. ethologus* 1EpR; 2EgC; ; *Aegithina tiphia* 2RmC; 2BvC; 2EpR; *Chloropsis hardwickii* 1BvC; 1EpR; 2EgC; 2AnR; *Irena puella* 2EgC; *Pycnonotus jacosus* 2RmC; 3SiC; 3NgC; 1BvC; *P. leucogenys* 2RmC; 3BvC; *Dicrurus leuphaeus* 1BvC; 1EpR; 2AnR; *D. aeneus* 1SiC; 1NgC; 1KeC; 2EpR; 3AnR; *D. remifer* 1KeC; 1BvC; 2EgC; *D. hottentottus* 3EgC; *Oriolus traillii* 1EgC; *Urocissa erythrorhyncha* 2EgC; *Corvus macrorhynchos tibetosinensis* 2RmC; BvC; *Aegithalos concinnus (annamensis)* 2RmC; BvC; 1EpR; *Parus dichorus* 3AnR; *P. monticolus* 2RmC; 3BvC; 2EgC; *P. spilonotus* 1RmC; 2EpR; 2AnR; *Melanochlora sultanea* 2BvC; 2EgC; *Sitta formosa* 1EpR; 3AnR; *Cinclus pallasii* 4SiC; 4NgC; 4KeC; 4KuC; *Troglodytes troglodytes* 4SiC; 2EgC; *Pomatorhinus hypoleucos* 2EgC; *P. ochraceiceps* 1EgC; 1AnR; *Turdoides striatus* 2BvC; 2EpR; *Napothera brevicaudata* 1SiC; 1NgC; 1KeC; 1KuC; 2EpR; 2EgC; *Spelaeornis badeigularis* 3KeC; 3KuC; 2EgC; 3AnR; *Garrulax leucolophus* 3NgC; 3KeC; 3KuC; 3BvC; 4EpR; 2AnR; *G. monileger* 2RmC; 3SiC; 2NgC; 2KeC; 2KuC; 4EpR; 2AnR; *G. Pectoralis* 2SiC; 2KeC; 3BvC; 2EpR; 2AnR; *Cutia nipalensis* 1EpR; 3EgC; *Actinodura egertoni* 2EpR; 2EgC; *A. waldeni (nipalensis)* 2AnR; *Yuhina bakeri* 3SiC; 3NgC; 2EgC; *flavicollis* 2SiC; 2NgC; 1AnR; *Y. zantholeuca* 3EgC; *Paradoxornis atrosupercilliari* 1KeC; 1EgC; *Erithacus pectoralis* 1BvC; *Phoenicurus auroreus* 2SiC; 2NgC; *Rhyacornis fuliginosus* 2SiC; 2NgC; 2KeC; 2KuC; *Chaimarrornis leucocephalus* 3SiC; 3NgC; 3KeC; 3KuC; *Enicurus scouleri* 4RmC; 3SiC; 1NgC; 1KeC; 2KuC; 2BvC; *E. schistaceus* 2NgC; 1KeC; 1KuC; 2BvC; *Monticola cinclorhynchus* 2RmC; 3BvC; *Myiophonus caeruleus (temminckii)* 2RmC; 2SiC; 1EgC; *Seicercus affinis (burkii)* 2BvC; 2EpR; *S. castaniceps* 2RmC; 2BvC; 3EpR; *Phylloscopus ricketti* 3EgC; *P. fuscatus* 2EgC; 3AnR; *Phragmaticola aedon* 3EgC; 2AnR; *Orthotomus cuculatus (cucullatus)* 1EgC; *Tesia castaneocoronata* 4EgC; 1AnR; *Muscicapa thalassina* 1BvC; 2EpR; 2EgC; 3AnR; *Niltava macgrigoriae* 2RmC; 3EpR; *Cyornis banyumas* 1EpR; 1EgC; 2AnR; *Rhipidura hypoxantha* 2EpR; *Prunella fulvescens* 2AnR; *P. immaculata* 1EpR; 1EgC; *Motacilla alba alboides* 3RmC; 2BvC; *M. cinerea (caspica)* 2NgC; 2KeC; 2KuC; *M. flava* 2NgC; 2KeC; 2KuC; *M. maderaspatensis* 1SiC; 1NgC; 1KeC; 1KuC; *Dendronanthus indicus* 1SiC; 1NgC; 1KeC; 1KuC; 2LpR; *Lanius cristatus* 1EgC; 2AnR; *L. tephronotus (schach)* 2SiC; 2KeC; 1BvC; 1EpR; *Gracula religiosa intermedia* 3RmC; 2BvC; 1AnR; *Aethopyga nipalensis (ezrai)* 1KeC; 1KuC; 1EpR; 3AnR; *A. saturata (johnsi)* 3EgC; 2AnR; *A. siparaja* 2RmC; 2BvC; 2EpR; *Arachnothera longirostra* 1SiC; 1NgC; 3EgC; *Dicaeum ignipectus* 2EgC; *Zosterops palpebrosa* 2RmC; 2BvC; 2EpR; *Passer montanus* 3RmC; 3BvC; *P. rutilans* 2RmC; *Lonchura striata* 2EpR; 3AnR; *L. punctulata* 3RmC; 3SiC; 2NgC; 2KeC; *L. malacca* 1RmC; 2EpR; *Serinus thibetanus* 1BvC; *Coccothraustes melanozanthos* 1EgC; *Emberiza rutila* 1BvC; *Melophus lathami (melanicterus)* 2RmC; 2SiC; 3AnR.

Table 1 depicts some of the useful indices to comment on the species structure in the avian communities of different localities. From the beginning, eastern Himalayas was considered to be one of the biodiversity hotspot, with 39% endemism[12]. The large number of bird species recorded in this study amply speak for the niche diversity and richness of the Mouling Forests. In the present study, 78 species were observed between 450 and 850 m, while 83 species between 850 and 1650 m. Of these, 47 were identified as common species, observed to occur at both lower and higher reaches of the forest (similarity index 0.58). Shannon–Weaver index of general diversity calculated to comment on the overall diversity, as it is reasonably independent of sample size[11], varied from 3.94 to 5.75 (mean 5.15; SD 0.58). However, this index of general diversity was observed to be marginally higher for the avian community of the higher reaches (diversity index 4.70) than for the lower elevations (diversity index 4.56). Such was the case for evenness and species richness indices too.

Index of dominance (range 0.09–0.30; mean 0.126; SD 0.005) was fairly low at all study sites, except for KuC at 650 m altitude, where the index of dominance was calculated as 0.3. This could possibly be attributed to the physical feature of the site and the abundance of water-dependent birds here. The KuC site exhibited lowest diversity index of 3.94. This site also showed minimum species richness (richness index 4.34) and evenness (evenness index 1.14) when compared to the avian community structure of the locations of the adjacent locations at the lower reaches. For example, RmC at 680 m and SiC at 460 m exhibited higher richness (6.87 and 6.46, respectively) and evenness (1.29 and 1.55, respectively). It is felt that heavy landslips had affected the vegetation and avian community at KuC while relatively undisturbed locations supported a comparatively rich avian community showing more diversity and little dominance. BvC at 840 m altitude exhibited the highest species diversity (richness index 5.75) and very low dominance (dominance index 0.11). In locations at further lower elevations, diversity index varied between 3.94 and 5.26 while it varied between 5.49 and 5.70 at locations with even higher elevations. Among the locations in higher altitudes, EpR at 1450 m showed minimum species dominance (dominance index 0.09) and maximum species richness (richness index 9.50).

Montane wet evergreen biotope extends an intricate microclimate of its own, characterized by its special set of physico-chemical and biological features. These conditions have encouraged its own avian assemblage, which is calculated as over 31.5% in the present investigation. It may be pointed out that only a few selected patches of Mouling Forests were studied; a more intensive study would surely result in identifying many more species from the eastern Himalayan wet evergreen biotope. In the present study, Sulfur-breasted Warblr (*Phylloscopus ricketti*) is being recorded for the first time in the Indian subcontinent. However, as the commoner species of leaf warbles were not recorded from the areas under study, confirmation of the occurrence of *P. ricketti* needs

Table 1. Different indices to comment on the species structure of the study sites

Study sites	Birds site	Species site	Richness index	Diversity index	Evenness index	Dominance index
RmC	59	29	6.87	5.26	1.29	0.16
SiC	56	27	6.46	5.11	1.55	0.19
NgC	52	26	6.34	4.95	1.52	0.18
KeC	43	25	6.38	4.42	1.37	0.15
KuC	32	16	4.34	3.94	1.14	0.30
BvC	78	40	8.95	5.75	1.56	0.11
EpR	75	42	9.50	5.49	1.47	0.09
EgC	77	40	8.98	5.69	1.54	0.10
AnR	73	36	8.16	5.70	1.59	0.13
mean	60.5	31.2	7.33	5.15	1.40	0.126
SD	15.4	8.25	1.58	0.58	0.15	0.05
Lower reaches	320	78	13.35	4.56	1.05	0.007
Higher reaches	225	83	15.14	4.70	1.06	0.009

further observational support. Absence of relatively common species of foothills, peripheral jungles and around habitations in the study sites and alongside the occurrence of very rare Mishmi Wren-babbler and many other less common species also demands further confirmation and more intensive studies. Some of the species, though recorded as rare in the present study, might appear regularly during other seasons or if the study was more intensive. The short list of species under the families, Sylviidae, Prunellidae and Dicaeidae was due to the limitations in study duration. However, the present effort records, for the first time, the avian assemblage of Mouling National Park with comments on their community structure. This study would help in the initiation of more detailed studies to enrich the list of species and to record the nature and extent of passage and local migration with the resident species.

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Molecular markers for genetic fidelity during micropropagation and germplasm conservation?

In recent years, with the advent of recombinant DNA technology and PCR, molecular markers are being used for a variety of studies. The molecular markers include Restriction Fragment Length Polymorphisms (RFLPs), Random Amplified Polymorphic DNAs (RAPDs), Amplified Fragment Length Polymorphisms (AFLPs), Simple Sequence Repeats (SSRs) or Sequence Tagged Microsatellite Sites (STMS), Sequence Tagged Sites (STS), DNA Amplification Fingerprinting (DAF) and Microsatellite Primed-PCR (MP-PCR) (ref. 1). More recently, molecular markers have also been used for testing the genetic fidelity during micropropagation/*ex situ* conservation on the one hand, and for characterization of plant genetic resources on the other. This aspect of the use of molecular markers has received attention in recent years due to the significance that is being attached to micropropagation of elite genotypes and to the *in situ* and *ex situ* conservation of plant genetic resources (PGRs). Molecular markers have particularly been suggested to be useful for confirmation of genetic fidelity in micropropagated tree species, where life span is quite long and performance of micropropagated plants could only be ascertained after their long