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Indigenous knowledge of *Lepcha* community for monitoring and conservation of birds

Bhoj Kumar Acharya*[1], Basundhara Chettri[1] & Lalitha Vijayan[2]

[1]Department of Zoology, Sikkim Government College, Tadong 737 102, Sikkim; Sàlim Ali Centre for Ornithology and Natural History, Anaikatty, Coimbatore, Tamil Nadu

E-mail: acharya2skm@gmail.com

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The non-professional volunteers are commonly used in biodiversity assessment due to lack of experts. The bird identification skills of indigenous *Lepcha* community have been recognized and the accuracy of data generated by them has been assesed. Bird sampling was done using point count method along the transects in three locations in Dzongu, North Sikkim. Two observers, a trained 'researcher' and a local *Lepcha* folk referred as citizen scientist independently sampled birds (species by former and varieties by the latter). The mean number of species and varieties per point was not significantly different from each other. Gross accuracy of data collected by citizen scientist was high. These results showed that indigenous taxonomic knowledge of *Lepcha* community can be applied for biodiversity assessment programme provided the individual biasness of lumping and splitting is taken care.

Keywords: Biodiversity, Birds, Dzongu, Himalaya, Indigenous knowledge, *Lepcha*

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Indigenous knowledge of thousands of ethnic groups across the globe, which reflects the experience of many generations, is closely associated with human development[1]. Himalayan region is the treasure house of indigenous knowledge on various disciplines including floral and faunal resources[2-4]. Despite the immense value of this knowledge, very little has been recorded yet and hence, much is on the verge of being lost. The global loss of biodiversity due to forest fragmentation and other anthropogenic pressures is alarming at present. Many species of plants and animals, especially in the hyper-diverse region such as Himalaya, are predicted to be extinct before the proper scientific documentation is made[5]. Straight forward approach to understand diversity of a particular habitat or area is to obtain information on species richness[6]. Estimation of species richness is a primary requisite for proposing strategies for biodiversity conservation and management[7]. However, procuring scientific data are difficult due to lack of resources, trained taxonomists, and time and logistical constraints. In addition, long-term monitoring of biodiversity is possible only with the assistance of non-professionals[8]. Hence, non-professional volunteers are being used for the rapid assessment as well as long-term monitoring of biodiversity in different parts of the world[9-14].

Volunteers used in other studies are individuals having no or only basic understanding about taxonomic or ecological science[9-14]. These volunteers were given basic training prior to their field visit. Ethnic communities with no scientific background, as used here, can effectively surrogate trained volunteers by means of taxonomic skills based on their indigenous knowledge. Conservation of biodiversity cannot be achieved fully unless we understand the prior knowledge of indigenous people[15]. The importance of indigenous knowledge for the promotion of biodiversity conservation and sustainable use of resources has been recognized very recently[15,16]. Traditional knowledge of various ethnic communities on conservation of plants in Sikkim and other parts of Himalaya have been documented[3,4,16-22]. However, the strength of indigenous knowledge for assessing faunal resources and their conservation has not been studied. The paper recognizes indigenous knowledge of *Lepcha* community, an aboriginal tribe

*Corresponding author

of Sikkim Himalaya, as an additional tool for monitoring and conservation of avifauna. The bird identification skills of *Lepcha* communities based on their indigenous knowledge were investigated. In the paper the bird data collected by 'researcher' and indigenous *Lepcha* tribe (hereafter 'citizen scientist') have been compared and validated.

Methodology

Sikkim, one of the smallest states of India, is situated at the western extremities of the Eastern Himalaya. Wholly mountainous terrain with a total geographical area of 7,096 km^2, it is surrounded by lofty Himalayan ranges in the northern, eastern and western sides. Dzongu, the abode for *Lepchas*, is the reserve for this ethnic group[23,24]. It is roughly triangular mountainous land located in the North-west part of Sikkim (Fig. 1) spanning an elevation range between 700 m and 6,000 m above sea level. Because of this high altitudinal variation, different vegetation types from warm subtropical forests at lower regions, temperate deciduous forests at middle elevations and alpine zones in the higher ridges exist in Dzongu. The climate ranges from hot tropical and subtropical at lower elevations, temperate type in the middle and arctic cold at the higher elevations with a mean temperature varying between 4.4°C in winter to 30°C in summer. Two major rivers, namely Teesta and Talung flowing through the area make this region moist all round the year.

Among the three major ethnic groups (*Lepcha, Bhutia* and *Nepali*) of Sikkim Himalaya, *Lepchas* are the most primitive and indigenous tribe[25]. The *Lepcha* communities are born naturalists who live in relative isolation from the outside world with their own traditional practices and beliefs[23,25]. Mongoloid in origin, *Lepchas* are quite innocent and possess very rich ethnic knowledge on medicine, food and biodiversityand have their own names for different species of wild flora and fauna[20,24,26-29]. The identity of endangered *Lepcha* tribe is under threat at present from the dominant religions and, which finally threatens the invaluable wealth of knowledge peoples[23,25]. The recognition and documentation of indigenous knowledge of this vanishing ethnic group is highly emphasized[23].

Fig. 1—Sampling locations in Dzongu, Sikkim

Sampling of birds was done in the low elevation tropical forest in Dzongu covering three locations – Sankalang (850m; 27° 29.3' N, 88° 30.6' E), Lingdong (980 m; 27° 29.4' N, 88° 30.7 'E) and Barphok (1120 m; 27° 29.5' N, 88° 30.2 'E). These locations are smaller forest patches sandwiched between agricultural land and habitation.

Point count method along the predetermined transects was used for sampling birds[30]. Three transects of 1,000 m length were marked at three locations mentioned above – transect 1 (Sankalang), transect 2 (Lingdong) and transect 3 (Barphok). Within the transect, permanent points were established for bird sampling maintaining a minimum of 100 m distance between the two points. In total, 156 points were sampled covering three transects. Observations on birds at every point were done for five minutes and all the birds seen were recorded. During sampling two observers were involved – a trained ecologist referred to as researcher and a local *Lepcha* folk referred to as citizen scientist. Citizen scientist had no scientific background on species determination but could identify birds in his own way based on indigenous taxonomic skills, in which he seemed to be knowledgeable. Both the observers independently sampled birds at every point and recorded observations – number of species by 'researcher' and number of varieties by citizen scientist. Sampling was done at all the points by both observers at the same time without interrupting each other. The list of birds generated by citizen scientist was shown to three other people of the community to verify whether *Lepcha* names recorded by former were correct or known to the community.

Species richness was obtained as a cumulative list of species observed by the researcher. Similarly, variety richness is considered as number of bird varieties recorded by citizen scientist during the study. Descriptive statistics such as mean and standard deviation of species and varieties was estimated in total as well as for each transect. Student '*t*' test for assessing variation in mean number of species and varieties per point was performed. Pearson correlation was performed between bird species richness and varieties per point for evaluating the relationship between the two. Sorensen similarity index (for species and varieties) between transects using statistical software Estimate S version 7 was calculated[31]. Gross accuracy is calculated as 100-[(A - B)*100/A], where 'A' is the number of species and 'B' the number of varieties[11]. Gross accuracy is an index which measures the efficiency of data collected by non-professional (citizen scientist in this case) in comparison to professional (researcher).

Results

The total number of species (combined species richness of three transects) observed by the researcher and total varieties by citizen scientist was 90 and 75, respectively. The number of species was higher than the varieties in all transects as well as in total but the mean number per point was not significantly different from each other except transect 3 (Table 1). Species-richness and varieties per point were significantly correlated ($p \leq 0.05$; Table 2). In comparison of the efficiency of citizen scientist with researcher, gross accuracy was 83.3%. Accuracy varied from 86.79 - 98.03% among transects (Table 2).

Similarities of species and varieties between transects is given in Table 3. Although similarity between all transect pairs are lower in the case of species compared to varieties, the pattern is similar. Species and varieties similarities between transect pairs showed strong significant positive correlation ($r = 0.98$; $p < 0.05$).

Discussion

The use of non-professional volunteers or amateur taxonomists is commonly observed in biodiversity assessment if the large landscape or long-term monitoring is involved[10,12,32,33].The indigenous people having no scientific background or training are not involved as volunteer for biodiversity studies. The paper is a pioneering work in this regard to bring into focus the indigenous knowledge of aboriginal vanishing *Lepcha* tribe in identifying birds and to test the accuracy of the data generated by them. Hence, this approach serves the dual purpose of documenting vanishing indigenous knowledge and conserving rich biodiversity.

Table 1—Number of bird species (observed by researcher) and varieties (observed by citizen scientist) in Dzongu, North Sikkim

Transects	Total number observed		Mean per point ± SD		*t*	*p*
	Species	Varieties	Species	Varieties		
Transect 1	53	46	3.9± 2.03	3.8± 1.8	0.42	0.33
Transect 2	51	50	3.58± 1.79	3.35± 1.31	0.77	0.22
Transect 3	50	44	4.47± 2.57	3.3± 2.14	2.17	0.01
Total	90	75	3.8± 1.9	3.6± 1.9	0.73	0.23

'*t*' represents *t*-test value between the two sets of data, number of bird species and varieties per point

Table 2—Accuracy of bird data obtained by citizen scientist in comparison to researcher

	Transect 1	Transect 2	Transect 3	Total
Gross accuracy (%)	88.0	98.03	86.79	83.3
r	0.38	0.45	0.18	0.33

'*r*' represents correlation co-efficient between species and varieties (all values are significant at $p \leq 0.05$)

Transects Table 3—Sorensen similarity matrix of bird species (to the right of diagonal) and varieties (to the left of diagonal) between different transects

Transects	Transect 1	Transect 2	Transect 3
Transect 1	-	0.56	0.50
Transect 2	0.65	-	0.54
Transect 3	0.6	0.64	-

Total number of varieties (observed by 'citizen scientist') was lower than total species-richness (observed by researcher) of birds. Similar observations were made in other taxain which number of species observed by experts was higher than the number of morphotypes of inexperienced volunteers[12,34]. Lumping (more than one species assigned to one variety) and splitting (single species assigned to more than one variety) are observed in data collected by volunteers[35]. The low estimation of birds by citizen scientist here is due to non-availability of separate names for some species having very little morphological differences (lumping). This occurred only in a few cases because the mean number of species and varieties per point were not significantly different. In the present case, splitting was expected due to plumage differences between male and female birds of the same species. Since, the citizen scientist could distinguish sexual dimorphism, splitting was not noted in the study. This reflects the strength and efficiency of bird identification skills of the ethnic *Lepcha* tribe. The correction of relatively few lumping and splitting errors by imparting training will lead in 100% accuracy. Since, the main objective of the rapid biodiversity assessment is not the formal description of species, advantage of indigenous tribe as a time- and resource-saver in assessing the biodiversity outweigh the minor error of lumping and splitting[14].

Strong correlation observed between bird species and varieties suggest an accurate estimation of species diversity using varieties. Gross accuracy values were very high in all the cases reflecting high taxonomic skills of the citizen scientist involved in the study. Since, observation skills vary among individual volunteers, comparison of accuracy among the individuals of the *Lepcha* tribe could provide better results and this could be tried[14,34]. Although similarities of species were lower than varieties, the pattern among transects was comparable. This shows that citizen scientist was consistent in identifying birds in different habitats or locations. Species reflect the diversity of habitat relatively better than morphotypes or varieties[34]. Hence, similarities of species are believed to be comparatively lower than varieties. Despite low sensitivity to habitat divergence, varieties act as useful tool in assessing the large scale changes of habitat.

The data presented here throw light on the wealth of indigenous knowledge of *Lepcha* community for the conservation of birds. Intimate indigenous knowledge of this community on fauna and flora enabled them to co-exist with their environment over many generations. It is observed that this knowledge can be utilized for assessment of biodiversity, but it needs some precaution because of observer bias. Before the application of this information, individual variation should be properly understood. Individuals should be selected based on trial observation on his/her knowledge. A detailed study involving more number of individuals covering wider landscape, habitat and taxa is needed for deeper understanding and application of this knowledge.

The study also gives an insight that such knowledge of other ethnic groups of the Himalaya should be recognized and documented on priority. The knowledge of all ethnic communities may serve as valuable data for developing the environmental management strategies because their livelihoods bring them in close link with the environment. Hence, useful indigenous knowledge and belief that support biodiversity conservation need to be documented before it vanishes from the world.

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