

## SIKKIM HIMALAYA: UNIQUE FEATURES OF BIOGEOGRAPHY AND ECOLOGY

G. S. Rawat and Sandeep Tambe

### ABSTRACT

The Sikkim Himalaya stands out as smallest but biologically most diverse Himalayan states in India. It is unique in several ways - most importantly, its close proximity to both the Tibetan Plateau and Bay of Bengal thereby having affinities with tropical moist forests in the south and cold desert in the north within a short distance of less than 100 kms. Heavy precipitation during winter as well as summer season has given rise to lush green vegetation. The state has strong influence of both west and east Himalayan biogeographic provinces. The west Himalayan elements in the state include Himalayan tahr (*Hemitragus jemlahicus*) and blue sheep (*Pseudois nayaur*). However, the state exhibits more affinities with the eastern Himalaya as evident from the presence of red panda (*Ailurus fulgens*), clouded leopard (*Neofelis nebulosa*), serow (*Capricornis milneedwardsii maritimus*) and high diversity of orchids and rhododendrons. The state is said to be the historical range of golden takin (*Budorcas taxicolor*). Angiosperms and lower groups of plants and animals exhibit high levels of endemism. This article deals with a few unique features of biogeography and ecology of the state along with priority areas of research and conservation.

**KEYWORDS:** Biogeography, Conservation, Endemic species, Orchids, Rhododendrons



Mt Khangchendzonga - the guardian deity of Sikkim

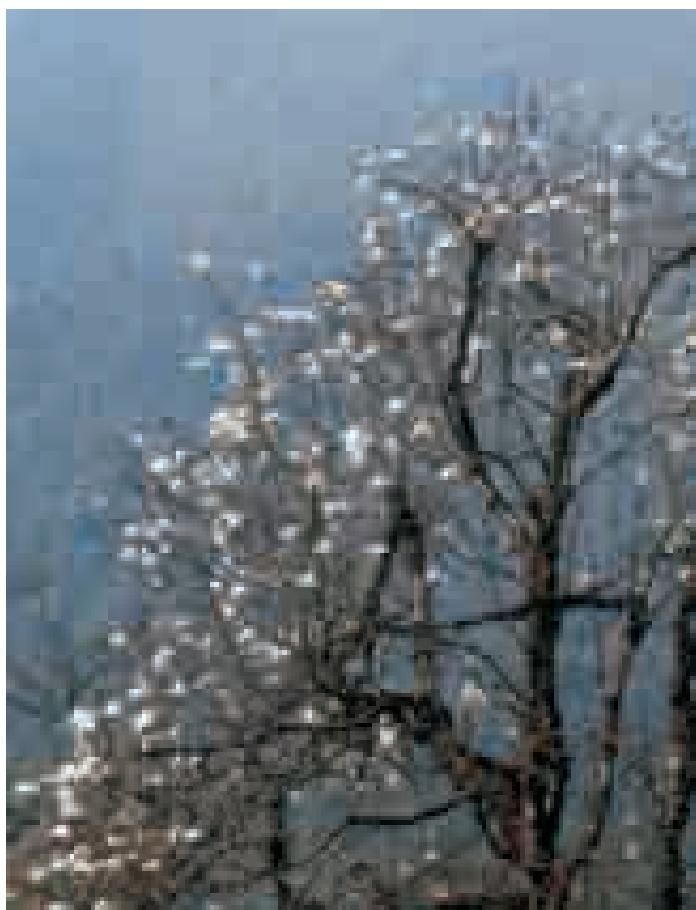


*Rhododendron niveum* - State Tree of Sikkim

## INTRODUCTION

Sikkim (ca. 7096 km<sup>2</sup>; 27° 05' to 28° 07' N latitudes and 87° 59' to 88° 56' E longitudes), wedged between Nepal and Bhutan is a small and most beautiful state of India well known for its scenic beauty, immensely rich biological diversity manifested by diverse eco-climatic conditions and wide altitudinal variation from about 300 m to 8500 m asl. Mount Khangchendzonga, the third highest peak in the world, and adjacent Singalila range strongly govern the relief features on the western part of the state while Chola range plays prominent role in determining physiography on the eastern part of the state. Together, these ranges, not only, strongly influence the atmospheric circulation and regional climate in the region but also affect the climate of adjacent regions. In the north, the state forms international boundary with Tibetan Autonomous Region of China while in the south it is bordered by West Bengal. The state is the major catchment of river Teesta that originates from Tso Lhamo lake in the north.

A large number of Naturalists, Field Biologists, Ecologists and Scientists have contributed to the current knowledge on the ecology and biogeography of Sikkim Himalaya. Pioneer among them was Sir Joseph Dalton Hooker who made historical botanical forays to the interiors of the state during 1848–49 (Hooker 1853). Subsequent to Hooker's exploration several European Botanists collected plants from the state, notably Sir George King, C.B. Clarke, D. Prain, J.S. Gamble, Sir George Watt, R. Pantling, G.A. Gammie, W.W. Smith and G.H. Cave. Hooker also made natural history observations on a few animal species during his expeditions. Most of these botanists have acknowledged the significant contributions made by the Lepcha community of Sikkim in documenting the floral and



*Magnolia campbellii* in bloom



*Cardiocrinum giganteum*  
Giant lily in Zemu Valley, Sikkim

faunal wealth of the state (Smith and Cave 1911). During the past few decades quite a few Indian botanists have updated the information on various taxonomic groups such as rhododendrons, orchids and ferns and made significant contributions (Pradhan and Lachungpa 1990; Lucksom 2007; Khelia 2010). However, information on the distribution of animal communities for the state is rather limited except detailed observations on the birds by Salim Ali and on butterflies by Meena Haribal (Ali 1962; Haribal 1992). More recently, Ms. Usha Lachunpa has collected ample information on the distribution of various faunal groups in the state which have been incorporated in the State Biodiversity Strategy and Action Plan (SBSAP) of the state (Lachungpa *et al.* 2003). Detailed ecological studies on the faunal communities have been undertaken by Dr. Nakul Chettri on birds and butterflies of KNP, Dr. Bhoj Kumar Acharya on birds of Sikkim, Dr. Basundhara Chettri on herpetofauna and Dr. Joya Thapa on mammals. Tambe (2007) conducted a detailed study on the ecology and management of alpine vegetation in Khangchendzonga National Park. A short study on the habitat use and food selection by wild and domestic ungulates in Tso Lhamo plateau was conducted by Chanchani (2007). Currently, a survey of small mammals and pheasants of Khangchendzonga BR by the Wildlife Institute of India is underway. Besides, Department of Science & Technology, Government of Sikkim has initiated a few ecological studies on various aspects in the state.

This article gives a brief overview of unique features of ecology and biogeography of Sikkim Himalaya based on published information. We flag a few issues of conserving unique floral and faunal assemblages and recommend further ecological investigations and biogeographic analysis of hitherto least studied groups

## UNIQUE FEATURES

Despite several commonalities of Central and Eastern Himalaya, Sikkim exhibits a few unique features. Notable among them are: contiguity of habitats from sub-tropical forests of Sal (*Shorea robusta*) to cold deserts within a distance of less than 100 kms; Sikkim plateau - one of the smallest biogeographic provinces in India; wide *Krummholz* zone in subalpine - alpine ecotone; intact transboundary biological corridors along horizontal axis and highest number of species named after any state in India. Sikkim has exceptionally diverse orchids and it is also believed to be centre of origin for *Cymbidium*. These features are further elaborated below:



Subtropical Sal forests with Chir pine along the Rangit river valley in South Sikkim

**Contiguity of habitats from sub-tropical forests to cold deserts:** The state exhibits great compression of eco-climatic zones owing to wide altitudinal gradient and fairly high degree of slopes. Perhaps no other Indian state would have such a contiguity of diverse habitat types from sub-tropical forests to dry alpine steppe within a short distance of less than 100 kms. Majority of the habitats are divided through two great river systems i.e., the Teesta and Rangit which are drained by numerous tributaries. Each eco-climatic zone is represented by its own distinct floral and faunal communities, some of which occupy more than one habitat and wider altitudinal range, especially a few migratory species. A large number of altitudinal migrants especially leaf-warblers reach treeline and adjacent alpine scrub to breed during summer and descend to foot-hills and further to peninsular India during winter. The foot-hill forests in the state harbour several floral and faunal elements, typical of eastern Himalaya. Notable among the floral assemblages are a variety of epiphytic orchids, aroids, wild banana, *Pandanus* and bamboos, while prominent avifauna include Rufous-necked Hornbill *Aceros nipalensis*, Great Indian Hornbill *Buceros bicornis homrai*, Chestnut-breasted Partridge, Black-breasted Parrotbill, Grey-crowned Prinia and Ward's Tropicbird. This region also exhibits a narrow range of *Sal - Chir* pine transition.

**Tso Lhamo Plateau – India's smallest biogeographic province:** The Sikkim plateau or popularly known as Tso Lhamo lies in the Trans-Himalayan region of the state, covering an area of about 400 sq. km and perhaps represents India's smallest biogeographic province (Rodgers and Panwar 1988). This province harbours populations of a few highly threatened mammalian fauna (Table 1) such as Tibetan argali (*Ovis ammon hodgsoni*), Tibetan gazelle (*Procapra picticaudata*) and southern kiang (*Equus kiang polyodon*). This area has also been the historical range of Tibetan antelope (*Pantholops hodgsonii*). The plateau is also used extensively by the native Dokpa herders for livestock (yak and sheep) grazing. Compared to 1A and 1B (Ladakh), this plateau is reported to have higher densities of Tibetan argali and Tibetan gazelle but these populations are susceptible to decline due to heavy human influx and livestock grazing. Given the strategic location of this area for national security and stake of local communities for pastures, this area would need a different model of protected area. Hence it is recommended that this plateau be notified as Conservation Reserve.



Tso Lhamo plateau - India's smallest biogeographic province

**An extensive Krummholz zone:** One of the interesting features of the state is perhaps widest and most extensive zone of *krummholz* (stunted forest) in the Himalayan region. The following associations are easily identifiable within *krummholz* zone viz., *Rhododendron wightii* – *R. fulgens*, *R. thomsonii*, *R. hodgsonii*, *R. lanatum* and *R. campanulatum*. These associations are usually found between 3500 - 4200 m asl on rocky and shady moist slopes. General height of the vegetation varies between 2 – 2.5 m and most of the formations are thick and impenetrable. Ground vegetation is dominated by mosses and lichens. *Krummholz* zone forms ideal habitat for a number of avian (e.g., blood pheasant, satyr tragopan) and mammalian fauna (e.g., Himalayan musk deer). Some of the protected areas well known for their extensive *krummholz* zone and high diversity of rhododendrons include Shingba WS (North), Kyongnosla WS (East), Pangolakha WS (East), Barsey WS (West) and Khangchendzonga Biosphere Reserve. Shingba Rhododendron Sanctuary is home to the endemic *Rhododendron niveum*, which has been designated as the State tree of Sikkim.



Dwarf *Rhododendron niveale* - mats at 4000 meters elevation in North Sikkim

**Most congenial habitats for orchids in the Himalaya:** Contiguous riverine habitats along sub-tropical and warm temperate belts surrounded by rich forests of Duars of north-west Bengal form congenial habitat for a variety of epiphytic as well as ground orchids. The deep valleys and lower hills retain considerable moisture throughout the year owing to summer as well as winter precipitation. The sub-tropical belt has a number of tall trees which form excellent host for epiphytes such as *Shorea robusta*, *Duabanga sonneratoides*, *Gmelina arborea*, *Terminalia tomentosa*, *Schima wallichii*, *Toona ciliata*, *Engelhardtia spicata*, and *Machilus odoratissima* to name a few. The common genera of orchids in these forests include *Dendrobium*, *Ascocentrum*, *Aerides*, *Acampe*, *Vanda*, *Cymbidium*, *Bulbophyllum*, *Flickingeria*, *Smitinandia*, *Phalaenopsis* and *Porpax*. This belt is also extremely rich in ground orchids represented by the species of *Nervillia*, *Galeola*, *Tropidia*, *Anoectochilus*, *Goodyera* and *Zeuxine*. Other notable species of orchids along foot-hills are snow orchid (*Diplomeris hirsuta*), Lady's slipper orchid (*Paphiopedilum venustum*) and Bamboo orchid (*Arundina graminifolia*) among others. In all, the state has over 525 species of orchids, including several endemic species reported by earlier workers and recently by Lucksom (2007).



*Pleione praecox*, a delicate orchid on moss beds in temperate forests

**An important trans-boundary biological corridor:** The Khangchendzonga Biosphere Reserve (KBR) and adjacent forested tracts on other side of Teesta are contiguous with Chola Range in the east. The KBR forms contiguous habitat with Khangchendzonga Conservation Area in Nepal (on the western side) and Singalila National Park in Darjeeling (Gorkha Hill Council) as well as several other protected areas in Sikkim (Maenam and Barsey). Thus the entire landscape covering over an area of more than 11,500 km<sup>2</sup> forms a transboundary conservation complex extending from Nepal through Sikkim, Chumbi valley of Tibet and further into Bhutan, providing one of the most important biological corridor in the region. The landscape provides connectivity from west to east and south to north and includes relatively intact subtropical and temperate forests which are otherwise fragmented in other parts of Himalaya, especially in Nepal (Sharma 2002). Besides several avian communities, these corridors would be used by a variety of other faunal groups in the long run.

**Highest number of vascular plants named after any Indian state:** The state has been a place of attraction for a large number of plant explorers and systematic botanists since the time of Sir J.D. Hooker. Owing to its peculiar geographical location, wedged between Nepal and Bhutan, Sikkim has always rewarded the plant explorers. This is evident from the

large number of taxa named after the state. A cursory look at the published literature on the flora of Bhutan and parts of Sikkim reveals that as many as 165 species named after Sikkim (Grierson and Long 1983-1991). This forms the largest number of vascular plants named after any Indian state. Notable taxa are:

*Astragalus sikkimensis*, *Cleisostoma sikkimensis*, *Euphorbia sikkimensis*, *Hedysarum sikkimense*, *Liparis sikkimensis*, *Cirrhopteridium sikkimense*, *Elatostema sikkimense*, *Salvia sikkimensis*, *Rubia sikkimensis*, *Vittaria sikkimensis*, *Salix sikkimensis*, *Gentiana sikkimensis*, *Lomatogonium sikkimense*, *Letsomia sikkimensis*, *Primula sikkimensis*, *Rubus sikkimensis*, *Saxifraga sikkimensis*, *Clematis sikkimensis*, *Corydalis sikkimensis*, *Kobresia sikkimensis*, *Draba sikkimensis*, *Ranunculus sikkimensis*, *Pedicularis sikkimensis*, *Prenanthes sikkimensis*, *Scrophularia sikkimensis*, *Taraxacum sikkimense*, *Allium sikkimense*, *Commelina sikkimensis*, *Agapetes sikkimensis*, *Ampelocissus sikkimensis*, *Begonia sikkimensis*, *Canarium sikkimense*, *Epilobium sikkimense*, *Ilex sikkimensis*, *Osbeckia sikkimensis*, *Pyrola sikkimensis*, *Vaccinium sikkimense* and *Viola sikkimensis*.



*Salix sikkimensis* - Sikkim willow



*Taraxacum sikkimensis*



*Ephedra gerardiana* var *sikkimensis*



*Hedysarum sikkimense*

Sikkim Himalaya is regarded as hot spot of *Pedicularis* diversity in Himalaya, having about 55 species i.e., 70% of the Indian Himalayan taxa (Hussain *et al.* 2010). Of these, nearly 16% species are said to be endemic to Sikkim Himalaya. Globally, Sikkim and adjacent Yunnan province of China is said to be centre of origin and diversification of this species. This may be true for several other plant groups. A detailed phytogeographic analysis may reveal more interesting facts about the state.



*Pedicularis roylei var. speciosa* in Zemu valley

## FUTURE RESEARCH AND CONSERVATION PRIORITIES

Sikkim Himalaya offers tremendous scope for further research on various aspects of ecology, biogeography and biodiversity. First and foremost, a detailed (large scale) vegetation map of the state needs to be prepared with the technical assistance from national agencies dealing with remote sensing and vegetation surveys such as Forest Survey of India and Indian Institute of Remote Sensing. Data on the distribution of various faunal groups collected by the research wing of Forest Department will need collation and projection in the form of spatial database so as to develop distribution maps of various species. Likewise, major plant communities and habitat types within various protected areas and also along Teesta and Rangit rivers need to be mapped to assess the habitat contiguity and critical areas all along the river. Under the wake of climate change baseline surveys on the populations of several endemic and ecologically sensitive species will have to be conducted along the altitudinal gradient so as to make future comparisons. Similarly, several groups of plants such as orchids, rhododendrons, primulas, ferns and other cryptogams await detailed ecological investigations.

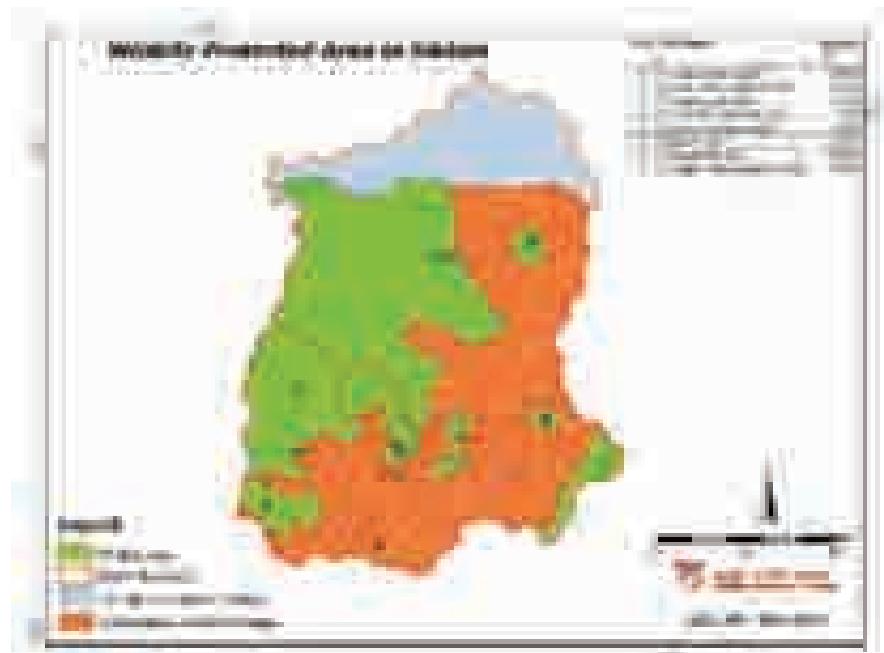
The state has already taken impressive strides in terms of protected area planning, implementation of the Wildlife (Protection) Act and gaining public support for wildlife conservation. The State boasts of 31% of the geographical area under the protected area network (sanctuary and national park) which is highest in the country as against the national average of about 5%. The state has launched an innovative and unique program for the participatory conservation of the alpine areas by enrolling local community level resource persons as *Himal Rakshaks* or Honorary Mountain Guardians. These *Himal Rakshaks* have been trained in participatory monitoring of the alpine areas. For the conservation of high altitude lakes impacted by tourism, the local community has been empowered and involved in the lake management through the *Pokhri Sanrakshan Samiti* initiative. The Chief Minister – Shri Pawan Chamling in an exemplary policy step banned the practice of grazing in forests. Blanket implementation of this ban over the last decade has resulted in phasing out of cattle from the forests and protected areas thereby making the sanctuaries and national park a haven for wildlife and as a result the populations of flagship species like blue sheep, red panda, wild dog etc are bouncing back. Also in a long term policy decision to conserve the medicinal plant germplasm, the State Government has prohibited the commercial extraction and transit of medicinal plants from forests. The state has also made remarkable progress in implementing national rural employment guarantee schemes and combining this programme with conservation activities and natural resource management.

Further proactive steps are needed especially in ensuring conservation of a few critical wildlife areas such as Tso Lhamo plateau that harbours a unique assemblage of flora and fauna. This area needs to be managed in the lines of Conservation Reserve, keeping the security personnel and local communities in confidence and in their partnership. Dialogues with the Government of China would also be needed for ensuring the protection of threatened species such as Tibetan gazelle and southern kiang on the other side of the border and eventually managing this area as Trans-boundary Peace Park.

Some of the sanctuaries in the cool temperate belt (1500 -3000 m asl), e.g., Fambong Lho WS in East and Maenam WS in South Sikkim need detailed biological surveys to assess the ecosystem coverage, identification of sensitive habitats and establishing linkages with other areas. Similarly, Kitam Bird Sanctuary ( $6 \text{ km}^2$ ), the only protected area in the sub-tropical belt needs to be expanded to cover the adjacent Reserved Forests. Efforts are also needed to ascertain the inclusion of threatened taxa such as Rusty-bellied and Lesser Shortwings, Kalij and Satyr Tragopans, Japalura lizard, Himalayan Bullfrog, etc., within these PAs. A patch of Reserve Forest ( $ca\ 5 \text{ km}^2$ ) near Rangrang (North Sikkim) has been selected as Butterfly Park for which feasibility survey has been completed by the state Forest Department. Similarly, near Tinkitam a patch of forest ( $5 \text{ km}^2$ ) is proposed to be declared as Ladys' Slipper Orchid (*Paphiopedilum fairrieanum*) Conservation Reserve. Reportedly (Ms. Usha Lachungpa, Senior Research Officer, *Personal communication*), the public hearing has been completed for further action. Rabdentse Bird Park in West Sikkim ( $2 \text{ km}^2$  area) has recently been fenced which has resulted in good recovery of *Castanopsis tribuloides*. Legally this falls under Reserved Forest and the main purpose of this park is to protect the birds and also awareness generation and entertainment of the visitors.



Bharal or Himalayan Blue sheep *Pseudois nayaur* is a caprid found extensively in the alpine zone of Sikkim Himalaya



Protected Area Network of Sikkim

The area around Himalayan Zoological Park, Gangtok (205 ha) serves as an important catchment for water supply to Gangtok city. This area and adjacent Ratey Chu Reserve Forests have been identified as Important Bird Area by BNHS (Islam and Rahmani 2004). These two areas form contiguous forest with the adjoining Fambong Lho WS. Considering their long term conservation significance they may be given the status of Wildlife Sanctuary.



Tso Lhamo supports India's only population of the Southern kiang (a sub - species) *Equus kiang polygodon*

**Table 1:** Mammalian fauna of Tso Lhamo Plateau, Sikkim [WPA = Wildlife (Protection) Act; IUCN Categories: NT = Near Threatened; DD = Data Deficient; LC = Least Concern; VU = Vulnerable; EN = Endangered]

Common Name	Scientific Name	IWPA	IUCN
1 Tibetan argali	<i>Ovis ammon hodgsonii</i>	I	Vulnerable
2 Tibetan gazelle	<i>Procapra picticaudata</i>	I	NT
3 Southern kiang	<i>Equus kiang polyodon</i>	I	DD
4 Blue sheep	<i>Pseudois nayaur</i>	I	LC
5 Tibetan wolf	<i>Canis lupus chanco</i>	I	VU
6 Tibetan sand fox	<i>Vulpes ferrilatus</i>	I	LC
7 Pallas's cat	<i>Felis manul</i>	I	NT
8 Snow leopard	<i>Uncia uncia</i>	I	EN
9 Eurasian lynx	<i>Lynx lynx</i>	I	EN
10 Himalayan marmot	<i>Marmota bobak</i>	II	LC
11 Tibetan woolly hare	<i>Lepus oiostolus</i>	II	LC
12 Plateau pika	<i>Ochotona curzoniae</i>	II	LC
13 Siberian weasel	<i>Mustela sibirica</i>	II	LC



Congregation of Nayan *Ovis ammon hodgsoni* in Tso Lhamo cold desert in North Sikkim



*Himal Rakshak Program* - A novel initiative to enlist the voluntary support of community based resource persons for conservation of the alpine zone

## AUTHORS:

### G. S. Rawat

Professor, Department of Habitat Ecology  
Wildlife Institute of India, Chandrabani,  
Dehradun, Uttarakhand - 248001, India  
Email: [rawatg@wii.gov.in](mailto:rawatg@wii.gov.in)  
Phone: +91 135 2640111–115 (EPABX)  
Fax: +91 135 2640117  
**(corresponding author)**

### Sandeep Tambe

Indian Forest Service  
Department of Rural Management and Development  
Gram Vikas Bhawan, Near Tashiling Secretariat  
Gangtok, Sikkim - 737101, India  
Email: [sandeep\\_tambe@yahoo.com](mailto:sandeep_tambe@yahoo.com)  
Phone: +91 94740 59791  
Fax: +91 3592 201441

## REFERENCES

- Ali, S. 1962. The Birds of Sikkim. Oxford University Press.
- Chanchani, P. 2007. Habitat Use and Food Selection by Wild and Domestic Ungulates in the Sikkim Trans-Himalaya. M. Sc. Dissertation, Wildlife Institute of India, Dehradun.
- Grierson, A. J. C., and Long, D. G., 1983-1991: Flora of Bhutan Vols 1-3. Royal Botanical Garden, Edinburgh.
- Haribal, M. 1992. The Butterflies of Sikkim Himalaya and their Natural History. Sikkim Nature Conservation Foundation, Gangtok, Sikkim.
- Hooker, J.D. 1853. The Himalayan Journal. Notes of a Naturalist. Vo. I and II. Reprint. Natraj Publishers, Dehra Dun.
- Hussain, T., A. Garg and Agnihotri, P. 2010. Genus *Pedicularis* L. (Scrophulariaceae) in India: A revisionary Study. Bishen Singh Mahendra Pal Singh, Dehra Dun.
- Islam, M. Z. and Rahmani, A.R. 2004. Important Bird Areas in India: Priority Sites for Conservation. Indian Bird Conservation Network. Bombay Natural History Society and BirdLife International, U.K.
- Khelia, B.S. 2010. Ferns and Fern Allies of Sikkim: A Pictorial Handbook, Part 1. Sikkim State Biodiversity Board & Botanical Survey of India.
- Lachungpa, U., Tambe S., Bhadauria, S.B.S., Arrawatia, M.L. and Poudyal, T.R. 2003. Sikkim State Biodiversity Strategy & Action Plan. Department of Forests, Environment & Wildlife Management, Government of Sikkim, Gangtok.
- Lucksom, S.Z. 2007, The Orchids of Sikkim and North East Himalaya. S.Z. Lucksom, Sikkim, India.
- Pradhan, U.C. and Lachungpa, S.T. 1990. Sikkim Himalayan Rhododendrons. Sikkim.
- Rodgers, W.A. and Panwar, H.S. 1988. Wildlife Protected Area Network in India. Vol. 1 & 2. Wildlife Institute of India, Dehradun.
- Sharma, E. 2002 Neighbouring countries and transboundary biodiversity conservation. Thematic Paper for NBSAP. GB Pant Institute of Himalayan Environment and Development, Sikkim Unit, Gangtok.
- Smith, W.W. and Cave G. H. 1911. The Vegetation of the Zemu and Llonakh Valleys of Sikkim. In the records of the Botanical Survey of India, Volume IV. No 5, Superintendent Government Printing, India.
- Tambe, S. 2007. Ecology and Management of the Alpine Landscape in the Khangchendzonga National Park, Sikkim Himalaya. Ph. D. Thesis. Wildlife Institute of India (FRI University), Dehra Dun.