

Moth communities across ‘moist temperate ban oak (*Quercus leucotrichophora*)’ and ‘tropical moist deciduous sal (*Shorea robusta*)’ forests in Uttarakhand (Western Himalaya), Northern India.

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INTRODUCTION & AIM

Lepidoptera is an order of insects that includes ‘moths (Heterocera) and butterflies’ (Rhopalocera) that are one of the main phytophagous groups, encompassing as estimated 1,40,000–1,57,000 extant species worldwide. In order Lepidoptera 90% of moth species are belongs to 129 (Lees and Zilli, 2019). Moths are mainly nocturnal, phytophagous insects that perform crucial ecological services such as pollinating in flowering plants and serving as a prey in the food chain. Macro-moths serve as environmental quality indicators because they show the health of ecosystems, climate change indicators and the potential to preserve microhabitats (Legal et al., 2020). The study was carried out to know the difference in species diversity, seasonality and community structure in the ban oak (*Quercus leucotrichophora*) forests in the Western Himalaya, and sal (*Shorea robusta*) forests in the ‘Shiwalik’ ranges of Uttarakhand, India.

METHODS

Sampling was carried out at eight sites (Fig. 1 & Image. 1) to collect data on moths in Uttarakhand. Four sampling sites were selected in ‘ban oak’ forest in the temperate ‘Himalaya’ and four sites were taken up in ‘sal forests’ in the ‘Shiwalik’ ranges of Uttarakhand, Northern India (Champion and Seth, 1968).

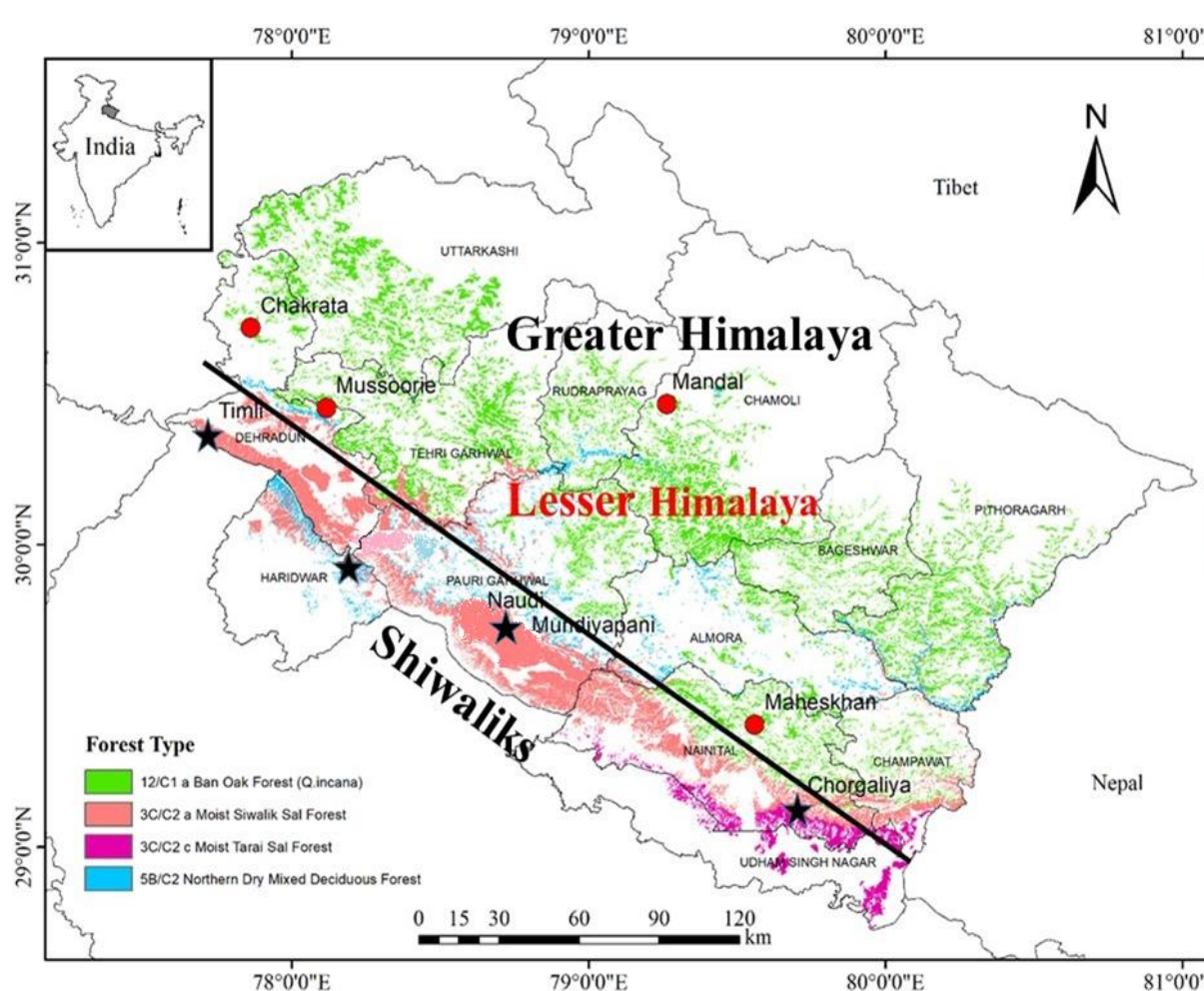


Fig. 1. Location of sampling sites in Ban Oak (*Q. leucotrichophora*) forests (marked as red circle) and ‘Shiwalik’ Sal (*S. robusta*) forests (marked as black star) in Uttarakhand, Northern India.

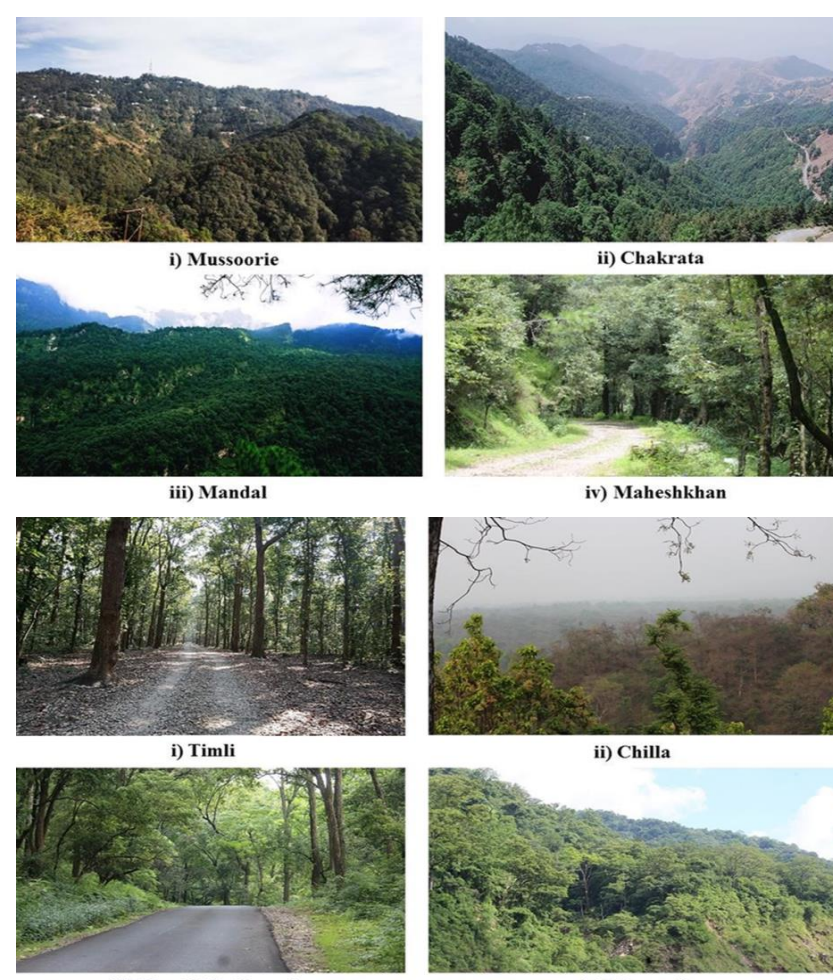


Image. 1. Ban oak forest sites in the ‘Western Himalaya’ and Sal forest sites in the ‘Shiwalik’ ranges of Uttarakhand, Northern India.

➤ Seasonal sampling (pre-monsoon; monsoon and post-monsoon) surveys covered 125 days for three years in succession (June 2020– October 2023) based on stratified random sampling. Sampling was carried out in the night from 1900 to 2200 hours, (just after sunset) when majority of moths are attracted to artificial light. For sampling, two moth screens were set up at each site with CFL bulbs compact fluorescent lamps [(27 Watt; 220–240 Volt; Cool Daylight (6,500–7,500K); Light Colour: White; 65 Lumen; Philips Co.)] hanging vertically in front of a white canvas cloth sheet (180 x 120 mm) (Fig. 2) (Raimondo et al. 2004).

➤ At the time of sampling, data was collected on moth species observed on the screen and Number of individuals of each moth species. During the time of each sampling GPS coordinates of each taxa, relative humidity and temperature were recorded. Moths were identified with the help of field guides (Shubhalaxmi, 2018), published literature (Hampson, 1892,1893; Haruta, 1992,1993) and from moth websites of India (<https://www.mothsofindia.org>, <https://www.inaturalist.org/projects/moth>, <https://www.flickr.com/groups/mothsofindia/>). Besides, comparison of specimens at National Forest Insect Collection at FRI, Dehradun (<https://nfic.icfre.gov.in/>). The data on species abundance for each sampling (forest type, site, and season-wise) was pooled and compiled on an M.S. Excel sheet. Then, data were analyzed using open access software ‘PAST version 4.16c’ for both forests independently.



Fig. 2. Moths were attracted to the moth screen during sampling using a CFL lamp at different forest rest house in sampling sites.

RESULTS & DISCUSSION

- A total of 9252 individuals of 633 species of macro-moths belonging to 22 families, 69 sub-families and 435 genera were sampled and identified.
- Out of 633 species, ban oak forest recorded 480 species that belonging to 22 families, whereas sal forests recorded 231 species belonging to 18 families, The family Geometridae (162) was most dominant, followed by Erebiidae (132) in ban oak forests, but in sal forests Erebiidae (68) was the most dominant family, followed by Geometridae (48) (Fig. 3).
- The Shannon diversity index was higher in ban oak forests (Fig. 4 - 1.94) in comparison to sal forests (Fig. 4 - 1.84). In sal forest among four sites Naudi-Mundiapani had greater species diversity comparison to others sal forest sites. Whereas in ban oak forests Maheshkhan had higher species diversity than other sites.
- The species richness and abundance showed two seasonal peaks annually, in sal forests, the peaks occurred during ‘monsoon’ (Fig. 5 - August), followed by ‘post-monsoon’ (Fig. 5 - October), while in ban oak forests the first peak occurred earlier during ‘pre-monsoon’ (Fig. 5 - June) followed by a second peak during ‘early post-monsoon’ (Fig. 5 - September), respectively.
- Moth communities of sal forests were distinct from that of ban oak forests as all the sal forest sites (Fig. 6 - blue square) were separate from that of ban oak forest sites (Fig. 6 - red circle). There in Timli had significant difference in community structure with other 03 sal forest sites. In ban oak forest sites, all sites had a distinct moth community. All ban oak forest sites had more beta diversity.
- Moth communities of sal forests and ban oak forest are distinct from each other during all the three seasons. In the both sal and ban oak forests, the ‘post-monsoon’ season (Fig. 7 - tringle and circle) had a distinct community structure, however the moth community during the ‘monsoon’ and ‘pre-monsoon’ seasons were quite similar to each other in both forest types.

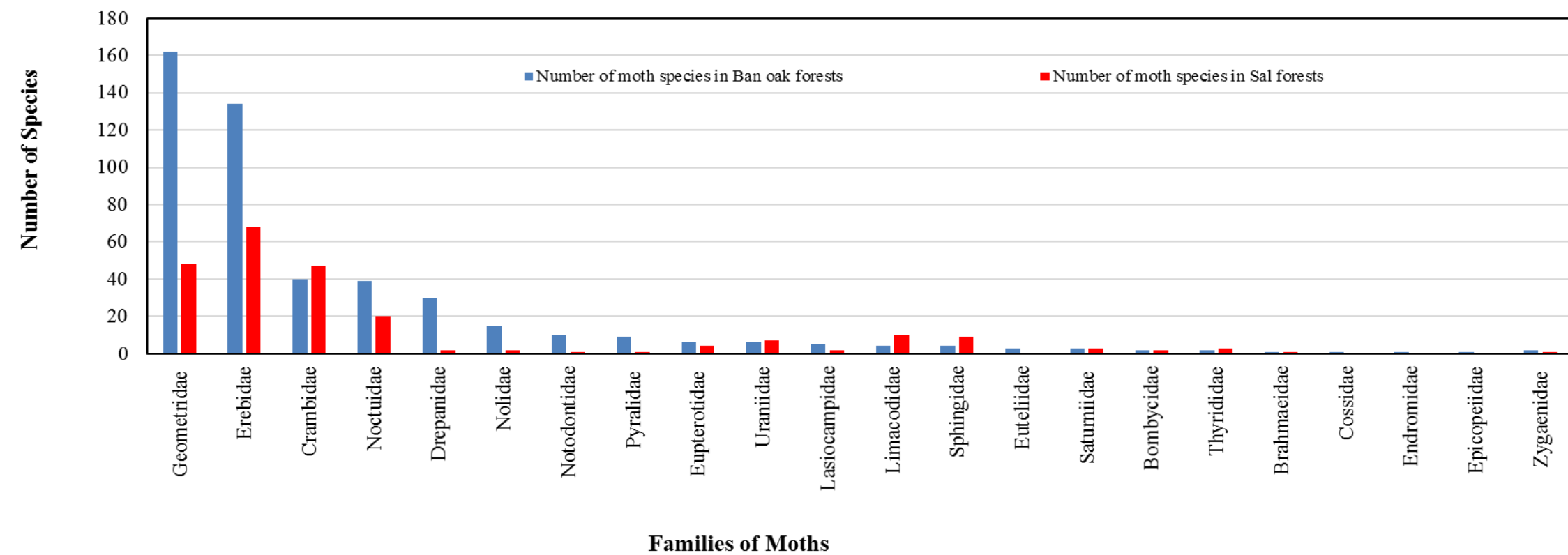


Fig. 3. Number of species in different families of moths both sal (*S. robusta*) and ban oak (*Q. leucotrichophora*) forests of Uttarakhand (Western Himalaya), India.

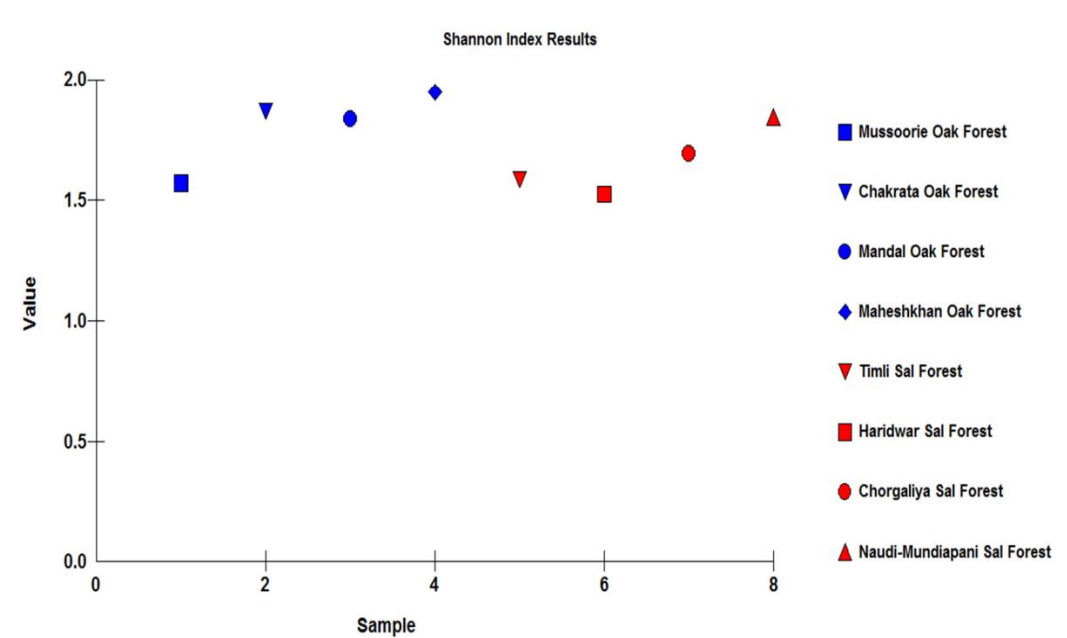


Fig. 4. Species diversity (Shannon index) of moths across different sites in both sal & ban oak forests of Uttarakhand, India during 2020–2023.

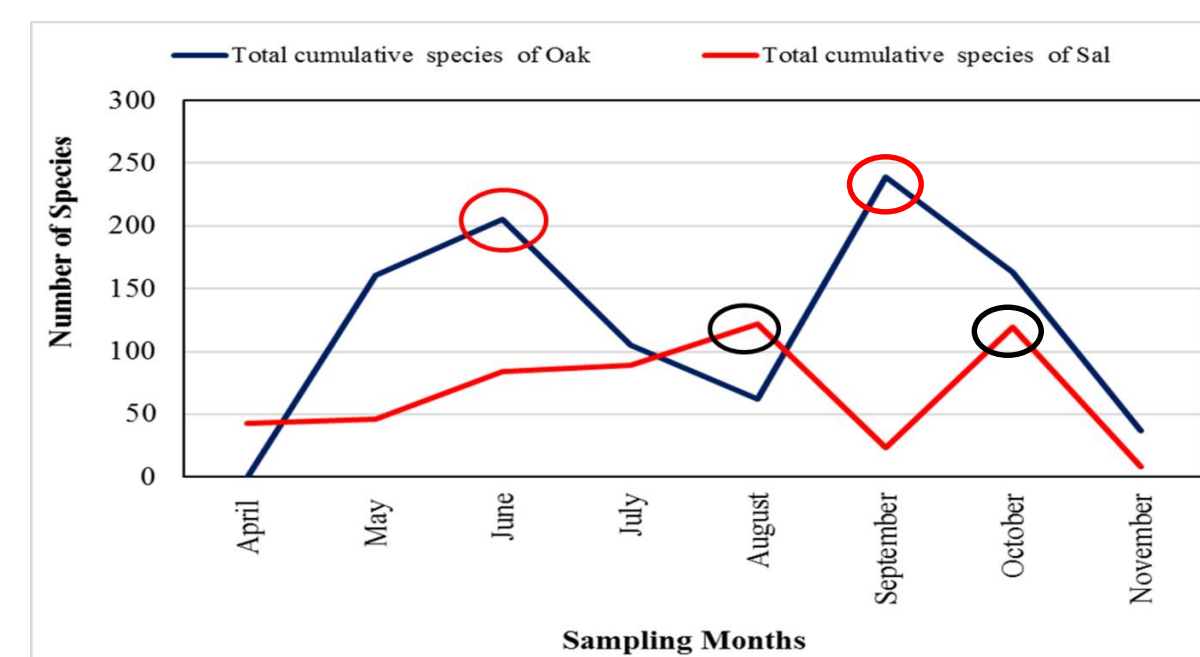


Fig. 5. Seasonality of number of moth species in flight across the year in both sal & ban oak forests of Uttarakhand.

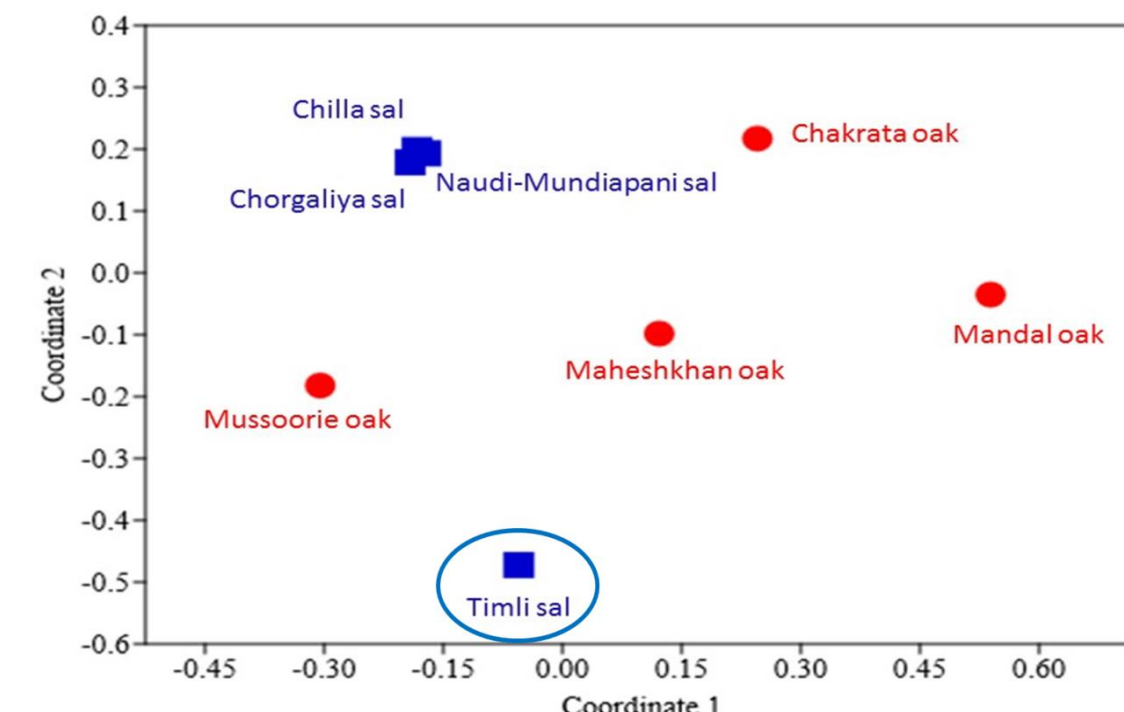


Fig. 6. Moth community structure across different sites of both sal and ban oak forests.

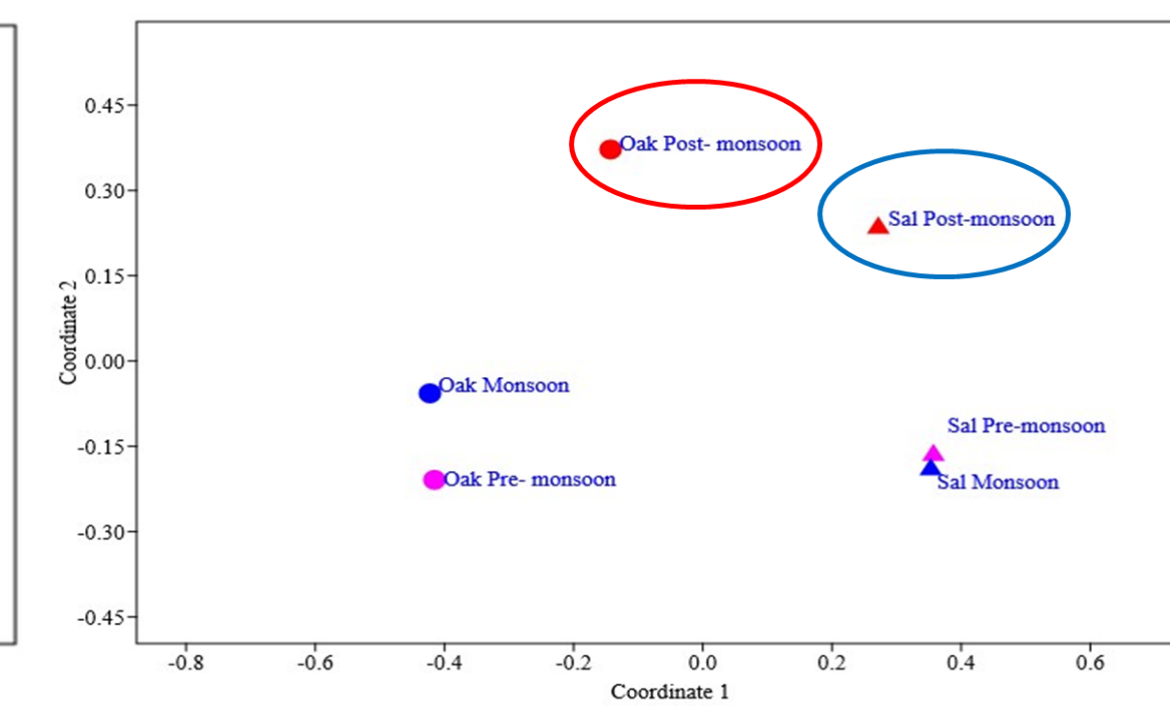


Fig. 7. Moth community structure across different seasons of both sal and ban oak forests.

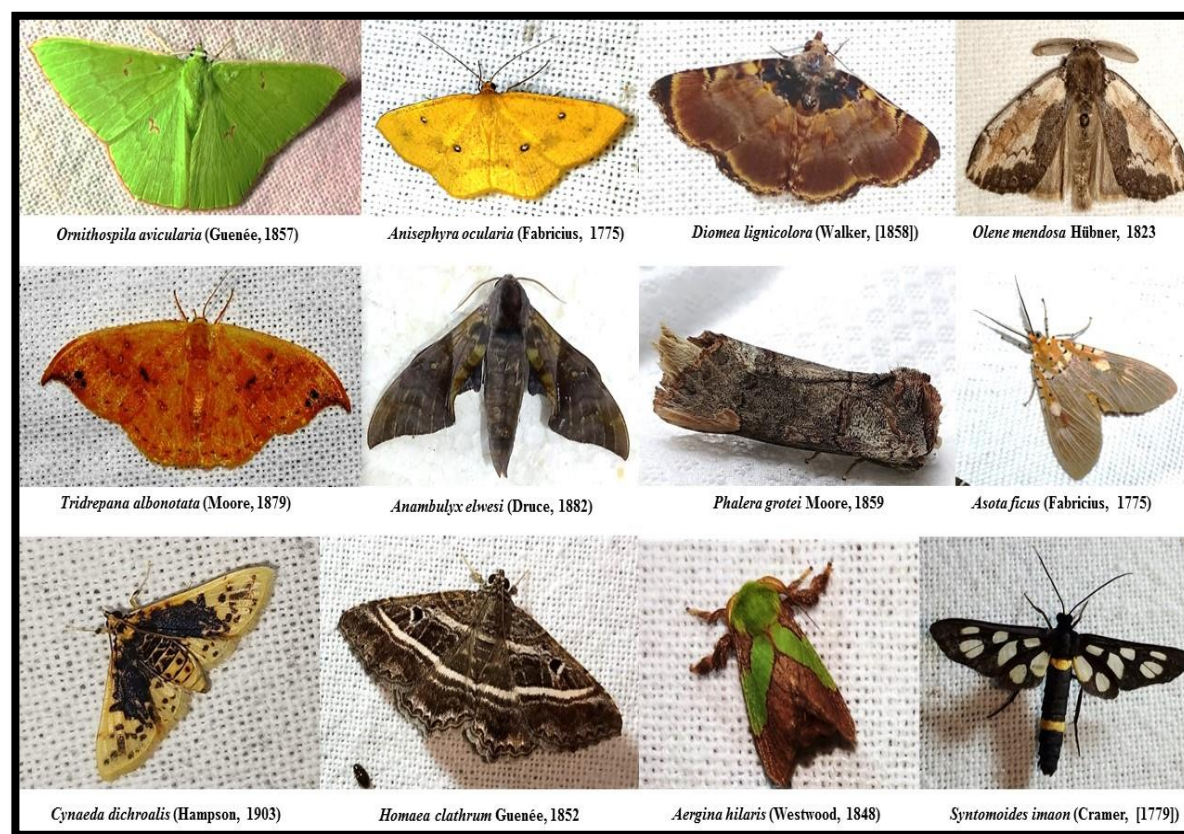


Image. 2. Unique moths of sal forests (*S. robusta*) of Uttarakhand, India.

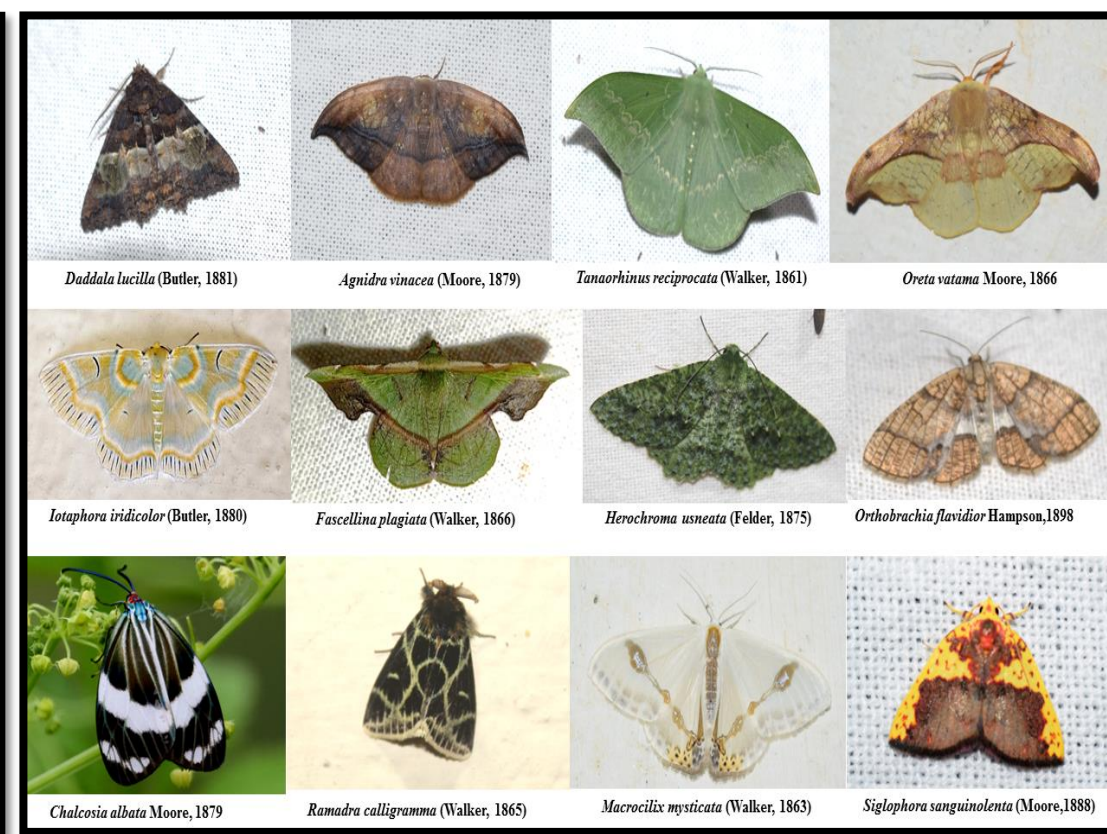


Image. 3. Unique moths of ban oak forests (*Q. leucotrichophora*) of Uttarakhand, India.

CONCLUSION

- This study identified distinct moth communities across these two mountain ranges of northern India, first one the ‘Shiwalik’ ranges (Sub-Himalaya) that are mainly ‘tropical’ typical of Peninsular India, south and south-east Asia, and the other lesser and greater Himalaya with typical ‘moist temperate forests’ that are spread across the entire Himalayan region from east to west.
- The study suggests that during specific season (post-monsoon), some of these forest sites (*i.e.* Mandal & Maheshkhan-ban oak forest; and Timli-sal forest) offer unique environmental conditions or resources that are particularly suited to certain moth species, study highlights the importance of complex interactions that occur throughout forest ecosystems and the value of preserving a variety of plant families and species for the conservation of native biodiversity-moth populations.
- These findings have an important consequence for managing ecosystems and conserving native biodiversity in both ‘Himalaya’ and ‘Shiwalik’ zoo-geographic sub-regions of northern India.

FUTURE WORK

- This study highlights the moth diversity and community structure in sal and ban oak forests of Uttarakhand (Western Himalaya) India. The study also provides a baseline data for supporting future studies in biodiversity, taxonomy, forest ecosystem and climate change.

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