Distribution and preliminary conservation assessments of commonly used forest species in the Nepalese Himalayas

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Balancing the trade-offs between biodiversity conservation and ecosystem service delivery is a colossal challenge in the areas of the globe with high productivity and high demand, such as in south Asia. In order to meet this challenge, we need enhanced knowledge of the species constituting these semi-natural systems. This paper reports the country-level preliminary conservation assessments for153 woody plant species from the Middle Hills in central Nepal based on the IUCN criteria. Distribution maps and threat categories are provided for all species. Ten species are categorized as Near Threatened, two as Endangered and one as Vulnerable. Conservation assessments could not be completed for 24species because of insufficient distribution data.

Key words: Species distribution, conservation assessments, forest species, Himalayas

In the global north, it is widely recognised that the conservation of semi-natural landscapes and their associated species are of paramount importance for the conservation of biodiversity, but these landscapes do not receive the same recognition in the global south. In south Asia, traditional semi-natural landscapes are still the backdrop for rural livelihoods, and cover large land areas. However, many of the region's traditional land uses are changing due to agricultural intensification or abandonment caused by socio-economic change (Sharma, 2016) in these tightly-linked social-ecological systems. Enhanced knowledge of the dynamics between land use and biodiversity will be critical for future successful biodiversity conservation and ecosystem service delivery. The shift towards a system's view where humans are seen as part of the system (Berkes, 2004; Folke, 2006; Sharma, 2016) will benefit both biodiversity conservation and ecosystem service delivery in Nepal and other countries in the region. A recent study on species diversity, forest structure, ecosystem services and forest management practices both in the community forests (CFs) and government managed forests (GMFs) at Panchase, situated towards the west of Pokhara (Måren *et al*., 2013) found that the CFs had greater species diversity and less degradation than the GMFs, which in practice acts as a resource which is open for unrestricted exploitation by all. The community forest user groups (CFUGs) at Panchase manage their forests so as to improve their condition by removing undesirable species in favour of the growth of the species with high value for fuel, fodder, fibre and medicine. However, it is not clear whether greater species diversity has any relationship with the numbers of rare species growing in the forest. Nepal's flora is believed to comprise around 7,000 species of flowering plants (Press *et. al*., 2000; Watson *et al*., 2011; Miehe *et al*., 2015), but only few of its species have been evaluated for their conservation status. The distribution data which are used to generate conservation assessments is derived primarily from herbarium specimens (Rich and Lewis, 1999; Antonovics *et al*., 2003), but these collections are very unevenly spread across Nepal (Watson *et al*., 2011), so the distribution patterns of most species are inadequately known.

In this study, we examined six locations in central Nepal, the three of which are within the Protected Areas (National Parks or Conservation Areas) and the rest three are outside the Protected Areas, in order to further examine the effects of different legal frameworks on maintenance of forest biodiversity. This paper reports the preliminary conservation assessments for all the species found in this study.

Materials and methods

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Study sites

Three forested areas in central Nepal ere studied, each with a study site within the protected area (National Park or Conservation Area) and an equivalent study site outside the protected area. These areas were Annapurna (Ghorepani inside the Annapurna Conservation Area and Panchase outside the protected area), the Kathmandu Valley (Shivapuri-Nagarjun National Park inside and Chandragiri outside the protected area) and Langtang (Langtang National Park inside and Bhalche outside the protected area) (see Figure 1). The study was conducted in the pre-monsoon season from February to June, 2010. Both the CFs and the GMFs (excluding plantations) were sampled using stratified random sampling. Sample plots of 10m×10m size were laid out across the study sites with similar the biophysical factors and elevation (see Måren *et al*. 2013 for further details). In each study site, equal numbers of plots (180) were sampled, totalling 540 plots in the three regions (six sites). Results from pH and loss on ignition (LOI) analyses indicated only small differences in the soil conditions of the sites and the regions.

In the mid-hills, Oak-Laurel forests are situated at higher elevations while the mixed *Schima-Castanopsis* forests are found at lower elevations. These forests differ considerably in their floristic composition and ecology (Dobremez, 1976). *Quercus semecarpifolia* Sm. is the dominant tree species in the Oak-Laurel forests with the species of laurel such as *Lindera pulcherrima* (Nees) Hook. f., *Neolitsea pallens* (D.Don) Momiy. & H. Hara ex H. Hara, *Machilus duthiei* King ex Hook. f. and *Machilus odoratissima* Nees. The Schima-Castanopsis forests are dominated by *Schima wallichii* (DC.) Korth., *Castanopsis indica* (Roxb.) Miq. and *Castanopsis tribuloides* (Sm.) A.DC.

Other species which are also commonly found in the mid-hill forests include several species of *Rhododendron*, *Acer* spp., *Prunus* spp., *Quercus glauca* Thunb., *Quercus lamellosa* Sm., *Quercus lanata* Sm., *Lyonia ovalifolia* (Wall.) Drude, *Eurya acuminate* DC., *Ilex dipyrena* Wall., *Symplocos ramosissima* Wall. ex G. Don and *Daphniphylum himalense* (Benth.) Mull. Arg. *Pinus wallichiana* A. B . Jacks. is found at the higher elevations while *Pinus roxburghii* Sarg. is noticed at the lower altitudes.

The less commonly occurring species include *Magnolia doltsopa* (Buch.-Ham. ex DC.) Figlar, *Taxus wallichiana* Zucc., *Edgeworthia gardneri* (Wall.) Meisn.etc. These forests are home to a number of important species of wildlife such as Himalayan black bear (*Ursus thibetanus*), tiger (*Panthera tigris*), Indian muntjak (*Muntiacus muntjak*), common leopard (*Panthera pardus*), jackal (*Canis aureus*) and several species of bats (Aryal and Dhungel, 2009; Miehe *et al*., 2015).

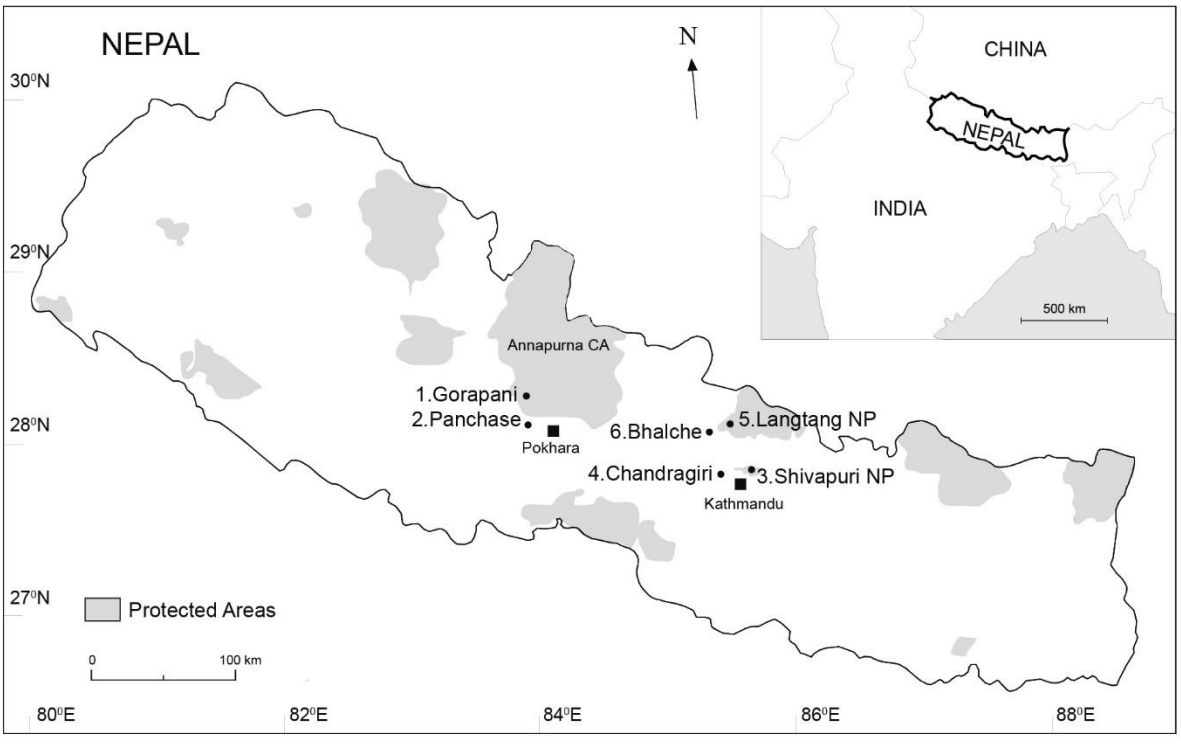

Figure 1: Map showing the localities of the six study sites within the three regions in central Nepal, the Himalayas.

Calculation of conservation assessments

The herbaria at the Royal Botanic Garden Edinburgh Herbarium (E), the Natural History Museum London (BM) and the National Herbarium and Plant Laboratories, Kathmandu (KATH) were consulted for specimens of the 153 woody species recorded during the study. All the specimens were photographed and data-based in the 'Padme database', which is used to manage all information for the Flora of Nepal project. Altogether, 4,374 herbarium specimens (1,927 specimens recorded from the E, 1,239 specimens from the BM and 1,208 from the KATH) together with the occurrence-records in the present study and unvouchered field records of the occurrences of the unambiguously identified common species in the 'Padme database' were used for the assessments. In addition to this, the distributions of species in the neighbour countries were also taken into consideration while assigning the categories. The assessments were based mostly on criteria B and A of the IUCN Categories and the criteria using extent of occurrence (EOO) and area of occupancy (AOO) plus evidence (or inferring) of decline in the habitat (IUCN, 2016). Species which are very close to qualifying or likely to qualify for a threatened category (critically endangered, endangered or vulnerable) in the near future were categorised as Near Threatened (NT). Evidence of population size and/or reduction was, generally, not available. The EOO was calculated using GeoCAT (Bachman *et al*. 2011; http://geocat.kew.org/) while the AOO using a facility in the 'Padme database'.

Results and discussion

One hundred and fifty-three woody plant species were recorded from the six study sites, comprising80species of trees, 48shrubs and 25woody climbers (see Annex I attached at the back). The highest species richness of trees and climbers were recorded at the Annapurna sites (trees 53; climbers 21), followed by the Kathmandu Valley (trees 44; climbers 18) and the Langtang sites (trees 26; climbers 11). There was a greater diversity of shrubs in the Kathmandu sites (30) and the Annapurna sites (30) followed by the Langtang sites (16). The most commonly recorded family was Rosaceae (26 species) followed by Lauraceae (9 species), Fagaceae and Ericaceae (both 7 species).

Preliminary conservation assessment

Two species, *Taxus wallichiana* Zucc. and *Hoya edenii* King ex Hook. f. were categorised as 'Endangered' (EN), one species, *Hypericum cordifolium* Choisy as' Vulnerable' (VU), ten species as 'Near Threatened' (NT) and 116 species as 'Least Concern' (LS). There were insufficient data to calculate conservation assessments for 24 species, and so those species were categorised as 'Data Deficient' (DD, see Table 1). The complete list of the species (trees, shrubs and climbers) found in the study sites along with their preliminary conservation assessments is presented in Annex I.

Table 1: Preliminary conservation assessments based on the IUCN criteria for 153woody plant species recorded at the Ghorepani, Panchase, Shivapuri, Chandragiri, Langtang and Bhalche sites in central Nepal

Data Deficient (DD)	Least Concern (LC)	Near Threatened (NT)	Vulnerable (VU)	Endangered (EN)	Critically Endangered (CE)
24	116	10	1	2	0

Tree species: Among the 80 species of trees, seven were categorised as 'Near Threatened' (NT) based on the IUCN criteria; the species being *Abies spectabilis* (D.Don) Mirb., *Acer caudatum* Wall., *Aesculus indica* (Colebr. ex Cambess.) Hook., *Camellia kissi* Wall., *Eriobotrya elliptica* Lindl., *Euonymus pendulus* Wall. and *Litsea doshia* (D.Don) Kosterm. *Taxus wallichiana* is the only tree species listed as 'EN' (A2 a, c, d). The population of this species is decreasing at an alarming rate because of commercial demand (Liu *et al*., 2011; Poudel *et al*., 2012; Gajurel *et al*., 2013), and it has been listed in the CITES Appendix 2 since 1995. Fifty eight species were fairly well distributed, and were categorized as 'LC' while 14 species were placed under 'DD'.

Shrubs: One species, *Hypericum cordifolium* Choisy was recorded as 'VU' (B1 a, b). Three species, *Daphne bholua* Buch.-Ham. ex D.Don, *Daphne papyracea* Wall. ex Steud. and *Edgeworthia gardneri* (Wall.) Meisn. were recorded as 'NT' while thirty-seven species fell into 'LC' category, and seven were categorized as 'DD'.

Climbers: One species, *Hoya edenii* King ex Hook. f. was assessed as 'EN', (B1 a, b) while 21were recorded as 'LC', and three were categorized as 'DD'.

Conclusion

This study clearly reflects the limitations of the data which are currently available. Almost 15% of the species were classified as 'Data Deficient' as their distributions were too poorly known to confidently assign them to any category. Several of these species have very limited distributions, and are known only from a few specimens, and so it is quite possible that a significant number of them are actually under threat of depletion or extinction. Looking at the maps of some of the common species, such as *Pinus roxburghii* and *P. Wallichiana* (see Annex II), it is evident that these species are certainly under-recorded andthe dataset is insufficient to make accurate conservation assessments for these species. Clearly, more distribution records are needed before we can be certain of the conservation status of these commonly occurring and widely utilized Nepalese woody plants.

Many natural resource systems, here exemplified by forests, fall under collective management or are subject to use by multiple individuals, often for a variety of purposes (Poteete and Ostrom, 2004). Sustaining these resources in the face of economic and demographic pressures depends upon an array of interdependent components including legislation and local engagement. In order to facilitate evidence-based natural resource management, we need to enhance our knowledge regarding the species richness, composition and dynamics of these systems. Pandey (2007) found comparatively higher species richness in the community forests than in the national parks and government forests he investigated, and in the sacred groves of the Western Ghats of India. Bhagwat *et al*. (2005) found informal protection traditions to contribute to successful biodiversity conservation. We see similar trends in some of our material; however, we cannot see this as an overriding trend for the dataset as a whole. In other words, these dynamics within social-ecological systems are context-dependent which call for enhanced knowledge in order to manage both ecosystem service delivery to the local people, and contribute to biodiversity conservation.

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References

Antonovics, J., Hood, M.E., Thrall, P.H., Abrams, J.Y.and Duthie, G.M. 2003. Herbarium studies on the distribution of anther-smut fungus (*Microbotryum violaceum*) and *Silene* species (Caryophyllaceae) in the eastern United States. *American Journal of Botany* **90:** 1522–1531. doi:10.3732/ajb.90.10.1522 accessed on June 14, 2016.

Aryal, A. and Dhungel, S.K. 2009.Species diversity and distribution of bats in Panchase region of Nepal. *Tigerpaper* **36 (2):** 14–18

Bachman, S., Moat, J., Hill, A.W., de la Torre, J. and Scott, B. 2011.Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. *ZooKeys* **150:** 117–126. http://dx.doi.org/ 10.3897/zookeys.150.2109 accessed on June 14, 2016.

Berkes, F. 2004. Rethinking community-based conservation. *Conservation Biology* **18 (3):** 621–630.

Bhagwat, S.A., Kushalappa, C.G., Williams, P.H. and Brown, N.D. 2005. The role of informal protected areas in maintaining biodiversity in the Western Ghats of India. *Ecology and Society***10:** 8.

Dobremez, J. F. 1976. **Le Nepal: Ecologieet Biogeographie**. Centre National de la Recherche Scientifique, Paris.

Folke, C. 2006. Resilience: The emergence of a perspective forsocial-ecological systems analyses. *Global Environmental Change* **16:** 253–267.

Gajurel, J. P., Cornejo, C., Werth, S., Shrestha, K. K. and Scheidegger, C. 2013.Development and characterization of microsatellite loci in the endangered species *Taxus wallichiana* (Taxaceae). *Applications in Plant Sciences* **1 (3):** 1200281. http://doi.org/10.3732/apps.1200281 accessed on July 18, 2016.

IUCN. 2016. Guidelines for Using the IUCN Red List Categories and Criteria, Version 12. Prepared by the Standards and Petitions Subcommittee, The International Union for Conservation of Nature. http://www.iucnredlist.org/documents/RedListGuidelines.pdf accessed on December 14, 2016.

Liu J., Gao, L.M., Li, D.Z., Zhang, D.Q. and Moller, M. 2011. Cross-species amplification and development of new microsatellite loci for *Taxus wallichiana* (Taxaceae). *American Journal of Botany* **98:** e70–e73.

Måren, I., Bhattarai, K.R. and Chaudhary, R.P. 2013. Forest ecosystem services and biodiversity in contrasting Himalayan forest management systems Environmental Conservation, published online doi:10.1017/S0376892913000258 accessed on October 15, 2016.

Miehe, G., Pendry, C.A. and Chaudhary, R. 2015**. Nepal: An introduction to the natural history, ecology, and human environment of the Himalayas**. Edinburgh: Royal Botanic Garden Edinburgh.

Pandey, S.S. 2007. Tree species diversity in existing community-based forest management systems in central mid-hills of Nepal. Uppsala, Sweden: Swedish Biodiversity Centre. Swedish University of Agricultural Sciences.

Poteete, A. R. and Ostrom, E. 2004. Heterogeneity, Group Size and Collective Action: The Role of Institutions in Forest Management. *Development and Change* **35:** 435–461. doi:10.1111/j.1467-7660.2004.00360.x accessed on January 9, 2017.

Poudel, R.C., Möller, M., Gao, L.M., Ahrends, A., Baral, S.R., Liu, J., Thomas, P. and Li, D.Z. 2012. Using Morphological, Molecular and Climatic Data to Delimitate Yews along the Hindu Kush-Himalaya and Adjacent Regions. *PLoS ONE* **7 (10):** e46873.
doi: 10.1371/journal.pone.0046873 accessed on December 16, 2016

Press, J. R., Shrestha, K. K. and Sutton, D. A. 2000. **Annotated Checklist of the Flowering Plants of Nepal**. London: The Natural History Museum.

Rich, T.C.G. and Lewis, J. 1999.Use of herbarium material for mapping the distribution of *Erophila* (Brassicaceae) taxa sensu Filfilan and Elkington in Britain and Ireland. *Watsonia* **22:** 377–385.

Sharma, L.N. 2016. The disturbance-diversity relationship: integrating biodiversity conservation and resource management in anthropogenic landscapes. PhD Thesis, Department of Biology, University of Bergen, Norway.

Annex I. List of the species recorded in the Annapurna (A) Region (Panchase and Ghorepani), the Kathmandu (K) Valley Region (Chandragiri and Shivapuri) and the Langtang (L) Region (Bhalche and Langtang], and their preliminary conservation assessment

SN	Scientific name	Family	Recorded from			P. Con. Asses.
			A	K	L	
	TREES					
1	*Abies spectabilis* (D.Don) Mirb	Pinaceae	✓			Near Threatened (NT)
2	*Acer caesium* Wall. ex Brandis	Sapindaceae	✓			Data Deficient (DD)
3	*Acer campbellii* Hook. f. & Thomson ex Hiern	Sapindaceae			✓	Least Concern (LC)
4	*Acer caudatum* Wall.	Sapindaceae	✓			Near Threatened (NT)
5	*Acer sterculiaceum* Wall.	Sapindaceae	✓			Least Concern (LC)
6	*Actinodaphne angustifolia* Nees	Lauraceae	✓			Data Deficient (DD)
7	*Actinodaphne sikkimensis* Meisn.	Lauraceae	✓			Data Deficient (DD)
8	*Aesculus indica* (Colebr. ex Cambess.) Hook	Sapindaceae	✓			Near Threatened (NT)
9	*Alnus nepalensis* D.Don	Betulaceae	✓			Least Concern (LC)
10	*Benthamidia capitata* (Wall.) H. Hara	Cornaceae			✓	Least Concern (LC)
11	*Betula alnoides* Buch.-Ham. ex D.Don	Betulaceae	✓	✓	✓	Data Deficient (DD)
12	*Camellia kissi* Wall.	Theaceae	✓	✓		Near Threatened (NT)
13	*Carpinus viminea* Lindl.	Betulaceae		✓		Least Concern (LC)
14	*Castanopsis tribuloides* (Sm.) A.DC.	Fagaceae		✓		Least Concern (LC)
15	*Cotoneaster frigidus* Wall. exLindl.	Rosaceae			✓	Least Concern (LC)
16	*Daphniphyllum himalense* (Benth.) Mull. Arg.	Daphniphyllaceae	✓	✓	✓	Least Concern (LC)
17	*Deutzia staminea* R. Br. ex Wall.	Hydrangeaceae	✓			Least Concern (LC)
18	*Dodecadenia grandiflora* Nees	Lauraceae	✓	✓		Least Concern (LC)
19	*Elaeagnus parvifolia* Wall. ex Royle	Elaeagnaceae	✓	✓	✓	Least Concern (LC)
20	*Eriobotrya dubia* (Lindl.) Decne.	Rosaceae		✓	✓	Data Deficient (DD)
21	*Eriobotrya elliptica* Lindl.	Rosaceae			✓	Near Threatened (NT)
22	*Euonymus pendulus* Wall.	Celestraceae		✓	✓	Near Threatened (NT)
23	*Eurya acuminate* DC.	Pentaphylacaceae	✓	✓	✓	Least Concern (LC)
24	*Euryacer asifolia* (D.Don) Kobuski	Pentaphylacaceae	✓	✓		Least Concern (LC)
25	*Ficus neriifolia* Sm.	Moraceae		✓	✓	Least Concern (LC)
26	*Ficus pumila* L.	Moraceae	✓			Data Deficient (DD)
27	*Fraxinus floribund* Wall.	Oleaceae	✓			Least Concern (LC)
28	*Garuga pinnata* Roxb.	Burseraceae		✓		Data Deficient (DD)
29	*Hydrangea heteromalla* D.Don	Hydrangeaceae			✓	Least Concern (LC)
30	*Ilex dipyrena* Wall.	Aquifoliaceae	✓	✓	✓	Least Concern (LC)
31	*Juglans regia* L.	Juglandaceae	✓			Least Concern (LC)
32	*Leucosceptrum canum* Sm.	Lamiaceae			✓	Least Concern (LC)
33	*Ligustrum confusum* Decne.	Oleaceae	✓	✓		Data Deficient (DD)
34	*Lindera pulcherrima* (Nees) Hook. f.	Lauraceae	✓	✓	✓	Least Concern (LC)
35	*Litsea doshia* (D.Don) Kosterm.	Lauraceae		✓	✓	Near Threatened (NT)
36	*Lyonia ovalifolia* (Wall.) Drude	Ericaceae	✓	✓	✓	Least Concern (LC)
37	*Lyonia villosa* (Hook. f.) Hand.-Mazz.	Ericaceae		✓		Least Concern (LC)
38	*Macaranga pustulata* King ex Hook. f.	Euphorbiaceae	✓			Least Concern (LC)
39	*Machilus clarkeana* King ex Hook. f.	Lauraceae	✓			Data Deficient (DD)
40	*Machilus duthiei* King ex Hook. f.	Lauraceae	✓	✓	✓	Least Concern (LC)
41	*Machilus odoratissima* Nees	Lauraceae	✓	✓		Least Concern (LC)

42	*Magnolia doltsopa* (Buch.-Ham. ex DC.) Figlar	Magnoliaceae	✓	✓		Data Deficient (DD)
43	*Maytenus rufa* (Wall.) H. Hara	Celastraceae		✓		Least Concern (LC)
44	*Myrica esculenta* Buch.-Ham. ex D.Don	Myricaceae	✓	✓	✓	Least Concern (LC)
45	*Myrsine semiserrata* Wall.	Primulaceae	✓	✓	✓	Least Concern (LC)
46	*Neolitsea pallens* (D.Don) Momiy. & H. Hara ex H. Hara	Lauraceae	✓	✓	✓	Least Concern (LC)
47	*Osmanthus fragrans* Lour.	Oleaceae	✓			Data Deficient (DD)
48	*Photinia integrifolia* Lindl.	Rosaceae		✓		Least Concern (LC)
49	*Pieris formosa* (Wall.) D.Don	Ericaceae	✓	✓	✓	Least Concern (LC)
50	*Pinus roxburghii* Sarg.	Pinaceae	✓	✓		Least Concern (LC)
51	*Pinus wallichiana* A.B.Jacks.	Pinaceae		✓		Least Concern (LC)
52	*Prunus cerasoides* D.Don	Rosaceae	✓	✓	✓	Least Concern (LC)
53	*Prunus cornuta* (Wall. ex Royle) Steud.	Rosaceae	✓			Least Concern (LC)
54	*Prunus napaulensis* (Ser.) Steud.	Rosaceae	✓			Data Deficient (DD)
55	*Prunus rufa* Hook. f.	Rosaceae		✓		Least Concern (LC)
56	*Prunus undulata* Buch.-Ham. ex D.Don	Rosaceae	✓			Least Concern (LC)
57	*Pyrularia edulis* (Wall. ex Roxb.) DC.	Santalaceae	✓		✓	Least Concern (LC)
58	*Pyrus pashia* Buch.-Ham. ex D.Don	Rosaceae	✓		✓	Least Concern (LC)
59	*Quercus glauca* Thunb.	Fagaceae		✓	✓	Least Concern (LC)
60	*Quercus lamellosa* Sm.	Fagaceae	✓	✓	✓	Data Deficient (DD)
61	*Quercus lanata* Sm.	Fagaceae		✓	✓	Least Concern (LC)
62	*Quercus semecarpifolia* Sm.	Fagaceae	✓	✓	✓	Least Concern (LC)
63	*Rhamnus purpureus* Edgew.	Rhamnaceae	✓			Least Concern (LC)
64	*Rhododendron arboretum* Sm.	Ericaceae	✓	✓	✓	Least Concern (LC)
65	*Rhododendron barbatum* Wall. ex G. Don	Ericaceae	✓			Least Concern (LC)
66	*Rhododendron campanulatum* D.Don	Ericaceae	✓			Least Concern (LC)
67	*Rhus javanica* Miller	Anacardiaceae			✓	Least Concern (LC)
68	*Rhus succedanea* L.	Anacardiaceae	✓	✓		Least Concern (LC)
69	*Salix obscura* Andersson	Salicaceae	✓			Data Deficient (DD)
70	*Saurauia napaulensis* DC.	Actinidiaceae		✓		Least Concern (LC)
71	*Schima wallichii* (DC.) Korth.	Theaceae		✓		Least Concern (LC)
72	*Skimmia arborescens* T. Anderson ex Gamble	Rutaceae		✓		Least Concern (LC)
73	*Sorbus vestita* (Wall. ex G.Don) Lodd.	Rosaceae	✓		✓	Least Concern (LC)
74	*Symplocos ramosissima* Wall. ex G.Don	Symplocaceae	✓	✓	✓	Least Concern (LC)
75	*Symplocos theifolia* D.Don	Symplocaceae	✓	✓		Least Concern (LC)
76	*Taxu swallichiana* Zucc.	Taxaceae	✓			Endangered (EN)
77	*Tsuga dumosa* (D.Don) Eichler	Pinaceae	✓			Least Concern (LC)
78	*Viburnum erubescens* Wall. ex DC.	Adoxaceae	✓	✓	✓	Least Concern (LC)
79	*Viburnum grandiflorum* Wall. ex DC.	Adoxaceae			✓	Least Concern (LC)
80	*Zizyphus incurva* Roxb.	Rhamnaceae		✓	✓	Least Concern (LC)

SHRUBS/BUSHES

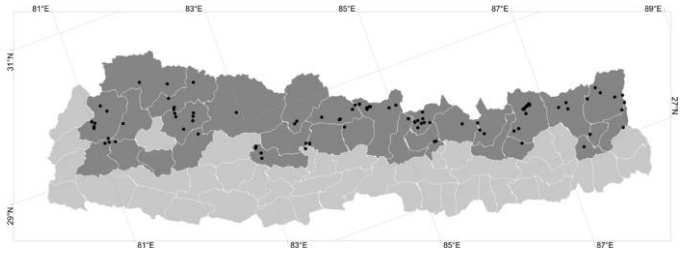
1	*Eleutherococcus cissifolius* (Griff. ex Seem.) Harms	Araliaceae	✓	✓		Least Concern (LC)
2	*Arundinaria maling* Gamble	Poaceae	✓	✓		Data Deficient (DD)
3	*Berberis aristata* DC.	Berberidaceae	✓	✓	✓	Least Concern (LC)
4	*Berberis asiatica* Roxb. ex DC.	Berberidaceae	✓	✓		Least Concern (LC)
5	*Berberis insignis* Hook. f. & Thomson	Berberidaceae		✓		Least Concern (LC)
6	*Berberis napaulensis* (DC.) Laferr.	Berberidaceae	✓	✓	✓	Least Concern (LC)
7	*Berberis wallichiana* DC.	Berberidaceae	✓			Least Concern (LC)
8	*Boenninghausenia albiflora* (Hook.) Rchb.	Rutaceae	✓	✓		Least Concern (LC)

	ex Meisn.					
9	*Colebrookea oppositifolia* Sm.	Lamiaceae		✓		Least Concern (LC)
10	*Colquhounia coccinea* Wall.	Lamiaceae		✓		Least Concern (LC)
11	*Cotoneaster acuminatus* Lindl.	Rosaceae	✓	✓		Least Concern (LC)
12	*Cotoneaster microphyllus* Wall. ex Lindl.	Rosaceae	✓	✓		Least Concern (LC)
13	*Daphne bholua* Buch.-Ham. ex D.Don	Thymelaeaceae	✓	✓	✓	Near threatened (NT)
14	*Daphne papyracea* Wall. ex Steud.	Thymelaeaceae	✓	✓		Near threatened (NT)
15	*Desmodium elegans* DC.	Leguminosae		✓		Least Concern (LC)
16	*Desmodium multiflorum* DC.	Leguminosae		✓		Least Concern (LC)
17	*Drepanostachyum falcatum* (Nees) Keng f.	Poaceae	✓			Data Deficient (DD)
18	*Edgeworthia gardneri* (Wall.) Meisn.	Thymelaeaceae			✓	Near threatened (NT)
19	*Gaultheria fragrantissima* Wall.	Ericaceae		✓	✓	Least Concern (LC)
20	*Hypericum cordifolium* Choisy	Hypericaceae		✓		Vulnerable (VU)
21	*Hypericum hookeranum* Wight&Arn.	Hypericaceae	✓	✓	✓	Least Concern (LC)
22	*Indigofera heterantha* Wall. ex Brandis	Leguminosae		✓	✓	Least Concern (LC)
23	*Inula cappa* (Buch.-Ham. ex D.Don) DC.	Compositae		✓		Least Concern (LC)
24	*Lonicera ligustrina* Wall.	Caprifoliaceae	✓			Data Deficient (DD)
25	*Maesa chisia* Buch.-Ham. ex D.Don	Primulaceae	✓			Least Concern (LC)
26	*Mussa endatreutleri* Stapf	Rubiaceae	✓			Least Concern (LC)
27	*Neillia rubiflora* D.Don	Rosaceae	✓			Least Concern (LC)
28	*Phyllanthus clarkei* Hook. f.	Euphorbiaceae		✓	✓	Least Concern (LC)
29	*Piptanthus nepalensis* (Hook.) D.Don	Leguminosae	✓			Least Concern (LC)
30	*Prinsepia utilis* Royle	Rosaceae	✓			Least Concern (LC)
31	*Randia tetrasperma* (Roxb.) Benth. & Hook. f. ex Brandis	Rubiaceae	✓	✓		Least Concern (LC)
32	*Ribesacum inatum* Wall. ex G. Don	Grossulariaceae	✓			Least Concern (LC)
33	*Rosa brunonii* Lindl.	Rosaceae	✓		✓	Least Concern (LC)
34	*Rosa macrophylla* Lindl.	Rosaceae	✓			Least Concern (LC)
35	*Rosa sericea* Lindl.	Rosaceae			✓	Least Concern (LC)
36	*Rubus calycinus* Wall. ex D.Don	Rosaceae				Least Concern (LC)
37	*Rubus ellipticus* Sm.	Rosaceae	✓	✓	✓	Data Deficient (DD)
38	*Rubus pentagonus* Wall. ex Focke	Rosaceae	✓			Least Concern (LC)
39	*Rubus sumatranus* Miq.	Rosaceae		✓		Data Deficient (DD)
40	*Sarcococca saligna* (D.Don) Mull. Arg.	Buxaceae	✓	✓		Data Deficient (DD)
41	*Sarcococca wallichii* Stapf	Buxaceae	✓	✓		Least Concern (LC)
42	*Spiraea canescens* D.Don	Rosaceae			✓	Data Deficient (DD)
43	*Swidao blonga* (Wall.) Sojak	Cornaceae	✓			Least Concern (LC)
44	*Viburnum cylindricum* Buch.-Ham. ex D.Don	Sambucaceae		✓	✓	Least Concern (LC)
45	*Viburnum mullaha* Buch.-Ham. ex D.Don	Sambucaceae		✓	✓	Least Concern (LC)
46	*Wikstroemia canescens* Meisn.	Thymelaeaceae		✓		Least Concern (LC)
47	*Zanthoxylum armatum* DC.	Rutaceae	✓	✓	✓	Least Concern (LC)
48	*Zanthoxylum oxyphyllum* Edgew.	Rutaceae	✓	✓	✓	Least Concern (LC)
	WOODY CLIMBERS					
1	*Ampelocissus rugosa* (Wall.) Planch.	Vitaceae		✓		Least Concern (LC)
2	*Aristolochia griffithii* Hook. f. & Thoms. Ex Duch.	Aristolochiaceae	✓	✓	✓	Least Concern (LC)
3	*Ceropegia longifolia* Wall.	Apocyanaceae	✓	✓	✓	Data Deficient (DD)
4	*Cissampelos pareira* L.	Menispermaceae			✓	Least Concern (LC)
5	*Clematis connata* DC.	Ranunculaceae	✓			Least Concern (LC)
6	*Clematis montana* Buch.-Ham. ex DC.	Ranunculaceae	✓			Least Concern (LC)
7	*Cochlianthus gracilis* Benth.	Leguminoceae	✓			Data Deficient (DD)
8	*Euonymus echinatus* Wall.	Celastraceae	✓	✓		Least Concern (LC)

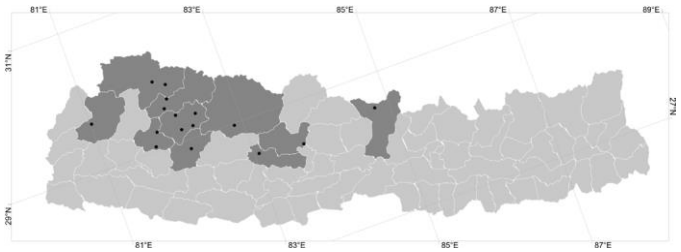
9	*Hedera nepalensis* K.Koch	Araliaceae	✓	✓	✓	Least Concern (LC)
10	*Hedyotis scandens* Roxb.	Rubiaceae		✓		Data Deficient (DD)
11	*Holboellia latifolia* Wall.	Lardizabalaceae	✓	✓	✓	Least Concern (LC)
12	*Hoya edenii*King ex Hook. f.	Apocyanaceae	✓	✓		Endangered (EN)
13	*Jasminum humile* L.	Oleaceae	✓	✓		Least Concern (LC)
14	*Jasminum officinale* L.	Oleaceae	✓	✓		Least Concern (LC)
15	*Piper mullesua* Buch.-Ham. ex D.Don	Piperaceae	✓	✓		Least Concern (LC)
16	*Rubia manjith* Roxb. ex Fleming	Rubiaceae	✓	✓	✓	Least Concern (LC)
17	*Rubus acuminatus* Sm.	Rosaceae		✓		Least Concern (LC)
18	*Rubus paniculatus* Sm.	Rosaceae	✓	✓	✓	Least Concern (LC)
19	*Sabia campanulata* Wall. ex Roxb.	Sabiaceae	✓	✓		Least Concern (LC)
20	*Schisandra grandiflora* (Wall.) Hook. f. & Thomson	Schisandraceae	✓			Least Concern (LC)
21	*Smilax aspera* L.	Smilacaceae	✓		✓	Least Concern (LC)
22	*Smilax elegans* Wall. ex Kunth	Smilacaceae		✓	✓	Least Concern (LC)
23	*Smilax ferox* Wall. ex Kunth	Smilacaceae	✓	✓	✓	Least Concern (LC)
24	*Smilax menispermoidea* A. DC.	Smilacaceae	✓			Least Concern (LC)
25	*Tetrastigma serrulatum* (Roxb.) Planch.	Vitaceae	✓	✓	✓	Least Concern (LC)

AnnexII: Distribution maps of the species recorded from the three Mid-hills regions of Nepal, based on the herbarium specimens deposited at the RBGE, BM and KATH

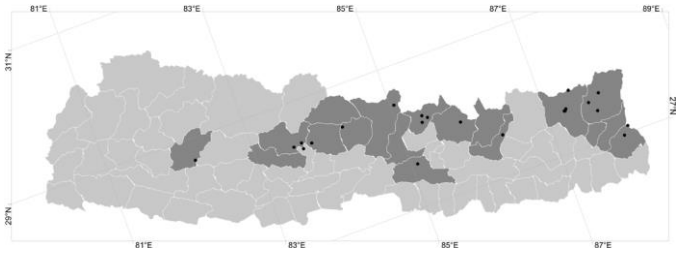
Trees



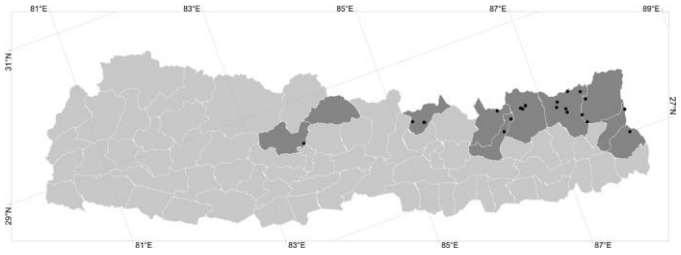
Abies spectabilis



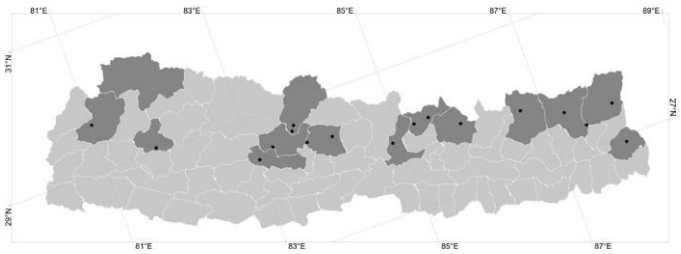
Acer caesium



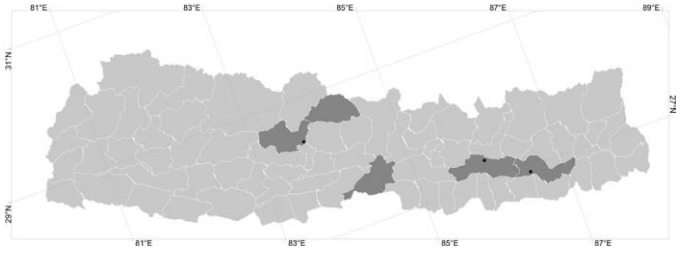
Acer campbellii



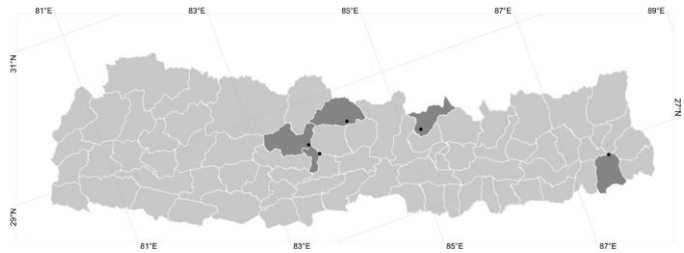
Acer caudatum



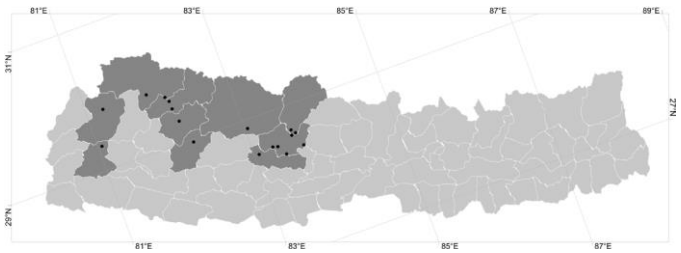
Acer sterculiaceum



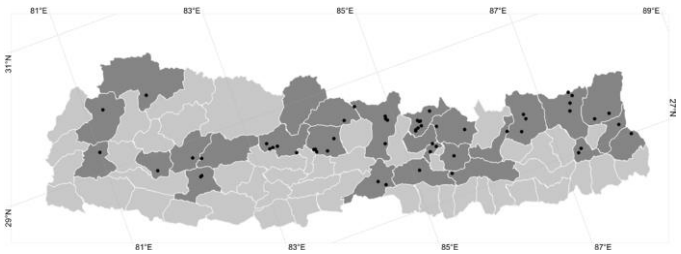
Actinodaphne angustifolia



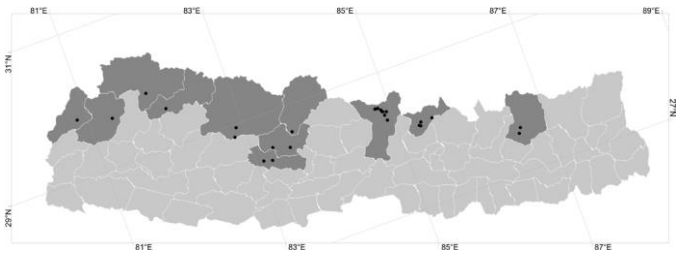
Actinodaphne sikkimensis



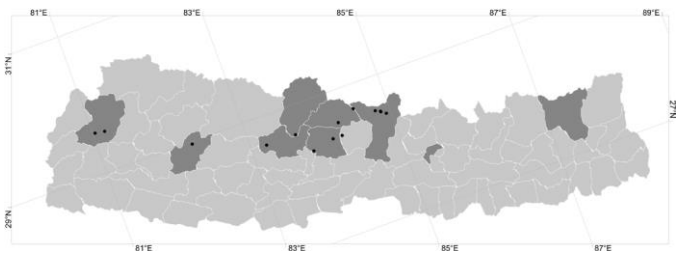
Aesculus indica



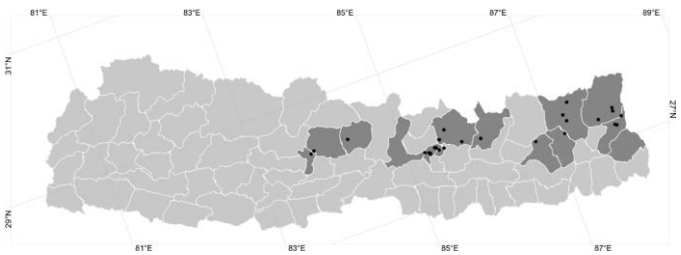
Alnus nepalensis



Benthamidia capitata

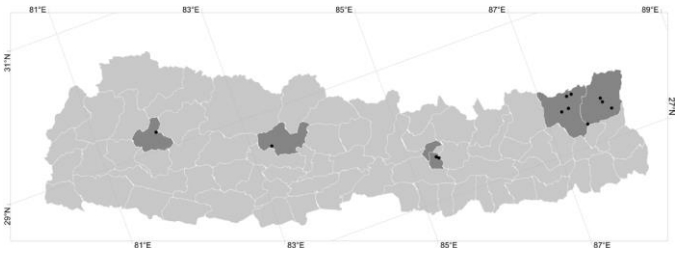


Betula alnoides

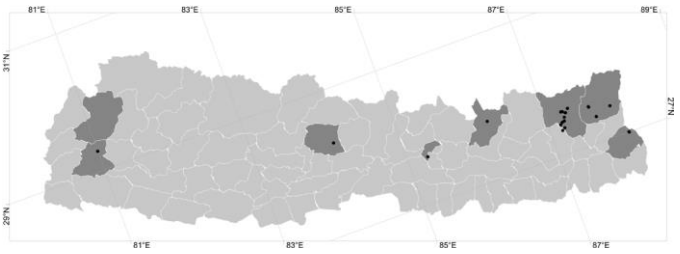


Camellia kissi

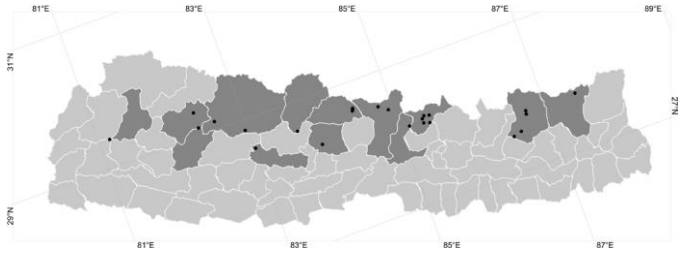
Trees



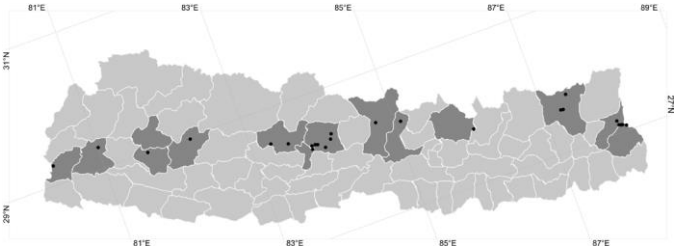
Carpinus viminea



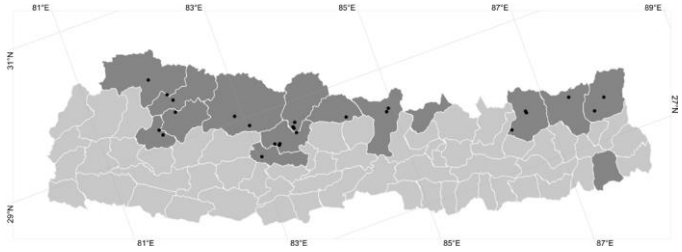
Castanopsis tribuloides



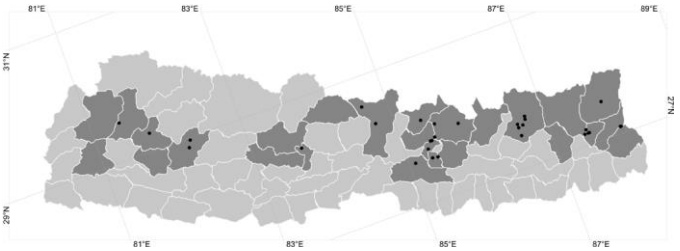
Cotoneaster frigidus



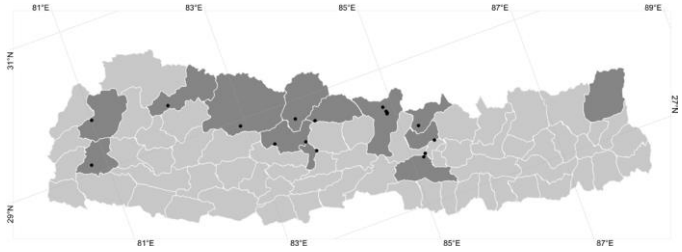
Daphniphyllum himalense



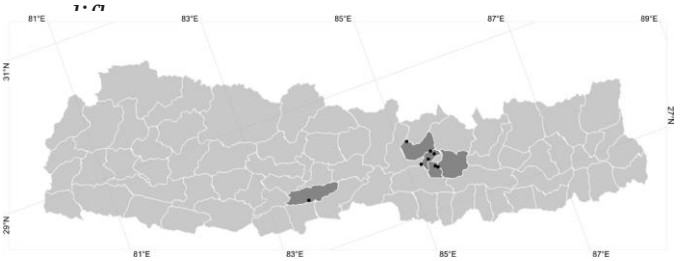
Deutzia staminea



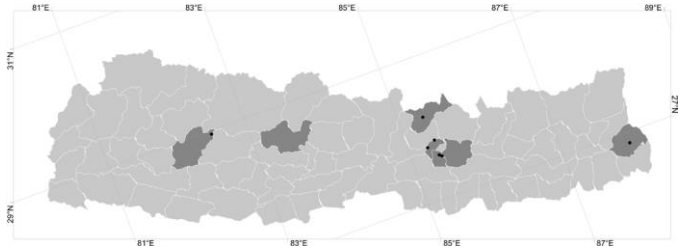
Dodecadenia



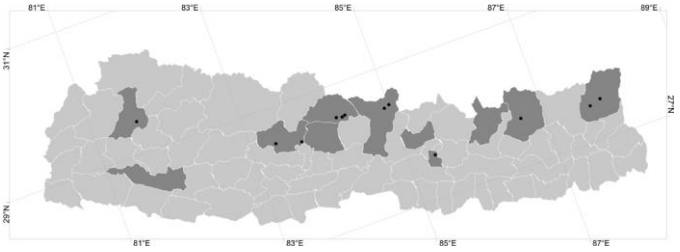
Elaeagnus parvifolia



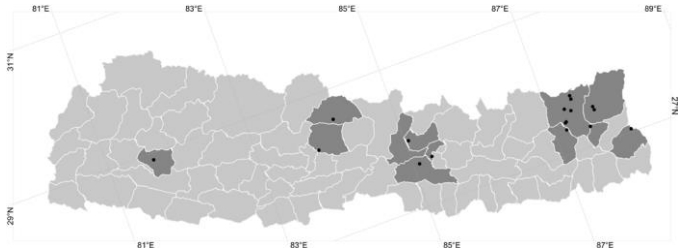
Eriobotrya dubia



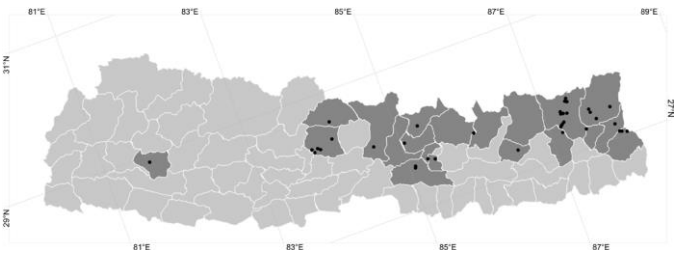
Eriobotrya elliptica



Euonymus pendulus

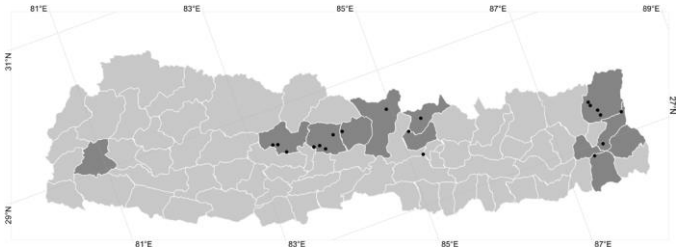


Eurya acuminata



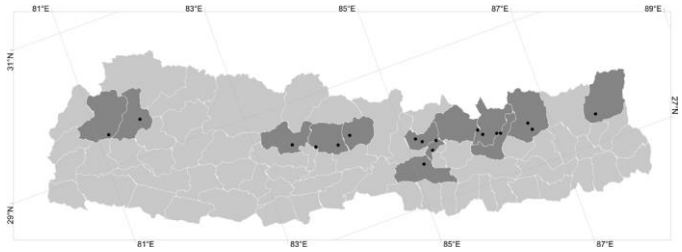
Eurya cerasifolia

Trees

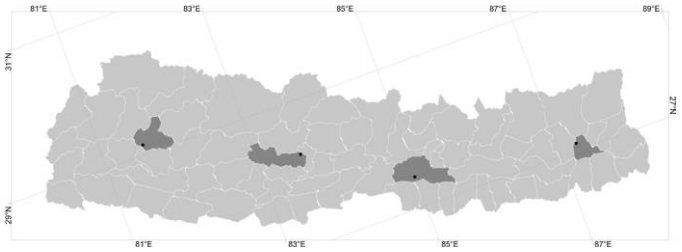


Ficus neriifolia

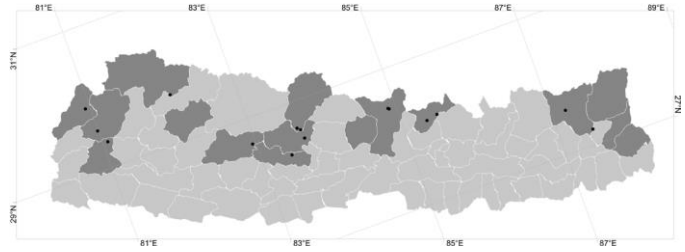
Ficus pumila



Fraxinus floribunda



Garuga pinnata



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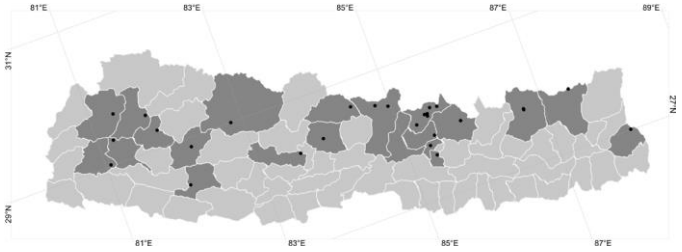
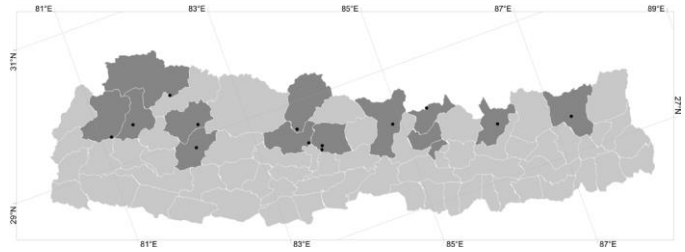
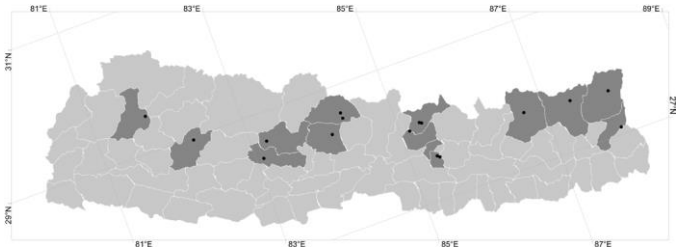


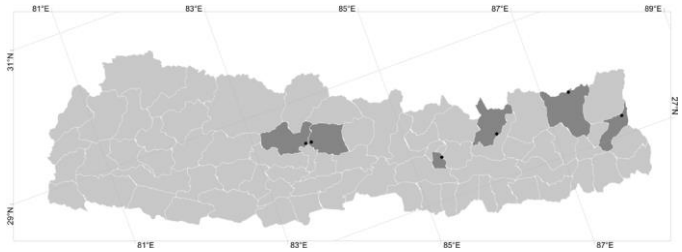
Ilex dipyrena



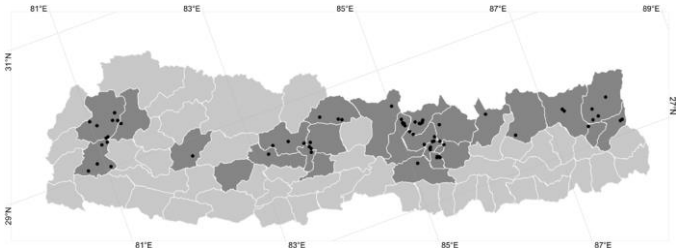
Juglans regia



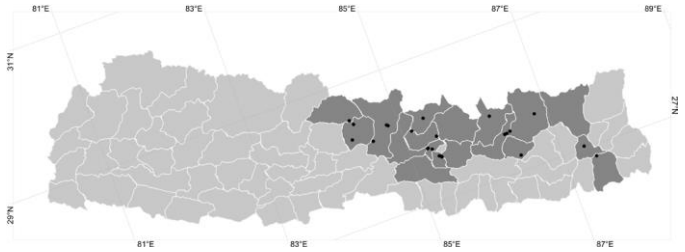
Leucosceptrum canum



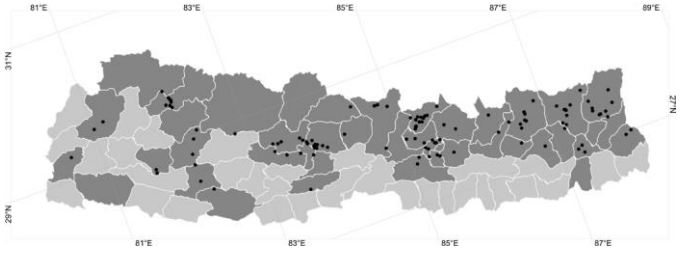
Ligustrum confusum



Lindera pulcherrima

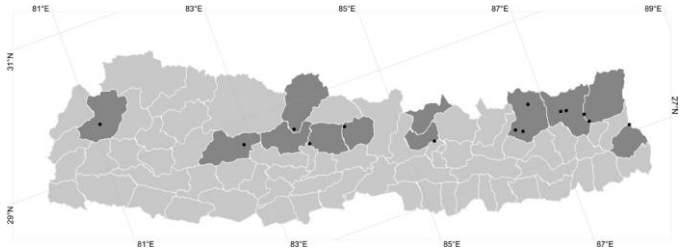


Litsea doshia

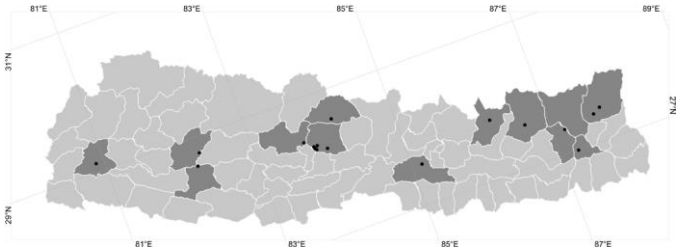


Lyonia ovalifolia

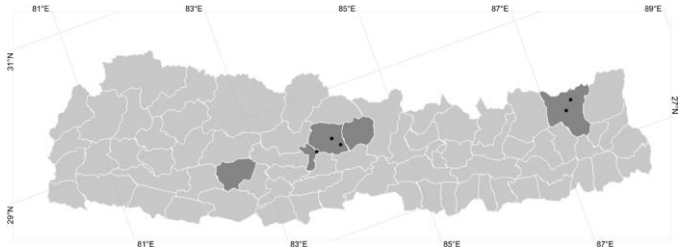
Trees



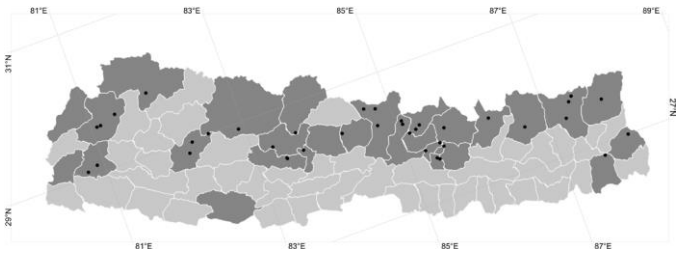
Lyoni avillosa



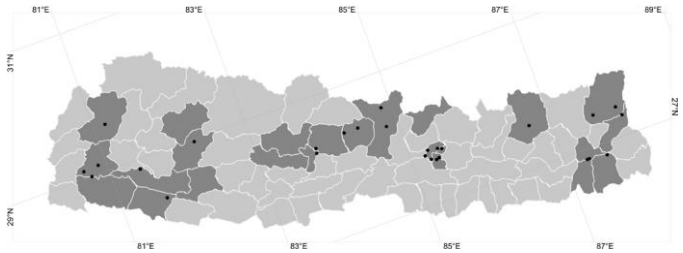
Macaranga pustulata



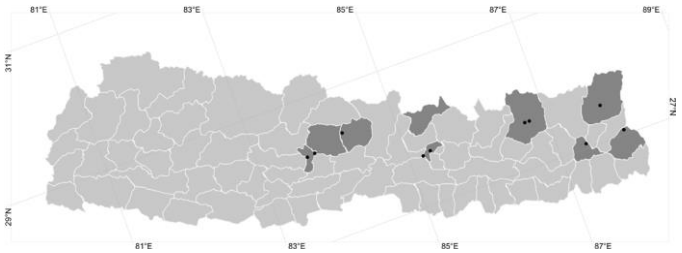
Machilus clarkeana



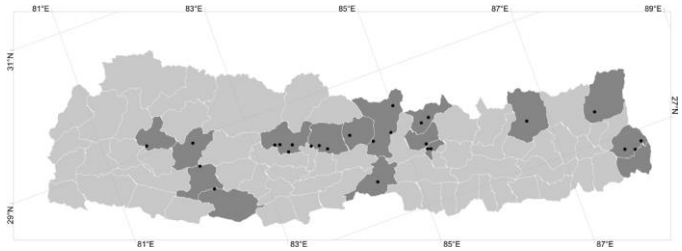
Machilus duthiei



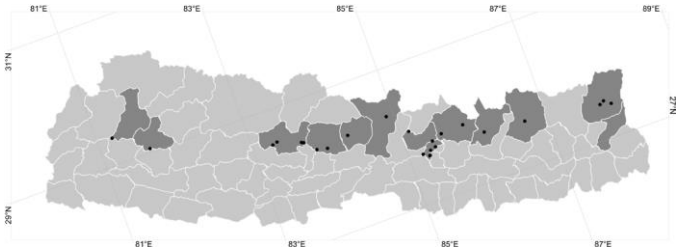
Machilus odoratissima



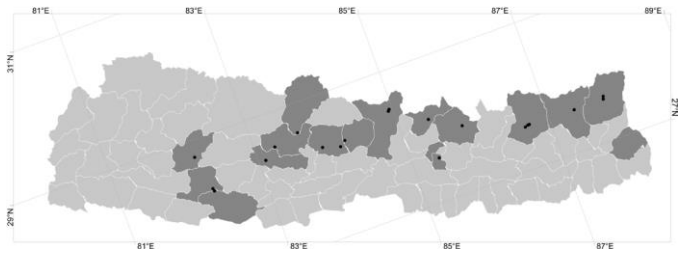
Magnolia doltsopa



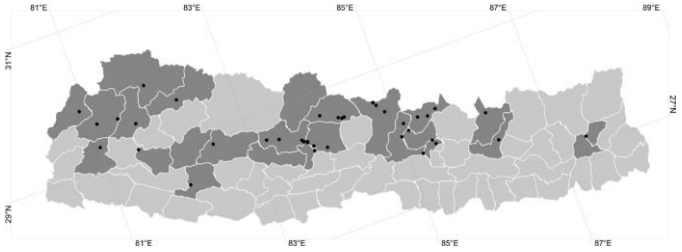
Maytenus rufa



Myrica esculenta

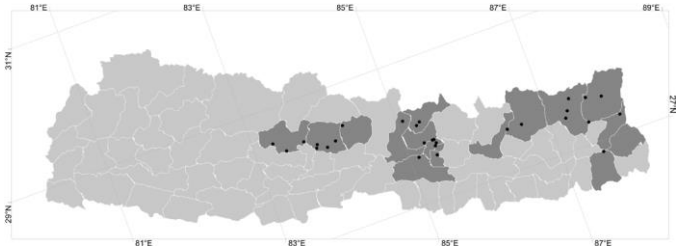


Myrsinesemis errata



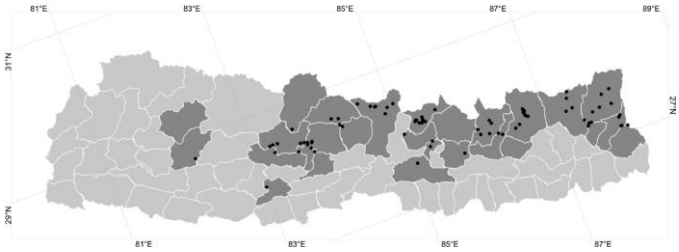
Neolitsea pallens

Osmanthus fragrans

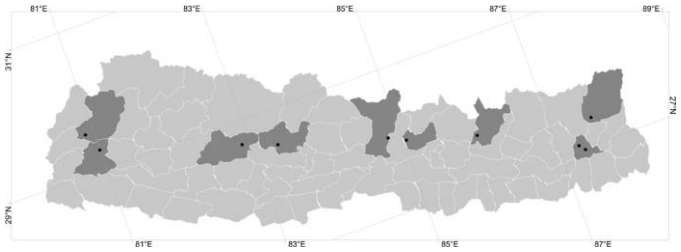


Photinia integrifolia

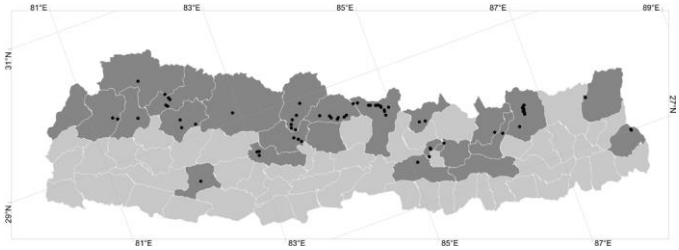
Trees



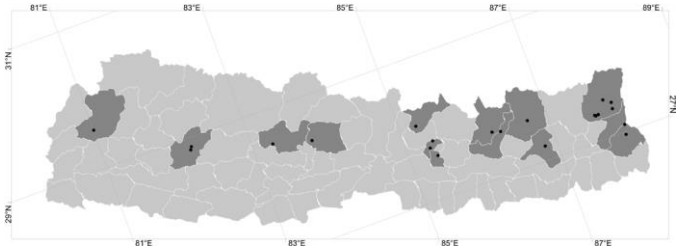
Pieris formosa



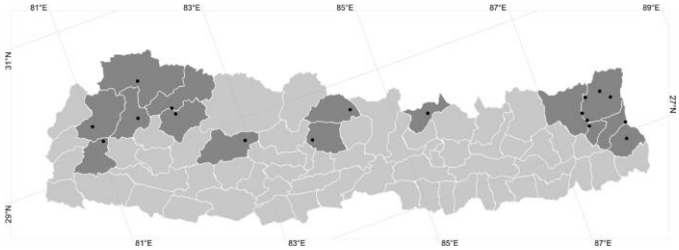
Pinus roxburghii



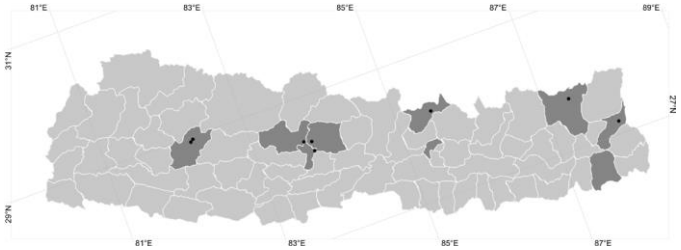
Pinus wallichiana



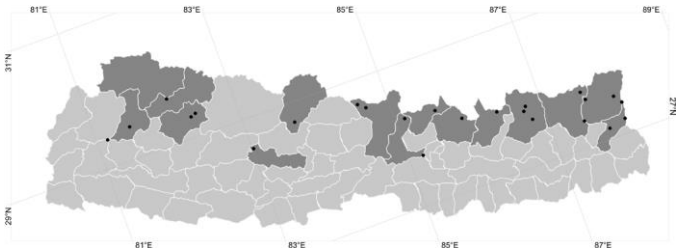
Prunus cerasoides



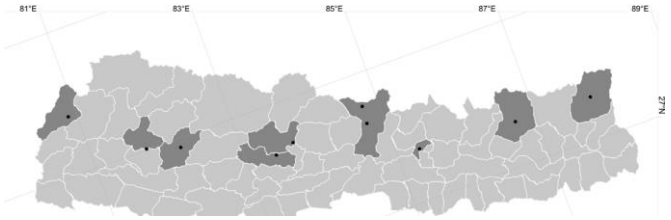
Prunus cornuta



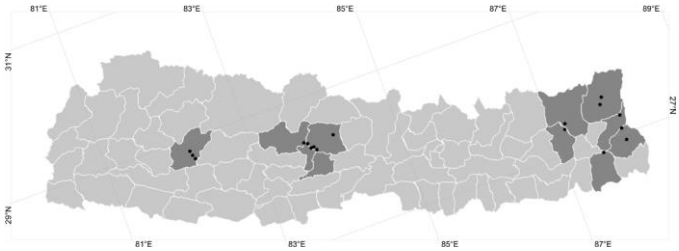
Prunus napaulensis



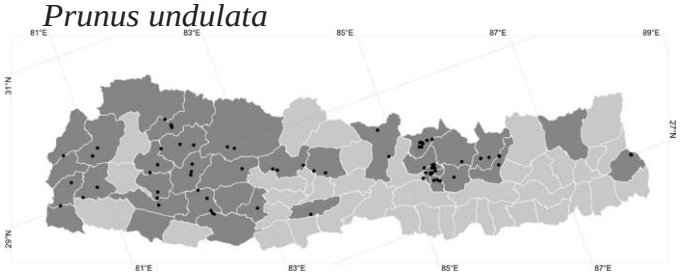
Prunus rufa



Prunus undulata

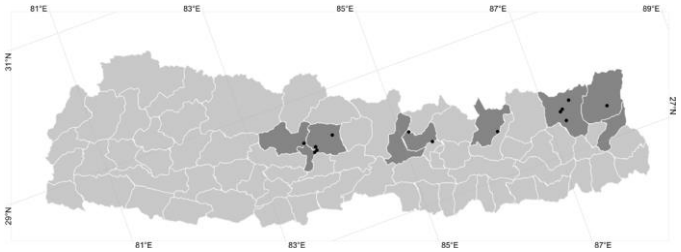


Pyrularia edulis



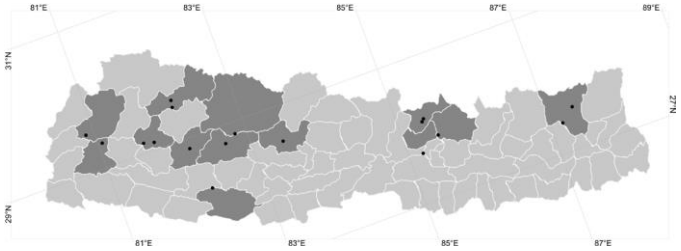
Pyrus pashia

Quercus glauca

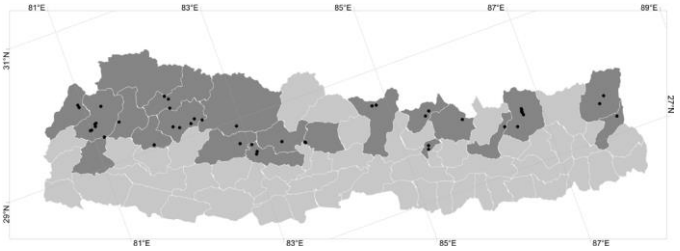


Quercus lamellosa

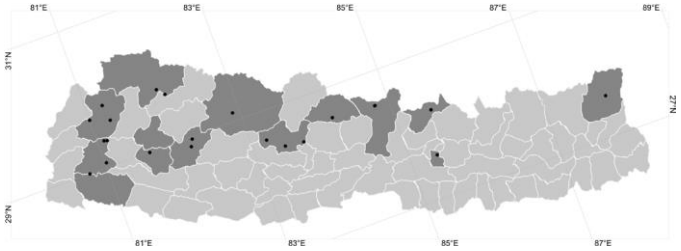
Trees



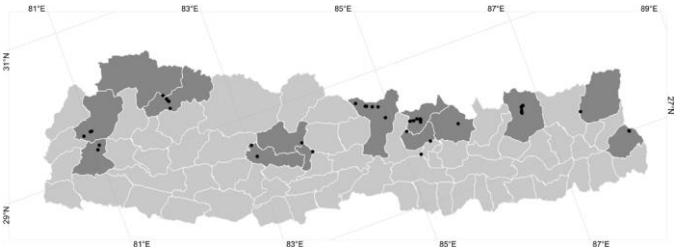
Quercus lanata



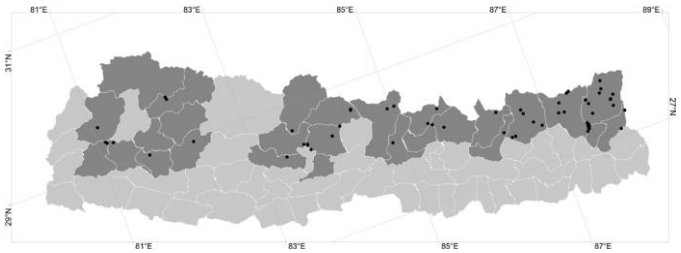
Quercus semecarpifolia



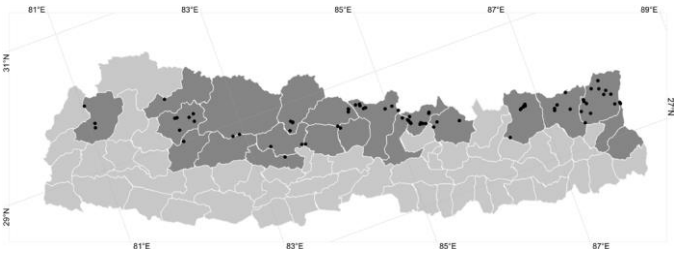
Rhamnus purpureus



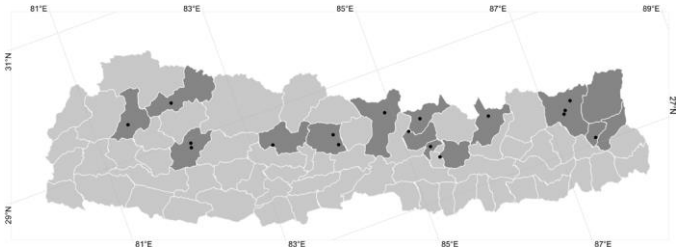
Rhododendron arboreum



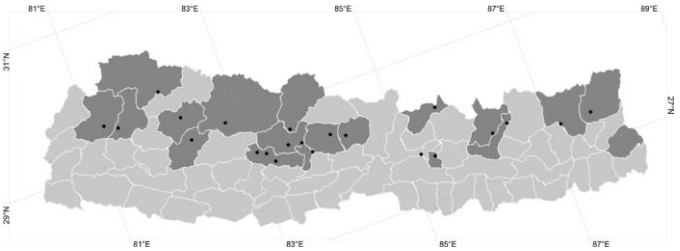
Rhododendron barbatum



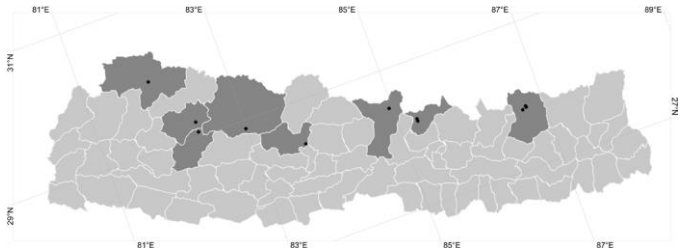
Rhododendron campanulatum



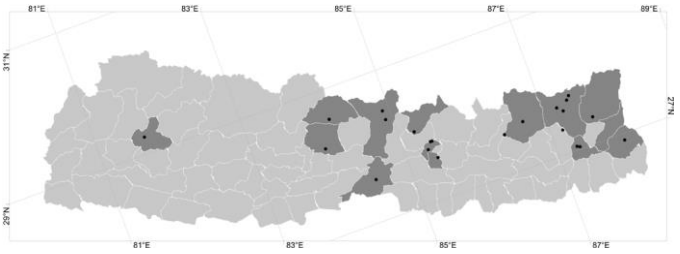
Rhus javanica



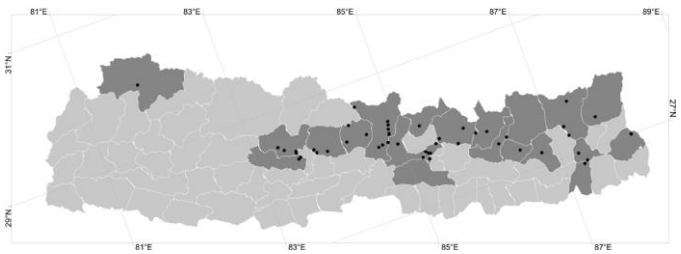
Rhus succedanea



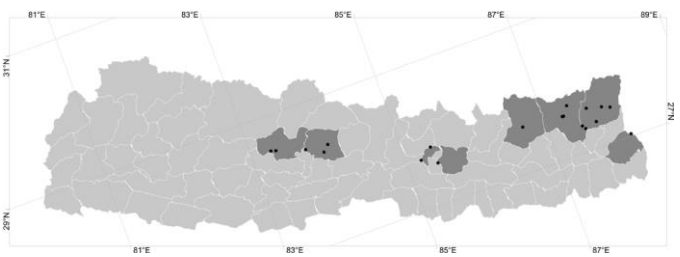
Salix obscura



Saurauia napaulensis

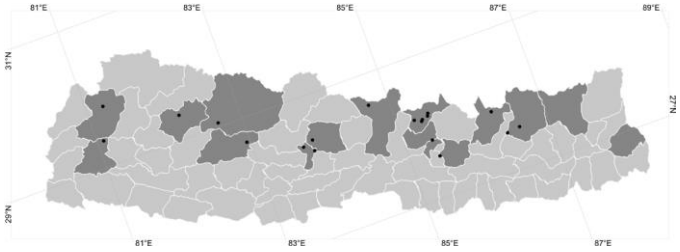


Schima wallichii

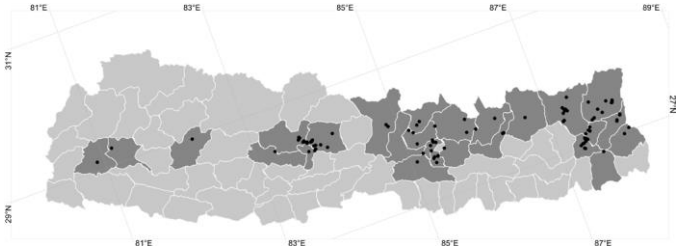


Skimmia arborescens

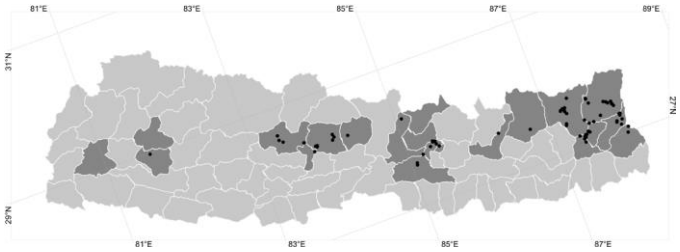
Trees



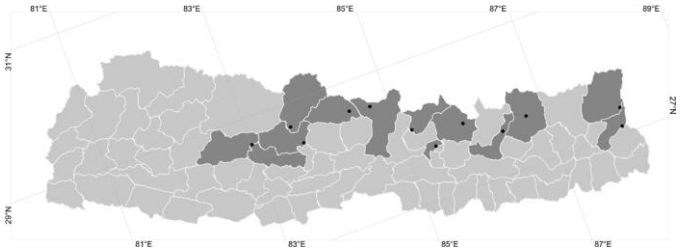
Sorbus vestita



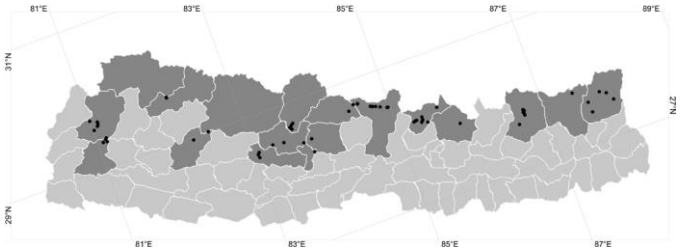
Symplocos ramosissima



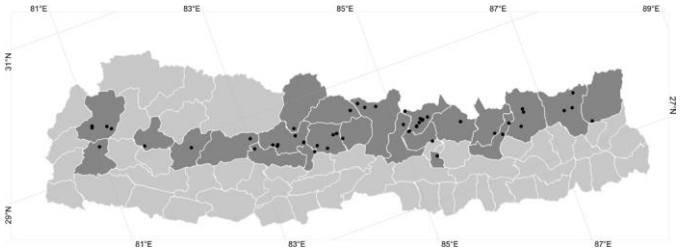
Symplocos theifolia



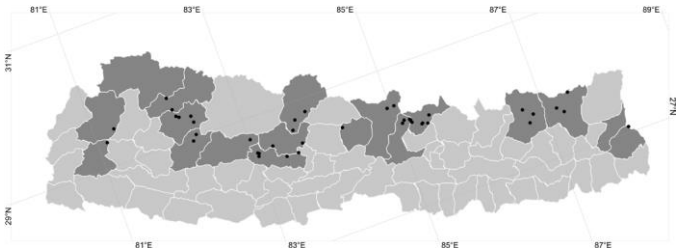
Taxus wallichiana



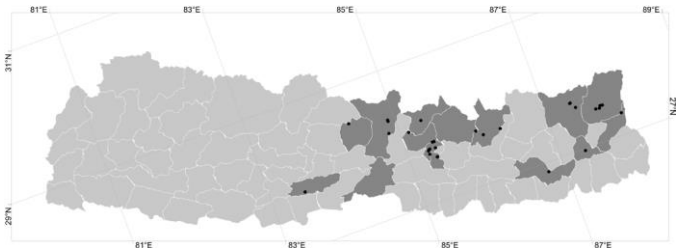
Tsuga dumosa



Viburnum erubescens

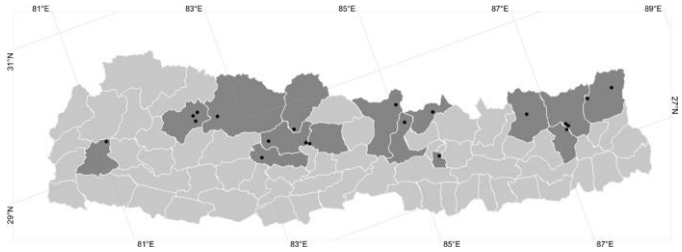


Viburnum grandiflorum

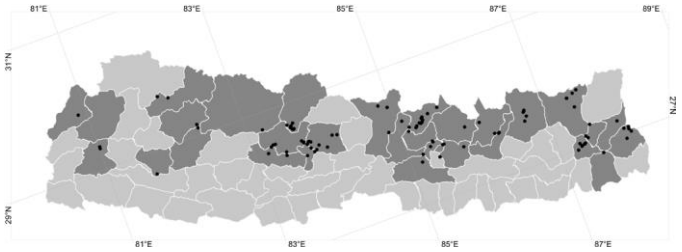


Zizyphu sincurva

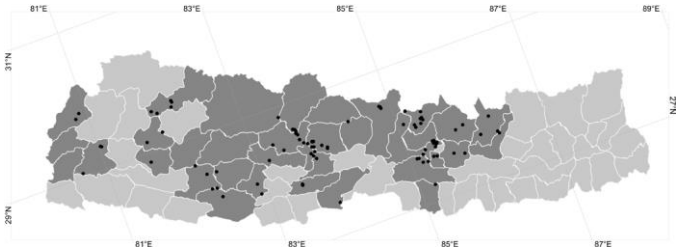
Shrubs



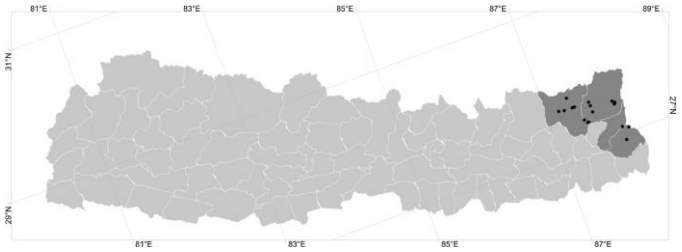
Eleutherococcu scissifolius



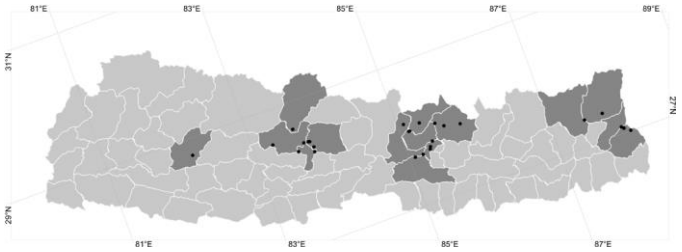
Berberis aristata



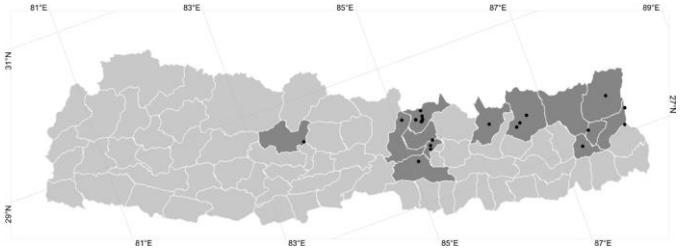
Berberis asiatica



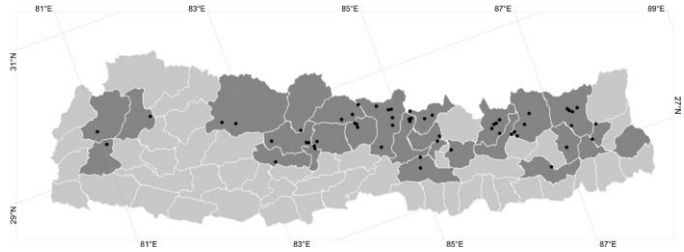
Berberis insignis



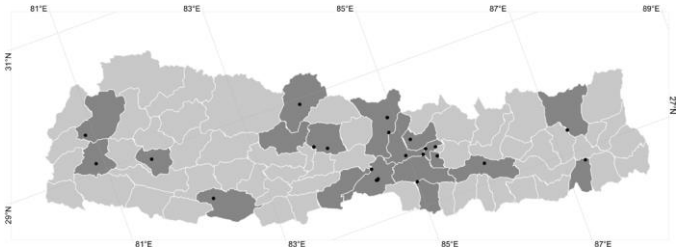
Berberis napaulensis



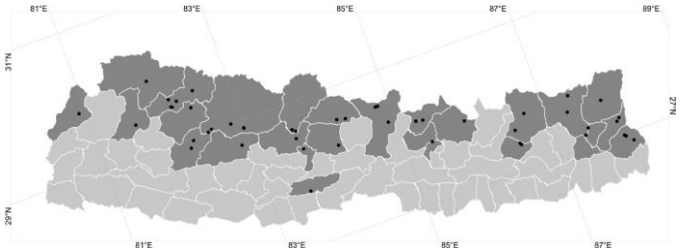
Berberis wallichiana



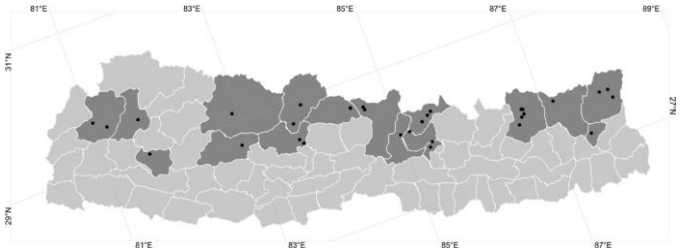
Boenninghausenia albiflora



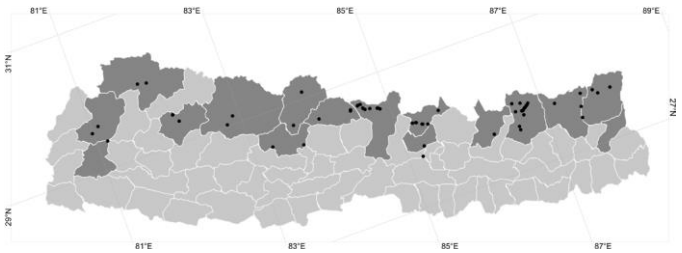
Colebrookea oppositifolia



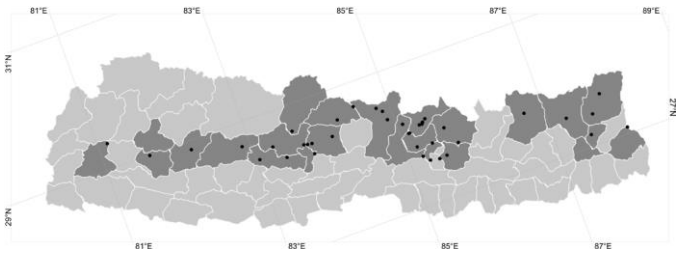
Colquhounia coccinea



Cotoneaster acuminatus

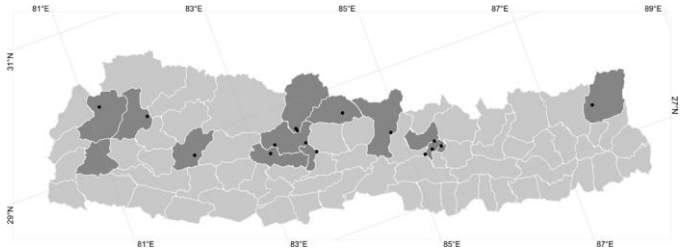


Cotoneaster microphyllus

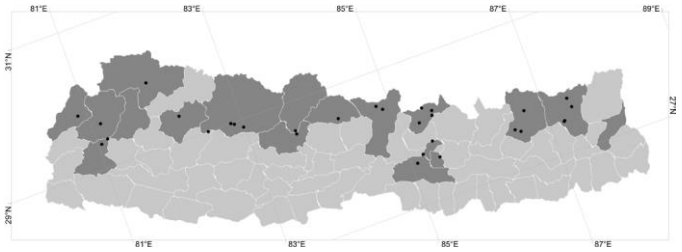


Daphne bholua

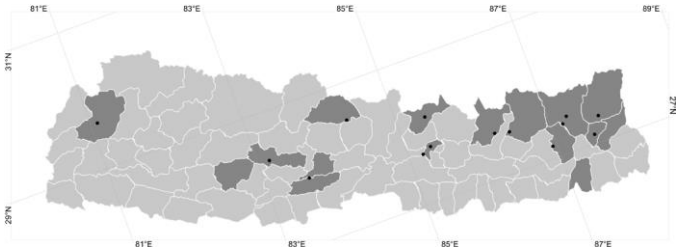
Shrubs



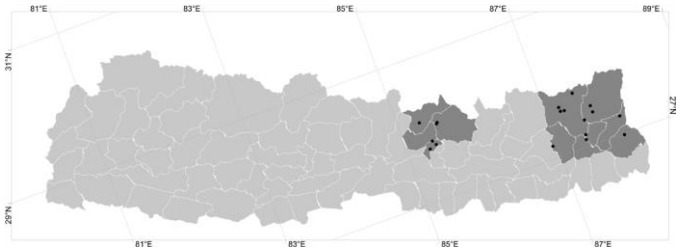
Daphne papyracea



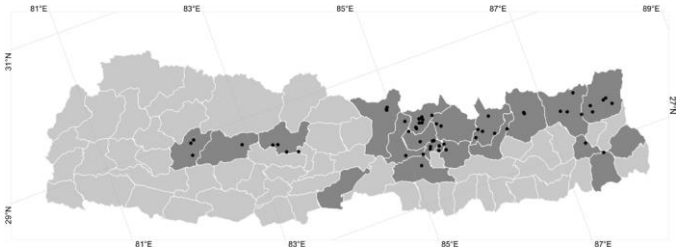
Desmodium elegans



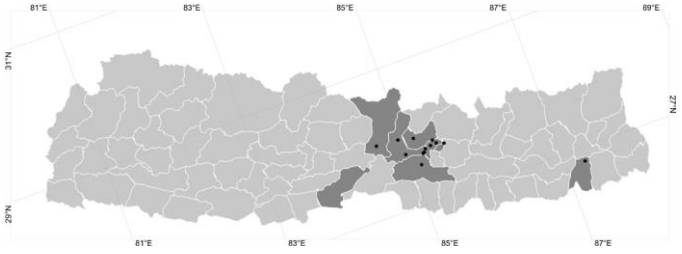
Desmodium multiflorum



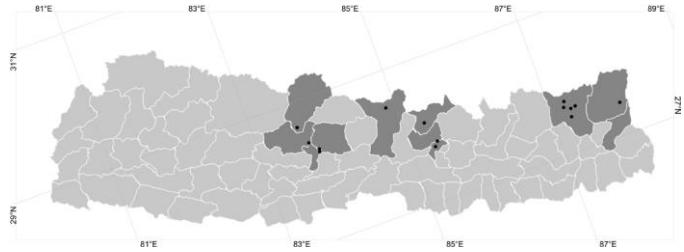
Edgeworthia gardneri



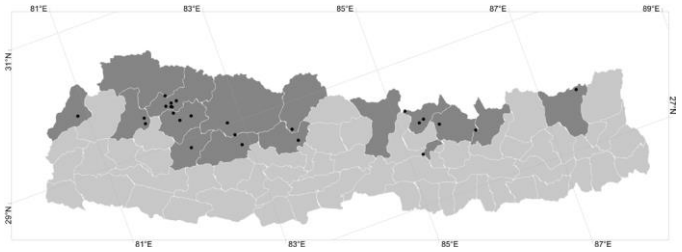
Gaultheria fragrantissima



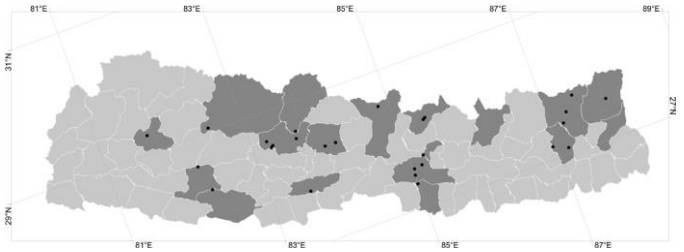
Hypericum cordifolium



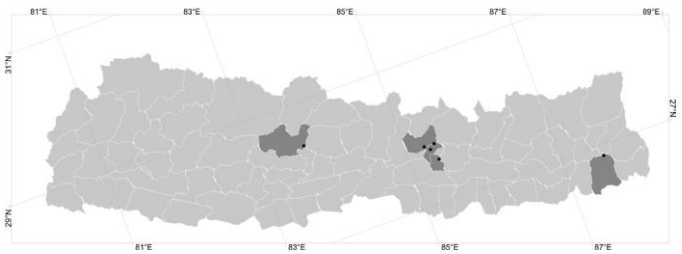
Hypericum hookeranum



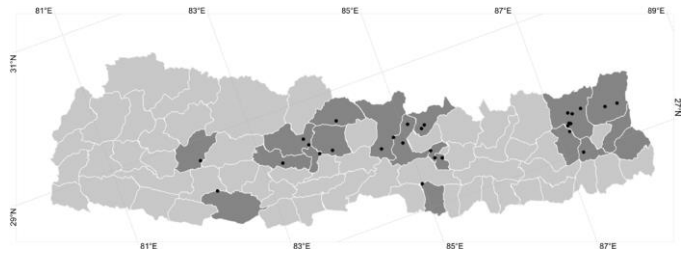
Indigofera heterantha



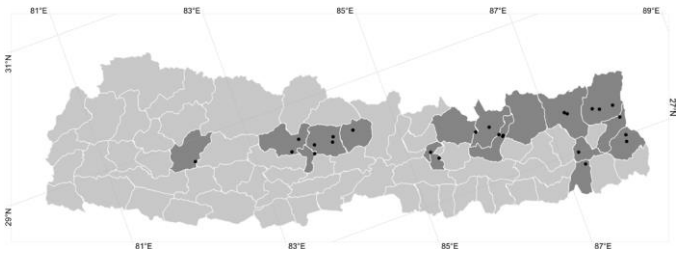
Inula cappa



Lonicera ligustrina

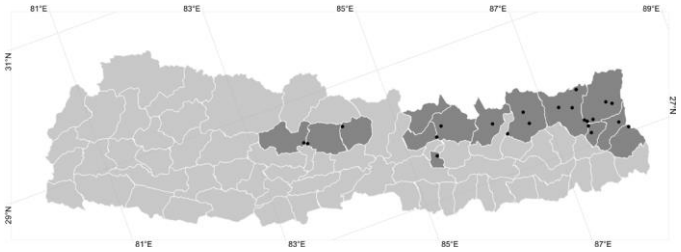


Maesa chisia

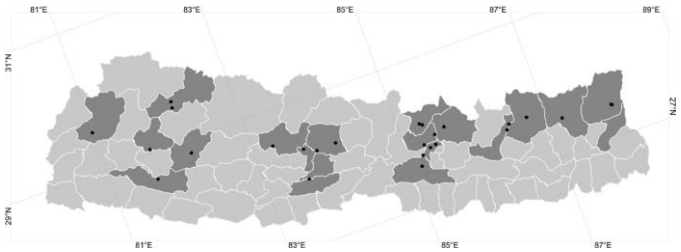


Mussaenda treutleri

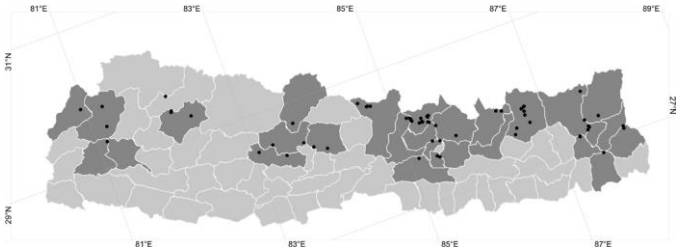
Shrubs



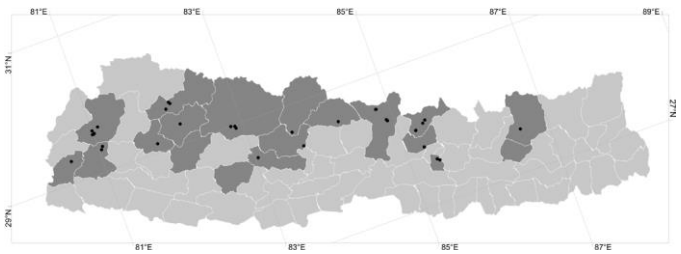
Neillia rubiflora



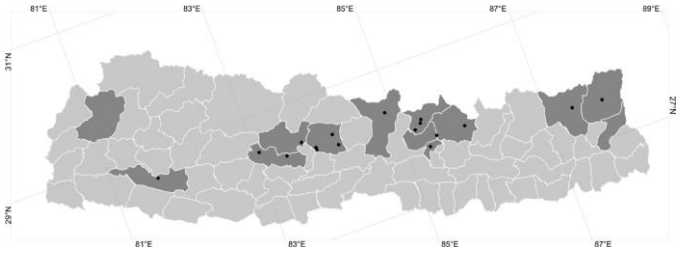
Phyllanthu sclarkei



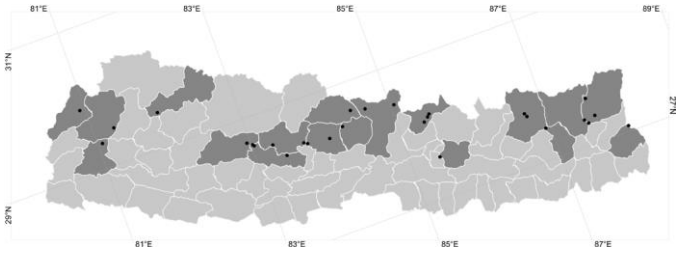
Piptanthus nepalensis



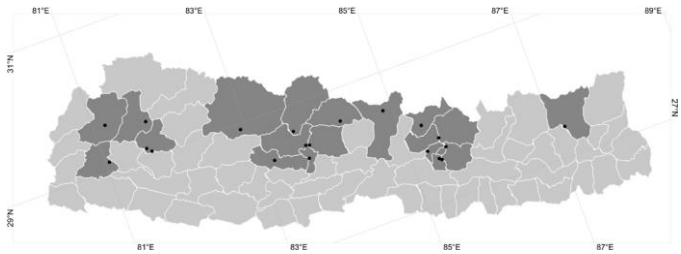
Prinsepia utilis



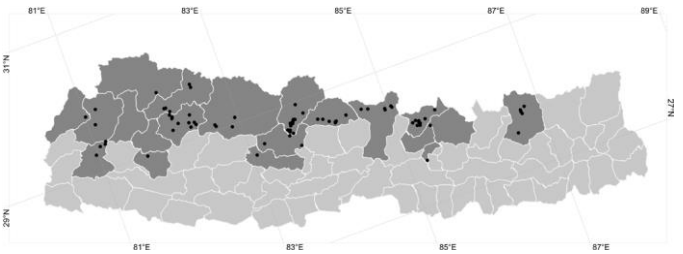
Randia tetrasperma



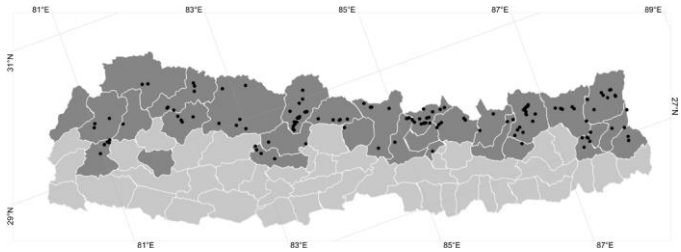
Ribes acuminatum



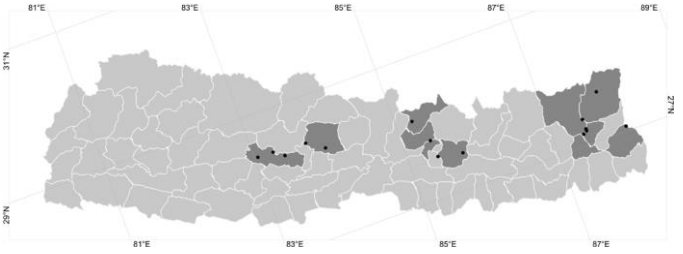
Rosa brunonii



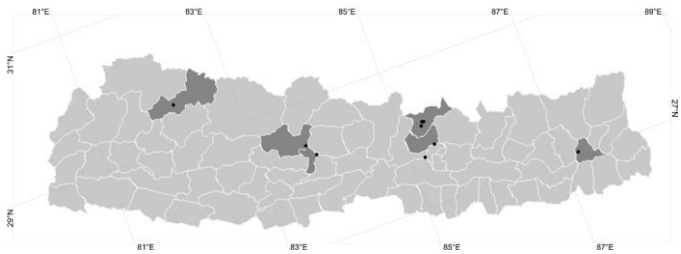
Rosa macrophylla



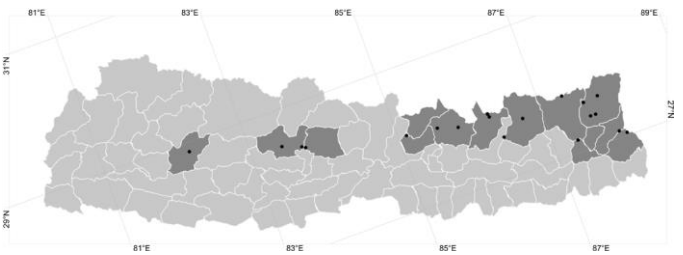
Rosa sericea



Rubus calycinus

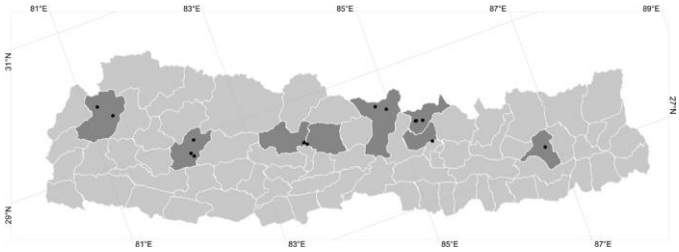


Rubus ellipticus

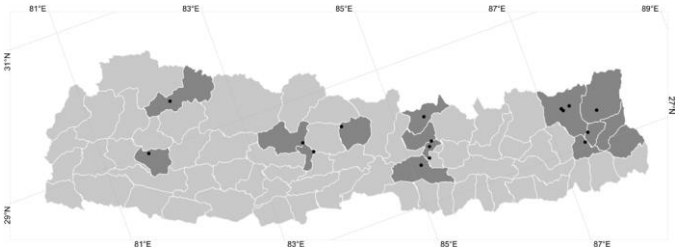


Rubus pentagonus

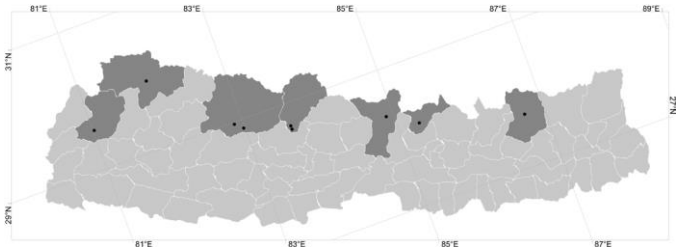
Shrubs



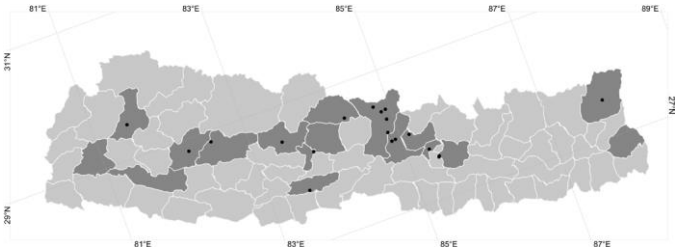
Sarcococca saligna



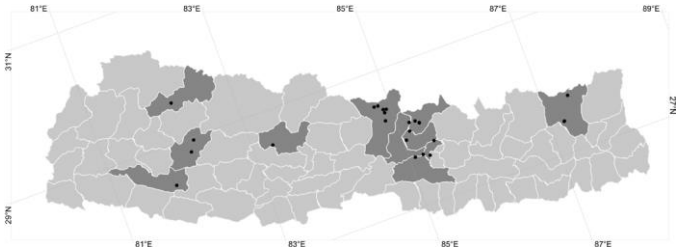
Sarcococca wallichii



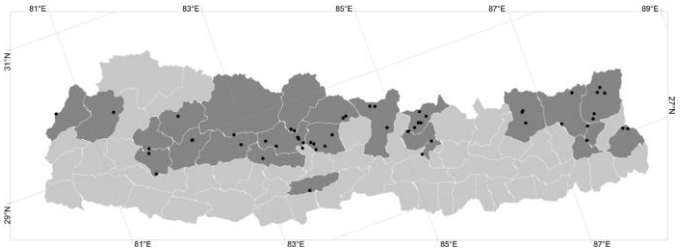
Spiraea canescens



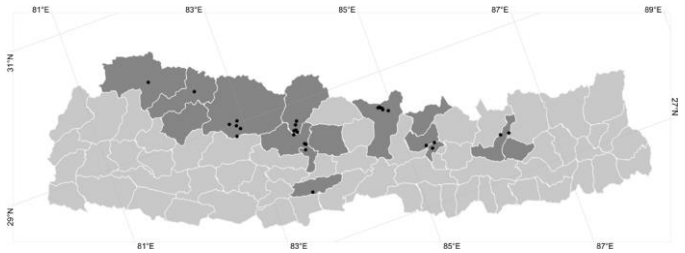
Swida oblonga



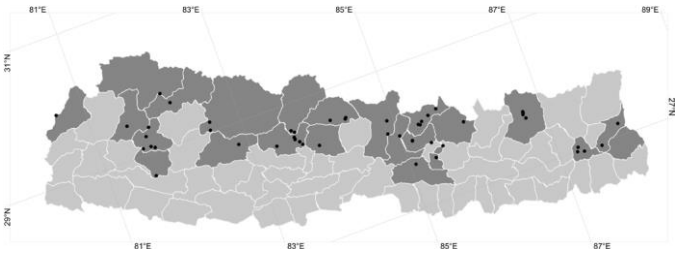
Viburnum cylindricum



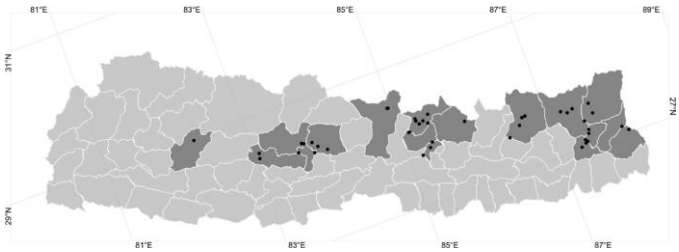
Viburnum mullaha



Wikstroemia canescens

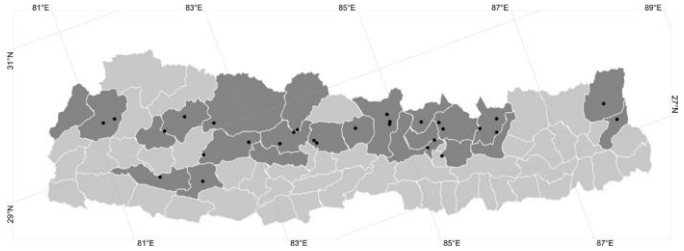


Zanthoxylum armatum

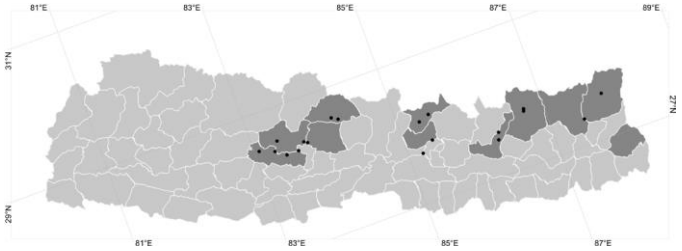


Zanthoxylum oxyphyllum

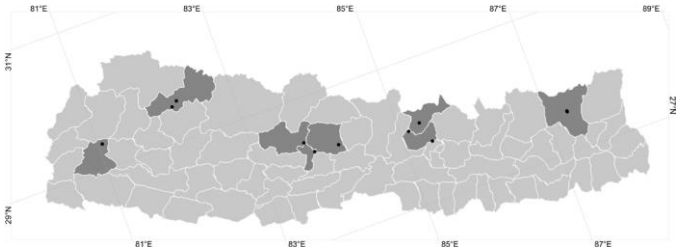
Climbers



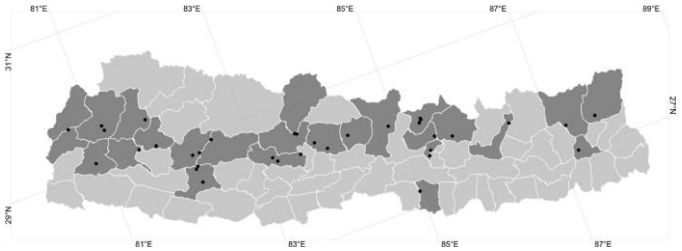
Ampelocis susrugosa



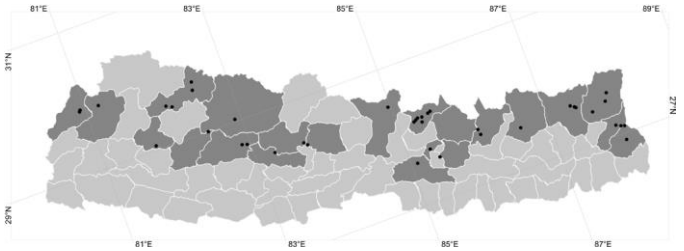
Aristolochiagriffithii



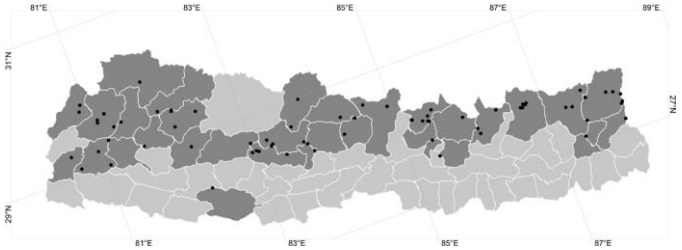
Ceropegialongifolia



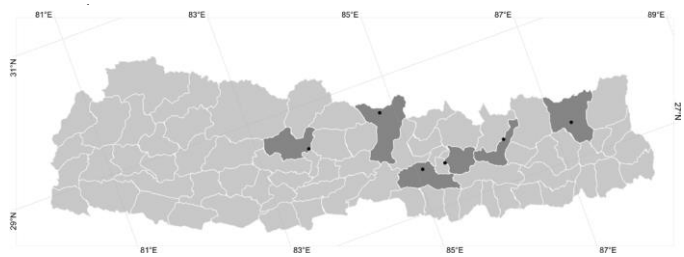
Cissampelospareira



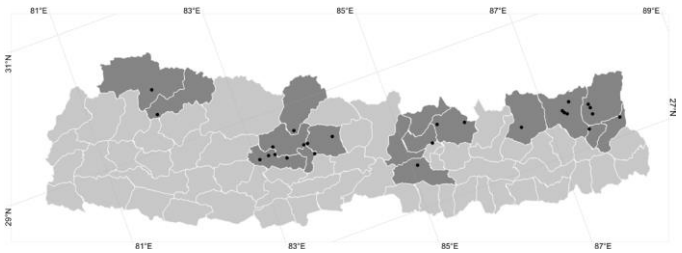
Clematis



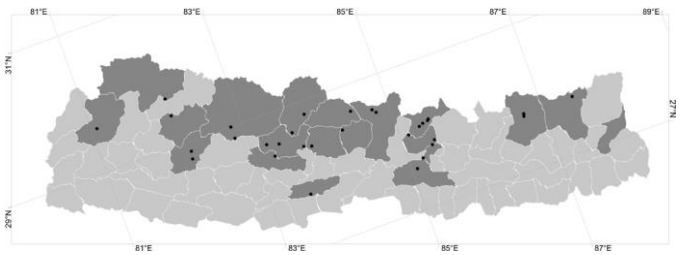
Clematis montana



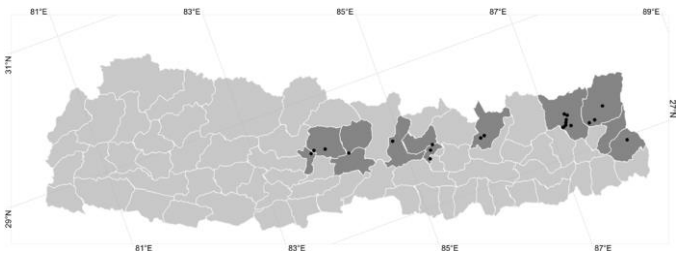
Cochlianthus gracilis



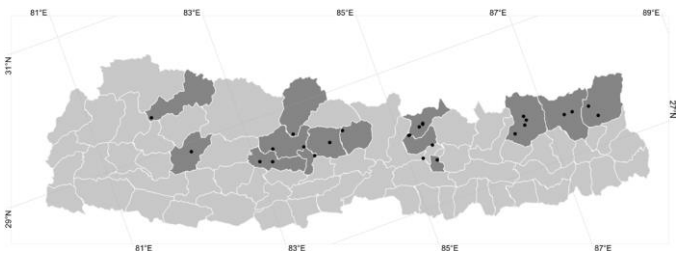
Euonymus echinatus



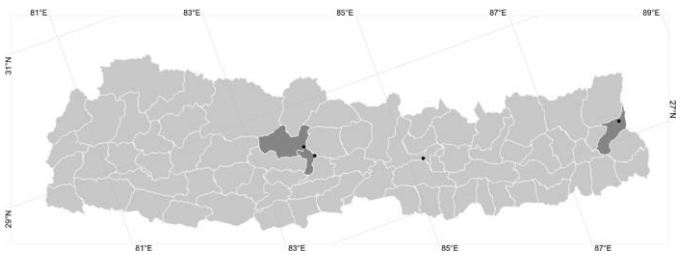
Hedera nepalensis



Hedyotis scandens

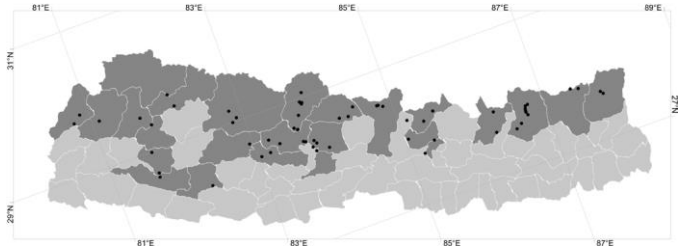


Holboellia latifolia

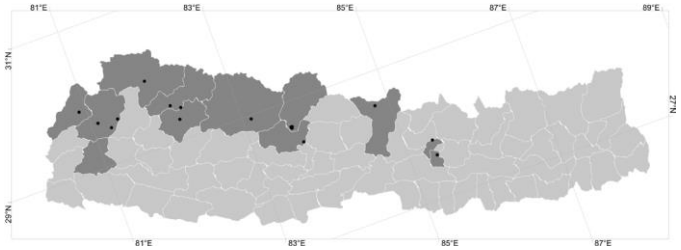


Hoya edenii

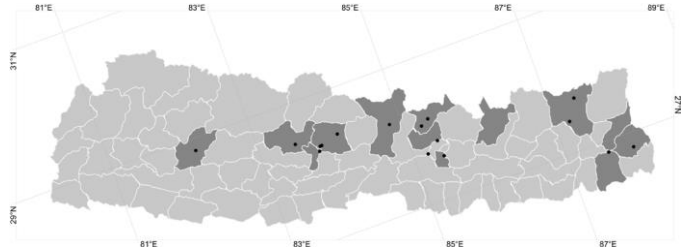
Climbers



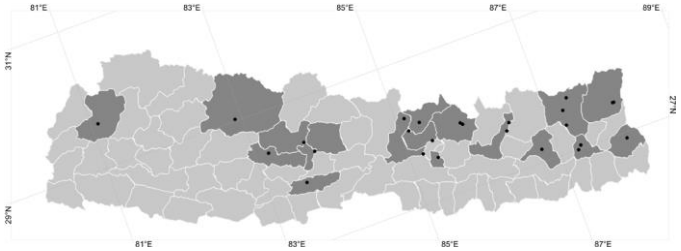
Jasminum humile



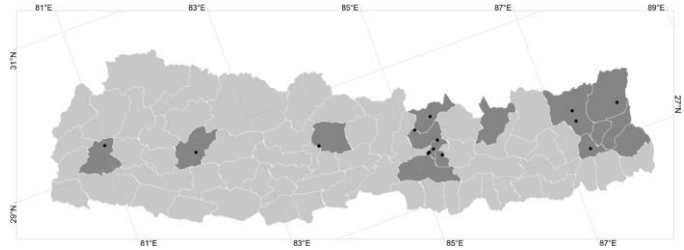
Jasminum officinale



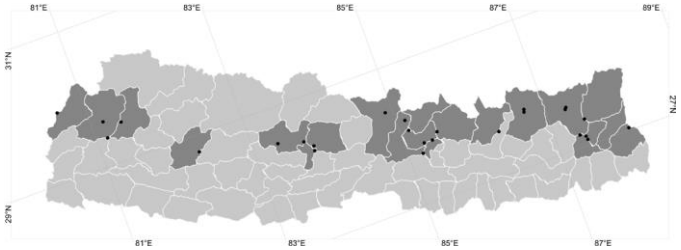
Piper mullesua



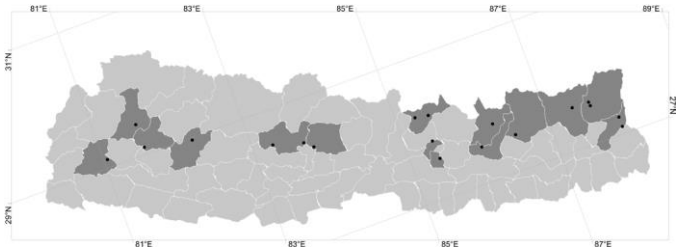
Rubia manjith



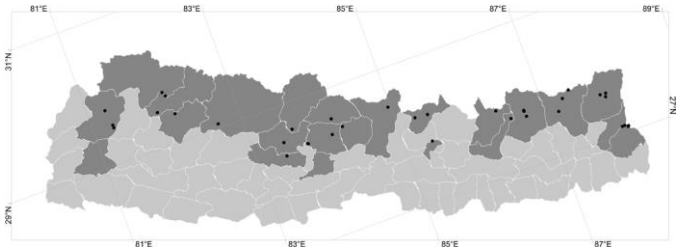
Rubus acuminatus



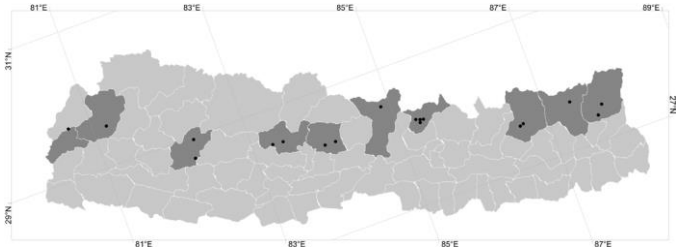
Rubus paniculatus



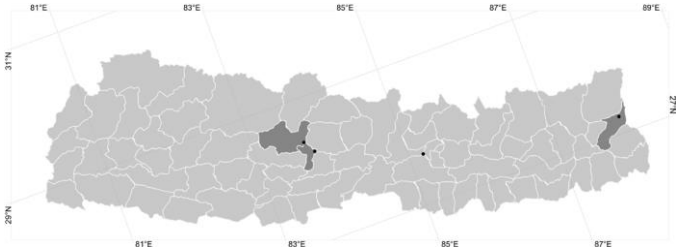
Sabia campanulata



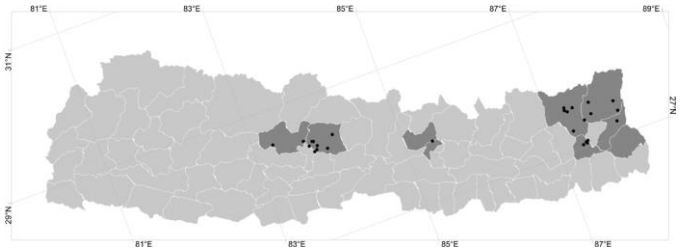
Schisandra grandiflora



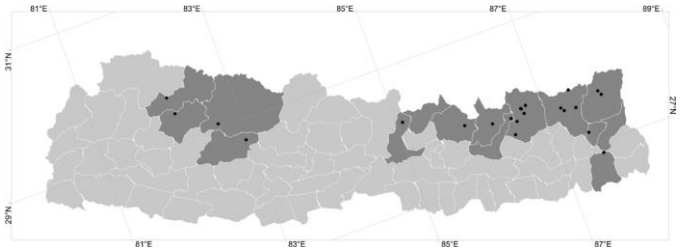
Smilax aspera



Smilax elegans

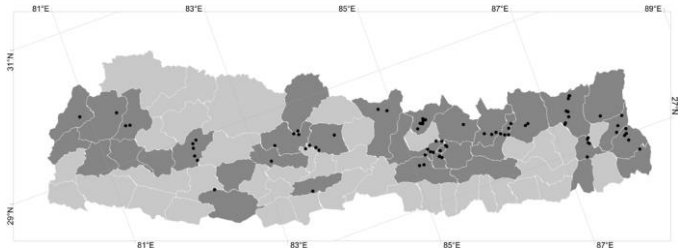


Smilax ferox



Smilax menispermoidea

Climbers



Tetrastigma serrulatum