

## Comparative Analysis of the Flora of Morang District and Adjoining Areas of Nepal

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### Abstract

Nine hundred and forty seven species of vascular plants under 661 genera and 172 families were recorded from Morang district and adjoining areas of Nepal. The genus-species ratio of the vascular plants in general and angiosperms in particular was 1:1.43 and 1:1.44, respectively; and 498 genera of vascular plants were represented by a single species only. On the basis of number of species, Polypodiaceae (11) was the largest family of pteridophytes, and Pinaceae (3) of gymnosperms. Among the angiosperms ten largest families were: Leguminosae (91)>Poaceae (80)> Asteraceae (57)>Euphorbiaceae (31)> Cyperaceae (28)> Rubiaceae(26) > Lamiaceae and Solanaceae (22 each) > Acanthaceae (21)> Orchidaceae (20) > Convolvulaceae (16). The biological spectrum of the study area was phanerotherophytic type.

*Key words:* Conservation, Exotic weeds, Floristic analysis, Life forms, Reproductive seasons

### Introduction

Situated between latitudes 26°20' to 27°10'N and longitudes 87° to 87°30'E, the study site is one of the populous areas of Nepal, the population density per sq km being 288 in 1981, 361 in 1991 and 453 in 2001. Physiographically the study site is divisible into three zones from south to north: (a) the Terai- a part of the Indo-Gangetic plain with elevation variations between 60 and 300 m, (b) the Bhabar zone with elevation variations between 150 to 700 m and (c) Mahabharat or mountain ranges with elevation variations between 700 to 2409 m. Nearly 81% of the total land of the study site is in Terai, 10% in Bhabar and 9% in mountain zone. Most of the lower altitude areas are under arable farming. In general, the study site has tropical and monsoonic type of climate with 1312 mm average annual rainfall,

and 30.6°C and 14.2°C average annual maximum and minimum temperatures, respectively.

Forests of the Terai and Bhabar zones are dominated by *Shorea robusta* in association with *Adina cordifolia*, *Cassia fistula*, *Cedrela toona*, *Dillenia pentagyna*, *Lagerstroemia parviflora*, *Mallotus philippensis*, *Phyllanthus emblica*, *Schleichera oleosa*, *Semecarpus anacardium* and *Terminalia alata*. The Terai riverine forest on new alluvial deposits is dominated by *Acacia catechu*-*Dalbergia sissoo* association in which *Ficus semicordata* and *Zigiphus mauritiana* have fair presence. On the other hand, riverine forest on old alluvial deposits is mainly composed of *Acacia catechu*, *Adina cordifolia*, *Aegle marmelos*, *Salmalia malabarica*, *Syzygium cumini*, *Terminalia alata*, *Trewia nudiflora*, etc. Species composition of the forest of mountain zone consists mainly of *Alnus nepalensis*, *Castanopsis indica*, *Pinus rox-*

*burghii*, *Pyrus pashia*, *Rhododendron arboreum*, *Salmalia malabarica*, *Schima wallichii*, etc.

This analytical study is based on the floristic expeditions of eight selected locations of the study site made during 1996 to 1998.

#### Materials and Methods

Three locations from Terai (Budhanagar 60 m, Biratnagar 72 m, Koshi Tappu 78 m), three locations from Bhabar (Belbari 150 m, Letang 241 m, Kerabari 457 m) and two locations from mountain zone (Singhdevisombare 1800 m, Tinjure 2200 m) were selected for the floristic expeditions. Among these Budhanagar, Biratnagar, Letang and Singhdevisombare were agricultural areas; Koshi Tappu was a protected wetland; and Belbari, Kerabari and Tinjure were forested areas. All the selected locations except Tinjure (Terhathum district) and Koshi Tappu (Sunsari district) belonged to Morang district. The reason for the selection of Tinjure was that the highest peak of Morang district in the Mahabharat ranges, the 'Mikjani' mountain (2409 m) was difficult to access and Tinjure was the nearest location to represent Mikjani whereas Koshi Tappu was selected as a representative of the protected Terai marshland.

Plant materials and field data were gathered by making regular visits to the selected locations for three consecutive years. The identified specimens of vascular plants were deposited in the Herbarium of Central Department of Botany (TUCH), Tribhuvan University, Kirtipur, Kathmandu.

#### Results and Discussion

In total 947 species of vascular plants (tropical and subtropical 79.5%, temperate 20.5%) were recorded from the study site

(Table 1) in which pteridophytes were represented by 23 families, 44 genera and 61 species; gymnosperms by 5 families, 6 genera and 7 species; and angiosperms by 144 families, 611 genera and 879 species.

Table 2 summarizes the number and percentage of the families, genera and species of dicots and monocots found within the study site. The ratio of the monocot to dicot families was 1:4.76; of genera 1:3.52 and of species 1:3.48. The genus-species ratio of angiosperms was 1:1.44 which was comparatively lower than 1:7 for British India (Hooker, 1872-1897), of 1:6 for India (Kumar and Krishnamurthy, 1992), 1:3.48 for Nepal (Press *et al.*, 2000), and 1:2.2 for the upper Gangetic plains (Duthie, 1903-1929). It indicates that the smaller the area the lower is the genus-species ratio.

In general, as many as 79 families of the vascular plants were represented by a single genus each and 60 families by single species each. Out of the total 661 genera of the study area, 498 were represented by a single species only (Jha and Jha, 2000; Jha, 2003). This finding was in agreement with Hooker's (1904) observation for the plains of the northern Indian subcontinent regarding the preponderance of genera with one species only.

The genera represented by five or more species in the study area were *Pteris* and *Selaginella* (5 species each) among the pteridophytes; *Cyperus* (14) and *Carex* (5) among the monocots; and *Ipomoea* (9), *Ficus* (8), *Solanum* (8), *Persicaria* (7), *Vigna* (7), *Acacia* (6), *Cassia* (6), *Euphorbia* (6), *Amaranthus* (5) and *Crotalaria* (5) among the dicots. Some of these genera were also dominant flora of plains of eastern Nepal in terms of number of species (Siwakoti and Varma, 1999).

The relative importance of families in a

flora is usually expressed by tabulating the largest ten families in the order of their number of species and comparing it with those of the adjacent regions. Table 3, thus, depicts the ten dominant families in Morang district and adjoining areas, the Terai plains of Nepal, whole Nepal, British India and the entire world. It is interesting to note that the Leguminosae, Asteraceae, Poaceae and Cyperaceae are the most dominant families in all the regions irrespective of their spatial size. According to Good (1953), almost everywhere Leguminosae, Asteraceae, Poaceae and Cyperaceae are among the first six, but thereafter much depends on whether the area concerned is temperate, in which case families such as Caryophyllaceae, Brassicaceae, Ranunculaceae, Rosaceae and Scrophulariaceae rank high; or whether it is tropical, in which case families such as Acanthaceae, Euphorbiaceae, Rubiaceae, Lamiaceae and Solanaceae take their place. The predominant tropical families such as Euphorbiaceae, Rubiaceae, Lamiaceae, Solanaceae and Acanthaceae were among the ten largest families in Morang district and adjoining areas of Nepal (Table 3).

The statistical analysis of basic life-forms (habits) indicated the predominance of herbs

followed by shrubs and trees in the study area (Table 4) which was mainly due to increase in human population, settlements and townships, modification or destruction of habitats, increase in area under arable farming, overgrazing, and roads and industries. In this context plant species deserving immediate conservation efforts due to their suitability in restoring the degraded ecosystems and their high potentials in fostering the rural cottage industries (edible fruits/vegetables/pot-herbs, feed for livestock, medicines, fuels, agricultural and household implements, thatch, mats, basketry, bee-keeping, sericulture etc.) were: *Acacia catechu* (Leguminosae), *Adina cordifolia* (Rubiaceae), *Aegle marmelos* (Rutaceae), *Aesandra butyracea* (Sapotaceae), *Alstonia scholaris* (Apocynaceae), *Borassus flabellifer* and *Calamus tenuis* (Arecaceae), *Cassine glauca* (Celastraceae), *Cyathea spinulosa* (Cyatheaceae / pteridophyta), *Dillenia pentagyna* (Dilleniaceae), *Ehretia laevis* (Cordiaceae), *Glochidion lanceolarium* (Euphorbiaceae), *Grewia subinaequalis* (Tiliaceae), *Holarrhena pubescens* (Apocynaceae), *Hymenodictyon*

Table 1. Floristic analysis of the explored vascular plants

Plant Group	Families	Genera	Species
Pteridophytes	23	44	61
Gymnosperms	5	6	7
Monocots	25	135	196
Dicots	119	476	683
<b>Total</b>	<b>172</b>	<b>661</b>	<b>947</b>

Table 2. Percentage and ratios of families, genera and species of monocots and dicots

Taxa	Dicots		Monocots		Total	Ratio	
	Total number	%	Total number	%		Monocots:Dicots	
Families	119	82.64	25	17.36	144	1	4.76
Genera	476	77.91	135	22.09	611	1	3.52
Species	683	77.70	196	22.30	879	1	3.48

Table 3. Representation of dominant families in various floras in the order of decreasing members

MDDA	TPN	NEP	BI	WF
Leguminosae	Poaceae	Asteraceae	Orchidaceae	Asteraceae
Poaceae	Leguminosae	Poaceae	Leguminosae	Poaceae
Asteraceae	Asteraceae	Orchidaceae	Poaceae	Orchidaceae
Euphorbiaceae	Cyperaceae	Leguminosae	Rubiaceae	Leguminosae
Cyperaceae	Euphorbiaceae	Rosaceae	Euphorbiaceae	Euphorbiaceae
Rubiaceae	Rubiaceae	Cyperaceae	Acanthaceae	Rubiaceae
Lamiaceae/Solanaceae	Acanthaceae	Scrophulariaceae	Asteraceae	Arecaceae
Acanthaceae	Convolvulaceae	Ranunculaceae	Cyperaceae	Liliaceae/Melastomataceae
Orchidoceae	Scrophulariaceae	Lamiaceae	Lamiaceae	Cyperaceae/Lamiaceae/Rosaceae
Convolvulaceae	Lamiaceae	Rubiaceae	Urticaceae	Myrtaceae/Scrophulariaceae

MDDA = Morang district and adjoining areas; TPN = Terai plains of Nepal (Siwakoti and Varma, 1999); NEP = Nepal (Hara *et al.*, 1978-1982); BI = British India (Hooker, 1904); WF = World Flora (Lawrence, 1965).

Table 4. Basic life form (habit) of the recorded vascular plants

Life form	Number of species	Percentage Contribution
Trees	141	14.9
Shrubs	142	15.0
Undershubs	42	4.4
Woody Climbers	34	3.6
Herbaceous climbers	55	5.9
Herbs	460	48.6
Hydrophytes	38	4.0
Epiphytes	32	3.3
Parasites	3	0.3
Total	947	100.0

Table 5. Raunkiaer's life forms in Morang district and adjoining areas\*

Life forms	Number of species	Percentage
P	330	34.9
C	139	14.7
H	61	6.4
G	134	14.2
T	282	29.8

\*P = Phanerophytes (perennating buds more than 0.3 m above ground); C = Chamaephytes (perennating buds up to 0.3 m above ground); H = Hemicryptophytes (perennating buds close to the ground/ nearly half hidden in the soil); G = Geophytes (perennating buds underground); T = Therophytes (annuals).

*excelsum* (Rubiaceae), *Lagerstroemia parviflora* (Lythraceae), *Litsea monopetala* (Lauraceae), *Madhuca longifolia* (Sapotaceae), *Mallotus philippensis* (Euphorbiaceae), *Mitragyna parviflora* (Rubiaceae), *Nelumbo nucifera* and *Nymphaea stellata* (Nymphaeaceae), *Oroxylum indicum*

(Bignoniaceae), *Pandanus nepalensis* (Pandanaeae), *Paris polyphylla* (Liliaceae), *Phoenix sylvestris* (Arecaceae), *Phyllanthus emblica* (Euphorbiaceae), *Piper longum* (Piperaceae), *Rauwolfia serpentina* (Apocynaceae), *Salix tetrasperma* (Salicaceae), *Salmalia malabarica* (Bombacaceae), *Schleichera oleosa* (Sapindaceae), *Semecarpus anacardium* (Anacardiaceae), *Shorea robusta* (Diperocarpaceae), *Spondias pinnata* (Anacardiaceae), *Sterculia villosa* (Sterculiaceae), *Syzygium cumini* (Myrtaceae), *Tamarindus indica* (Leguminosae), *Taxus baccata* (Taxaceae/ gymnosperm), *Terminalia bellirica* and *T. chebula* (Combretaceae), *Trewia nudiflora* (Euphorbiaceae), *Uvaria hamiltonii* (Annonaceae), *Vetiveria zizanioides* (Poaceae) and *Ziziphus mauritiana* (Rhamnaceae).

The study of Raunkiaer's (1934) life forms showed predominance of phanerophytes (34.9%) followed by therophytes (29.8%) (Table 5). Thus biological spectrum of the study area was phanero-therophytic type. The phanerophytes are the plants of warm and moist climate and therophytes of warm and dry climate. The climate of Morang district and adjoining areas in general is warm and dry during summer and warm and moist during the rainy season. This explains the preponderance of phanerophytes and therophytes in the study area.

Phenological information can also be used to study animal-plant interactions which affect pollination, seed dispersal, and fruit/seed predation. These interactions are important for

plant reproduction and reciprocally for food for the animals involved (Frankie *et al.*, 1974). Observations made on the recorded plants in the study area revealed that 50% species attained the reproductive phase during September-November, 22% in December-February, and 23% in March-August whereas flowering and fruiting occurred throughout the year in only 5% species.

Some of the notable exotic weed species of the study area were *Alternanthera paronychioides*, *A. philoxeroides*, *Chromolaena odorata*, *Eichhornia crassipes*, *Eupatorium adenophorum*, *Gomphrena celosioides*, *Ipomoea carnea*, *Lantana camara*, *Mecardonia procumbens*, *Mikania micrantha*, *Parthenium hysterophorus*, *Peperomia pellucida*, *Solanum aculeatissimum* and *Tridax procumbens*. Among These *C. odorata*, *E. adenophorum*, *L. camara* and *M. micrantha* were most obnoxious in forests; *A. philoxeroides*, *E. crassipes* and *I. carnea* in wetlands; and *P. hysterophorus* in grazing fields, road-sides etc.

Some of the taxa of the study area not included in any of the standard publications on the flora of Nepal (Hara *et al.*, 1978-1982; Iwatsuki, 1988; Siwakoti and Varma, 1999; Press *et al.*, 2000; HMG, 2001) were *Stenochlaena palustre* L. (Lomariopsidaceae) among the pteridophytes and *Borassus flabellifer* L. (Arecaceae), *Cassine paniculata* (Wight & Arn.) Raman (Celastraceae), *Cerato-phyllum demersum* L. (Cerato-phyllaceae), *Cochorus urticifolius* Wight & Arn. (Tiliaceae), *Dysophylla cruciata* Benth. (Lamiaceae), *Nymphaea pubescens* Willd. (Nymphaeaceae), *Ocimum sanctum* L. (Lamiaceae), *Opuntia elatior* Mill (Cactaceae), *Prosopis cineraria* L. (Leguminosae) and *Sclerostachya fusca* (Roxb.) A. Camus (Poaceae) among the angiosperms.

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### References

- Duthie, J.F 1903-1929. *Flora of Upper Gangetic Plain and the adjacent Siwalik and Sub-Himalayan Tracts*, 3 volumes, Calcutta.
- Frankie, G.W., G. Baker and P.A. Opler 1974. Tropical plant phenology: applications for studies in community ecology. In: *Phenology and Seasonality Modeling* (Ed. H. Lieth). Springer-Verlag, Berlin-Heidelberg-New York. pp. 287-296.
- Good, R. 1953. *The Geography of Flowering Plants*. Longmans, London.
- Hara, H. and L.H.J. Williams (Eds.) 1979. *An Enumeration of the Flowering Plants of Nepal*, Vol. 2. British Museum (Natural History) Publ. **810**: 1-220.
- Hara, H., A.O. Chater and L.H.J. Williams (Eds.) 1982. *An Enumeration of the Flowering Plants of Nepal*, Vol. 3. British Museum (Natural History) Publ. **854**: 1-226.
- Hara, H., W.T. Stearn and L.H.J. Williams (Eds.) 1978. *An Enumeration of Flowering Plants of Nepal*, Vol. 1. British Museum (Natural History) Publ. **777**: 1-154.
- HMG (His Majesty's Government, Nepal) 2001. *Flowering Plants of Nepal (Phanerogams)*. Department of Plant Resources, Lalitpur.
- Hooker, J.D. 1904. *A Sketch of the Flora of British India*. Eyre and Srottswoode, London.
- Iwatsuki, K. 1988. An enumeration of the pteridophytes of Nepal. In: *The Himalayan Plants*, Vol. 1. (Eds. H. Ohba and S.B. Malla) University of Tokyo, Tokyo. pp. 231-339.
- Jha, S. 2003. *Ecological study of some selected grasses and forbs found in Morang district of Nepal*. Tribhuvan University, Kathmandu. (Ph.D. Thesis)
- Jha, S. and P.K. Jha 2000. Contributions to the flora of Morang district and adjoining areas of Nepal. *Lidia* (A Norwegian Journal of Botany) **5(1-2)**: 25-64.
- Kumar, T.S. and K.U. Krishnamurthy. 1992. Comparative analysis of the flora of Shervaroy Hills of Eastern Ghats. *Geobios new reports II*: 31-38.
- Lawrence, G.H.M. 1965. *Taxonomy of Vascular Plants*. Macmillan Co., New York.
- Press, J.R., K.K. Shrestha and D.A. Sutton 2000. *Annotated Checklist of the Flowering Plants of Nepal*. The Natural History Museum, London.
- Raunkiaer, C. 1934. *The life form of Plants and Statistical Plant Geography*. Clarendon Press, Oxford.
- Siwakoti, M. and S.K. Varma 1999. *Plant Diversity of Eastern Nepal*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.