

A HANDBOOK OF THE GYMNOSPERMS OF NEPAL



Keshab Raj Rajbhandari
Lajmina Joshi
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Front cover photo: Female cones of *Pinus wallichiana* (left) and *Abies spectabilis* (right). West Nepal, Dolpa district, Phoksundo, 3500 m, 1982.9.30 (Photo: K. R. Rajbhandari).

Back cover photo: *Larix griffithii* (upper photo). East Nepal, Taplejung district, Ghunsa, Rambuk Kharka, 2012.4.9. (Photo: S. K. Rai). *Larix potaninii* var. *himalaica* (lower photo). Central Nepal, Rasuwa district, Langtang, 2009.8.18 (Photo: S. K. Rai).

FOREWORD

The present book '*A handbook of the gymnosperms of Nepal*' includes descriptions and keys of the native gymnosperms of Nepal. Gymnosperms are seed plants with an ovule that is not enclosed in a carpel, as is the case in angiosperms. Gymnosperms are important plants in the flora and vegetation of Nepal. Gymnosperms, especially conifers, play an important role in the forests of Nepal. Almost all the species of conifers of Nepal form forests from the subtropical to the subalpine regions. They are very useful from economic point of view. They provide timber, resin, medicinal plants and dyes.

The present book is based on the herbarium specimens, digitized images and field surveys. The taxonomy of the gymnosperms of Nepal with keys and descriptions for their identification is presented in this book. The representative herbarium specimens (one from each district) are given in each taxon. Anatomical descriptions of the gymnosperms of Nepal are provided for each species.

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Sanjeev Kumar Rai
Director General
Department of Plant Resources

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Keshab Raj Rajbhandari
Lajmina Joshi
Rita Chhetri
Subhash Khatri

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INTRODUCTION

The gymnosperms (Gr. *gymnos*, naked; *sperma*, seed) are seed-bearing plants. They bear their seeds exposed on open megasporophylls (carpels) in contrast to the angiosperms (Gr. *angeion*, a vessel or receptacle; *sperma*, seed) which bear them enclosed within closed megasporophylls or carpels. The gymnosperms are a comparatively small group of the present day vegetation and include about 383 genera and 1026 species (Christenhusz et al., 2011). They are very ancient and include the most primitive seed plants.

The adult plants of gymnosperms are tall, woody, perennial trees or shrubs. The leaves may be dimorphic or of one kind only. The foliage leaves are large and few (*Cycas*) or small and numerous (*Pinus*). The scale leaves may also be present. The foliage leaves are usually evergreen. They may be arranged usually in a spiral manner except in Cupressaceae and Gnetales in which the leaf-arrangement is cyclic. Leaves may be simple as in *Pinus* or compound, e.g., *Cycas*. In most of the conifers which grow in relatively dry, poor soils, the leaves are modified into long, narrow needles, as they are popularly called, to combat the arid conditions. The flowers are unisexual and except in Gnetales have no perianth. They are aggregated, in majority of cases, in compact cones, in which a number of male sporophylls (stamens) or female sporophylls (carpels) are arranged on an elongated axis. The female cones are long-lived structures, sometimes remaining on the plants for several years before they become mature and the seeds are ripened. The male cones are usually smaller and short-lived. The megasporophylls (female carpels) may be broad (*Cycas*) or peltate (*Taxus*). The pollen sacs (microsporangia) may be arranged in definite groups or sori like ferns as in *Cycas* while in conifers, the number of sporangia is reduced frequently to two. The megasporophyll is variable. It may be foliar or leaf-like as in Cycadaceae or cauline as in Taxaceae, while in Pinaceae, it is probably a complex structure. The ovules are borne on the leafy sporophylls. The outer envelope of the ovule or megasporangium is often present forming an aril in *Taxus* or an outgrowth (epimatium) as in *Podocarpus*. It is naked and not enclosed in an ovary like the angiosperms, consequently the pollen-grain is directly carried to the micropyle by wind where it is caught in a drop of mucilage secreted at the apex of the nucellus. The seeds of gymnosperms may be enclosed at maturity by fused cone scales or bracts, which are sometimes fleshy causing the fruiting structures (cones) to be confused with berries (Christenhusz et al., 2011).

Gymnosperms are important plants in the flora and vegetation of Nepal.

Gymnosperms, especially conifers, play an important role in the forests of Nepal. Almost all the species of conifers of Nepal form forests from the subtropical to the subalpine regions. While *Pinus roxburghii* is an important tree in the forest of the subtropical region, *Pinus wallichiana* covers a large area in the temperate region. Sometimes it occurs up to the treeline in the subalpine region. *Gnetum montanum*, the only species in the family Gnetaceae in Nepal occurs in the moist forest of the subtropical region in central Nepal. *Cedrus deodara* and *Abies pindrow* occur in west Nepal. *Larix potaninii* var. *himalaica* and *Taxus wallichiana* var. *mairei* occur in central Nepal. *Picea smithiana* and *Taxus contorta* occur in west and central Nepal. *Abies densa* and *Larix griffithii* are found only in east Nepal. *Abies spectabilis* is a major tree to form subalpine forest usually occurring with birch (*Betula utilis*). In the alpine region *Ephedra* and *Juniperus* species are commonly found and sometimes cover its large areas.

The first book on the gymnosperms of Nepal was by David Don published in 1825 based on the collections of plants collected in Nepal by Francis Buchanan-Hamilton in 1802-1803 and Nathaniel Wallich in 1820-1821. In his book '*Prodromus florae Nepalensis*' Don reported seven species of gymnosperms from Nepal (*Cupressus torulosa*, *Juniperus recurva*, *J. squamata*, *Pinus dumosa* (*Tsuga dumosa*), *Pinus excelsa*, *Pinus spectabilis* (*Abies spectabilis*) and *Podocarpus neriifolius*). Hooker (1888) recorded eight species from Nepal. Travelling from the same route as that of Buchanan-Hamilton and Wallich from Raxaul to Kathmandu and then to Nuwakot in Nepal in 1907, Burkill (1910) reported only one species (*Pinus longifolia*) of gymnosperm collected near Niakot (Nuwakot). Biswas (1933) in a study of the distribution of wild conifers in the Indian Empire mentions the specimens of the following seven species from Nepal, *Juniperus pseudosabina*, *Juniperus recurva*, *Taxus baccata*, *Podocarpus neriifolia*, *Cedrus libani*, *Tsuga brunoniana* and *Abies webbiana*. Banerji (1952) studied the distribution of gymnosperms in eastern Nepal. Based on the plants collected by S. Nakao in 1952 and 1953 in central Nepal Kitamura (1955) reported 12 species of gymnosperms. In 1966 Satake (1966a-c) and Tuyama (1966) reported six species of gymnosperms from east Nepal. In the same way, in 1971 Satake (1971a-c) reported 5 species of gymnosperms (*Taxus baccata* subsp. *wallichiana*, *Pinus griffithii*, *P. roxburghii*, *Tsuga dumosa* and *Juniperus recurva*) from Kathmandu valley and Rasuwa district (central Nepal). In 1974 T. B. Shrestha prepared accounts of gymnosperms of Nepal and in 1999 he again updated his paper and reported 20 species. In the same time Dobremez (1974) gave a summary and complimentary notes on the gymnosperm accounts of T. B. Shrestha. Dobremez & Jest (1976) gave a list of 7 species of gymnosperms,

which they collected in 1970 in the Manaslu area in central Nepal. Bhargava & Bhargava (1978), in their study on distribution of Gymnosperms in Nepal Himalaya based on their personal collections and studies at the herbaria of the Department of Medicinal Plants, and Natural History Museum, Kathmandu, reported 33 species. Franco (1978a-d), Lewis (1978) and Hara et al. (1978) in '*An enumeration of the flowering plants of Nepal volume 1*' reported 23 species from Nepal. In 1988 Suzuki & Noshiro published wood anatomy of the Nepalese gymnosperms. Ohba & Akiyama (1992) reported *Abies spectabilis*, *Juniperus indica*, *J. recurva* and *J. squamata* from Jaljale Himal area (east Nepal). Ohba (1999) reported *Ephedra gerardiana* and Akiyama (1999a-b) reported *Tsuga dumosa* and *Juniperus recurva* from Ganesh Himal area (central Nepal). Miyamoto (2000) reported four species (*Ephedra gerardiana*, *Abies spectabilis*, *Tsuga dumosa* and *Juniperus indica*) from Hinku and Hunku valleys (east Nepal). Press et al. (2000) in their '*Annotated checklist of the flowering plants of Nepal*' recorded 26 species of gymnosperms from Nepal. Bista (2006) in his study on gymnosperms of Nepal noted 26 taxa from Nepal. Fushimi (2008) reported *Ephedra gerardiana* and *E. pachyclada* and Noshiro (2008a-b) reported *Abies spectabilis*, *Pinus wallichiana*, *Cupressus torulosa*, *Juniperus indica*, *J. recurva* and *J. squamata* from Mustang area in central Nepal. On the basis of herbarium specimens preserved in the National Herbarium of Nepal (KATH) Rajbhandari & Joshi (2010a-g) and Rajbhandari et al. (2015) reported 22 native species of gymnosperms in Nepal. Hamanaka et al. (2011) on their study of molecular genetic characteristics reported two species of *Ephedra* (*E. gerardiana* and *E. pachyclada*) from Nepal. Devkota (2013) reported 27 species of gymnosperms from Nepal. Poudel et al. (2012) reported three species of *Taxus* (*T. contorta*, *T. mairei* and *T. wallichiana*) from Nepal and Bhatt et al. (2017) described them in Nepali. K. K. Shrestha et al. (2018) in their book '*Handbook of flowering plants of Nepal*' reported 33 species of gymnosperms from Nepal.

In Nepal the native gymnosperms are represented by 7 families, 13 genera, 23 species and 3 varieties. In a book published by the Botanical Society of Nepal we presented an article with the status and distribution of Nepalese gymnosperms (Rajbhandari et al., 2020). We present here the taxonomy of these taxa with keys and descriptions for their identification. The representative herbarium specimens (one from each district) are given in each taxon.

Regarding the format of the species information in the book the valid scientific name of the plant (in bold letters) is given first. After valid name author(s) of name and its publication are included. Whenever available, the valid name is followed by synonym of the plant (in italics). In the synonyms, the

basionym is given first. In case of many synonyms the basionym is followed by other synonyms in alphabetical order. After synonym Nepali name and English name are provided wherever available. This is then followed by the habit of the plant whether it is a herb, shrub, tree or climber and then by short description of the plant. Then the general distribution, ecology and uses of the species are given as far as available. The places of collection of three phytogeographical zones of Nepal according to Stearn (1960), i.e., West Nepal (from western border to 83° E longitude), Central Nepal (from 83° E longitude to 86°30' E longitude) and East Nepal (from 86°30' E longitude to eastern border) are included. One specimen (if available) from the district in each zone preserved in the herbaria of Nepal or international herbaria is listed. District name, locality and date of collection, altitude, collector(s), field number and acronym of the herbarium, where the herbarium is deposited, are given for each specimen. Type specimen (holotype, isotype, syntype, lectotype) is included, if it is from Nepal. One more specimen besides the type specimen, if available from the same district is included along with the type specimen. The names of herbaria where specimens of gymnosperms from Nepal are preserved are given (Table 1). The anatomical characters of the Nepalese gymnosperms are included in this book. The importance of anatomical studies of the woody plants were shown by Suzuki & Noshiro in their article '*Wood structure of Himalayan plants*' published in 1988. They write '*It is well known that information on the wood structure of trees growing in a country or in a region is indispensable, not only for the taxonomical and systematic studies of these plants, but also for the correct evaluation of the forest resources*' (Suzuki & Noshiro, 1988).

Table 1. List of herbaria where specimens of Nepalese gymnosperms are preserved.

<u>Acronym</u>	<u>Institution</u>	<u>Country</u>
A	Harvard University Herbaria, Cambridge, Massachusetts	U. S. A.
BAYLU	Baylor University, Waco, Texas	U. S. A.
BM	Natural History Museum, London	U. K.
E	Royal Botanic Garden Edinburgh, Edinburgh, Scotland	U. K.
K	Royal Botanic Gardens, Kew, Surrey	U. K.
KATH	Department of Plant Resources, Godawari, Lalitpur	Nepal
TI	University of Tokyo, Tokyo	Japan
TUCH	Central Department of Botany, Tribhuvan University, Kathmandu	Nepal

Christenhusz et al. presented in 2011 a classification and linear sequence of the gymnosperms based on molecular and morphological studies. In the

classification they listed currently accepted genera for each family and arranged according to their (probable) phylogenetic position. Gymnosperms are divided into four subclasses, 8 orders and 12 families. The linear classification of the extant gymnosperms according to Christenhusz et al. (2011) is given as below. Genera found wild in Nepal are given in bold letters in the family.

GYMNOSPERMAE

(number of species in Nepal are included in the bracket)

Subclass I. Cycadidae

Order A. Cycadales

Family 1. Cycadaceae – **Cycas** (1 species)

Family 2. Zamiaceae – 9 genera

Subclass II. Ginkgoidae

Order B. Ginkgoales

Family 3. Ginkgoaceae - *Ginkgo*

Subclass III. Gnetidae

Order C. Welwitschiales

Family 4. Welwitschiaceae - *Welwitschia*

Order D. Gnetales

Family 5. Gnetaceae – **Gnetum** (1 species)

Order E. Ephedrales

Family 6. Ephedraceae – **Ephedra** (2 species and 1 variety)

Subclass IV. Pinidae

Order F. Pinales

Family 7. Pinaceae – 11 genera including **Abies** (3 species),
Cedrus (1 species), **Larix** (2 species), **Picea** (1 species),
Pinus (2 species), **Tsuga** (1 species)

Order G. Araucariales

Family 8. Araucariaceae – 3 genera

Family 9. Podocarpaceae – 19 genera including **Podocarpus** (1 species)

Order H. Cupressales

Family 10. Sciadopityaceae - *Sciadopitys*

Family 11. Cupressaceae – 29 genera including **Cupressus** (1 species), **Juniperus** (5 species and 1 variety)

Family 12. Taxaceae – 6 genera including **Taxus** (2 species and 1 variety)



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