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VANSAPATI MARGA
THAPATHALI, KATHMANDU

FOREWORD

Nepal is a rich in natural resources with geographic and climatic diversity which culminates into a great diversity of flora and fauna including endemic flora and fauna. Nepal is one of the important places for scientists, naturalists and researchers in unveiling natural treasures. The Department of Plant Resources (DPR) is engaged in developing new methods and technique in plant resources in conservation, sustainable use and equitable sharing of benefits to enhance livelihood of rural people.

Since its establishment in 2016 B.S., this department has been involved in plant exploration, taxonomical identification, ecological studies, mycology, anatomy, ethnobotany, biotechnology ,study of active chemical constituents, biological activity of active ingredients, bio-prospecting etc. With our long time dedication and expertise, we have been successful in bringing out the valuable publications such as local flora, fascicles, checklists, MSDS of MAPs and catalogues of flowering as well as non-flowering plants of Nepal. In addition to this department has developed generic guidelines for Good Agriculture Practices (GAP) and Good Cultivation Practices (GCP) of Medicinal and Aromatic Plants (MAPs) as national standard. The department also conducts phytochemical screening researches for bio-prospecting of unexplored plant of Nepal.

Being one of the parties to the Convention on Biological diversity 1992, Nepal Biodiversity Strategy and Action plan 2014-2020 has given emphasis on the publication of all the volumes of Nepal Flora by 2020. Volume 3 and companion volume to the Flora of Nepal have already been published in collaboration with Royal Botanical Garden Edinburgh, UK, Society of Himalayan Botany, Japan, Nepal Academy of Science and Technology (NAST) and Central Department of Botany, Tribhuvan University. Furthermore emphasis is given to the accreditation of laboratories of DPR. The laboratory accreditation is in the process and first assessment of laboratory has been carried out by National Accreditation Body for Testing and Calibration Laboratory (NABL), India.

For dissemination of information on the activities, we conduct seminar, workshops, interactions, publish newsletters and scientific bulletins. I hope the present bulletin of Plant Resource will provide adequate materials to the interested readers, researchers, students and concerned stakeholders.

I would like to thank the painstaking efforts of all the paper contributors, editorial board members, reviewers and staffs of Publicity and Documentation Section of DPR to bring out this publication in this form.

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Rajdev Prasad Yadav
Director General
April 2016

Editorial

We are pleased to bring out the present issue of Plant Resource "Bull.Dept.Pl.Res.No. 38", a continuation of research publication by Department of Plant Resources (DPR). The issue carries a score of peer reviewed articles based on original research. Since this publication intends to highlight on the scope and objectives of our Department, we are aware that the publication should accommodate as many articles as possible so that it represents the work of DPR. And at the same time we are also aware of the need to produce the scientific quality and integrity of the research articles. 20 articles have been incorporated in this issue under different categories like systematic botany, ethnobotanical study, floristic survey, ecology, biotechnology, study of the effect of active chemical constituents of plants on the live animals and biological study (Microbiological). This issue also includes a special article on Endemic Flowering Plants of Nepal. Nepal is rich not only in floristic and faunal diversity but also on endemism due to its phytogeographical diversity.

We encourage our scientists to pursue quality research and contribute to build scientific knowledge on phytochemical screening and pharmaceutical researches for bio-prospecting of unexplored plant of Nepal . The reviewers of the articles published here have contributed much of their knowledge and time to justify the quality of research articles. We heartily thank them all. We duely acknowledge the contribution of contributors for their interest in publishing their valued work in this publication and looking forward to further cooperation and collaboration with other scientific institution. We value the comments and opinion of our contributors and readers. We apologize in advance for any lapses in this issue and at the same time promise to improve the future issues based on your valued input.

Revised checklist to the mycotaxa proposed from Nepal

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Abstract

The proposed mycotaxa accumulated since the works of Berkely (1854) from Nepal are revised based on 156 published papers for their endemism.The papers record about 5 monotypic taxa and 203 species of mycobiota gathered from different regions of Nepalese Himalayan belt. At present, the list shows 131 endemic species. Among them the nomenclature of 120 taxa remains as proposed, while 11 species have undergone synonyms. Sixtyfour species have been recorded to occure in other countries.Two taxa remains invalid.

Key words : Endemic taxa, distribution, synonyms, Nepal Himalaya

Introduction

Nepal Himalaya has been considered as centre for origin, appearance and dominance of number of mycobiota and their distribution pattern between high and low altitude forms, the present number of species is 10 times smaller in comparison to India (Adhikari 1990ab, 2000, 2009, 2014a). Yet the mycoflora Nepal serves as a connecting link with Sino-Japanese, Western and Central Asiatic, North East American, partly North African and mostly Indian subcontinent. The eastern sector shows some of the flora characteristic to South-East Asia, while the rest shows their affinity with the North- West Himalayan elements. Adhikari (2000, 2014ab) also considered 3 mycogeographic regions on the basis of findings of *Amauroderma rugosum* in (Sanghu, Dhankuta) Eastern Himalaya and *Aecidium urticae* in (Bajhang) North-West Himalaya, which supports the view of Stearn (1960) to be divided into 3 phytogeographic regions. The horizontal and vertical distribution of many mycoflora in Nepal coincides well with the phytogeographical division proposed by Dobremez (1972). The alpine zone is rich in many endemic mycobiotypes. Some species from the subtropical and tropical zones include pantropical species. In the dry N.W. Nepal there occur several xerophilous species which are absent from the rest of Nepal; some of them are endemic, others range from Nepal through Middle Asia to W. Europe (Kreisel, 1976)

Several papers on the newly proposed mycotaxa have accumulated since the works of Berkeley (1854) gathered in different regons of Nepalese Himalayan belts. Many mycobiota still await their discovery. Revision is sough necessary in time to time as there is much change in taxonomic treatments of the taxa. (Adhikari, 1992, 2009). A glimpse to the proposed taxa can be found in the literatures like: *'History of mycological explorations in Nepal'* (Adhikari, 1990), Adhikari (1992), Berkeley (1839, 1847), *'Cryptogams of the Himalayas' vol. 3: Pakistan and Nepal'* (1995 – see Ono *et al.*), *'Mushrooms of Nepal'* (Adhikari, 2000, 2014b), '*Researches on the Nepalese Mycoflora, part* 1 (Adhikari, 2009) *&* *2* (Adhikari, 2012) and '*Biodiversite des Basidiomycetes au Nepal: etude systematique et biogeographique. Specialite Ecologie-Mycoloique'* (Adhikari, 1996).

Till now 721 genera 2467 species 5 gen.nov. and 203 sp. nov. have been reported (Adhikari, 2000, 2009, 2014b) from different regions of Nepalese Himalayan belt. The revised list shows that among 131 endemic species the nomenclacture of 120 species remains as proposed, while 11 species have undergone nomenclature changes. Sixtyfour species have been recorded to occure in other countries.Two taxa remains invalid.

Materials and methods

This paper is the result of review of 155 papers to find out the prevailing endemic mycobiota of this Himalayan country. Near about 20 species were found unpublished records (not provided here) deposited in different herbaria of the world (for list see Adhikari, 2014b). The year of publication of the proposed new species follows the authors (indicated in the parenthesis). Moreover based on the web data (Mycobank, 2015; Wikipedia , 2013; Species Fungorum, 2015; Catalogue of Life: 2012 Annual Checklist)), different publications [Guzmán & Ramírez-Guillén, (2004), Núòez & Ryvarden (2001), Ramadive (2012), Yang (1997) and Zhuang & Wei (1994, 2002)] and list of species deposited in CAB Herbarium (Meulder,2006), the species are grouped under monotypic taxa, endemic species, species reported from other countries, nomenclature changes and distribution and invalid taxa (according to ICBN).

Enumeration of species

1. Monotypic taxa

A. From Nepal

a. *Brachycodiellopsis*; *Brachycodiellopsis fimicola* Decock, Castaneda-Ruiz & Adhikari (2004) - Nepal
b. *Cladosporothyrium*; *Cladosporothyrium nepalense* Katumoto (1984) - Nepal
c. *Paraphialocephla: Paraphialocephla himalayana* Budathoki (1997) - Nepal
d. *Paraaoria: Paraaoria himalayan* Verma & Kamal (1987) - Nepal

B. From Nepal and other country

a. *Amylaria*: *Amylaria himalayensis* Corner (Balfour-Browne, 1955) – Bhutan (Holotype) and Nepal

2. Endemic species

1. *Aecidium pleurospermae* Balfour Browne (1955)
2. *Alternaria nepalensis* Simmon [1997; L'article *Alternaria nepalensis* n'existe pas encore. Comment faire pour le créer ?, Wikipedia] (see 2007)
3. *Anixiopsis biplanata* Guého & De Vroey (1986)
4. *Apiosordaria otanii* Udagawa (1990)
5. *Apiosordaria vestita* Udagawa & Horie (1982)
6. *Arcyria aureoglobosa* Yamamoto (1990)
7. *Arcyria nepalensis* Poelt (1969)
8. *Arcyria poeltii* Nannenga-Bremekamp & Yamamoto (1990)
9. *Botryobasidium subbotryosum* Rattan (1977)
10. *Bovista substerilis* Kreisel (1976)
11. *Bovista vascelloides* Kreisel (1976)
12. *Bovistella poeltii* Kreisel (1969)
13. *Cercophora himalayensis* Udagawa & Sugiyama (1982)
14. *Cercospora nepalensis* Singh & Nisha (1973b)
15. *Cercospora zantedeschiana* Singh & Nisha (1973b)
16. *Ceriporia subcorticulata* Ryv. & (in Hjort. & Ryv., 1984)
17. *Chroogomphus asiaticus* Miller & Aime (2001)
18. *Chrysomyxa taghishae* Balfour Browne (1955)
19. *Clavulina alta* Corner (1968- in Balfour – Browne, 1968)
20. *Coleosporium anemones* Ono, Adhikari & Rajbhandari (1988)
21. *Coleosporium nepalense* Durrieu (1979)
22. *Coniochaeta emodensis* Udagawa & Horie (1982)
23. *Coniochaeta nepalica* Minoura, Morinaga & Muroi (1977)
24. *Coniochaeta perangusta* Udagawa & Sugiyama (1982)
25. *Dasyscyphus thindii* Sharma (1983a)
26. *Debaromyces nepalensis* Goto & Sugiyama (1968)
27. *Dictyostelium aureocephalum* Hagiwara (1991)
28. *Dictyostelium elegans* Hagiwara (1990)
29. *Dictyostelium gracile* Hagiwara (1983)
30. *Dictyostelium longosporum* Hagiwara (1983)
31. *Dictyostelium medium* Hagiwara (1990)
32. *Disciseda ochrochalcea* Kreisel (1976)
33. *Eupenicillium nepalense* Takada & Udagawa (1983)
34. *Galasinospora himalayensis* Horie & Udagawa (1974) [=*Neurospora himalayensis* (Y. Horie & Udagawa) García, Stchigel, Cano, Guarro and Hawksworth (2004)]
35. *Gymnosporangium pamarense* Balfour-Browne 1955)
36. *Hamaspora dobremezii* Durrieu (1975)

37. *Hamaspora viennotii* Durrieu (1977b)
38. *Hapalophragmium nepalense* Durrieu (1980)
39. *Isia anixielloides* Udagawa & Sugiyama (1982)
40. *Lactarius thakalorum* Bills & Cotter (1989)
41. *Lamproderma nigrisplendidum* Poelt (1969)
42. *Lycogala fuscoviolaceum* Onsberg (1973)
43. *Lycoperdon altimontanum* Kreisel (1976)
44. *Lycoperdon elongatum* Berk. (1854)
45. *Lycoperdon lambinonii* var. *quercetorum* Kreisel (1976)
46. *Melampsora ribis* Durrieu (1979)
47. *Meliola castanopsidis* Budathoki & Singh (1994)
48. *Meliola oscmanthiana* Budathoki & Singh (1994) (should be *Meliola osmanthiana* Adhikari (2009)
49. *Meliola santalacearum* Budathoki & Singh (1994)
50. *Mollisia dhankutae Balfour-Browne (1968)*
51. *Mycovellosiella nerii-indici* Kirti, Sanjay, Singh & Srivastava (1997) (in Bhalla, Singh and Srivastava ,1997)
52. *Mycovellosiella solanacearum* Kirti, Sanjay, Singh & Srivastava (1997) (in Bhalla, Singh and Srivastava ,1997)
53. *Mycovellosiella malloti* Kharwar, Singh & Chaudhary (1996)(in Kherwar & Singh, 1996)
54. *Mycovellosiella mucunae* Kharwar, Singh & Chaudhary (1996) (in Kherwar & Singh, 1996)
55. *Mycovellosiella viticis* Kharwar, Singh & Chaudhary (1996) (in Kherwar & Singh, 1996)
56. *Pachykytospora nepalensis* Hattori (2002)(in Hattori, Adhikari, Suda & Doi, 2002)
57. *Parrotia melamchinensis* Balfour Browne (1968)
58. *Passalora nepalensis* Adhikari & Manandhar (1986)
59. *Periconiella litseae Singh, Bhalla, & Singh (1998) [= Periconiella litseae* Budathoki (2009)]
60. *Phaeoramularia clematidis* Singh, Chaudhary &Morgan-Jones (1995)
61. *Phaeoramularia nepalensis* Singh, Chaudhary & Morgan-Jones (1995)
62. *Phaeoramularia pyricola* Singh, Chaudhary & Morgan-Jones (1995)
63. *Phellinus poltii* Ryvarden & Hjortstam (1977)
64. *Phellinus subsanfordii* Hattori (2002)
65. *Pholiota microspora* (Berk.) Sacc. var. *himalensis* Adhikari & Watanabe (2014)(in Adhikari, Watanabe & Parajuli, 2014)
66. *Phragmidium quinqueloculare* var. *triseptatum* Durrieu (1977)
67. *Pleurotus nepalensis* Corner (1955 – in Balfour-Browne, 1955; Mycobank, August 2015[update], Index Fungorum lists)
68. *Podosporium himalensis* Balfour Browne (1968)
69. *Pseudocercospora heterospermi* Budathoki & Singh (1995)
70. *Pseudocercospora hibiscigena* Singh, Singh & Tripathi (1996)
71. *Pseudocercospora himalayana* Budathoki & Singh (1995)
72. *Pseudocercospora justiciicola* Singh, Singh & Tripathi (1996)
73. *Pseudocercospora pileae* Singh, Singh & Tripathi (1996)
74. *Pseudocercospora smilacis* Budathoki & Singh (1995)
75. *Pseudocercospora urticacearum* Verma & Kamal (1989)
76. *Pseudocercosporella arcuata* Singh, Singh, & Bhall (1997)
77. *Pseudocercosporella woodfordiana* Singh, Singh & Bhall *(1997)*
78. *Puccinia annapurnae* Durrieu (1979)
79. *Puccinia kathmanduensis* Adhikari (1998)
80. *Puccinia kyangjinensis* Ono, Adhikari & Rajbhandari (1988)
81. *Puccinia mallae* Durrieu (1979)
82. *Puccinia manangensis* Durrieu (1979)
83. *Puccinia mercei* Durrieu (1987)
84. *Puccinia morduei* Adhikari (1998)
85. *Puccinia ophiopogonis* var. *phulchowkiensis* Adhikari (1998)
86. *Radulum spongiosum* Berk. (1854)
87. *Ramaria fuscobrunnea* Corner (in Balfour-Browne, 1955)
88. *Ravenelia microcephala* Durrieu (1980)
89. *Rhytisma piceum* Berk. (1854c)
90. *Russula chloroides* var. *godavariensis* Adhikari (1999)

91. *Russula delica* var. *dobremezii* Adhikari (1999)
92. *Russula kathmanduensis* Adhikari (1999)
93. *Russula nepalensis* Adhikari (1990)
94. *Schiffnerula cannabis* McPartland & Hughes (1994)
95. *Secotium himalaicum* Zang & Doi (1995)
96. *Spathularia bifurcata* Otani (1982)
97. *Sporormia nepalensis* Udagawa & Sugiyama (1982)
98. *Stenella mahoniae* Verma, Budhathoki & Kamal (1989)
99. *Stenella osyrina* Chaudhary & Singh (1996) (in Chaudhary, Singh & Morgan-jeans, 1996)
100. *Stenella rhododendricola* Misra, Srivastava & Kamal *(1999)*
101. *Stenellopsis nepalensis* Chaudhary & Singh (1996)
102. *Stereum endocrocinum* Berk. (1854b)
103. *Talaromyces convolutus* Udagawa (1993) [*Penicillium convolutum* Udagawa, anamorph]
104. *Talaromyces emodensis* Udagawa (1993) [*Penicillium emodense* Udagawa, anamorph]
105. *Talaromyces tardifaciens* Udagawa (1993) [*Penicillium tardifaciens* Udagawa, anamorph]
106. *Taphrina nepalensis* Otani & Bhandary (1982)
107. *Thielavia emodensis* Udagawa & Sugiyama (1982)
108. *Thielavia expensa* Udagawa & Sugiyama (1982)
109. *Tretospora himalayana* Chaudhary & Singh (1996)
110. *Trichaptum montanum* Hattori (2002)(in Hattori, Adhikari, Suda & Doi, 2002)
111. *Uncinula embeliae* Verma, Chand & Kamal (1990)
112. *Uncinula kydiae-calcynae* Verma, Chand & Kamal (1990)
113. *Uromyces dobremezii* Durrieu (1979)
114. *Uromyces himalaicus* Ono, Adhikari & Rajbhandari (1988)
115. *Uromyces langtangensis* Durr. (1987) [*Uremyces amoenus* Sydow & Sydow (1906) – in Ono, Adhikari & Kaneko (1995)]. Comment – *Uromyces langtangensis* with teliosporae 27-37 x 18-29 µm is larger and very different from *U. amoenus* (India, Nepal, NParadise Valley, Mount Tacoma, Washington) with teliosporae 18-28 x 14 - 22 µm (Durrieu, 2015, Pers. com.), so retention of *Uromyces langtangensis* Durrieu, is proposed as endemic to Nepal
116. *Uromyces obesus* Durrieu (1987)
117. *Uromyces tamagadiensis* Adhikari (1998)
118. *Ustilago kathmanduensis* Adhikari (1998)
119. *Xeromphalina aspara* Mass (1992)
120. *Xylaria fistuca* Berk. (1854d)

3. Species reported from other countries

1. *Alternaria longissima* Deighton & Macgarrie (1968) (in Seung-Hun, Mathur and Neergaard, 1982) - Korea
2. *Amanita chepangiana* Tulloss & Bhandary (1992) in China (Yang, 1997; Wikipedia, 2013)
3. *Amanita cinnamomescens* Tulloss, Iqbal, Khalid & Bhandary (2001) – in Pakistan (holotype)
4. *Anixiopsis stercoraria* (Hansen) Hansen (1897) - Australia and New Guinea (Catalogue of Life: 2012 Annual Checklist)
5. *Botryobasidium subbotryosum* Rattan (1977)- Indian subcontinent (Ranadive, 2013; Wikipedia, 2015)
6. *Chromocyphella bryophyticola* Balfour Browne (1968) – Australia (Atlas of Living Australia, (Catalogue of Life: 2012 Annual Checklist) *bie.ala.org.au/***species***/urn:lsid:catalogueoflife.org:taxon:4f7d760a (Wikipedia, 2014).*
7. *Coleosporium pseudocampanulae* Kaneko, Kakishima & Ono (1990, in Zhuang & Wei, 1994) - China
8. *Coleosporium himalayense* Durrieu (1977a) – India (in Singh, Khan & Mizra. 1987)
9. *Dictyostelium clavatum* Hagiwara (1990) - Nepal and Taiwan (**Z.Y.Yeh,** in *BiotaTaiwanica*, publicaton year not given, 2002 web)
10. *Dictyostelium exiguum* Hagiwara (1983) - Nepal and Taiwan (**Z.Y.Yeh** *BiotaTaiwanica* publication year not provided, 2002 web)
11. *Diderma niveum* Onsberg (1973)- New Zealand (2010) [in The New Zealand Plant Conservation Network; Stephenson, (2003); widely distributed in the mountains of Europe

and western North America (Martin & Alexoupulos 1969) and also known from the Antarctic (Ing & Smith 1983) in Stephenson (2003)]

12. *Disciseda alpina* Kreisel (1976) – Mongolia (in Kreisel, 2008).
13. *Grammothele bambusicola* Ryvarden & Hjortstam (1984) (in Hjortstam & Ryvarden, 1984) – China [Zhou & Dai, 2012)
14. *Hamaspora nepalensis* Durrieu (1975) – China (Zhuang, 1984)
15. *Hemitrichia serpula* (Scop.) Rost. var. *tubiglabra* Nann.-Brem. & Yam. (1990) – China
16. *Inonotus hamusetulus* Ryv.(1984) (Ranadive, 2013) - India
17. *Lentaria macrospora* Corner (1968) (in Balfour-Browne, 1968) - Asia
18. *Leotia himalayaensis* Otani (1982) - China
19. *Lycoperdon niveum* Kreisel (1969)- Artic-alpine species so far known from the Himalayas and Iceland.
20. *Lycoperdon perlatum* var. *dobremezianum* Kreisel (1976) - India
21. *Lycoperdon yetisodale* Kreisel (1969) - China
22. *Mollisia dhankutae* Balfour Browne (1968) – India (in Agarwal, 2005)
23. *Mycovellosiella adinae- cordifoli* Kharwar & Narayan (2000) - India
24. *Mycovellosiella desmodigena* Kharwar & Narayan (2000) - India
25. *Mycovellosiella neri* Kharwar & Narayan (2000)- India
26. *Peniophora bicornis* Ryvarden & Hjortstam (1979) [Nepal (type locality), Gabon, Reunion Island, Singapore, Taiwan in Hjortstam & Ryvarden, 1984; Mycobank, 2015)
27. *Phellinus acontextus* Ryv. & Hjort. (1984)[in Ryvarden (1984); Hattori (1999); Ranadive (2013)] – India, Japan
28. *Phragmidium cinnamomeum* Durrieu (1980, in Zhuang & Wei, 1994) - China
29. *Physarum plicatum* Nann.-Bremek. & Yamam. (1990)
30. *Polyporus vivax* Berk. (1854) – Australia [in Atlas of Living Australia,Scott), 1934; *Hookers J. Bot. Kew Gard. Misc. 6: 140. 1854*
31. *Pseudobeltrania chumrungensis* Sutton (1970) - Hawaii (2005, Pathogens of plants of Hawaii- *www.hear.org/pph/hosts/1692.htm)*
32. *Puccinia heraclei nepalensis* Durrieu (1979)(in Zhuang & Wei, 1994) - China
33. *Puccinia nepalensis* Barclay & Dietel (1890)(in Zhuang & Wei, 1994) - China
34. *Puccinia pilearum* Durrieu (1977)(in Zhuang & Wei, 1994) - China
35. *Schizopora roseotingens* Hjort. & Ryv. (1984) (Ranadive, 2013) - India
36. *Stemonaria argentella* Y. Yamam (1990) – Australia ((Atlas of Living Australia, Catalogue of Life: 2012 Annual Checklist))
37. *Stemonitis laxifila* Nan.-Bremekamp & Yamamoto (1988) – Australia (Catalogue of Life: 2012 Annual Checklist)
38. *Sterchherinum albo-fibrillosa* (Hjort. & Ryv.) Hallenb. & Hjort. (1984) (in Web-2011) - India
39. *Suillus adhikarii* Das, Chakraborty & Cotter (2015) – India (type)
40. *Trametes tephroleuca* Berk. (1854) - Europe, Japan China, N. America, India and Nepal
41. *Veronaea ficina* Kharwar & Singh (2004) - India
42. *Veronaea grewiicola* Kharwar & Singh (2004) - India
43. *Veronaea hippocratiae* Kharwar & Singh (2004) - India

4. Nomenclature changes and distribution

Taxa proposed (Syn. denoted by = and enclosed in large brackets [ ]) Valid name

A. Endemic to Nepal

1. [= *Achaetomium nepalense* Udagawa & Sugiyama (1982)] *Chaetomium nepalense* (Udagawa & Y. Sugiy.) Arx (1985)
2. [=*Anixiella sphaerospora* Y. Horie & Udagawa (1974); *Neurospora sphaerospora* (Horie & Udagawa) García, Stchigel & Guarro (2004)] *Gelasinospora sphaerospora* (Horie & Udagawa) Arx 1982
3. [= *Cordyceps nepalensis* Zang & Kinjo (1998)] *Ophiocordyceps nepalensis* (Zang & Kinjo) Sung, Sung, Hywel-Jones & Spatafora (2007). This species is treated as conspecific of *Ophiocordyceps sinensis*. [Sung, Sung, Hywel-Jones & Spatafora, 2007; Shrestha *et al*. (2010) *Mycology.* 1(4):228-236]. But, recently Shrestha (2011) *Nep. Jour. Sc. Tech.* 12:

103-110, alone has treated *Ophiocordyceps multiaxialis* and *Ophiocordyceps nepalensis* as separate species.

4. [= *Eupenicillium angustiporcatum* Takada & Udagawa (1983)] *Penicillium angustiporcatum* Takada & Udagawa (1983) in MycoBank and, Wikipedia, (2015)
5. [= *Phaeoramularia adenostemmatis* Verma & Kamal (1989)] *Passalora adenostemmatis* (Verma & Kamal) Braun & Crous (in Crous & Braun, *CBS Diversity Ser.* (Utrecht) 1: 437 (2003).
6. [= *Sphacelotheca himalensis* Kakishima & Ono (1988)] ***Microbotryum himalense*** (Kakish. & Y. **Ono**) **Vánky**, *Mycotaxon* 67: 44 (1998, *Ustilago himalensis* (Kakis. & Ono) Vánky & Oberw., 1994:50 (*Sph.h.*)– *Polyg. macrophyllum* (= *Microb. himalense*)
7. [= *Sphaeria nepalensis* Berk. (1854d)] *Valsa nepalensis* (Berk.) Sacc. (1882)
8. [= *Stilbum lateritium Berk.* (1854)] *Tubercularia lateritia* (Berk.) Seifert, (1985) Wikipedia modified on 28 August 2015, at 17:29
9. [= *Ustilago ocrearum* Berk.(1854c); *Bauhinus ocrearum* (Berk.)Denchev & R.T. Moore (2006) in Denchev & Shin (2006), *Mycol. Balcanica* 3(1):72] *Microbotryum ocrearum* (Berk.)Vánky (1998)
10. [= *Verrucispora Khan*, Budathoki & Kamal (1991)] *Verrucisporota* Shaw & Alcorn (1993)
11. [= *Verrucispora luculiae Khan,* Budathoki & Kamal (1991)] *Verrucisporota luculiae* (*Khan,* Budathoki & Kamal) Shaw & Alcorn (1993)

B. <u>Reported in other countries</u>

1. [= *Achaetomium purpurascens* Udagawa & Sugiyama (1982) *Chaetomium purpurascens* (Udagawa & Y. Sugiy.) Arx (1985) (Cannon, 1986) – Australia and Nepal
2. [= *Anixiella micropertusa* Horie & Udagawa (1973)] *Gelasinospora micropertusa* (Horie & Udagawa) Von Arx (1982) (Atlas of Living Australia: Catalogue of Life: 2012 Annual checklist) – Australia, Nepal
3. [= *Anthracoidea nepalensis* Kakishima & Ono (1988)] *Anthracoidea dissiformis* (Lira) M. Piatak (2012) – China, India, Nepal
4. [= *Cercospora trifolii repentis* Singh & Nisha (1973)] ***Cercospora zebrine***Peck (1877: Hedwigia 16: 124.)-in many countries
5. [= *Dictyostelium magnum* Hagiwara (1983)] *Dictyostelium gigantium* Singh (1947) – India, Nepal
6. [= *Irpex zonatus* Berkeley (1854b)] *Antrodiella zonata* (Berk.) Ryv.(1992) (in Núòez & Ryvarden, 2001, Ramadive, 2012) – Asia (India, Japan, Thailand, China), New Zealand, Russia, Argentina, Nepal
7. [= *Lentinus inquinance* Berk (1854a)] *Lentinus badius* (Berk.)Berk. (1847) – India, Nepal, Malaysia, Thailand, Japan
8. [= *Lentinus nepalensis* Berk. (1854a); *Pocillaria nepalensis* (Berk.) Kuntz.; *Pocillaria velutinus* (Fr.) Kuntz (1891)] *Lentinus velutinus* Fr (1830) – Australia, India, Nepal
9. [= *Lycoperdon emodensis* Berk.(1854); *Lycoperdon pyriforme* Schaeff.: Pers] *Morganella pyriformis* (Schaeff.: Pers.) Kreisel & Krüger [Mycotaxon 86:175. (2003) - *Worldwide*
10. [= *Phlebia albofibrillosa* Hjort.& Ryv. (1984)] *Steccherinum albofibrillosa* (Hjort. & Ryv.) Hallenb. & Hjort – India, Nepal
11. [= *Polyporus cereus* Berk. (1854); *Polyporus xeranticus* Berk. (1854)] *Hymenochaete xerantica* (Berk.) S.H. He & Y.C.Dai, *Fungal Diversity* 56(1): 90 (2012) - Europe, N. America, Japan and Nepal.
12. [= *Polyporus elatinus* Berk.(1854a)]

Postia tephroleuca (Fr.) Julich (1982) - Common

13. [= *Polyporus flavidus* Berk.(1854b)] *Inonotus flavidus* (Berk.) Ryv.(1984) - Japan and Taiwan, Nepal
14. [= *Polyporus florideus* Berk. (1854b)] *Microporus xanthopus* (Fr.) Kuntz. (1898) –Common
15. [= *Polyporus nepalensis* Berk.(1854); *Polyporus menziesii* Berk. (1843); *Polyporus corium* Berk. (1854); *Polyporus thwaitesii* Berk.(1854); *Polystictus nepalensis* (Berk.) Cooke (1886)*; Microporus nepalensis* (Berk.) Kuntze (1898) in Wikipedia 2014]] *Trametes menziesii* (Berk.) Ryvarden (1972 in Mycobank and Wikipedia, (2014).
16. [= *Polyporus pictilis* Berk. ((1854b)] *Tramates versicolor* (L.:Fr.)Pilat – Common
17. [= *Puccinia commelinae* Durrieu (1979); *Puccinia durrieui* Ono (1990)] *Puccinia adhikarii* Ono ((1995) – Comment = *Puccinia commelinae* Durrieu was preoccupied by *P. commelinae* Holway (1904), it was replaced by *P. commelinae-benghalensi* Zhuang (1998) – (Durrieu, 2015- Pers. Com.), Wikipedia 18 September 2014 kl. 13.34. *Puccinia adhikarii* Ono (1995), in Zhuang & Wei (1994) as *P. durrieui* Ono) – Nepal and China.
18. [= *Ravenelia pennatae* Durr. (1980)] *Ravenelia parasnathii* Yadav (1963) – India, Nepal
19. [= *Scleroderma nitidum* Berkeley (1854b)] *Veligaster nitidum* (Berk.) Guzman & Tapia (1995)(in Guzmán & Ramírez-Guillén,2004) - Virgin Islands Costa Rica, Cuba, Mexico and Nepal (type locality)]
20. [= *Trametes versatilis* Berk (Berkeley, 1854)] *Trichaptum byssogenum* (Jungh.) Ryv. - Europe, N. America and Nepal.
21. [= *Ustilago emodensis* Berk.(1854c)] *Liroa emodensis* (Berk.)Ciferri.(1933) – India, Nepal, China, Japan
22. [= *Ustilago endotricha* Berk (1854c)] *Farysporium endotrichum* (Berk.) Vánky *Mycotaxon.* 71:208 (1999) – Australia

5. Invalid taxa

(No diagonsotic characters and Latin diagnoses of both genera and species given according to code of ICBN)

1. *Epiccospora parasitica* Budhathoki gen. et sp. nov. on *Osyaris orborea* (1994)
2. *Fulviomyces nepalensis* Budhathoki gen. et sp. nov. on *Eurya acuminate* (1994)

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References

Anixiopsis stercoraria: keratinic *fungi* isolated from the soil in northwestern *Nepal*. *Bull. Soc. Fr. Mycol. Med*. 6:207-210. *Anixiopsis stercoraria* (Hansen) Hansen. *Botanische Zeitung* 55:127, 1897

Adhikari, M. K.1990a The genus *Russula* from Nepal (ll).*Cryptogams of the Himalayas. vol. 2 Central and Eastern Nepal.* Eds. by M.Watanabe and S. B. Malla. National Science Museum, Tsukuba, Japan. 101-112.

Adhikari, M. K.1990b History of mycological explorations in Nepal. *Cryptog. Mycol.* 11 (2) 111-128.

Adhikari, M. K.1992 (2049) Nepalma naya patta lagaieka dhusiharu: samkshipta vivaran (= newly discovered fungi from Nepal: brief discussion). *Kalpavriksha.*2 (16) : 3-6. b. - Idem. *Ibid.* 2 (17) : 5-10.

Adhikari, M. K.1996 *Biodiversite des Basidiomycetes au Nepal: etude systematique et biogeographique. Specialite Ecologie-Mycoloique.*These du Doctorat de L'Universite present devant l'Universite Paul Sabatier, Toulouse, France. No. d'ordre 2309, pg. 205.

Adhikari, M. K. 1998 New records of some Teliomycetes from Nepal. *Nat. Hist. Soc. Nep. Bull* 8 (1-4): 2 – 8

Adhikari, M. K.2000 *Mushrooms of Nepal.* Edited by G. Durrieu, P.U. Printers Battishputali, Kathmandu, Nepal. pg 236

Adhikari, M. K. 2009 *Researches on the Nepalese mycoflora: revised account on the history of mycological explorations.* Published by K. S. Adhikari, Kathmandu, Nepal, pg. 92

Adhikari, M. K. 2012 *Researches on the Nepalese mycoflora-2: checklist of macrofungi (mushrooms). Publish*ed by K. S. Adhikari , Kathmandu, Nepal. Pg. 90

Adhikari, M.K. 2014a. The status of collection and utilization of Nepalese mycobiota. In: *Proceedings of the seminar on mushroom consumption and poisoning risk* (Ed. J.K. Raut), Nepal Academy of Science & Technology, Khumaltar, Lalitpur. P 13-18

Adhikari, M. K.2014b *Mushrooms of Nepal.* Edited by H. V. T Cotter and G. Durrieu, Published by K. S. Adhikari, Kathmandu, GPO Box no. 21758, Nepal. pg 340.

Adhikari M. K et Durrieu, G. 1999 Trois nouvelles Russules du Nepal, *Bull. Soc. Mycol. Fr.*, 115 (2) 187-193.

Adhikari, M. K. and Manandhar, V. 1986 A new *Passalora* species from Nepal. *Cryptog. Mycol.* 7 (4) : 327-330.

Adhikari, M. K,, Watanabe, K, and Parajuli, G. P. 2014. A new variety of *Pholiota microspora* (Berk.) Sacc. (Agaricales) from Nepal. *Biodiversitas* 15: 99-101.

Agarwal, D. K. 2005 *Mollisia dhankutae* Belfour-Browne: a new record for India. *Indian Phytopath.* 58 (3): 343

Arx, V. 1982. In: *Persoonia*. 11(4):447

Arx, V. 1985 , In: *Proc. Indian Acad. Sci., Pl. Sci.* 94(2–3):344

Balfour - Browne, F. L. 1955 Some Himalayan fungi. *Bull. Brit. Mus.* (*Nat. Hist.*) Ser. Bot. 1: 189-218.

Balfour - Browne, F. L. 1968 Fungi of recent Nepal expedition. *Bull. Brit. Mus.* (*Nat. Hist.*) Ser. Bot. 4: 99-141.

Barclay and Dietel 1890 *Hedwigia* 29:265

Berkeley, M. J. 1854a Decades XLI - XLIII. Indian fungi. *Hooker's Jour. Bot.* Kew. Gard. Misc. jour. 6 : 129-143. b - Decades XLIV - XLVI. Indian fungi. *Ibid.* 6: 161-174. c - Decades XLVII - XLVIII. Indian fungi. *Ibid.* 6: 204-212. d - Decades XLIX - L. Indian fungi. *Ibid.* 6: 225-235. (reprint 1969, Decades of fungi 1-62, Amsterdam, Asher Co. 280).

Berkeley, M. J. 1839 Description of exotic fungi in the collection of Sir W. J. Hooker, from memoirs and notes of J. F. Klotzsch, with additions and corrections" in *Annals of natural history* 3 pp. 325 - 401

Berkeley, M. J. 1847 *London Journal of Botany* 6: 491 [2015 MycoBank]

Bhall, K. Singh, S. K. and Srivastava, A. K. 1997 Further *Mycovellosiella* species from the Indian sub-continent *Mycological Research* 101: 1496-1498

Bhall, K., Singh, S. K. and Srivastava , A. K. 1997 Further *Mycovellosiella* species from the Indian sub-continent. *Mycological Research*. 101 (12): 1496–1498

Bills, G. F. and Cotter, H. V. T. 1989 Taxonomy and ethnomycology of *Lactarius* Sec. Dapetes (Russulaceae) in Nepal. *Memoirs of New York Botanical Garden.* 49: 192-197.

Budathoki, U. 1994 Two new follicolous Hyphomycetes from Kathmandu valley. *Proceedings of Second National Botanical Conference*, Kathmandu, Nepal, pg. 94-97.

Budathoki, U. 1997 *Paraphialocephla* gen. nov.: A foliicolous Hyphomycetes from Kathmandu valley in Nepal Himalaya. *In recent research in ecology, environment and pollution.* 10: 121-125..

Budathoki, U. 2009 A new species of *Periconiella* from Kathmandu valley, Nepal. *Recent Mycological Researches.* Edited by S. C. Sati. 77 – 80 pg.

Budathoki, U. and Singh P. N.1994 Some new black mildews from Kathmandu valley. *Indian Phytopathology* 47 (4): 377- 381

Budathoki, U. and Singh, P. N. 1995 A new dictyosporic foliicolous Hyphomycete from Kathmandu valley (Nepal). *Ind. Phytopath.* 48: 103

Budathoki, U. and Singh, S. K. 1995 Three new species of *Pseudocercospora* from the Nepal Himalaya. *Mycol. Res*. 99 (2): 230-232

Budathoki, U., Verma, R. K. and Kamal 1980 New species of *Phaeoramularia, Pseudocercospora* and *Stenella* from Nepal. *Ind. Phytopath.* 41 (1):53 –60.

Cannon, P. F. 1986 A revision of *Achaetomium, Achaetomiella* and *Subramaniula*, and some similar species of *Chaetomium. Transactions of the British Mycological Society*. 87 (1): 45–76

Chaudhary, R. K., Singh, S. K. and Morgan-Jones, G. 1996 Notes on Hyphomycetes.LXXI. New species of *Stenella*, *Stenellopsis* and *Tretospora* from Nepal. *Mycotaxon*. 57: 201-209

Ciferri, R. 1933. Ustilaginales esotici nuovi o rari. I *Nuovo Giornale Botanico Italiano* 40: 264 [Database Copyright © 2015 MycoBank]

Corner, E. J. H. 1955 *Pleurotus nepalensis* sp. nov. *Bull. Brit. Mus.(Nat. Hist.)Botany.*1(7):191-191.

Crane, P. E. 2005 Rust fungi on Rhododendrons in Asia: *Diaphanopellis forrestii* gen. et sp. nov. new species of *Caeoma,* and expanded descriptions of *Chrysomyxa dietelii* and *C. succinea*. *Mycologia*, 97(2): 534-548.

Crane, P. E., Yamaoka, Y., Engkhaninun, J. and Kakishima, M. 2005 *Caeoma tsukubaense* n. sp., a *Rhododendron* rust fungus of Japan and southern Asia, and its relationship to *Chrysomyxa rhododendri. Mycoscience. 46 (3):* 143 – 147

Cumins, G. B. 1943 Uredinales from the northwest Himalayas. *Mycologia.* 35: 446 – 456

Das, K., Chakraborty, D and Cotter, H.V.T. 2015 *Suillus Adhikarii, a* new species from the subalpine Himalaya of India and Nepal associated with *Larix*. Phytotaxa 219 (3): 289-295

Decock, C., Castaneda Ruiz, R. and Adhikari, M. K**.** 2004 Taxonomy and phylogeny of *Brachycodiellopsis fimicola* gen. et sp. nov. a sporodochial to synematous coprophilus fungi related to Microascales (Ascomycetes) from Nepal *Cryptogamie Mycologie. 25* (2): 137 - 147

DeHoog, G. S. 1973 *Cordana ellipsoidea* new species of dematiaceae Hyphomycete. *Acta. Bot. NEERL.* 22 (3) : 209-212.

Deighton, F. C. and Macgarrie, Q. D. 1968 *Alternaria longissima* sp. nov. *Ibid*. 113: 15

Denchev and Shin, H.D. 2006 , In *Mycol. Balcanica* 3(1):72

DeVrdey, C. and Recacochea, M. 1977 Keratinophilic fungi isolated from the soil in northwestern Nepal. *Bull. Soc. Fr. Myco. Med.* 6 (2): 207-210.

Dietel, P. 1890. Uredineen aus dem Himalaya. *Hedwigia.* 29:259-270

Dobremez, J. F. 1972 Misé au point d'une méthod cartographique d'etude des montagnes tropicales du Népal. Ecologie et phytogeographie. Thése Université Gronoble. France. P379.

Durrieu, G. 1975 Deux nouveaux *Hamaspora* (Uredinales) de L'Himalaya. *Mycotaxon* 2(1):205-208.

Durrieu, G. 1977a Un nouveau *Coleosporium* autoxine (Uredinales). *Mycotaxon*. 5: 453-458.

Durrieu, G. 1977b Les rouilles des *Rubus* au Nepal. In Travaux dedies a G.Viennot-Bourgin Paris. *Soc. Fr. Phytopath*. 108-117.

Durrieu, G. 1979 Uredinales nouvelles de l'Himalaya. *Mycotaxon* 9(2): 482-492.

Durrieu, G. 1980 Uredinales du Nepal.*Cryptog, Mycol*. 1: 33-68.

Durrieu, G. 1987 Uredinales from Nepal. *Mycologia* 79: 90-96.

García, D., Stchigel, A. M., José Cano, J., Josep Guarro, J. and Hawksworth, D. L 2004 A synopsis and re-circumscription of *Neurospora* (syn. *Gelasinospora*) based on ultrastructural and 28S rDNA sequence data Mycological Research. 108 (10): 1119–1142

García, D., Stchigel, A.M., Cano, J., Guarro, J. and Hawksworth, D.L. 2004 A synopsis and re-circumscription of *Neurospora* (syn. *Gelasinospora*) based on ultrastructural and 28S rDNA sequence data, In: *Mycol. Res.* 108(10):1119–1142

Gochenaur, S. E. 1980 *Coniochaeta nepalica* a common long soil fungus. *Mycotaxon*. 19:85–92

Goto, S. and Sugiyama, J. 1968 Studies on the himalayan yeasts and moulds (1):a new species of *Debaryomyces* and some asporogenus yeasts. *Jour. Jap. Bot.* 43 (4): 102-107.

Gueho, E. and De Vroey, C. 1986 A new species of *Anixiopsis. Can. Jour. Bot*. 64 (10) : 2207-2210.

Guzman G. and *Tapia F. 1995. New species, new combinations and new records of Veligaster (Sclerodermataceae). Doc Mycol* 25 *(98–100):*185–*195.*

Guzmán, G. and Ramírez-Guillén, F. 2004 *Scleroderma stellatum* versus *Scleroderma bermudense:* the status of *Scleroderma echinatum* and the first record of *Veligaster nitidum* from the Virgin Islands *Mycologia* 96(6):1370 -1379,

Guzmán, G. and Ramírez-Guillén, F. 2004 *Scleroderma stellatum* versus *Scleroderma bermudense:* the status of *Scleroderma echinatum* and the first record of *Veligaster nitidum* from the Virgin Islands *Mycologia.* 96 (6);1370-1379

Hagiwara, H. 1982 Altitudinal distribution of dictyostelid cellular slime moulds in Gosainkunda region of Nepal. *Reports on Cryptogamic study in Nepal.* Ed. Y. Otani, National Science Museum, Tokyo, Japan. 105-117.

Hagiwara, H. 1983 Four new species of dictyostelid cellular slime moulds from Nepal. *Bull. Nat. Sc. Mus.* ser. B. 9 : 149-158.

Hagiwara, H. 1988 Enumeration of dictyostelid cellular slime molds in the Kathmandu valley of Nepal. *Cryptogams of the Himalayas.vol.1.The Kathmandu valley.* Eds. M. Watanabe and S. B. Malla. National Science Museum, Tsukuba, Japan, 21-27.

Hagiwara, H. 1990 Enumeration of the dictyostelid cellular slime molds obtained from Mt. Phulchowki in the Kathmandu valley, Nepal. *Cryptogams of the Himalayas. vol.2. Central and eastern Nepal.* Eds. M. Watanabe and S. B. Malla. National Science Museum, Tsukuba, Japan. 23-32.

Hagiwara, H. 1991 *Dictyostelium aureocephalim*, a new dictyostelid cellular slime mold for Nepal. *Bull. Nat. Sc. Mus.* Ser, B. 17 (1): 103-107.

Hagiwara, H.1992a *Dictyostelium clavatum* sp. nov. and *Dictyostelium*

medium sp. nov. : new dictyostelid cellular slime mold from Nepal. *Bull. Nat. Sc. Mus.* Ser B. 14(1) : 1-6.

Hagiwara, H.1992b Taxonomic studies in Dictyostelids 1. *Dictyostelium giganteum* singh, *D. firmibasis* Hagiwara and *D. magnum* Hagiwara. *Bull. Nat. Sc. Mus.* Ser. B. 18 (3) : 101-107.

Hansen, E. C. 1897 *Botanische Zeitung* 55: 127 [On *Anixiopsis stercoraria* (Hansen) Hansen, 1897 and its imperfect stage: *Keratinomyces ajelloi* Vanbreuseghem, 1952 *Mycopathologia et mycologia applicata* . 30-XII-1963], 21 (3-4):179-203

Hattori, T., Adhikari, M. K., Suda, T. and Doi, Y. 2002 A list of polypores (Basidiomycotina, Aphyllophorales) collected in Jumla, Nepal. *Bull Natl. Sci Mus Ser B ,* 28;(2) : 27-38

Hjortstam, K. 1983 Studies in the genus *Hyphodontia* Basidiomycetes 1.*Hyphodontia* section *Hyphodontia. Mycotaxon*. 17 (1) : 550-554.

Hjortstam, K. and Ryvarden L. 1984. Some new and noteworthy basidiomycetes (Aphyllophorales) from Nepal. Mycotaxon 20(1):133–151.

Horie, Y. and Udagawa, S. 1974 *Anixiella* and *Gelasinospora* from Himalayan soils. *Trans. Mycol. Soc. Jap*. 15 : 196-205

Jülich, W. 1982. Notes on some Basidiomycetes (Aphyllophorales and Heterobasidiomycetes). *Persoonia.* 11(4):421-428 Kakishima, M.and Ono. Y. 1988 Three species of smut fungi (Ustilaginales) from Nepal. *Cryptogams of the Himalayas. vol.1: The Kathmandu valley.* Eds. M. Watanabe and S. B. Malla. National Science Museum, Tsukuba, Japan. 127-132.

Kamal, Khan, M. K and Budathoki, U.1980 A peculiar foliicolous Hypnmycete (2) from Kathmandu valley (Nepal). *Ana. Net.* 15:5.

Kaneko, S., Kakishima, M. and Ono, Y. 1993 *Coleosporium* (Uredinales) from Nepal. *Cryptogams of the Himalayas. Vol.2: Central and eastern Nepal*. Eds M. Watanabe and S. B. Malla. National Science Museum, Tsukuba, Japan. 85-90.

Katumoto, K. 1984 *Cladosporothyrium* a new genus of Ceolomycetes from Nepal. *Tran. Mycol. Soc. Jap.* 25: 225-229.

Khan, M. K, Budathoki, U. and Kamal, 1991 New foliicolous Hyphomycete from Kathmandu valley.(Nepal*). Ind. Phytopath*. 44: 21 – 29

Kharwar, R. N. and Narayan, S. 2000 Some novel species of genus *Mycovellosiella* from forest flora of Nepal and India. *Journal of Living World* . 7 (1): 10-20

Kharwar, R. N. and Singh, R. K.1996 New species of *Mycovellosiella* associated with foliar spots in Nepal .*Microbiological Research*. 100 (6):689- 692.

Kharwar, R. N. and Singh, R. K.2004 Additions to the Hyphomycete genus *Veronaea* as phytoparasitic species. *Microbiological Research*. 159 (2): 103-111

Kreisel, H. 1969 Gasteromyzeten aus Nepal. *Khumbu Himal*. 6 (1): 25-36.

Kreisel, H. 1976 Gasteromyzeten aus Nepal.II *Feddes Reportorium*. 87 (1-2): 83-107.

Kreisel, H. 2008;Gasteromyzeten aus der Mongolischen Volksrepublik *Feddes Repertorium.* 86(5):321-327.

Kuntze, O. 1898. Revisio generum plantarum. 3:1-576 [Database Copyright © 2015 MycoBank]

Maas, G. 1992 Myceneae of the Himalayan foothills. *Persoonia*. 15 (1): 50-53.

McPartland J. M. and Hughes S. J. 1994 *Cannabis* Pathogens VII: a new species *Schiffnerula cannabis*, *Mycologia*, 86 (6) (Nov. - Dec., 1994):867-869

Meulder, H. 2006 List of Nepalese fungal species deposited in CAB Herbarium AMK Mededelingen 1: 2-8

Miller, O.K. and Aime, M.C. (2001) Systematics, ecology and world distribution in the genus *Chroogomphus* (*Gomphidiaceae*), In *Trichomycetes and Other Fungal Groups,* Robert W. Lichwardt Commemoration Volume (Enfield):315–333

Minoura, K., Morinaga, T. and Muroi, T. 1975a Some Ascomycete isolated from soils of Nepal (1). *Rep. Tottori Mycol. Inst*. 12: 171-185.

Minoura, K., Morinaga, T. and Muroi, T. 1975b Some Ascomycetes isolated from soils of Nepal 2. *Trans. Mycol. Soc. Japan*. 16 366-377.

Minoura, K., Morinaga, T. and Muroi, T. 1977 Some Ascomycetes isolated from soils of Nepal. 3. *Trans. Mycol. Soc. Japan*. 18 : 119-124.

Misra, S., Srivastava, A. K. and Kamal 1999. Further additions to *Stenella* from India and Nepal. *Mycological Research*.103 (3): 268-270. Department of Botany, University of Gorakhpur, Gorakhpur, India

Morinaga, T., Katayama, F. and Minoura, K.1977 Some Hyphomycetes isolated from soils of Nepal. *Jour. Jap. Bot*. 52 (2): 50-55.

Nannenga-Bremekamp, N. E. and Yamamoto, Y. 1988 *Stemonitis laxifila* (Myxomycetes), a new species from Nepal. *Cryptogams of the Himalayas. vol. 1.: The Kathmandu valley.* Eds. M. Watanabe and S. B. Malla. National Science Museum, Tsukuba, Japan. 29-30.

Nannenga-Bremekamp, N.E. and Yamamoto, Y**.** 1990. Two new species and a new variety of Myxomycetes from Nepal. *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* Section C **93** (3): 281-285

Núòez, M and Ryvarden, L. 2001 *East Asian polypores* -2. *Synopsis Fungorum* 14, *Fungiflora* 522 pg.

Oda, T., Tanaka, C. and Tsuda, M. 2000 *Amanita sinensis*, new to Japan and Nepal. *Mycoscience*. 41: 403 - 405.

Ono, Y. Adhikari, M. K. and Rajbhandari, K. R. 1988 Rust fungi of the Kathmandu valley and adjacent areas. *Cryptogams of the Himalayas* vol. 1: *The Kathmandu valley.* Eds. M. Watanabe and S. B. Malla, National Science Museum, Tsukuba Japan. 115-125.

Ono, Y., Adhikari, M. K. and Kaneko, R. 1995 An annotated list of the rust fungi (Uredinales) of Nepal. *Cryptogams of the Himalayas.* vol. 3 *Nepal and Pakiistan.* Eds, M. Watanabe and H. Hagiwara, National Science Museum, Tsukuba, Japan. 69-125.

Ono, Y., Adhikari, M. K. and Rajbhandari, K. R. 1990 Uredinales of Nepal. *Rept. Tottori Mycol. Inst.* 28: 57-75.

Onsberg, P. 1973 *Lycogala fuscoviolaceum* sp. nov. and *Diderma niveum* from Nepal. *Bot. Tidskr*. 76: 159-162.

Otani, Y. 1982a Cup fungi collected in Nepal-1. *Reports on the Cryptogamic study in Nepal.* Ed. Y. Otani, National Science Museum, Tokyo.75-91.

Otani, Y. and Bhandary, H. R. 1982 A new *Taphrina* species on fern *Pteris quadriaurita* Retz. *Ibid.* 7-10.

Pegler, D. N. 1977 *Pleurotus* (Agaricales) in India, Nepal and Pakistan. *Kew Bull.* 31 (3): 501-510.

Pi¹tek, M. 2012 The identity of *Cintractia disciformis*: reclassification and synonymy of a southern Asian smut parasitic on *Carex* sect. *Aulocystis.IMA fungus.* 3 (1): 39-43

Poelt, J. 1965 Myxomycetes aus Nepal. *Khumbu Himal*. 1(2): 59-70.

Ramadive, K. R. 2013 An overview of Aphyllophorales (wood rotting fungi)from India. *Int. Jour. Curr. Microbial App. Sci.* 2(12):112 - 139

Rattan S. S. 1977 The resupinate Aphyllophorales from north west Himalayas. *Biblio. Mycol*. 60:1 – 427

Ryvarden, L. 1977 Some wood inhabiting Aphyllophoraceous fungi from Nepal. *Khumbu Himal*. 6: 379-386.

Ryvarden, L. 1984. *Mycotaxon.* 20:145

Saccardo, P. A. 1882. *Syllog. Fung.* 1: 125 & 15: 369 (*Valsa nepalensis*)

Seshita, Y. and Hirahara, S. 1968 Mucoraceae isolated from soil in Nepal. *Bull. Hiroshima Jogakuin Coll.27*: 157-161.

Seung-Hun, Y., Mathur, S. B. and Neergaard, P. 1982 Taxonomy and pathogenicity of four seed-borne species of *Alternaria* from sesame *Transactions of the British Mycological Society.* 78 (3): 447–458

Sharma, M. P. 1983b Helotiales type specimens in the PAN Herbarium. *Ibid.* 91: 139-150.

Sharma, M. P. 1983a A new *Dasyscyphus* species from India. *Fungi of Indian Subcontinent: a collection of Papers. Biblio. Mycol*. 91: 115-121.

Sharma, M. P. and Sharma, R. 1983 Two new records of inoperculates from the Himalayas (India). *Ibid*. 91: 171-179.

Shaw, D. E. and Alcorn, J. L. 1993 New names for *Verrucispora* and its species. *Australian Systematic Botany* 6(3) 273 - 276

Simmons EG. 2007 *Alternaria. An identification manual.* CBS Biodiversity Series 6. CBS Fungal Biodiversity Centre, Utrecht, The Netherlands

Singer, R. 1936. Studien zur Systematik der Basidiomyceten. I. *Beihefte zum Botanischen Zentralblatt.* 56:137-156

Singh, A., Bhalla, K. and Singh, S. K. 1998 Three phytoparasitic species of *Periconiella* from Indian subcontinent *Indian phytopathology*. 51 (1): 30-35

Singh, P. N., Singh, S.K and Tripathi, S. C. 1996 New species of *Pseudocercospora* causing leaf spots of forest plants of Nepal. 100(9): 1129–1132

Singh, S. C. and Nisha 1973a Notes on some Cercosporae of Nepal. 1. *Jour. Sc.* 5 (1):: 22-24.

Singh, S. C. and Nisha 1973b Notes on some Cercosporae of Nepal.2. *Jour. Tri. Uni*. 8 : 91-99.

Singh, S. K. Chaudhary, R. K., Morgan-Jones, G. 1995 Notes on Hyphomycetes. LXVII. Three new species of *Phaeoramularia* from Nepal. *Mycotaxon.* 54 57-66

Singh, S. K., Singh, P. N. and Bhall, K 1997 Novel taxa of *Pseudocercosporella* from Nepal Himalaya Mycological Research (101 5: 542–544

Singh, S., Khan, S. N. and Mizra, B M. 1987 Two new species and some noteworthy records of Fungi on Indian conifers. *Indian Forester.* 113(5):359-365

Stephenson, S.L. 2003. Myxomycetes of New Zealand. *Fungi of New Zealand. Ngâ Harore o Aotearoa* **3**: xiv + 238 p. Hong Kong: Fungal Diversity Press,

Sutton, B. C. 1970 Two Hyphomycetes new to Nepal. *Trans. Brit. Mycol. Soc.* 55: 504-506.

Sydow, H. and Sydow, P. 1906 *Ann. Mycol.* 4:28

Takada, M. and Udagawa, S. 1983 Two new species of *Eupenicillium* from Nepalese soil. *Tran. Mycol. Soc. Jap*. 24: 143-150.

Tanaka, E., Tanaka, C., Gafur, A. and Tsuda, M. 2002 *Heteroepichloë*, gen. nov. (Clavicipitaceae; Ascomycotina) on bamboo plants in East Asia. *Mycoscience.* 43 (2)

Thind, K. S, Sharma, M. P. and Singh, H. 1983 The Nepal Helotiales-1. *Fungi of Indian subcontinent: a collection of papers*. *Biblio. Mycol.* 91 : 265-279.

Tokumasu, S. 1988 Hyphomycetes from pine leaf litter of Nepal. *Cryptogams of the Himalayas. vol. 1. The Kathmandu valley*. Eds. M. Watanabe and S. B. Malla. National Science Museum, Tsukuba, Japan. 147-154.

Tulloss RE., Iqbal SH, Khalid AN, Bhatt RP, Bhatt VK. 2001. Studies in *Amanita* (Amanitaceae) from southern Asia. I. Some species of Pakistan's. Northwest Frontier Province. Mycotaxon 77: 455–490.

Tulloss, R. E. and Bhandary, H. R. 1992 *Amanita chepangiana;* a new species from Nepal. *Mycotaxon.* XLLIII : 25-31.

Udagawa, S 1993 Three new species of Talaromyces from Nepal. Mycotaxon, 48: 141-156

Udagawa, S. and Horie, Y. 1982 Two new species of terrestrial Ascomycetes from eastern Nepal. *Reports on the Cryptogamic Study in Nepal.* Ed. Y. Otani, National Science Museum, Japan, 97-104.

Udagawa, S. and Sugiyama, J. 1982 New records and new species of Ascomycetous microfungi from Nepal: a preliminary report on the expedition of 1980. *Reports on the Cryptogamic study in Nepal.* Ed. Y. Otani, National Science Museum, Japan, 11-46.

Udagawa, S.1990 A new species of *Apiosordaria* and some interesting Ascomycetes from Nepal. *Cryptogams of the Himalayas. Vol.2: central and eastern Nepal.* Eds. M. Watanabe and S, B. Malla. National Sci. Mus., Tsukuba, Japan. 73-84.

Vánky, K. (1998) The genus *Microbotryum* (smut fungi), *Mycotaxon* 67:33–60

Verma, R.K and Kamal (1986, publ. 1987). *Paraaoria himalayana* gen. et sp.nov., a foliicolous coelomycete on citrus from Nepal. *Transactions of the British Mycological Society* **87** (4): 645-647. (not seen).

Verma, R.K., Chand, R. and Kamal. 1990. Two new species of *Uncinula* from Nepal. *Mycological Research* 94 (1): 128-130.

Yadav A. S. 1963 Contribution to the knowledge of Uredineae of Bihar III. *Indian Phytopathology* 16, 138-142

Yamamoto, Y. 1990: Two new species of Myxomycetes from Central Nepal. *Shokubutsu-chiri-bunrui-kenkyo 65*: 296-300.

Yamamoto, Y. and Hagiwara, H. 1990 Myxomycetes from central Nepal 2 Cryptogams *of the Himalayas. vol. 2: central and eastern Nepal.* Eds. M. Watanabe and S. B. Malla, National Science Museum, Tsukuba, Japan. 33-40.

Yang, Z. 1997 Die *Amanita* arten von sud-west China. *Biblio. Mycol.* 170:56. J. Cramer, Berlin, Stuttgart.

Zang, M. and Doi, Y. 1995 *Secotium himalaicum* sp. nov. from Nepal a folklore concerning the food of abominable snowman. *Acta. Bot. Yunnanica* 17 (1): *30- 32*

Zang, M. and Kinjo, N. 1998 Notes on the alpine *Cordyceps* of China and near by nations.*Mycotaxon.* LXVI : 215 – 229.

Zhou,.L and Dai, Y. 2012 Wood-inhabiting fungi in southern China 5. New species of *Theleporus* and *Grammothele* (Polyporales, Basidiomycota). *Mycologia*. 104 (4): 915-924

Zhuang J.1984 A general survey of rust-flora in the Mt. Namjagbarwa region *Jour. Mountain Research* (Institute of Microbiology, Academia Sinica)

Zhuang, J.Y. 1998 Notes on *Puccinia commelinae-benghalensis* nom. nov., In: *Mycosystema* 17(1):95–96

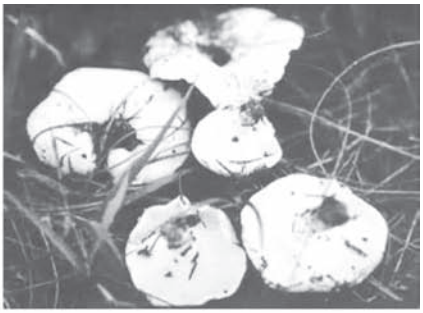
Zuuang, J and Wei, S 1994 Annotated checklist of rust fungi from the Mt.Qomolangma region (Tibetan Everest Himalaya). *Mycotaxon*. 7: Zhuang, J. Y. and Wei, S. X. 2002 Records of Nepalese rust fungi deposited in CAB Herbarium 24 (2):5- 10

Web - The Herbarium, The Natural History Museums and Botanical Garden, University of Oslo. APHYLLOPHORALES -Updated 2011/12/29

Photographs

Russula kathmanduensis

Russula nepalensis



Russula chloroides var. godavariensis

Russula delica var. *dobremezii*

Lactarius thakalorum

Amanita cinnamomescens

Suillus adhikarii

Pholiota microspora var. *himalensis*

Amanita chepangiana

Puccinia adhikarii

Gymnosporangium padmarense

Passalora nepalensis

Eragrostis cilianensis (Poaceae), a new record for Nepal

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Abstract

Eragrostis cilianensis (Poaceae) is reported as a new record for Nepal.

Key words: *Eragrostis cilianensis*, new record, Nepal.

Introduction

Eragrostis Wolf is a genus belonging to the family Poaceae, tribe Eragrostideae. It is represented by 350 species in the world, distributed in the tropical and subtropical regions and is characterized by annual or perennial herbs with 2- to many-flowered spikelets and 3-veined lemmas (Chen & Peterson, 2006). Fourteen species of *Eragrostis* have been reported from Nepal (Hara et al., 1978; Press et al., 2000; Rajbhandari, 2010). Recently, a specimen of *Eragrostis* collected from Dolpa District, West Nepal has been identified as *Eragrostis cilianensis*. This species has not been reported before from Nepal and is a new addition to the flora of Nepal.

Eragrostis cilianensis (All.) Vign. ex Janch., Mitt. Naturwiss. Vereins Univ. Wien, n. s., 5: 110 (1907). (Fig. 1).

Poa cilianensis All., Fl. Pedem. 2: 246 (1785).

Loosely tufted annual herb; culms 10-35 cm high, erect or geniculate at base, a line of glands below each node. Leaf sheaths with tubercle hairs; ligules a line of hairs. Leaf blades flat, glabrous, 6–15 × 0.2–0.5 cm. Panicle oblong or pyramidal, 6-12 cm long; branch usually solitary, ascending. Spikelets dark green or gray-green, compressed, oblong or ovate-oblong, 5–7 × 2–2.2 mm, 10–14-flowered. Glumes subequal or lower glume slightly shorter, 1-veined; upper glume 1–3-veined, glandular along middle vein, 2 mm long. Lemmas chartaceous, broadly ovate-oblong, conspicuously 3-veined, lowest lemma 2–2.4 mm long. Palea persistent, oblanceolate, apex rounded, 1–1.5 mm long, ciliolate along keels. Stamens 3; anthers 0.5 mm long. Caryopsis oblong.

Fig. 1. *Eragrostis cilianensis* (Rajbhandari & Malla 6932)

Distribution: Tropical and subtropical regions of the world; India, Nepal, Bhutan, China.

Ecology: Occurs on the flat roof of the house.

Fl. & fr.: July-October.

Specimen examined: West Nepal, Dolpa District, Dunai, 2000 m, 1982.10.3, *K. R. Rajbhandari & K. J. Malla* 6932 (KATH).

Notes: *Eragrostis cilianensis* is an annual glandular species with spikelets breaking up from below upwards. *Eragrostis ciliacensis* is closely related to *Eragrostis minor* Host, which has crateriform (bowl-shaped) glands on its pedicels, whereas the pedicels of *Eragrostis cilianensis* are devoid of such glands.

Acknowledgements

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References

Chen, S. and Peterson, P. M. 2006. *Eragrostis* Wolf. *In*: *Flora of China Vol. 22: Poaceae* (Eds. Wu, Z., Raven, P. H. and Hong, D.). Science Press, Beijing, China and Missouri Botanical Garden Press, St. Louis, U. S. A. pp. 471-479.

Hara, H., Stearn, W. T. and Williams, L. H. J. (eds.). 1978. *An enumeration of the flowering plants of Nepal Vol. 1*. British Museum (Natural History), London.

Press, J. R., Shrestha, K. K. and Sutton, D. A. 2000. *Annotated checklist of the flowering plants of Nepal*. Natural History Museum, London.

Rajbhandari, K. R. 2010. Gramineae. *In*: Rajbhandari, K. R. and Baral, S. R. (eds.), *Catalogue of Nepalese flowering plants – 1: Gymnosperms and Monocotyledons*. National Herbarium and Plant Laboratories, Department of Plant Resources, Godawari, Lalitpur, Nepal, pp. 102-147.

Zephyranthes citrina Baker (Amaryllidaceae), a new record for flora of Nepal

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Abstract

Zephyranthes citrina Baker (Amaryllidaceae) is reported as a new record for flora of Nepal.

Keywords: *Zephyranthes citrina*, new record, Nepal.

Introduction

Zephyranthes Herbert belonging to family Amaryllidaceae is a genus of about 40 species, are native to tropical, subtropical and warm temperate regions of America (Mabberley, 2002). Two species of *Zephyranthes*, viz., *Zephyranthes candida* (Lindl.) Herb. and *Zephyranthes carinata* Herb. have already been reported from Nepal (Rajbhandari and Baral 2010). While collecting herbarium specimens a specimen of Zephyranthes was collected from Sarlahi district, central Nepal which was later identified at National Herbarium and Plant Laboratories, Godawari, Lalitpur (KATH) as *Zephyranthes citrina* Baker. This species is a new record for the flora of Nepal, not recorded by Hara et al. (1978), Press et al. (2000), Bista et al. (2001), Rajbhandari and Baral (2010) and Rajbhandari et al. (2015). The three species of *Zephyranthes* can be distinguished by the following characters.

1a. Stigma divided; perianth pink, with basal tube .....*Z. carinata*

1b. Stigma capitate; perianth white or yellow, with or without basal tube 2

2a. Perianth white (sometimes pinkish on the outside), without basal tube…….*Z. candida*

2b. Perianth bright yellow, with basal tube ....*Z. citrina*

Zephyranthes citrina Baker in Bot. Mag. 108: pl. 6605 (1882)
Zephyranthes eggersiana Urb. in Symb. Antill. 5: 292 (1907)
Common name: Yellow zephyrlily, citron zephyrlily, yellow rain lily.

Perennial herb with bulb. Leaf blade dull green, to 4 mm wide. Spathe 1.6–2.6 cm. Flowers erect; perianth lemon yellow, funnel-shaped, 3.1–5 cm; perianth tube green, 0.7–1 cm, increasing in diameter, less than 1/3 perianth length, ca. 1/2 (1/3–3/4) filament length, less than 1/2 spathe length; tepals rarely reflexed; stamens diverging, in 2 distinctly subequal sets; filaments filiform, subequal, 1.2–2 cm; anthers 5–7 mm; style longer than perianth tube; stigma capitate, usually among or below anthers, not exserted more than 1 mm beyond anthers; pedicel 2.3–4.4 cm, usually longer than spathe. 2n = 48. (Flora of North America Editorial Committee, 2002).

Distribution: Mexico, US, Central and South America, tropical Africa, Malay Peninsula, Southern Asia, China, Japan and India.

Ecology: Natural grassland.

Flowering: July-October.

Specimen examined: Chhatauna, Sarlahi District, 81 m, 2015.10.19, G. Parmar 20151019 (KATH).

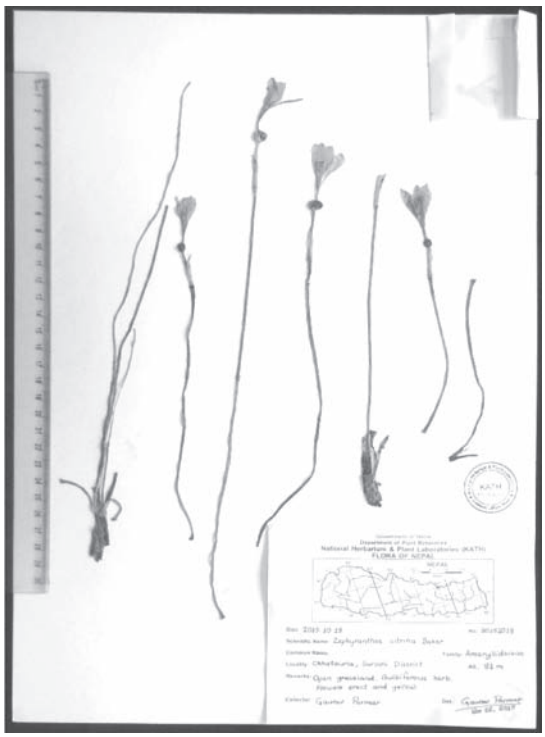

Figure 1: Herbarium of *Zephyranthes citrina* Baker

Figure 2: A plant of *Zephyranthes citrina* Baker

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References

Bista, M.S., Adhikari, M.K. and Rajbhandari, K.R. (Eds.). 2001. *Flowering Plants of Nepal (Phanerogams)*. Department of Plant Resources, Kathmandu, Nepal.

Flora of North America Editorial Committee (Eds.). 2002. *Magnoliophyta: Liliidae: Liliales and Orchidales. Flora of North America,* Vol. XXVI. New York and Oxford.

Hara, H., Stearn, W.T. and Williams, L.H.J. (Eds.). 1978. *An Enumeration of the Flowering Plants of Nepal,* Vol. I. British Museum (Natural History), London, U.K.

Mabberley, D.J. 2002. *The Plant-Book. A Portable Dictionary of the Vascular Plants*. Second edition. Cambridge University Press, U.K.

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

Rajbhandari, K.R. and Baral, S.R. (Eds.). 2010. *Catalogue of Nepalese Flowering Plants - I: Gymnosperms and Monocotyledons*. National Herbarium and Plant Laboratories, Department of Plant Resources, Lalitpur, Nepal.

Rajbhandari, K.R., Bhatt, G.D., Chhetri, R. and Rai, S.K. 2015. *Catalogue of Nepalese Flowering Plants Supplement 1*. National Herbarium and Plant Laboratories, Department of Plant Resources, Lalitpur, Nepal.

Documentation of the Flora of Ramaroshan Wetland Complex, Achham, West Nepal

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Abstract

Present study documents the flowering plants and some cryptogams of the Ramaroshan wetland complex, Achham on exploring the complete rounding the series of 12 lakes. This study compiled 124 species belonging to 55 families. Among them 72 herbs, 24 shrubs, 13 trees and rest of the 3 species are climbers.

Key Words: Wetland flora, Ramaroshan complex, Achham

Introduction

Wetlands are defined as "natural or artificially created areas, such as swamp, marsh, riverine floodplain, lake, water storage area and agricultural land containing water from underground water resources or atmospheric precipitation that may be permanent or temporary, static or flowing and fresh water or saline". Wetlands are considered as the most productive and dynamic ecosystem of the earth. Nepal is a signatory country of the international wetland convention (Ramsar/Iran) 1971 and ratified it on 17 April 1988. Nepal Biodiversity Strategy 2002 has recognized wetlands as one of the sectoral strategies. Upto now Nepal has 9 wetlands of Ramsar sites. Recently one more from Kaski district (Including Phewa, Begnas, Rupa etc.) is added this year.

Ramaroshan area which lies in the Achham district, the far western region of Nepal. It is 42 km. away from district headquarter of the Achham district, Mangalsain. This area is accessible by gravelled motorable road. It lies in the north –east corner of Achham bordering with Bajura and Kalikot district. It is famous for its 12 wetlands (6 lakes and 6 marshes) and 18 flatlands (www.ramaroshanwetland.com). The wetland complex started from 2350 m to 3792 m above sea level. The popular stream 'Kailash' which flows through the middle of the district is originated from this lake area. The conservation of wetlands requires some prerequsites like inventory, responsible organization, legislation and continuous monitoring (Bhandari *et al*.,1994). The understanding, exploration and documentation of wetland flora from the western part of Nepal are less than the eastern. It may be due to the remoteness and tough geographic features of it (Basnet *et al*., 2013). So we focused to document the existing plant species.

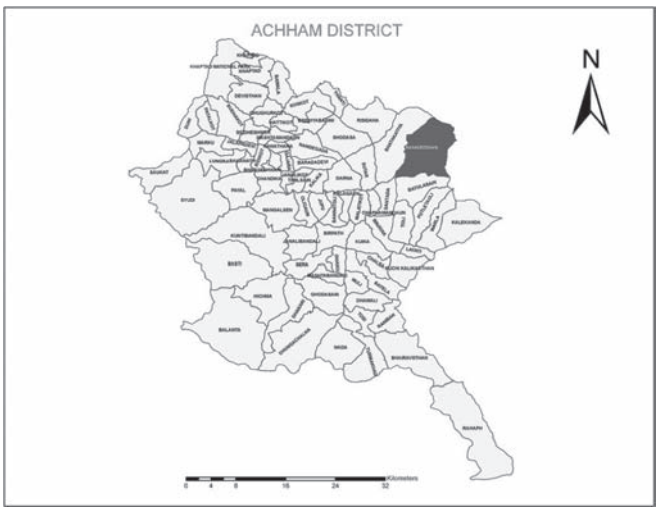

Fig: Map of study area

Materials and Methods

The present study based on herbarium and information collection during the field visits that were organized twice representing pre-monsoon and post-monsoon in 2015. The authors completely visited these 12 wetland complex by foot along the trail. The aquatic and semi-aquatic plants were

collected up to 5 meter and 100 meter from lakes margin respectively. During field visit, field note, photography and enumeration (Those identified in the field) of the species were done. The collected herbarium specimens were later identified with comparison at the KATH deposited herbarium and consulting standard literatures (Flora of china, Flora of Bhutan, Flora of British India, Flowers of Himalaya). Later the collected specimens were deposited in KATH herbarium after proper identification.

Result and Discussion

Altogether 124 (5 aquatic, 5 semi-aquatic and 102 terrestrial) flowering plants species were recorded belonging to 55 families. Among them, 72 herbs, 24 shrubs, 13 trees, 3 climbers are given in Annex-1. In terms of habit herbs were dominant (64%) followed by shrubs (21%) and trees (11%), finally the least number of species were recorded as climbers (2.67%). The largest families recorded were Asteraceae (11 species), then Poaceae, Rosaceae and Cyperaceae with 7 species each. The families like Polygonaceae and Urticaceae with 5 and 4 species respectively. Lauraceae, Berberidaceae and Caryophyllaceae each family consists of 3 species. *Paris polyphylla, Rubia manjith*, *Iris kemaonensis, Origanum vulgare, Tanacetum dolichophyllum* and *Taxus contorta* are common medicinal plants.The common trees were *Aesculus indica, Dodecadenia grandiflora, Lindera pulcherrima, Persea odoratissima, Quercus semicarpifolia* and *Rhododendron arboretum*. We record 11 species of pteridophytes. Among them the common are *Asplenium ensiforme*, *Cheilanthes dalhousiae, Drynaria propinqua , Notholaena himalaica, Oleandra wallichii, Goniophlebium argutum, Polystichum piceopaleaceum* and *Onychium cryptogammoides* belonging to the pteridophytes and 1 species of algae were also listed.

The findings of this study partially contribute to the flora of Nepal, green wealth of the country and commitment to the Ramsar Convention, 1971 and the Convention on Biological Diversity, 1992. It also adds value on ecotourism promotion of the wetland and conservation awareness for the local communities.

Conclusion

The study document 112 species of flowering plants 12 species of cryptogams (1 algae and 11 pteridophytes) belonging to 55 families. The highest number of species reported belonging to the family Asteraceae and lowest number of species reported belonging to the families like Violaceae, Valerianaceae, Buxaceae etc. The wetland is dominated by herbs. We hope this study may help to understanding and documenting the floral diversity of mid hills to high altitude wetlands.

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References

Anonymous, 2002. *Pteridophytes of Nepal*, Department of Plant Resources (DPR), Kathmandu, Nepal.

Basnet, R., Paudel, H.R. and Budha, R. 2013. *Documentation of flora in and around Dhorbaraha wetlands, Western Nepal*. Bull.Dept. Pl. Res. N. 35, pg 22-27, Department of Plant Resources (DPR), Kathmandu, Nepal.

Bhandari, B., Shrestha, T.B. and Mc Eachern (Eds.) 1994. *Safeguarding Wetlands in Nepal*. Proceeding of the Workshop on Wetlands Management in Nepal, 3-5 March, 1993, Kathmandu, IUCN Nepal.

Ministry of Forest and Soil Conservation, 2002. *Nepal Biodiversity Strategy*, Kathmandu, Nepal.

Stainton, J.D.A 1972. *Forest of Nepal*, John Murray, London.

http://www.ramsar.org 2016 /1/24

www.floraofchina.com

www.flraofbritishindia.com

www.floraofbhutan.com

http://www.ramaroshanwetland.com

Fig. 1: Ramaroshan Lakes with vegetation

Fig. 2: *Potamogeton nudosus*

Fig. 3: *Symplocos paniculata*

Annex

Table 1: Plant species recorded during field visit

S.N.	Scientific Name	Family	Habit	Habitat	Collection number	Date of collection
1.	*Aconitum spicatum* (Bruhl) stapf	Ranunculaceae	S	EM	EN	
2.	*Aconogonum molle* (D.Don) Hara	Polygonaceae	S	EM	EN	
3.	*Aesculus indica* (Colebr.ex Cambess.) Hook.	Hippocastanaceae	T	EM	EN	
4.	*Allium tuberosum Rottl.ex Sprengel*	Liliaceae	H	EM	201506029	2015.6.8
5.	*Anaphalis busua* (Buch.- Ham. ex D. Don.)	Asteraceae	H	EM	EN	
6.	*Anaphalis contorta* (D.Don) Hook.f.	Asteraceae	H	EM	EN	
7.	*Anaphalis triplinervis* (Sims) C. B. Clarke	Asteraceae	H	EM	EN	
8.	*Arenaria debilis* Hook. f. ex Edgew. & Hook. f.	Caryophyllaceeae	H	EM	EN	
9.	*Arenaria depauperata* (Edgew.)	Caryophyllaceeae	H	EM	20151019	2015.10.27
10.	*Arisaema propinqum* Schott	Araceae	H	EM	EN	
11.	*Arundinella hookeri* Munro	Poaceae	S	EM	EN	
12.	*Barbaria intermedia* Boreau	Brassicaceae	H	SA	20151043	2015.10.28
13.	*Berberis aristata* DC.	Berberidaceae	S	EM	EN	
14.	*Berberis asiatica* Roxb.ex DC.	Berberidaceae	S	EM	EN	
15.	*Berchemia flavescens* (Wall.) Brongn.	Rhamnaceae	T	EM	20150603	2015.6.8
16.	*Bidens tripartita* L.	Asteraceae	H	SA	20151008	2015.10.27
17.	*Bistorta amplexicaulis* (D.Don) Greene	Polygonaceae	H	EM	EN	
18.	*Bistorta milletii* H. Lev.	Polygonaceae	H	EM	EN	
19.	*Boerhavia diffusa* L.	Nyctaginaceae	H	EM	EN	
20.	*Carex baccans* Nees	Cyperaceae	H	EM	20150607	2015.6.6
21.	*Carex* sp	Cyperaceae	H	EM	EN	
22.	*Carex* sp	Cyperaceae	H	EM	EN	
23.	*Carpesium cernum* L.	Asteraceae	H	EM	20151016	2015.10.27
24.	*Chromolaena adenophora*	Asteraceae	H	EM	EN	
25.	*Clinopodium umbrosum* (M. Bieb.) C. Koch	Lamiaceae	H	EM	EN	
26.	*Corydalis hookeri* Prain	Fumaricaceae	H	EM	20151036	2015.10.28
27.	*Cotoneaster acuminatus* Lindl	Rosaceae	S	EM	20151017	2015.10.27
28.	*Cotoneaster baciallaris* Wall.	Rosaceae	S	EM	201506041	2015.6.9
29.	*Cotoneaster microphyllus* Wall.ex Lindl.	Rosaceae	S	EM	201506017	2015.6.8
30.	*Cynodon dactylon* (L.) Pers.	Poaceae	H	EM	EN	
31.	*Cynoglossum zelanicum* (Vahl) Thunb. ex Lehm.	Boraginaceae	H	EM	EN	
32.	*Cythula capitata* Moq.	Amaranthaceae	S	EM	EN	
33.	*Danthonia cumminsii* Hook .f.	Poaceae	H	EM	20151006	2015.10.27
34.	*Dicrocephala benthamii* C.B.Clarke	Asteraceae	H	EM	20151022	2015.10.27
35.	*Digitaria cruciata* (Nees ex Steudel)	Poaceae	H	EM	EN	
36.	*Dodecadenia grandiflora* Nees	Lauraceae	T	EM	20151013	2015.10.27
37.	*Elaegnus parvifolia* Wall.	Elaegnaceae	S	EM	20151032	2015.10.28
38.	*Elatostema monandrum* (Buch.- Ham. ex D. Don.)	Urticaceae	H	EM	EN	
39.	*Elatostema obtusum* Wedd.	Urticaceae	H	EM	EN	
40.	*Elatostema sessile* J.R. and G.Forst.	Urticaceae	H	EM	EN	
41.	*Eleocharis congesta* D. Don	Cyperaceae	H	A	201506036	2015.6.6

42.	*Elsholtzia fruiticosa* (D. Don) Rehder	Lamiaceae	H	SA	20151020	2015.10.27
43.	*Eltsholtzia strobilifera* Benth.	Lamiaceae	H	TE	EN	
44.	*Epilobium palustre* L.	Onagraceae	H	TE	20151031	2015.10.28
45.	*Euonymus tingens* Wall.	Celastraceae	T	TE	EN	
46.	*Fagopyrum tataricum* (L.) Gaertn.	Polygonaceae	H	TE	EN	
47.	*Fragaria nubicola* Lindl.	Rosaceae	H	TE	EN	
48.	*Galinsuga ciliata* (Raf.) Blake	Asteraceae	H	TE	EN	
49.	*Galium elegans* Wall.ex Roxb.	Rubiaceae	H	TE	EN	
50.	*Gaultheria nummularioides* D. Don	Ericaceae	H	TE	20151046	2015.10.28
51.	*Geranium nepalense* Sweet	Geraniaceae	H	TE	EN	
52.	*Hedera nepalensis* K. Koch	Araceae	C	TE	EN	
53.	*Hemiphragma heterophyllum* Wall.	Scrophulariaceae	H	TE	EN	
54.	*Hydrangea aspera* Buch -Ham ex D. Don	Hydrangeaceae	T	TE	20151030	2015.10.28
55.	*Hypericum elodeoides* Choisy	Hypericaceae	H	TE	201506031	2015.6.8
56.	*Ilex dyprena* Wall.	Aquifoliaceae	T	TE	20150602	2015.6.8
57.	*Impatiens racemosa* DC.	Balsaminaceae	H	TE	20151021	2015.10.27
58.	*Impatiens serrata* Benth.	Balsaminaceae	H	TE	20151033	2015.10.28
59.	*Iris kemaonensis* D.Don	Iridaceae	H	TE	EN	
60.	*Jasminum humile* L.	Oleaceae	C	TE	201506010	2015.6.8
61.	*Juncus articulatus* L.	Juncaceae	H	SA	20151040	2015.10.28
62.	*Kyllinga brevifolia* Rottb.	Cyperaceae	H	TE	EN	
63.	*Lecanthus peduncularis* (Royle) Wedd	Urticaceae	H	TE	EN	
64	*Lindera pulcherrima* (Nees) Benth.ex Hook.f.	Lauraceae	T	TE	20151037	2015.10.28
65.	*Lobelia pyramidalis* Wall.	Lobeliaceae	S	TE	20151023	2015.10.27
66.	*Lyonia villosa* (Hook. f.) Hand.- Mazz.	Ericaceae	S	TE	EN	
67.	*Mahonia nepaulensis* DC.	Berberidaceae	S	TE	EN	
68.	*Malaxis muscifera* (Lindl.) Kuntze	Orchidaceae	H	TE	EN	
69.	*Mazus surculosus* D.Don	Scrophulariaceae	H	TE	20151002	2015.10.27
70.	*Microstegium nodum* (Trin.) A. Camus	Poaceae	H	TE	EN	
71.	*Myriactis nepalensis* Less	Asteraceae	H	TE	20151004	2015.10.27
72.	*Myriophyllum spicatum* L.	Haloragaceae	H	A	20151012	2015.10.27
73.	*Origanum vulgare* L.	Lamiaceae	H	TE	EN	
74.	*Oxalis corniculata* L.	Oxalidaceae	H	TE	EN	
75.	*Paris polyphylla* Smith.	Liliaceae	H	TE	201506030	2015.6.8
76.	*Parochetus communis* Buch -Ham ex D. Don	Fabaceae	H	TE	EN	
77.	*Persea odoratissima* (Nees) Kosterm.	Lauraceae	T	TE	EN	
78.	*Persicaria capitata* Buch -Ham ex D. Don	Polygonaceae	H	TE	201506039	2015.6.8
79.	*Persicaria posumbo* Buch -Ham ex D. Don	Polygonaceae	H	SA	EN	
80.	*Pilea symmerica* Wedd.	Urticaceae	H	TE	20151034	2015.10.28
81.	*Plantago erosa* Wall.	Plantaginaceae	H	TE	201506035	2015.6.8
82.	*Poa annua* L.	Poaceae	H	TE	20151027	2015.10.27
83.	*Pogonantherum paniceum* (Lam.) Hackel	Poaceae	H	TE	EN	
84.	*Polypogon fugax* Nees ex Steudel	Poaceae	H	TE	201506027	2015.6.7
85.	*Potamogeton crispus* L.	Potamogetonaceae	H	A	20151007	2015.10.27
86.	*Potamogeton lucens* L.	Potamogetonaceae	H	A	20151011	2015.10.27
	Potamogeton nudosus	Potamogetonaceae	H	A	EN	
87.	*Pteracanthus lachenensis* (C. B. Clarke) Bremek	Acanthaceae	S	TE	20151020	2015.10.27
88.	*Quercus semicarpifolia* Sm.	Fagaceae	T	TE	EN	

89.	*Rhododendron arboretum* Sm.	Ericaceae	T	TE	EN	
90.	*Rosa microphylla* Lindl.	Rosaceae	S	TE	20151014	2015.10.27
91.	*Roscoea purpurea* Smith	Zingiberaceae	H	TE	201506018	2015.6.6
92.	*Rubia manjith* Roxb. ex Fleming	Rubiaceae	C	TE	EN	
93.	*Rubus ellipticus* Sm.	Rosaceae	S	TE	EN	
94.	*Rubus nepalensis* (Hook.f.) Kuntze	Rosaceae	S	TE	201506024	2015.6.8
95.	*Rumex nepaulensis* Spreng.	Polygonaceae	H	TE	EN	
96.	*Salix babylonica* L.	Salicaceae	T	TE	EN	
97.	*Sarcococca hookeriana* Baill.	Buxaceae	S	TE	EN	
98.	*Senecio alatus* Wall.	Asteraceae	S	TE	EN	
99.	*Skimmia anquetilia* N. P.Taylor & Airy	Rutaceae	S	TE	20151044	1015.10.28
100	*Smilax elegans* Wall. ex Kunth	Smilacaceae	S	TE	EN	
101.	*Solanum nigrum* L.	Solanaceae	S	TE	EN	
102.	*Stellaria monosperma* Buch -Ham ex D. Don	Caryophyllaceae	H	TE	EN	
103.	*Stephania gracilenta Miers*	Menispermaceae	C	TE	EN	
104.	*Symplocos paniculata* (Thunb.) Miq.	Symplocaceae	T	TE	20150601	2015.6.8
105.	*Tanacetum dolichophyllum* Kitam.	Asteraceae	H	TE	EN	
106.	*Taxus contorta* Griff.	Taxaceae	T	TE	201506019	2015.6.8
107.	*Thalictrum virgatum* Hook. f. Thoms.	Ranunculaceae	H	TE	EN	
108.	*Utricularia australis* R.Br.	Lentibulariaceae	H	A	201506038	2015.6.6
109.	*Valeriana hardwiki* Wall	Valerianaceae	H	EM	20151042	2015.10.28
110.	*Viburnum erubescens* Wall.	Caprifoliaceae	S	EM	20150605	2015.6.6
111.	*Viola betonicifolia* Sm.	Violaceae	H	EM	EN	
112.	*Zanthoxylum nepalense* Babu	Rutaceae	S	EM	EN	

Some frequently found cryptogams

S.N.	Scientific Name	Family	Habit	Habitat	Collection number	Date of collection
1.	*Asplenium ensiforme*	Aspleniaceae	H	EM	201506014	2015.6.6
2.	*Chara* sp	Algae	H	A	20151046	2015.10.28
3.	*Cheilanthes dalhousiae* Hook.	Pteridaceae	H	EM	EN	
4.	*Drynaria propinqua* (Wall. Ex Mett.)	Polypodiaceae	E	EM	EN	
5.	*Goniophlebium argutum*	Polypodiaceae	H	EM	201506025	2015.6.7
6.	*Huperzia pulcherrima* (Wall.ex Hook.&Grew.) Pich.Serm.		E	EM	20151045	2015.10.28
7.	*Lepisorus mehrae* Fraser-Jenk.	Polypodiaceae	E	EM	201506020	2015.6.6
8.	*Notholaena himalaica* Fras.- Jenk.	Pteridaceae	H	EM	EN	
9.	*Oleandra wallichii* (Hook.) C.Presl.	Oleandraceae	H	EM	201506013	2015.6.6
10.	*Onychium cryptogammoides* Christ	Pteridaceae	H	EM	EN	
11.	*Polystichum lachenense* (Hook.) Bedd.	Dryopteridaceae	H	EM	EN	
12.	*Polystichum piceopaleaceum* Tagawa	Dryopteridaceae	H	EM	201506011	2015.6.6

H= Herb, S= Shrub, T= Tree, E= Epiphyte, A= Aquatic, SA= Semi-Aquatic, EM= Emergent, C=Climber, EN=Enumeration

Preliminary Documentation of Basidiomycetous Fungi (Polypores and Mushrooms) found in Bardia National Park and its Buffer Zone Area, Western Nepal

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Abstract

The study was conducted for Basidiomycetous fungi especially polypores and mushrooms, found in Bardia national park and its buffer zone area (Shivapur VDC-3 and 7 of upper and lower Bankhet village respectively; Shivapur VDC-5, Bakuwa village and Neulapur VDC-1, Ambreni village) from October 28 to November 3, 2015. Total of 42 species of basidiomycetous fungi were collected. Out of them, three species being at juvenile stage were unidentified and rest of the identified species were from eight orders belonging to 12 families and 23 genera. Polyporales was found to be the dominant order in the study area with 22 species, followed by Thelephorales (five species). Similarly, Polyporaceae was found to be the dominant family represented by 21 species, followed by Thelephoraceae and Xylariaceae, represented by four and three species respectively. *Shorea robusta* Gaertn., a dominant tree species of the study area, was found to be key host plant for 21 basidiomycetous species, followed by *Terminalia alata* Roth (six species).

Keywords: Basidiomycetes, fungi, polypores, mushrooms, Bardia national park, buffer zone

Introduction

Basidiomycetes, the Club fungi, is the second largest group of higher fungi. They are mostly saprophytic and some parasitic. The basidiomycetes differ from all other fungi in that they produce the haploid spores called basidiospores at the club shaped basidium during sexual reproduction (Alexopoulos and Mims, 1979). They have highly developed, profusely branched and septate mycelium of two types i.e. primary mycelium and secondary mycelium. The most familiar members of this class are mushrooms, toadstools, rusts, smuts, bracket fungi or polypores, etc. Members of basidiomycetes can secrete cellulose and lignin digesting enzymes. So, they are the best known decomposers of wood.

Polypores, also known as 'bracket' or 'shelf' fungi due to 'shelflike' fruiting bodies of some species, are tubiferous basidiomycetes. They have minute to large tubes (Miller, 1984). The tubes open to the exterior by means of pores. The spore bearing surface (pore surface) is located on the underside of the pileus. In each species these tube mouths, or pores are of definite size and shape (Overholts, 1953). The reproductive cells (basidia) form a layer on the inner surface of the tubes. The fruiting body (basidiocarp) may be fleshy, leathery, tough, corky or woody. If they are fleshy, they seldom have a central stipe and therefore, do not resemble a gilled mushroom. Typically they lack a stem, and with a few exceptions are hoof shaped (like a horse hoof) to 'resupinate' (lying flat on the substratum on which they are produced. Polypores on the other hand, often have lateral stipes or no stipe at all (Miller, 1984).Their hyphae are mono-, di- or trimatic. They inhabit wood and cause serious decay, and so are generally known as 'wood rotting fungi' (takhtechyau or bahuchhidritchyau in nepali) (Adhikari, 1988).

Mushroom can be defined as a macro-fungus with a distinctive fruiting body, which can be either epigeous or hypogeous (Suman and Sharma, 2005). Fungi generally in the class basidiomycetes are commonly called mushrooms, toadstools, gill fungi, or agarics. A mushroom is generally fleshy, spore bearing fruiting body (i.e. basidiocarp) of a fungus, typically produced above ground on soil or on its food source and characterized by heterotrophic mode

of nutrition (Shrestha, 2014). Mushrooms form large fruiting bodies visible without the aid of microscope. It mostly grows during the rainy season on damp rotten logs of woods, trunks of trees, decaying organic matter and in a damp soil rich in organic matter.

Nepal is a well famed place for mycodiversity. So far 1,150 mushroom species have been reported from Nepal (Adhikari, 2012). Among them 157 species are reported to be endemic to Nepal (Adhikari, 2009); 140 species are edible (Adhikari, 2014a), 66 species are poisonous (Adhikari, 2009) and 75 species are medicinal (Adhikari, 2009). Christensen *et al*. (2008), though mentioned of 228 edible species found in Nepal, but while listing they provided the list of 60 species only. The investigation on mushrooms of Nepal started since the contribution of Lloyd (1808) and Berkeley (1838), ever since several papers have been published and several botanical expeditions have been done (Aryal and Budhathoki, 2013). Among the biotypes of Nepal, phanerogamic floral diversity has been studied immensely but the study on cryptogamic flora, especially mycodiversity has got less attention (Adhikari, 2012). Mushrooms generally prefer wet region over dry region for its habitat resulting in its high diversity in the central and eastern Nepal as compared to the western Nepal.

It has been observed that intense mycological exploration and investigations has been done in central Nepal as compared to eastern and western Nepal (Adhikari, 2000). Moreover, work on mycological exploration and investigation from low land Terai region is less as compared to mountain and hilly region. Therefore, present study was undertaken to document the uninvestigated mycodiversity of Bardia national park and its buffer zone area which is situated in the less explored region of western Nepal.

Materials and Method

Study area

Bardia national park is situated in Bardia district of western Nepal. It covers an area of 968 sq. km. and its surrounding area covering 328 sq. km is designated as a buffer zone. The buffer zone includes altogether 20 village development committees (VDCs) around the park. Forest area occupies 59% of the buffer zone; and total cultivated area in the buffer zone is 41% (Paudel, 2015). Altitude varies from 152 m at Manau Ghat to 1,441m at Sukarmala, the highest point of the Churiya range. Mean annual rainfall at Chisapani at the foot of the Churiya is 2,230 mm, and at Gularia to the south of the park is 1,560 mm. Climate of the study area is typically tropical with hot climate. Temperature during the hot season rises upto a maximum of 45˚C and falls down to 5˚C during the winter season (Paudel, 2015).

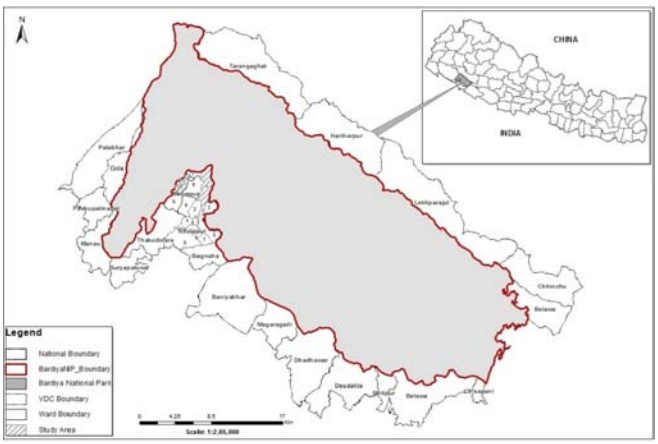

Figure 1: Map of the study area

About 70% of the park is covered with dominantly sal forest with a balanced mixture of grasslands, savannah and riverine forest (Chaudhary, 1998). Altogether 839 species of flora were estimated in the park (BPP, 1995). One hundred and seventy three species of vascular plants are recorded in the park: six pteridophytes, one gymnosperm, 140 dicots and 26 monocots (Bhuju et al., 2006). Upadhyay (2005) classified seven major vegetation types in the park. These are: sal forest (*Shorea robusta*, *Terminalia alata* and *Buchanania latifolia*), khair-sissoo forest (*Dalbergia sissoo* and *Acacia catechu*), moist riverine forest (*Syzygium cumini, Mallotus phillippensis, Bombax ceiba*), mixed hardwood forest (*Adina cordifolia, Casearia tomentosa, Mitragyna parviflora*), wooded grassland forest (*Saccharum spontaneum, Imperata cylindrica, Erithrina ravennae*), Phantas (open grassland) and Flood plain grassland (*Saccharum spontaneum, S. benghalensis, Phragmatis karka* and *Arundo donax*).

Collection and Identification

The park and its buffer zone area (Shivapur VDC-3 and 7 of upper and lower Bankhet village respectively; Shivapur VDC-5, Bakuwa village and Neulapur VDC-1, Ambreni village) were extensively explored for basidiomycetous fungi from October 28 to November 3, 2015. Altogether 42 species of basidiomycetous fungi were collected from nature in the study area. The species collected were well air dried in the shade and packed in paper envelops with proper tag numbers. The species found in the soil were collected carefully by digging with the help of a digger. Other specimens which were found to grow on fallen or rotten branches/wooden logs, branches or trunks of dying or dead plants; or trunks of living plants were collected along with their host plant by cutting with the help of saw. During collection, at least one basidiocarp was left for their spore dispersal.

Photographs of all the species were taken in their natural habitat prior to collection. The habitat/ substrate including ecological parameters viz. altitude, vegetation composition, soil type was recorded. The paper envelops were brought to National Herbarium and Plant Laboratories (KATH), Godawari for identification and making herbarium specimens. The identifications were done following key identifying characters of relevant literatures (Alexopoulos and Mims, 1979; Dickson and Lucas, 1979; Pacioni, 1981; Svrèek, 1983; Miller, 1984; Adhikari, 2014). It was also identified by tallying photographs of the relevant literatures and cross checking the collected specimens to that of identified herbarium specimens deposited at Mycology section of National Herbarium and Plant Laboratories. Some species were also identified seeking the help of expert of Mycology. The nomenclature of all the identified species follows Adhikari (2012, 2014).

Results and Discussion

Total of 42 species of basidiomycetous fungi from eight orders belonging to 12 families and 23 genera were collected from the study area (Table 1). During collection, at least one basidiocarp was left for their spore dispersal which support sustainable and scientific collection practice (Adhikari, 2000). Although distribution of macro-fungal species is low in hot and dry season, collection of basidiomycetous fungi was carried out during autumn season for the species commonly found in this season rather than rainy season resulting in fewer collections. Most of the collected basidiomycetous fungi are the members of polyporales. Polyporales, the dominant order, in the study area with 22 species was followed by Thelephorales (five species). Similarly, Polyporaceae was found to be the dominant family represented by 21 species. It was followed by Thelephoraceae and Xylariaceae, represented by four and three species respectively.

Table1: List of Basidiomycetous fungi collected from Bardia national park and its buffer zone area

S. N.	Name of Species/ Collection No.	Family	Order	Altitude	Host Plants/ Substrates	Locality
1	*Auricularia auricular-judea* (Bull.) Quel. 834B	Auriculariaceae	Auriculariales	158 m	Log of locally called 'Guthil' (*Trewia nudiflora* L.)	Shivapur-3, upper Bankhet
2	*Coriolus hirsutus* (Fr.) Quel. 808B	Polyporaceae	Polyporales	160 m	Pole of *Shorea robusta* Gaertn.	Bardia national park near Shivapur-3, upper Bankhet
3	*Dacrymyces palmatus* (Schw.) Bres. 842B	Dacrymycetaceae	Dacrymycetales	160 m	Log of *Dalbergia sissoo* Roxb. ex DC.	Shivapur-3, upper Bankhet
4	*Daediolopsis confragosa* (Bolt.: Fr.) Schr. var. *confragosa* 807B	Polyporaceae	Polyporales	160 m	Log of *Terminalia alata* Roth	Shivapur-3, upper Bankhet
5	*Daldinia concentrica* (Bolt.: Fr.) Cos. & de Not. 814B	Xylariaceae	Xylariales	160 m	Branch of living tree of *Morus australis* Poir.	Shivapur-7, lower Bankhet

6	*Favolus alveolaris* (D.C. ex Fr.) Quel. 825B	Polyporaceae	Polyporales	160 m	Electric pole of *Shorea robusta* Gaertn.	Shivapur-7, lower Bankhet
7	*Fomes fomentarius* (L.: Fr.) Kicks. 822B	Polyporaceae	Polyporales	160 m	Trunk of living tree of *Shorea robusta* Gaertn.	Bardia national park near Shivapur-3, upper Bankhet
8	*Ganoderma applanatum* (Pers.) Pat. 817B	Ganodermataceae	Polyporales	160 m	Log of *Shorea robusta* Gaertn.	Shivapur-7, lower Bankhet
9	*Heterobasidion annosum* (Fr.) Bref. 844B	Bonderzewiaceae	Russulales	158 m	Trunk of living tree of *Shorea robusta* Gaertn.	Shivapur-3, upper Bankhet
10	*Hexagonia* sp. 819B	Polyporaceae	Polyporales	160 m	Log of *Mangifera indica* L.	Bardia national park near Shivapur-7, lower Bankhet
11	*Hexagonia* sp. 836B	Polyporaceae	Polyporales	168 m	Log of *Shorea robusta* Gaertn.	Neulapur-1, Ambreni
12	*Innonotus hispidus* (Fr.) Karst. 813B	Hymenochaetaceae	Hymenochaetales	156 m	Pole of *Shorea robusta* Gaertn.	Shivapur-5, Bakuwa
13	*Lenzites betulina* (L.) Fr. 816B	Polyporaceae	Polyporales	158 m	Log of *Dalbergia sissoo* Roxb. ex DC.	Shivapur-7, lower Bankhet
14	*Microporus xanthopus* (Fr.) Kuntze 841B	Polyporaceae	Polyporales	160 m	Dead bark of log of *Shorea robusta* Gaertn.	Shivapur-3, upper Bankhet
15	*Microporus vernicipes* (Perk.) Kuntze 862B	Polyporaceae	Polyporales	168 m	Log of *Shorea robusta* Gaertn.	Neulapur-1, Ambreni
16	*Oxyporus populinus* (Schw.: Fr.) Donk. 815B	Schizophoraceae	Hymenochaetales	168 m	Dead branch of living tree of *Morus australis* Poir.	Neulapur-1, Ambreni
17	*Phellinus* sp. 835B	Hymenochaetaceae	Hymenochaetales	168 m	Trunk of dying tree of *Terminalia alata* Roth	Neulapur-1, Ambreni
18	*Phelloden niger* (Fr.) Karst. 802B	Bankeraceae	Thelephorales	160 m	Log of *Dalbergia sissoo* Roxb. ex DC.	Shivapur-3, upper Bankhet
19	*Polyporus* sp. 801B	Polyporaceae	Polyporales	160 m	Log of of *Terminalia alata* Roth	Shivapur-3, upper Bankhet
20	*Polyporus* sp. 860B	Polyporaceae	Polyporales	158 m	Grow on dead branch of living tree of *Holarrhena pubescens* Wall. ex G. Don	Shivapur-7, lower Bankhet
21	*Polyporus* sp. 803B	Polyporaceae	Polyporales	160 m	Log of *Dalbergia sissoo* Roxb. ex DC.	Shivapur-3, upper Bankhet
22	*Polyporus* sp. 843B	Polyporaceae	Polyporales	160 m	Log of *Shorea robusta* Gaertn.	Shivapur-7, lower Bankhet
23	*Polyporus* sp. 845B	Polyporaceae	Polyporales	158 m	Dead bark of log of *Shorea robusta* Gaertn.	Shivapur-3, upper Bankhet
24	*Polyporus squamosus* Michel. Fr. 815B	Polypopraceae	Polyporales	158 m	Log of *Terminalia alata* Roth	Shivapur-7, lower Bankhet
25	*Polyporus versicolor* (L.) Fr. 809B	Polyporaceae	Polyporales	160 m	Stump of *Terminalia alata* Roth	Bardia national park near Shivapur-3, upper Bankhet
26	*Pycnoporus cinnabarinus* (Jacq.: Fr.) Karst. 824B	Polyporaceae	Polyporales	168 m	Log of *Psidium guajava* L.	Neulapur-1, Ambreni
27	*Pycnoporus coccineus* (Fr.) Bond. & Singer 839B	Polyporaceae	Polyporales	168 m	Log of *Shorea robusta* Gaertn.	Neulapur-1, Ambreni

28	*Pycnoporus* sp. 821B	Polyporaceae	Polyporales	160 m	Log of locally called 'Guthil' (*Trewia nudiflora* L.)	Shivapur-7, lower Bankhet
29	*Schizophyllum commune* (Fr.) Fr. 861B	Schizophyllaceae	Agaricales	168 m	Log of *Terminalia alata* Roth	Neulapur-1, Ambreni
30	*Spongipellius delectans* (Peck) Murr. 895B	Polyporaceae	Polyporales	160 m	Fallen branch of *Populus ciliate* Wall. ex Royle	Shivapur-3, upper Bankhet
31	*Stereum rugosum* (Pers.: Fr.) Fr. 837B	Stereaceae	Russulales	159 m	Dead bark of log of *Shorea robusta* Gaertn.	Bardia national park, near Shivapur-7, lower Bankhet
32	*Stereum* sp. 336B	Stereaceae	Russulales	157 m	Log of *Shorea robusta* Gaertn.	Shivapur-7, lower Bankhet
33	*Trametes hirsuta* (Fr.) Pilat. 853B	Thelephoraceae	Thelephorales	160 m	Log of *Acacia catechu* (L. f.) Willd.	Bardia national park near Shivapur-3, upper Bankhet
34	*Trametes* sp. 801B	Thelephoraceae	Thelephorales	160 m	Log of *Shorea robusta* Gaertn.	Bardia national park near Shivapur-3, upper Bankhet
35	*Trametes incana* Lev. 818B	Thelephoraceae	Thelephorales	157 m	Log of *Acacia catechu* (L. f.) Willd.	Shivapur-7, lower Bankhet
36	*Trametes pubescens* (Schum.: Fr.) Pilat 833B	Thelephoraceae	Thelephorales	160 m	Log of *Shorea robusta* Gaertn.	Shivapur-3, upper Bankhet
37	*Trichaptum byssogennum*(Jungh.) Ryv. 801B	Polyporaceae	Polyporales	168 m	Log of *Shorea robusta* Gaertn.	Neulapur-1, Ambreni
38	*Xylaria furcata* Fr. 823B	Xylariaceae	Xylarialres	161 m	Log of *Shorea robusta* Gaertn.	Shivapur-7, lower Bankhet
39	*Xylaria nigripes* (KI.) Sacc. 860B	Xylariaceae	Xylariales	130 m	Log of *Shorea robusta* Gaertn.	Shivapur-7, lower Bankhet
40	Unidentified1 844B			161 m	Substrate unknown	Shivapur-3, upper Bankhet
41	Unidentified2 859B			162 m	Log of locally called 'Guthil' (*Trewia nudiflora* L.)	Shivapur-3, upper Bankhet (Khokharpur tole)
42	Unidentified3 858B			158 m	Log of *Shorea robusta* Gaertn.	Shivapur-7, lower Bankhet

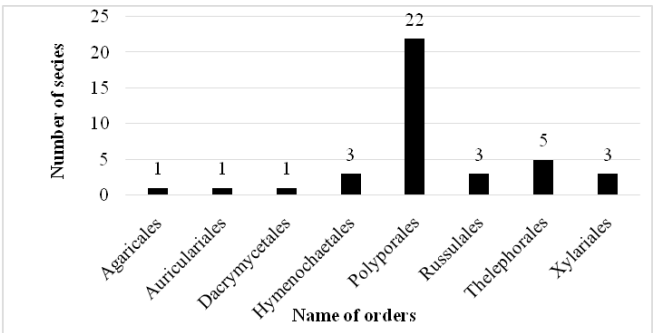

Figure 2: Orders representing number of species in the study area

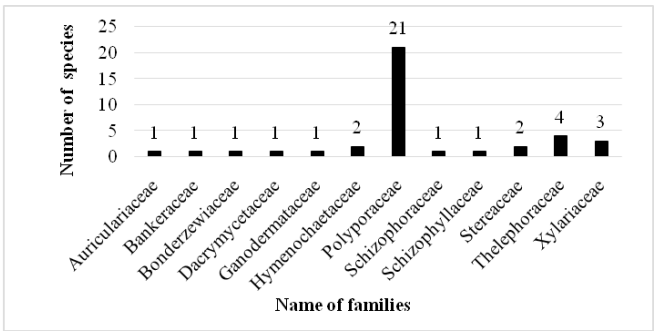

Figure3: Families representing number of species in the study area

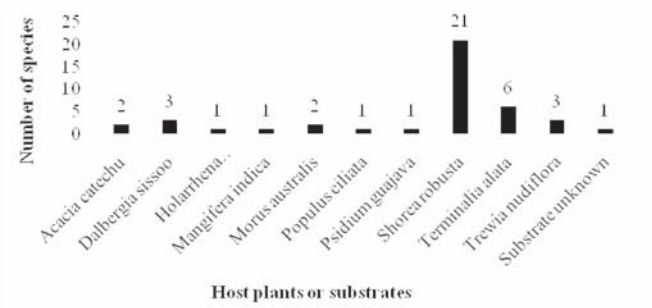

Figure 4: Host plants or substrates harboring number of fungal species in the study area

Polypores were the most common and were found to grow on dead woods, fallen logs, stumps, rotten branches but some such as *Daldinia concentrica* (Figure 5), *Fomes fomentarius* (Figure 6),

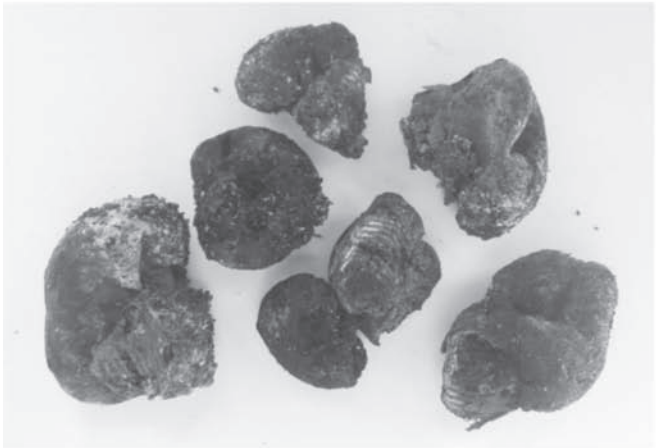

Figure 5: *Daldinia concentrica* (Bolt.: Fr.) Cos. & de Not.

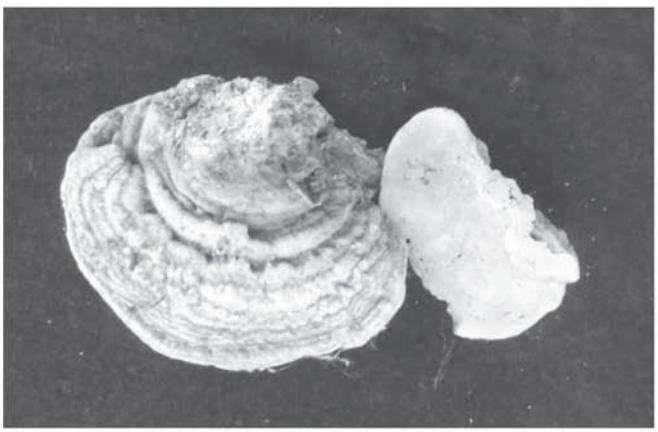

Figure 6: *Fomes fomentarius* (L.: Fr.) Kicks.

Heterobasidion annosum, etc. were found on dead branches of trees and trunks of living trees. Out of 42 fungal species, *Daediolopsis confragosa* var.*confragosa* (Figure 7), *Pycnoporus cinnabarinus* (Figure 8), *Xylaria furcata* (Figure 9), *Trichaptum byssogennum* (Figure 10), *Trametes* sp. and *Polyporus* sp. were found to be very common in the study area. *Shorea robusta* Gaertn. which is the dominant tree species of the study area was found to be key host plant for 21 basidiomycetous species. It was followed by *Terminalia alata* Roth which was found to host six species.

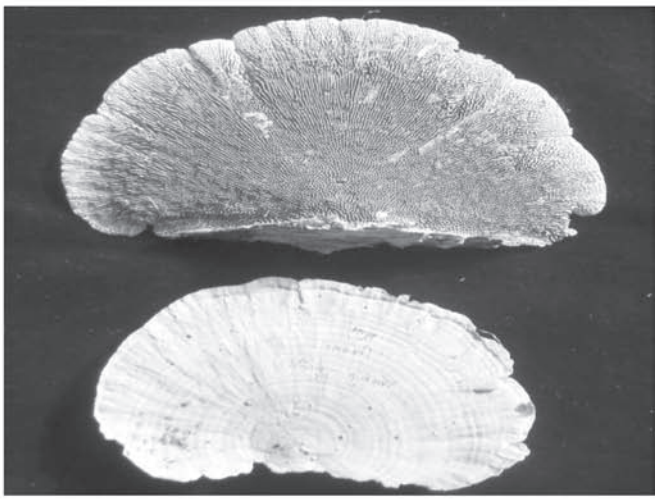

Figure 7: *Daediolopsis confragosa* (Bolt.: Fr.) Schr. var.

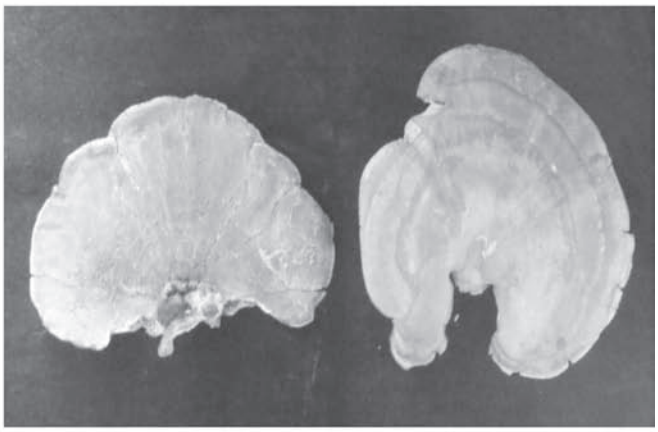

Figure 8: *Pycnoporus cinnabarinus* (Jacq.: Fr.) Karst. *confragosa*

Figure 9: *Xylaria furcata* Fr.

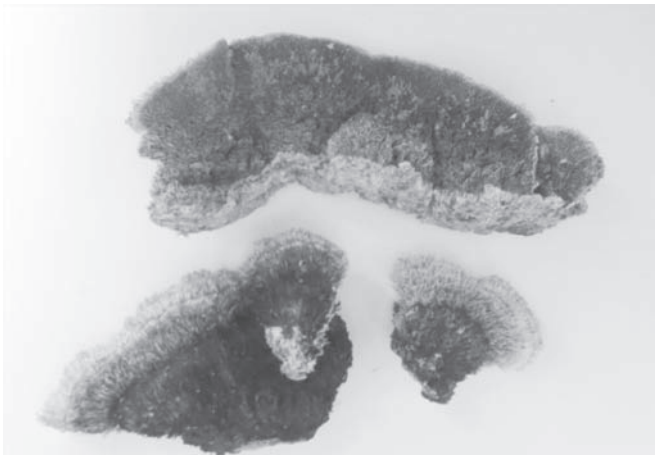

Figure 10: *Trichaptum byssogennum* (Jungh.) Ryv.

All the host plants or substrates of the fungal species were identified except one since it was almost rotten old wooden log. On other hand, three fungal species, out of 42, could not be identified as the collected species were at juvenile stage.

Conclusion

Total of 42 species of basidiomycetous fungi were collected. Out of them, three species being at juvenile stage were unidentified and rest of the identified species were from eight orders belonging to 12 families and 23 genera were collected from selected study area of Bardia national park and its buffer zone area. Polyporales and Polyporaceae were the dominant order and family respectively. *Shorea robusta* Gaertn. was found to be the major host plant for 21 basidiomycetous species.

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References

Adhikari, M.K. 1988. Polypores (wood - rotting fungi) of Nepal. *Banko Jankari*, 2(1):9–20.

Adhikari, M.K. 2000. Status and conservation of fungi in Nepal. *Journal of Natural History Museum*, 19: 117–133.

Adhikari, M.K. 2009. *Researches on the Nepalese mycoflora*: *revised account on the history of mycological explorations*. Published by K.S. Adhikari, Kathmandu, Nepal.

Adhikari, M.K. 2012. *Researches on the Nepalese mycoflora–2: checklist of macrofungi (mushrooms)*. Published by K.S. Adhikari, Kathmandu, Nepal.

Adhikari, M.K. 2014. *Mushrooms of Nepal*. (Eds. Durrieu, G. and Cotter, H.V.T.). Published by K.S. Adhikari, Kathmandu, Nepal.

Adhikari, M.K. 2014a. Addition and correction to the knowledge on edibility of wild mushrooms in Nepal: a discussion. *Bulletin of the Department of Plant Resources,* 36:1–15.

Alexopoulos, C.J. and C.W. Mims. 1979. *Introductory Mycology*. John Willey and Sons, Inc. New York. USA.

Aryal, H.P. and Budhathoki, U. 2013. Ethnomycological studies on some macro-fungi in Rupandehi district, Nepal. *Banko Jankari*, 23(1):51–56.

Berkely, M.J. 1838. Description of exotic fungi in the collection of Sir W.J. Hooker from memories and notes of J.F. Hooker from memories and notes of J.F. Klotsch with addition and correction. *Ans. Natural History*, 3:375–401.

Bhuju, U.R., Shakya, P.R., Poudel, N.P. and Bajimaya, S.S. 2006. *Final Report on the Protected Area Learning Network (Phase II)*, EPP/FLS Project- Terai Arc Landscape, Nepal.

BPP. 1995. *Biodiversity profiles of the Terai and Siwalik physiographic zones*. Biodiversity profile project. Publication no. 12. Department of

National Parks and Wildlife Conservation, Kathmandu, Nepal.

Chaudhary, R.P. 1998. *Biodiversity in Nepal (Status and Conservation)*. Published by S. Devi, Saharanpur (U.P.) and Tecpress Books, India.

Christensen, M., Bhattarai, S., Devkota, S. and Larsen, H.O. 2008. Collection and use of wild edible fungi in Nepal. *Ecology and Botany*, 62(1): 12–23.

Dickson, C. and Lucas, J. 1979. *The Encyclopedia of Mushrooms*. Orbis Publishing Limited, London.

Lloyd, C. G. 1808. *Mycological notes*. Mycology. Lloyd Library & Museum, Cincinnati, Ohio, USA.

Miller, O.K. Jr. 1984. *Mushrooms of North America.* Published by E.P. Dutton, a Division of Elsevier-Dutton Publishing company, New York, USA.

Overholts, L.O. 1953. *The Polyporaceae of the United States, Alaska, and Canada*. University of Washington Press, USA.

Pacioni, G. 1981. *Simon & Schuster's Guide to Mushrooms.* (Ed. Lincoff, G.). Simon & Schuster Inc., USA.

Paudel, P. 2015. *Habitat distribution, people's perception and threats to turtle (study from Bardia national park, Nepal).* Bachelor' degree project report, Institute of Forestry, Tribhuvan University, Pokhara, Nepal.

Shrestha, J.B. 2014. Present scenario and prospects of mushroom cultivation in Nepal. *In: Proceedings of the seminar in mushroom consumption and poisoning risk* (Ed. Raut, J.K.). Nepal Academy of Science and Technology, Lalitpur, Nepal. Pp. 23–28.

Suman, B.C. and Sharma, V.P. 2005. *Mushroom (Cultivation, Processing and Uses).* Agrobios, Jodhpur, India.

Svrèek, M. 1983. *The Hamlyn Book of Mushrooms and Fungi*. The Hamlyn Publishing Group Limited, Artia, Prague, Czechoslovakia.

Documentation of Plant diversity Conserved in Botanical Gardens of Makwanpur, Nepal

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Abstract

This study documents the plants conserved in three Botanical Gardens (BGs) of Makwanpur district. All record plants are in living condition in field and herbarium also prepared and deposited in KATH herbarium. Brindavan BG, Mountain BG and Tistung BG comprise 302 species, 190 species and 138 species respectively. Total 510 plant species were recorded from 391 genera and 130 families. Among them 409 medicinal, 74 ornamental, 35 threatened and 12 protected plant species. BGs are playing important role in conservation of genetic resources of local as well national flora of Nepal.

Keywords: Botanical Garden, Makwanpur, Brindavan, Daman, Tistung, ex-situ, in-situ conservation

Introduction

Among the 11 Botanical Gardens (BGs) of Nepal, three Botanical Gardens (Brindavan BG, Mountain BG and Tistung BG) are in Makwanpur district. This district lies between 84º41' to 84º35' E longitude and 27º21' to 27º24' N latitude), cover total area of 2390 sq km. Its altitude ranges from 166m (at Hathidhunga, Raigaun) to 2584m (at Simbhanjyang, Daman), (Singh, 2003). Due to wide variation in altitude, it harbors plants of tropical, sub-tropical, temperate and sub-alpine vegetation zones (Stainton, 1972). So, three BGs were established for the *ex-situ* and *in-situ* conservation of pteridophytes, gymnosperms, orchids, succulents, cactus, medicinal, ornamental, rare, endangered, threatened and protected plants. The main purpose of these BGs is to carry scientific research, collection of herbarium, identification of plants, technology development and educational awareness as well as conservation of genetic resources (Singh, 2003, Lamichhane et al, 2014). Brindavan BG was established in 2019 BS as a medicinal herbal garden under the Department of Plant Resoureces formerly named as Department of Medicinal Plants. It is located at an altitude of 350-450 m in tropical zone of Churiya range of Central Nepal, Hetauda. It is surrounded by Sal (*Shorea robusta* Gaertn.) forest and deciduous riverine forest. Similarly, Mountain BG established in 2022 BS, is located at an altitude of 2320 m in Daman area, and is surrounded by Pine, Oak and Rhododendron forest. It harbors generally plants of high mountains with Temperate and Subalpine climate. Likely, Tistung BG was established in 2022 BS, and is located at an altitude of 1900m in Tistung area, and is surrounded by Pine forest (DPRO, 2014, Chapagain et al, 2015)

Materials and Methods

Plants were recorded from three BGs, which were collected from different parts of Makwanpur district and some other places of Nepal (DPRO, 2014, Chapagain et al, 2015). Some ornamental species were exotic too. All plants are in living condition in field and herbarium also prepared and deposited in KATH Herbarium, Godawari. Plants were identified and their uses recorded with help of related literatures (Stainton, 1988, Polunin and Stainton, 1987, Shrestha and Joshi, 1996, Manandhar, 2002, Baral and Kurmi, 2006, Bhattarai and Ghimire, 2006, DPR, 2007, Raskoti, 2009).

Result and Discussion

Diversity

The study recorded 510 plant species which belongs to 391 genera and 130 families (Appendix-1). Among them 218 (42.7%) are herb, 114 (22.4%) are shrub, 152 (29.8%) are tree and 26 (5.1%) are

climber in habit. Out of them 409 species are medicinal (170 herb, 87 shrub, 132 tree and 20 climber) (Figure-1), 74 ornamental species, 10 invasive species and 27 other species. Among the three BGs, Brindavan BG, harbors 302 species, Mountain BG, harbors 190 species and Tistung BG, harbors 138 species of plants (Appendix 1). Among below listed plantsvarious parts are used for different medicinal and other purposesviz.110 sp. for leaves, 96 sp. roots, 66 sp. flowers, 55 sp. fruits, 25 sp. stems, 83 sp. bark, 11 sp. rhizome, 21 sp. seeds, 70 sp. whole plants and some other parts (Appendix-1).

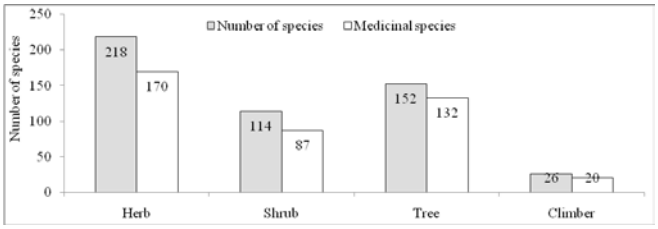

Figure 1: Number of species and medicinal plants on the basis of life form

Among the 130 families, Asteraceae is the largest family with 38 species, which followed by Fabaceae (35 sp.), Orchidaceae (22 sp.), Euphorbiaceae (18 sp.) and so on (Appendix-1 and Figure-2).

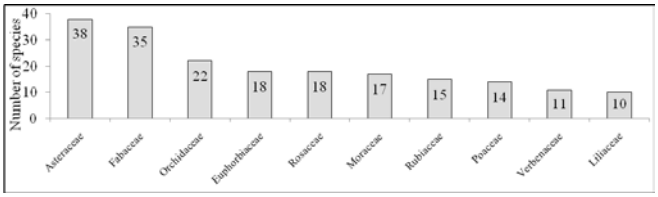

Figure 2: Top 10 dominant families in BGs

Threaten Category

According to IUCN and CAMP (2012) catagory, 60 plant species were recorded as threatened medicinal and aromatic plants in Nepal (DPR, 2012). Among the total 35 threatened species enlisted in these three BGs, 11 species are vulnerable, 6 CITES listed,6 endangered, 5 threatened and 3 rare and12 protected(out of 18 protected species), (Appendix-2, Figure-3).

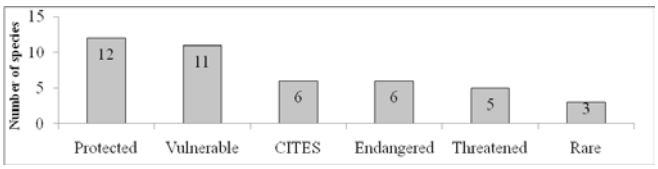

Figure3: Status of threatened plants in BGs

Table 1: Medicinal plants prioritized for research and development

S.N.	Scientific name	नेपाली नाम	Nepali name	Family
1	*Aconitum spicatum* (Bruhl) Stapf	विष	Bikh	Ranuncnlaceae
2	*Acorus calamus* L.	बोझो	Bojho	Araceae
3	*Asparagus racemosus* Willd. *	कुरीलो	Kurilo	Asparagaceae
4	*Azadirachta indica* A. Juss.	नीम	Neem	Meliaceae
5	*Bergenia ciliata* (Haw.) Sternb.	पाषण भेद	Pakhan Ved	Saxifragaceae
6	*Cinnamomum glaucescens* (Nees.) Nand.Mazz*	सुगन्ध कोकिला	Sugandhakokila	Lauraceae
7	*Cinnamomum tamala* (Buch.-Ham.) Nees & Eberm	तेजपात	Tejpat	Lauraceae
8	*Dioscorea deltoidea* Wall. ex Griseb.	बन तरुल	Ban tarul	Dioscoreaceae
9	*Gaultheria fragrantissima* Wall.	धसिंगरे	Dhasingre	Ericaceae
10	*Juglans regia* L.	ओखर	Okhar	Juglandaceae
11	Lichens	झ्याउ	Jhyau	
12	*Morchella conica* Pers.	गुच्छी च्याउ	Guchchhi chyau	Helvellaceae
13	*Phyllanthus emblica* L.	अमला	Amala	Euphorbiaceae
14	*Piper longum* L.*	पिपला	Pipla	Piperaceae
15	*Rauvolfia serpentina*(L.) Benth ex Kurz*	सर्पगन्धा	Sarpagandha	Apocynaceae
16	*Rheum australe* D. Don	पदम चाल	Padam chal	Polygonaceae
17	*Rubia manjith* Roxb. ex Fleming	मजिठो	Majitho	Rubiaceae
18	*Sapindus mukorossi* Gaertn.	रिट्ठा	Riththa	Sapindaceae
19	*Swertia chirayita* (Roxb. ex Fleming) Karsten*	चिराइतो	Chiraito	Gentianaceae
20	*Tagetes minuta* L.	जंगली सयपत्री	Janjali sayapatri	Asteraceae
21	*Taxus wallichiana* Zucc.*	लौठ सल्ला	Lauth sallo	Taxaceae
22	*Tinospora sinensis* (Lour.) Merr.*	गुर्जो	Gurjo	Menispermaceae
23	*Valeriana jatamansii* Jones*	सुगन्धवाल	Sugandhawala	Valerianaceae
24	*Zanthoxylum armatum* DC.*	टिमुर	Timur	Rutaceae

(*-priotized for agro-technology development)

Prioritized medicinal plants

DPR (2011) has prioritized 30 medicinal plants for research and development in Nepal. These 3 BGs of Makwanpur comprises 24 species among them (Table-1). Similarly, out of 12 species prioritized for agro-technology development, 9 species are conserved and promoted for research in these BGs (Table-1).

Conclusion

Since its establishment, Brindavan BG has been used to conserve genetic resources of more than 302 plant species. Similarly, Mountain BG, Daman and Tistung BG have conserved 190 and 138 species respectively. Among the total 510 species conserved, 409 species medicinal, 74 species ornamental, 35 species threatened, 12 protected species were conserved and promoted for agro-medicinal farming. BGs have been practized for the *in-situ* and *ex-situ* conservation techniques for conservation of rare, endangered, economically important medicinal and ornamental plants. It has conducted trainings for agro-farming of medicinal plants and researches on aromatic plants.

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References

Baral, S.R. and Kurmi, P.P. 2006. *A Compedium of Medicinal Plants in Nepal*. Mass Printing Press, Kathmandu.

Bhattarai, K.R and Ghimire, M.D. 2006. *Cultivation and sustainable harvesting of commercially important medicinal and aromatic plants of Nepal*. Heritage Research and Development Forum, Nepal.

Chapagain, N.H., Pandit, R.K. and Tamang, R. 2015. *Plantlist of Makwanpur district*. District Plant Resources Office, Makwanpur

DPR. 2007. Medicinal Plants of Nepal (Revised).*Bull. Department of Plant Resources No. 28*, Thapathali, Kathmandu.

DPR. 2011. *Medicinal Plants Prioritized for Research and Development of Nepal.* Department of Plant Resources, Thapathali, Kathmandu.

DPR. 2012. *Plants of Nepal: Fact Sheet.* Department of Plant Resources, Thapathali, Kathmandu.

DPRO. 2014. *District Plant Resources Office, Makwanpur.* District Plant Resources Office, Makwanpur.

Lamichhane, D., Baral, D. and Nepali, K.B. Documentation of medicinal plants conserved in National Botanical Garden, Godawari, Lalitpur. *Bul.Dept.Pl.Res.No.*36.

Manandhar, N.P. 2002. *Plants and People of Nepal.* Timber Press, Portland, Oregon.

Pathak, M. and chapagain N.H. Preliminary Enumeration of Flora of Parsa Wildlife Reserve, Central Nepal. *Bul.Dept.Pl.Res.No.*36.

Polunin, O. and Stainton, A. 1987. *Concise Flowers of Himalaya*. Oxford University Press, New Delhi, India.

Raskoti, B.B. 2009. *The Orchids of Nepal*. Quality Printers, Kathmandu, Nepal.

Shrestha, T.B. and Joshi R.M. 1996. *Rare, endemic and endangerewd plants of Nepal*. WWF Program, Kathmandu, Nepal.

Singh, A.P. 2003. Status and trade of medicinal plants of Makwanpur with some activities of District Plant Resources office. *Bul.Dept.Pl.Res.No.*22.

Stainton A. 1988. *Flowers of the Himalaya. A Supplement*. Oxford University Press, New Delhi, India.

Stainton, J.D.A. 1972. *Forest of Nepal*. John Murray, London.

Appendix 1: Plants of Brindavan, Mountain and Tistung Botanical Garden of Makwanpur

S.N.	Scientific name	Nepali name	Family	Lf	Use	Part	BGs
1	*Abelmoschus moschatus* Medik.	Latakasturi	Malvaceae	S	Med	Wh	B
2	*Abies spectabilis* (D. Don) Mirb.	Talis patra	Pinaceae	T	Med	St	MT
3	*Abrus precatorius* L.	Ratigedi	Fabaceae	C	Med	Sd	B
4	*Acacia catechu* (L. f.) Willd.	Khayar	Fabaceae	T	Med	St	B
5	*Acacia nilotica* (L.) Willd. ex Delile	Babul	Fabaceae	S	Med	Fr	B
6	*Acacia rugata* (Lam.) Voigt	Sikakai	Fabaceae	S	Med	Fr	B
7	*Acalypha hispida* Blume	Red cattail	Euphorbiaceae	S	Orn	Fl	B
8	*Acer pectinatum* Wall. ex Pax.	Firfire	Aceraceae	T	Tim	St	M
9	*Achyranthus aspera* L.	Datiwan	Amaranthaceae	H	Med	Rt	B
10	*Achyranthus bidentata* Blume	Dattiwan	Amaranthaceae	H	Med	Rt	B
11	*Aconitum spicatum* (Bruhl) Stapf	Bikh	Ranuncnlaceae	H	Med	Rt	MT
12	*Aconogonum molle* (D. Don) H. Hara	Thotne	Polygonaceae	H	Med	St	M
13	*Acorus calamus* L.	Bojho	Araceae	H	Med	Rh	MT
14	*Adina cordifolia* (Willd.ex Roxb.) Benth. & Hook.f. ex Brandis	Karam	Rubiaceae	T	Med	Br	B
15	*Aegle marmelos* (L.) Correa	Bel	Rutaceae	T	Med	Br, Fr	B
16	*Aeschynanthus hookeri* C.B. Clarke		Gesneriaceae	H	Orn	Fl	T
17	*Aesculus indica* (Colebr. ex Cambess.) Hook.	Lekh pangro	Hippocastanaceae	T	Med	Sd	MT
18	*Agapanthus africanus* (L.) Hoffmanns.	Lily	Liliaceae	H	Orn	Fl	BM
19	*Agave americana* L.	Kettuke	Agavaceae	S	Med	Lf	BMT
20	*Agave cantula* Roxb.	Kettuki	Agavaceae	S	Med	Lf	BMT
21	*Ageratum conyzoides* L.	Gandhe	Asteraceae	H	Med	Lf	B
22	*Ageratum houstonianum* Mill.	Nilo gandhe	Asteraceae	H	Med	Lf	B
23	*Ageretina adenophora* (Spreng.) King & H.Rob.	Banmara	Asteraceae	H	Med	Lf	BT
24	*Ainsliaea latifolia* (D. Don) Sch. Bip.	Sahadeva/	Asteraceae	H	Med	Fl	M
25	*Albizia chinensis* (Osbeck.) Merr.	Kalo siris	Fabaceae	T	Med	Br	B
26	*Albizia julibrissin* Durazz.	Patke siris	Fabaceae	T	Med	Br	B
27	*Albizia procera* (Roxb.) Benth.	Seto siris	Fabaceae	T	Tim	St	B
28	*Allium wallichii* Kunth	Banlasun	Amaryllidaceae	H	Med	Bulb	T
29	*Alnus nepalensis* D. Don	Utis	Betulaceae	T	Med	Br	MT
30	*Aloe vera* (L.) Burm. f.	Ghiu kumari	Liliaceae	H	Med	Lf	BMT
31	*Alpinia bractaeta*Rosc.	Alpinea	Zingiberaceae	H	Med	Rh	B
32	*Alstonia scholaris* (L.) R. Br.	Chhatiwan	Apocynaceae	T	Med	Br	B
33	*Alternanthera sessilis* (L.) DC.	Vringaraj	Amaranthaceae	H	Med	Lf	B
34	*Amaranthus lividus* L.	Latte saag	Amaranthaceae	H	Med	Lf	B
35	*Amaranthus spinosus* L.	Lhude	Amaranthaceae	H	Med	Rt	B
36	*Amaranthus viridis* L.	Latte saag	Amaranthaceae	H	Med	Lf	B
37	*Amomum subulatum* Roxb.	Alainchi	Zingiberaceae	H	Med	Fr	MT
38	*Anagallis arvensis* L.	Armale	Primulaceae	H	Med	Wh	B
39	*Anaphalis busua* (Buch.-Ham. ex Don) DC.	Buki ful	Asteraceae	H	Med	Fl	M
40	*Anaphalis contorta* (D.Don.) Hook.f.	Buki ful	Asteraceae	H	Med	Fl	M
41	*Anaphalis margaritacea* (L.) Benth.	Lekh buki	Asteraceae	H	Med	Lf	M
42	*Anaphalis triplinervis* (Sims.) C.B. Clarke	Lekh buki	Asteraceae	H	Med	Fl	M
43	*Andrographis paniculata* (Brum. f.) Nees	Kalomegh	Acanthaceae	H	Med	Wh	B
44	*Anemone vitifolia* Buch-Ham ex DC.	Kangarate	Ranuncnlaceae	H	Med	Rt	M
45	*Annona squamosa* L.	Sarifa	Annonaceae	T	Med	Rt	B
46	*Anthocephalus chinensis* (Lam.) A.Rich. ex Walp.	Kadam	Rubiaceae	T	Med	Br	B
47	*Anthogonium gracile* Wall. ex Lindl	Vui sunkhari	Orchidaceae	H	Orn	Fl	T
48	*Araucaria bidwilli* Hook.	Kade salla	Araucariaceae	T	Orn	Wh	M
49	*Araucaria columnaris* J.R.Forst. Hook.	Kade salla	Araucariaceae	T	Orn	Wh	B
50	*Ardisia solanacea* Roxb.	Damai fal	Myrsinaceae	S	Med	Wh	B
51	*Areca catechu* L.	Supari	Arecaceae	T	Med	Fr	B
52	*Argemone maxicana* L.	Thakal	Papavaraceae	H	Med	Rt, Lf	B
53	*Arisaema costatum* (Wall.) Mart.	Sarpa makai	Araceae	H	Med	Tuber	M
54	*Arisaema turtosum* (Wall.) Schott	Sarpa makai	Araceae	H	Med	Tuber	MT
55	*Aristolochia indica* L.	Isharmul	Aristolochiaceae	C	Med	Rt, Lf	B
56	*Artemisia dubia* Wall. ex Besser	Tite pati	Asteraceae	H	Med	Lf	MT
57	*Artemisia indica* Willd.	Tite pati	Asteraceae	H	Med	Lf	B

58	*Artocarpus heterophyllus* Lam.	Katahar	Moraceae	T	Med	Rt, Br	B
59	*Artocarpus lakoocha* Wall. ex Roxb.	Badahar	Moraceae	T	Med	Latex	B
60	*Arundinaria intermedia* Munro	Nigalo	Poaceae	H	Fod	St	B
61	*Asclepias curassavica* L.	Khursani ful	Asclepiadaceae	H	Med	Rt, Lf	B
62	*Asparagus filicinus* Buch.-Ham ex D. Don	Ban kurilo	Asparagaceae	H	Med	Rt	B
63	*Asparagus racemosus* Willd.	Kurilo	Asparagaceae	S	Med	Rt	MT
64	*Astilbe rivularis* Buch.-Ham. ex D. Don	Thulo okhati	Saxifragaceae	H	Med	Rt	MT
65	*Atropa belladonna* L.	Beladona	Solanaceae	H	Med	Rt	M
66	*Azadirachta indica* A. Juss.	Neem	Meliaceae	T	Med	Lf	B
67	*Azalea sp.*	Ajelia	Ericaceae	S	Orn	Fl	BMT
68	*Barleria strigosa* Willd	Ban urdherya	Acanthaceae	H	Med	Rt, Lf	B
69	*Bauhinia purpurea* L.	Tanki	Fabaceae	T	Med	Br	T
70	*Bauhinia vahlii* Wight & Arn.	Vorla	Fabaceae	C	Med	Fr, Rt	B
71	*Bauhinia variegata* L.	Koiralo	Fabaceae	T	Med	Br	B
72	*Begonia picta* Smith.	Magar kache	Begoniaceae	H	Med	Wh	B
73	*Begonia rubella* Buch.-Ham. ex D. Don	Magar kache	Begoniaceae	H	Med	Wh	M
74	*Belamcanda chinensis* (L.) Redoute	Tarbare ful	Iridaceae	H	Med	Rt	M
75	*Berberis aristata* DC.	Chutro	Berberidaceae	S	Med	Br, Lf	M
76	*Berberis asiatica* Roxb. ex DC.	Chutro	Berberidaceae	S	Med	Fr	MT
77	*Bergenia ciliata* (Haw.) Sternb.	Pakhan Ved	Saxifragaceae	H	Med	Rh	MT
78	*Betula alnoides* Buch.-Ham. ex D. Don	Saur	Betulaceae	T	Med	Br	MT
79	*Bidens pilosa* L.	Tikhe kurro	Asteraceae	H	Med	St, Lf	B
80	*Bischofia javanica* Blume	Kaijal	Staphyllaceae	T	Med	Lf	B
81	*Bixa orellana* L.	Sidure	Bixaceae	S	Med	Rt, Br	B
82	*Boehmeria platyphylla* D. Don.	Kamle	Urticaceae	H	Med	Lf	B
83	*Boehmeria rugulosa* Wedd.	Dar	Urticaceae	T	Med	Br	B
84	*Boenninghausenia albiflora* (Hook.) Reichenb. ex Meissn.	Makhe mauro	Rutaceae	H	Med	Wh	T
85	*Boerrhavia diffusa* L.	Punarwa	Nyctaginaceae	S	Med	Wh	B
86	*Bombax ceiba* L.	Simal	Bombacaceae	T	Med	Fl, latex	BT
87	*Bougainvillea glabra* Choisy	Barhamase	Nyctaginaceae	S	Orn	Fl	B
88	*Brachycorythis obcordata* (Lindl.)	Gamdol	Orchidaceae	H	Med	Rt	T
89	*Brassaiopsis hainla* (Buch.-Ham.ex D. Don) Seem.	Seto chuletro	Araliaceae	T	Fod	Fl	T
90	*Bridelia retusa* (L.) Spreng.	Gayo	Euphorbiaceae	T	Med	Rt, Br	T
91	*Bryophyllum pinnatum* (Lam.) Oken	Patthar churna	Crassulaceae	H	Med	Lf	B
92	*Buddleja asiatica* Lour.	Vimsen pati	Buddlejaceae	T	Med	Br	B
93	*Butea buteiformis* (Voigt) Grierson	Bhuletro	Fabaceae	S	Med	Sd	B
94	*Butea monosperma* (Lam.) Kuntze	Palans	Fabaceae	T	Med	Fl	B
95	*Calamus tenuis* Roxb.	Bet	Arecaceae	S	Rat	St	B
96	*Calliandra brevipes* Benth.		Fabaceae	S	Orn	Wh	B
97	*Callicarpa arborea* Roxb.	Guyalo	Verbenaceae	T	Med	Br	B
98	*Callicarpa macrophylla* Vahl.	Dahichamle	Verbenaceae	S	Med	Rt, Fr	B
99	*Callistemon citrinus* (Curtis) Skeels	Kalki	Myrtaceae	T	Orn	Fl	BMT
100	*Calotropis gigantea* (L.) Dryand.	Aank	Asclepiadaceae	H	Med	Latex	B
101	*Camellia sinensis* (L.) Kuntze	Chiya	Theaceae	S	Med	Lf	MT
102	*Campanula pallida* Wall.	Nepali bis	Campanulaceae	H	Med	Rt	M
103	*Canarium bengalense* Roxb.	Goguldhup	Burseraceae	T	Med	Latex	T
104	*Canna edulis* Ker Gawl.	Ful tarul	Cannaceae	H	Med	Rh	MT
105	*Cannabis sativa* L.	Ganja	Cannabaceae	H	Med	Lf	MT
106	*Careya arborea* Roxb.	Kumvi	Lecythidaceae	T	Med	Br	B
107	*Carica papaya* L.	Mewa	Caricaceae	S	Med	Fr	B
108	*Caryopteris odorata* (D.Don) B.L.Robinson	Mohani	Verbenaceae	S	Med	Br	B
109	*Caryota urens* L.	Rangbhang	Arecaceae	T	Orn	Wh	B
110	*Cassia alata* L.	Dadpat	Fabaceae	S	Med	Lf	B
111	*Cassia fistula* L.	Rajbrikcha	Fabaceae	T	Med	Fr, Br	B
112	*Cassia floribunda* Cav.	Tapre	Fabaceae	S	Med	Sd	B
113	*Cassia siamea* (Lam.) Irwin et Barneby	Tapre	Fabaceae	S	Orn	Fl	B
114	*Cassia tora* L.	Tapre	Fabaceae	H	Med	Rt, Lf	B
115	*Castanopsis indica* (Roxb.) Miq.	Katus	Fagaceae	T	Med	Br	T
116	*Castanopsis tribuloides* (Sm.) A. DC.	Musure katush	Fagaceae	T	Med	Rt	M
117	*Catharanthus roseus* (L.) G. Don	Sadabahar	Apocynaceae	H	Med	Wh	B

118	*Cautleya spicata* (Sm.) Baker	Panisarro	Zingiberaceae	H	Med	Rh	T
119	*Cedrus deodara* (Roxb. ex D. Don) G. Don	Devdar	Pinaceae	T	Med	Lf	MT
120	*Centella asiatica* (L.) Urb.	Ghodtapre	Apiaceae	H	Med	Wh	BMT
121	*Centratherum anthelminticum* (L.) Gamble	Kalo jira	Asteraceae	H	Med	Sd	B
122	*Cephaelis ipecacuanha* (Brot.) A.Rich.	Ipikak	Rubiaceae	H	Med	Rt	B
123	*Cheilanthes bicolor* (Forssk.) Kaulf.	Ranisinka	Pteridaceae	H	Med	Wh	BMT
124	*Chenopodium album* L.	Bethe	Chenopodiaceae	H	Med	Lf	B
125	*Chlorophytum arundinaceum* Baker	Seto musli	Liliaceae	H	Med	Rt	B
126	*Chlorophytum borivilianum* L.	Seto musli	Liliaceae	H	Med	Rt	B
127	*Chlorophytum nepalense* (Lindl.) Baker	Ban lasun	Liliaceae	H	Med	Rt	M
128	*Choerospondias axillaris* (Roxb.) B. L. Burtt & A. W. Hill	Lapsi	Anacardiaceae	T	Med	Fr	T
129	*Chromolaena odorata* (L.) King & H.E. Robins.	Banmara	Asteraceae	H	Med	Lf	B
130	*Chrysanthemum cinerariifolium* (Trevir.) Vis.	Pairethram	Asteraceae	H	Med	Lf	MT
131	*Chrysanthemum indicum* L.	Godavari ful	Asteraceae	H	Orn	Fl	BMT
132	*Cinnamomum camphora* (L.) J. Presl	Kapur	Lauraceae	T	Med	Latex	BT
133	*Cinnamomum glaucescens* (Nees.) Nand.Mazz	Sugandhakokila	Lauraceae	T	Med	Fr	BT
134	*Cinnamomum tamala* (Buch.-Ham.) Nees & Eberm.	Tejpat	Lauraceae	T	Med	Lf	BT
135	*Cissampelos pariera* L.	Gujar gano	Menispermaceae	C	Med	St bulb	B
136	*Cissus quadrangularis* L.	Sissus	Vitaceae	C	Orn	Wh	B
137	*Cleistocalyx operculata* (Roxb.) Merr. & Perry	Kyamuno	Myrtaceae	T	Med	Br, Lf	T
138	*Clerodendrum indicum* (L.) Kuntze	Chinde	Verbenaceae	S	Med	Wh	B
139	*Clerodendrum viscosum* Vent.	Vati	Verbenaceae	S	Med	Br, Lf	B
140	*Coccinea grandis* (L.). Voigt.	Gol kakri	Cucurbiataceae	C	Med	Rt	B
141	*Codiaeum variegatum* (L.) Blume	Chhirke	Euphorbiaceae	S	Orn	Lf	B
142	*Coelogyne cristata* Lindl.	Chandigava	Orchidaceae	H	Orn	Fl	M
143	*Coffea arabica* L.	Kafi	Rubiaceae	S	Med	Sd	B
144	*Coix lachryma-jobi* L.	Vir kaulo	Poaceae	H	Med	Rt, Sd	B
145	*Colebrookea oppositifolia* Sm.	Dhusure	Lamiaceae	S	Med	Lf	B
146	*Conyza japonica* (Thunb) Less ex DC.	Salayo jhar	Asteraceae	H	Med	Wh	B
147	*Corchorus aestuans* L.	Balu jhar	Tiliaceae	S	Med	Rt	B
148	*Cordyline fruticosa* (L.) A. Chev.	Ratopate	Liliaceae	H	Orn	Wh	B
149	*Coriaria nepalensis* Wall.	Machhyan	Coriariaceae	S	Med	Lf, Fr	M
150	*Corydalis chaerophylla* DC.	Pahele	Papavaraceae	H	Med	Lf	T
151	*Costus speciosus* (Koenig) Sm.	Betlauri	Zingiberaceae	H	Med	Rt	B
152	*Cotoneaster acuminatus* Lindl.	Dhalke ful	Rosaceae	S	Orn	Wh	M
153	*Crassocephalum crepidiodes* (Benth.) S. Moore	Dhedu phule	Asteraceae	H	Med	Rt, Lf	B
154	*Crataeva unilocularis* Buch.-Ham.	Sipligan	Capparaceae	T	Med	Br	B
155	*Crinum amoenum* Roxb. ex Ker Gawl.	Lily	Amaryllidaceae	H	Orn	Fl	B
156	*Crocus sativus* L.	Kesar	Iridaceae	H	Med	Pistle	T
157	*Cryptomeria japonica* (L.f.) D.Don.	Dhupi	Taxodiaceae	T	Orn	Wh	M
158	*Crysanthemum cinerariifolium* (Trevir) Vis.	Pairethram	Asteraceae	H	Med	Fl	T
159	*Cuphea hyssopifolia* Kunth.	Cuphea	Lythraceae	H	Orn	Fl	B
160	*Cupressus torulosa* D. Don.	Dhupi	Cuppresaceae	T	Med	Lf	MT
161	*Curculigo orchioides* Gaertn.	Syal dhote	Hypoxidaceae	H	Med	Rt	M
162	*Curcuma amada* Roxb.	Aamhaldi	Zingiberaceae	H	Med	Rh	B
163	*Curcuma angustifolia* Roxb.	Haledo	Zingiberaceae	H	Med	Rh	B
164	*Curcuma domestica* Valet.	Haledo	Zingiberaceae	H	Med	Rh	BMT
165	*Curcuma zedoaria* Rose	Kachur	Zingiberaceae	H	Med	Rh	B
166	*Cuscuta reflexa* Roxb.	Akashbeli	Convolvulaceae	C	Med	Wh	BMT
167	*Cutleya spicata* (J. E. Smith) Baker	Panisaro	Zingiberaceae	H	Orn	Wh	MT
168	*Cyanotis cristata* (L.) D. Don.	Sano kane	Commelinaceae	H	Orn	Wh	M
169	*Cycas pectinata* Griff.	Kalbal	Cycadaceae	S	Orn	Wh	B
170	*Cycas revoluta* Thunb.	Jagar	Cycadaceae	S	Med	Wh	BMT
171	*Cymbidium erythraum* Lindl.	Sunkhari	Orchidaceae	H	Orn	Fl	M
172	*Cymbidium iridioides* D. Don	Sunkhari	Orchidaceae	H	Med	Lf	M
173	*Cymbidium longifolium* D. Don	Sunkhari	Orchidaceae	H	Orn	Fl	M
174	*Cymbopogon flexuosus* (Nees ex Steud.) W. Watson	Kagati ghans	Poaceae	H	Med	Lf oil	BT
175	*Cymbopogon martinii* (Roxb.) W. Watson	Pamarosa	Poaceae	H	Med	Lf oil	BT
176	*Cymbopogon martinii* var. *sofia* Bruno	Zinger grass	Poaceae	H	Med	Lf oil	B
177	*Cymbopogon winterianus* Jowitt	Citronella	Poaceae	H	Med	Lf oil	BT

178	*Cynodon dactylon* (L.) Pers.	Dubo	Poaceae	H	Med	Wh	B
179	*Cynoglossum zeylanicum* (Vahl ex Hornem.) Thunb. ex Lehm.	Kanike kurro	Boraginaceae	H	Med	Rt	B
180	*Cyperus rotundus* L.	Mothe	Cyperaceae	H	Med	Rt	B
181	*Dalbergia latifolia* Roxb.	Sati sal	Fabaceae	T	Med	Br	B
182	*Dalbergia sissoo* Roxb. ex DC.	Sissau	Fabaceae	T	Med	Br	B
183	*Daphne bholua* Buch.-Ham. ex D. Don	Lokta	Thymelaeaceae	S	Med	Br	MT
184	*Daphne papyracea* Wall. ex Steud.	Barua	Thymelaeaceae	S	Med	Br	M
185	*Daphniphyllum himalense* (Benth.) Mull. Arg.	Rakchan	Daphniphyllaceae	T	Med	Wood	M
186	*Datura metel* L.	Kalo Dhaturo	Solanaceae	H	Med	Sd	M
187	*Datura stramonium* L.	Setro dhaturo	Solanaceae	H	Med	Fr	B
188	*Delonix regia* L.	Gulmohor	Fabaceae	T	Orn	Fl	B
189	*Dendrobium anceps* Sw.	Sunkhari	Orchidaceae	H	Orn	Fl	B
190	*Dendrobium longicornu* Lindl.	Sunkhari	Orchidaceae	H	Med	Wh	M
191	*Dendrobium moschatum* (Buch-Ham.) Sw.	Sunkhari	Orchidaceae	H	Orn	Fl	B
192	*Dendrocalamus strictus* (Roxb.) Nees	Bans	Poaceae	S	Med	juice	BMT
193	*Desmotrichum fimbriatum* Bl.	Jibanti	Orchidaceae	H	Orn	Fl	MT
194	*Dianthus caryophyllus* L.	Dianthus	Caryophyllaceae	H	Orn	Fl	M
195	*Didymocarpus albicalyx* C.B. Clarke	Kumkum	Gesneriaceae	H	Med	Lf	M
196	*Digitalis purpurea* L.	Digitalis	Scrophulariaceae	H	Med	Rt	MT
197	*Dillenia pentagyna* Roxb.	Tatari	Dilleniaceae	T	Med	Br	B
198	*Dioscorea alata* L.	Ghar Tarul	Dioscoreaceae	C	Med	Tuber	B
199	*Dioscorea bulbifera* L.	Gittha	Dioscoreaceae	C	Med	Tuber	BMT
200	*Dioscorea deltoidea* Wall. ex Griseb.	Ban tarul	Dioscoreaceae	C	Med	Tuber	BMT
201	*Diploknema butyracea* (Roxb.) Baehni	Chiuri	Sapotaceae	T	Med	Sd, Br	B
202	*Dipsacus inermis* Wall.	Banmula	Dipsacaceae	H	Med	Rt	MT
203	*Dracaena reflexa* Lam.	Dresena	Liliaceae	H	Orn	Wh	B
204	*Drymaria diandra* Blume	Avijalo	Caryophyllaceae	H	Med	Wh	B
205	*Drypetes roxburghii* (Wall.) Hurusawa.	Putranjiba	Euphorbiaceae	S	Med	Lf, Fr	B
206	*Duranta erecta* L.	Nil kanda	Verbenaceae	S	Med	Lf	BT
207	*Eclipta prostrata* L.	Vringaraj	Asteraceae	H	Med	Wh	B
208	*Edgeworthia gardneri* (Wall.) Meisn.	Argeli	Thymelaeaceae	S	Med	Rt, Br	M
209	*Ehretia acuminata* R. Br.	Datarunga	Boraginaceae	T	Med	Br	B
210	*Elaeagnus infundibularis* Momiy.	Goyalo	Elaeagnaceae	S	Med	Fr	B
211	*Elaeagnus parvifolia* Wall. ex Royle.	Guyeli	Elaeagnaceae	S	Med	Fr	B
212	*Elaeocarpus sphaericus* (Gaertn.) K. Schum.	Rudrakshaya	Elaeocarpaceae	T	Med	Sd	B
213	*Elephantopus scaber* L.	Sahasrabuti	Asteraceae	H	Med	Rt	BM
214	*Elusine indica* (L.) Gaertn.	Kode jhar	Poaceae	H	Med	Wh	B
215	*Engelhardia spicata* Lesch. ex Blume	Mauwa	Juglandaceae	T	Med	Br	T
216	*Ephedra gerardiana* Wall. ex Stapf	Somlata	Ephedraceae	H	Med	Wh	M
217	*Eria coronaria* (Lindl.) Rchb. f.	Sunkhari	Orchidaceae	H	Orn	Fl	T
218	*Eria graminifolia* Lindl.	Sunkhari	Orchidaceae	H	Orn	Fl	MT
219	*Eria lasiopetala* (Willd.) Ormerod	Sunkhari	Orchidaceae	H	Orn	Fl	B
220	*Eriobotrya elliptica* Lindl.	Maya	Rosaceae	T	Orn	Fl	MT
221	*Erythrina stricta* Roxb.	Phaledo	Fabaceae	T	Med	Br	B
222	*Eucalyptus camaldulensis* Dehnh.	Masala	Myrtaceae	T	Med	Lf	B
223	*Eucalyptus citriodora* Hook.	Masala	Myrtaceae	T	Med	Lf	BMT
224	*Euonymus tingens* Wall.	Kasuri	Celastraceae	T	Med	Br	M
225	*Euphorbia cotinifolia* L.	Dudhe	Euphorbiaceae	S	Orn	Wh	B
226	*Euphorbia hirta* L.	Dhudhe Jhar	Euphorbiaceae	H	Med	Latex	B
227	*Euphorbia pulcherrima* Willd. ex Klotzsch	Lalupate	Euphorbiaceae	S	Orn	Fl	M
228	*Euphorbia royleana* Boiss.	Siudi	Euphorbiaceae	T	Med	Latex	BT
229	*Euphorbia thymifolia* L.	Dudhe jhar	Euphorbiaceae	S	Med	Wh	B
230	*Euphorbia tirucalli* L.	Chepte siudi	Euphorbiaceae	T	Med	Latex, Br	B
231	*Eurya acuminata* DC.	Jhigani	Theaceae	T	Med	Lf, Fr	T
232	*Eurya cerasifolia* (D. Don) kobuski	Baklo jhino	Theaceae	T	Orn	Wh	T
233	*Fagopyrum tataricum* (L.) Gaertn.	Tite fapar	Polygonaceae	H	Med	Wh	M
234	*Ficus auriculata* Lour.	Nimaro	Moraceae	T	Med	Latex	BMT
235	*Ficus benghalensis* L.	Bar	Moraceae	T	Med	Latex	B
236	*Ficus benjamina* L.	Swami	Moraceae	T	Med	Latex	B
237	*Ficus elastica* Roxb. ex Hornem.	Rabar	Moraceae	T	Rub	Latex	B

238	*Ficus hederacea* Roxb.	Dudhe lahara	Moraceae	S	Orn	Wh	B
239	*Ficus hispida* L.	Khasreto	Moraceae	T	Med	juice	B
240	*Ficus lacor* Buch.-Ham.	Kavro	Moraceae	T	Med	Wh	T
241	*Ficus neriifolia* Sm.	Dudhilo	Moraceae	T	Med	Latex	T
242	*Ficus racemosa* L.	Dumri	Moraceae	T	Med	Fr	B
243	*Ficus religiosa* L.	Pipal	Moraceae	T	Med	Latex, Lf	B
244	*Ficus sarmentosa* Buch.-Ham. ex Sm.	Berulo	Moraceae	T	Med	Latex	M
245	*Ficus semicordata* Buch.-Ham. ex Sm.	Khanyu	Moraceae	T	Med	Latex	T
246	*Flemingia fruticolosa* Wall	Vatwasi	Fabaceae	H	Med	Rt	B
247	*Fragaria nubicola* Lindl. ex Lacaita	Bhuin aiselu	Rosaceae	H	Med	Lf	M
248	*Fraxinus floribunda* Wall.	Lakuri	Oleaceae	T	Med	St	MT
249	*Fuchsia hybrida*	Krishna kali	Onagraceae	H	Orn	Fl	M
250	*Galinsoga parviflora* Cav.	Ilame	Asteraceae	H	Med	Wh	B
251	*Gardenia jasminoides* Ellis	Indra kamal	Rubiaceae	S	Med	Fr	M
252	*Gastrochilus distichus* (Lindl) Ktze.	Sunkhari	Orchidaceae	H	Orn	Fl	T
253	*Gaultheria fragrantissima* Wall.	Dhasingre	Ericaceae	S	Med	Lf	MT
254	*Gelseminum stans* (L.) Kuntze	Pahele ful	Bignoniaceae	T	Orn	Wh	B
255	*Gerbera nivea* (DC.) Sch. Bip	Jhulo	Asteraceae	H	Orn	Fl	MT
256	*Ginkgo biloba* L.		Ginkgoaceae	T	Med	Lf, Rt	B
257	*Girardinia diversifolia* (Link) Friis	Allo	Urticaceae	H	Med	Br	MT
258	*Gnaphalium affine* D. Don.	Bokre ful	Asteraceae	H	Orn	Wh	M
259	*Gomphrena globosa* L.	Makhamali	Asteraceae	H	Med	Rt	B
260	*Gonostegia hirta* (Blume) Miq.	Chiple	Urticaceae	H	Med	Wh	M
261	*Gossypium arboreum* L.	Kapas	Malvaceae	S	Med	Lf, Rt	B
262	*Grevillea robusta* A. Cunn. ex R. Br.	Kangiyo ful	Proteaceae	H	Orn	Fl	MT
263	*Hedera nepalensis* K. Koch	Kathe dudhela	Araliaceae	S	Med	Lf	M
264	*Hedyotis diffusa* Wall.	Majithe jhar	Rubiaceae	H	Med	Wh	B
265	*Heliconia rostrata* W.J. Kress	Kerapate ful	Heliconiaceae	H	Orn	Fl	B
266	*Hemiphragma heterophyllum* Wall.	Nas jhar	Scrophulariaceae	H	Med	Wh	M
267	*Hibiscus rosa-sinensis* L.	Ghanti ful	Malvaceae	S	Med	Rt, Lf	BMT
268	*Holarrhena pubescens* (Buch.-Ham.) Wall. ex G. Don	Khirro	Apocynaceae	T	Med	Br	B
269	*Holmskioldia sanguinea* Retz.	Aputali	Verbenaceae	S	Orn	Fl	B
270	*Hoya linearis* Wall. ex D. Don	Dudhe lahara	Asclepiadaceae	C	Orn	Wh	B
271	*Hydrangea anomala* D. Don	Hansaraj	Hydrangeaceae	S	Orn	Fl	BMT
272	*Hymenopogon parasiticus* Wall.	Biri	Rubiaceae	H	Orn	Fl	M
273	*Hypoxis aurea* Lour.	Karsul	Hypoxidaceae	H	Med	Wh	T
274	*Imperata cylindrica* (L.) P. Beauv.	Siru	Poaceae	H	Med	Rt	B
275	*Inula cappa* (Buch.-Ham. ex D. Don) DC.	Gaitihare	Asteraceae	H	Med	Fl, Lf	M
276	*Ioxora coccinea* L.		Rubiaceae	S	Orn	Fl	B
277	*Ipomoea quamoclit* L.	Jayanti ful	Convolvulaceae	C	Med	Wh	B
278	*Jacaranda mimosifolia* D.Don	Jakaranda	Bignoniaceae	T	Med	Br, Lf	B
279	*Jasminum auriculatum* Vahl.	Juhi	Oleaceae	S	Med	Rt, Fl	B
280	*Jasminum humile* L.	Jai	Oleaceae	S	Med	Rt, Br	BMT
281	*Jatropha curcas* L.	Sajiwan	Euphorbiaceae	S	Med	Juice	B
282	*Juglans regia* L.	Okhar	Juglandaceae	T	Med	Br	MT
283	*Juniperus horizontalis* Moench	Dhupi	Cuppresaceae	S	Med	St	MT
284	*Juniperus indica* Bertol.	Dhupi	Cuppresaceae	S	Med	St	MT
285	*Juniperus recurva* Buch.-Ham.ex D.Don	Dhupi	Cuppresaceae	S	Med	St	M
286	*Justicia adhatoda* L.	Asuro	Acanthaceae	S	Med	Lf	B
287	*Lagerstroemia indica* L.	Asare ful	Lythraceae	T	Med	Br, Lf	BT
288	*Lagerstroemia parviflora* Roxb.	Bot dhayero	Lythraceae	T	Med	Lf, Fl	B
289	*Lantana camara* L.	Banfanda	Verbenaceae	S	Med	St, Lf	B
290	*Lawsonia inermis* L.	Mehandi	Lythraceae	S	Med	Rt, Lf	B
291	*Lecanthus peduncularis* (Royle) Wedd.	Kholejhar	Urticaceae	H	Med	Rt	M
292	*Leptodermis lanceolata* Wall.	Bhui champa	Rubiaceae	S	Med	Wh	T
293	*Leucaena leucocephala* (Lam.) de Wit	Ipil lipil	Fabaceae	T	Fod	Lf	B
294	*Leucas cephalotes* (Roth) Spreng.	Dronapuspi	Lamiaceae	H	Med	Wh	B
295	*Lindenbergia grandiflora* (Buch.-Ham. ex D.Don) Benth.	Vedi ful	Scrophulariaceae	H	Med	Lf	T
296	*Lindera neesiana* (Wall. ex Nees) Kurz	Siltimur	Lauraceae	T	Med	Fr	M
297	*Litchi chinensis* Sonner	Litchi	Sapindaceae	T	Med	Lf	B

298	*Litsea cubeba* (Lour.) Pers.	Siltimur	Lauraceae	T	Med	Sd	M
299	*Litsea monopetala* (Roxb.) Pers.	Kutmero	Lauraceae	T	Med	Rt, Br	B
300	*Lobelia pyramidalis* Wall.	Eklebir	Lobeliaceae	H	Med	Rt	M
301	*Luculia gratissima* (Wall.) Sweet	Gaitihare	Rubiaceae	S	Med	Br	T
302	*Ludwigia hyssopifolia* (G. Don) Exell	Lwang jhar	Onagraceae	H	Med	Lf	B
303	*Lyonia ovalifolia* (Wall.) Drude	Angeri	Ericaceae	T	Med	Lf	M
304	*Maesa chisia* Buch.-Ham. ex D. Don	Bilaune	Myrsinaceae	S	Med	Rt Br,Fr	BM
305	*Maesa macrophylla* (Wall.) DC.	Vogate	Myrsinaceae	S	Med	Br, Lf	T
306	*Mahonia napaulensis* DC.	Jamanemandro	Berberidaceae	S	Med	Br	BMT
307	*Mallotus philippensis* (Lam.) Mull. Arg.	Sindure	Euphorbiaceae	T	Med	Fr	B
308	*Malvaviscus arboreus* Cav.	Ghantiphool	Malvaceae	S	Orn	Fl	T
309	*Mangifera india* L.	Aamp	Anacardiaceae	T	Med	Br	B
310	*Manihot esculenta* Crantz.	Simal tarul	Euphorbiaceae	S	Food	Rt	B
311	*Manilkara zapota* (L.) P. Royen	Sapota	Sapotaceae	T	Med	Br	B
312	*Matricaria chamomilla* L.	Kamomail	Asteraceae	H	Med	Fl	B
313	*Melastoma melabathricum* L.	Kali angeri	Melastomaceae	S	Med	Wh	T
314	*Melia azedarach* L.	Bakaino	Meliaceae	T	Med	Br	MT
315	*Mentha arvensis* L.	Pudina	Lamiaceae	H	Med	Lf	MT
316	*Michelia champaca* L.	Champ	Magnoliaceae	T	Med	Br	BMT
317	*Mikania micrantha* Kunth	Lahare banmara	Asteraceae	C	Wed	Wh	B
318	*Millettia extensa* Benth.	Gaujo	Fabaceae	S	Med	Rt	B
319	*Mimosa pudica* L.	Lajjawati	Fabaceae	H	Med	Rt	B
320	*Mimosa rubicaulis* Lam.	Arari	Fabaceae	S	Med	Lf, Rt	B
321	*Mirabilis jalapa* L.	Malati	Nyctaginaceae	H	Med	Rt	B
322	*Morchella conica* Pers.	Guchchhi chyau	Helvellaceae	H	Med	Wh	M
323	*Moringa oleifera* Lam.	Sahijan	Moringaceae	T	Med	Rt	B
324	*Morus alba* L.	Kimbu	Moraceae	T	Med	Latex	B
325	*Morus serrata* Roxb.	Kimbu	Moraceae	T	Med	Latex	T
326	*Mucuna monosperma* DC.	Baldhyangra	Fabaceae	C	Med	Sd	B
327	*Mucuna pruriens* (L.) DC.	Kauso	Fabaceae	H	Med	Sd	B
328	*Murdannia divergens* (C. B. Clarke) Bruckn.	Kane	Commelinaceae	H	Orn	Wh	B
329	*Murraya koenigii* (L.) Spreng.	Mitho neem	Rutaceae	S	Med	Br, Lf	B
330	*Murraya paniculata* (L.) Jack	Kamini ful	Rutaceae	S	Med	Br, Lf	B
331	*Musa paradisiaca* L.	Kera	Musaceae	H	Med	Core, Rt	M
332	*Myrica esculenta* Buch.-Ham. ex D. Don	Kaphal	Myricaceae	T	Med	Br	MT
333	*Nerium indicum* L.	Karbir	Apocynaceae	S	Orn	Wh	B
334	*Nyctanthes arbor-tristis* L.	Parijat	Oleaceae	S	Med	Br, Lf	B
335	*Oberonia ensiformis* (Sm.) Lindl.	Sunkhari	Orchidaceae	H	Orn	Fl	M
336	*Oberonia falconeri* Hook.	Sunkhari	Orchidaceae	H	Orn	Fl	B
337	*Ocimum basilicum* L.	Babari	Lamiaceae	H	Med	Lf	M
338	*Ocimum sanctum* L.	Tulasi	Lamiaceae	H	Med	Lf	BM
339	*Olea europaea* L.	Jaitun	Oleaceae	S	Med	Rt, Br, Lf	B
340	*Operculina turpethum* (L.) Silva Manso	Nisodh	Convolvulaceae	C	Med	Rt	BT
341	*Ophiopogon clarkei* Hook. f.	Ban supadi	Liliaceae	H	Orn	Wh	M
342	*Oplismenus compositus* (L.) P. Beauv.		Poaceae	H	Fod	Wh	B
343	*Opuntia monacantha* (Willd.) Haw.	Nakhbeni	Cactaceae	S	Med	Fr	M
344	*Oroxylum indicum* (L.) Kurz	Tatelo	Bignoniaceae	T	Med	Br, Sd	B
345	*Osbeckia nepalensis* Hook.	Seto chulsi	Melastomaceae	S	Med	Rt	T
346	*Osbeckia stellata* Buch.-Ham. ex D. Don	Chulsi	Melastomaceae	S	Med	Rt	MT
347	*Osmanthus fragrans* Lour.	Singre	Oleaceae	T	Med	Br, Fl	B
348	*Oxalis corniculata* L.	Chari amilo	Oxalidaceae	H	Med	Wh	B
349	*Oxyspora paniculata* (D. Don) Candolle		Melastomaceae	S	Orn	Fl	T
350	*Paederia foetida* L.	Padejhar	Rubiaceae	H	Med	Rt, Fr	B
351	*Pandanus nepalensis* St.John	Kewara	Pandanaceae	S	Med	Sd	B
352	*Papaver somniferum* L.	Aphim	Papavaraceae	H	Med	Latex	T
353	*Papilionanthe teres* (Roxb.) Shltr.	Sunkhari	Orchidaceae	H	Orn	Fl	B
354	*Paris polyphylla* Sm.	Satuwa	Liliaceae	H	Med	Rh	T
355	*Parochetus communis* Buch.-Ham. ex D.Don.	Kerau jhar	Fabaceae	H	Med	Rt, Lf	M
356	*Parthenium hysterophorus* L.	Parthenium	Asteraceae	H	Wed	Wh	B
357	*Paulownia tomentosa* (Thunb.) Steud.	Poulenia	Paulowniaceae	T	Tim	St	BT

358	*Pelatantheria insectifera* (Rchb.f.) Ridl.	Sunkhari	Orchidaceae	H	Orn	Fl	B
359	*Persea americana* Mill	Avocardo	Lauraceae	T	Food	Fr	B
360	*Persea odoratissima* (Nees) Kosterm.	Kaulo	Lauraceae	T	Med	Br	T
361	*Persicaria chinensis* (L.) H. Gross	Kukur thotne	Polygonaceae	H	Med	Wh	T
362	*Phoenix acaulis* Roxb. ex Buch.-Ham.	Khajuri thakal	Arecaceae	S	Med	Rt, Fr	B
363	*Phoenix dactylifera* L.	Khajuri thakal	Arecaceae	S	Med	Lf, Fr	B
364	*Phoenix humilis* Royle. ex Buch-Ham. K. f.	Thakal	Arecaceae	S	Food	Fr	B
365	*Pholidota imbricata* Hook.	Sunkhari	Orchidaceae	H	Med	Pseudobulb	M
366	*Phyllanthus amarus* Schum. & Thomsoni	Bhui amala	Euphorbiaceae	S	Med	Wh	B
367	*Phyllanthus emblica* L.	Amala	Euphorbiaceae	T	Med	Br, Fr	MT
368	*Phytolacca acinosa* Roxb.	Jaringo	Phytolaccaceae	H	Med	Wh	M
369	*Pieris formosa* (Wall.) D. Don	Balu	Ericaceae	S	Med	Lf	M
370	*Pilea scripta* (Buch.-Ham. ex D. Don) Wedd.	Gagleti	Urticaceae	H	Wed	Wh	M
371	*Pinus patula* Schiede ex Schldtl. & Cham.	Pate sallo	Pinaceae	T	Med	Latex	MT
372	*Pinus roxburghii* Sarg.	Rani salla	Pinaceae	T	Med	Latex	BT
373	*Pinus wallichiana* A. B. Jacks.	Gobre sallo	Pinaceae	T	Med	Latex	MT
374	*Piper betle* L.	Pan	Piperaceae	C	Med	Rt, Lf	B
375	*Piper longum* L.	Pipla	Piperaceae	C	Med	Rt, Fr	B
376	*Piper nigrum* L.	Marich	Piperaceae	C	Food	Fr	B
377	*Piptanthus nepalensis* (Hook.) D. Don	Vatmase jhar	Fabaceae	S	Orn	Fl	M
378	*Plantago erosa* Wall.	Isabgol	Plantaginaceae	H	Med	Rt	M
379	*Plantago major* L.	Isabgol	Plantaginaceae	H	Med	Sd	M
380	*Pleione praecox* (Sm.) D. Don	Sunkhari	Orchidaceae	H	Med	Pseudobulb	M
381	*Plumbago zeylanica* L.	Chitu	Plumbaginaceae	S	Med	Wh	B
382	*Plumeria rubra* L.	Chuwa	Apocynaceae	T	Med	Rt, Br	B
383	*Podocarpus neriifolius* D.Don	Gunsi	Podocarpaceae	T	Med	Lf, Br	B
384	*Pogostemon benghalensis* (Brum. f.) Kuntze	Rudilo	Lamiaceae	H	Med	Lf	B
385	*Pogostemon glaber* Benth.	Rudilo	Lamiaceae	H	Med	Lf	B
386	*Polyalthea longifolia* (Sonn.) Thwaites	Asoka	Annonaceae	T	Med	Br	M
387	*Potentilla fructicosa* L.	Bajradanti	Rosaceae	H	Med	Rt	M
388	*Potentilla fulgens* Wall. ex Hook.	Bajradanti	Rosaceae	H	Med	Rt	T
389	*Potentilla peduncularis* D. Don	Nagbhya	Rosaceae	H	Med	Rt	M
390	*Premna latifolia* L.	Ginneri	Verbenaceae	T	Med	Br	B
391	*Primula glomerata*	Medosoro	Primulaceae	H	Orn	Fl	M
392	*Prinsepia utilis* Royle	Bhekali	Rosaceae	S	Med	Sd	M
393	*Prunus cerasoides* D.Don.	Paiyu	Rosaceae	T	Med	Br	M
394	*Prunus cornuta* (Wall. ex Royle) Steud.	Baan aaru	Rosaceae	T	Med	Br	M
395	*Prunus domestica* L.	Alucha	Rosaceae	T	Med	Fr	M
396	*Prunus persica* (L.) Batsch.	Aaru	Rosaceae	T	Med	Bud	M
397	*Psidium guajava* L.	Amba	Myrtaceae	T	Med	Br	M
398	*Pterocarpus marsupium* Roxb	Bijayasal	Fabaceae	T	Med	St, Lf	B
399	*Punica granatum* L.	Darim	Punicaceae	T	Med	Fr	M
400	*Pyracantha crenulata* (D. Don) M. Roem.	Ghangaru	Rosaceae	S	Med	Fr	MT
401	*Pyrostegia venusta* (Ker Gawl.) Miers	Swosthani ful	Bignoniaceae	C	Orn	Fl	B
402	*Pyrus communis* L.	Naspati	Rosaceae	T	Med	Fr	M
403	*Pyrus pashia* Buch.-Ham. ex D. Don	Mayal	Rosaceae	T	Med	Fr	BMT
404	*Quercus glauca* Thunb.	Falant	Fagaceae	T	Tim	St	MT
405	*Quercus lanata* Sm.	Banjha	Fagaceae	T	Med	Br	M
406	*Quercus semecarpifolia* Sm.	Khasru	Fagaceae	T	Med	Br	MT
407	*Quisqualis indica* L.	Baja ful	Combertaceae	S	Med	Lf, Sd	B
408	*Rauvolfia canescens* L.	Sarpagandha	Apocynaceae	S	Med	Rt	B
409	*Rauvolfia serpentina* (L.) Benth. ex Kurz	Sarpagandha	Apocynaceae	H	Med	Rt	B
410	*Reinwardtia indica* Dumort.	Pyauli	Linaceae	H	Med	Lf	B
411	*Rhaphidophora decursiva* (Roxb.) Schott	Thulo kanchirne	Araceae	C	Orn	Wh	B
412	*Rheum australe* D. Don	Padam chal	Polygonaceae	H	Med	Rt, petiole	M
413	*Rhododendron arboreum* Sm.	Laligurans	Ericaceae	T	Med	Fl	M
414	*Rhododendron barbatum* Wall. ex G. Don	Rapu	Ericaceae	T	Med	Lf	M
415	*Rhododendron lepidotum* Wall. ex G. Don	Bhale Sunpati	Ericaceae	S	Med	Wh	M
416	*Rhus javanica* L.	Vaki amilo	Anacardiaceae	T	Med	Fr	M
417	*Rhus succedencea* L.	Valayo	Anacardiaceae	T	Med	Lf, Fr	M

418	*Rhus wallichii* Hook. f.	Valayo	Anacardiaceae	T	Med	Fr	M
419	*Ricinus communis* L.	Ader	Euphorbiaceae	S	Med	Lf, Rt	B
420	*Rosa indica* L.	Gulaf	Rosaceae	S	Med	Rt	M
421	*Rosmarinus officinalis* L.	Rosemary	Lamiaceae	H	Med	Lf	B
422	*Rubia manjith* Roxb. ex Fleming	Majitho	Rubiaceae	C	Med	St, Rt	M
423	*Rubus ellipticus* Sm.	Aiselu	Rosaceae	S	Med	Rt	BMT
424	*Rubus foliolosus* D.Don	Aiselu	Rosaceae	S	Med	St pith	M
425	*Rubus nepalensis* (Hook. f.) Kuntze	Bhui aiselu	Rosaceae	H	Food	Fr	M
426	*Rumex hastatus* D.Don	Charimal	Polygonaceae	H	Med	Wh	B
427	*Rumex nepalensis* Spreng.	Halhale	Polygonaceae	H	Med	Rt	M
428	*Rungia parviflora* (Retz.) Nees	Ukuche jhar	Acanthaceae	H	Med	Wh	B
429	*Saccharum spontaneum* L.	Kans	Poaceae	H	Med	Rt	B
430	*Sagina saginoides* (L.) Karsten	Sagina	Caryophyllaceae	H	Wed	Wh	M
431	*Sambucus hookeri* Rehder	Kanike ful	Sambucaceae	S	Orn	Fl	BT
432	*Santalum album* L.	Srikhanda	Santalaceae	S	Med	St	B
433	*Sapindus mukorossi* Gaertn.	Riththa	Sapindaceae	T	Med	Fr, Fr Br	MT
434	*Sapium inisgne* (Royle) Benth.ex Hook.f.	Khirro	Euphorbiaceae	T	Med	Latex, Lf	T
435	*Saurauia napaulensis* DC.	Gogan	Saurauiaceae	T	Med	Br	T
436	*Schefflera venulosa* (Wight & Arn.) Harms,	Kaichal	Araliaceae	H	Orn	Wh	B
437	*Schima wallichii* (DC.) Korth.	Chilaune	Theaceae	T	Med	Br	B
438	*Schleichera oleosa* (Lour.) Oken	Kusum	Sapindaceae	T	Med	Br, Fr	B
439	*Scoparia dulcis* L.	Mitha jhar	Scrophulariaceae	H	Med	Wh	B
440	*Scurrula elata* (Edgew.) Danser	Aijeru	Loranthaceae	H	Med	Lf	M
441	*Scutellaria discolor* Colebr.	Ratopate	Lamiaceae	H	Med	Rt	T
442	*Sedum morganianum* E. Walther	Ativala	Crassulaceae	H	Orn	Wh	M
443	*Selinum wallichianum* (DC.) Raizada & Saxena	Vutkesh	Apiaceae	H	Med	Lf	M
444	*Semecarpus anacardium* L.f.	Valayo	Anacardiaceae	T	Med	Fr latex	B
445	*Senecio cappa* Buch.-Ham. ex D.Don	Pramiji	Asteraceae	H	Med	Rt, Lf	M
446	*Sesbania grandiflora* (L.) Pers.	Agasti	Fabaceae	S	Med	Rt, Br	B
447	*Shorea robusta* Gaertn.	Sal	Dipterocarpaceae	T	Med	Latex, Br	B
448	*Smallanthus sonchifolius* (Poepp.) H. Rob.	Bhui syau	Asteraceae	H	Food	Tuber	T
449	*Smilax aspera* L.	Kukurdaino	Liliaceae	H	Med	St	BMT
450	*Solanum anguivi* Lam.	Thulo bihi	Solanaceae	H	Med	Rt, Fr	B
451	*Solanum nigrum* L.	Kaligadhi	Solanaceae	H	Wed	Wh	B
452	*Solanum surattense* Burm. f.	Kanthakari	Solanaceae	H	Med	Fr	B
453	*Solanum torvum* Swartz	Bihi	Solanaceae	H	Med	Fr	B
454	*Sonchus arvensis* L.	Dudhe	Asteraceae	H	Orn	Wh	B
455	*Spermacoce latifolia* Aubl.		Rubiaceae	H	Med	Lf	B
456	*Spilanthes paniculata* Wall.ex DC.	Marauti	Asteraceae	H	Med	Fl	B
457	*Spiranthes sinensis* (Pers.) Ames	Vui khari	Orchidaceae	H	Orn	Fl	M
458	*Spondias pinnata* (L.f.) Kurz	Amaro	Anacardiaceae	T	Med	Lf, Br	B
459	*Stellaria media* (L.) Vill.	Armale jhar	Caryophyllaceae	H	Med	Wh	B
460	*Stellaria monosperma* Buch.-Ham. ex D. Don	Jethi madhu	Caryophyllaceae	H	Med	St	MT
461	*Stephania glandulifera* Miers	Batulpate	Menispermaceae	C	Med	Lf	B
462	*Stevia rebaudiana* (Bertoni) Bertoni	Chinijhar	Asteraceae	H	Med	Lf	T
463	*Streblus aspera* Lour	Kakasi	Moraceae	S	Med	Rt, Br	B
464	*Swertia angustifolia* Buch.-Ham. ex D.Don	Chiraito	Gentianaceae	H	Med	Wh	T
465	*Swertia chirayita* (Roxb. ex Fleming) Karsten	Chiraito	Gentianaceae	H	Med	Wh	M
466	*Symplocos pyrifolia* Wall. ex G. Don	Kholme	Symplocaceae	T	Med	Sd	M
467	*Syzygium cumini* (L.) Skeels	Jamuna	Myrtaceae	T	Med	Br	B
468	*Tabernemontana divaricata* (L.) R.Br.	Takkar	Apocynaceae	S	Med	Fl	B
469	*Tagetes minuta* L.	Jangali sayapatri	Asteraceae	H	Med	Fl	MT
470	*Tagetus erecta* L.	Sayapatri	Asteraceae	H	Med	Rt, Lf	M
471	*Tamarindus indica* L.	Imali	Fabaceae	T	Med	Rt	B
472	*Taxus wallichiana* Zucc.	Lauth sallo	Taxaceae	T	Med	Lf	MT
473	*Tectona grandis* L.f.	Teak	Verbenaceae	T	Med	Br, Fl	B
474	*Terminalia alata* Heyne ex Roth	Saj	Combertaceae	T	Med	Br	B
475	*Terminalia bellirica* (Gaertn.) Roxb.	Barro	Combertaceae	T	Med	Fr	B
476	*Terminalia chebula* Retz.	Harro	Combertaceae	T	Med	Fr	B
477	*Termnalia catappa* L.	Kagaje badam	Combertaceae	T	Med	Br, Lf	B

478	*Tetrastigma serrulatum* (Roxb.) Planch.	Pani lahara	Vitaceae	C	Med	Rt	T
479	*Thevetia peruviana* (Pres.) K. Schi	Pahelo karbir	Apocynaceae	S	Orn	Fl	B
480	*Thuja orientalis* L.	Mayur pankhi	Cuppresaceae	S	Orn	Wh	M
481	*Thunbergia coccinea* Wall. ex D.Don	Thapauli lahara	Acanthaceae	C	Med	Rt	B
482	*Thysanolaena maxima* (Roxb.) Kuntze	Amriso	Poaceae	H	Med	Rt	B
483	*Tinospora sinensis* (Lour.) Merr.	Gurjo	Menispermaceae	C	Med	St	BT
484	*Toona ciliata* M.Roem.	Tuni	Meliaceae	T	Med	Br	B
485	*Trewia nudiflora* L.	Vellor	Euphorbiaceae	T	Med	Wh	B
486	*Trichosanthes tricuspidata* Lour.	Indreni	Cucurbiataceae	C	Med	Sd, Rt	M
487	*Trifolium repens* L.	Beuli	Fabaceae	H	Orn	Fl	M
488	*Tsuga dumosa* (D. Don) Eichler	Thingre salla	Pinaceae	T	Tim	St	M
489	*Urena lobata* L.	Nalu kurro	Malvaceae	H	Med	Lf	B
490	*Urtica dioica* L.	Sisno	Urticaceae	H	Med	Lf	MT
491	*Vaccinium nummularia* Hook. f. & Thomson ex C. B. Clarke	Kali gedi	Ericaceae	S	Wed	Wh	M
492	*Valeriana jatamansii* Jones	Sugandhawala	Valerianaceae	H	Med	Rt	MT
493	*Vanda testacea* (Lindl.) Rchb.f.	Sunkhari	Orchidaceae	H	Med	Lf	B
494	*Vernonia amygdalina* Del.	Tito pate	Asteraceae	S	Med	Lf	B
495	*Vetiveria zizanioides* (L.) Nash	Khas khas	Poaceae	H	Med	Oil	B
496	*Viburnum erubescens* Wall. ex DC.	Ganmane	Sambucaceae	T	Med	Lf, Sd	M
497	*Vitex negundo* L.	Simali	Verbenaceae	S	Med	Lf	M
498	*Wendlandia coriacea* (Wall.) DC.	Tilka	Rubiaceae	T	Fod	Lf	B
499	*Wikstroemia canescens* Meisn.	Furke pate	Thymelaeaceae	S	Fibre	Br	M
500	*Withania somnifera* (L.) Dunal	Ashwogandha	Solanaceae	H	Med	Rt	B
501	*Woodfordia fruticosa* (L.) Kurz	Dhayero	Lythraceae	S	Med	Fl	B
502	*Xanthium Strumarium* L.	Bhede kurro	Asteraceae	H	Med	Fr	B
503	*Xeromphis spinosa* (Thunb.) Keay	Mainkanda	Rubiaceae	T	Med	Fr	B
504	*Youngia japonica* (L.) DC.	Dudhe	Asteraceae	H	Med	Lf	B
505	*Yucca gloriosa* L.	Kettuki	Agavaceae	S	Med	St	M
506	*Zantedeschia aethiopica* (L.)	Darsan pipal	Araceae	H	Med	Rh	B
507	*Zanthoxylum armatum* DC.	Timur	Rutaceae	S	Med	Fr	BMT
508	*Zephyranthes carinata* Herb.		Amaryllidaceae	H	Orn	Fl	B
509	*Zizyphus incurva* Roxb.	Hade bayer	Rhamnaceae	T	Food	Fr	T
510	*Zizyphus mauritiana* Lam.	Bayar	Rhamnaceae	S	Med	Fr	B

Acronyms: In BGs= Botanical Gardens, B=Brindavan BG, M=Mountain BG, T=Tistung BG, In Lf=Life form, H=Herb, S=Shrub, T=Timber, C=Climber, In Use Med=Medicinal, Orn=Ornamental, Tim=Timber, Fod=Fodder, Rat=Rattans, Rub=Rubber, Wed=Weeds, In part use: Lf=Leaves, Rt=Roots, Br=Bark, St=Stems, Fl=Flower, Fr=Fruit, Sd=Seed, Rh=Rhizome, Wh=Whole plant

Appendix 2: Plants of threaten category found in BGs of makwanpur

S. N.	**Scientific name**	**Status**
1	*Abies spectabilis* (D. Don) Mirb.	NT, Protected
2	*Acacia catechu* (L. f.) Willd.	CT, Protected
3	*Aconitum spicatum* (Bruhl) Stapf	CT
4	*Alstonia scholaris* (L.) R. Br.	Rare
5	*Asparagus racemosus* Willd.	Vul (CAMP)
6	*Bergenia ciliata* (Haw.) Sternb.	CT
7	*Bombax ceiba* L.	Protected
8	*Butea monosperma* (Lam.) Kuntze	EN
9	*Choerospondias axillaris* (Roxb.) B. L. Burtt & A. W. Hill	Rare
10	*Cinnamomum glaucescens* (Nees.) Nand.Mazz	Protected
11	*Crataeva unilocularis* Buch.-Ham.	Rare
12	*Curculigo orchioides* Gaertn.	Vul (CAMP)
13	*Cycas pectinata* Griff.	CITES II, EN
14	*Dalbergia latifolia* Roxb.	Vul, Protected
15	*Dioscorea deltoidea* Wall. ex Griseb.	CITES II, CT
16	*Elaeocarpus sphaericus* (Gaertn.) K. Schum.	Vul
17	*Juglans regia* L.	Protected
18	Lichens	Protected
19	*Michelia champaca* L.	EN, Protected
20	*Operculina turpethum* (L.) Silva Manso	EN(CAMP)
21	Orchids	CITES II
22	*Oroxylum indicum* (L.) Kurz	Vul
23	*Paris polyphylla* Sm.	Vul
24	*Piper longum* L.	Vul (CAMP)
25	*Podocarpus neriifolius* D.Don	CITES III
26	*Pterocarpus marsupium* Roxb	Protected
27	*Rauvolfia serpentina* (L.) Benth. ex Kurz	CITES II, EN
28	*Rheum australe* D. Don	Vul (CAMP)
29	*Rubia manjith* Roxb. ex Fleming	Vul (CAMP)
30	*Shorea robusta* Gaertn.	Protected
31	*Swertia angustifolia* Buch.-Ham. ex D.Don	EN (CAMP)
32	*Swertia chirayita* (Roxb. ex Fleming) Karsten	Vul
33	*Taxus wallichiana* Zucc.	CITES II, Protected
34	*Tinospora sinensis* (Lour.) Merr.	Vul (CAMP)
35	*Valeriana jatamansii* Jones	Protected

(Acronyms: NT=Near threatened, CT= Commercially threatened, Vul= Vulnerable, EN=Endangered)

Puccinia thaliae Dietel (Uredinales) parasitic on *Canna indica* L.: a new record from Nepal

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Abstract

Puccinia thaliae Dietel, the rust, found parasitic on cultivated *Canna indica* L., was collected in Bhanimadal, Rudreswar tole, Lalitpur, which is new report from Nepal.

Key words – Canna, Rust, Nepal

Introduction

The horticultural plant *Canna* L. parasitized by *Puccinia thaliae* Dietel (the fungal disease rust:Urediniomycetes, Uredinales, Pucciniaceae) produces pustules on the both surface of plant's leaves. The rust attacks severely causing yellow to yellow brown spots on the upper leaf-surface, which coalesce and turn to brown-to-black as the disease increases. It infects the stems also.

Canna indica L.(Sarbada in Nepali) is a popular ornamental plant cultivated everywhere in Nepal. It is native to tropical South America. Kaur, Rush, Ferrin & Aime (2011**)** confirmed the pathogen parasitic on this plant as *Puccinia thaliae* Dietel by rDNA sequencing *Puccinia thaliae* has been reported previously from Hawaii, India and South Africa (Gardner & Martinez, 1985; Gardner & Hodges, 1989; Jeeva *et al.*, 2004; van Jaarsveld *et al.*, 2006; Nelson , 2013; Neo &Tham, 2009).

The literatures on rust fungi of Nepal [Balfour-Browne (1955, 1968), Durrieu (1975 - 87), Gjaerum & Steineger (1978), Adhikari *et al.*, (1984 - 89), Ono, Adhikari & Rajbhandari (1988 - 1991,), Ono, Kakishima & Adhikari (1990), Kaneko *et al*. (1990), Ono, Adhikari & Kaneko (1996) and Adhikari (1996, 1998)] do not record the existence of the present rust fungi from Nepal.

The present author accidently found this rust at Bhanimandal, Lalitpur, parasitizing the *Canna* plant. The rust was studied under the microscopic magnification of 10 x 40. The specimen is deposited in National Herbarium and Plant Laboratories, Kathmandu (KATH), Nepal.

Description

***Puccinia thaliae* Dietel,** *Hedwigia*. 38:250 (1899); Sivanesan, A. 1970. *Puccinia thaliae*. CMI Descriptions of pathogenic fungi and bacteria. 267:1-2 [=*Puccinia cannae* (Wint.) P. Henn. *Hedwigia*. 41: 105 (1902); *Uredo cannae* Wint. *Hedwigia.* 23: 172 (1884)] **– Figures ABC**

Aecia not found. Uredinia pustules 1-2 mm in diameter, golden yellow to yellowish brown, subepidermal, erumpent, irregular-shaped, uredinia on both leaf surfaces, sori scattered to covering the entire leaf with coalescing pustules. Urediniospores 26 – 40 x 16 – 26. 4 µm, light yellow to golden yellow, subglobose to ovoid or pyriform, echinulate, apical wall thickened, 1.5 ìm, germ pores one to two equatorial. Pedicles very short often not attached, wall thick. Telia and teliospores not found.

Specimen examined – Parasitic on *Canna indica* L cultivated, Bhanimandal, Lalitpur, Nepal. 2015.09.17 (2072. 05. 31) Adhikari, no. 207231. KATH

Distribution – Hawaii, South Africa, India, Thailand and Nepal

Comments – Telia and teliospores were not observed on any of the collected samples. This rust was not

found during extensive plant disease surveys in the south Pacific in the 1970s and early 1980s, but it was found in Fiji in 1984 and later in other South Pacific countries. Most of the Pacific collections have only uredinia, but one collection from Fiji has telia, and they have also been found in Hawaii. .Pathogen identity was confirmed as *Puccinia thaliae* Dietel by nuclear ribosomal large subunit (28S) DNA sequencing with rust-specific primers (Kaur, Rush, Ferrin & Aime, 2011).

References

Adhikari, M. K. 1996 Biodiversite des Basidiomycetes au Nepal: etude systematique et biogeographique. Specialite Ecologie - Mycoloique. 1996. These du Doctorat de L'Universite present devant l'Universite Paul Sabatier, Toulouse, France. no. d'ordre 2309, pg. 205

Adhikari, M. K. 1998 New records of some Teliomycetes from Nepal. *Nat. Hist. Soc. Nep. Bull* 8 (1-4): 2 - 8

Adhikari, M. K., Manandhar, V. and Baidya, S. 1987 New records of some fungi and hosts from Nepal. *Jour. Eco. Tax. Bot.* 10 (1) : 199-202.

Adhikari, M. K., Manandhar, V. and Yami, D. T. 1987-90 Some parasitic fungi on the medicinal plants from Nepal. *Jour. Nat. Hist. Mus.* 11 (3) : 67-72.

Adhikari, M. K. and Yami, D. T. 1985 Parasitic fungi on the medicinal plant *Cymbopogon* from Nepal. *Jour. Inst. Sc. Tech.* (TU) 8: 1-6.

Balfour - Browne, F. L. 1955 Some Himalayan fungi. *Bull. Brit. Mus.* (*Nat. Hist.*) Ser. Bot. 1 : 189-218.

Balfour - Browne, F. L. 1968 Fungi of recent Nepal expedition. *Ibid.* 4 : 99-141.

Dietel, P. 1899 *Uredineae brasilienses*, a cl. E. Ule lectae- II. *Hedwigia.* 38:248-259

Durrieu, G. 1975a Deux nouveaux *Hamaspora* (Uredinales) de L'Himalaya. *Mycotaxon* 2 :205-208.

Durrieu, G. 1975b Les champignons phytopathogenes du Nepal: Aspects biogeographiques. *Bull. Soc. Hist. Nat.* Toulouse. 3 : 113-117.

Durrieu, G. 1976 Les champignons parasites des vegetaux dans l'Himalaya du Nepal et le centre Afghanistan. Collques Internationaux du CNRS No. 268. Himalaya:Ecologie-Ethnologie, 103-107.

Durrieu, G. 1977a Un nouveau *Coleosporium* autoxine (Uredinales).*Mycotaxon*. 5 : 453-458.

Durrieu, G. 1977b Les rouilles des *Rubus* au Nepal. In Travaux dedies a G.Viennot-Bourgin Paris. *Soc. Fr. Phytopath*. 108-117.

Durrieu, G. 1979a Uredinales nouvelles de l'Himalaya. *Mycotaxon* 9 : 82-192.

Durrieu, G. 1979b Biogeographie des Uredinales des l'Himalaya. *Cahier Nepalais*. 52: 34-36.

Durrieu, G. 1980 Uredinales du Nepal.*Cryptog, Mycol*. 1 : 33-68.

Durrieu, G. 1987 Uredinales from Nepal. *Mycologia* 79 : 90-96.

Gardner, D. E. and Martinez, A. P, 1985. Occurrence of Canna Rust (*Puccinia thaliae*) in Hawaii. *Plant Disease* 69, 1101.

Gjaerum, H. B. and Steineger, E. 1978 Some interesting Nepalese rust fungi. *Kailash.*(*Jour. Him. Stud.*) 6 : 37-43.

Jeeva, M. L, Hegde, V., Makeshkumar, T., Sriram, S., Nair, R.R,, Edison, S, and Mathur, N, 2004. Rust of Queensland arrowroot (*Canna edulis*) caused by *Puccinia thaliae*: a new record for India.*Plant Pathology* 53, 261.

Kaneko, S., Kakishima, M. and Ono, Y. 1993 *Coleosporium* (Uredinales) from Nepal. *Cryptogams of the Himalayas. vol.2:Central and eastern Nepal*. Eds M. Watanabe and S. B. Malla. National Science Museum, Tsukuba, Japan. 85-90.

Kaur, R., Rush, T. A. Ferrin, D. M. and Aime, M. C. 2011 First Report of *Puccinia thaliae* Rust on Canna Lily in Louisiana. *American Phytopathological Society.* 95 (3):353.1 - 353.1

Nelson, S. 2013 Rust of Canna lily. *Plant diesease*

Neo, N.W. and Tham, F.Y. 2009 Occurrence of leaf rust of Canna in Singapore caused by *Puccinia thaliae. New Disease Reports*. 19, 67.

Ono, Y. , Adhikari , M. K. and Kaneko, R. 1996 An annotated list of the rust fungi (Uredinales) of Nepal. *Cryptogams of the Himalayas*. vol. 3 *Nepal and Pakiistan.* Eds, M. Watanabe and H. Hagiwara, National Science Museum, Tsukuba, Japan. 69 -125.

Ono, Y., Adhikari, M. K. and Rajbhandari, K. R. 1988 Rust fungi of the Kathmandu valley and adjacent areas. *Cryptogams of the Himalayas* vol. 1: *The Kathmandu Valley.* Eds. M. Watanabe and S. B. Malla, National Science Museum, Tsukuba Japan. 115 125.

Ono, Y., Adhikari, M. K. and Rajbhandari, K. R. 1990 Uredinales of Nepal. *Rept. Tottori Mycol. Inst.* 28 : 57 75.

Ono, Y., Adhikari, M. K. and Rajbhandari, K. R. 1991 New host and geographic distribution records of *Anthracoidea smithii* (Ustilaginales) in Nepal. *Tran. Mycol. Soc. Japan.* 32 : 65 69.

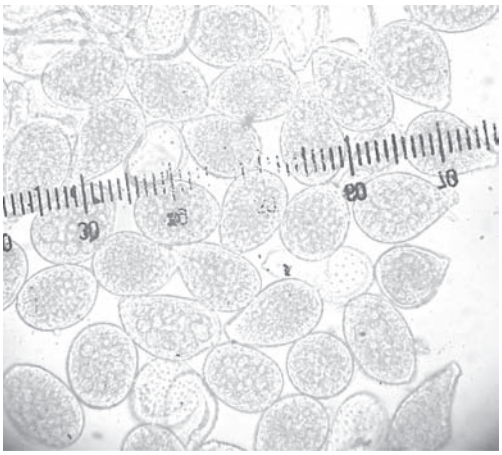
Ono, Y., Kakishima, M. and Adhikari, M. K. 1990 Graminicolous rust fungi (Uredinales) from Nepal. *Cryptogams of the Himalayas*. vol.2 *Central and Eastern Nepal*. Eds, M. Watanabe and S. B. Malla, National Science Museum, Tsukuba, Japan. 91 99.

Van Jaarsveld, L. C, Kriel, W.M. and Minnaar, A, 2006. First report of *Puccinia thaliae* on Canna lily in South Africa. *Plant Disease*90, 113.

Photograph

A. Photographs showing infected *Canna*

B. Close up view of rust



C. Urediniospores (10 x 40 magnification)

Effect of Different Soil Combinations on the Growth Rate of *Ardisia macrocarpa* Wall.

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Abstsract

Ardisia macrocarpa Wall. commonly known as "Damai phal" is distributed in Nepal ranging from 1500-2400m above sea level. The present research work aimed to determine the suitable soil condition for the growth of *A. macrocarpa*. Study was carried out in green house at National Botanical Garden (NBG), Godawari, Lalitpur. Soil samples included forest, ground and sandy soil with different concentration of compost manure. Phenotypic traits such as height of plant, number of leaves and number of branches were recorded and used for data analysis. Morphological data showed range of variations in growing pattern of *A. macrocarpa*. The result showed that plant height, number of leaves and the number of branches were found to be maximum in the neutral sandy soil with pH of 6.20. The findings suggested that *A. macrocarpa* has a potential to attain growth under stress of nutrient availability.

Key words: Soil samples, phenotypic traits, growth rate, *Ardisia macrocarpa*.

Introduction

The study of phenological aspects of plant involves the observation, recording and interpretation of the timing of their life history events (Fenner, 1998).Natural population of plant shows intricate pattern of variation (Briggs and Walters, 1997). Intra and inter population variation in nature are nearly of quantitative rather than discontinuous kind (Falconer, 1981). Plants compete for different resources (eg; nutrients, space, light, moisture, etc). Only those survive, reproduce and increase in number which is best suited at that particular environmental condition (Morris *et al*. 2005). Plant grows on soil and their growth depends on quantity and quality of nutrients in it (Sharma, 2006). Soil type influences growth of the plant directly or indirectly by interacting with a large number of factors (Garg and Kumar, 2012).

The genus *Ardisia* belongs to the family Myrsinaceae. It consists of about 500 species worldwide. Three species of *Ardisia* occur in Nepal. The study species i.e. *Ardisia macrocarpa* Wall. is a shrub upto 2m high occurring in Central and Eastern Nepal at altitude ranging from 1500-2400m. In Nepali it is called as ''Damai phal'' (GoN, 2003). The leaves are 5-17cm long and 1.5-4cm broad, alternate, short petioled, lanceolate, narrowed at both ends, crisped crenulate with marginal row of pink dots and glabrous. Flowers are small, bisexual, stalked and white in colour. Corymb is sub-terminal. Fruit is a berry which is 0.7cm in diameter, globose, depressed, bright red and spotted. The flowering is in July and fruiting period is from October to January. It commonly occurs on shady forest floor (Shakya, 1986). Ripe berries are eaten raw especially by the people of Tamang community (Shrestha, 1988). *A. macrocarpa.* is an evergreen shrub with attractive fruits. So, it was selected for the study to promote it in floriculture with its ornamental value. Research work on the growth rate of *Ardisia* is not yet performed in Nepal as well as other countries. This study aims to know the best soil condition for the growth of *A. macrocarpa.*

Material and method

Preparation of soil sample

Different soil samples such as ground soil collected from barren land, forest soil collected from the National Botanical Garden (NBG), Godawari, and sandy soil (sand mixed with soil in the ratio of 1:3) were prepared. The initial readings on pH and nutrients viz. Nitrogen (N), Phosphorus (P) and

Potassium (K) of each soil sample were measured. Various soil concentration of each soil samples were made by mixing it with compost manure in the ratios of -0:1 (neutral), 1:2, 1:3 and 1:4 compost manure to soil.

Seeds were collected from Conservation and Educational Garden of NBG in December 2013 and preserved in refrigerator at l8°C. Healthy seeds of *A. macrocarpa* were chosen and sown at a time in each combination of soil in January 2014. Data of vegetative characters like length of shoots and number of leaves were recorded frequently at an interval of 7 days from germination period. SPSS version 17.0 was used to perform t-test and graphs were prepared in MS Excel.

Result and Discussion

In Table 1, variability in soil pH and the basic plant nutrient N, P and K in all the studied soil samples at the initial period of the experiment are shown. The ground and forest soil were alkaline in nature whereas sandy soil was slightly acidic in nature. However, presence of N, P and K were high in forest soil whereas least in sandy soil.

At different composition of ground soil with compost manure, the average plant height, number of leaves and number of branches were found to be higher at 4:1 concentration (Figure 1). The maximum plant height was 26.4 cm, and the number of leaves was 39 while the number of branches was 3.

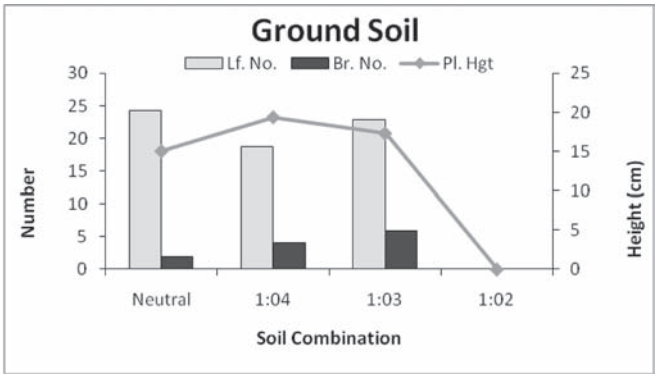

Figure 1: Variation in the average plant height (Pl.Hgt.), number of leaves (Lf. no.) and number of branches (Br. no.) in different combinations of ground soil with compost manure.

In the present study, Figure 2 shows the average increase in plant height, number of leaves and number of branches in sandy soil combinations of different concentration. The maximum plant height was 44.8 cm, number of leaves was 93, and the number of branches was 10 at 3:1 forest soil composition. Few plants grown in the pots containing this soil type died because the roots were eaten by insect called 'khumre' in nepali.

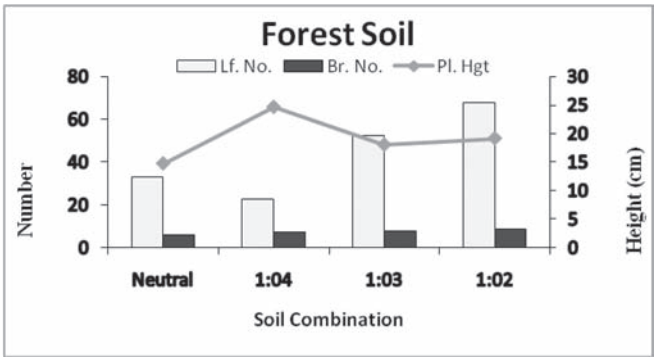

Figure 2: Variation in the average plant height (Pl.Hgt.), number of leaves (Lf. no.) and number of branches (Br. no.) in different combinations of forest soil with compost manure.

Figure 3, reveals the average increase in plant height, number of leaves and number of branches in sandy

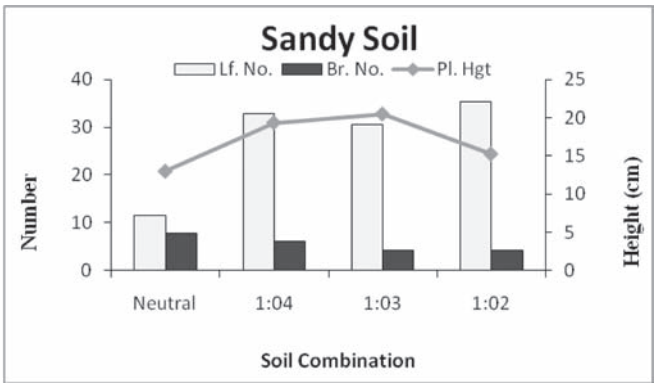

Figure 3: Variation in the average plant height (Pl.Hgt.), number of leaves (Lf. no.) and number of branches (Br. no.) in different combinations of sandy soil with compost manure.

Table 1: The variability in soil pH and nutrient in all studied soil samples

Soil type	pH(1:2.5% H_2O)	Total Nitrogen (N %)	Available Phosphorus (P_2O_6) Kg/ha	Available Potassium (K_2O) Kg/ha
Ground soil	7.60	0.23	34.09	482.4
Forest soil	7.60	0.25	45.10	616.4
Sandy soil	6.20	0.15	22.03	227.8

soil combinations of different concentration. The maximum plant height was 48.5 cm, the number of leaves was 138 and the number of branches was 15 at neutral sandy soil composition.

Discussion

Various factors such as soil pH, soil moisture, soil temperature, availability of micro and macro nutrients, etc. determine the growth and development of a plant (Korner, 2003). Growth rate of any plant is influenced by nutrient availability, its environment and their genetic constitution (Joshi and Joshi, 1998; Parmar and Pant, 2015).Macronutrients such as nitrogen and phosphorus required for the plant are mostly available at neutral soil pH (6-8) (Singh *et al*., 2006).

According to the findings of Muller and Brandes (1997) increase in shoot length of *Artemisia annua* in sandy soil was less than its normal height which is totally different from the result of this study. However, Nepali *et al*., (2015) carried similar work in *Lilium nepalense* found that sandy soil with less pH than other experimental soil samples has high growth of shoots, leaves and number of leaves. Similarly, the sand mixed with gravel supported the maximum increase in plant height, fresh weight and dry weight of *Euphorbia lathyris* followed by sand and other soils in Rajasthan (Garg and Kumar, 2012). Jackson (1987) also found that sandy-loam to sandy soil was the most suitable soil condition for the growth of *Dalbergia sissoo*. Sandy soil holds less moisture and nutrients per unit volume but permits more rapid percolation of precipitation water than other soils. From these above research works, it is clear that some plants prefer sandy soil for their proper growth. *A. macrocarpa* showed better growth in nutrient deficient soil than in nutrient rich soil which indicates that it has a potential to attain growth under stress of nutrient availability. The plant height, leaf number and branch number of *A. macrocarpa* were highest in neutral sandy soil which may be because it prefers slightly acidic soil.

Conclusion

From this study, plant height, number of leaves as well as number of branches were found to be higher in neutral sandy soil in comparison to forest soil and ground soil. Thus, it can be interpreted that *Ardisia macrocarpa* prefers sandy soil with pH of 6.20 for the propagation and better growth. Environmental factors or gene are responsible for the morphological characters. For the confirmatory test, it is suggested to progeny test, reciprocal transplant practice as well as study on molecular level.

Acknowledgements

We express our sincere gratitude to Mr. Rajdev Prasad Yadav, Director General of Department of Plant Resources, Mr. Dinesh Baral, Garden Officer and all the staffs of National Botanical Garden, Godawari.

References

Falconer, D.S. 1981. *Introduction to Quantitative Genetics*, Ed.2. Longmans Green, London/New York.

Fenner, M. 1998. The phenology of growth and reproduction in plants. *Perspectives in Plant Ecology, Evolution and Systematics*, 1/1: 78-91.

Garg, J. and Kumar, A. 2012.Effect of Different Soil Types on Growth And Productivity of *Euphorbia lathyris* L. a Hydrocarbon Yielding Plant. *International Journal of Life Science &Pharma Research,* 2(3): 164-173.

GoN. 2003. *Flora of Royal Botanical Garden (Phanerogams).*

Jackson, J.K. 1987. Manual of Afforestation in Nepal. Nepal-UK Forestry Research Project, Kathmandu, Nepal. 232.

Joshi, N. 2008.*Flowers of National Botanical Garden*, Godawari, Nepal.

Joshi, K.K. and Joshi, S.D. 1998. *Studies on genetic diversity in Alnus nepalensis D.Don*. A project

report submitted to NAST (Nepal Academy of Science and Technology).

Korner, C. 2003. *Alpine Plant Life: Functional Plant Ecology of High Mountain Ecosystems*. Spinger, Germany.

Morris, C.D., Fynn R.W.S. and Kirkman K.P. 2005. Plant strategies and trait trade-offs influence trends in competitive ability along gradients of soil fertility and disturbance. *Journal of Ecology*, 93: 384-394.

Muller, M. and Brandes, D. 1997.Growth and development of *Artemisia annua* L.

Nepali, K.B., Lamichhane, D. and Baral, D. 2015. Study in the growth rate of *Lilium nepalense* D.Don. in different soil combinations. *Bulletin Department of Plant Resources No. 37*:77-80.

Parmar, G. and Pant, B. 2015.Comparative Study of in vitro growth rates of intra-generic orchid species, viz., *Coelogyne stricta* (D.Don) Schltr. and *Coelogyne flaccid* Lindl. *Bull.Department of Plant Resources No. 37*: 72-76.

Shakya, P.R. 1986. Flora of Kathmandu valley. *Bulletin of Department of Medicinal Plants of Nepal,* No. 11.

Sharma P.D. 2006. *Ecology and Environment*. Rastogi Publications, Meerut, India.

Shrestha, P. 1988. Contribution to the Ethnobotany of the Tamangs of Kathmandu Valley. Contribution to Nepalese Studies (CNAS), Tribhuvan University, 15 (2).

Singh, J.S., Singh, S.P. and Gupta, S.R. 2008. *Ecology environment and resource conservation*. Anamaya Publisher, New Delhi.

Stainton, A. 1988.*Flowers of the Himalaya A Supplement*.Oxford University Press, Jai Singh Road, New Delhi.

Vishnoi, R., Rajwar, G.S. and Kuniyal P.C. 2010. Effect of Different Sand and Soil Ratios on the Growth of *Terminalia arjuna* W. & A. *New York Science Journal*, 3(11):22-26.

Population status of *Curculigo orchoides* Gaertn. in a Community Managed Forest of Banke District, Nepal

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Abstract

The rhizomatous *Curculigo orchioides* Gaertn. (family Hypoxidaceae) is a medicinal plant with trade value in Nepal. Population structure of *C. orchioides* was studied in *Shorea robusta* and *Terminalia alata* forest Jalandhara Community Forest, Banke district, Western Nepal. It was abundantly found in the study forest with 87% frequency. This might be due to better management of the forest. Community user group of this forest can get benefit by the sustainable harvesting of this species.

Key words: Medicinal plant, Kalomusli, Population structure, Utilization, Management

Introduction

Curculigo orchioides Gaertn, belongs to family Hypoxidaceae, is commonly known as Kalomusli, Banjari (Tamang) and Musaleri (Tharu). The genus *Curculigo* comprises 70 species (www.tropicos.org). Out of 70 species, four species such as *C. capitulata C. crassifolia, C. gracilis* and *C. orchioides.* are found in Nepal (Press *et al*., 2005). Among them, *C orchioides* is an important medicinal plant. The rhizome is used for demulcent, diuretic, tonic, aphrodisiac, piles, jaundice, asthma, diarrhoea and gonorrhea (Anonymous, 2007). It is also one of the major ingredients of many Ayurvedic products like Aswagandharishta, Ghandak Rasayan (SDVKVS, 1999) and therapeutic products like Musale Churna, Shaktibardhak Yog, Tentex royal (Shrestha & Shrestha. 2004). Dried rhizomes are used for preparation of pharmaceutical drug *Rhizoma Curculiginis* (ESON, 2009).

Due to its wide range of uses in ethnomedicine, both in the Ayurvedic and Chinese systems of traditional health care, a large number of phytochemical and pharmacological investigations have been undertaken (Shrestha *et al.,*2008). Only few biological study of this plant has been done in Nepal. Phenology, population structure, and regeneration strategies of *Curculigo orchioides, was studied in* the inner Terai, Central Nepal by Shrestha *et al.* (2011).

People collect whole rhizome inhibiting vegetative propagation and thus affecting regeneration. Besides these other activities like land use changes, habitat destruction, uprooting and destroying entire plant during collection are considered major threats to this plant. Low regenerative potential through sexual reproduction and high vulnerability to habitat disturbance appear to be the major constraints for maintaining natural population of *C. orchioides* (Shrestha *et al*., 2011). Though wild population of *C. orchioides* are reported to be declining rapidly, and the plant has been assigned to various threat categories, as vulnerable (CAMP, 2001) and threatened (Manandhar, 2002) , there is no detailed study on conservation status of this plant. Thus this study was undertaken to know its population structure in natural growing habitat.

Material and methods

Study area

The study site was selected by discussion with staffs of District Plant Resource Office and District Forest Office, Banke district. According to them, the availability of *Curculigo orchioides* was high in Jalandhara Community Forest of Banke district (Figure 1). The Jalandhara community forest ($28^0$14"29' N Latitude and $81^0$76"76' E Longitude) is situated in Banke district, Bheri zone of Mid-

Western Development region. This district covers an area 2,337 km^2. Forests account for 50.17 per cent (0.11miilion ha) of total land of the district. Major ecosystems in the district are Sal (*Shorea robusta*) forest, deciduous riverine forest, savannahs and grasslands, mixed hardwood forest, flood plain community, Bhabar and foot hills of Chure. The area of Jalandhara community forest is about 76 hectare and elevation ranges from 135 to 150 m.

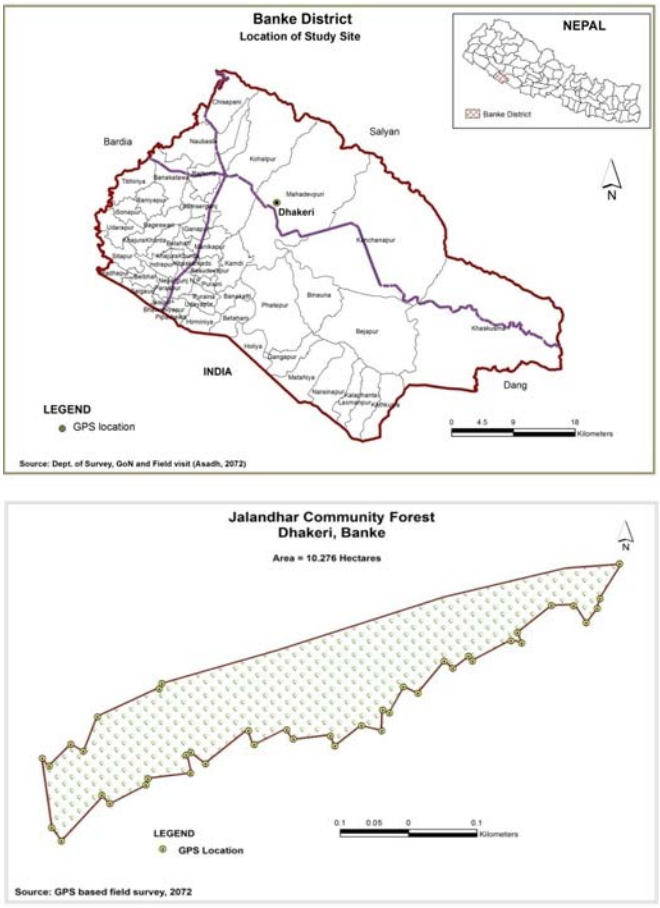

Figure 1 : Map showing study sites

Data collection

For primary data collection, field visit was carried out during the flowering season, on June 2015. To study the population of *C. orchioides* in natural habitat altogether 42 quadrats, 19 in sunny place and 23 in shady place were laid in the *curculigo* rich area systematically in study sites. Data were collected by making quadrats of 1m × 1m at a regular interval of 50m distance in the study sites. The number of the individuals were counted in each quadrat. In addition, associated species were recorded. To estimate the population of *C. orchioides* frequency (%), density, abundance was calculated (Zobel *et al*., 1987). Global Positioning System (GPS Garmin e Trex 10) was used to record the latitude, longitude and elevation for each plot.

The frequency was determined with the help of the following formula:

$$\text{Frequency}(\%) = \frac{\text{No. of plots with species}}{\text{Total no. of plots taken}} \times 100$$

Density was calculated as:

$$\text{Density (individual/ha)} = \frac{\text{Total no. of species} \times 10{,}000\text{m}^2}{\text{Total no. of plots} \times \text{size of quadrats}}$$

After calculating frequency, density of the species, abundance was scaled up (Zobel *et al*., 1987).

Some secondary data about trade of this species were also collected from Jadibuti Association of Nepal (JABAN, 2014).

Results and discussion

During the present study, *C orchioides* was found abundantly in Jalandhar Community Forest, of Banke district. The frequency of *C. orchioides* was low (57%) in sunny place and high (87%) in shady and marshy places. Similarly density of the species was minimum (11053 plant/hectare) and high (50869 plant/hectare) in sunny and shady place, respectively (Table 1). In sunny place, common dominant species associated with *C. orchioides* in studied populations were *Parthenium hysterophorus* L., whereas in shady place, we found mainly the associated species are *Murraya koenigii* (L.) Spreng., *Mallotus philippensis* (Lam.) Muell.-Arg. and grasses (Table 1). Field observation revealed that shady marshy open places with tree vegetation are the preferred habitat for this species. Shrestha *et al*. (2011) also reported that partial canopy are suitable for vegetative growth as well as flowering and fruiting of *C. orchioides*.

High frequency and plant density show that species preferred to grow in shady place. Low density in sunny place may be due to poor regeneration, low

Collection site	Frequency	Density (individual/ha)	Abundance	Phenology	Associated plants
Sunny place	57.14%	11052.63	Frequent	No flowering	*Parthenium hysterophorus, Murraya koenigii, Mallotus philippinensis*, grasses
Shady place	86.95%	50869.56	Dominant	Flowering	*Murraya koenigii, Sida acuta, Mallotus philippinensi, Terminalia alata, Dioscorea bulbifera,*

seed germination and competition with invasive alien species *Parthenium hysterophorus* .

High frequency and density of the plant in the study site may be due to different reasons like suitable habitat and climatic condition for the plant, no anthropogenic disturbance and the better management of the forest. *C. orchioides* is listed as endangered and going to loss in natural habitat (CAMP, 2001). Although the species is categorized as endangered, there is no management plan for conservation in Nepal.

Conclusion

It is concluded that the population of *Curculigo orchioides* in Jalandhara Community Forest is abundant. Sustainable harvesting, domestication and cultivation of such useful medicinal *C. orchioides* should be encouraged to fulfill market demand, which will increase the income of local people. Such economically important *C. orchioides* should be conserved with both in situ and ex situ methods of conservation. Further studies should be initiated to increase vegetative propagation, seed germination, seedling establishment and detail ecological adaptation of species to strengthen conservation program.

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References

Anonymous. 2007. *Medicinal Plants of Nepal (Revised edition)*. Bull. Dept. Pl. Res. No 28. Department of Plant Resources, Thapathali, Kathmandu, Nepal.

CAMP, 2001. *Highlights and outcomes of the Conservation Assessment and Management Planning (CAMP) workshop, Pokhara, Nepal.* pp. 46-53. *In*: N. Bhattarai & M. Karki (eds.) *Sharing Local and National Experiences in Conservation of Medicinal and Aromatic Plants in South Asia*. Proceedings of Regional Workshop at Pokhara, Nepal. HMG/N, IDRC and MAPPA.

ESON, 2009. *Maps-Net Nepal Database*, Ethnobotanical Society of Nepal (ESON), www.eson.org.np/*mapsnetnepal*.htm

JABAN, 2014. *Medicinal and Aromatic Plants* Stakeholders Directory, Nepal. Jadibuti Association of Nepal (JABAN). 15p.

Manandhar, N. P. 2002. *Plants and People of Nepal*. Timber Press, Oregon, USA.

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

SDVKVS. 1999. *Ayurvedic Products of Singha Durbar Vaidhyakhana Vikas Samiti*. Singha Durbar Vaidya Khana Vikas Samiti (SDVKVS), Anamnagar, Kathmandu Nepal.

Shrestha, U. B. and Shrestha, S. 2004. *Major Non-Timber Forest Products of Nepal*. Bhundipuran

Parkashan, Kathmandu, Nepal. 411 p.

Shrestha, B. B., Dall'Acqua S., Gewali M. B., Jha P. K. and Innocenti G. 2008. Biology and phytochemistry of *Curculigo orchioides* Gaerten. pp. 50-67. *In*: P.K. Jha, S. B. Karmacharya, M. K. Chettri, C. B. Thapa & B. B. Shrestha (eds.) *Medicinal Plants of Nepal: An Anthology of Contemporary Research*. Ecological Society (ECOS), Kathmandu, Nepal.

Shrestha, B. B., Jha P. K. and Kandel D. R. 2011. Reproductive ecology and conservation prospects of a threatened medicinal plant *Curculigo orchioides* Gaertn. in Nepal, *Tropical Ecology* **52**(1): 91-101, International Society for Tropical Ecology.

Zobel, D.B., Jha, P.K., Behan M.J. and Yadav U.K.R. 1987. *A Practical Manual for Ecology.* Ratna Pustak Distributors, Kathmandu, Nepal.

Population Structure and Regeneration Status of Cyathea (Cyatheaceae) in Nepal

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Abstract

The tree fern (*Cyathea)* is distinct from other ferns by having erect trunk like stem. Tree fern is distributed throughout tropical and subtropical regions in central and eastern Nepal. Five species of tree ferns have been recorded from Nepal. The tree ferns is included in appendix-II of CITES list although there is no trade record. This paper identifies the localities where the tree fern is found and their regeneration status in central and eastern Nepal. The present study focused on field survey which was conducted between June to July, 2015 in selected VDCs of Kaski and Tanahu districts in central Nepal, secondary information collection and compilation as well as the views of district forest officers of the districts in Central and Eastern Nepal. The tree fern is found in 19 districts of Nepal. A total of 176 individual trees with 101 matured tree, 40 immature and 35 young stage were recorded with their geographical coordinates in Kaski and Tanahu districts. The occurrence of individuals indicates that the regeneration of tree fern is fair. Felling of trunk of Cyathea is major problem in central Nepal.

Key words: *Cyathea, regeneration, Kaski district, Tanahu district*

Introduction

Population structure and regeneration studies of species help to record the number of particular taxa in the definite natural areas. These types of research seem to be very indispensible to quantify individual species within the natural boundary of the country. Population and regeneration status, distribution and ecological characters of the plants provide information to conserve the species and encourage its sustainable use (Bhattacharya and Sharma, 2008).

Cyathea, the tree ferns of family Cyatheaceae are distinct from other ferns by having trunk like erect stem (Dong, 2009), some of them reaching upto 20 m in height (Tryon and Tryon, 1982), and includes about 600 species globally (Korall *et al*., 2006). The *Cyathea* is distributed from sea level to tropical and subtropical areas (Tryon and Gastony, 1975) in the world.

Nepal is well known for its unique topography and climatic conditions that provided suitable habitat for diversity of the flora and fauna. Fern diversity in Nepal is high and 550 species and 30 subspecies of ferns and fern allies are reported (Fraser-Jenkins *et al.,* 2015). Altogether, six species of *Cyathea* namely *Cyathea brunoniana, C. spinulosa, C. gigantea, C. henryi, C. khasyana and C. sollyana* are documented mainly from central and eastern Nepal.

The genus *Cyathea* prefers to grow in moist habitats and is mostly terrestrial in nature. Among them *Cyathea spinulosa* is well known species for their excellent beauty of outdoor decoration. So, it is also raised in the gardens for ornamental purposes (Gurung, 1991). Local communities use young floral buds as food. In rainy days, the leaves are cut and used to make umbrellas. The trunk of the tree is extensively used to make pillar of traditional houses and shed. Local people in central Nepal consider that the trunk of *Cyathea* is as strong as the cemented pillar. In eastern India, the trunk of *Cyathea* species is exploited commercially while *Cyathea gigantea* trunk is popularly used to grow orchids (Khan *et al*., 2002). Leaves of the species are used to cure bodyache by the *Apatani* tribe (Kala, 2005); rhizome in combination with black pepper and milk are used to cure white discharge (Rout *et al*., 2009) as well as various decorative items like pots, flower vases, ash trays etc. are also prepared from the woody stem (Paul *et al*., 2015)

The species from genus *Cyathea* are included in CITES lists (www.cites.org). The species was previously considered as "vulnerable" in **Nepal**, and, more recently, as *Least concern (LC)* in 2001 in Nepal based on a CAMP workshop held in January 2001. There is no intensive study of the *Cyathea* with respect to its regeneration and distribution in Nepal. However, few literatures are available regarding the occurance of the species (Gurung, 1991; Thapa, 2002; Bhattarai *et al.* 2004; Bhuju and Joshi, 2009; Bhagwat and Shrestha, 2010; Sharma *et al*., 2013; Fraser-Jenkins *et al.* 2015) in different localities of country but no quantitative information including population structure of *Cyathea* is available for Nepal. No detailed study on *Cyathea* species has been carried out and very little information is available on population structure and regeneration status of the species. So, understanding the current population structure and regeneration status of *Cyathea* species is very important to develop on effective conservation initiative in the natural habitat.

The present study focuses on the study *Cyathea* regarding its population status, distribution and regeneration in central and eastern Nepal. The specific objective of the study are i) to assess the distribution of *Cyathea* species in central and eastern Nepal, ii) to assess the population structure of *Cyathea* species in some parts of central Nepal, and iii) to find out the regeneration status of *Cyathea* in its natural habitat.

Taxonomy of Cyathea species found in Nepal

Cyathea is the type genus of the family Cyatheaceae. They are mostly terrestrial ferns, usually with a single tall stem. Rarely, the trunk may be branched or creeping. Many species also develop a fibrous mass of roots at the base of the trunk. Taxonomic characteristics of *Cyathea* species recorded from Nepal according to Fraser-Jenkins *et al*., 2015 is as follows

***Cyathea spinulosa* Wall. *ex* Hook.**

The commonest tall tree fern reached up to of 4m height. The leaves of *C. spinulosa* are 2.5 to 6m long, bipinnate-tripinnatifid mostly spiny at the base and arranged spirally at the apex of the stipe with oblong, acute, serrulate segments. Stipe and rachis pale brown, prominently spiny, with smaller spines on the pinna-costae, stipe-bases bearing many narrowly lanceolate, bicolorus scale with darkish brown centre and thin pale toothed margins; pinnule costules and lobe midribs paler beneath, bearing small, whitish, lanceolate and deciduous scales beneath when young, becoming glabrous, but no hairs (below); young sori are surrounded by a thin white indusium, which shrivels and usually drops off on maturity. In Nepal, it occurs in warm and humid places at altitudes between 335 and 2000m (Gurung, 1991; Fraser-Jenkins *et al*., 2015)

***Cyathea brunoniana* (C.B. Clarke) C.B. Clarke and Baker**

A tall tree fern, trunk up to 6m height, very similar to *C. spinulosa* but it is found slightly in higher altitude, apex pale to mid brown, but stipe and rachis, though spiny, less so than *C. spinulosa* and with slightly smaller spines becoming warts further up the axes, diagnostically as well as scattered scales. It has small rather dense hairs clothing the undersurface of the costules or pinnule axes. It has sori with a small basal indusium at one side.

***Cyathea gigantea* (Wall. ex Hook.) Holttum**.

A matured tree reaching up to height of 5m, stipe dark chestnut brown to nearly blace, matt, without spines, bearing many narrow chestnut-brown glossy scales with paler, fimbriate edge; rachis similar to other *Cyathea* but with few or no scales; frond bipinnate, tripinnatified, ultimate lobos usually rather shallow. Fertile pinnules with markedly V-shaped rows of exindusiate sori.

***Cyathea henryi* (Baker) Copel**.

This species is very much similar to that of *C. gigantea*. It only differs from *C. gigantea* by having longer and larger pinnules with more scales beneath their costules, more pairs of veinlets in the ultimate lobes, which are longer , becoming slightly rectangular and the lower ones on larger pinnae are more deeply separated from each other. The sori are found well apart forming weak V-shape but more parallel line than *C. gigantea.*

***Cyathea khasyana* (T. Moore ex Kuhn) Domin**

One of the large tree fern reached up to the height of 4.7m. It is different from other *Cyathea* species by having non spiny stipe and rachis, minutely muricate below dark brown to purple brown, with a line of yellow stipes up the sides, bearing many narrow mid-casaneous brown, glossy scales towards the stipe-base with paler, ciliate margins, pinnule-lobes rather small, narrow and usually parallel sided, with small apical and often upper marginal teeth bearing many small dark-tipped, sori exindusiate.

***Cyathea sollyana* (Griff.) Fraser-Jenk.**

The tallest tree fern of Indo-Himalaya reaching up to 15m height, usually an unbranched trunk, stipe and rachis pale to mid-brown, smooth but often slightly warty in the lower parts, glossy without spines or thorns, stipe-base scales linear-lanceolate, pale brown with darker cilia at the margins. White scales present beneath when leaf very young, fertile segments normally narrowed, completely covered in exindusiate sori; sori close packed along the midrib**.**

Materials and Methods

Study area

The study was carried out in selected Village Development Committees (VDCs) of Kaski and Tanahu districts of Central Nepal. Geographically Kaski district lies at 83°40' to 84°12' East longitudes and 28°06 to 28°36' North latitudes. Four types of climatic zones are found in these districts, subtropical, temperate, alpine and tundra climate. The total annual rainfall of Kaski districts is about 4200mm; maximum rainfall up to 1700mm occurring during August and similarly, the maximum temperature is recorded 32°C in summer and 2.2°C in winter season. Bhadaure Tamagi, Kande, Pumdibhumdi, Lwang-ghalel VDCs and Lekhanath municipality towards forested gully on east of Begnas lake were selected as sample area for field study mainly based on the availability of *Cyathea* species from Kaski district. Tanahu is adjoing district of Kaski and climatic condition is almost similar to that of Kaski. The Kahun Shivapur and Dhorphirdi VDCs of Tanahu district were taken for sample study site.

Population structure and field Survey

Field survey for population structure and regeneration study of *Cyathea* species was conducted between June to July, 2015 in selected VDCs of each districts. Location of each of the individual *Cyathea* species was marked with GPS (Garmin 62cx). Field survey and data collection was based on the guidelines given by CITES COP-16.

A group discussion was conducted in the respective VDCs of the districts in order to generate accurate field level data of tree fern and their availability. The questionnaire was mainly focused on distribution of the species, regeneration status, part(s) used and occurrence of the species in the area. On the basis of villagers information the author with field assistance travelled to the forest area more than 5km each day in order to quote the species and their geo-coordinates. The walking distance was considered as the transect line and numbers of the tree ferns available both sides were recorded with coordinates, number of tree ferns available, their maturity stage as matured tree, immature and young stage trees were also recorded.

The individuals of *Cyathea* species recorded in the field were categorized into young individuals having upto 1.0m height, immature individuals having 1.0-1.5m height and mature individuals having more than 2.0m stem height.

To collect the information about the population structure of *Cyathea* from eastern Nepal secondary information mostly literatures were consulted. Besides secondary information from literatures and 39 district forest officer's form mountain and Himalayan regions of central and eastern Nepal were consulted about the *Cyathea* species by phone calls. All the respective district forest officers took more than 10 days to collect the information and share with author. Other than Kaski and Tanahu district, the occurrence of *Cyathea* species based on the observation of respective district forest officers and their staffs in the field were recorded.

Results and Discussion

Distribution of Cyathea species

The distribution of *Cyathea* species is restricted to some parts of the 19 districts of eastern and central Nepal (Table-1). The dominance of *Cyathea* species is recorded from an attitude of 1,400m -1,600m asl. in the study site, though the plant showed distributed from 500m-1,800m in Nepal. The *Cyathea* species in Pingshree, Shivanagar VDC in Tanahu district is confined mostly above 600 - 800m asl but that in Kaski district above from 1,400m asl. The present study found that the species is more frequently occurring at 1,400-1,600m asl in Kaski district of central Nepal along the bank of gullies, rivulets and permanent water sources. The genus *Cyathea* is mostly recorded from the bank of rivers, gullies and in shady, well-moistened places under the dark canopy of *Alnus* forest canopy in Lwangghalel VDC of Kaski district, however under the canopy of *Schima wallichii-Castanopsis indica* forest in Pingshree khola of Tanahu district.

The total numbers of *Cyathea* plant in the study site with mature tree, immature and young with their geographical coordinates are presented in Table-2. The Cyathea species is mostly associated with *Schima wallichii, Castanopsis indica, Myrica esculenta, Engelhartia spicata, Erythriana arborescence* in Pingshree Khola in Tanahu but it is associated mostly by *Alnus nepalensis* in Lwangghalel VDC of Kaski.

The present study recorded a total of 176 individuals of *Cyathea* species from Kaski and Tanahu districts with 101 individual matured trees, 40 of immature and 35 of young stage. Among them large number of trees were recorded in Lwangghalel VDC of Kaski having 89 trees with 50, 22 and 17 individuals of matured tree, immature and young stage respectively. The present study only covers about 10km of transect walk along the forest and gullies of Lwangghalel VDC. According to local communities the species mainly found in the present survey areas there have seen significant number of individuals also in nearby Kaskikot, Dhampus VDCs also. Similarly, 9 individual *Cyathea* species were recorded from Raniban with 5 at matured stage, 1 immature stage and 3 at young stages and 26 individual from Deurali-Tamagi VDC of Kaski where all individuals

Table 1: *Cyathea* recorded from districts and their location

S.N.	Districts	Areas within the districts	Remarks
1	Manang	Jagat-Dharapani	On shady & moist places
2.	Palpa	Ridikhola	On shady & moist places
3.	Parbat	Panchase Area	On shady & moist places
4.	Kaski	Near Pokhara, Dhampus, Raniban, Begnas, Panchase, Lwangghalel, Kande,	On shady & moist places
5.	Tanahu	Kahunshivapur-2,pingsirikhola, Near khairenitar-Chhabise village	On shady & moist places
6	Gorkha	Komale and Balu khola	On shady & moist places
7.	Lamjung	Opposite side of Marsyandi river near Jagat/Syange/ Ghermu VDC-5, 6, Tagrin VDCs	More than 100 large tree
8.	Dhading	Raniban below Nagarjun ridge below Jamachok	
9.	Kathmandu	Sundarijal	
10	Bhaktapur	Nagarkot, Sankhu near Changunarayan temple	
11	Dolakha	Totalabari, Tamba-Bhotekoshi valley	
12	Solukhumbu	Dudhkoshi	
13	Sankhuwasava	Near Arunriver below Num, Arun valley	
14	Bhojpur	Dingla, Chirkhowa	
15	Ilam	Rangapani, satpokhari, Pyang VDC 1850m asl	Krishna Ram Bhattarai, posted on facebook
16	Panchthar	On the way to Phidim (12 pokhari)	
17	Taplejung	Garhi Danra-Linkim-Tuwa, Tamur valley, mewa khola	
18	Nuwakot	Different VDCs of northern belt	
19	Kavre	Some places of borders sites towards Bhaktapur	

Table 2: Areas surveyed under study showing geographical positions and number of trees recorded

S.N.	Village/Area	Altitude m	Latitude	Longitude	No. of Matured tree	No. immature tree	No. of young	Estimated no. of tree fern in 10x10 m plot	Remarks
1	Raniban, Kaski	940	28.1966	83.9661	2	1	1	4	3m apart
2	Raniban	956	28.1916	83.9665	2	0	2	4	
3	Raniban	865	28.1976	83.9661	1	0	0	1	
Total					**5**	**1**	**3**	**9**	
4	4km west from Deurali, Kaski	1627	775697	3128672	1	0	2	3	WGS 84
5	4km west from Deurali, Kaski	1616	775616	3128727	3	0	1	4	
6	4km west from Deurali	1616	775515	3128737	3	1	0	4	
7	4km west from Deurali	1614	775515	3128747	4	0	0	5	
8	4km west from Deurali	1610	775411	3128717	2	2	1	4	
9	4km west from Deurali	1618	775442	3128719	1	2	0	3	
10	4km west from Deurali	1654	776354	3128682	1	1	1	3	
Total					**15**	**6**	**5**	**26**	
11	Lwangghalel, Kaleli, Kaski	1091	785026	3134789	0	2	3	5	
12	Lwangghalel	1442	781798	3138705	4	1	1	6	
13	Lwangghalel	1417	781874	3138419	3	1	2	7	
14	Lwangghalel	1418	781882	3138408	3	0	0	3	
15	Lwangghalel	1430	781840	313829	2	0	0	2	
16	Lwangghalel	1430	781839	3138291	3	2	2	7	
17	Lwangghalel	1430	781795	3138258	6	3	3	12	
18	Lwangghalel	1431	781794	3138216	3	0	0	3	
19	Lwangghalel	1432	781805	3138187	5	1	2	8	
20	Lwangghalel	1434	781824	3138171	4	1	2	7	
21	Lwangghalel	1458	781555	3138957	4	1	1	6	
22	Lwangghalel	1458	781555	3138958	1	5	1	7	
23	Lwangghalel	1368	781882	3138865	4	2	0	6	
24	Lwangghalel	1362	781899	3138876	3	2	0	5	
25	Lwangghalel	1360	781910	3138877	4	1	0	5	
Total					**50**	**22**	**17**	**89**	
26	Pingshree khola, jhejhardikhola Tanahu	865.3	231127	3093142	2	2	2	6	
27	Pingshree khola	869	231125	3093134	3	0	3	6	
28	Pingshree khola	865.2	231127	3093143	6	0	0	6	
29	Pingshree khola	859	231127	3093155	4	0	0	4	
30	Pingshree khola	851	231115	3093235	7	5	3	15	
31	Pingshree khola	858	230808	3093187	5	2	1	8	
32	Pingshree khola	857	230800	3093172	5	2	1	8	
Total					**32**	**11**	**10**	53	

were at mature stage. A total of 53 individuals of *Cyathea* were recorded from Pingshree khola of Shivanagar VDC of Tanahu district with 32 individual at matured tree, 11 and 10 individuals of immature and young stage respectively (Table 2).

Regeneration status of Cyathea

Regeneration status of the species was calculated on the basis of relative proportion of individuals at young, immature and mature stage. From the present study it is revealed that in all samples VDC the number of mature tree is higher than in young and immature. Paul *et al*. 2015 showed that 60% population regeneration of *C. gigantea* in eastern Himalaya (India) is at very poor regeneration stage. This result is more or less similar to the present study. However, the immature and young stage tree ferns are present in all studied sites indicating that the regeneration rate is slow but showed either fair or good or poor regeneration condition in Lwangghalel, Bhadaure Tamagi, Rani ban and Pingshree Khola of Tanahu district (Table 1)

Conclusion

Present study found a total of 176 *Cyathea* individual trees with 101 at matured, 40 at immature and 35 at young stage recorded from Kaski and Tanahu districts. About 63% of the observed individuals were matured tree and only 20% individual were at young stage indicating that the population regeneration is fair. Similarly the *Cyathea* species is recorded from 19 districts of eastern and central Nepal. The felling of tree trunk to make the pillar of local houses and shed is a challenging problem to conserve the species in Nepal.

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References

Bhagat, I. M. and Shrestha, S. 2010. Fern and Fern-Allies of Eastern Terai. *Short communication* Our Nature *:* 8.

Bhattacharyya, N. and S. Sharma. 2008. Assessment of availability, ecological feature, and habitat preference of the medicinal herb *Houttuynia cordata* Thunb in the Brahmaputra Valley of Assam, India. *Environ Monit. Assess*. Springer Science + Business Media B.V.

Bhattarai1,K.R., Vetaas, O.R. and Grytnes, J.A., 2004. Fern species richness along a central Himalayan elevational gradient, Nepal. *Journal of Biogeography* (J. Biogeogr.) **31**: 389–400

Bhuju, D. R. & Joshi, G.P. 2009. Records of *Cyathea spinulosa* Wallich ex Hooker(Cyatheaceae) and *Cycas pectinata* Griff.(Cycadaceae) from the Churiya Hills of Eastern Nepal. *Nepal Journal of Science and Technology* **10** :69-72.

Dong, S.Y. 2009. Hainan tree ferns (Cyatheaceaae): morphological, ecological and phytogeographical observations. *Ann. Bot. Gennici* 46: 381-388.

Fraser-Jenkins, C.R., Kandel, D..& Pariyar, S. 2015. *Ferns and Fern-allies of Nepal-1*. National Herbarium and Plant Laboratories , Department of Plant Resources, Ministry of Forests and Soil Conservation, Kathmandu, Nepal.

Gurung, V.L. 1991. *Ferns- The beauty of Nepalese flora*. Sahayogi press, Tripureshwor, Kathmandu, Nepal.

Kala, C.P., 2005. Ethnomedicinal botany of the Apatani in the Eastern Himalayan region of India. *J Ethnobiol Ethnomed* **1**: 1-12.

Khan, M.L., Upadhyaya ,K., Singha, L.B. and Devi, K.A. 2002. A plea for conservation of threatened tree fern (*Cyathea gigantea*). *Curr Sci* 82: 375-376.

Korall, P., Pryer, K.M., Metzgar, J.S., Schneider, H. and Conant, D.S. 2006. Tree ferns: monophyletic groups and their relationships as revealed by four

protein-coding plastid loci. *Mol Phylogenet Evol* 39: 830-845.

Paul, A., Bhattacharjee, S., Choudhury, B.I. and Khan, M.L. 2015. Population Structure and Regeneration Status of *Cyathea gigantea* (Wallich ex Hook. f.) Holttum, a Tree Fern in Arunachal Pradesh, India. *Journal of Forest and Environmental Science*. **31**:164-176.

Sharma, B.K., Timilsina, K., Rai, R., Maharjan, B.K, and Joshi, A. 2013. Biodiversity Resource Inventory Ecosystem Assessment of Bhadaure Tamagi VDC, Kaski. (A technical report submitted to IUCN, Nepal).

Thapa, N. 2002. *Pteridopytes of Nepal*. Ministry of Forests and Soil Conservation, Department of Plant Resources, Kathmandu, Nepal.

Tryon, R. M. and Gastony, G. J. 1975. The biogeography of endemism in Cyatheaceae. *Fern Gazette* 11:73-79

Tryon, R.M. and, Tryon, A.F., 1982. *Ferns and Allied Plants, with Special Reference to Tropical America.* Springer-Verlag, New York.

Zobel, D.B., M.J. Behen, P.K. Jha, and U.K.R. Yadav. 1987. *A practical manual for ecology. Kathmandu, Nepal*: Ratna Book Distributors.

www.cites.org/eng/resources/species.html

Documentation of Ethnomedicinal Knowledge on Plant Resources Used by Baram Community in Arupokhari VDC, Gorkha District, Central Nepal

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Abstract

The present paper highlights 80 species of plants used as medicine by the Baram (Baramu) community of Arupokhari VDC of Gorkha District. These reported plants were used in cough, cold, fever and gastritis, wound, diarrhea and other diseases.

Keywords: Ethno-medicine, Baram community, Arupokhari VDC, Gorkha district

Introduction

Ethno-botanical studies required to document and explore the traditional knowledge hidden in different ethnic group (Manandhar, 1993, Pandey, 2013, Parajuli, 2013). Among the 103 indigenous groups of Nepal, Baram (Baramu) is also one such ethnic group. Baram (or Baramu) is one of the indigenous minority nationalities scattered in different villages in the districts of Gorkha and territories (CBS, 2O11). According to their mythology, they call themselves off-springs of what they call five brothers: Surel, Sunuwar, Jirel, Rai (Khambu) and Limbu, and claim to have scattered to the west from the east (Gautam and Thapa Magar, 1994). The Baram people are a Tibeto-Burman ethnic group (Kansakar et al, 2011). The objective of this study is to document the traditional knowledge of Baram community regarding ethno-medicine.

Materials and Methods

This study was conducted in indigenous Baram community at Arupokhari VDC, Gorkha district, Central Nepal during September 2015. This VDC inhibits most common Mountain Sal forest, Chirpine forest and *Schima-Castanopsis* forest at altitude ranges from 500 m asl to 1300 m asl. In the course of study, 8 experienced villagers (5 male and 3 female) were interviewed of age range between 40-80 years old. The plants were identified with the help of photographs and related literatures (Polunin and Stainton, 1984, Baral and Kurmi, 2006, Jha et al., 2008, Manandhar, 2002, Shrestha, 1998, Shrestha and Shrestha, 2004, Stainton, 1998).

Results and Discussion

Total 80 species of 74 genera belongs to 44 families being used by Baram community as medicine to cure 27 diseases and troubles. Some major families are Moraceae (7 spp.), Asteraceae (6 spp.), Fabaceae (6 spp.), Lamiaceae (4 spp.), Verbenaceae (4 spp.) and others used to cure different diseases. On the basis of life form (habit) of plants 29 herb, 16 shrub, 29 tree and 6 climber species being used from past. Among all, 14 species being using in cough, 9 species in cold, 9 species fever, 9 species gastritis, 8 species in wound, 7 species in diarrhea and so on.

Ethno-medicinal use of plants

The information is arranged in alphabetical order of botanical name followed by family, nepali name, roman name habit and uses.

***Abrus precatorius* L.,** Fabaceae, रतिगेडी / लालगेडी, Ratigedi, Climber

Root directly is used to reduce hotness in stomach due to eating *Capsicum* spp.

***Acorus calamus* L.,** Araceae, बोझो, Bhojo, Herb

Juice of rhizome is drink to cure cough, cold and diarrhea.

***Agave americana* L.,** Agavaceae, हात्तीवार / केतुकी, Kettuke, Shrub

Leaves juice is apply to kill worms on wound.

***Ageratum conyzoides* L.,** Asteraceae, गन्धे, Gandhe, Herb

Juice of leaves is applied to stop bleeding in cut.

***Ageretina adenophora* (Spreng.) King & H.Rob.,** Asteraceae, बनमारा, Banmara, Herb

Juice of leaves is applied to stop bleeding.

***Allium sativum* L.,** Amaryllidaceae, लसुन, Lasun, Herb

Bulb is directly eating to reduce gastritis.

***Aloe vera* (L.) Burm. f.,** Liliaceae, घिउ कुमारी, Ghiu kumara, Herb

Juice of leaves is applied to cure skin burn by fire.

***Ananas comosus* (L.) Merr.,** Bromeliaceae, भूई कटहर, Bhui katahar, Herb

Fruit is directly eating to reduce warmness of body.

***Artemisia indica* Willd.,** Asteraceae, तिते पाती, Tite pati, Herb

Juice of leaves is applied to kill human louse, worms and also cure scabies.

Artocarpus heterophyllus Lam., Moraceae, कटहर, Katahar, Tree

Leves is directly fed cattles to control cough.

***Artocarpus lakoocha* Wall. ex Roxb.,** Moraceae, बडहर, Badahar, Tree

Milky latex is applied to cure mumps.

***Azadirachta indica* A. Juss.,** Meliaceae, नीम, Neem, Tree

Juice of leaves is eating to cure cough and applied on skin diseases.

***Bauhinia variegata* L.,** Fabaceae, कोइरालो, Koiralo, Tree

Juice of bark is eating to cure fever, diarrhea as well as amebic dysentery.

***Belamcanda chinensis* (L.) Redoute,** Iridaceae, तरवारे फूल/खुकुरी धारे, Tarbare phool/ Khukuri dhare, Herb

Decoction of root is eating to cure diarrhea.

***Boenninghausenia albiflora* (Hook.) Reichenb. ex Meissn.,** Rutaceae, माखे माउरो/ माउरे झार, Makhe Mauro/ Maure jhar, Herb

Plant decoction is eating to cure cold and whole plant used for insect repelent.

***Bombax ceiba* L.,** Bombacaceae, सिमल, Simal, Tree

Dried flower is directly eating to cure dysentery.

***Buddleja paniculata* Wall.,** Buddlejaceae, भिमसेन पाती, Vimsen pati, Tree

Juice of leaves is use to kill fishes.

***Callicarpa arborea* Roxb.,** Verbenaceae, गुयालो, Guyalo, Tree

Decoction of bark is eating to cure fever.

***Callicarpa macrophylla* Vahl.,** Verbenaceae, दही चाम्ले/ दहीकमला, Dahichamle, Shrub

Decoction of bark as well as root is eating to cure fever, typhoid.

***Calotropis gigantea* (L.) Dryand.,** Asclepiadaceae, आँक, Aank, Shrub

Milky juice is applied to cure joint fracture and dried stem is use as smoke in Pinas.

***Cannabis sativa* L.,** Cannabaceae, गाँजा, Ganja, Herb

Decoction of leaves is fed to cure diarrhea of goat and other cattles.

***Centella asiatica* (L.) Urb.,** Apiaceae, घोडताप्रे, Ghodtapre, Herb

Decoction of plant is eating to cure fever and to reduce warmness of body.

***Cheilanthes bicolor* (Forssk.) Kaulf.,** Pteridaceae, रानी सिन्का/ काली सिन्का, Ranisinka, Herb

Mixture of leaf decoction of *Scutellaria discolor, Psidium guavaja* and *Cheilanthes bicolor* is eating twice a day to cure gastritis troubles.

***Chromolaena odorata* (L.) King & H.E. Robins.,** Asteraceae, सेतो वनमारा, Banmara, Shrub

Decoction of leaves is applied to stop bleeding as well as skin ring of cattle.

***Cissampelos pariera* L.,** Menispermaceae, गुजर गानो, Gujar gano, Climber

Decoction of rhizome /root is eating to cure gastritis problems.

***Citrus aurantifolia* (Christ.) Swingle ,** Rutaceae, कागती, Kagati, Lemon, Tree

Juice of fruit is applied to cure pimple.

***Cleistocalyx operculata* (Roxb.) Merr. & Perry,** Myrtaceae, क्यामुनो, Kyamuno, Tree

Dry leaves is used as smoke to cure cold, Pinas.

***Colebrookea oppositifolia* Sm.,** Lamiaceae, धुसुरे, Dhusure, Shrub

Juice of young bud is applied to remove leech from nose of cattle.

***Costus speciosus* (Koenig) Sm.,** Zingiberaceae, बेतलौरी, Betlauri, Herb

Juice of root is eating to cure fever.

***Cuscuta reflexa* Roxb.,** Convolvulaceae, अकाश बेली, Akashbeli, Climber

Juice of whole plant is eating to cure jaundice and applied in bone fracture.

***Dolichus lablab* L.,** Fabaceae, सिमी, Simi, Climber

Juice of leaves is applied in ringworm disease on skin.

***Drymaria diandra* Blume,** Caryophyllaceae, अविजालो, Avijalo, Herb

Whole plant is used to cure Pinas, a disease in which bleeding from nose.

***Erythrina stricta* Roxb.,** Fabaceae, फलेदो, Phaledo, Tree

Juice of bark is eating to cure diarrhea and fever.

***Euphorbia thymifolia* L.,** Euphorbiaceae, दुधे झार, Dudhe jhar, Herb

Juice of leaves/sap is applied to stop bleeding.

***Ficus benghalensis* L.,** Moraceae, वर, Bar, Tree

Milky latex is applied to cure mumps.

***Ficus racemosa* L.,** Moraceae, डुम्री, Dumri, Tree

Milky latex is applied to cure mumps.

***Ficus sarmentosa* Buch.-Ham. ex Sm.,** Moraceae, बेरुलो, Berulo, Tree

Milky latex is applied to cure mumps.

***Ficus semicordata* Buch.-Ham. ex Sm.,** Moraceae, खन्यू, Khanyu, Tree

Watery juice is eating to decrease warmness of body and rehydration.

***Inula cappa* (Buch.-Ham. ex D. Don) DC.,** Asteraceae, गाईतिहारे, Gaitihare, Herb

Juice of leaves is eating to increase appetite and leaves also used to make 'Marcha', which use to make alcoholic beverages.

***Justicia adhatoda* L.,** Acanthaceae, असुरो, Asuro/ Vashak, Shrub

Leaves boil in water and drink to cure cough.

Lichens, झयाउ, Lichens, Herb

Powder of whole plant is applied to stop bleeding in cut.

***Lyonia ovalifolia* (Wall.) Drude,** Ericaceae, अंगेरी, Angeri, Tree

Juice of leaves/bud is applied to control scabies.

***Maesa macrophylla* (Wall.) DC.,** Myrsinaceae, भगटे, Vogate, Shrub

Juice of leaves is used to fish poisoning.

***Millettia extensa* Benth.,** Fabaceae, गाउजो, Gaujo, Shrub

Juice of root applied to control scabies.

***Mimosa pudica* L.,** Fabaceae, लज्जावती, Lajjawati, Herb

Juice of leaves is eating to cure jundice, reduce warmness of body.

***Morus alba* L.,** Moraceae, किम्बु, Kimbu, Tree

Latex is used in anthe-helmintic for cattle.

***Musa paradisiaca* L.,** Musaceae, केरा, Kera, Herb

Juice of young bud of flower is eating to cure jundice.

***Mussaenda macrophylla* Wall.,** Rubiaceae, धोविनी, Dhobini, Shrub

Juice of root is eating to treat typhoid.

***Myrica esculenta* Buch.-Ham. ex D. Don,** Myricaceae, काफल, Kaphal, Tree

Juice of leaves applied to control toothache.

***Nicotiana tabacum* L.,** Solanaceae, सुर्ती, Surti, Herb

Juice of leaves applied to kill and remove leeches from the nose of cattle.

***Nyctanthes arbor-tristis* L.,** Oleaceae, पारिजात, Parijat, Shrub

Juice of leaves is drink to cure cough.

***Ocimum sanctum* L.,** Lamiaceae, तुलसी, Tulasi, Herb

Leaves boils in water and drink to cure fever, cough, cold.

***Oroxylum indicum* (L.) Kurz,** Bignoniaceae, टटेलो, Tatelo, Tree

Decoction of bark is drink to cure jundice, seed eat in fever and paste of bark applied in wound.

***Osbeckia nepalensis* Hook.,** Melastomaceae, सेतो चुल्सी, Seto chulsi, Shrub

Leaves boils in water and drink to cure fever.

***Phyllanthus emblica* L.,** Euphorbiaceae, अमला, Amala, Tree

Fruit is eat to cure cold and cough.

***Pinus roxburghii* Sarg.,** Pinaceae, सल्ला, Khote salla, Tree

Resin is applied to cure mumps.

***Piper longum* L.,** Piperaceae, पिपला, Pipla, Climber

Fruit is directly eating to cure cold and cough.

***Pogostemon benghalensis* (Brum. f.) Kuntze,** Lamiaceae, रुदिलो, Rudilo, Herb

Decoction of leaves use to cure cold and cough.

***Premna latifolia* L.,** Verbenaceae, गिन्नेरी, Ginneri, Tree

Juice of bark is drink to reduce gastritis problem.

***Prunus persica* (L.) Batsch.,** Rosaceae, आरु, Aaru, Tree

Juice of young bud is applied to kill worms on wound.

***Psidium guavaja* L.,** Myrtaceae, अम्बा, Amba, Tree

Juice mixture of leaves of *Psidium guavaja, Scutellaria discolor* and *Cheilanthes bicolor* is drink twice a day to cure gastritis and Bark decoction use to cure diarrhea.

***Rhododendron arboreum* Sm.,** Ericaceae, लाली गुराँस, Laligurans, Tree

Flower is directly eating to control diarrhea.

***Rubus ellipticus* Sm.,** Rosaceae, ऐसेलु, Aiselu, Shrub

Juice of root is drink to cure gastric and young bud used in stomach pain.

***Saccharum spontaneum* L.,** Poaceae, काँस, Kans, Herb

Root paste is directly applied to remove helminths of cattle.

***Sapium inisgne* (Royle) Benth.ex Hook.f.,** Euphorbiaceae, खिर्रो, Khirro, Tree

Milky latex is used in fish poisoning.

***Schima wallichii* (DC.) Korth.,** Theaceae, चिलाउने, Chilaune, Tree

Juice of bark is used in fish poisoning as well as drink in gastritis problem.

***Scutellaria discolor* Colebr.,** Lamiaceae, रातपाते, Ratopate, Herb

Juice mixture of leaves of *Scutellaria discolor, Psidium guavaja* and *Cheilanthes bicolor* is drink twice a day to cure gastritis. Root decoction is drink to cure fever.

***Solanum virginiatum* L.,** Solanaceae, कण्टकारी, Kanthakari, Herb

Dry fruit is used as smoke in toothache.

***Spermacoce latifolia* Aubl. ,** Rubiaceae, कुनेझार, Kune jhar, Herb

Juice of whole plant is applied to cure wound.

***Spilanthes paniculata* Wall.ex DC.,** Asteraceae, मरौटी, Marauti, Herb

Flower is applied to control toothache and stomach pain due to cold.

***Stephania glandulifera* Miers,** Menispermaceae, वाटुलपाते, Batulpate, Climber

Root juice is drink to cure cough.

***Syzygium cumini* (L.) Skeels,** Myrtaceae, जामुना, Jamuna, Tree

Juice of bark is drink to cure dysentery.

***Tectaria macrodonta* (Fee) C.Chr.,** Aspidiaceae, काली निउरो, Kali niuro, Herb

Root juice is drink to cure dysentery.

***Terminalia bellirica* (Gaertn.) Roxb.,** Combertaceae, वर्रो, Barro, Tree

Fruit is directly eating to cure cold and cough.

***Terminalia chebula* Retz.,** Combertaceae, हर्रो, Harro, Tree

Fruit is directly eating to cure cold and cough.

***Urtica dioica* L.,** Urticaceae, सिस्नु, Sisno, Herb

Leaves paste is use to make bandage in joint fracture/breakage.

***Vitex negundo* L.,** Verbenaceae, सिमाली, Simali, Shrub

Juice of leaves is used to cure cough and Pinas.

***Woodfordia fruticosa* (L.) Kurz,** Lythraceae, धैंयारो, Dhayero, Shrub

Flower is directly eating to cure dysentery.

***Zanthoxylum armatum* DC.,** Rutaceae, टिमुर, Timur, Shrub

Fruit is directly applied to cure toothache.

***Zingiber officinale* (Willd.) Roscoe,** Zingiberaceae, अदुवा, Aduwa, Herb

Rhizome is directly eat to cure cold and cough.

Herbal plants are used in the form of juice, decoction, paste and also use directly by chewing. The most common cold and cough problem were treated by

using some plants like *Phyllanthus emblica, Pogostemon benghalensis, Terminalia bellirica, Terminalia chebula, Zingiber officinale, Acorus calamus* and *Ocimum sanctum*. Similarly, *Cheilanthes bicolor, Allium sativum, Cissampelos pariera, Osbeckia nepalensis, Premna latifolia, Scutellaria discolor and Rubus ellipticus* were used to cure gastritis. Most of the milky latex bearing plants (*Artocarpus lakoocha, Ficus benghalensis, Ficus racemosa, Ficus sarmentosa*) used to cure mumps problem. Only two species *Mussaenda macrophylla* and *Callicarpa macrophylla* are used to treat typhoid disease.

Conclusion

The Baram people of Gorkha district Central Nepal possess rich ethno-medicinal knowledge and practiced several species of plants to cure different diseases and health troubles. The globalization and modernization creating problem to conserve the Baram language as well as traditional practice to use medicinal plants. Documentation as well as bio-prospecting and patenting is very important to provide fair share of benefit to indigenous people.

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References

Baral, S.R. and Kurmi, P.P. 2006. *A Compendium of Medicinal Plants of Nepal*. pub: Mrs Rachana Sharma, 281 Maiju Bahal, Chabahil, Kathmandu, Nepal.

CBS. 2011. *Population census 2010: National report.* Central Bureau of Statistics, Kathmandu, Nepal.

Gautam, R. and Thapa Magar, A.K. 1994. *Tribal ethnography of Nepal*. Vol.I. Delhi Book Faith, India.

Jha, P.K., Kamacharya, S.B, Chettri, M.K., Thapa, C.B. and Shrestha, B.B. (Eds.). 2008. *Medicinal Plants of Nepal: An Anthology of Contemporary Research*. Ecological Society of Nepal (ECOS), Kathmandu, Nepal.

Kansakar, T.R., Yadav, Y.P., Chalise, K.P., Prasain, B., Dhakal, D.N. and Paudel, K. 2011. A Socialinguistic study of the Baram language. *Himalayan Linguistics.* vol 10(1), pp.187-225.

Manandhar, N.P. 2002. *Plants and People of Nepal*. Timber Press, Oregon, USA.

Manandhar, N.P.1993. Ethnobotanical note on Folk-lore Remedies of Baglung District, Nepal. *CNAS Journal,* vol.20, No.2, pp. 183-196.

Pandey, J. 2013. Documentation of Ethnomedicinal Knowledge on Plant Resources Used by Magar Community in Dhaanbang VDC, Salyan District. *Bull. Dept. Pl. Res*. No. 35, pp. 62-66.

Parajuli, R.R. 2013. Indigenous Knowledge on Medicinal Plants: Maipokhari, Maimajhuwa and Mabu VDCs of Ilam District, Eastern Nepal. *Bull. Dept. Pl. Res*. No. 35, pp. 50-58.

Polunin, O. and Stainton, A. 1984. *Flowers of Himalaya*. Oxford University Press, India.

Shrestha, U.B. and Shrestha, S. 2004. *Major Non-timber Forest Products of Nepal*. Bhudipuran Prakashan, Kathmandu.

Stainton, A. 1988. *Flowers of the Himalaya: A Supplement*. Oxford University Press, New Delhi, India.

Documentation of Indigenous Knowledge on Medicinal Use of Plants by Raji Community in West Nepal

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Abstract

The present work was carried out with the aim to document the indigenous knowledge on medicinal use of plants by Raji community in west Nepal. The study was mainly based on primary data collected during the explorative field study representing locality with significant Raji population. As per the approved annual program of District Plant Resources Office (DPRO) Kailali for the fiscal year 2014/15, the work was carried out in the year 2015. Among 61 plant species were identified in the present study highest number of species was recorded in Bhuruwa, Khailad-4 of Kailali. Similarly, highest number belongs to herbs (22 species) followed by trees (20 species) of trees. The most commonly used part of plants for medicinal purpose was root (24 species) followed by leaf (14 species). According to types of health problems, greater numbers of plant species (12 species) are found to be used by Raji to treat gastrointestinal problem.

The study revealed that Raji community still has a strong traditional knowledge on medicinal plants use and they are still applying traditional healing practices. But strength of indigenous knowledge and practice is higher in the locality where Raji population is in significant number with their own socio-cultural settings. The strength becomes weaker and weaker with decrease in households and population along with socio-cultural erosion.

Key Words: Indigenous knowledge, Raji, plants, medicinal uses, west Nepal.

Introduction

Indigenous knowledge is such type of empirical idea and methodology, which is generated through series of hits and trials, from generations to generations. In other words, indigenous Knowledge is human life experience in distinct natural and social compound within unique local and contemporary setting. It is not formally taught but perceived in particular context at a certain stage of the perceiver's consciousness that grows in the world of local events (Maskay, 2007). Indigenous knowledge or synonymously traditional knowledge is tested and refined knowledge selected through thousands of years or even more.

Nepal is not only rich in biodiversity but also rich in ethnic diversity. Each ethnic community has localized distribution with unique socio-cultural characteristics. Raji is an indigenous community and are believed to originate from Surkhet with most households today living in the Chure hills and low land Terai of the Mid Western Region and the Far Western Region. The Rajis speak a Tibeto-Burman language without a script. The Rajis are divided into three clans the Purbe (Atharathari), the Bandale (Barathari) and the Naukale (Nauthari). The language also varies slightly according to clan.

According to National Census 2011, there is only 4235 Raji population in Nepal. Raji are mainly distributed in Mid Western and Far Western regions and represented by 2106 and 2036 in number respectively. Eastern, Middle and Western regions have sparse distribution of Raji and represented by significantly low numbers 33, 30 and 30 respectively (CBS, 2011). The largest Raji population is found in Surkhet and Kailali districts, followed by Dang, Bardiya and Kanchanpur districts. Government of Nepal (GoN) has enlisted the Raji community in vulnerable community list. According to Social Protection Programme Implementation Guidelines

(GoN, 2008), each Raji is entitled to NRs. 1000 per month from the respective VDC or municipality office under the Social Protection Programme of the Government of Nepal.

The Rajis used to live a nomadic life in the past (Gautam & Thapa Magar, 1994) and prefer to live along river banks and within forest areas. However, with the adoption of a semi-nomadic lifestyle, they tend to gradually move out of the forest. Agriculture is a newly embraced occupation for Raji and probably the last among other communities, which tends to rely on it for their self-subsistence, although most Raji families also remain dependant on traditional means of survival. Raji are renowned for their skills at honey hunting and fishing. Amongst the Raji a specific classification of diseases and concepts prevail and although the Rajis have begun to use modern medicine, they generally resort to it only their own traditional healers fail to cure the disease, making it important for them to retain their knowledge in this regard (UNRCHC, 2012).

Statement of the problem

Many indigenous communities have been abandoning their traditional customs and thereby lose their plant knowledge over time (Benzet et al., 2000). Change in life style, urbanization, ignorance of new generation and biodiversity loss are major causes of significant decrease in traditional knowledge on medicinal plants among various ethnic communities of Nepal (Maskey, 2007; Thapa, 2012). Indigenous Knowledge is traditionally transmitted orally but is now vulnerable to people's migration and the youth adopting new and different lifestyles and values. The Rajis' substantial Indigenous Knowledge is also at risk of disappearing with the older generation of Rajis.

Objectives

Following are the objectives of present study;

- To document the indigenous medicinal practices by Raji community.
- To analyze the results of research.

Methodology

Literature review was first activity conducted to carry out the research. Various relevant documents were collected and studied. On the basis of literature review, methodology and study site was finalized.

Study Area

Since the research is mainly confined with traditional medicinal plant uses by Raji community, the study areas are selected where Raji community lives from generations to generation. Accordingly following are the study areas.

Study site 1	:	Krishnapur – 5
District	:	Kanchanpur
Geographical Position	:	28° 50.602' N; 80° 28.636' E
Altitude	:	196 m
Study site 2	:	Bhuruwa, Khailad VDC – 4
District	:	Kailali
Geographical Position	:	28° 29.717' N; 80° 55.539' E
Altitude	:	147 m
Study site 3	:	Chhinchu – 11
District	:	Surkhet
Geographical Position	:	28° 27.869' N; 81° 43.009' E
Altitude	:	559 m
Study site 4	:	Kuta, Taranga – 4
District	:	Surkhet
Geographical Position	:	28° 41.313' N; 81° 23.862' E
Altitude	:	325 m
Study site 5	:	Sanashree, Taratal MN–2
District	:	Bardiya

Research Design and Data Collection

Exploratory research design was selected for present study. The study mainly focuses on collecting and analyzing the first hand information. While, secondary data were also analyzed at the discussion part of the study. Elders, traditional healers, farmers

of the community were identified as key informants from preliminary discussion. Field study was conducted in 2015.

Interview method was used to collect the primary information about medicinal uses of plants. Semi-structured open-ended questionnaire was used while interviewing the respondent. But before taking the interview, prior informed consent was taken from each and every respondent. After completing the interview, transect walk was conducted in the nearby forest where information was added and herbarium specimens were collected for uncommon species. Audio recordings were also taken in the interview and in the transect walk, and the recording were used in verifying the data. The specimens were identified with the help of standard literatures and technical supports from experts of KATH. The herbarium prepared during the study was stored in DPRO Kailali Herbarium.

Results and Discussions

Number of medicinal plant species used by Raji in different locality

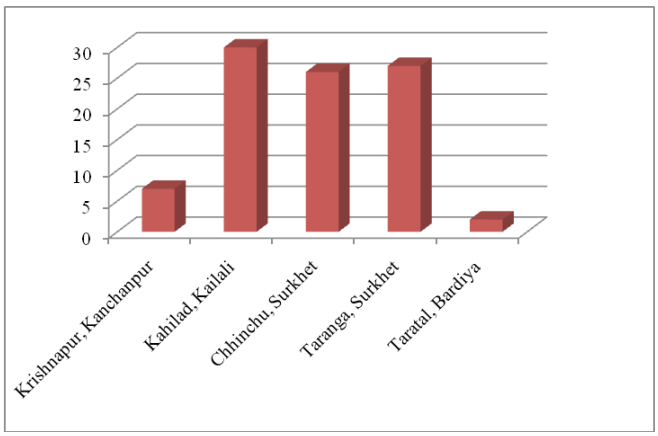

Figure 1. Number of medicinal plant species used by Raji in different localities

In the study, highest number of species was recorded in Bhuruwa, Khailad of Kailali, where 30 species of medicinal plants were found to be used to treat different health problems. This figure was followed by Taranga and Chhinchu of Surkhet where 27 and 26 species of medicinal plants were recorded respectively. Krishnapur, Kanchanpur stands in 4th position with seven medicinal plants used by Raji community. Lowest number of species of medicinal plant was reported in Taratal of Bardiya. The research team could not make contact with majority of key informants at Taratal, because at the time of field study, most of the people of the community were engaged in public contribution program for local development work, popularly called as 'begari'.

Taxonomic Diversity

Altogether 61 plant species were identified which are used by Raji community for medicinal purpose. Among these, 46 species were identified up to species level, 5 species up to genera and three species upto family level only while remaining 8 were unidentified because the specimens were not at flowering or fruiting stage. Among identified species belongs to 29 family and 46 genera. During the study, 42 species belonging to 26 families of dicotyledons, 3 species belonging to 2 families and 2 genera of Monocotyledon, one species of Pteridophytes were recorded. The largest family was Asteraceae having 7 species followed by Fabaceae (4 spp.), Apocynaceae (3 spp.), Combretaceae (3 spp.), Phyllanthaceae (3 spp.), Rutaceae (3 spp.).

Life forms

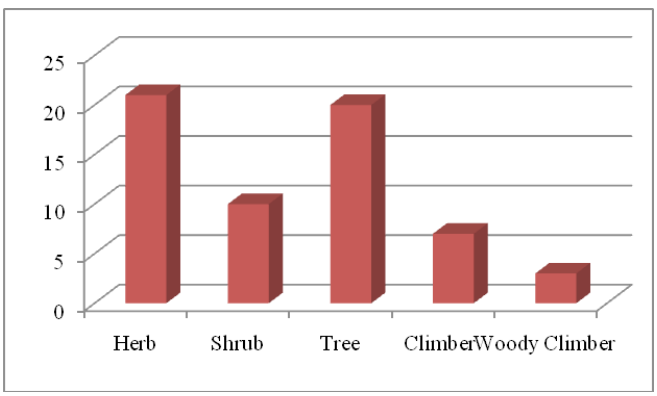

Figure 2. Life forms of medicinal plant species used by Raji

Based on life forms, highest number belongs to herbs (22 species, 34.42%) followed by trees (20 species, 32.79%) of trees, shrubs (10 species, 16.39%), climbers (7 species, 11.49%). Lowest number is represented by woody climber with 3 species (4.92%) which are found to be used by Raji community for medicinal purpose.

Plant parts

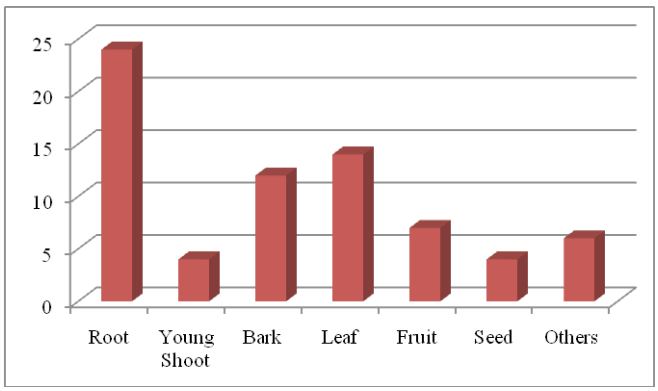

Figure 3. Medicinal Plant parts used by Raji

The most commonly used part of plants for medicinal purpose was root (24 species, 39.34%) followed by leaf (14 species, 22.95%), bark (12 species, 19.67%), fruit (7 species, 11.48%), young shoot and seed both (4 species, 6.56%). 6 species (9.84%) have other parts such as whole plant, leaf sap, leaf latex, stem, bulb, flower etc. used for medicinal purpose. Some species have more than one part used for medicinal purpose; the virtual number of species seems to be more than total number of species enumerated in the study.

Treatment of health problem category

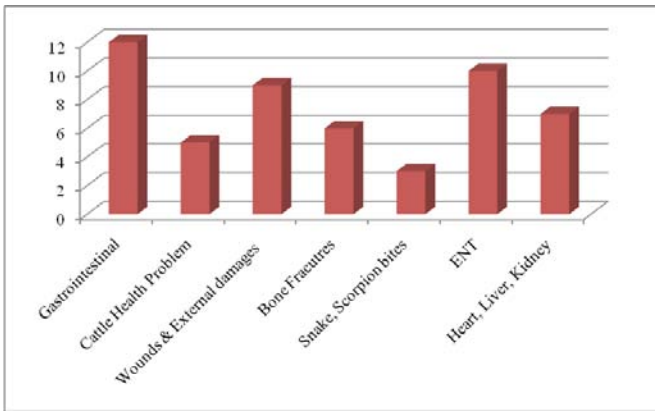

Figure 4. Number of species used to treat health problems by Raji

According to types of health problems, greater number of plant species (12 species, 19.67%) are found to be used by Raji to treat gastrointestinal problem, which is followed by gradually lesser number of species of medicinal plants to treat ENT problems (10 species, 16.39%), wounds and external damages (9 species, 14.75%), heart, liver kidney problems (7 species, 11.48%), bone fractures (6 species, 9.84%), cattle health problems (5 species, 8.20%) and antidote against snake and scorpion bites (3 species, 4.92%). Remaining species are used to treat against fever, muscle pain, headache, arthritis etc.

Conclusion

Altogether 61 species of medicinal plants are found to be used by Raji to treat the health problems. From above results, it can be concluded that Raji community still have a strong traditional knowledge on medicinal plants use and they are still applying traditional healing practices. But strength of indigenous knowledge and practice is higher in the locality where Raji population is in significant number with their own socio-cultural settings. The strength becomes weaker and weaker with decrease in households and population along with socio-cultural erosion. The high diversity of medicinal plant species used by Raji of Bhuruwa, Khailad-4 of Kailali is closely linked with the fact that Bhuruwa is most likely the highest number of households with highest population of Raji in Nepal. The finding is supported by greater number of medicinal plant species reported from Chhinchu and Taranga followed by lower number of medicinal plant species used by Raji in Kanchanpur and Bardiya.

Acknowledgements

We are indebted to the respondents and all the Raji community of the study sites, which is the core of the research. We are also grateful to Mr. Yam Bahadur Thapa (then Director General of Department of Plant Resources, Thapathali) and Mr. Balaram Adhikari (then Regional Director of Far Western Regional Forest Directorate, Dhangadhi) for guiding the research and providing the valuable suggestions. We are thankful to DPRO Kailali for providing us an immense opportunity to conduct the present research.

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References

Benzet, B., Cevallos, J., Santana, F. , Rosales J. and Graf, S. 2000. Losing knowledge about plant use in the Sierra De Manantlan Biospehre Reserve, Mexico. *Economic Botany* 54: 183- 191.

CBS. 2011. *National Population and Housing Census, 2011 (National Report), Vol. 1, NPHC 2011*. Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics, Kathmandu, Nepal.

GoN. 2008. *Social Protection Programme Implementation Guidelines*.

Gautam, R. and Thapa Magar, A.K. 1994. *Tribal ethnography of Nepal*, *Vol. 1*. Delhi Book Faith, India.

Maskey, S. 2007. *Indigenous knowledge system as resource for sustaining Raji work and life, A case study of Surkhet district*. Social Inclusion Research Fund Secretariat, SNV Netherlands Development Organization, Kathmandu, Nepal.

Thapa, L. B. 2012. Indigenous knowledge on common medicinal plants among Raji. *Nepalese Journal of Biosciences* 2: 88-92.

UNRCHC. 2012. Field Bulletin: The Raji Community in the Far West. Issue 35, February 2012.

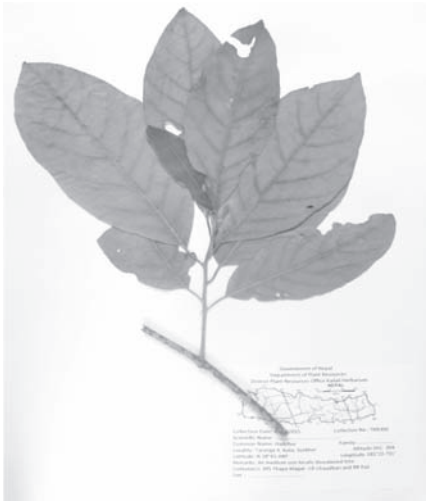
Appendix

List of plant species and their information collected during Traditional Knowledge of Raji of West Nepal

S. No.	Scientific Name	Family	Habitat	Raji Name	Nepali/Local Name	Medicinal Uses	Parts Used
1	*Achyranthes aspera* L.	Amaranthaceae	Herb	Chichibhrata		in abdominal pain (abdominalache), for body freshness	Roots, Leaves
2	*Ageratum conyzoides* L.	Asteraceae	Herb	Raunia	Gandhe Jhar	in cuts and wounds	Leaves
3	*Alstonia scholaris* (L.) R. Br.	Apocynaceae	Tree	-	Chhatiwan	in abdominal disorders, gastritics	Barks
4	*Antidesma acidum* Retz.	Phyllanthaceae	Tree	Chau	Dakh, Archal, Chuklepat	in wounds	Leaves
5	*Artemisia* sp.	Asteraceae	Shrub	Pati	Titepati	in short urination period	Roots
6	*Asparagus filicinus* Buch.-Ham. ex D. Don	Asparagaceae	Herb	Bhale Gansya	Kurilo	in fractures of limbs	Roots
7	*Asparagus racemosus* Wild.	Asparagaceae	Herb	Pothi Gansya	Kurilo	in fractures of limbs, wounds, cuts, body pain, for the increment on the prolactine hormone and hence the mother's milk	Roots
8	*Bergenia ciliata* Sternb.	Saxifragaceae	Herb	Pasanved	Pasanved	in naval rigidity, abdominal pain	Roots
9	*Bridelia retusa* (L.) A.Juss	Phyllanthaceae	Tree	Drek	Gayo	headache, body pain	Seeds, Barks, Roots
10	*Calotropis gigantea* (L.) R. Br. ex Schult.	Apocynaceae	Shrub	Madar	Aank	in the rabies, sutzure and pain in vessels	Flower, Leaves
11	*Carica papaya* L.	Caricaceae	Tree	Mewa	Mewa	in stinged wounds of Centipede, in diffferent stones, spermatorrhea	Leaves, Seeds/Roots
12	*Cassia fistula* L.	Fabaceae	Tree	Aainrokha	Rajabrikkchha	in the snakebites	Leaves ans stem tip
13	*Centella asiatica* (L.) Urban	Apiaceae	Herb	Ghodtapre	Ghodtapre	in black spot tongue disease, to escape from high temperature	Leaves/Whole plant
14	*Cissampelos pareira* L.	Menispermaceae	Climber	Ganogurjo	-	in naval rigidity of large mammals, oxes	Underground stem
15	*Cissampelos* sp.	Menispermaceae	Climber	Khaltya	Padalpate, Tite, Musibeli	in diarrhoea, abdominalache, naval rigidity	Roots
16	*Clausena pentaphylla* DC.	Rutaceae	Shrub	Pradha	-	in abdominalache	Roots
17	*Cleistocalyx operculatus* (Roxb.) Merr. & L.M. Perry	Myrtaceae	Tree	Bhadrajabu	Kyamuna	In sinusitis, cuts and wounds	Leaves
18	*Clematis* sp.	Ranunculaceae	Climber	Shikari lahara	-	in fractures of limbs	Roots
19	*Colebrookea oppositifolia* Sm.	Lamiaceae	Shrub	Dhurseuli	Dhursure	In conjunctivitis, and eye diseases	Newly tips
20	*Cynoglossum* sp.	Boraginaceae	Herb	Kaniike kuro	Kaniike kuro	In conjunctivitis, and eye diseases	Newly tips
21	*Datura metel* L.	Solanaceae	Shrub	Dhaturo	Dhaturo	in hydroseal	Leaves and Fruits
22	*Eclipta alba* (L.) Hassk.	Asteraceae	Herb	Kal/Angare jhar	Bhringaraj	In filthy mud, skin corrosion	Whole plant
23	*Elephantopus scaber* L.	Asteraceae	Herb	-	-	in pathogens over the wounds of animals	Roots
24	*Ficus racemosa* L.	Moraceae	Tree	Umri	Dumri	in quick maturity of wounds	Latex of leaves
25	*Ficus semicordata* Buch.-Ham. ex Sm.	Moraceae	Tree	Khurure	Khaniyo	in marasmus	Fruits
26	*Hydrocotyle sp.*	Araliaceae	Herb	Binase jhar		in sinusitis	Leaves
27	*Lygodium flexuosum* (L.) Sw.	Lygodiaceae	Herb	Kwanblaka	Unyu	in dry cracks of foot base	Roots
28	*Millettia extensa* (Benth.) Baker	Fabaceae	Woody climber	Gaujo	Gaujo	in ticks and mites of cattle and in fishing	Roots

29	*Momordica charantia* L.	Cucurbitaceae	Climber	Karela	Karela	in controlling of blood pressure	Fruits
30	*Murraya koenigii* (L.) Sprengel	Rutaceae	Shrub	Daineri	Karipatta	lice, ticks and mites of cattle	Leaves
31	*Oroxylum indicum*(L.) Benth. ex Kurz	Bigoniaceae	Tree	Pradha	Tatelo	in conjuncitivis, vomit control, jaundice, abdominal swell, wounds and knee displacement	Fruits, Narks
32	*Oxalis cornuculata* L.	Oxalidaceae	Herb	Khapsurung	Chariamilo	in naval rigidity, conjunctivitis	Leaves
33	*Phanera vahlii* Benth.	Fabaceae	Woody climber	Mik lahara	Bhorla	in abdominalache, normal bowel, dysentery	Barks
34	*Phyllanthus emblica* L.	Phyllanthaceae	Tree	Aaunla	Amala	in coughs	Fruits
35	*Piper peepuloides* Rox b.	Piperacear	Climber	Pimpali	Pipala	in coughs	Fruits, Roots
36	*Prunus persica* (L.) Batsch	Rosaceae	Tree	Aaru	Aaru	in pathogens over the wounds of cattle	Newly tips
37	*Rauvolfia serpentina* (L.) Benth. ex Kurz	Apocynaceae	Herb	Dhadbiruwa	Sarpagandha	in heart pain	Roots
38	*Rhus wallichi* Hook.f.	Anacardiaceae	Tree	Ryakh	Valayo	in conjunctivitis and eye diseases	Seeds
39	*Sapindus mukorossi* Gaertn.	Sapindaceae	Tree	-	Ritha	in pained parts	Fruits
40	*Schleichera oleosa* (Lour.) Merr.	Sapindaceae	Tree	-	Kusum	in control of lices	Seeds
41	*Smilax ovalifolia* Roxb. ex D. Don	Smilacaceae	Climber	Ralbu, chela	Kukurdaino	in arthritis, joint pain	Roots
42	*Solanum nigrum* L.	Solanaceae	Herb	Khakhani	Kaligedi, Kalikuinya	in braco-clavical pain	Leaves and Roots
43	*Sonchus oleraceus* L	Asteraceae	Shrub	Dudhi		in miscarriage	Roots
44	*Spatholobus parviflorus* (Roxb.) Kuntze	Fabaceae	Woody Climber	Sinee	Moya, Debrelahara	in pain and sprains	Barka
45	*Spondias pinnata* (L. f.) Kurz	Anacardiaceae	Tree	Amaro	Amaro	in abdominalache	Barks
46	*Terminalia arjuna* (Roxb.) Wight & Arn.	Combretaceae	Tree	Arjun	Arjun	in fractures of limbs	Barks
47	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Tree	Vayarang	Barro	in urinary track infection and urinary problems	Barks
48	*Terminalia chebula* Retz.	Combretaceae	Tree	Harra/Harai	Harro	in coughs, dysentery, gingivitis, scurvy	Fruits, Roots
49	*Triumfetta bartramia* L.	Malvaceae	Herb	Biskapro		in wounds	Leaves
50	*Vernonia aspera* Buch. - Ham.	Asteraceae	Herb	Bareauns/ Thuloausadhi	-	in abdominalache	Roots
51	*Ziziphus mauritiana* Lam.	Rhamnaceae	Shrub	Kla	Bayer	in jaundice, toothache	Roots
52	-	Asteraceae	Herb	Kalijiri	Kalojira	in heart pain, cough, nausea vomiting	Seeds
53	-	-	Herb	Bhule	Jangali besar	in cuts and wounds	Stems
54	-	-	Shrub	Bons	-	in tonsillitis	Barks
55	-	Rutaceae	Shrub	-	-	in irregular menstrual period	Roots
56	-	Malvaceae	Tree	-	Singane	in fractures of limbs	Barks
57	-	-	Tree	Byanki	Hadchur	in fractures, wounds, lymphy dots	Barks
58	-	-	Herb	Choti	Banmula	in naval rigidity of oxes	Roots
59	-	-	Climber	Bhedko aauns	-	in wounds and cuts	Roots
60	-	-	Herb	Fudune jhar	-	in pneumonia	Roots
61	-	-	Herb	Lodi	-	in conjunctivitis, and eye diseases	Barks

Photographs of some unidentified species

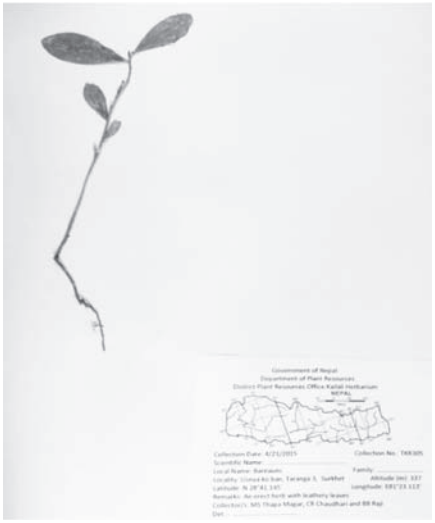


Hadchur

Lodi

Phudune Jhar

Vedko auns



Bareauns

Kalijiri

Screening of Physico – Chemical Parameters and chemical composition of essential oil of Turmeric Leaves (*Curcuma domestica*)

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Abstract

The essential oil from dried leaves of ***Curcuma domestica*** (Zingiberaceae), commonly known as turmeric was isolated by hydro-distillation using clevenger apparatus and the oil percentage was 1.0 %. Specific Gravity, Refractive Index, Optical Rotation, Acid Value, Ester Value were determined and TLC was performed. The GC-MS analysis of the oil showed presence of terpenes, alcohols and some other compounds. The major compounds were Phellanderene (alpha), Terpinolene, Eucalyptol, Limonene, Myrcene, Pinene (alpha), Terpinene (gamma), Cymene (para), Terpinene (alpha), Pinene (beta), , Carene (delta-3), , Ocimene (E-beta), Terpen-4-ol.

Key Words: *Curcuma, leaves, essential oil, physico-chemical properties, chemical composition, GC-MS, TLC*

Introduction

Curcuma domestica (Zingiberaceae) is an annual herb commonly known as turmeric. The plant is indigenous to Bangladesh, Sri Lanka and India and is also widely cultivated in China, Japan, Brazil, Nepal and Thailand. It is selected as **One Village One Product (OVOP)** reference for Sunsari district by Nepal Government along with other twenty two products into different districts.

Essential oils are complex mixtures of secondary plant metabolites which can be obtained from turmeric flowers, barks, roots, leaves, peels, seeds etc.

Physicochemical properties of oil like colour, odour, density, specific gravity, refractive index, optical rotation, acid value, etc indirectly influence the quality of essential oil. The commercial importance of oil mostly depends on these physicochemical properties, which provide baseline data to determine its suitability for consumption.

Turmeric leaf oil has various chemical compounds that include phellandrene, limonene, zingiberene, curcumene, turmerone and cineole.

The ***Curcuma domestica*** can be used for the prevention of Brain tumors, prostate cancer, skin cancer, leukemia, multiple myeloma, metastasis prevention, chemotherapy enhancer, Alzheimer's prevention, eye health, weight loss, natural painkiller & anti-inflammatory, liver health, Parkinson's disease, multiple sclerosis, depression, better sleep, antibacterial. It has long been used as a folk medicine and used to some extent as a digestive aid and in the treatment of fever, infections, dysentery, arthritis and other physiological problems. Some literature reviews showed that the Turmeric leaf oil can be used as biofuel in alternative of petrol.

Materials and Methods

Fresh leaves of ***Curcuma domestica*** were collected from Saptari district located in Eastern Development Region of Nepal in January 2015 and dried in shade for one month. Leaves (5Kg) were hydro distilled in a Clevenger apparatus for six hours. The yield of essential oil was 1.0%. The oil thus obtained was dried over anhydrous sodium sulfate and stored in a sealed glass vial at low temperature prior to analysis.

Physico – Chemical Properties

The values of Physico – Chemical Parameters determined were as follows:

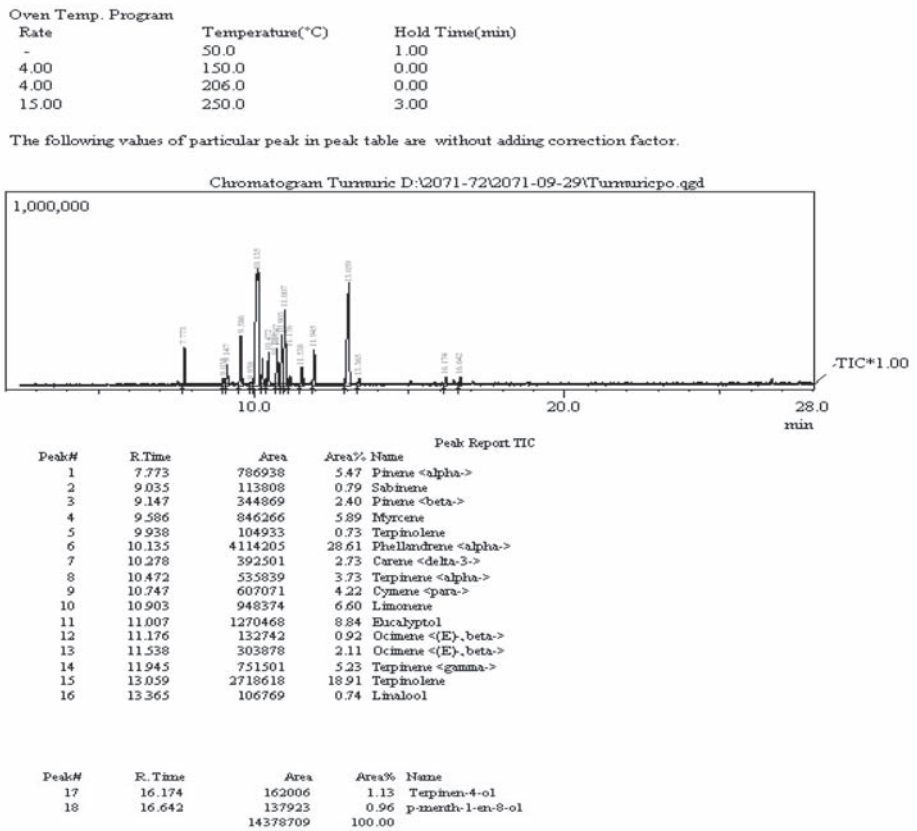
S.N.	Parameters	Results	Methods
1	Colour	Pale Yellow	
2	Odour	Characteristic	
3	Oil Percentage	1.0%	hydro-distillation of dried leaves using Clevenger apparatus, British Pharmacopia, Vol. 11.1988 (Appendix XI E A137E volatile oil in Drug)
4	Specific Gravity	0.8555 at 24.6 ºC	AOAC 19th Edition, 2012 (Vol. II Ch-41, Page 2-3 method no. 985.19
5	Refractive Index	1.476 at 26.8 ºC	ISO 280:1999 (E)
6	Optical Rotation	38.83º at 27.83 ºC	AOAC 19th Edition, 2012 (Vol. II Ch-36, Page 19-20method no. 920.142
7	Acid Value	0.203	ISO 1242:1999 (E)
8	Ester Value	8.8454	British Standard methods of tests for essential oils (1953)

Thin Layer Chromatography (TLC)

TLC was carried out in the solvent system of n-hexane:ethyl acetate (96:4). Anisaldehyde methanolic sulfuric acid (0.5ml Anisaldehyde + 10 ml Glacial acetic acid + 85 ml Methanol+ 5 ml conc. Sulfuric acid) was used as developing reagent and TLC plate was heated in oven at 110 p C for 10 minutes. Six Spots were observed with Rf values 0.11, 0.22, 0.30, 0.58, 0.78 and 0.95.

GC/MS Analysis

The oil obtained from hyrodistillation was injected on a GCMS – QP 2010 Plus (SHIMADZU), Gas Chromatography Mass Spectrometer instrument using a Rtx-5MS column (30m X 0.25mm X 0.25 µm). and with library NIST 11 and FFNCS 1.3. Carrier gas was Helium.



Oven Temp. Program

Rate	Temperature(°C)	Hold Time(min)
-	50.0	1.00
4.00	150.0	0.00
4.00	206.0	0.00
15.00	250.0	3.00

The following values of particular peak in peak table are without adding correction factor.

Peak Report TIC

Peak#	R.Time	Area	Area%	Name
1	7.773	786938	5.47	Pinene <alpha->
2	9.035	113808	0.79	Sabinene
3	9.147	344869	2.40	Pinene <beta->
4	9.586	846266	5.89	Myrcene
5	9.938	104933	0.73	Terpinolene
6	10.135	4114205	28.61	Phellandrene <alpha->
7	10.278	392501	2.73	Carene <delta-3->
8	10.472	535839	3.73	Terpinene <alpha->
9	10.747	607071	4.22	Cymene <para->
10	10.903	948374	6.60	Limonene
11	11.007	1270468	8.84	Eucalyptol
12	11.176	132742	0.92	Ocimene <(E)-,beta->
13	11.538	303878	2.11	Ocimene <(E)-,beta->
14	11.945	751501	5.23	Terpinene <gamma->
15	13.059	2718618	18.91	Terpinolene
16	13.365	106769	0.74	Linalool
17	16.174	162006	1.13	Terpinen-4-ol
18	16.642	137923	0.96	p-menth-1-en-8-ol
		14378709	100.00	

Fig.1: Showing the temp. program, chromatogram and chemical constituents of *Curcuma domestica* oil

Results and Discussion

The oil was obtained by conventional hydro distillation of the leaves of Curcuma domestica in a Clevenger apparatus. The oil percentage obtained was 1.0% on fresh weight basis. Compounds were identified by the GCMS instrument by making comparison with MS-library: Nist-11 and FFNSC 1.3. GC-MS analysis resulted in the identification of following compounds: Phellanderene (alpha) 28.61%, Terpinolene 19.64%, Eucalyptol 8.84%, Limonene 6.60%, Myrcene 5.89%, Pinene (alpha) 5.47%, Terpinene (gamma) 5.23%, Cymene (para) 4.22%, Terpinene (alpha) 3.73%, Pinene (beta) 2.40%, , Carene (delta-3) 2.73%, , Ocimene (E-beta) 3.03%, Terpen-4-ol 1.13%., p-menth-1-en-8-ol 0.96%, Sabinene 0.79% and Linalool 0.74%, in the turmeric leaves oil.

Physico – chemical parameters (Specific Gravity: 0.8555 at 24.6 p C, Refractive Index: 1.476 at 26.8 p C, Optical Rotation: 38.83p at 27.83 p C, Acid Value: 0.203 and Ester Value: 8.8454 were determined.

Conclusion

We conclude that the essential oil of turmeric leaves can be isolated by simple hydrodistillation method and thus the chemical composition and other physio-chemical parameters were studied. . The findings of this study indicate the presence of the major chemical constituents as terpernes, Phellanderene (alpha), Terpinolene, Limonene, Myrcene, Pinene (alpha) and alcohol: Eucalyptol which is also consistent with number of spots obtained in TLC. The TLC performed of the oil can be henceforth used as reference TLC for further analysis.

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References

Guenther E. The Essential Oils. D. Van Nostr and Co., Princeton N.J., 1; 1948. p. 316-8.

Perry LM. Medicinal Plants of East and South East Asia. MIT Press, Cambridge, MA; 1980. p. 439.

Behura S, Srivastava VK. Essential Oils of Leaves of Curcuma Species; 2004. p. 109-10

Anonymous, The Wealth of India; Raw Material, CSIR; New Delhi; 1950.p. 402.

Shah NC. Traditional use of Turmeric (Curcuma longa) in India J Med Arom Plant Sci; 1997. p. 948-95.

Raina VK, Srivastava SK, Jain N, Ahmed A, Syamasundar KV, Agarwal KK. Essentail Oil composition of Curcuma longa L. C.V. Roma from the plains of Northern India. Flavour and Fragr J; 2002. p. 99-102.

Material Safety Data Sheet of Essential Oils from Nepal, GON, DPR, NPRL, Thapathali, Kathmandu, Nepal 2015.

Topographical variation of chemical constituents of Essential Oil of *Rhododendron anthopogon* (sunpati) leaves by Gas Chromatography-Mass Spectrometry

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Abstract

The chemical composition of essential oil of *Rhododendron anthopogon* leaves obtained from hydrodistillation process was investigated by using gas chromatography-mass spectrometry (GC-MS). The chemical constituents in essential oil may vary with soil conditions, altitudes, climatic conditions and other environmental factors. The essential oils obtained from the plant leaves collected from three different places of Nepal were thus analyzed by using GC-MS and compared. It was found that the major chemical constituents present in the oils of the given plant collected from the three different places varied to some extent.

Keywords: essential oil, *Rhododendron anthopogon*, GC-MS analysis, topographical variation.

Introduction

Essential oils are complex mixtures, constituted by terpenoid hydrocarbons, oxygenated terpenes and sesquiterpenes which originated from the plant secondary metabolism and are responsible for characteristic aroma of plant [1]. Essential oils are valuable natural products used as raw materials in many fields such as perfumes, cosmetics, aromatherapy, spices and nutrition [2]. *Rhododendron anthopogon* is an evergreen shrub growing up to an altitude of 4,500 m a.s.l. found in temperate zone of Nepal from east to west. This plant is commonly known as Anthopogon and in Nepal as Sunpati. Due to its aromatic properties, it is widely used as incense. Furthermore, Himalayan healer (or Amchi) uses its leaves and fresh flowers as tea for drinking to promote digestive heat, stimulate appetite and to relieve liver disorders. *R. anthopogon* is also used for sore throat, common cold and lung problems [3]. The essential oil of *R. anthopogon* known as anthopogon oil or sunpati oil (in Nepal) is commonly obtained by steam distillation of its aerial parts and is a good natural source of a faintly balsamic essence. Anthopogon oil can be used on the skin and hair [3]. According to Himalayan aromatherapy, this oil stimulates the nervous system and has been used for treating sore muscles and gouty rheumatic conditions [3]. The major components of the aerial parts of the oil are the monoterpenes á-pinene, â-pinene, limonene and the sesquiterpene ä-cadinene [2]. By far the research conducted on major chemical constituents of an essential oil have shown that the several factors such as nutrients, environmental conditions, extraction processes, drying methods, soil conditions, climatic conditions, etc. affects the components in essential oils [4-8].

The development of gas chromatographic technique has facilitated the separation of volatile components in essential oil and mass spectrometry detector has provided a means to identify chemical compounds. Thus, in recent years a hyphenated system, GC-MS in which gas chromatography is coupled with mass spectrometry detector would initially separates a volatile organic mixture into its components by chromatography which are then further identified tentatively by mass spectrometry using a MS library.

Experimental Methods and Materials

a) Plant sample collection

Fresh leaves of *R. anthopogon* were collected from three different places of Nepal located at different

altitude in the same season. These plant samples were collected from Lauribina of Gosaikunda area, central region of Nepal, Jiri of Dolakha District, central region and Papung of Talpejung district, eastern region of Nepal located at an altitude of about 4300m, 3700m and 2000m a.s.l. respectively. These plant samples were then identified at Natural Products Research Laboratory (NPRL), Kathmandu and were left to dry in shade for some weeks.

b) Extraction of essential oil from leaves

100gm leaves of each sample of *R. anthopogon* collected from the three different places were subjected to the hydrodistillation process using Clevenger apparatus to extraction the essential oil for about 5 hours. The percentage of essential oils i.e. oil % obtained from each 100gm sample was also noted. The oils from each three places thus obtained were separated from the hydrosol, tagged and then stored at 4 ^{0}C for further analysis.

c) Analysis of essential oil samples by GC-MS

The chemical constituents in the essential oils were separated using a Shimadzu gas chromatography (GC 2010) with Rtx-5MS column (25m×0.25mm×0.25µm). 0.5 µL of undiluted essential oil was injected into the GC inlet maintaining column flow rate of 0.8 mL/min and purge flow 3 mL/min after fixing the split ratio at 90.0. The initial column oven temperature was set at 50.0°C and the injection temperature was 180°C.

Fig 1: Shimadzu GCMS-QP2010 Plus available at DPR

Table 1: Oven Temperature Program.

Rate	Temperature (°C)	Hold Time (min)
-	50.0	1.00
9.00	150.0	0.00
9.00	206.0	0.00
15.00	250.0	3.00

GCMS analysis for the qualification of the essential oil was carried out in a Shimadzu GCMS-QP2010 Plus. During the analysis, the ion source temperature and the interface temperature was set at 200°C and 250°C respectively. The detector scanning start time was 4.10 min and end time was 24.00 min; scan speed was 2500 with scanning range of m/z 40.00-1090.00. The MS library used in the analysis process was NIST 11, FFNSC 1.3.

Results and Discussion

R. anthopogon belongs to the Ericaceae family. Altogether 3 samples of the plant under study were collected from three different places of Nepal.

The oil percentages of *R. anthopogon* leaves obtained during hydrodistillation are tabulated below in Table 2.

Table 2: Oil % of Sunpati leaves samples of three different places.

S. No.	Sample collected from	Oil percentage
1	Gosaikunda	0.5
2	Dolakha	0.5
3	Taplejung	0.4

The chromatograms obtained for each of the oil sample are shown below:

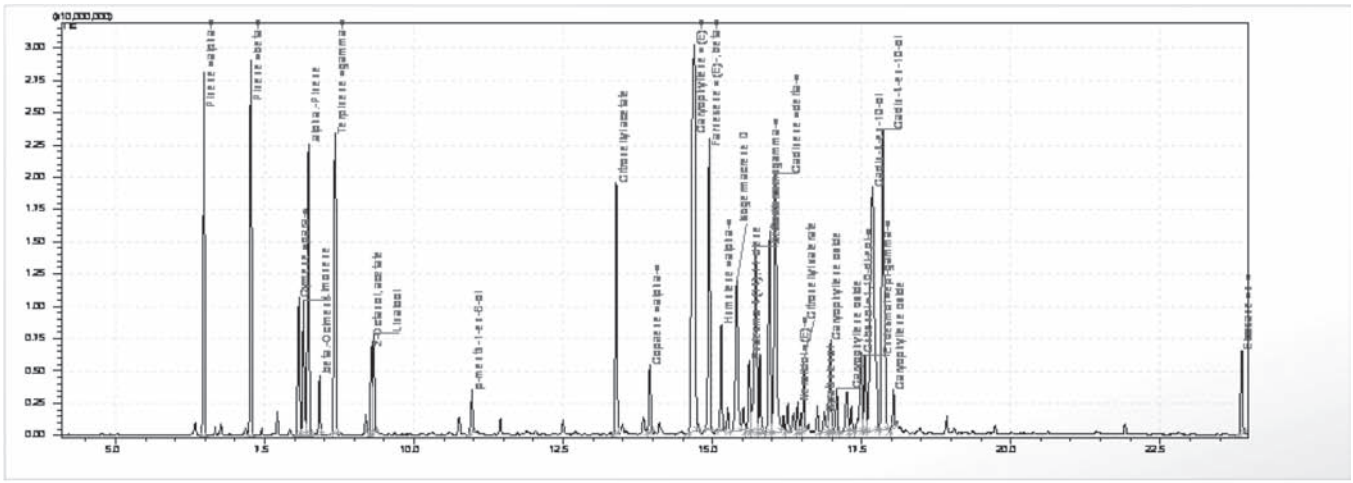

Fig 2: Chromatogram of anthopogon oil from Gosaikunda

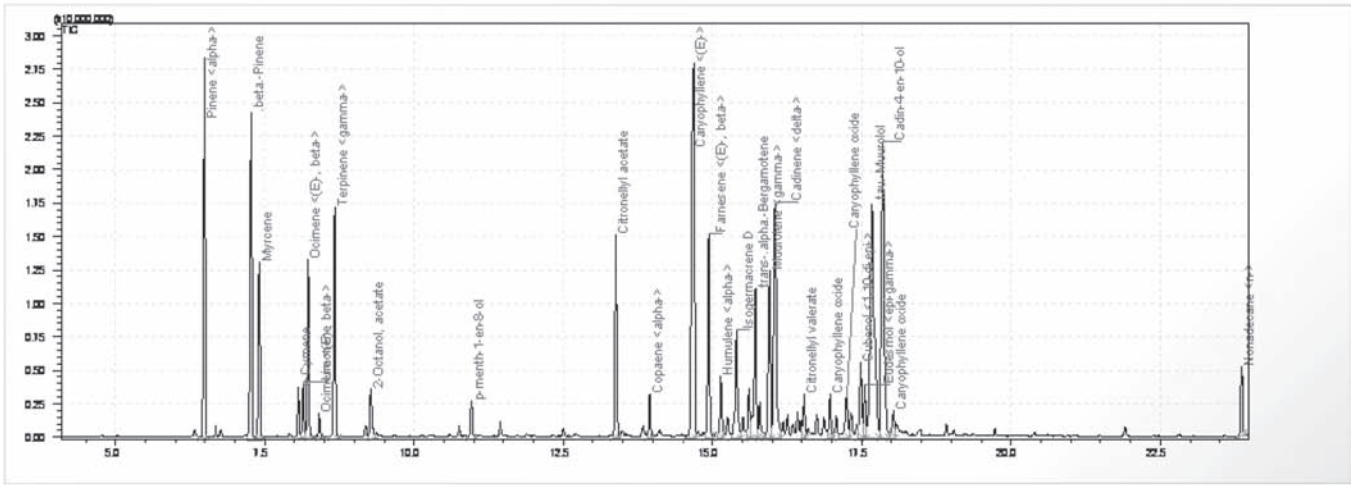

Fig 3: Chromatogram of anthopogon oil from Dolakha

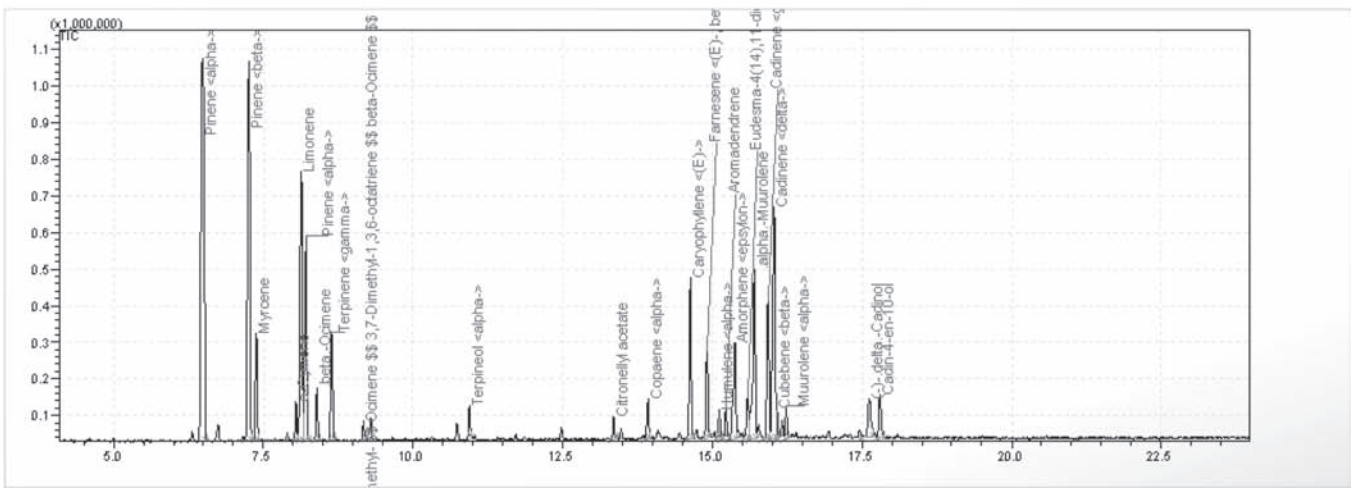

Fig 4: Chromatogram of anthopogon oil from Taplejung

Table 3: Chemical composition of essential oils of *R. anthopogon* leaves collected from three different places of Nepal

S. No.	Chemical Constituents	Oil from Gosaikunda	Oil from Dolakha	Oil from Taplejung	Remarks
1	Pinene <alpha->	10.00	7.48	26.10	Compounds were identified with the help of MS. The numerical values of the constituents are the relative peak area % in chromatogram without considering correction factors. The relative peak area % corresponds to the composition % of the constituents present in the oil.
2	Pinene <beta->	5.23	7.36	13.59	
3	Cymene <para->	2.06	-	-	
4	Limonene	2.09	1.13	9.03	
5	beta Ocimene	0.82	4.04	1.89	
6	Terpinene <gamma->	5.25	4.98	3.08	
7	2-Octanol, acetate	1.21	1.16	-	
8	Lilanool	1.38	-	1.37	
9	p-Menth-1-en-8-ol	0.65	0.94	-	
10	Citronellyl acetate	4.14	3.88	0.59	
11	Copaene <alpha->	0.95	0.90	1.02	
12	Caryophyllene <(E)->	12.52	11.55	4.97	
13	Farnesene <(E)-, beta->	5.2	4.39	2.37	
14	Humulene <alpha->	1.63	1.25	0.80	
15	Isogermacrene D	3.27	3.94	-	
16	Eudesma-4(14),11-diene	1.26	-	1.44	
17	Amorphene <alpha->	3.84	-	-	
18	beta –Curcumene	1.17	-	-	
19	Cadinene <gamma->	3.59	-	4.22	
20	Cadinene <delta->	6.34	6.61	9.50	
21	alpha-Muurolene	0.42	-	7.88	
22	Nerlidol <(E)->	0.43	-	-	
23	Citronellyl valerate	0.94	0.83	-	
24	Spathulenol	0.50	-	-	
25	Caryophyllene oxide	3.01	3.14	-	
26	Epiglobulol	0.73	-	4.22	
27	Cubenol	0.41	-	-	
28	Cubenol <1,10-di-epi->	1.71	1.72	-	
29	Eudesmol <epi-gamma->	1.25	1.11	-	
30	Cadin-4-en-10-ol	16.59	8.63	1.37	
31	Eicosane <n->	1.35	-	-	
32	Mycerene	-	3.23	2.82	
33	o-Cymene	-	1.07	1.07	
34	trans-alpha-Bergamotene	-	4.73	-	
35	tau-Muurolol	-	10.79	-	
36	Nonadecane <n->	-	1.34	-	
37	Aromadendrene	-	-	1.01	
38	Amorphene <epsylon->	-	-	3.98	
39	Cubene <beta->	-	-	0.51	
40	(-)-delta-Cadinol	-	-	1.84	

The above table shows the major components in the anthopogon oil are:

- Pinene <alpha->
- Pinene <beta->
- Limonene
- Terpinene <gamma->
- Citronellyl acetate
- Caryophyllene <(E)->
- Farnesene <(E)-, beta->
- Isogermacrene D
- Cadinene <gamma->
- Cadinene <delta->
- Cadin-4-en-10-ol
- Myrcene

Here, some major chemical constituents have more or less similar composition % in all the oil samples collected from the three different places. Except, in the oil sample from Taplejunj which contain

pinene<alpha->, pinene<beta-> and limonene with higher % but citronellyl acetate, caryophyllene<(E)->, farnesene<(E)-,beta-> and isogermacrene D have lower % compared to the oils from Gosaikunda and Dolakha. Further some chemical components present in the oil from Gosaikunda are absent in the oils from Dolakha and Taplejung, but it lacks the major component myrcene. The high % constituents: beta-ocimene, trans-alpha-bergamotene and tau-muurolol present in oil from Dolakha are almost absent in the oils from Gosaikunda and Taplejung. Similarly, alpha-muurolene, epiglobulol and amorphene <epsylon-> that have high % in the oil from Taplejung are almost absent in the oils from Gosaikunda and Dolakha.

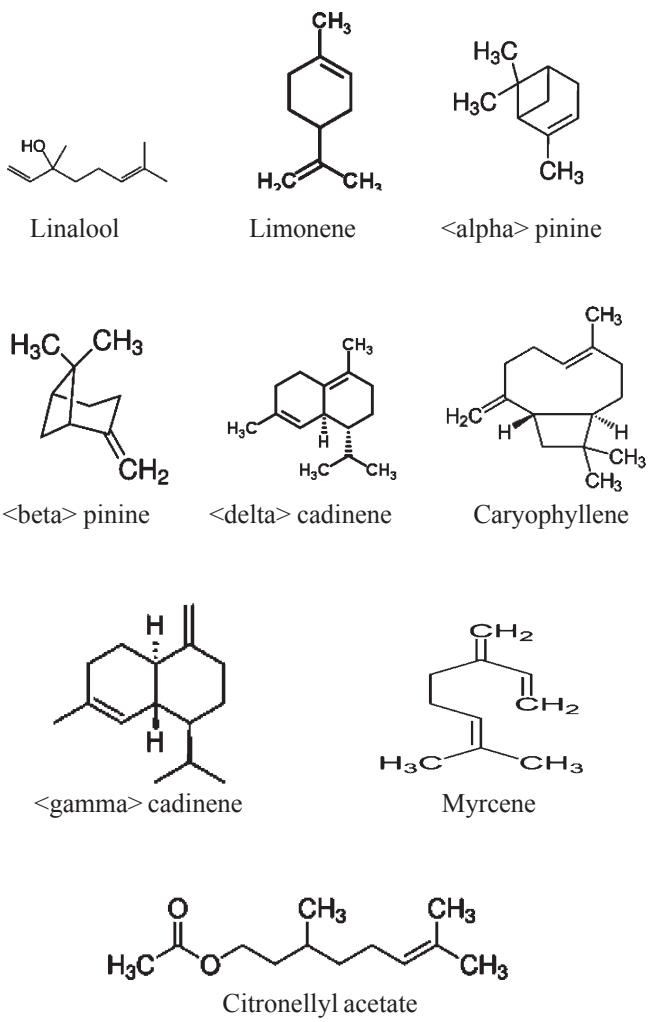

Fig 5: Showing some chemical structures of *R. anthopogon oil*

Conclusion

The present study shows that Oil % is slightly high in plant samples collected from Gosaikunda and Dolakha than from Taplejung. The major chemical constituents of the oils under study were Pinene<alpha->, Pinene<beta->, Limonene, Terpinene<gamma->, Citronellyl acetate, Caryophyllene<(E)->, Farnesene<(E)-,beta->, Isogermacrene D, Cadinene<gamma->, Cadinene<delta-> and Myrcene.

Further, the variation in chemical composition in oil samples of different places indicates that topography is one of the major factors affecting the chemical constituents of the essential oil of *Rhododendron anthopogon* (sunpati). These topographical differences can be considered to be the differences in soil conditions and altitudes, however since the sample collection were carried out in the same season and of random plants the climatic conditions and other factors are not studied. Thus, we can finally conclude the chemical constituents of essential oil of *Rhododendron anthopogon* vary due to the topographical variation.

Acknowledgements

The authors are highly obliged to Mr. Yam Bahadur Thapa (Former Director General, DPR) and Mrs. Sushma Upadhyaya (Deputy Director General, DPR), for providing us with the necessary laboratory facilities and resources. We would like to express our sincere thanks to Mr. Tara Datta Bhatta (Head of instrument section, DPR) and Mrs. Jyoti Joshi (Chief, NPRL) for their constructive suggestions and encouragement. And we would also like to acknowledge the entire family member of Department of Plant Resources, Thapathali, for their unflinching help and support.

References

Chamorro, E. R., Zambón, S. N., Morales, W. G., Sequeira, A. F., and Velasco, G. A., (2012). Study of the Chemical Composition of Essential Oils by Gas Chromatography, in *Gas Chromatography*

in Plant Science, Wine Technology, Toxicology and Some Specific Applications, Dr. Bekir Salih (Ed.), ISBN: 978-953-51-0127-7, InTech, DOI: 10.5772/33201.

Innocenti, G., Dall'Acqua, S., Scialino, G., Banfi, E., Sosa, S., Gurung, K., Barbera, M., and Carrara, M. (2010). Chemical Composition and Biological Properties of *Rhododendron anthopogon* Essential Oil. *Molecules*, 15: 2326-2338.

Siwakoti, M. (2008). Medicinal and edible plants in wetlands of Nepal. In *Medicinal Plants in Nepal: An Anthology of Contemporary Research*; Jha, P.K., Karmacharya, S.B., Chettri, M.K., Thapa, C.B., Shrestha, B.B., Eds.; Ecological Society (ECOS): Kathmandu, Nepal: 131–139.

Yamaura, T., Tanaka, S., and Tobana, M. (1989). Light Dependent Formation of Glandular Trichomes and Monoterpenes in Thyme Seedlings. *Phytochemistry*, 28: 741-744.

Rajeswara, R., Bhaskaruni, R., and Kakaraparthi, P. S. (1990). Variation in Yields and Quality of Geranium, under varied Climatic and Fertility Conditions. *J. Ess. Oil Res.*, 2: 73-79.

Mejdoub, R. and Katsiotis, S. T. (1998). Factors influencing the yield and the quality of the obtaining essential oil from leaves of *Eucalyptus citriodora* Hook. growing in Crete. *Scientica pharmaceutica*, 66: 93-105.

Aminzadeh, M., Amiri, F., Abadi, E. A., Mahdevi, K., and Fadai, Sh. (2010). Factors Affecting on Essential Chemical Composition of *Thymus kotschyanus* in Iran. *World Applied Sciences Journal,* 8(7): 847-856.

Pradhan, R., and Paudel, K. (2015). Seasonal variation of the essential oil of *Nardostachys grandiflora* DC. *Bulletin of Department of Plant Resources,* 36: 76-79.

Screening of the Physico – Chemical Parameters and chemical composition of essential oil of Citronella (*Cymbopogon winterianus* Jowitt)

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Abstract

The essential oil of fresh leaves of Citronella (*Cymbopogon winterianus Jowitt*) was isolated by hydro-distillation method using clevenger apparatus and the oil percentage was 1.4 %. Specific Gravity, Refractive Index, Optical Rotation, Acid Value and Ester Value were determined and TLC was performed. In total, fifteen compounds were identified by GCMS analysis and some of these major compounds were Nerol , Neral , Nerol acetate, Cetronellol, Cetronellal.

Key Words: *Citronella, Fresh leaves, essential oil, physico-chemical parameters, chemical composition, GC-MS, TLC*

Introduction

Citronella (***Cymbopogon winterianus Jowitt***) is an aromatic grass belonging to the family Poaceae which gives essential oils upon steam distillation. It is a perennial herb which forms one-meter-high compact and strong clumps, with extensive use in popular medicine. This is used extensively as a source of perfumery, soap, cosmetic and flavoring industry throughout the world. It is used as antimycotic, acaricide and repellent against a variety of insects. Traditionally used for the treatment of fever, intestinal parasites and digestive problems. It can be used as massage oil for aching joints and muscles. The essential oils are natural products that exhibit a variety of biological properties, such as analgesic anticonvulsant and anxiolytic.

Materials and Methods

Fresh leaves of ***Citronella*** were collected from Dhanusha district located in Western Development Region of Nepal in May 2015. Collected fresh leaves were hydro distilled in a Clevenger apparatus for six hours. The yield of essential oil was 1.4%. The oil thus obtained was dried over anhydrous sodium sulphate and stored in a sealed glass vial at low temperature prior to analysis.

Physico – Chemical Parameters

The Physico – Chemical Parameters determined were as follows:

S.N.	Parameters	Results	Methods
1	Colour	Light Yellow	
2	Odour	Characteristic	
3	Oil Percentage	1.4%	hydro-distillation of dried leaves using Clevenger apparatus, British Pharmacopia, Vol. 11.1988 (Appendix XI E A137E volatile oil in Drug)
4	Specific Gravity	0.9453 at 24.6 ^{o}C	AOAC 19th Edition, 2012 (Vol. II Ch-41, Page 2-3 method no. 985.19
5	Refractive Index	1.471 at 26.8^{o}C	ISO 280:1999 (E)
6	Optical Rotation	-1.16^{o} at 28.2^{o}C	AOAC 19th Edition, 2012 (Vol. II Ch-36, Page 19-20method no. 920.142
7	Acid Value	1.873	ISO 1242:1999 (E)
8	Ester Value	17.70	British Standard methods of tests for essential oils (1953)

Thin Layer Chromatography (TLC)

TLC was carried out in the solvent system of n-hexane:ethyl acetate (96:4). Anisaldehyde methanolic sulfuric acid (0.5ml Anisaldehyde + 10 ml Glacial acetic acid + 85 ml Methanol+ 5 ml conc. Sulfuric acid) was used as developing reagent and TLC plate was heated in oven at 110 p C for 10 minutes. Four spots were observed with RF values of 0.17, 0.46, 0.61, and 0.84.

GC/MS Analysis

The oil obtained from hyrodistillation was injected on a GCMS – QP 2010 Plus (SHIMADZU), Gas Chromatography Mass Spectrometer instrument using a Rtx-5MS column (30m X 0.25mm X 0.25 µm) and with library NIST 11 and FFNCS 1.3 . Carrier gas was Helium.

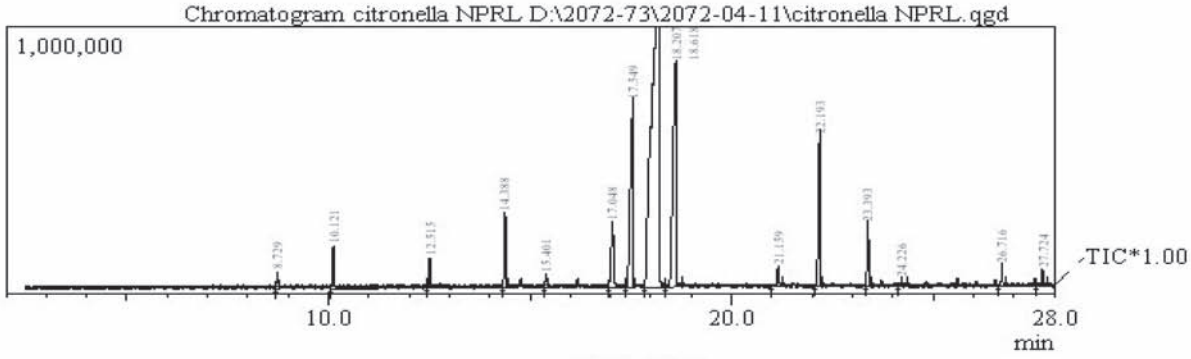
Results and Discussion

The oil was obtained by conventional hydro distillation of fresh leaves of Citronella in a Clevenger apparatus. The oil percentage obtained was 1.4% on fresh weight basis. During GC-MS analysis, compounds were identified by using MS-library: Nist-11 and FFNSC 1.3. GC-MS analysis of Citronella oil resulted in the identification of following compounds: Nerol (52.97%), Neral (27.43%), Nerol acetate (6.34%) and Cetronellol (3.80%), Cetronellal (2.57%), Cyclohexene, 1-methyl-4-(1-methylethenyl)-(s) (1.82%) , Linalool (1.02%), Citronellyl acetate (0.74%), trans-z, alpha-Bisabolene epoxide (0.60%), Isogeranial (0.55%), Hept-5-en-2-oneÂ6 methylÃ (0.53%), Alpha-Cadinol (0.40%).

Oven Temp. Program

Rate	Temperature(°C)	Hold Time(min)
-	50.0	0.00
4.00	140.0	0.00
11.00	206.0	0.00
14.00	250.0	9.00

The following values of particular peak in peak table are without adding correction factor.



Peak Report TIC

Peak#	R.Time	Area	Area%	Name
1	8.729	156387	0.53	Hept-5-en-2-one <6-methyl->
2	10.121	533427	1.82	Cyclohexene, 1-methyl-4-(1-methylethenyl)-, (S)-
3	12.515	299791	1.02	Linalool
4	14.388	751741	2.57	Citronellal
5	15.401	160667	0.55	Isogeranial
6	17.048	1113665	3.80	Citronellol
7	17.549	3323340	11.35	Neral
8	18.207	15128710	51.67	Nerol
9	18.618	4708703	16.08	2,6-Octadienal, 3,7-dimethyl-, (Z)- $$ .beta.-Citral $$ cis-Citral $$ cis-3,7-Dimethyl-2,6-octad
10	21.159	215850	0.74	Citronellyl acetate
11	22.193	1856922	6.34	2,6-Octadien-1-ol, 3,7-dimethyl-, acetate, (Z)-
12	23.393	636772	2.17	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-,[1R-(1R*,4Z,9S*)]-
13	24.226	101238	0.35	Humulene
14	26.716	176210	0.60	trans-Z-.alpha.-Bisabolene epoxide
15	27.724	118582	0.40	.alpha.-Cadinol
		29282005	100.00	

Fig. 1: Showing the temp. program, chromatogram and chemical constituents of citronella oil

Physico – chemical parameters (Specific Gravity: 0.9453 at 24.6 p C, Refractive Index: 1.471 at 26.8 p C, Optical Rotation: -1.16p at 28.2 p C, Acid Value: 1.873 and Ester Value: 17.70) were determined.

Conclusion

We conclude that the essential oil of citronella leaves can be isolated by simple hydrodistillation method and thus the chemical composition and other physio-chemical parameters were studied. The findings of this study indicate the presence of the major chemical constituents as Nerol , Neral, Nerol acetate and Cetronellol, Cetronellal. The TLC performed of the oil can be henceforth used as reference TLC for further analysis.

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References

Rajeswara Rao, B.R., Bhattacharya, A.K., Sukhamal Chand and Kaul P.N. 1993. Cultural chemical methods of weed control foe citronella Java (Cymbopogon winterianus Jowitt). Indian Perfumer 37: 270-274.

Kaul, P.N., Bhattacharya, A.K., and Rajeshwara Rao B.R. 1997. Chemical composition of the essential oil of Java Citronella (Cymbopogon winterianus Jowitt) grown in Andhra Pradesh. PAFAI J. 19: 29-33.

Guenther, E., 1950. In: Guenther, E. (Ed.), Essential oils. Van Nostrand Co., Inc, London.

Singh, K., Chowdhury, A., Singh, D.V. 1996. Effect of diuron and nitrogen weed growth, oil, yield and N utilization in citronella.

Adams RP, 2007. Identification of essential oil components by gas chromatograpy/mass spectroscopy, 4th Edition. Illinois USA: Allured Publishing Corporation, Carol Stream, Ill, p. 804.

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Antifungal activity of *Lantana camara* L. leaves extract against plant pathogenic fungi

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Abstract

In-vitro studies were carried out to determine the antifungal activity of methanolic extract of leaves of *Lantana camara* L. against *Bipolaris sorokiniana* (Sacc.) Shoemaker, *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc., *Fusarium oxysporum* Schltdl., *Rhizoctonia solani* J.G. Kühn and *Verticillium alboatrum* Reinke and Berthold by poisoned food technique. The results revealed that methanolic extract of leaves of *L. camara* had strong antifungal activity with significant inhibition on the growth of *B. sorokiniana* and *V. alboatrum*.

Keywords: *Lantana camara* extract, antifungal activity, poisoned food technique

Introduction

Application of synthetic fungicides has been the primary means for management of crop diseases. However, apart from their high costs, their residues pose potential health hazards and environmental contamination (Okinbo and Osuinde, 2003). Besides, frequent application of fungicides could lead to the development of resistance in pathogen populations (Kumar *et al.*, 2007). Thus, substantial use of chemical pesticides induces problems of health and environmental hazards in agricultural system. Therefore, it is important to find a practical, cost effective and non-toxic method to manage plant diseases. So, for human and plants, natural products of antimicrobial activity are best biorational alternatives today (Tiwari *et al.*, 2007).

Biologically active substances have been reported to be present in various green plants. Plant derived substances have recently become of great interest owing to their versatile applications (Baris *et al.*, 2006). The substances of plant origin have very high potential as pesticides. These substances can not only be easily procured from profusely available plants, but also have an additional advantage of being biodegradable and non-pollutant. Active constituents of the medicinal and aromatic plants have been found to be less phytotoxic, more systemic and easily biodegradable (Fawcett and Spencer, 1970).

Lantana camara L. is a perennial shrub belonging to family Verbenaceae. Due to its resilient nature, the plant is widely distributed in the pantropic. It is a problem weed dominating native species and disrupting biodiversity (Priyansha and Joshi, 2013). It is among top ten invasive weeds on the earth (Sharma *et al.*, 2005). Hence, strategies should be developed to optimize the usefulness of this plant. It has several uses, mainly as herbal medicine and in some areas as firewood and mulch (Sharma *et al.*, 1988; Sharma *et al.*, 1999; Day *et al.*, 2003). This plant, besides being easily available, possesses non-phytotoxic compounds that are found to exhibit inhibitory effect on pathogens (Vaidya and Bhattarai, 2009). It has also shown strong insecticidal and antimicrobial activity in numerous experiments. Storing potatoes with lantana leaves nearly eliminates the damage caused by *Phthorimaea operculella* Zeller, the potato tuber moth (Lal, 1987). It has been proven to be rich in verbascosides which have strong antifungal properties (Oyourou *et al.*, 2013). Lantana fixed extracts and essential oils have been shown to be effective against plant pathogens and storage fungi such as *Alternaria* spp. (Srivastava and Singh, 2011), wood rot fungi (Tripathi *et al.*, 2009), *Penicillium digitatum* (Pers.) Sacc. (Oyourou *et al.*, 2013), *Mucor* spp. and *Fusarium solani* (Mart.) Sacc. (Rizvi *et al.*, 2013), *Aspergillus niger* Tiegh., *Penicillium funiculosum* Thom, *Rhizomucor*

auricus and *Trichoderma reesi* (Dharmagadda *et al*., 2005) etc.

There is a large demand for new fungicides for use in food protection, agriculture and medicine. In recent years there has been a growing trend to evaluate the antimicrobial activity of the extracts and isolates of medicinal plants, because of resistance developed by pathogens, gross side effects of synthetic drugs due to indiscriminate use and their expensive treatment regimen (Nychas, 1995; Tauxe, 1997; Cowan, 1999; Smid and Gorris, 1999; Sheriff, 2001; Tomoko *et al.*, 2002). Hence, this research was conducted to identify environmentally feasible alternatives to synthetic fungicides for crop protection.

Material and Methods

Collection of plant materials

L. camara plants were collected from Sankhamul, Lalitpur in the month of May 2015. After collection, leaves were separated, washed with water and shade dried for 15 days. Then they were powdered in a grinder.

Preparation of methanolic extract

The 50 g of powdered leaves were macerated with 300 ml of 80 % methanol in a dropping funnel for three days. The extract was collected and the residue was macerated again with 50 ml of 80% methanol for 24 hours. The process was repeated twice. The liquid extract was air dried for one month till thick consistency was obtained.

Fungal isolates

Antifungal activity of the *L. camara* extract was evaluated against five species of fungal plant pathogens obtained from Biological Section, Department of Plant Resources. These pathogens had been isolated from different parts of *Swertia chirayita* (Roxb. ex Fleming) Karsten exhibiting various disease symptoms (Table 1).

Evaluation of antifungal activity by poisoned food technique

Antifungal activity of the *L. camara* extract was determined by poisoned food technique (Das *et al.*, 2010). Sabouraud Dextrose Agar (SDA) poisoned with *Lantana* extract of 5% strength was prepared by dissolving 5 parts extract to 95 parts of SDA followed by thorough stirring for uniform dissolution. Control medium was prepared by adding distilled water instead of *L. camara* extract in the same ratio. The media were then sterilized at 121ºC at 15 psi pressure for 15 minutes. SDA plates were prepared by pouring 15 ml of the sterilized medium into each petri-plate. With a sterile 6 mm cork borer, discs were cut from the growing edge of seven-day-old cultures of each of the five fungal species and each disc was placed at the center of an SDA plate. Each treatment was done in triplicate. The inoculated plates were incubated at 25±2°C for seven days. The diameters of the fungal colonies (linear growth) were measured on second, fifth and seventh day.

The fungitoxicity of the extract in terms of percentage inhibition of mycelial growth was calculated using the following formula:

$$\text{Percent inhibition} = \frac{C - T}{C} \times 100$$

where,

C = Average diameter of mycelial growth in control plate

T = Average diameter of mycelial growth in treatment plate.

Table 1: Fungal species used for the screening of antifungal activity

S.no.	Fungal species	Isolate designation	Source part of *S. chirayita*
1	*Bipolaris sorokiniana* (Sacc.) Shoemaker	Sc-Ila1-8-Le	Leaf
2	*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.	Sc-Ila2-11-Le	Leaf
3	*Fusarium oxysporum* Schltdl.	Sc-Ila1-1-Ro	Root
4	*Rhizoctonia solani* J.G. Kühn	Sc-Ila1-5-St	Stem
5	*Verticillium alboatrum* Reinke & Berthold	Sc-Ila1-1-Ro	Root

Statistical analysis

All the tests were conducted in triplicates and observations were expressed as mean ± standard error (SE). The linear growths (colony diameters) of the test fungi in poisoned medium and control condition were compared by paired-samples t test. The percent inhibitions of the fungal growths of the test fungi by the *L. camara* extract were compared by Tukey's HSD test.

Result and Discussion

In the present study, antifungal activity of methanol extract of *L. camara* against five different fungal species was studied by poisoned food technique (Table 2 and 3, Figure 1).

The comparison of the colony diameter of different test fungi grown in *L. camara*-extract-poisoned medium and in control condition showed that the linear growths of *B. sorokiniana*, *F. oxysporum* and *V. alboatrum* in poisoned medium was significantly different in comparison to their growths in control condition on second, fifth as well as seventh days. However, linear growth of *C. gloeosporoides* was not affected significantly. In case of *R. solani*, the growth on treated and control conditions differed significantly on second day. The fifth and seventh day observations for *R. solani* could not be compared since the diameter of colonies formed under both treated and control conditions had exceeded the petridish diameter (9 cm) (Table 2).

On comparing percentage inhibition of the five test species of fungi by *L. camara* extract, it was found that, on second day, *R. solani* growth was best inhibited followed by *B. sorokiniana* and *V. alboatrum*, while *F. solani* was least inhibited. Similarly on fifth day, *B. sorokiniana* was found to be most inhibited followed by *V. alboatrum* and *F. oxysporum*. Similar trend was also observed on seventh day (Plates 1a to 1e). However, negative inhibition was observed in case of *C. gloeosporoides* on second and fifth day i.e. its growth was promoted by *L. camara* extract (Table 3 and Figure 1)

Fungitoxic effects of fixed extracts of *L. camara* has been reported against several fungal plant pathogens. Naz and Bano (2013) evaluated antimicrobial potential of extracts of *L. camara* in different

Table 2: Comparison of colony growth fungi in poisoned media and control condition

S.no.	Fungi	Mean colony diameter±SE (cm)		Sig. (2-tailed)*	Difference at 5% level of significance
		Poisoned medium	Control		
1	*Bipolaris sorokiniana* (Sacc.) Shoemaker on day 2	1.85 ± .03	2.60 ± .03	.006	significantly different
2	*B. sorokiniana* on day 5	3.15 ± .03	5.95 ± .03	.000	significantly different
3	*B. sorokiniana* on day 7	4.00 ± .05	7.85 ± .03	.000	significantly different
4	*Colletotrichum gloeosporioides (Penz.)* Penz. & Sacc. on day 2	1.63 ± .07	1.48 ± .03	.188	not significantly different
5	*C. gloeosporiodes* on day 5	3.37 ± .07	3.25 ± .03	.250	not significantly different
6	*C. gloeosporiodes* on day 7	4.60 ± .05	4.65 ± .03	.478	not significantly different
7	*Fusarium oxysporum* Schltdl. on day 2	1.70 ± .05	2.02 ± .02	.019	significantly different
8	*F. oxysporum* on day 5	4.83 ± .04	5.55 ± .06	.004	significantly different
9	*F. oxysporum* on day 7	6.93 ± .02	7.75 ± .03	.002	significantly different
10	*Rhizoctonia solani* J.G. Kühn on day 2	2.78 ± .38	7.47 ± .02	.006	significantly different
11	*R. solani on day 5*	9.00 ± .00	9.00 ± .00	could not be interpreted	colony diameter exceeding petridish diameter
12	*R. solani on day 7*	9.00 ± .00	9.00 ± .00		
13	*Verticillium alboatrum* Reinke & Berthold on Day 2	1.55 ± .10	2.12 ± .02	.021	significantly different
14	*V. alboatrum* on Day 5	4.52 ± .03	5.57 ± .02	.002	significantly different
15	*V. alboatrum* on Day 7	6.32 ± .07	7.58 ± .04	.007	significantly different

*** sig. value generated by paired sample T test**

Table 3: Percent of inhibition shown by leaves of 80% methanolic extract of *Lantana camara* L. against five different plant pathogenic fungi

S.no.	Fungus species	Percentage inhibition ± SE*		
		on 2nd day	on 5th day	on 7th day
1	*Bipolaris sorokiniana* (Sacc.) Shoemaker	28.85 ± 1.11^{c}	47.06 ± 0.49^{d}	49.04 ± 0.64^{d}
2	*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.	-10.11 ± 4.90^{a}	-3.59 ± 2.05^{a}	1.08 ± 1.08^{a}
3	*Fusarium oxysporum* Schltdl.	15.70 ± 2.48^{bc}	12.91 ± 0.79^{b}	10.54 ± 0.22^{b}
4	*Rhizoctonia solani* J.G. Kühn	62.72 ± 5.13^{d}	COULD NOT BE COMPARED	
5	*Verticillium alboatrum* Reinke & Berthold	26.77 ± 4.72^{c}	18.86 ± 0.60^{c}	16.70 ± 0.88^{c}
6	Control treatment	0.00 ± 0.00^{ab}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}

*Grouping on the basis of Tukey's HSD at 5% level of significance. In columns, the means followed by the same letters are not significantly different (P=0.05)

solvents and concluded that the methanolic leaf extract exhibited significant inhibition against *Aspergillus flavus* Link and *Aspergillus fumigatus* Fresen. Srivastava and Singh (2011) have reported significant antifungal activity of *L. camara* extracts against *Alternaria* sp. Tripathi *et al*. (2009) demonstrated efficient antifungal activity of ethanol and hot water extract of this plant against wood destroying white and brown rot fungi. Sharma and Kumar (2009) have suggested that *L. camara* extracts can be used to manage *Fusarium oxysporum* Schltdl., an important destructive soil borne pathogen. Sailaja (2014) has reported prominent antifungal activity of *L. camara* extracts against *Aspergillus niger* Tiegh. and *Candida albicans* (C.P. Robin) Berkhout.

Conclusion

The results obtained from this study indicate that methanolic extract of *L. camara* has strong antifungal activity against two fungal pathogens viz. *B. sorokiniana* and *V. alboatrum*. The extract also showed moderate antifungal activity against *F. oxysporum*. Hence, it can be concluded that highly effective ecofriendly fungicidal agents can be developed by optimizing the extraction and separation procedure of *L. camara* extracts.

Acknowledgment

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References

Baris, O., Gulluce, M., Sahin, F., Ozer, H., Kilic, H., Ozkan, H., Sokmen, M. and Ozbek, T. 2006. Biological activities of the essential oil and methanol extract of *Achillea biebersteinii* Afan. (Asteraceae). *Turk. J. Biol.*, 30: 65-73.

Cowan, M.M. 1999. Plants products as antimicrobial agents. *Clin. Microbial. Rev.*, 12: 564-582.

Das, K., Tiwari, R. K. S. and Shrivastava, D.K. 2010. Techniques for evaluation of medicinal plant products as antimicrobial -: current methods and future trends. *Journal of Medicinal Plants Research*, 4(2): 104-111.

Day, M.D., Wiley, C.J., Playford, J. and Zalucki, M.P. 2003. *Lantana: Current Management Status and Future Prospects*, pp 20-25. Australian Centre for International Agricultural Research, Canberra, Australia.

Dharmagadda, V.S.S., Tandon, M. and Vasudevan, P. 2005. Biocidal activity of the essential oil of *Lantana camara*, *Ocimum sanctum* and *Tagetes patula*. *Journal of Scientific & Industrial Research*, 64: 53-56.

Fawcett, C.H. and Spencer, D.H. 1970. Plant chemotherapy with natural products. *Ann. Rev. Phytopath.*, 8: 403-418.

Kumar, A.S., Reddy, N.P., Reddy, K.H. and Devi, M.C. 2007. Evaluation of fungicidal resistance

among *Colletotrichum gloeosporioides* isolates causing mango anthracnose in Agri-export zone of Andhra Pradesh, India. *Plant Pathology*, 16: 157-160.

Lal, L. 1987. Studies on natural repellents against potato tuber moth (*Phthorimaea operculella* Zeller) in country stores. *Potato Research*, 30(2): 329-334.

Naz, R. and Bano, A. 2013. Phytochemical screenig, antioxidants and antimicrobial potential of *Lantana camara* in different solvents. *Asian Pac. J. Trop.*, *Dis.* 3(6): 480-486.

Nychas, G.J., 1995. Natural antimicrobials from plants. In: *New Methods of Food Preservation* (Ed. Gould, G.W.). Blackie Academic and Professional, London, United Kingdom. Pp.58-59.

Okinbo, R.N. and Osuinde, M.I. 2003. Fungal leaf spot diseases of mango (*Mangifera indica* L.) in Southeastern Nigeria and biological control with *Bacillus subtilis*. *Plant Protection Sciences*, 39: 70-77.

Oyourou, J.N., Combrinck, S., Regnier, T. and Marston, A. 2013. Purification, stability and antifungal activity of verbascoside from *Lippia javanica* and *Lantana camara* extracts. *Industrial Crops and Products*, 43: 820-826.

Priyanska, N. and Joshi, P.K. 2013. A review of *Lantana camara* studies in India. *International Journal of Scientific and Research Publications*, 3(10):1-11.

Rizvi, Z.F., Mukhtar, R., Chaudhary, M.F. and Zia, M. 2013. Antibacterial and antifungal activity of *Lawsonia inermis*, *Lantana camara* and *Swertia angustifolia*. *Pak. J. Bot.*, 45(1): 275-278.

Sailaja, I. 2014. Antifungal activity of some wild plant extracts against fungal pathogens. *Int. J. Intg. Med. Sci.*, 1(2): 41-44.

Sharma G.P., Raghubanshi, A.S. and Singh, J.S. 2005. *Lantana* invasion: An overview. *Weed Biology and Management,* 5(4): 157-165.

Sharma, B. and Kumar, P. 2009. In vitro antifungal potency of some plant extracts against *Fusarium oxysporum*. *Int. J. G. Pharmacy*., 3(1): 63-65.

Sharma, O.P., Makkar, H.P.S. and Dawra, R.K. 1988. A review of the noxious plant *Lantana camara*. *Toxicon,* 26: 975-987.

Sheriff, Z.U. 2001. *Modern Herbal Therapy for Common Ailments: Nature Pharmacy Series*, Vol. 1. Spectrum Book Limited, Ibadan, Nigeria in Association with Safari Books (Export) Limited, United Kingdom.

Smid, E.J., and Gorris, L.G.M. 1999. Natural antimicrobials for food preservation. In: *Handbook of Food Preservation* (Ed. Rahman, M.S.). Marker Dekker Inc., New York, USA. Pp. 285-308.

Srivastava, D and Singh, P. 2011. Antifungal potential of two common weeds against plant pathogenic fungi – *Alternaria*s pp. *Asian Journal of Experimental Biological Sciences,* 2(3): 525-528.

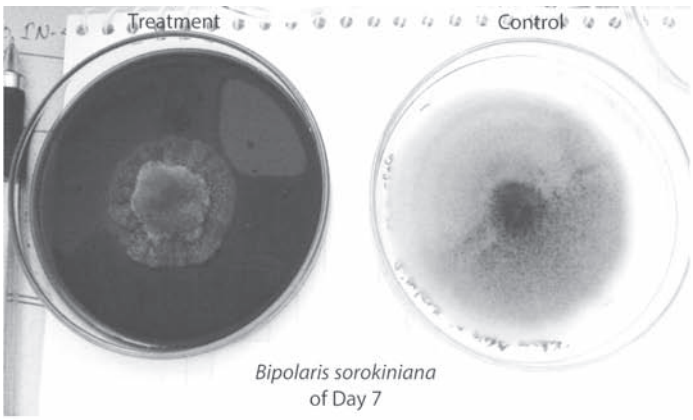
Tauxe, R.V. 1997. Emerging food borne diseases: an evolving public challenge. *Diary Food Environ. Sanit.*, 17:788-795.

Tiwari, R.K.S., Singh, A., Das, K. and Sinha, A. 2007. Efficacy of extracts of medicinal plants against *Rhizoctonia solani*. *Ann. Plant Prot. Sci.*, 15(2): 460-539.

Tomoko, N., Takashi, A., Hiromu, T., Yuka, I., Hiroko, M., Munekazu, I., Toshiyuki, T., Tetsuro, I., Fujio, A., Iriya, I., Tsutomu, N. and Kazuhito, W. 2002. Antimicrobial activity of extracts prepared from tropical and subtropical plants on methicillin-resistant *Staphylococcus aureus*. *J. Health Sci.*, 48: 273-276.

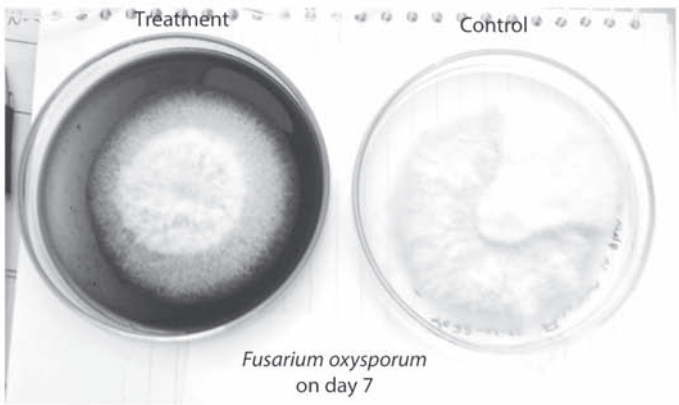
Tripathi, S., Rawat, K., Swati, D. and Himani, P. 2009. Potential of *Lantana camara* Linn.: Weed against wood destroying fungi. *Indian Forest*, 135(3):403-411.

Vaidya, G.S. and Bhattarai, N. 2009. Antagonistic study of *Lantana camara* (Linn) against with pathogenic bacteria. *Scientific World*, 7(7): 64-67.



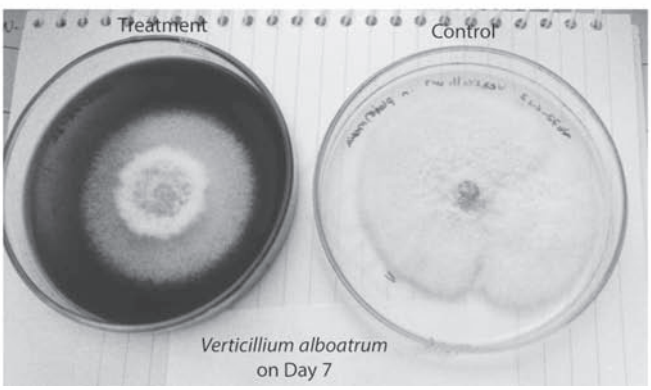
a. *Bipolaris sorokiniana*

b. *Colletotrichum gloeosporiodes*



c. *Fusarium oxysporium*

d. *Rhizoctonia solani*



e. *Verticillium alboatrum*

Plate 1: Growth of test fungi in *L. camara*-extract-treated and control medium

Acclimatization of two epiphytic orchids: *Coelogyne stricta* (D. Don) Schltr. and *Coelogyne flaccida* Lindl. propagated under *in vitro* conditions

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Abstract

In vitro propagation is the best alternative method for conservation of rare and endangered orchids. Nevertheless, its wider implication is restricted due to high percentage of plant loss during transferring to *ex vitro* condition. Hence, the goal of this study was to find out the best acclimatization substrates for *Coelogyne stricta* (D. Don) Schltr. and *Coelogyne flaccida* Lindl. grown under *in vitro* conditions. The acclimatization procedure included gradual hardening from incubation room to natural environment. *In vitro* grown plantlets having well developed shoots & roots and measuring more than 2.5 cm in height were subsequently transferred to different acclimatization substrates/potting mixture for acclimatization. Plantlets of *C. stricta* showed best survival rate of 90% in potting mixture consisting of coco-peat + sphagnum moss + sand in the ratio of 2:1:1 followed by 80% in tree fern powder + sand in the ratio of 2:1. Similarly, *C. flaccida* showed best survival rate of 80% in the potting mixture consisting of tree fern powder + sphagnum moss in the ratio of 2:1 followed by 70% in coco-peat + sphagnum moss + sand in the ratio of 2:1:1.

Keywords: Acclimatization, *in vitro*, potting mixture, *Coelogyne stricta*, *Coelogyne flaccida*.

Introduction

In vitro propagation has been extensively utilized for rapid and mass multiplication of many plant species including orchids. During the *in vitro* stage, plants are kept in a controlled environment, characterized by high humidity, low light intensity, supplementary sugar supply and growth regulators (Murashige 1974; Viegas et al. 2005). However, its application is restricted often by the high percentage rate of plant loss when transferred to *ex vitro* condition. This is due to plantlets need to get adjusted with many harsh conditions of *ex vitro* environment like high level of irradiance, low humidity and limiting water due to low hydraulic conductivity of roots and root-stem connections (Fila et al. 1998). Acclimatization of the plantlets can overcome these problems with the subsequent use of green house and gradual lowering in air humidity (Lavanya et al. 2009). The development of successful hardening technique is prerequisite for *in vitro* propagation method. Hardening accounts for about 60% of the total production cost (Hazarika 2003). Therefore, an efficient and cost-effective acclimatization technique is necessary for *in vitro* raised plantlets. So, we endeavored to develop a new efficient and cost-effective hardening technique for *in vitro* raised plantlets of *Coelogyne stricta* (D. Don) Schltr. and *Coelogyne flaccida* Lindl. They both are ornamental and medicinal orchids belonging to family Orchidaceae.

Coelogyne stricta, a native orchid of Nepal, is commonly known as 'The Rigid Coelogyne Pseudobulb' and is an epiphyte found on tree trunks or lithophytes on mossy rocks at elevations of 1400-2000 m (Raskoti 2009; Rajbhandari 2015). It has high aesthetic value (Figure 1) so it is used as an ornamental plant in different gardens, nurseries, hotels, etc. Its medicinal value is due to paste of its pseudobulb which is applied to the forehead against headache and fever (Baral and Kurmi 2006; Pant and Raskoti 2013).

Figure 1: A flower of *Coelogyne stricta*

Figure 2: A flower of *Coelogyne flaccida*

Coelogyne flaccida, a native orchid of Nepal, is commonly known as 'The Loose Coelogyne Pseudobulb' and is an epiphyte found on tree trunks at elevations of 900-1100 m (Raskoti 2009; Rajbhandari 2015). It also has high aesthetic value (Figure 2) so is also used as an ornamental plant in different gardens, nurseries, hotels, etc. Its medicinal value resides on the paste of its pseudobulb, which is used for headache treatment; and the juice is convenient for indigestion relief (Manandhar 2002; Pant and Raskoti 2013).

Both of these orchid species are vanishing rapidly from their natural habitat and are restricted to narrow areas due to their uncontrolled collection, illegal trade, deforestation, habitat destruction and high price in the national and international markets. So, various tissue culture protocols have been developed for large scale production of both these orchids using their seeds and pseudo-bulbs as explants. Nevertheless, no acclimatization techniques for these orchids have been developed for *in vitro* propagated plantlets. So, from both conservation and commercial point of view it is imperative to develop acclimatization techniques of these orchids using standard method. Therefore, the present study was undertaken to optimize the acclimatization of *in vitro* raised *C. stricta* and *C. flaccida* as the final stage of successful *in vitro* propagation. Eight different potting mixture were tested in this study.

Materials and methods

The *in vitro* grown plantlets of *Coelogyne stricta* (D. Don) Schltr. (Figure 3) and *Coelogyne flaccida* Lindl. (Figure 4) having well developed shoots and roots and measuring more than 2.5 cm in height maintained at 25± 2ÚC and 16 hours photoperiod were taken from incubation room of Tissue Culture Section of National Herbarium and Plant Laboratories, Godawari, Lalitpur.

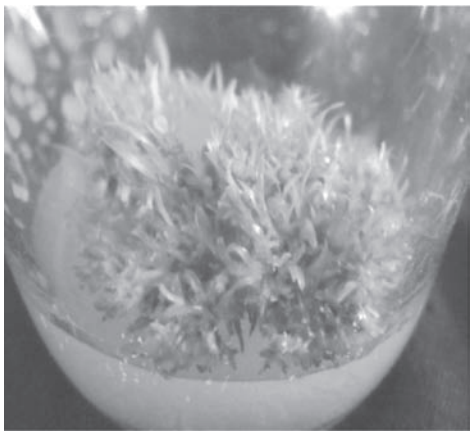

Figure 3: *In vitro* grown plantlets of *C. stricta*

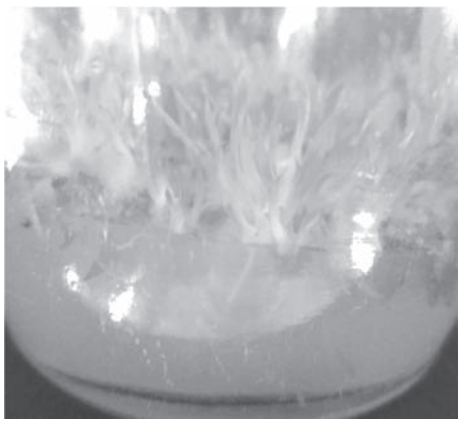

Figure 4: *In vitro* grown plantlets of *C. flaccida*

The jars containing well developed plantlets were opened and kept at room temperature for one week. The plantlets were then taken out from the jars and washed in running tap water thoroughly to remove traces of adhered medium and agar from the surface of plantlets. The plantlets were rinsed in bavistin (0.1%, w/v) for five minutes to kill fungus if present and to minimize the chances of infection. After that the plantlets were washed with distilled water and dried using blotting paper.

The plantlets were transferred to cleaned plastic trays containing different potting mixtures (Table 1 & 2). Ten plantlets of both orchids were tested against each combination of potting mixture separately. Coco-peat and tree fern powder used for the potting mixture were made wet using tap water prior to use. The sand used was washed with water and made dry under the direct exposure of sunlight.

NPK solution (5%) was sprayed once a week for fastening their growth. The plants were then covered using transparent polythene sheets, with holes made for aeration, to control humidity. The plants were kept in green house for three months and finally transferred to the natural environment.

Results and Discussion

The well developed *in vitro* grown plantlets of *Coelogyne stricta* (D. Don) Schltr. and *Coelogyne flaccida* Lindl. measuring more than 2.5 cm in height showed best survival rate of 90% and 80% on potting mixture consisting of coco-peat + sphagnum moss + sand (2:1:1) and tree fern powder + sphagnum moss (2:1) respectively (Table 1 & 2). It suggests the effectiveness of coco-peat, tree fern powder and sphagnum moss in the successful acclimatization of *in vitro* grown epiphytic orchids. Coco-peat, tree fern powder and sphagnum moss were used because of their high water holding capacity to provide moisture to the plantlets and sand might provide the heat needed for the initiation of new roots that is suitable to adapt to the natural environment.

Franco et al. (2007) in the acclimatization of *Cattleya trianae* found substrate of pine-coconut (1:1), coconut fiber alone and pine-coconut-coal (1:1:1) had the percent survival of 80, 76 and 60% respectively while the lowest percentage survival was recorded for pine bark at 12%. Similarly, Das et al. (2007) found 90% of *Cymbidium devonianum* plantlets survived on substratum containing brick, charcoal and decaying litter in the ratio of (1:1:1) with a layer of moss on top while Dutra et al. (2009) found 90% survival of the 35 weeks old seedlings of *Cyrtopodium punctatum* when potted in coconut hush rowing medium.

Table 1: Acclimatization of *Coelogyne stricta* (D. Don) Schltr. in different potting mixture

Potting mixture	Ratio of potting mixture	Total number of plantlets	No. of plantlets hardened after				% of acclimatization
			2nd week	4th week	6th week	8th week	
Coco-peat + sphagnum moss	2:1	10	8	8	7	7	70
Coco-peat + sphagnum moss + sand	2:1:1	10	10	9	9	9	90
Coco-peat + sphagnum moss + sand + soil	2:1:1:1	10	6	6	5	4	40
Coco-peat + sand	2:1	10	6	6	6	6	60
Coco-peat + sand + soil	2:1:1	10	6	6	4	4	40
Tree fern powder + sphagnum moss	2:1	10	8	6	6	6	60
Tree fern powder + sphagnum moss + sand	2:1:1	10	6	6	6	6	60
Tree fern powder + sand	2:1	10	10	8	8	8	80

Table 2: Acclimatization of *Coelogyne flaccida* Lindl. in different potting mixture

Potting mixture	Ratio of potting mixture	Total number of plantlets	No. of plantlets hardened after				% of acclimatization
			2nd week	4th week	6th week	8th week	
Coco-peat + sphagnum moss	2:1	10	7	6	6	6	60
Coco-peat+ sphagnum moss + sand	2:1:1	10	7	7	7	7	70
Coco-peat+ sphagnum moss + sand + soil	2:1:1:1	10	6	6	5	5	50
Coco-peat + sand	2:1	10	7	6	6	5	50
Coco-peat+ sand + soil	2:1:1	10	6	5	4	4	40
Tree fern powder + sphagnum moss	2:1	10	8	8	8	8	80
Tree fern powder + sphagnum moss + sand	2:1:1	10	7	7	6	6	60
Tree fern powder + sand	2:1	10	7	6	5	5	50

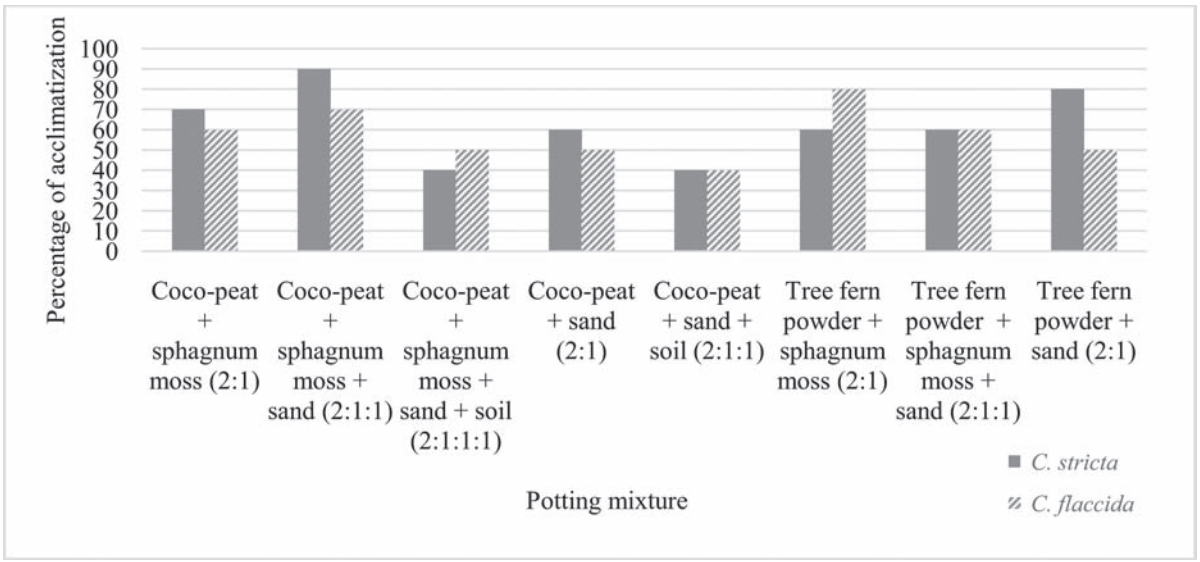

Figure 5: Comparative percentage acclimatization of *Coelogyne stricta* and C*oelogyne flaccida* in different potting mixture

Kaur and Bhutani (2009) recorded nearly 75% of plantlets survival of *Vanda testacea* when transferred to pots containing epiphytic compost (1 charcoal: 1 brick pieces: 1 bats). Pant and Shrestha (2011) successfully hardened nearly 70% *Phaius tancarvilleae* on potting mixture containing coco-peat and sphagnum moss (2:1). Gogoi et al. (2012) in *Cymbidium eburneum* reported survivability of 70 % when complete plantlets were grown in the compost mixture comprising brick, charcoal and decaying litter in the ratio 1:1:1 and a layer of moss on top.

Pant and Thapa (1012) in *Dendrobium primulinum* successfully hardened nearly 70% in the potting mixture containing coco-peat and sphagnum moss in the ratio of 2:1 while Paudel and Pant (2012) in *Esmeralda clarkei* reported 85% survival in potting mixture consisting of soil, sand and sawdust (1:1:1). Pradhan et al. (2013) in *Dendrobium densiflorum* found out 85% survival in coco-peat, litter and clay (2:1:1) while Warghat et al. (2014) found cent percent survival in *Dactylorhiza hatagirea* when grown in potting mixture consisting of coco-peat + vermiculite + perlite (1:1:1).

Optimum acclimatization substrate/potting mixture may vary for different species, and so for intra-generic species. Different optimum potting mixture of these orchid species might be due to their different genetic constitution, physiological state and endogenous growth regulators present in them. After the hardening phase, the plants were taken to a greenhouse (Figure 6 & 7) and later to the natural environment on their host trees where they showed qualitative characteristics such as vigor, hardness and waxy texture, green coloration in the leaves and velamen formation.

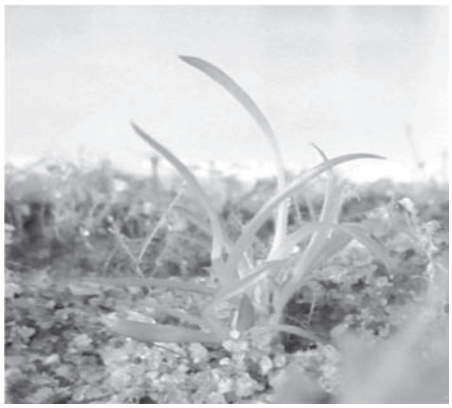

Figure 6: Acclimatized plantlet of *C. stricta*

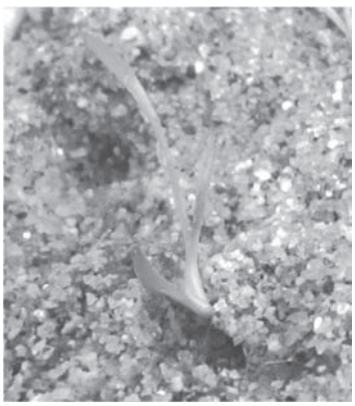

Figure 7: Acclimatized plantlet of *C. flaccida*

Conclusions

The best acclimatization substrate for plantlets of *Coelogyne stricta* was found to be potting mixture consisting of coco-peat + sphagnum moss + sand in the ratio of 2:1:1 with survival rate of 90% while *C. flaccida* showed best survival rate of 80% in the potting mixture consisting of tree fern powder + sphagnum moss in the ratio of 2:1.

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Reference

Baral, S.R. and Kurmi, P.P. 2006. *A Compendium of Medicinal Plants of Nepal*. Mass Printing Press, Kathmandu, Nepal.

Das, M.C., Kumaria, S. and Tandon, P. 2007. Protocorm Regeneration, Multiple Shoot Induction and *ex vitro* Establishment of *Cymbidium devonianum* Paxt. *Asian Journal of Plant Sciences, 6: 349-353.*

Dutra, D., Kane, M.E. and Richardson, L. 2009. Asymbiotic seed germination and in vitro seedling development of *Cyrtopodium punctatum*: a propagation protocol for an endangered Florida native orchid. *Plant Cell Tiss Organ Cult*., 96:235-243.

Fila, G., Ghashghaie, J. and Cornic, G. 1998. Photosynthesis, leaf conductance and water relation of in vitro cultured grapevine rootstock in relation to acclimatization, *Physiol. Plant*, 102: 411-418.

Franco, M., Guevara, G., Mesa, N. and Uruena, G. 2007. Hardening of the national flower of Colombia, the threatened *Cattleya trianae* (Orchidaceae), from *in vitro* culture with previous invigoration phase. *International Journal of Tropical Biology and Conservation*, 55(2): 681-691.

Gogoi, K., Kumaria, S. and Tandon, P. 2012. Ex situ conservation of *Cymbidium eburneum* Lindl.: a threatened and vulnerable orchid, by asymbiotic seed germination. *3 Biotech*, 2(4): 337-343.

Hazarika, B.N. 2003. Acclimatization of *in vitro* raised plants, *Curr. Sci.*, 85: 1704-1712.

Kaur, S. and Bhutani, K.K. 2009. *In vitro* Propagation of *Vanda testacea* (Lindl.) Reichb.f. – A Rare Orchid of High Medicinal Value. *Plant Tissue Cult. & Biotech.,* 19(1): 1-7.

Lavanya, M., Venkateshwarlu, B. and Devi, B.P. 2009. Acclimatization of neem microshoots adaptable to semi sterile conditions, *Ind. J. Biotechnol.,* 8:218-222.

Manandhar, N.P. 2002. *Plants and People of Nepal*. Timber Press, Portland, Oregon, USA.

Murashige, T. 1974. Plant propagation through tissue cultures. *Ann. Rev. Plant. Physiol.,* 25: 135-66.

Pant, B. and Raskoti, B.B. 2013. *Medicinal Orchids of Nepal*. Himalayan Map House (P.) Ltd, Kathmandu, Nepal.

Pant, B. and Shrestha, S. 2011. *In vitro* Mass Propagation of a Ground Orchid *Phaius tancarvilleae* (L'Her.) Blume through Shoot Tip Culture. *Plant Tissue Cult. & Biotech.,* 21(2): 181 188.

Pant, B. and Thapa, D. 2012. *In vitro* mass propagation of an epiphytic orchid, *Dendrobium primulinum* Lindl. through shoot tip culture. *African Journal of Biotechnology,* 11(42): 9970-9974.

Paudel, M.R. and Pant, B. 2012. *In vitro* micropropagation of rare orchid (*Esmeralda clarkei* Rchb.f.) from shoot tip section. *International Journal of Biology, Pharmacy and Allied Sciences* (IJBPAS), 1(11): 1587-1597.

Pradhan, S., Paudel, Y.P. and Pant, B. 2013. Efficient regenaration of plants from shoot tip explants *of Dendrobium densiflorum* Lindl., a medicinal orchid. *African Journal of Biotechnology,* 12(12): 1378-1383.

Rajbhandari, K.R. 2015. *A Handbook of the Orchids of Nepal*. Department of Plant Resources, Thapathali, Kathmandu, Nepal.

Raskoti, B.B. 2009. *The Orchids of Nepal*. Bhakta Bahadur Raskoti and Rita Ale Publication, Nepal.

Viegas, P.H., Pereira, A.M.L., Ambrosano, G.M.B. and Batista, M.F. 2005. Acclimatization of micropropagated *Heliconia bihai* (Heliconiaceae) plants. *Sci. Agric. (Piracicaba, Braz.),* 62: 299-301.

Warghat, A.R., Bajpai, P.K., Srivastava, R.B., Chaurasia, O.P., Chauhan, R.S. and Sood, H. 2014. In vitro protocorm development and mass multiplication of an endangered orchid, *Dactylorhiza hatagirea*. *Turkish Journal of Botany,* 38: 737-746.

Micropropagation of *Pogostemon cablin* (Benth.) (Patchouli)

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Abstract

The present study aims to investigate an efficient protocol of micropropagation of *Pogostemon cablin* (Benth.). It is commercially important plant for its aromatic patchouli oil. It was newly introduced in Nepal from Assam, India by Chaudhary Biosys Pvt. Ltd, Nepal. Plants were regenerated using leaf and shoot tip explants in Murashige and Skoog (MS) medium supplemented with phyto hormones BAP and NAA and the medium was also fortified with 3% sucrose and 0.8% agar. The best multiplication was found in lower concentration of BAP (i.e. 0.1 to 1mg/l) with 0.1ml/l NAA. For rooting, the *in vitro* multiplied micro shoots were acclimatized and transferred to non sterile sands for induction of roots maintaining humidity in poly house. After four weeks, the microshoots induced roots in sand. The rooted plants were grown in polybags filled with soil for further growth.

Key words: *Pogostemoncablin*, explants, Benzyl amino purine, Napththalene acetic acid, shoot proliferation, micro propagation

Introduction

Patchouli (*Pogostemon cablin* Benth.) is commercially important plant for its aromatic patchouli oil. Patchouli belongs to family Lamiaceae. Its oil is commercially used in perfumes and cosmetics (Hasegawa *et al*., 1992; Maheswari *et al.*, 1993). It also possess ant insecticidal, antifungal and bacteriostatic properties (Kukreja*et.al*, 1990, Yang1996, Pattnaik*et.al*. 1996). In aromatherapy it is used to calm nerve, relief depression and stress. The oil extensively used as a flavoring ingredient in major food products, including alcoholic and non-alcoholic beverages, frozen dairy desserts, candy, baked goods, gelatin, meat and meat products. The oil is regarded as the best fixative for heavy perfumes which imparts strength, character, alluring notes and lasting qualities, (Farooqui and Sreeramu 2001).This crop grows 400m above sea level. It prefers a warm humid climate with fairly heavy and evenly distributed rainfall of 2500 to 3000 mm per annum, a temperature of 24 to 28ºC and an average atmospheric humidity of 75%. In less rainfall areas, irrigation is needed for its well growth and partially shaded area is best conditions for its vegetative growth. It is relatively a hardy plant and adapts itself to a wide range of soil conditions. A well drained loamy soil rich in humus and nutrients with a loose friable structure and with no impervious hard layer at the bottom is ideal for patchouli cultivation. A pH range of 5.6 to 6.2 is suitable (Farooqui and Sreeramu 2001). Because of shade loving crop it can be grown as an intercrop with other trees. It is native plant of tropical area and widely grown to India, Maleysia, Indonesis Philippines and Singapore.

Conventionally, the vegetative propagation was done by stem cuttings and also from seeds. Propagation from seeds could not produce true to type plants and propagation from stem cutting could not produce sufficient amount of plants. Its need more space and time. In Nepal, it is newly introduced plants from Assam, India by Chaudhary Biosys Pvt. Ltd., Nepal (Chaudhary Biosys Pvt. Ltd Nepal is a plant oil exporters in Nepal. It was established in 2004 to collectively work with INGO's, Government Agencies and Communities in the field of Non-Timber Forest Product (NTFP) by establishing a world class Medicinal and Aromatic Plant based Processing Industry to uplift the less privileged community in Nepal).It was cultivated in Kakervitta, Jhapa district and in Chitwan district . The distillation unit was also established in Jhapa district. Many

farmers have shown their interest to cultivate this plant. Tissue culture method is an alternative method for large scale commercial production. Hence the present study aims to develop an efficient method of micro propagation using nodal and leaf explants for the production of patchouli plants to mitigate the demands of farmers.

Material and Method

The elite plants were brought from Chaudhary Biosys Pvt. Ltd., Nepal and planted in pots as mother stocks. The shoot tips were taken from these plants, washed in running tap water for one hour with few drops of teepol and again washed with distilled water. These shoot tip were surface sterilized with 0.1% mercuric chloride solution for 5 minutes and washed with sterilized distilled water for five times. Aseptically, unnecessary parts from these explants were cut down by sharp sterilized blade into small shoot tips (1-2mm) and also into single leaves as explants. These shoot tips and single leaves were then cultured in MS medium with different concentration of hormones**.** Ten replicates were made in each concentration of BAP and NAA. The medium was also fortified with 0.1% Casein hydrolysate, 3% sucrose and 8% agar for solidification of medium. The pH of the medium was adjusted to 5.5 before autoclaving. The cultures were then incubated at 25±2 ÚC under 16 hour photoperiod under 3 kilo lux light intensity provided by white florescence tubes.

The proliferated micro shoots from these shoot tips and leaves were again subcultured in MS medium with different concentration of BAP and NAA**.** Among the different concentration of BAP and NAA, best hormone concentration was identified and standardized. The microshoots proliferated were subcultured in the same medium for large scale propagation.

For rooting of microshoots, the cultured bottles were acclimatized in poly house for a week. Then the microshoots were removed from the culture flasks, washed thoroughly to remove the medium, cut down 2.5 to 3cm long and were transferred on propagator filled with non-sterile sands (Rajbhandary & Bajaj, 1991) maintaining the humidity in poly house. After two weeks, the microshoots regenerated roots. The rooted plantlets were transferred to polybags with soil for further growth.

Result

The shoot tip cultured in MS medium with different concentration of hormones showed different response on different hormones concentration after 4 weeks of culture (Table -1). After four weeks of culture, the shoot tip explants began to regenerate microshoots by direct organogenesis in the MS medium containing 0.1 to 1mg/l BAP in combination with 0.1mg/l NAA. The best multiplication was found in the MS medium containing1mg/l BAP and 0.1mg/l NAA (Fig-1).In higher concentration of hormone (2mg/l BAP with 0.1mg/l NAA), callus was regenerated at the base along with microshoots (Table-1). The leaf explants began to regenerate microshoots by direct organogenesis from the end of the petiole in the medium 1mg/l BAP with 0.1mg/l NAA after five weeks of culture (Fig-2).

The regenerated micro shoots on different concentration of hormones were again subcultured on MS medium different concentration of BAP with 0.1mg/l NAA and medium without hormone (Table 2). In tested four concentration of BAP and NAA,

Table 1 : Shoot tips responses in MS medium with different concentration of BAP along with 0.1mg/l NAA.

S. No.	Conc. of growth hormone(mg/l)		Average no. of micro shoots	Callus formation	Ht. of micro shoots in cm	Condition of micro shoots
	BAP	NAA				
1	0.1	0.1	10 to12	Absence of callus	1 to1. 3	Weak
2	0.5	0.1	10 to12	Absence of callus	1 to1. 5	Healthy
3	1	0.1	15 to 18	Absence of callus	1 to1. 5	Healthy
4	2	0.1	Stunted 6 to 8	Callus at base	1 to 0.5	Sunted weak
5	MS Medium without hormone		3 to 5	Absence of callus	1 to1. 5	Weak

Table 2 : Multiplication of microshoots responses in MS medium with different concentration of BAP and NAA.

S. No.	Conc. of growth hormone(mg/l)		Average no of micro shoots	Callus formation	Ht. of micro shoots in cm	Condition of micro shoots
	BAP	NAA				
1	0.1	0.1	20 to 25	Absence of callus	1 to1.3	Healthy
2	0.5	0.1	20 to 25	Absence of callus	3 to 3.5	Healthy
3	1	0.1	20 to 30	Absence of callus	2 to 3.5	Thin sunted shoots and not so good
4	Medium without hormone		18 to 20	Absence of callus	3 to 3.5	Healthy

the best multiplication of micro shoots was observed in the MS medium containing 0.5mg/l BAP with 0.1mg/l NAA (Fig-3).

For rooting, the subcultured bottles were acclimatized in poly house. The micros hoots were taken out from bottle, washed thoroughly with tap water and 2.5 cm to 3cm long shoots were transferred to sand (Fig. 4). The shoots developed roots within four weeks (Fig. 5). The rooted plantlets were then transferred in poly bags for further growth. Then the micropropagated plants were ready for field transfer (Fig. 6).

Discussions

Micropropagation of Patchouli plant has been developed by many researchers for many purposes. Misra M (1996) used leaf and node explants of Patchouli for shoot multiplication on MS medium with BA at 1.0 mg/L. He found that shoot formation frequency was maximum (83%) with BA at 1.0 mg/L. Similarly, Maruyama et al.1997 inoculated node explants on MS medium fortified with 2 µM/l BA which initiated multiple shoots after 25 days. *In vitro* initiated nodes were used for incapsulation. M. Kumaraswamy and M. Anuradha (2010) obtained multiple shoots from nodal explants in MS medium supplemented with 0.5 mg/l BAP. They found that within four weeks of culture, explants regenerated multiple shoots which attained a height of 3.6 cm. Hua Jin *et al*. (2014) found that nodal stem with a single node (the second or third node of *in vitro* plantlets) was the most responsive explants in the MS medium with BA at 0.1–0.2 mg/l. They also pointed out that combinations of BA and NAA resulted in slower shoot development and growth as compared to BA alone. But in our experiment, we used BAP along with NAA for the proliferation of microshoots from shoot tip and leaf explant.

For rooting, most of the authors used half strength MS medium with auxin. Hua Jin*et al.*, (2014) reported that half strength MS medium with 0.2mg/l IBAwas effective for rooting. M. Kumaraswamy and M. Anuradha (2010) rooted shoots in half strength MS medium with 100mg/l activated charcoal. In our experiment, we used non sterile sands for rooting maintaining the humidity of propagator in polyhouse.

Conclusion

The current study provided information about the efficient protocol of micropropagation for commercial production by *in vitro* method of *Pogestomon cablin*, which fulfilled the demand of newly introduced plant in Nepal.

Acknowledgement

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References

Farooqui, A.A. and Sreeramu, B.S. 2001. *Cultivation of medicinal and aromatic crops. University Press (India) Ltd.,* Hyderabad, India.

Hasegawa Y, Tajima K, Toi N, Sugimura Y (1992). An *additional constituent occurring in the oil from a patchouli cultivar.* Flavour Frag. J., 7: 333-335.

Hua Jin, Zhi-Cheng Deng, Hong He (2014*). Effect of explant types and plant growth regulators on direct regeneration in medicinal plant Pogostemon cablin.* POJ 7(5):322-327.

Kukreja AK, Mathur AK, Zaim M (1990*) Mass production of virus-free patchouli plants [Pogostemoncablin (Blanco) Benth.] by in vitro culture*. Trop Agr. 67(2):101–104.

Kumara Swamy M, Balasubramanya S, Anuradha M (2010) *In vitro multiplication of Pogostemon cablin Benth. through direct regeneration.*Afr J Biotechnol. 9(14): 2069– 2075.

Maheshwari, ML, Vasantha Kumar T, Neelam Sharma and Chandel KPS (1993). *Patchouli- An Indian perspective*. Indian Perfumer, 37:9-11.

Misra M (1996) *Regeneration of patchouli (Pogostemon cablin Benth.) plants from leaf and node callus, and evaluation after growth in the field*. Plant Cell Rep. 15: 991–994.

Pattnaik, S., Subramanyam VR and Kole (1996). Antibacterial and antifungal activity of ten essential oils in vitro. Microbios. 86: 237- 246.

Rajbhandary, S.B., Bajaj Y.P.S. (1991). *Rooting of in-vitro produced shoots in non-sterile sand and the inssexpensive and efficient technique for en-mass micro propagation* Biotechnology in Agriculture and Forestry (ed Y.P.S. Bajaj) 262-268.

Figure 1: Proliferation from shoot tip explant after four weeks

Figure 2: Leaf explant in MS medium supplemented with 1.0 mg/l BAP +0.1mg/l NAA

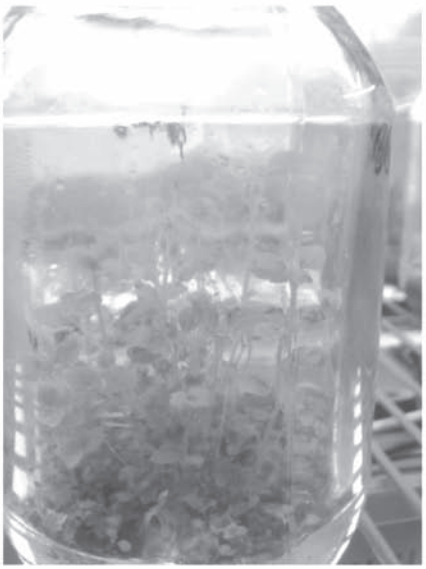

Figure 3: Shoot tip explant in MS medium supplemented with 0.5mgl BAP +0.1mgl NAA

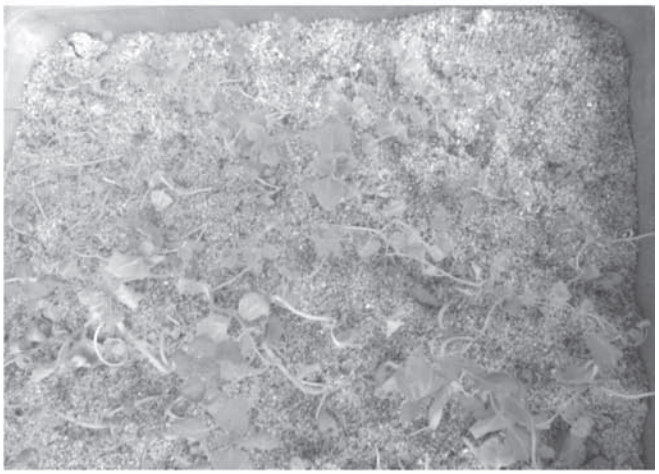

Figure 4: Microshoots transfered in non sterile sands for rooting

Figure 5: Sand rooted plants

Figure 6: Plants in polybags

Clonal propagation of *Gmelina arborea* Roxb. by Nodal culture

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Abstract

Primary cultures were established with nodal segments from juvenile shoots of 6 month old nursery grown *Gmelina arborea* Roxb. Plants. These nodal explant were cultured on a MS medium supplimented with BAP (1.0 mg/L) + NAA(0.1 mg/l) and sucrose (3%) produced optimum bud break in nodal explants. 2-4 shoots were produce from single node explant after 4 weeks of inoculation. Adventitious buds, between 6-8 were formed when in vitro derived single node explants were subcultured on same MS medium. Rooting and field establishement work was under research.

Key words: *Gmelina arborea* , Nodal explants, growth hormones, shoot proliferation, micro propagation

Introduction

The species *Gmelina arborea* Roxb. is an economically and also medicinally important forest tree. *Gmelina arborea* Roxb. locally known as **gamhar, Khamari** was multipurpose tree which belongs to family Lamiaceae. It is found in sub tropical and temperate forest of Nepal up to 1,200 metres above sea level. Gamhar has also been introduced to most tropical countries as a timber tree.

It was a fast-growing deciduous tall tree attains height up to 30 m with girth of 1.2 to 4 high on favourable sites. *Gmelina* grow best on freely drained, fertile soils, with no hardpan or other impediment to root development. (http:www.Forestrynepal.org resources/trees/ Gmelina arborea). Flowering takes place during February to April when the tree is more or less leafless whereas fruiting starts from May onwards up to June. Frequently found in *Shorea robusta* forest, especially the wetter types. Outside Nepal it extends from Pakistan to Vietnam and southern China. .(http:www.Forestrynepal.org resources/ trees/Gmelina arborea). It is widely planted in tropical countries as a fast-growing timber tree, and in particular as a source of wood for paper pulp.

Gmelina arborea timber is reasonably strong for its weight. Once seasoned, it is a very steady timber and moderately resistant to decay and ranges from very resistant to moderately resistant to termites. Its timber is highly esteemed for door and window panels, joinery and furniture especially for drawers, wardrobes, cupboards, kitchen and camp furniture, and musical instruments because of its lightweight, stability and durability. *Gmelina arborea* is a popular timber for picture and slate frames, various types of brush backs, brush handles and toys also for handles of chisels, files, saws, screw drivers, sickles etc. It is also used in artificial limbs, carriages and bobbins. Gamhar is used in papermaking and matchwood industry too.

Planting *G. arborea* with crops like maize and cassava has been found beneficial in increasing the simultaneous production of wood and food. When intercropped with maize and cassava, it performs better under closely stocked stands of cassava, yams and maize. Micropropagation technique plays an important role in conservation and multiplication and also large scale production of an forest tree species. This technique is most valuable for true-to-type of plant production. Conventionally this tree can be propagated by seedlings, stem cuttings, and grafting. There are many factors, which could lead to failure of rooting in stem cuttings. Now a days people are interested for commercial plantation of forest tree species but planting material is not available in sufficient amount so that , this research work was carried out for mass propagation to fulfill growing demand of tree plantation.

Material and Method

Gmelina arborea plant was brought from Jhapa district and grown in Biotechnology nursery at Thapathali. 1-2 cm long shoots were cut from 6 month old juvenile plants of *Gmelina arborea.* The shoots were surface sterilized first by washing in running tap water for about half an hour with few drops of liquid detergent Tween-20. After washing the explants were thoroughly rinsed with distilled water for 4-5 times. Further sterilization was done inside a laminar air flow. Explants were surface sterilized with freshly prepared 0.1 % w/v aqueous solution of Mercuric chloride for 5-7 minutes. The explants were then thoroughly rinsed for 3-4 times with sterilize distilled water.

Single or double nodal explants were inoculated onto MS basal (Murashige and Skoog, 1962) medium supplemented with different combination of plant growth regulators Benzyl amino purine (1.0 mg/l ,1.5mg/l , 2.0 mg/l, 2.5 mg/l and 3.0mg/l) and Naphthalene acetic acid (0.1 mg/l) for bud break and shoot proliferation. Sucrose 3% was used as carbon sources and media were adjusted to pH 5.8 before sterilized. The media were solidified with 0.8% agar and were autoclaved at 121 °C/ 15 lbpsi.

Before inoculation, explants were transferred to sterilize Petri dish with the help of sterile forceps under strict aseptic conditions. The leaves were removed and single node about 0.5 to 1.0 cm long was transferred to culture bottles containing MS medium with different concentration of growth hormone, BAP and NAA (Figure 1). The cultures were incubated under 16 hour photoperiod with light intensity of 3000 lux florescent tube light and temperature of 25± 2°C.

Result

Shoot proliferation

After four weeks of inoculation, explants started to show signs of shoot initiation. 2-4 new shoots were produced from the nodal explant.(Figure 2) The micro shoots with 3-4 node were subculture onto the MS medium with same concentration of growth . After 6 weeks 6-8 shoots were regenerate from single node. (Figure 3) The culture was maintained by regular sub culturing at 4 week of intervals to fresh medium with the same composition. Among all combination of growth hormones 1.0 mg/l BAP and 0.1 mg/l NAA gave highest number of shoot proliferation than other hormone concentration (Table 1). At higher concentration of BAP few number of shoot were proliferated.

The acclimatization and field establisment work is in research. It was observed that *In vitro* propagate *Gmelina arborea* plants from explants showed that multiplication rate are still low and leaves were defoliated therefore research to improve the protocol efficiency is to be continued.

This table show that explants responded to all media. Media with BAP 1.0 mg/l and NAA 0.1mg/l showed best results for shoot initiation from nodal explant. Each nodal explant with single node gives rise 2-4 shoot after 4 week. When subculture in high concentration of BAP 3.0 mg/l showed explant swelling only but no any shoot proliferation was obtained. The best concentration for shoot multiplication and condition of plant was found in hormone concentration 1.0 mg/l BAP and 0.1 mg/l NAA. In this composition, micro shoots were very healthy and strong .

Table 1: Effect of different concentration of growth hormone level on Gmelina arborea Roxb. shoot multiplication

S.No.	BAP +NAA mg/l	After 4 weeks		After 6 weeks		Remarks
		No. of Shoot per explant	No. of Node per shoot	No. of Shoot per node	No. of Node per shoot	
1	1.0 + 0.1	2-4	2-3	6-8	4-6	Micro shoot proliferation
2	1.5 + 0.1	2-3	2-3	2-3	3-4	Few number of microshoot
3	2.0 + 0.1	1-2	1-2	2-3	2-3	Few number of microshoot
4	2.5 + 0.1	1-2	2-3	2-3	2-3	Few number of microshoot
5	3.0 + 0.1	No shoot Proliferation	-	-	-	Explant swelling only

Disscussion

There are only few research work carried out for micropropagation of *Gmelina arborea.* Nakamura (2006) used shoots apices as a explant and culture on ½ Gamberg media solidify with 3.2 gm/l of gelrite and he used growth hormone 0.0 and 0.002 mg/l of IBA and sucrose. Induced multiple shoots were subculture into same media for micropropagation of *Gmelina arborea.* Lisette Valverde-Cerdas, Laura Alvarado, Ana Hine (2004) inoculated nodal segment of germinated seedling in different concentration of Benzylamino purine. Isidro E.Suarez, Claudia C, Acosta, Kellen C, Gatti (2013) found that control of BAP showed increase in shoot proliferation, shoot length and leaf number while IBA induce higher root number, root length and rooting percentage. Higher survival rate were observed when plants were transferred to peat.Gamboa & Abdelnour (1999) reported a new shoot formation from explants with pre-existing meristems, isolated from *in vitro* germinated plants, cultured in 2.46ìM BAP supplied MS semisolid medium. Kannan V.R. & Jasrai Y.T. (1996), obtained multiple shoots from single node explants of mature *Gmelina arborea* Roxb. on MS medium supplemented with 6-benzyladenine (BA). Seven to nine shoots were formed when in vitro derived single node explants were subcultured on MS medium supplemented with 1.1 micromolar BA. Most of the researcher used nodal cutting as an explant for micropropagation of *Gmelina arborea*. They used growth hormone Benzyle amino purine and Napthelene acetic acid for microshoot regeneration. In our reserch work we used nodal explant as an initial plant material for micropropagation of *Gmelina arborea.* Incase of growing media we used MS media with growth hormone Benzyle amino purine and Napthelene acetic acid. We found low concentration of auxin was suitable and condition of plants was also found to be healthy.

Conclusion

Gmelina arborea Roxb. is multipurpose tree which is cultivated in many country including Nepal .Tissue culture is only the best tool for true to type plant production. The objective of this present research work was to maximize the number of microshoots per culture bottle manipulating the appropriate concentration of growth hormones. We found Benzyl amino purine (BAP) 1.0 mg/l and Naphthalene acetic acid (NAA) 0.1 mg /l promoted higher frequency of shoot proliferation.

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References

Cerdas, L. V., Alvarado, L. and Hine, A. 2004. Micropropagation of clones from controlled crosses of *Gmelina arborea* in Costa Rica, 187–194

Gamboa, J.P.; Abdelnour, A. 1999. Micropropagación de melina (*Gmelina arborea* ROXB). Agr. Costarricense 23(1):69-76

Kannan, V.; Jasral, Y. 1996. Micropropagation of *Gmelina arborea*. Plant Cell, Tissue and Organ Culture (The Netherlands). 46:269-271.

http:www.Forestrynepal.org resources/trees/ Gmelina arborea

Nakamura, K. 2006. Micropropagation of *Shorea roxberghii* and *Gmelina arborea* by shoot apex culture .Plantation technology in tropical forest science, 137-150

Suarez, I. E., Acosta, C. C. and Gatti, K. C. (2013) In vitro multiplication of *Gmelina arborea* Roxb. rev.udcaactual.divulg.cient. vol.16

Figure 1: Nodal explant culture

Figure 2: Shoot regeneration after 4 weeks

Figure 3: 6 weeks old micro plants

Endemic Flowering Plants of Nepal: An update

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Abstract

The existing list of the endemic flowering plants of Nepal is revised, the present list of the flowering plants of Nepal is updated on the basis of published literature and the status of these endemic plants is presented. The result shows that there are 324 species of Nepalese endemic flowering plants distributed under 132 genera and 45 families.

Key words: Endemic plants, flowering plants, flora of Nepal, endemism, Himalaya.

Introduction

Endemic flowering plants of Nepal are those plants whose distributions are confined to Nepal. If the plant is found outside Nepal then it is not endemic to Nepal. In a wider sense, the distribution of any endemic taxonomic unit is confined to a particular country or geographical region (Good, 1974; Rajbhandari, 2013). The high mountains and islands have shown greater endemism in general. The high number of endemic species in such area is attributed to the isolation that allows the persistence and divergence of the population (MacArthur & Wilson, 1967; Bruchmann & Hobohm, 2014). Importance of the endemic plants lies on the fact that if it is lost from a particular country or region it will be lost from the world as well. Therefore, utmost importance has to be given for the conservation of these plants.

The first information on the endemic flowering plants of Nepal was provided by Hara & Williams (1979) and Hara *et al*. (1978, 1982) in their books '*An enumeration of the flowering plants of Nepal volumes 1-3*' which later became a source for preparing the list of the endemic flowering plants of Nepal. Joshi and Joshi (1991) provided a list of 283 endemic flowering plants of Nepal giving emphasis on their conservation. Shrestha & Joshi (1996) reported 246 species of endemic flowering plants of Nepal of which 77 species have now been reported from outside Nepal and 155 species have been added to the list as endemic to Nepal (see Appendix 1 to 4). On the basis of the list of Shrestha & Joshi, Chaudhary (1998) has also given a list of endemic flowering plants of Nepal. Ghimire (2005) reported endemic flowering plants of Dolpo (northwest Nepal) area. Bhuju *et al*. (2007) in '*Nepal biodiversity resource book: Protected areas, Ramsar sites and world heritage sites*' have included as an Annex 1.5 a list of the endemic flowering plants and have recorded 316 species out of total 399 taxa (species, subspecies, variety) including some common species distributed in India, Nepal, Bhutan and China, e.g., *Habenaria edgeworthii* Hook. f. ex Collett, *Oberonia prainiana* King & Pantl., *Peristylus densus* (Lindl.) Satapau & Kalipada, and *Poa rajbhandarii* Noltie. Out of 316 species listed 100 species have been recorded from outside Nepal and are henceforth no more endemic to Nepal. The Department of Plant Resources published endemic flowering plants of Nepal in three parts which included 282 species (Rajbhandari & Adhikari, 2009; Rajbhandari & Dhungana, 2010, 2011a). Rajbhandari & Dhungana (2011b) and Rajbhandari (2013) analysed the diversity of Nepalese endemic flowering plants and noted that the families having large number of endemic species were *Asteraceae* (22 species), *Saxifragaceae* (21 species), *Papaveraceae* (20 species) and *Ranunculaceae* (20 species) and the genera having large number of endemic plants were *Saxifraga* (21 species), *Pedicularis* (12 species), *Meconopsis* (11 speices) and *Impatiens* (10

species). Rajbhandari *et al*. (2015) reported that in the National Herbarium of Nepal (KATH) herbarium specimens of 128 species of endemic flowering plants of Nepal are preserved. Miehe *et al*. (2015) have noted that 399 endemic flowering plants of Nepal listed by Bhuju et al. (2007) are unevenly distributed. The number of endemic flowering plants of Nepal is not yet clearly known. An update is now necessary to make clear the status of the endemic flowering plants of Nepal. The objective of this paper is to present the status of the endemic flowering plants of Nepal by revising their existing list and updating them on the basis of published literature.

Results

Among 282 species of endemic flowering plants of Nepal reported by the Department of Plant Resources in the books '*Endemic flowering plants of Nepal part 1 to 3*' 18 species have been reported from outside Nepal and 60 species have been added as endemic to Nepal (see Appendix 2, 3). In total, occurrence of 132 species (2.4%) of the previously recorded Nepalese endemic flowering plants has been reported from outside Nepal (Appendix 1).

The present list includes 324 species of Nepalese endemic flowering plants distributed under 132 genera and 45 families (Table 1, Appendix 4). This is about 6% of the 5500 species of flowering plants recorded from Nepal (Rajbhandari, 2016). Twelve flowering plant families in Nepal have 10 or more than 10 endemic species (Table 2). Among them the families having large number of endemic species are *Apiaceae* (28 species), *Asteraceae* (22 species), *Fabaceae* (21 species), *Saxifragaceae* (21 species), *Orchidaceae* (20 species), *Papaveraceae* (20 species) and *Ranunculaceae* (20 species). Sixteen genera have 5 or more than 5 species of endemic flowering plants in Nepal (Table 3). The genera having large number of endemic plants are *Saxifraga* (21 species), *Pedicularis* (13 species), *Meconopsis* (11 species), *Aconitum* (10 species) and *Impatiens* (10 species). There is no endemic flowering plant family in Nepal. However, there is one endemic flowering plant genus (*Discretitheca*) in Nepal. *Discretitheca* belonging to *Lamiaceae* family was first described by P. D. Cantino in an article written by Cantino *et al*. in 1999. This is a monotypic genus which contains only one known species *Discretitheca nepalensis* (Moldenke) P. D. Cantino. Nine tree species are found among the endemic plants of Nepal. These species are *Mallotus bicarpellatus* T. Kuros., *Litsea doshia* (D. Don) Kosterm., *Machilus pubescens* Blume, *Salix nepalensis* Yonek., *Prunus himalaica* Kitam., *Prunus jajarkotensis* H. Hara, *Prunus taplejungnica* H. Ohba & S. Akiyama, *Prunus topkegolensis* H. Ohba & S. Akiyama and *Sorbus sharmae* M. F. Watson, V. Manandhar & Rushforth.

Table 1. List of endemic flowering plants of Nepal with families and genera.

Acanthaceae
Justicia - 1 species
Strobilanthes - 3 species
Thunbergia – 1 species

Amaryllidaceae
Allium - 1 species

Apiaceae
Acronema – 8 species
Conioselinum – 1 species
Cortia – 1 species
Cortiella – 1 species
Dolpojestella – 1 species
Heracleum – 1 species
Keraymonia – 2 species
Lalldhwojia – 2 species
Oreocome – 2 species
Pimpinella – 3 species
Rohmooa – 1 species
Sinocarum – 2 species
Synclinostyles – 2 species
Vicatia – 1 species

Apocynaceae
Brachystelma – 1 species
Ceropegia – 2 species

Asparagaceae
Asparagus – 1 species

Asteraceae
Artemisia – 2 species
Cicerbita – 1 species
Cirsium – 2 species
Crepis – 1 species
Leontopodium – 2 species
Saussurea – 7 species
Senecio – 2 species
Synotis - 2 species
Taraxacum – 3 species

Balsaminaceae
Impatiens – 10 species

Begoniaceae
Begonia – 7 species

Berberidaceae
Berberis – 2 species

Boraginaceae
Arnebia – 1 species
Microula – 1 species
Onosma – 3 species

Brassicaceae
Aphragmus – 2 species
Draba – 3 species
Lepidostemon – 1 species
Noccaea – 1 species
Solms-laubachia – 2 species

Campanulaceae
Codonopsis – 3 species
Cyananthus – 2 species

Caryophyllaceae
Arenaria – 2 species
Silene – 7 species

Crassulaceae
Rhodiola – 1 species
Rosularia – 1 species
Sedum – 1 species

Cucurbitaceae
Gomphogyne – 1 species

Cyperaceae
Carex – 7 species

Elaeagnaceae
Elaeagnus – 1 species

Ericaceae
Rhododendron – 2 species

Eriocaulaceae
Eriocaulon – 4 species

Euphorbiaceae
Croton – 1 species
Leptopus – 1 species
Mallotus – 1 species

Fabaceae
Astragalus – 9 species
Colutea – 1 species
Crotalaria – 1 species
Hedysarum – 1 species
Millettia – 1 species
Oxytropis – 7 species
Rhynchosia – 1 species

Gentianaceae
Gentiana - 5 species
Gentianella – 2 species
Swertia - 3 species

Hypericaceae
Hypericum – 1 species

Iridaceae
Iris – 1 species

Juncaceae
Juncus – 2 species

Lamiaceae
Clinopodium – 1 species
Discretitheca – 1 species
Eriophyton – 2 species
Isodon – 3 species
Microtoena – 1 species
Nepeta – 1 species
Salvia – 1 species

Lauraceae
Litsea – 1 species
Machilus – 1 species

Lythraceae
Rotala – 1 species

Oleaceae
Jasminum – 1 species

Onagraceae
Epilobium – 2 species

Orchidaceae
Bhutanthera – 1 species
Bulbophyllum – 1 species
Eria – 4 species
Gastrochilus - 1 species
Herminium - 1 species
Liparis – 2 species
Malaxis – 2 species
Neottia – 2 species
Oberonia – 1 species
Odontochilus – 1 species
Oreorchis – 1 species
Panisea – 1 species
Pleione – 1 species
Sunipia – 1 species

Orobanchaceae
Euphrasia – 1 species
Pedicularis – 13 species

Papaveraceae
Corydalis – 9 species
Meconopsis – 11 species

Plantaginaceae
Lagotis – 1 species
Veronica – 1 species

Poaceae
Borinda – 1 species
Elymus – 1 species
Eulaliopsis – 1 species
Festuca – 3 species
Himalayacalamus – 5 species
Poa - 3 species
Saccharum – 1 species
Sinarundinaria – 1 species
Stipa – 1 species
Thamnocalamus – 1 species

Polygonaceae
Bistorta – 3 species
Fagopyrum – 1 species
Fallopia – 1 species

Primulaceae
Primula – 5 species

Ranunculaceae
Aconitum – 10 species
Anemone – 1 species
Clematis – 3 species
Delphinium – 3 species
Oxygraphis – 1 species
Ranunculus – 2 species

Rosaceae
Potentilla – 2 species
Prunus – 4 species
Sibbaldia – 1 species
Sorbus – 1 species

Rubiaceae
Galium – 2 species
Ophiorrhiza – 1 species

Salicaceae
Salix – 3 species

Saxifragaceae
Saxifraga – 21 species

Scrophulariaceae
Scrophularia – 2 species

Urticaceae
Pilea – 1 species

Zingiberaceae
Roscoea – 3 species

Table 2. List of families having ten or more than ten species of endemic flowering plants of Nepal

Apiaceae – 28 species	*Ranunculaceae* – 20 species
Asteraceae – 22 species	*Poaceae* – 17 species
Fabaceae – 21 species	*Orobanchaceae* – 14 species
Saxifragaceae – 21 species	*Balsaminaceae* – 10 species
Orchidaceae – 20 species	*Gentianaceae* – 10 species
Papaveraceae – 20 species	*Lamiaceae* – 10 species

Table 3. List of genera having five or more than five species of endemic flowering plants of Nepal

Saxifraga – 21 species	*Begonia* – 7 species
Pedicularis – 13 species	*Carex* – 7 species
Meconopsis – 11 species	*Oxytropis* – 7 species
Aconitum – 10 species	*Saussurea* – 7 species
Impatiens – 10 species	*Silene* – 7 species
Astragalus – 9 species	*Gentiana* – 5 species
Corydalis – 9 species	*Himalayacalamus* – 5 species
Acronema – 8 species	*Primula* – 5 species

Conclusion

For the proper conservation measures to be undertaken for the endemic flowering plants of Nepal a systematic investigation of these plants should be carried out in order to understand their natural habitat, which will furnish the ecological requirements of different species. Rajbhandari *et al*. (2015) reported that there are 128 species of herbarium specimens of endemic flowering plants of Nepal preserved in the National Herbarium of Nepal (KATH). For the identification as well as to know the locality and habitat of these endemic plants it is essential that the specimens of all the Nepalese endemic species should be represented in the Herbarium of Nepal.

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References

Bhuju, U. R., Shakya, P. R., Basnet, T. B. and Shrestha, S. 2007. *Nepal biodiversity resource book: Protected areas, Ramsar sites and world heritage sites*. International Centre for Integrated Mountain Development, Kathmandu, Nepal.

Bruchmann, I. and Hobohm, C. 2014. Factors that create and increase endemism. *In*: Hobohm, C. (ed.), *Endemism in vascular plants*. Springer Science+Business Media Dordrecht, 51-68.

Cantino, P. D., Wagstaff, S. J. and Olmstead, R. G. 1999. *Caryopteris* (Lamiaceae) and the conflict between phylogenetic and pragmatic considerations in botanical nomenclature. *Syst. Bot*. 23(3): 369-386.

Chaudhary, R. P. 1998. *Biodiversity of Nepal: Status and conservation*. S. Devi, Saharanpur (U. P.),

India and Tecpress Books, Bangkok, Thailand.

Ghimire, S. K. 2005. The endemic flora in Dolpo, north-west Nepal: Distribution patterns, life forms, habitat specificity and conservation status. *Botanica Orientalis* (Nepal) 5: 30-39.

Good, R. 1974. *The Geography of the flowering plants*. Longman Group Ltd., London, U. K.

Hara, H., Stearn, W. T. and Williams, L. H. J. (eds.). 1978. *An enumeration of the flowering plants of Nepal Vol. 1*. British Museum (Natural History) London.

Hara, H., Stearn, W. T. and Williams, L. H. J. (eds.). 1982. *An enumeration of the flowering plants of Nepal Vol. 3*. British Museum (Natural History), London.

Hara, H. and Williams, L. H. J. (eds.). 1979. *An enumeration of the flowering plants of Nepal Vol. 2*. British Museum (Natural History), London.

Joshi, A. R. and Joshi, D. P. 1991. Endemic plants of Nepal Himalaya: Conservation status and future direction. *Mountain Environment and Development* (Nepal) 1(2):1-35.

MacArthur, R. H. and Wilson, E. O. 1967. *The theory of island biogeography.* Princeton University Press, Princeton, NJ.

Miehe, G., Welk, E., Kluge, J. and Pendry, C. 2015. Himalayan plant distribution patterns. *In*: Miehe, G., Pendry, C. and Chaudhary, R. (eds.), *Nepal: An introduction to the natural history, ecology and human environment of the Himalayas*. Royal Botanic Garden Edinburgh, Edinburgh, U. K., pp. 144-167.

Press, J. R., Shrestha, K. K. and Sutton, D. A. 2000. *Annotated checklist of the flowering plants of Nepal*. Natural History Museum, London.

Rajbhandari, K. R. 2013. Endemic flowering plants. *In*: Jha, P. K., Neupane, F. P., Shrestha, M. L. and Khanal, I. P. (eds.), *Biological diversity and conservation. Nepalpedia Series No. 2*, Nepal Academy of Science and Technology (NAST), Lalitpur, Nepal, pp. 309-313.

Rajbhandari, K. R. 2016. History of botanical explorations in Nepal: 1802-2015. *In*: Jha, P. K., Siwakoti, M. and Rajbhandary, S. (eds.), *Frontiers of botany*, Central Department of Botany, Tribhuvan University, Kathmandu, Nepal, pp. 1-99.

Rajbhandari, K. R. and Adhikari, M. K. 2009. *Endemic flowering plants of Nepal, Part 1*. Department of Plant Resources Bulletin Special Publication 1. Department of Plant Resources, Kathmandu, Nepal.

Rajbhandari, K. R., Bhatt, G. D., Chhetri, R. and Rai, S. K. 2015. *Catalogue of Nepalese flowering plants Supplement 1*. Government of Nepal, National Herbarium and Plant Labaoratories, Department of Plant Resources, Godawari, Lalitpur, Nepal.

Rajbhandari, K. R. and Dhungana, S. K. 2010. *Endemic flowering plants of Nepal, Part 2*. Department of Plant Resources Bulletin Special Publication 2. Department of Plant Resources, Kathmandu, Nepal.

Rajbhandari, K.R. and Dhungana, S. K. 2011a. *Endemic Flowering Plants of Nepal, Part 3*. Department of Plant Resources Bulletin Special Publication 3. Department of Plant Resources, Kathmandu, Nepal.

Rajbhandari, K. R. and Dhungana, S. K. 2011b. Diversity of the endemic flowering plants of Nepal. *Bull. Dept. Pl. Res*. (Nepal) 33: 7-11.

Shrestha, T.B. and Joshi, R. M. 1996. *Rare, endemic and endangered plants of Nepal*. WWF Nepal Program, Kathmandu, Nepal.

Appendix 1: List of the flowering plants of Nepal reported as endemic to Nepal by different authors (Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Bhuju *et al*., 2007; Rajbhandari & Adhikari, 2009; Rajbhandari & Dhungana, 2010, 2011a; Rajbhandari *et al*., 2015), but now also reported from outside Nepal. (Distr. = Distribution. W. = West Nepal (from western border to 83° E longitude. C. = Central Nepal (from 83° E longitude to 86°30' E longitude). E. = East Nepal (from 86°30' E longitude to eastern border).

ACANTHACEAE

Strobilanthes angustifrons C. B. Clarke in Hooker, Fl. Brit. Ind. 4: 466 (1884).
Goldfussia acuminata P. R. Shakya, J. Jap. Bot. 50: 99 (1975).
Distr.: India (West Himalaya), W. Nepal.

Strobilanthes cuneata (P. R. Shakya) J. R. I. Wood, Edinb. J. Bot. 51(4): 218 (1994).
Dossifluga cuneata P. R. Shakya, J. Jap. Bot. 50: 99 (1975).
Distr.: C. Nepal, China (Tibet).

Strobilanthes lamiifolia (Nees) T. Anders., J. Linn. Soc., Bot. 9: 476 (1867).
Goldfussia lamiifolia Nees in Wallich, Pl. Asiat. Rar. 3: 88 (1832).
Pteracanthus rotundifolius (D. Don) Bremek., Verh. Kon. Ned. Akad. Wetens., Afd. Natuurk., Tweede Sect. 2, 41(1): 199 (1944).
Ruellia rotundifolia D. Don, Prodr. Fl. Nepal. 120 (1825).
Distr.: India, C. Nepal, Bhutan, China.

Strobilanthes tamburensis C. B. Clarke in Hooker, Fl. Brit. Ind. 4: 454 (1884).
Distr.: E. Nepal, Bhutan.

Strobilanthes tomentosa (Nees) J. R. I. Wood, Kew Bull. 64: 16 (2009).
Aechmanthera tomentosa Nees in Wallich, Pl. Asiat. Rar. 3: 87 (1832).
Aechmanthera claudiae Bernardi, Candollea 18: 243 (1963).
Distr.: Pakistan, India, Nepal, Bhutan, Bangladesh, China, Myanmar, Laos.

APIACEAE

Arcuatopterus harae (Pimenov) Pimenov & Ostr., Feddes Repert. 111: 557 (2000).
Angelica harae Pimenov, Feddes Repert. 98 (7-8): 379 (1987).
Distr.: E. Nepal, India (Himalaya).

Cortia depressa (D. Don) C. Norman, J. Bot. 75: 96 (1937).
Athamanta depressa D. Don, Prodr. Fl. Nepal. 184 (1825).
Schulzia nepalensis (C. Norman) M. Hiroe, Umbell. World 765 (1979).
Cortia nepalensis C. Norman, J. Bot. 67: 245 (1929).
Cortia lindleyi DC., Prodr. 4: 187 (1830).
Cortia oreomyrrhiformis Farille & Malla, Candollea 40: 545 (1985).
Distr.: Nepal, India (Darjeeling, Sikkim), Bhutan, China (Tibet).

Cortiella hookeri (C. B. Clarke) C. Norman, J. Bot. 75: 94 (1937).
Cortia hookeri C. B. Clarke in Hooker, Fl. Brit. Ind. 2: 702 (1879).
Pleurospermum glaciale (Bonner) M. Hiroe, Umbell. World 747 (1979).
Cortiella glacialis Bonner, Candollea 13: 320 (1951).
Distr.: E. Nepal, India (Sikkim), Bhutan, China (Tibet).

Dolpojestella mallaeana (Farille & Malla) Farille & Lachard, Acta Bot. Galli. 149(4): 370 (2002).
Chamaesium mallaeanum Farille & Malla, Candollea 40: 536 (1985).
Distr.: C. Nepal, China (Tibet).

Heracleum woodii M. F. Watson, Edinb. J. Bot. 53: 133 (1996).
Distr.: C. Nepal, India (Sikkim), Bhutan.

Kedarnatha hameliana (Farille & Malla) Pimenov & Kljuykov, Feddes Repert. 115: 235 (2004).
Indoschulzia hameliana (Farille & S. B. Malla) Pimenov & Kljuykov, Kew Bull. 50 (3): 641 (1995).
Trachydium hamelianum Farille & S. B. Malla, Bull. Soc. Bot. Fr. Lett. Bot. 131 (1): 64 (1984).

Distr.: C. Nepal, Bhutan.

Keraymonia cortiformis Farille, Cauwet-Marc & S. B. Malla, Candollea 40 (2): 531 (1985).
Distr.: C. Nepal, Bhutan.

Peucedanum nepalense P. K. Mukh., Ind. For. 95: 567 (1969).
Peucedanum glaucum DC., Prodr. 4: 179 (1830).
Distr.: India, C. Nepal.

Pimpinella pimpinellisimulacrum (Farille & S. B. Malla) Farille, Candollea 40: 554 (1985).
Similisinocarum pimpinellisimulacrum Farille & S. B. Malla, Bull. Soc. Bot. Fr. Lett. Bot. 131 (1): 70 (1984).
Distr.: C. Nepal, China (Tibet).

Pimpinella tongloensis P. K. Mukh., Bull. Bot. Surv. Ind. 12: 78 (1970).
Pimpinella diversifolia DC. var. *alpina* C. B. Clarke in Hooker, Fl. Brit. Ind. 2: 688 (1879).
Distr.: C. Nepal, India (Darjeeling).

Pleurospermum rotundatum (DC.) C. B. Clarke in Hooker, Fl. Brit. Ind. 2: 703 (1879).
Hymenolaena rotundata DC., Prodr. 4: 245 (1830).
Distr.: C. Nepal, China (Tibet).

APOCYNACEAE

Caralluma staintonii H. Hara, J. Jap. Bot. 52: 357 (1977).
Apteranthes staintonii (H. Hara) Meve & Liede, Pl. Syst. Evol. 234 (1-4): 199 (2002).
Distr.: India, W. Nepal.

ARACEAE

Arisaema costatum (Wall.) Mart. ex Schott, Melet. Bot.: 17 (1832).
Arum costatum Wall., Tent. Fl. Napal.: 28 (1824).
Distr.: C. Nepal, China.

Arisaema exappendiculatum H. Hara, J. Jap. Bot. 40: 21 (1965).
Distr.: E. Nepal, China.

Arisaema vexillatum H. Hara & H. Ohashi, J. Jap. Bot. 48: 99 (1973).
Distr.: E. Nepal, China (Tibet).

ASTERACEAE

Artemisia tukuchaensis Kitam., Acta Phytotax. Geobot. 30: 127 (1979).
Distr.: C. Nepal, Bhutan.

Cirsium nishiokae Kitam., Acta Phytotax. Geobot. 23: 75 (1968).
Distr.: Nepal, India (Darjeeling).

Cremanthodium nepalense Kitam., Acta Phytotax. Geobot. 15: 105 (1954).
Distr.: C. Nepal and China (Tibet).

Cremanthodium purpureifolium Kitam., Acta Phytotax. Geobot. 15: 106 (1954).
Distr.: Nepal and China (Tibet).

Saussurea laminamaensis Kitam., Acta Phytotax. Geobot. 32: 140 (1981).
Distr.: E. Nepal, India (Sikkim).

Saussurea spicata Ludlow ex Kitam., Acta Phytotax. Geobot. 30: 128 (1979).
Distr.: C. Nepal, India (Sikkim), Bhutan.

Saussurrea graminifolia Wall. ex DC., Prodr. 6: 536 (1838).
Saussurea stafleuana Lipsch., Novosti Sist. Vyssh. Rast. 19: 181 (1982).
Distr.: India, Nepal, Bhutan, China.

Saussurea topkegolensis H. Ohba & S. Akiyama in Ohba & Akiyama, Alpine Fl. Jaljale Himal: 68 (1992).
Distr.: E. Nepal, China.

Taraxacum mucronulatum van Soest, Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 270 (1961).
Distr.: W. Nepal, India (E. Himalaya).

BALSAMINACEAE

Impatiens insignis DC., Prodr. 1: 688 (1824).
Distr.: C. Nepal, India (E. Himalaya).

Impatiens leptoceras DC., Prodr. 1: 688 (1824).
Distr.: C. Nepal, India (E. Himalaya), China.

Impatiens sunkoshiensis S. Akiyama, H. Ohba & Wakabaya. in Ohba & Malla, Himal. Pl. 2: 77 (1991).
Distr.: E. Nepal, Bhutan.

BERBERIDACEAE

Berberis hamiltoniana Ahrendt, Gard. Ill. 64: 426 (1944).
Distr.: India, Nepal, China (Tibet).

Berberis karnaliensis Bh. Adhikari, Edinb. J. Bot. 69: 500 (2012).
Distr.: India, W. Nepal.

Berberis wallichiana DC., Prodr. 1: 107 (1824).
Berberis poluninii Ahrendt, J. Linn. Soc. Bot. 57: 73 (1961).
Distr.: C. Nepal, India (E. Himalaya), Bhutan.

BRASSICACEAE

Cardamine nepalensis N. Kurosaki & H. Ohba, J. Jap. Bot. 64 (5): 135 (1989).
Distr.: C. Nepal, India (Sikkim).

Diplotaxis harra (Forssk.) Boiss., Fl. Orient. 1: 388 (1867).
Diplotaxis nepalensis H. Hara, J. Jap. Bot. 49: 129 (1974).
Distr.: SW Europe, N Africa, SW Asia, Afghanistan, Pakistan, India, W. Nepal.

Erysimum benthamii Monnet, Notul. Syst. (Paris) 2: 242 (1912).
Erysimum dolpoense H. Hara, J. Jap. Bot. 50: 265 (1975).
Distr.: India, C. Nepal, Bhutan, China, Myanmar.

Eutrema lowndesii (H. Hara) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 133 (2005).
Glaribraya lowndesii H. Hara, J. Jap. Bot. 53: 136 (1978).
Taphrospermum lowndesii (H. Hara) Al-Shehbaz, Harvard Pap. Bot. 5(1): 106 (2000).
Distr.: C. Nepal, China.

CARYOPHYLLACEAE

Silene holosteifolia Bocquet & Chater in Hara & Williams, Enum. Fl. Pl. Nepal 2: 55 (1979).
Distr.: C. Nepal, Bhutan.

Silene indica Roxb. ex Otth in DC., Prodr. 1: 368 (1824).
Silene pseudocashmeriana Bocquet & Chater in Hara & Williams, Enum. Fl. Pl. Nepal 2: 56 (1979).
Distr.: Pakistan, India, Nepal, Bhutan, China (Tibet).

Stellaria congestiflora H. Hara, J. Jap. Bot. 52: 195 (1977).
Distr.: C. Nepal, India (Sikkim), Bhutan, China (Tibet).

CELASTRACEAE

Euonymus forbesianus Loes., Engl. Jahrb. 30: 457 (1902) as '*forbesiana*'.
Distr.: India, Nepal, China, Myanmar, Cambodia, Vietnam.

Euonymus nanoides Loes. & Rehder, Pl. Wilson. 1(3): 492 (1913).
Euonymus oresbius W. W. Sm., Notes Roy. Bot. Gard. Edinb. 10(46): 34 (1917) as '*oresbia*'
Distr.: Nepal (doubtful)

Maytenus ovatus (Wall ex Wight & Arn.) Loes. in Engl. & Prantl., Nat. Pflanzenfam. 20b: 140 (1942).
Celastrus ovatus Wall. ex Wight & Arn., Prodr. 159 (1834).
Gymnosporia ovata Wall. ex M. Lawson in Hooker, Fl. Brit. Ind. 1: 619 (1875).
Distr.: India (Karnataka, Tamil Nadu and Kerala, endemic to India)

CRASSULACEAE

Rhodiola amabilis (H. Ohba) H. Ohba, J. Jap. Bot. 51: 386 (1976).
Sedum amabile H. Ohba, J. Jap. Bot. 51: 295 (1976).
Distr.: C. Nepal, Bhutan.

CYPERACEAE

Carex breviprophylla O. Yano, Bot. J. Linn. Soc. 179: 20 (2015).
Kobresia gandakiensis Rajbh. & H. Ohba in Ohba & Malla, Himal. Pl. 2: 132 (1991).
Distr.: C. Nepal, India (Sikkim).

Carex fissiglumis (C. B. Clarke) S. R. Zhang & O. Yano, Bot. J. Linn. Soc. 179: 21(2015).
Kobresia fissiglumis C. B. Clarke in Hooker, Fl. Brit. Ind. 6: 696 (1894).

Kobresia esenbeckii (Kunth) Noltie var. *fissiglumis* (C. B. Clarke) Noltie, Edinb. J. Bot. 50(1): 43 (1993).
Distr.: Nepal, China.

Carex harae (Rajbh. & H. Ohba) O. Yano, Bot. J. Linn. Soc. 179: 22 (2015).
Kobresia harae Rajbh. & H. Ohba, J. Jap. Bot. 62: 193 (1987).
Distr.: C. Nepal, India (Sikkim).

Carex kanaii (Rajbh. & H. Ohba) S. R. Zhang & O. Yano, Bot. J. Linn. Soc. 179: 22 (2015).
Kobresia kanaii Rajbh. & H. Ohba in Ohba & Malla, Himal. Pl. 2: 135 (1991).
Distr.: India, C. Nepal.

Carex obscura Nees, Contr. Bot. Ind: 126 (1834).
Distr.: India, Nepal.

Schoenoplectiella juncoides (Roxb.) Lye, Lidia 6: 25 (2003).
Scirpus juncoides Roxb., Fl. Ind. 1: 218 (1820).
Schoenoplectus juncoides (Roxb.) Palla, Bot. Jahrb. Syst. 10: 299 (1888).
Scirpus quadrangulus D. Don, Prodr. Fl. Nepal.: 40 (1825).
Distr.: Asia to Pacific, C. Nepal.

ERIOCAULACEAE

Eriocaulon nepalense Prescott ex Bong., Mem. Acad. Imp. Sci. St. Petersb. Ser. 6, Sci. Math. 1: 610 (1831).
Eriocaulon staintonii Satake, J. Jap. Bot. 48: 316 (1973).
Distr.: E. Nepal, India (Himalaya).

EUPHORBIACEAE

Baliospermum nepalense Hurusawa & Ya. Tanaka in Hara, Fl. E. Himal. 174 (1966).
Distr.: E. Nepal, India (Sikkim), Bhutan.

Euphorbia pseudosikkimensis (Hurusawa & Ya. Tanaka) Radcl.-Sm., Kew Bull. 32: 216 (1981).
Tithymalus pseudosikkimensis Hurusawa & Ya. Tanaka in Hara, Fl. E. Him. 182 (1966).
Euphorbia schillingii Radcl.-Sm., Kew Mag. 4 (3): 112 (1987).
Distr.: Nepal, India (Sikkim), Bhutan, China.

Euphorbia rosea Retz., Obser. Ot. 4: 26 (1786).
Distr.: Afghanistan, Nepal, Sri Lanka.

Glochidion nubigenum Hook. f., Fl. Brit. Ind. 5: 315 (1887).
Glochidion metanubigenum Hurusawa & Ya. Tanaka in Hara, Fl. E. Himal. 177 (1966).
Distr.: India, Nepal, Bhutan, Thailand.

FABACEAE

Acacia eburnea Willd., Sp. Pl. 4(2): 1081 (1806).
Distr.: C. Asia, Afghanistan, India, Nepal, Sri Lanka.

Caragana gerardiana Royle, Ill. B. Him. T. 39, f. 1 (1834).
Caragana campanulata Vass., Nov. Syst. Pl. Vasc. 13: 195 (1976).
Distr.: Pakistan, India, C. Nepal.

Ormosia glauca Wall., Pl. Asiat. Rar. 2: 23 (1831).
Distr.: Nepal, India (Sikkim).

GENTIANACEAE

Gentiana decemfida Buch.-Ham. ex D. Don, Prodr. Fl. Nepal.: 127 (1825).
Distr.: India (Himalaya), Nepal.

Lomatogonium micranthum H. Sm., J. Jap. Bot. 56: 277 (1967).
Distr.: C. Nepal China (Tibet).

Swertia paniculata Wall., Pl. Asiat. Rar. 3: 3 (1831).
Swertia gracilescens H. Sm., Bull. Brit. Mus. (Nat. Hist.) Bot. 4: 251 (1970).
Distr.: India, C. Nepal, Bhutan, China, Myanmar.

Tripterospermum nigrobaccatum H. Hara, J. Jap. Bot. 40: 19 (1965).
Distr.: E. Nepal, India (Darjeeling, Sikkim), Bhutan.

LAMIACEAE

Elsholtzia concinna Vautier, Candollea 17: 43 (1959).
Distr.: E. Nepal, Bhutan.

Eriophyton tuberosum (Hedge) Ryding, Taxon 60: 483 (2011).
Lamium tuberosum Hedge, Notes Roy. Bot. Gard.

Edinb. 25: 49 (1963).
Distr.: W. Nepal, China (Tibet).

LENTIBULARIACEAE

Utricularia christopheri P. Taylor, Kew Bull. 41: 12 (1986).
Distr.: E. Nepal, India (Sikkim).

ORCHIDACEAE

Habenaria edgeworthii Hook. f. ex Collett in Collett, Fl. Siml.: 504 (1902).
Platanthera edgeworthii (Hook. f. ex Collet) R. K. Gupta, Fl. Nainitalensis: 349 (1968).
Distr.: Pakistan, India, Nepal, Bhutan.

Oberonia prainiana King & Pantl., J. Asiat. Soc. Bengal 64(3): 331 (1896).
Distr.: India, Nepal.

Peristylus densus (Lindl.) Santapau & Kalipada, J. Bombay Nat. Hist. Soc. 57: 128 (1960).
Coeloglossum densum Lindl., Gen. Sp. Orchid. Pl.: 302 (1832).
Distr.: Nepal, India (Sikkim).

OROBANCHACEAE

Pedicularis confertiflora Prain, J. Asiat. Soc. Bengal 58 (2): 258 (1989).
Pedicularis sectifolia Yamazaki, J. Jap. Bot. 45: 172 (1970).
Distr.: India, W. Nepal, Bhutan, China.

Pedicularis poluninii Tsoong, Acta Phytotax. Sin. 3: 290, 323 (Jan. 1955).
Distr.: C. Nepal, China (Tibet).

Pedicularis siphonantha D. Don, Prodr. Fl. Nep.: 95 (1825).
Pedicularis tsoongii Yamazaki, J. Jap. Bot. 45: 174 (1970).
Distr.: India, W. Nepal, Bhutan, China.

Pedicularis wallichii Bunge, Bull. Acad. Imp. Sci. Saint-Petersb. 8: 251 (1843).
Pedicularis wallichoides Yamazaki, J. Jap. Bot. 46: 246 (1971).
Distr.: C. Nepal, China (Tibet).

PAPAVERACEAE

Corydalis lathyroides Prain, J. Asiat. Soc. Bengal 65(2): 23 (1896).
Corydalis brevicalcarata Ludlow, Bull. Brit. Mus. (Nat. Hist.), Bot. 5: 287 (1975).
Distr.: India (Uttar Pradesh, Sikkim), W. Nepal, Bhutan.

Corydalis latiflora Hook. f. & Thomson, Fl. Ind.: 270 (1855).
Corydalis alburyi Ludlow, Bull. Brit. Mus. (Nat. Hist.), Bot. 5: 49 (1975).
Distr.: W. Nepal, India (Sikkim), Bhutan, China (Tibet).

Corydalis staintonii Ludlow, Bull. Brit. Mus. (Nat. Hist.), Bot. 5: 65 (1975).
Corydalis sykesii Ludlow, Bull. Brit. Mus. (Nat. Hist.) Bot. 5: 66 (1975).
Distr.: W. and C. Nepal, India (Sikkim), Bhutan.

Meconopsis dhwojii G. Tayl. ex Hay, New Fl. & Silva 4: 225 (1932).
Distr.: C. & E. Nepal, China (Tibet).

POACEAE

Bromus nepalensis Melderis in Hara *et al*., Enum. Fl. Pl. Nepal 1: 125 (1978).
Distr.: C. Nepal, China (Tibet).

Deyeuxia nepalensis Bor, Kew Bull. 1957: 411 (1958).
Calamagrostis staintonii G. Singh, Taxon 33(1): 94 (1984).
Distr.: C. Nepal, China (Sichuan, Yunnan).

Duthiea brachypodium (P. Candargy) Keng & Keng f., Acta Phytotax. Sin. 10(2): 182 (1965).
Duthiea nepalensis Bor, Kew Bull. 1953: 550 (1954).
Distr.: C. Nepal, Bhutan, China.

Elymus antiquus (Nevski) Tzvelev, Rast. Tsentr. Azii 4: 20 (1968).
Elymus microlepis (Melderis) Melderis in Hara *et al*., Enum. Fl. Pl. Nepal 1: 131 (1978).
Agropyron microlepis Melderis in Bor, Grass. Ind.: 692 (1960).

Agropyron antiquus Nevski, Izv. Bot. Sada Akad. Nauk SSSR 30: 515 (1932).
Distr.: W. Nepal, China.

Poa albertii Regel subsp. **arnoldii** (Melderis) Olonova & G. Zhu, Fl. China 22: 308 (2006).
Poa arnoldii Melderis in Hara *et al*., Enum. Fl. Pl. Nepal 1: 142 (1978).
Distr.: W. Nepal, China.

Poa harae Rajbh., Acta Phytotax. Geobot. 39: 55 (1988).
Distr.: E. Nepal, India (Sikkim, Assam).

Poa hylobatis Bor, Bull. Bot. Surv. Ind. 7: 132 (1965).
Distr.: W. Nepal, China.

Poa kanaii Rajbh., Acta Phytotax. Geobot. 39: 58 (1988).
Distr.: India (Garhwal), C. Nepal. 4600 m.

Poa mustangensis Rajbh., Acta Phytotax. Geobot. 39: 61 (1988).
Distr.: India, C. Nepal, Bhutan, China.

Poa rajbhandarii Noltie, Edinb. J. Bot. 57: 288 (2000).
Distr.: India, Nepal, Bhutan, China.

Poa stapfiana Bor, Kew Bull. 1949: 239 (1949).
Poa x digyna Melderis in Hara *et al*., Enum. Fl. Pl. Nepal 1: 143 (1978).
Distr.: Iran, Pakistan, India (W. Himalaya, Sikkim), C. Nepal, ?China (Tibet).

POLYGONACEAE

Bistorta jaljalensis H. Ohba & S. Akiyama, Alpine Fl. Jaljale Himal: 10 (1992).
Distr.: India, E. Nepal, Bhutan, China.

Bistorta sherei H. Ohba & S. Akiyama, Alpine Fl. Jaljale Himal: 11 (1992).
Distr.: E. Nepal, Bhutan, China (Tibet).

PRIMULACEAE

Primula aureata Fletcher, Gard. Ill. 63: 283 (1941).
Distr.: C. and E. Nepal, India (Sikkim).

RANUNCULACEAE

Aconitum alpino-nepalense Tamura, Acta Phytotax. Geobot. 23: 100 (1968).
Distr.: E. Nepal, China (Tibet). 4350 m.

Aconitum heterophylloides (Bruehl) Stapf , Ann. Roy. Bot. Gard. (Calcutta) 10(2): 171 (1905).
Aconitum nepalense Lauener, Notes Roy. Bot. Gard. Edinb. 25: 24 (1963).
Distr.: C. Nepal, India (Sikkim), Bhutan, China (Tibet).

Aconitum soongaricum Stapf, Ann. Roy. Bot. Gard. (Calcutta) 10(2): 141 (1905).
Distr.: C. Asia, India, Nepal, China.

Aconitum spicatum (Bruehl) Stapf, Ann. Roy. Bot. Gard. (Calcutta) 10(2): 165 (1905).
Aconitum balangrense Lauener, Notes Roy. Bot. Gard. Edinb. 26: 3 (1964).
Aconitum deltoideum Lauener, Notes Roy. Bot. Gard. Edinb. 32: 411 (1973).
Aconitum tamuranum Lauener, Notes Roy. Bot. Gard. Edinb. 26: 3 (1964).
Distr.: India, Nepal, Bhutan, China.

Anemone polycarpa W. E. Evans, Notes Roy. Bot. Gard. Edinb. 13: 154 (1921).
Anemone obtusiloba D. Don subsp. *omalocarpella* Bruehl, Ann. Bot. Gard. (Calcutta) 5: 78 (1896).
Distr.: Nepal, India (Sikkim), Bhutan, China.

Clematis alternata Kitam. & Tamura, Acta Phytotax. Geobot. 15: 129 (1954).
Distr.: C. Nepal, China (Tibet).

Clematis connata DC. var. **confusa** (Grey-Wilson) W. T. Wang, Acta Phytax. Sinica 39(1): 14 (2001).
Clematis confusa Grey-Wilson, Kew Mag. 8: 161 (1991).
Distr.: E. Nepal, China.

Clematis orientalis L., Sp. Pl.: 543 (1753).
Distr.: Central Europe, Asia.

Delphinium altissimum Wall., Pl. Asiat. Rar. 2 (6): 25 (1831).
Distr.: C. Nepal, India (NE India), Bhutan, China (Tibet).

Delphinium cashmerianum Royle, Ill. Bot. Himal. Mts. 1 (2): 55 (1834).
Distr.: W. & C. Nepal, India.

Delphinium tabatae Tamura, Acta Phytotax. Geobot. 37: 156 (1986).
Distr.: W. Nepal, China (Tibet).

Ranunculus albertii Regel & Schmalh., Acta Hort. Petrop. 5: 223 (1877).
Distr.: Nepal, China.

Ranunculus glabricaulis (Hand.-Mazz.) L. liou, Fl. Reipubl. Popularis Sin. 28: 298 (1980).
Distr.: Nepal, China.

Ranunculus cantoniensis DC.
Ranunculus napaulensis DC., Prodr. 1: 39 (1824).
Distr.: C. Nepal, Bhutan, China, S. Korea, Japan.

Thalictrum dalzellii Hook., Icon. Pl. 9: t. 868 (1852).
Distr.: India, Nepal.

Thalictrum rotundifolium DC., Syst. Nat. 1: 185 (1817).
Distr.: C. Nepal, China (Tibet).

Thalictrum squamiferum Lecoy., Bull. Soc. Bot. Belg. 16: 229 (1877).
Distr.: Nepal, India (Sikkim), Bhutan, China.

ROSACEAE

Cotoneaster acuminatus Lindl., Trans. Linn. Soc. London 13(1): 101 (1822).
Cotoneaster bisramianus Klotz, Wiss. Z. Univ. Jena, Math. 21: 996 (1972).
Cotoneaster paradoxus Klotz, Wiss. Z. Univ. Jena, Math. 27(1): 24 (1978).
Cotoneaster staintonii Klotz, Wiss. Z. Univ. Jena, Math. 21: 971 (1972).
Distr.: India, Nepal, Bhutan, China.

Cotoneaster affinis Lindl. , Trans. Linn. Soc. London 13(1): 101 (1822).
Cotoneaster virgatus Klotz, Wiss. Z. Univ. Jena, Math. 27(1): 22 (1978).
Cotoneaster wattii Klotz, Wiss. Z. Univ. Jena, Math. 27(1): 23 (1978).
Distr.: India, Nepal, Bhutan, China.

Cotoneaster integrifolius (Roxb.) G. Klotz, Wiss. Z. Martin-Luther-Univ. Halle-Wittenberg, Math.-Naturwiss. Reihe 12(10): 779 (1963).
Cotoneaster linearifolius (Klotz) Klotz, Wiss. Z. Univ. Jena, Math. 27(1): 20 (1978)
Cotoneaster poluninii Klotz, Wiss. Z. Univ. Jena, Math. 27(1): 21 (1978).
Distr.: India, Nepal, Bhutan, China.

Cotoneaster racemiflorus (Desf.) K Koch, Dendrologie 1: 170 (1869).
Mespilus racemiflorus Desf., Cat. Pl. Horti Paris., ed. 3: 409 (1829).
Cotoneaster inexpectatus Klotz, Wiss. Z. Univ. Jena, Math. 27(1): 23 (1978).
Distr.: Africa, East, Central, North, Southwest Asia, India, Nepal, China.

Potentilla x microcontigua H. Ikeda & H. Ohba, J. Jap. Bot. 68: 35 (1993).
Distr.: E. Nepal.
Note: Hybrid species.

Potentilla x micropeduncularis H. Ikeda & H. Ohba, J. Jap. Bot. 7: 253 (1996).
Distr.: C. Nepal.
Note: Hybrid species.

Potentilla x polyjosephiana H. Ikeda & H. Ohba, J. Linn. Soc., Bot. 112: 183 (1993).
Distr.: E. Nepal.
Note: Hybrid species.

Potentilla saundersiana Royle, Ill. Bot. Him. 207 (1835).
Potentilla williamsii Sojak, Bot. Jahrb. Syst. 109: 25 (1987).
Distr.: India, Nepal, Bhutan, China.

Rubus glandulifer N. P. Balakr., J. Bombay Nat. Hist. Soc. 67: 58 (1970).
Rubus lanatus Wall. ex Hook. f. in Hooker, Fl. Brit. India 2(5): 331 (1896).
Distr.: India, Nepal.

Rubus x semi-nepalensis Naruh., J. Jap. Bot. 65 (6): 187 (1990).
Distr.: E. Nepal.
Note: Hybrid species.

Sibbaldia adpressa Bunge in Ledebour, Fl. Altaic. 1: 428 (1829).
Sibbaldia minutissima Kitam., Acta Phytotax. Geobot. 15: 132 (1955).
Distr.: Russia, C. Nepal, China, Mongolia.

RUBIACEAE

Rubia alata Wall. in Roxburgh, Fl. Ind. 1: 384 (1820).
Distr.: C. Nepal, China.

Wendlandia puberula DC., Prodr. 4: 412 (1830).
Wendlandia appendiculata Wall. ex Cowan, Notes Roy. Bot. Gard. Edinb. 16: 255 (1932).
Distr.: India, C. Nepal, Myanmar.

SALICACEAE

Homalium napaulense (DC.) Benth., J. Linn. Soc. Bot. 4: 34 (1860).
Blackwellia napaulensis DC., Prodr. 2: 54 (1825).
Distr.: India, Nepal, China.

Salix anticecrenata Kimura in Hara, Fl. E. Himal. 3: 14 (1975).
Distr.: E. Nepal, China.

Salix eriostachya Wall. ex Anderss., Kungl. Svensk. Vet. Akad. Handl. 1850: 493 (1851).
Distr.: C. Nepal, India (Sikkim), China.

SCROPHULARIACEAE

Oreosolen williamsii Yamazaki, J. Jap. Bot. 46: 245 (1971).
Distr.: C. Nepal, India (Sikkim).

ZINGIBERACEAE

Roscoea capitata J. E. Sm., Trans Linn. Soc. 13: 461 (1822).
Disstribution: C. Nepal, China (Tibet).

Appendix 2. The following 19 species which were recorded as endemic to Nepal by Rajbhandari & Adhikari (2009), Rajbhandari & Dhungana (2010, 2011a) and Rajbhandari et al. (2015) are now non-endemic to Nepal due to their reports of occurrence outside Nepal.

ACANTHACEAE

Strobilanthes tomentosa (Nees) J. R. I. Wood, Kew Bull. 64: 16 (2009).
Aechmanthera tomentosa Nees in Wallich, Pl. Asiat. Rar. 3: 87 (1832).
Aechmanthera claudiae Bernardi, Candollea 18: 243 (1963).
Distr.: Pakistan, India, Nepal, Bhutan, Bangladesh, China, Myanmar, Laos.
Ref.: Hara *et al.*, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

APIACEAE

Peucedanum nepalense P. K. Mukh, Ind. For. 95: 567 (1969).
Peucedanum glaucum DC., Prodr. 4: 179 (1830).
Distr.: India, C. Nepal.
Ref.: Hara *et al.*, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

APOCYNACEAE

Caralluma staintonii H. Hara, J. Jap. Bot. 52: 357 (1977).
Apteranthes staintonii (H. Hara) Meve & Liede, Pl. Syst. Evol. 234 (1-4): 199 (2002).
Distr.: India, W. Nepal.
Ref.: Hara *et al.*, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

ASTERACEAE

Saussurrea graminifolia Wall. ex DC., Prodr. 6: 536 (1838).
Saussurea stafleuana Lipsch., Novosti Sist. Vyssh. Rast. 19: 181 (1982).
Distr.: India, Nepal, Bhutan, China (Tibet).
Ref.: Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Saussurea topkegolensis H. Ohba & S. Akiyama in Ohba & Akiyama, Alpine Fl. Jaljale Himal: 68 (1992).
Distr.: E. Nepal, China.
Ref.: Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

BERBERIDACEAE

Berberis karnaliensis Bh. Adhikari, Edinb. J. Bot. 69: 500 (2012).
Distr.: India, W. Nepal.
Ref.: Rajbhandari *et al*., 2015.

CYPERACEAE

Carex breviprophylla O. Yano, Bot. J. Linn. Soc. 179: 20 (2015).
Kobresia gandakiensis Rajbh. & H. Ohba in Ohba & Malla, Himal. Pl. 2: 132 (1991).
Distr.: C. Nepal, India (Sikkim).
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Carex harae (Rajbh. & H. Ohba) O. Yano, Bot. J. Linn. Soc. 179: 22 (2015).
Kobresia harae Rajbh. & H. Ohba, J. Jap. Bot. 62: 193 (1987).
Distr.: C. Nepal, India (Sikkim).
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Carex kanaii (Rajbh. & H. Ohba) S. R. Zhang & O. Yano, Bot. J. Linn. Soc. 179: 22 (2015).
Kobresia kanaii Rajbh. & H. Ohba in Ohba & Malla, Himal. Pl. 2: 135 (1991).
Distr.: India, C. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

ERIOCAULACEAE

Eriocaulon nepalense Prescott ex Bong., Mem. Acad. Imp. Sci. St. Petersb. Ser. 6, Sci. Math. 1: 610 (1831).
Eriocaulon staintonii Satake, J. Jap. Bot. 48: 316 (1973).
Distr.: E. Nepal, India (Himalaya).

Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari 2009.

EUPHORBIACEAE

Euphorbia pseudosikkimensis (Hurusawa & Ya. Tanaka) Radcl.-Sm., Kew Bull. 32: 216 (1981).
Tithymalus pseudosikkimensis Hurusawa & Ya. Tanaka in Fl. E. Him. 182 (1966).
Euphorbia schillingii Radcl.-Sm. in Kew Mag. 4 (3): 112 (1987).
Distr.: Nepal, India (Sikkim), Bhutan, China.
Ref.: Hara *et al*., 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

LAMIACEAE

Elsholtzia concinna Vautier, Candollea 17: 43 (1959).
Distr.: E. Nepal, Bhutan.
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Eriophyton tuberosum (Hedge) Ryding O, Taxon 60: 483 (2011).
Lamium tuberosum Hedge, Notes Roy. Bot. Gard. Edinb. 25: 49 (1963).
Distr.: W. Nepal, China (Tibet).
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

PAPAVERACEAE

Meconopsis dhwojii G. Tayl. ex Hay, New Fl. & Silva 4: 225 (1932).
Distr.: C. & E. Nepal, China (Tibet).
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

POACEAE

Bromus nepalensis Melderis in Enum. Fl. Pl. Nepal 1: 125 (1978).
Distr.: C. Nepal, China (Tibet).
Ref.: Hara *et al.*, 1978. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Poa kanaii Rajbh., Acta Phytotax. Geobot. 39: 58 (1988).
Distr.: India (Garhwal), C. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

RUBIACEAE

Rubia alata Wall. in Roxburgh, Fl. Ind. 1: 384 (1820).
Distr.: C. Nepal, China.
Ref.: Hara *et al.*, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Wendlandia puberula DC., Prodr. 4: 412 (1830).
Wendlandia appendiculata Wall. ex Cowan, Notes Roy. Bot. Gard. Edinb. 16: 255 (1932).
Distr.: India, C. Nepal, Myanmar.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Appendix 3. The following 60 endemic species of Nepal are not recorded in the *Endemic Flowering Plants of Nepal part 1, 2, 3* and *Catalogue of Nepalese flowering plants Supplement 1* (Rajbhandari & Adhikari, 2009; Rajbhandari & Dhungana, 2010, 2011a; Rajbhandari *et al*., 2015).

ACANTHACEAE

Strobilanthes nutans ((Nees) T. Anders.
Goldfussia nutans Nees
Thunbergia nepalensis Bh. Adhikari & J. R. I. Wood

APIACEAE
Acronema bryophilum Farille & Lachard
Acronema cryptosciadeum Farille & Lachard
Acronema mukherjeeanum Farille & Lachard
Acronema phaeosciadeum Farille & Lachard
Acronema pneumatophobium Farille & Lachard
Acronema refugicolum Farille & Lachard
Conioselinum nepalense Pimenov & Kljuykov
Lalldhwojia pastinacifolia Pimenov & Kljuykov
Oreocome depauperata Pimenov & Kljuykov
Oreocome involucellata Pimenov & Kljuykov
Pimpinella acronemastrum Farille & Lachard
Pimpinella kawalekhensis Farille & Lachard
Rohmooa kirmzii Farille & Lachard
Sinocarum staintonianum P. K. Mukherjee ex Farille & Lachard
Synclinostyles denisjordanii Farille & Lachard
Synclinostyles exadversum Farille & Lachard

ASTERACEAE
Synotis managensis S. Joshi, K. Shrestha & D. Bajracharya

BALSAMINACEAE
Impatiens recticalcarata S. Akiyama

BEGONIACEAE
Begonia nuwakotensis S. Rajbhandary
Begonia panththarensis S. Rajbhandary
Begonia taligera S. Rajbhandary

BERBERIDACEAE
Berberis pendryi Bh. Adhikari

BRASSICACEAE

Lepidostemon williamsii (H. Hara) Al-Shehbaz
Draba williamsii H. Hara

CUCURBITACEAE
Gomphogyne nepalensis W. J. de Wilde & Duyfjes

CYPERACEAE
Carex staintonii X. F. Jin, H. Ikeda & O. Yano

EUPHORBIACEAE
Leptopus nepalensis B. Adhikari, R. P. Chaudhary & S. K. Ghimire

FABACEAE
Astragalus jumlaensis Podlech
Astragalus lobbichleri Podlech
Astragalus nepalensis Podlech
Astragalus notabilis Podlech
Astragalus poluninii Podlech
Astragalus pseudorigidulus Podlech

ORCHIDACEAE
Bhutanthera fimbriata B. B. Raskoti
Bulbophyllum nepalense Raskoti & Ale
Gastrochilus nepalensis B. B. Raskoti
Herminium hongdeyuanii B. B. Raskoti
Liparis langtangensis B. B. Raskoti & Ale
Neottia chandrae B. B. Raskoti, J. J. Wood & R. Ale
Odontochilus nandae Raskoti & H. Kurzweil
Panisea panchaseensis Subedi
Sunipia nepalensis B. B. Raskoti & R. Ale

OROBANCHACEAE
Pedicularis yamazakiana R. R. Mill

PAPAVERACEAE
Corydalis simplex Liden
Meconopsis autumnalis P. A. Egan
Meconopsis lamjungensis T. Yoshida, H. Sun & Grey-Wilson
Meconopsis manasluensis P. A. Egan
Meconopsis simikotensis Grey-Wilson

POACEAE
Himalayacalamus planatus Stapleton
Poa hideaki-ohbae Rajbh.
Sinarundinaria langtangensis R. Manandhar &

Bajracharya

RANUNCULACEAE
Clematis staintonii W. T. Wang
Delphinium unifolium Tamura

ROSACEAE
Prunus taplejunica H. Ohba & S. Akiyama,
Prunus topkegolensis H. Ohba & S. Akiyama

RUBIACEAE

Galium nepalense Schoenb.-Tem. & Ehrendorfer
Galium saipalense Schoenb.-Tem. & Ehrendorfer
Ophiorrhiza nepalensis Deb & Mondal

SALICACEAE

Salix staintoniana Skvortsov

Appendix 4: List of the endemic flowering plants of Nepal. Reference includes species reported as endemic to Nepal by different authors. Distr. = Distribution. Ref. = Reference. W. = West Nepal (from western border to 83° E longitude. C. = Central Nepal (from 83° E longitude to 86°30' E longitude). E. = East Nepal (from 86°30' E longitude to eastern border).

ACANTHACEAE

Justicia tukuchensis V. A. W. Graham, J. Jap. Bot. 56: 117 (1981).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Strobilanthes bheriensis (P. R. Shakya) J. R. I. Wood, Edinb. J. Bot. 51(4): 218 (1994).
Dossifluga bheriensis P. R. Shakya, J. Jap. Bot. 50: 97 (1975).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Strobilanthes nutans ((Nees) T. Anders., J. Linn. Soc. Bot. 9: 475 (1867).
Goldfussia nutans Nees in Wallich, Plant. Asiat. Rar. 3: 88 (1832).
Distr.: C. Nepal.

Strobilanthes saccata J. R. I. Wood, Edinb. J. Bot. 51: 256 (1994).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Thunbergia nepalensis Bh. Adhikari & J. R. I. Wood, Kew Bull. 68(4): 652 (2013).
Distr.: W. Nepal.

AMARYLLIDACEAE

Allium hypsistum Stearn, Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 188 (1960).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1978; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

APIACEAE

Acronema bryophilum Farille & Lachard, Acta Bot. Galli. 149(4): 373 (2002).
Distr.: C. Nepal.

Acronema cryptosciadeum Farille & Lachard, Acta Bot. Galli. 149(4): 375 (2002).
Distr.: E. Nepal.

Acronema dyssimetriradiata Farille, Cauwet-Marc & S. B. Malla, Candollea 40 (2): 557 (1985).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Acronema johrianum Babu, Brittonia 25: 159 (1973).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Acronema mukherjeeanum Farille & Lachard, Acta Bot. Galli. 149(4): 373 (2002).
Distr.: C. Nepal.

Acronema phaeosciadeum Farille & Lachard, Acta Bot. Galli. 149(4): 374 (2002).
Distr.: C. Nepal.

Acronema pneumatophobium Farille & Lachard, Acta Bot. Galli. 149(4): 374 (2002).
Distr.: C, Nepal.

Acronema refugicolum Farille & Lachard, Acta Bot. Galli. 149(4): 376 (2002).
Distr.: C. Nepal.

Conioselinum nepalense Pimenov & Kljuykov, Willdenowia 33: 361 (2003).
Distr.: C. Nepal.

Cortia staintoniana Farille, Cauwet-Marc & S. B. Malla, Candollea 40: 545 (1985).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Cortiella lamondiana Fullarton & M. F. Watson, Edinb. J. Bot. 53 (1): 130 (1996).

Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Dolpojestella shrestaeanum (Farille & Malla) Farille & Lachard, Acta Bot. Galli. 149 (4): 370 (2002).
Chamaesium shrestaeanum Farille & Malla, Candollea 40: 537 (1985).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Heracleum lallii C. Norman, J. Bot. 67: 247 (1929).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi,1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Keraymonia nipaulensis Farille, Cawet-Marc & S. B. Malla, Candollea 40 (2): 528 (1985).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Keraymonia triradiata Farille, Cawet-Marc & S. B. Malla, Candollea, 40 (2): 531 (1985).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Lalldhwojia pastinacifolia Pimenov & Kljuykov, Willdenowia 32: 93 (2002).
Distr.: C. Nepal.

Lalldhwojia staintonii Farille, Rev. Gen. Bot. 91 (1076-78): 28 (1984).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Oreocome depauperata Pimenov & Kljuykov, Willdnowia 31: 120 (2001).
Distr.: W. Nepal.

Oreocome involucellata Pimenov & Kljuykov, Willdnowia 31: 118 (2001).
Distr.: W. Nepal.

Pimpinella acronemastrum Farille & Lachard, Acta Bot. Galli. 149(4): 379 (2002).
Distr.: C. Nepal.

Pimpinella inundata (Farille & S. B. Malla) P. K. Mukh. & Constance, Edinb. J. Bot. 48: 44 (1991).
Ligusticum inundatum Farille & S. B. Malla, Candolea 40 (2): 551 (1985).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pimpinella kawalekhensis Farille & Lachard, Acta Bot. Galli. 149(4): 378 (2002).
Distr.: W Nepal

Rohmooa kirmzii Farille & Lachard, Acta Bot. Galli. 149(4): 377 (2002).
Distr.: C. Nepal.

Sinocarum normanianum (Cauwet-Marc & Farille) Farille, Candollea 40: 561 (1985).
Similisinocarum normanianum Cauwet-Marc & Farille, Bull. Soc. Bot. Fr. Lett. Bot. 131 (1): 68 (1984).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Sinocarum staintonianum P. K. Mukh. ex Farille & Lachard, Acta Bot. Galli. 149(4): 378 (2002).
Distr.: C. Nepal.

Synclinostyles denisjordanii Farille & Lachard, Acta Bot. Galli. 149(4): 376 (2002).
Distr.: C. Nepal.

Synclinostyles exadversum Farille & Lachard, Acta Bot. Galli. 149(4): 377 (2002).
Distr.: C. Nepal.

Vicatia nepalensis Pimenov, P. K. Mukh. & Kljuykov, Feddes Repert. 102: 377 (1991).
Distr.: W. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

APOCYNACEAE

Brachystelma nepalense (A. R. Sm.) Meve, Kew Bull. 52 (4): 1012 (1997).
Riocreuxia nepalensis A. R. Sm., Kew Bull. 21: 296 (1967).
Distr.: W. Nepal.

Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Ceropegia meleagris H. Huber, Mem. Soc. Brot. 12: 48 (1957).
Distr.: C. Nepal,
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Ceropegia poluniniana Bruyns, Kew Bull. 44: 723 (1989).
Distr.: W. Nepal.
Ref.: Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

ASPARAGACEAE

Asparagus penicillatus H. Hara, J. Jap. Bot. 49: 134 (1974).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1978; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

ASTERACEAE

Artemisia mustangensis Yonek. in Ohba *et al*., Fl. Mustang, Nepal: 339 (2008).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Artemisia nepalica Yonek. in Ohba *et al*., Fl. Mustang, Nepal: 346 (2008).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Cicerbita nepalensis Kitam., Acta Phytotax. Geobot. 30: 127 (1979).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Cirsium flavisquamatum Kitam., Acta Phytotax. Geobot. 26: 16 (1974).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Cirsium phulchokiense Kitam., Acta Phytotax. Geobot. 26: 16 (1974).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Crepis himalaica Kitam., Acta Phytotax. Geobot. 15: 106 (1954).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Leontopodium makianum Kitam., Acta Phytotax. Geobot. 15: 78 (1953).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Leontopodium montisganeshii S. Akiyama, Bull. Natn. Sci. Mus., Tokyo, Ser. B. 25(1): 1 (1999).
Distr.: C. Nepal.
Ref.: Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Saussurea bhutkesh K. Fujikawa & H. Ohba, Edinb. J. Bot. 59: 283 (2002).
Distr.: E. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Saussurea chrysotricha Ludlow, Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 70 (1956).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Saussurea dhwojii Kitam., Acta Phytotax. Geobot. 30: 128 (1979).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Saussurea kanaii K. Fujikawa & H. Ohba, Edinb. J. Bot. 59(2): 286 (2002).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Saussurea linearifolia Ludlow, Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 72 (1956).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Saussurea platyphyllaria Ludlow, Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 73 (1956).
Distr.: W. Nepal.

Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Saussurea rolwalingensis K. Fujikawa & H. Ohba, J. Jap. Bot. 82(6): 328 (2007).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Senecio brunneo-villosus Kitam., Acta Phytotax. Geobot. 30: 129 (1979).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Senecio topkegolensis Kitam., Acta Phytotax. Geobot. 32: 140 (1981).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Synotis managensis S. Joshi, Kanti Shrestha & D. Bajracharya, Pleione 7(2): 542 (2013).
Distr.: C. Nepal.

Synotis panduriformis C. Jeffrey & Y. L. Chen, Kew Bull. 39: 287 (1984).
Senecio panduriformis Kitam., Acta Phytotax. Geobot. 30: 130 (1979).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Taraxacum amabile van Soest, Wentia 10: 8 (1963).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Taraxacum nepalense van Soest, Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 271 (1961).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Taraxacum staintonii van Soest, Wentia 10: 54, t. 25 (1963).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

BALSAMINACEAE

Impatiens arunensis Grey-Wilson, Kew Bull. 44: 65 (1989).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Impatiens bajurensis S. Akiyama & H. Ohba, J. Jap. Bot. 68: 157 (1993).
Distr.: W. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Impatiens gorepaniensis Grey-Wilson, Kew Bull. 44: 715 (1989).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Impatiens harae H. Ohba & S. Akiyama, J. Jap. Bot. 62 (12): 368 (1987).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Impatiens kathmanduensis Grey-Wilson, Kew Bull. 44 (1): 119 (1989).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Impatiens kharensis S. Akiyama, H. Ohba & Wakabaya. in Ohba & Malla, Himal. Pl. 2: 75 (1991).
Distr.: C. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Impatiens mallae S. Akiyama & H. Ohba, J. Jap. Bot. 67: 187 (1992).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Impatiens recticalcarata S. Akiyama, Bull. Natl. Mus. Nat. Sci., Tokyo, B. 35(2): 51 (2009).
Distr.: C. Nepal.

Impatiens scullyi Hook. f., Rec. Bot. Surv. Ind. 4: 15 & 21 (1905).

Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Impatiens williamsii H. Hara, J. Jap. Bot. 47: 142 (1972).
Distr.: W. & C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

BEGONIACEAE

Begonia flagellaris H. Hara, J. Jap. Bot. 48: 358 (1973).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Begonia leptoptera H. Hara, J. Jap. Bot. 48: 98 (1973).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Begonia minicarpa H. Hara, J. Jap. Bot. 47: 112, f. 2 (1972).
Distr.: E. Nepal.
Ref.: Hara & Williams, 1979; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Begonia nuwakotensis S. Rajbhandary, Gard. Bull. Sing. 62(1): 144 (2010).
Distr.: C. Nepal.

Begonia panththarensis S. Rajbhandary, Gard. Bull. Sing. 62(1): 147 (2010).
Distr.: E. Nepal.

Begonia taligera S. Rajbhandary, Gard. Bull. Sing. 62(1): 150 (2010).
Distr.: C. Nepal.

Begonia tribenensis C. R. Rao, J. Bombay Nat. Hist. Soc. 65: 724 (1969).
Distr.: E. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

BERBERIDACEAE

Berberis mucrifolia Ahrendt, J. Roy. Hort. Soc. Lond. 81: 135 (1956).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Berberis pendryi Bh. Adhikari, Edinb. J. Bot. 69: 477 (2012).
Distr.: C. Nepal.

BORAGINACEAE

Arnebia nepalensis (Kitam.) H. Hara in H. Hara *et al.*, Enum. Fl. Pl. Nepal 3: 99 (1982).
Macrotomia nepalensis Kitam. in Kihara, Peoples Nep. Him. 423 (1957).
Distr.: C. Nepal.
Ref.: Hara *et al*., 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Microula mustangensis Yonek. in Ohba *et al*., Fl. Mustang, Nepal: 244 (2008).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Onosma bheriense H. Hara, J. Jap. Bot. 51: 10 (1976).
Distr.: W. Nepal.
Ref.: Hara *et al*., 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Onosma verruculosum I. M. Johnst., J. Arn. Arb. 32: 356 (1951).
Maharanga verruculosa (I. M. Johnst.) I. M. Johnst., J. Arn. Arb. 35: 81 (1954).
Distr.: E. Nepal.
Ref.: Hara *et al*., 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Onosma wallichianum (A. DC.) Benth. ex C. B. Clarke in Hooker, Fl. Brit. Ind. 4: 179 (1883).
Maharanga wallichiana A. DC., Prodr. 10: 71 (1846).
Distr.: C. Nepal.

Ref.: Hara *et al*., 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

BRASSICACEAE

Aphragmus hinkuensis (Kats. Arai, H. Ohba & Al-Shehbaz) Al-Shehbaz & S. I. Warwick, Can. J. Bot. 84: 279 (2006).
Lignariella hinkuensis Kats. Arai, H. Ohba & Al-Shehbaz, Harvard Pap. Bot. 5(1): 117 (2000).
Distr.: E. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Aphragmus nepalensis (H. Hara) Al-Shehbaz, Harvard Pap. Bot. 5(1): 112 (2000).
Staintoniella nepalensis H. Hara, J. Jap. Bot. 49: 196 (1974).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Draba macbeathiana Al-Shehbaz, Novon 12(3): 315 (2002).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Draba poluniniana Al-Shehbaz, Harvard Pap. Bot. 8(2): 17 (2004).
Distr.: W. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Draba staintonii Jafri ex H. Hara in Hara & Williams, Enum. Fl. Pl. Nepal 2: 42 (1979).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Lepidostemon williamsii (H. Hara) Al-Shehbaz, *Edinb. J. Bot. 59(3): 446 (2000).*
Draba williamsii H. Hara, J. Jap. Bot. 52: 353 (1977).
Distr.: W. & C. Nepal.

Noccaea nepalensis Al-Shehbaz, Adansonia, Ser. 3, 24(1): 89 (2002).
Distr.: W. & C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Solms-laubachia haranensis (Al-Shehbaz) J. P. Yue, Al-Shehbaz & H. Sun, Ann. Missouri Bot. Gard. 95: 534 (2008).
Desideria haranensis Al-Shehbaz, Ann. Missouri Bot. Gard. 87: 559 (2001).
Ermaniopsis pumila H. Hara, J. Jap. Bot. 49: 200 (1974).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Solms-laubachia nepalensis (H. Hara) J. P. Yue, Al-Shehbaz & H. Sun, Ann. Missouri Bot. Gard. 95: 535 (2008).
Desideria nepalensis H. Hara, J. Jap. Bot. 50: 264 (1975).
Distr.: E. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

CAMPANULACEAE

Codonopsis bragaensis Grey-Wilson, Plantsman 12 (2): 99 (1990).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Codonopsis grey-wilsonii J. M. H. Shaw, New Plantsman 3 (2): 93 (1996).
Codonopsis nepalensis Grey-Wilson, Plantsman 12 (2): 99 (1990).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Codonopsis nepalensis H. Hara, J. Jap. Bot. 53: 138 (1978).
Distr.: C. Nepal.
Ref.: Hara *et al*., 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Cyananthus hayanus Marq., New Fl. & Silv. 8: 207 (1936).
Distr.: C. Nepal.
Ref.: Hara *et al*., 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Cyananthus himalaicus K. K. Shrestha, Brittonia 44: 253 (1992).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

CARYOPHYLLACEAE

Arenaria mukerjeeana (Majumdar) H. Hara, J. Jap. Bot. 51: 7 (1976).
Stellaria mukerjeeana Majumdar, Blumea 16: 267 (1968).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Arenaria paramelanandra H. Hara, J. Jap. Bot. 52 (7): 193 (1977).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Silene davidlongii Rajbh. & Mitsuo Suzuki, J. Jap. Bot. 82(5): 276 (2007).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Silene fissicalyx Bocquet & Chater in Hara & Williams, Enum. Fl. Pl. Nepal 2: 55 (1979).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Silene greywilsonii Rajbh. & Mitsuo Suzuki, J. Jap. Bot. 82(5): 278 (2007).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Silene helleboriflora Exell & Bocquet, Candollea 17: 37 (1959).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Silene hideakiohbae Rajbh. & Mitsuo Suzuki, J. Jap. Bot. 82(5): 275 (2007).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Silene stellariifolia Bocquet & Chater in Hara & Williams, Enum. Fl. Pl. Nepal 2: 56 (1979).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Silene vautierae Bocquet, Candollea 22: 17 (1967).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

CRASSULACEAE

Rhodiola nepalica (H. Ohba) H. Ohba, J. Jap. Bot. 51: 386 (1976).
Sedum nepalicum H. Ohba, J. Jap. Bot. 49: 322 (1974).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Rosularia marnieri (R.-Hamet ex H. Ohba) H. Ohba, J. Jap. Bot. 52:7 (1977).
Sedum marnieri R.-Hamet ex H. Ohba, J. Jap. Bot. 49: 260 (1974).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Sedum pseudo-multicaule H. Ohba, J. Jap. Bot. 53: 328 (1978).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

CUCURBITACEAE

Gomphogyne nepalensis W. J. de Wilde & Duyfjes, For Bull. (Bot.) 35: 60 (2007).
Distr.: C. Nepal.

CYPERACEAE

Carex esbirajbhandarii (Rajbh. & H. Ohba) O. Yano, J. Linn. Soc. 179: 21 (2015).
Kobresia esbirajbhandarii Rajbh. & H. Ohba, J. Jap. Bot. 62 (9): 272 (1987).
Distr.: E. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Carex gandakiensis Katsuyama in Ohba *et al*., Fl. Mustang, Nepal: 444 (2008).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Carex himalaica T. Koyama, Bot. Mag. (Tokyo) 86: 278 (1973).
Distr.: E. Nepal.
Ref.: Hara *et al*., 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Carex mallae (Rajbh. & H. Ohba) O. Yano, J. Linn. Soc. 179: 23 (2015).
Kobresia mallae Rajbh. & H. Ohba, J. Jap. Bot. 62: 257 (1987).
Distr.: C. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Carex rhombifructa Ohwi, J. Jap. Bot. 44: 60 (1966).
Distr.: C. Nepal.
Ref.: Hara *et al*., 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Carex rufulistolon T. Koyama, Acta Phytotax. Geobot. 15 (4): 111 (1954).
Distr.: C. Nepal.
Ref.: Hara *et al*., 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Carex staintonii X. F. Jin, H. Ikeda & O. Yano, J. Jap. Bot. 90(2): 111 (2015).
Distr.: C. Nepal.

ELAEAGNACEAE

Elaeagnus tricholepis Momiy., J. Jap. Bot. 48: 262 (1973).
Distr.: C. Nepal.
Ref.: Hara *et al*., 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

ERICACEAE

Rhododendron cowanianum Davidian, Notes Roy. Bot. Gard. Edinb. 21: 99 (1952).
Distr.: C. Nepal.
Ref.: Hara *et al*., 1982; Press *et al*., 2000; Rajbhandari & Adhikari, 2009.

Rhododendron lowndesii Davidian, Notes Roy. Bot. Gard. Edinb. 21: 99 (1952).
Distr.: C. Nepal.
Ref.: Hara *et al*., 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

ERIOCAULACEAE

Eriocaulon exsertum Satake in Hara, Fl. E. Himal. 2: 156 (1971).
Distr.: E. Nepal.
Ref.: Hara *et al*., 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Eriocaulon kathmanduense Satake in Hara, Fl. E. Himal. 2: 157, f. 10 (1971).
Distr.: C. Nepal.
Ref.: Hara *et al*., 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Eriocaulon obclavatum Satake in Hara, Fl. E. Himal. 2: 158 (1971).
Distr.: E. Nepal.
Ref.: Hara *et al*., 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

Eriocaulon trisectoides Satake in Hara, Fl. E. Himal. 2: 159 (1971).
Distr.: E. Nepal.
Ref.: Hara *et al*., 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Adhikari, 2009.

EUPHORBIACEAE

Croton nepalensis T. Kuros., Edinb. J. Bot. 61(1): 34 (2004).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

Leptopus nepalensis B. Adhikari, R. P. Chaudhary & S. K. Ghimire, Blumea 55: 162 (2010).
Distr.: C. Nepal.

Mallotus bicarpellatus T. Kuros., Edinb. J. Bot. 61(1): 31 (2004).
Distr.: C. Nepal.
Ref.: Rajbhandari & Adhikari, 2009.

FABACEAE

Astragalus barclayanus Podlech, Novon 14: 217 (2004).
Distr.: C. Nepal.
Ref.: Rahbhandari & Dhungana, 2010.

Astragalus chateri Vassilcz., Nov. Syst. Pl. Vasc. 16: 140 (1979).
Distr.: W. Nepal.
Ref.: Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Astragalus jumlaensis Podlech, Feddes Repert. 117(3-4): 227 (2006).
Distr.: W. Nepal.

Astragalus lobbichleri Podlech, Feddes Repert. 120(1&2): 50 (2009).
Distr.: C. Nepal.

Astragalus nakaoi Kitam. in Kihara, Peoples Nep. Him.: 422 (1957).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Astragalus nepalensis Podlech, Sendtnera 6: 137 (1999).
Distr.: C. Nepal.

Astragalus notablis Podlech, Feddes Repert. 117(3-4): 230. 2006.
Distr.: C. Nepal.

Astragalus poluninii Podlech, Sendtnera 7: 178 (2001).
Distr.: W. Nepal.

Astragalus pseudorigidulus Podlech, Feddes Repert. 120(1&2): 55 (2009).
Distr.: W. Nepal.

Colutea multiflora Shap. ex Ali, Bot. Not. 112, 4: 491 (1959).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Crotalaria kanaii H. Ohashi, J. Jap. Bot. 51: 301(1976).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Hedysarum manaslense (Kitam.) H. Ohashi, J. Jap. Bot. 50 (10): 23 1975).
Astragalus manaslensis Kitam. in Hara & Williams, Enum. Fl. Pl. Nep. 2: 122 (1979).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Millettia nepalensis R. N. Parker, Kew Bull. 1931: 42 (1931).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Oxytropis arenae-ripariae Vass., Nov. Syst. Pl. Vasc. 14: 170 (1977).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Oxytropis fasciculiflorum Vass., Nov. Syst. Pl. Vasc. 14: 176 (1977).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Oxytropis graminetorum Vass., Nov. Syst. Pl. Vasc. 14: 174 (1977).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi,

1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Oxytropis morenarum Vass., Nov. Syst. Pl. Vasc. 14: 172 (1977).
Distr.: W. & C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Oxytropis nepalensis Vass., Nov. Syst. Pl. Vasc. 14: 175 (1977).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Oxytropis torrentium Vass., Nov. Syst. Pl. Vasc. 14: 174 (1977).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Oxytropis williamsii Vass., Nov. Syst. Pl. Vasc. 14: 168 (1977).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

Rhynchosia nepalensis H. Ohashi & Tateishi, Bot. Mag. (Tokyo) 90: 228 (1977).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rahbhandari & Dhungana, 2010.

GENTIANACEAE

Gentiana chateri T. N. Ho, Bull. Nat. Hist. Mus. Lond. (Bot.) 23: 55 (1993).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Gentiana pentasticta C. Marq., J. Roy. Hort. Soc., London 57: 211 (1932).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982. Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Gentiana radicans H. Sm., Notes Roy. Bot. Gard. Edinb. 2: 250 (1965).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982. Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Gentiana sagarmathae Miyamoto & H. Ohba, J. Jap. Bot. 71: 45 (1996).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Gentiana tetramerus Miyamoto in Ohba *et al*., Fl. Mustang, Nepal: 221 (2008).
Distr.: C. Nepal.
Ref.: Rajbhandari & Dhungana, 2010.

Gentianella glanduligera Airy Shaw in Hooker, Ic. Pl. 35: t. 3431 (1943).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982. Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Gentianella lowndesii H. Sm., J. Jap. Bot. 56: 276 (1981)
Distr.: W. & C. Nepal.
Ref.: Hara *et al.*, 1982. Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Swertia acaulis H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 4: 242 (1970).
Distr.: C. & E. Nepal.
Ref.: Hara *et al.*, 1982. Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Swertia barunensis P. Chassot, Bot. J. Linn. Soc. 141: 389 (2003).
Distr.: E. Nepal.
Ref.: Rajbhandari & Dhungana, 2010.

Swertia nepalensis J. Shah, Pak. J. For. 38 (2): 79 (1988).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

HYPERICACEAE

Hypericum cordifolium Choisy in DC., Prodr. 1:

545 (1824).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

IRIDACEAE

Iris staintonii H. Hara, J. Jap. Bot. 49: 203 (1974).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1978. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

JUNCACEAE

Juncus ganeshii Miyamoto & H. Ohba, J. Jap. Bot. 70: 245-252 (1995).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Juncus mustangensis Miyamoto & H. Ohba, J. Jap. Bot. 78: 154 (2003).
Distr.: C. Nepal.
Ref.: Rajbhandari & Dhungana, 2010.

LAMIACEAE

Clinopodium nepalense (Kitam. & Murata) Braeuchler & Heubl, Taxon 55: 979 (2006).
Micromeria nepalensis Kitam. & Murata in Kitamura, Fn. & Fl. Nep. Him.: 214 (1955).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Discretitheca nepalensis (Moldenke) P. D. Cantino, Syst. Bot. 23(3): 381 (1999).
Caryopteris nepalensis Moldenke, Phytologia 7: 77 (1959).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Eriophyton nepalense (Hedge) Ryding, Taxon 60: 482 (2011).
Lamium nepalense Hedge, Notes Roy. Bot. Gard. Edinb. 29(1): 30 (1969).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Eriophyton staintonii (Hedge) Ryding, Taxon 60(2): 483 (2011).
Lamium staintonii Hedge, Notes Roy. Bot. Gard. Edinb. 29(1): 29 (1969).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Isodon dhankutanus Murata, Acta Phytotax. Geobot. 22: 21 (1966).
Rabdosia dhankutanus (Murata) H. Hara, J. Jap. Bot. 4: 194 (1972).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Rajbhandari & Dhungana, 2010.

Isodon namikawanus Murata, Acta Phytotax. Geobot. 22: 22 (1966).
Rabdosia namikawana (Murata) H. Hara, J. Jap. Bot. 47: 198 (1972).
Distr.: W. and C. Nepal.
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Rajbhandari & Dhungana, 2010.

Isodon phulchokiensis H. W. Li, J. Arnold Arbor. 69(4): 332 (1988).
Rabdosia phulchokiensis Murata in Fl. E. Him. 3: 96 (1975).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982. Rajbhandari & Dhungana, 2010.

Microtoena nepalensis Stearn in Hara *et al*., Enum. Fl. Pl. Nepal 3: 158 (1982).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Nepeta staintonii Hedge, Notes Roy. Bot. Gard. Edinb. 26: 355 (1966).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Salvia transhimalaica Yonek. in Ohba *et al*., Fl. Mustang, Nepal: 265 (2008).
Distr.: C. Nepal.
Ref.: Rajbhandari & Dhungana, 2010.

LAURACEAE

Litsea doshia (D. Don) Kosterm., J. Sci. Res. (Jakarta) 1: 90 (1952).
Tetranthera doshia D. Don, Prodr. Fl. Nepal.: 65 (1825).
Distr.: C. and E. Nepal.
Ref.: Rajbhandari & Dhungana, 2010.

Machilus pubescens Blume, Mus. Bot. Lugd.-Bat. 1(21): 330 (1851).
Persea blumei Kosterm., Reinwardtia 9: 110 (1974).
Cinnamomum tomentosum D. Don, Prodr. Fl. Nepal. 66 (1825).
Persea tomentosa (D. Don) Spreng., Syst. Veg. 4, Cur. Post. 156 (1827).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

LYTHRACEAE

Rotala rubra (Buch.-Ham. ex D. Don) H. Hara, J. Jap. Bot. 52: 197 (1977).
Ammania rubra Buch.-Ham. ex D. Don, Prodr. Fl. Nep. 220 (1825).
Rotala alata Koehne, Bot. Jahrb. 1: 171 (1880).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

OLEACEAE

Jasminum amabile H. Hara, J. Jap. Bot. 52: 356 (1977).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

ONAGRACEAE

Epilobium brevisquamatum Raven, Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 371 (1962).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Epilobium staintonii Raven, Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 354 (1962).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

ORCHIDACEAE

Bhutanthera fimbriata B. B. Raskoti, Phytotaxa 62: 57 (2012).
Distr.: C. Nepal.

Bulbophyllum nepalense Raskoti & Ale, Edinb. J. Bot. 70(2): 381 (2013).
Distr.: C. Nepal.

Eria annapurnensis L. R. Shakya & M. R. Shrestha, Edinb. J. Bot. 64(1): 1 (2007).
Distr.: C. Nepal.
Ref.: Rahbhandari & Dhungana, 2010.

Eria baniaii Bajracharya, Shakya & Chettri, J Orchid Soc. India 16(1-2): 91 (2002).
Distr.: C. Nepal.
Ref.: Rahbhandari & Dhungana, 2010.

Eria nepalensis D. M. Bajracharya & K. K. Shrestha, J. Jap. Bot. 78(3): 158 (2003).
Distr.: C. Nepal.
Ref.: Rahbhandari & Dhungana, 2010.

Eria pokharensis D. M. Bajracharya, A. Subedi & K. K. Shrestha, J. Orchid Soc. Ind. 17(1-2): 1 (2003).
Distr.: C. Nepal.
Ref.: Rahbhandari & Dhungana, 2010.

Gastrochilus nepalensis B. B. Raskoti, Phytotaxa 233(2): 180 (2015).
Distr.: C. Nepal.

Herminium hongdeyuanii B. B. Raskoti, Phytotaxa 98(1): 23 (2013).
Distr.: C. Nepal.

Liparis langtangensis B. B. Raskoti & Ale, Novon 23: 83 (2014).
Distr.: C. Nepal.

Liparis olivacea Lindl., Gen. Sp. Orchid. Pl. 1: 27 (1830).

Distr.: C. Nepal.
Ref.: Hara *et al*., 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Malaxis dolpensis M. R. Shrestha, L. R. Shakya & S. K. Ghimire, Pleione 1: 6 (2007).
Distr.: W. Nepal.
Ref.: Rajbhandari & Dhungana, 2010.

Malaxis tamurensis Tuyama in Hara, Fl. E. Himal.: 444 (1966).
Distr.: E. Nepal.
Ref.: Hara *et al*., 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Neottia chandrae B. B. Raskoti, J. J. Wood & R. Ale, Nordic J. Bot. 30: 187 (2012).
Distr.: C. Nepal.

Neottia nepalensis (N. P. Balakr.) Szlach., Fragm. Florist. Geobot. Suppl. 3: 118 (1995).
Listera nepalensis N. P. Balakr., Blumea 14: 237 (1966).
Distr.: C. Nepal.
Ref.: Hara *et al*., 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Oberonia nepalensis L. R. Shakya & R. P. Chaudhary, Harvard Pap. Bot. 4 (1): 359 (1999).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Odontochilus nandae Raskoti & H. Kurzweil, Phytotaxa 233 (3): 293 (2015).
Distr.: C. Nepal.

Oreorchis porphyranthes Tuyama, J. Jap. Bot. 50: 69 (1975).
Distr.: C. Nepal.
Ref.: Hara *et al*., 1978; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Panisea panchaseensis Subedi, Nord. J. Bot. 29(3): 361 (2011).
Distr.: C. Nepal.

Pleione coronaria P. J. Cribb & C. Z. Tang, Curtis's Bot. Mag. 184: 123 (1983).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Sunipia nepalensis B. B. Raskoti & R. Ale, Phytotaxa 31: 55 (2011).
Distr.: C. Nepal.

OROBANCHACEAE

Euphrasia nepalensis Pugsley, J. Bot. 74: 278 (1936).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis annapurnensis Yamazaki, J. Jap. Bot. 45: 146 (1970).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis anserantha Yamazaki, Acta Phytotax. Geobot. 19: 110 (1963).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Rajbhandari & Dhungana, 2011.

Pedicularis breviscaposa Yamazaki, Acta Phytotax. Geobot. 15: 147 (1954).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis chamissonoides Yamazaki, J. Jap. Bot. 45: 148 (1970).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis cornigera Yamazaki, J. Jap. Bot. 55: 293 (1980).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis muguensis Yamazaki in Hara & Malla, Himal. Pl. 1: 104 (1988).
Distr.: W. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis odontoloma Yamazaki, J. Jap. Bot. 53:

321 (1978).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis oxyrhyncha Yamazaki, J. Jap. Bot. 61: 297 (1986).
Distr.: E. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis pseudoregeliana Tsoong, Acta Phytotax. Sin. 3: 284, 322 (Jan. 1955).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis tamurensis Yamazaki, J. Jap. Bot. 45: 174 (1970).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis terrenoflora Yamazaki in Hara, Fl. E. Him. 3: 102 (1975).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis yalungensis Yamazaki, J. Jap. Bot. 61: 77 (1986).
Distr.: C. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Pedicularis yamazakiana R. R. Mill, Edinb. J Bot. 68(1): 86 (2011).
Distri.: W. Nepal.

PAPAVERACEAE

Corydalis calycina Liden, Bull. Brit. Mus. (Nat. Hist.), Bot. 18(6): 532 (1989).
Distr.: W. & C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Corydalis clavibracteata Ludlow, Bull. Brit. Mus. (Nat. Hist.), Bot. 5: 53 (1975).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Corydalis megacalyx Ludlow, Bull. Brit. Mus. (Nat. Hist.), Bot. 5: 58 (1975).
Distr.: W., C. & E. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Corydalis simplex Liden, Bull. Brit. Mus. (Nat. Hist.), Bot. 18(6): 514 (1989).
Distr.: W. & C. Nepal.

Corydalis spicata Liden, Bull. Brit. Mus. (Nat. Hist.), Bot. 18(6): 528 (1989).
Distr.: W. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Corydalis stipulata Liden, Bull. Brit. Mus. (Nat. Hist.), Bot. 18(6): 528 (1989).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Corydalis terracina Liden, Bull. Brit. Mus. (Nat. Hist.), Bot. 18(6): 522 (1989).
Distr.: W. & C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Corydalis uncinata Liden, Bull. Brit. Mus. (Nat. Hist.), Bot. 18(6): 528 (1989).
Distr.: W. & C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Corydalis uncinatella Liden, Bull. Brit. Mus. (Nat. Hist.), Bot. 18(6): 528 (1989).
Distr.: W. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Meconopsis autumnalis P. A. Egan, Phytotaxa 20: 48 (2011).
Distr.: **C. Nepal.**

Meconopsis chankeliensis Grey-Wilson, Curtis's Bot. Mag. 23(2): 203 (2006).

Distr.: W. Nepal.
Ref.: Rajbhandari & Dhungana, 2010.

Meconopsis ganeshensis Grey-Wilson, Curtis's Bot. Mag. 23(2): 188 (2006).
Distr.: C. Nepal.
Ref.: Rajbhandari & Dhungana, 2010.

Meconopsis gracilipes G. Tayl., Gen. Meconopsis: 38 (1834).
Meconopsis rebeccae H. S. Debnath & M. P. Nayar, J. Jap. Bot. 64(5): 157 (1989).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Meconopsis lamjungensis T. Yoshida, H. Sun & Grey-Wilson, Curtis's Bot. Mag. 29(2): 207 (2012).
Distr.: C. Nepal.

Meconopsis manasluensis P. A. Egan, Phytotaxa 20: 50 (2011).
Distr.: **C. Nepal.**

Meconopsis napaulensis DC., Prodr. 1: 121 (1824).
Meconopsis longipetiolata G. Tayl., Gard. Chron. 1932, Ser. III, 13: 41 (1932).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Meconopsis regia G. Tayl., J. Bot. 67: 259 (1929).
Distr.: W. & C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Meconopsis simikotensis Grey-Wilson, Alp. Gard. 74(2): 220 (2006).
Distr.: W. Nepal.

Meconopsis staintonii Grey-Wilson, Curtis's Bot. Mag. 23(2): 190 (2006).
Distr.: C. Nepal.
Ref.: Rajbhandari & Dhungana, 2010.

Meconopsis taylorii L. H. J. Williams, Trans. & Proc. Bot. Soc. Edinb. 41: 347 (1972).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

PLANTAGINACEAE

Lagotis nepalensis Yamazaki, J. Jap. Bot. 46: 243 (1971).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

Veronica emodi Yamazaki, J. Jap. Bot. 45: 76 (1970).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011.

POACEAE

Borinda emeryi Stapleton, Edinb. J. Bot. 51: 286 (1994).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Elymus nepalensis (Melderis) Melderis in Hara *et al*., Enum. Fl. Pl. Nepal 1: 131 (1978).
Agropyron nepalense Melderis in Bor, Grass. Ind.: 692 (1960).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1978. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Eulaliopsis sykesii Bor, Kew Bull. 1957: 412 (1958).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1978. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Festuca eriobasis H. Scholz, Willdenowia 18 (2): 431 (1989).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Festuca nepalica E. B. Alexeev, Byull. Moskovsk. Obshch. Isp. Prir. Otd. Biol. 82: 99 (1977).
Distr.: W. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Festuca poluninii E. B. Alexeev, Byull. Moskovsk. Obshch. Isp. Prir. Otd. Biol. 83: 111 (1978).
Distr.: W. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Himalayacalamus asper Stapleton, Edinb. J. Bot. 51: 310 (1994).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Himalayacalamus cupreus Stapleton, Edinb. J. Bot. 51: 314 (1994).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Himalayacalamus fimbriatus Stapleton, Edinb. J. Bot. 51: 316 (1994).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Himalayacalamus planatus Stapleton, J. Bot. Res. Inst. Texas 1(1): 137 (2007).
Distr.: C. Nepal.

Himalayacalamus porcatus Stapleton, Edinb. J. Bot. 51: 318 (1994).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Poa hideaki-ohbae Rajbh., J. Jap. Bot. 88(2): 77 (2013).
Distr.: C. Nepal

Poa imperialis Bor, Kew Bull. 1957: 414 (1958).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1978. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Poa langtangensis Melderis in Hara *et al*., Enum. Fl. Pl. Nep. 1: 143 (1978).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1978. Shrestha & Joshi, 1996.

Saccharum williamsii (Bor) Bor, Grasses Burma, Ceylon, India & Pakistan: 214 (1960).
Erianthus williamsii Bor, Kew Bull. 1957: 413 (1957).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1978. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Sinarundinaria langtangensis R. Manandhar & Bajracharya, Pleione 6(2): 381 (2012).
Distr.: C. Nepal.

Stipa staintonii Bor, Bull. Bot. Surv. Ind. 7: 133 (1965).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1978. Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Thamnocalamus chigar (Stapleton) Stapleton, J. Bot. Res. Inst. Texas 1: 140 (2007).
Borinda chigar Stapleton, Edinb. J. Bot. 51: 286 (1994).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

POLYGONACEAE

Bistorta confusa (Meisn.) Greene, Leafl. Bot. Obs. Crit. 1: 21 (1904).
Polygonum confusum Meisn. in Wallich, Pl. Asiat. Rar. 3: 53 (1843).
Distr.: C. Nepal.
Ref.: Rajbhandari & Dhungana, 2010.

Bistorta diopetes H. Ohba & S. Akiyama, Alpine Fl. Jaljale Himal: 9 (1992).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Bistorta milletioides H. Ohba & S. Akiyama, Alpine Fl. Jaljale Himal: 10 (1992).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Fagopyrum megacarpum H. Hara, J. Jap. Bot. 47: 137 (May 1972).
Eskemukerjea megacarpum (H. Hara) H. Hara in Hara *et al*., Enum. Fl. Pl. Nepal 3: 173 (1982).
Eskemukerjeea nepalensis Malick & Sengupta, Bull. Bot. Surv. Ind. 11: 433 (June 1972).

Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Fallopia filipes (H. Hara) Holub, Folia Geobot. Phyt. Praha 9: 273 (1974).
Bilderdykia filipes H. Hara, J. Jap. Bot. 47: 137 (1972).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

PRIMULACEAE

Primula didyma W. W. Sm., Notes Roy. Bot. Gard. Edinb. 16: 228 (1931).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Primula poluninii Fletcher, J. Roy. Hort. Soc., Lond. 88: 488 (1963).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Primula ramzanae Fletcher, J. Roy. Hort. Soc., Lond. 79: 358 (1954).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Primula sharmae Fletcher, Trans. Roy. Soc. Edinb. 33: 119 (1941).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

Primula wigramiana W. W. Sm., Notes Roy. Bot. Gard. Edinb. 18: 182 (1934).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2010.

RANUNCULACEAE

Aconitum amplexicaule Lauener, Notes Roy. Bot. Gard. Edinb. 26: 7 (1964).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Aconitum angulatum Tamura, Acta Phytotax. Geobot. 23: 100 (1968).
Distr.: E. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Aconitum bhedingense Lauener, Notes Roy. Bot. Gard. Edinb. 25: 26 (1963).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Aconitum deltoideum Lauener, Notes Roy. Bot. Gard. Edinb. 32: 411 (1973).
Distr.: E. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Aconitum dhwojii Lauener, Notes Roy. Bot. Gard. Edinb. 25: 26 (1963).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Aconitum poluninii Lauener, Notes Roy. Bot. Gard. Edinb. 26: 7 (1964).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Aconitum staintonii Lauener, Notes Roy. Bot. Gard. Edinb. 26: 4 (1964).
Distr.: E. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Aconitum tabatae Tamura, Acta Phytotax. Geobot. 37: 152 (1986).
Distr.: W. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Aconitum tamuranum Lauener, Notes Roy. Bot. Gard. Edinb. 26: 3 (1964).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Aconitum williamsii Lauener, Notes Roy. Bot. Gard. Edinb. 26: 6 (1964).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Anemone fuscopurpurea H. Hara, J. Jap. Bot. 48: 353 (1973).
Distr.: E. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Clematis bracteolata Tamura, Acta Phytotax. Geobot. 23: 29 (1968).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Clematis phlebantha L. H. J. Williams, J. Roy. Hort. Soc., London 93: 345 (1968).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Clematis staintonii W. T. Wang, Acta Phytotax. Sinica 38 (4): 333 (2000).
Distr.: C. Nepal.

Delphinium himalayai Munz, J. Arn. Arb. 49: 145 (1968).
Distr.: W. & C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Delphinium unifolium Tamura, J. Phytogeogr. Taxon. 27: 35 (1979).
Distr.: C. Nepal.
Ref.: Press *et al*., 2000.

Delphinium williamsii Munz, J. Arn. Arb. 48: 541 (1967).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Oxygraphis nepalensis Tamura, J. Geobot. 26 (3): 68 (1978).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Ranunculus himalaicus Tamura, J. Geobot. 26 (3): 68, 9 (1978).
Distr.: W. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Ranunculus makaluensis Kadota in Ohba & Malla, Himal. Pl. 2: 106 (1991).
Distr.: E. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

ROSACEAE

Potentilla makaluensis H. Ikeda & H. Ohba, J. Jap. Bot. 67: 149 (1992).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Potentilla turfosoides H. Ikeda & H. Ohba in Ohba, Himal. Pl. 3: 62 (1999).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Prunus himalaica Kitam., Acta Phytotax. Geobot. 15: 131 (1954).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000. Rajbhandari & Dhungana, 2011a.

Prunus jajarkotensis H. Hara, J. Jap. Bot. 52: 355 (1977).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi,

1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Prunus taplejunica H. Ohba & S. Akiyama, Bull. Nat. Sci. Mus., Tokyo, B. **36** (4): 135 (2010).
Distr.: E. Nepal.

Prunus topkegolensis H. Ohba & S. Akiyama, Bull. Nat. Sci. Mus., Tokyo, B. **36** (4): 134 (2010).
Distr.: E. Nepal.

Sibbaldia emodi H. Ikeda & H. Ohba, J. Jap. Bot. 71 (4): 188 (1996).
Distr.: C. & E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Sorbus sharmae M. F. Watson, V. Manandhar & Rushforth, Int. Dendrol. Soc. Year Book 2009: 79 (2010).
Distr.: C. & E. Nepal.
Ref.: Rajbhandari & Dhungana, 2011a.

RUBIACEAE

Galium nepalense Schoenb.-Tem. & Ehrendorfer, Pl. Syst. Evol. 155: 82 (1987).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000.

Galium saipalense Schoenb.-Tem. & Ehrendorfer, Pl. Syst. Evol. 155: 82 (1987).
Distr.: W. Nepal.
Ref.: Press *et al.*, 2000.

Ophiorrhiza nepalensis Deb & Mondal, J. Bombay Nat. Hist. Soc. 79(3): 644 (1982).
Distr.: E. Nepal.

SALICACEAE

Salix nepalensis Yonek. in Ohba *et al.*, Flora of Mustang, Nepal: 14 (2008).
Distr.: C. Nepal.
Ref.: Rajbhandari & Dhungana, 2011a.

Salix plectilis Kimura in Hara, Fl. E. Himal.: 45 (1966).
Distr.: E. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Salix staintoniana Skvortsov, Byull. Moskovsk. Obshch. Isp. Prir. Otd. Biol. 83 (1): 123 (1978).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000.

SAXIFRAGACEAE

Saxifraga alpigena H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 97 (1958).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga amabilis H. Ohba & Wakabaya., J. Jap. Bot. 62 (6): 162 (1987).
Distr.: C. & E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga cinerea H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 128 (1958).
Distr.: W. & C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga excellens H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 230 (1960).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga ganeshii H. Ohba & S. Akiyama, J. Jap. Bot. 74: 223 (1999).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga harae H. Ohba & Wakabaya., J. Jap. Bot. 62 (6): 163 (1987).
Distr.: E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga hypostoma H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 103 (1958).
Distr.: W. & C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi,

1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga jaljalensis H. Ohba & S. Akiyama in Ohba & Akiyama, Alp. Fl. Jaljale Himal: 31 (1992).
Distr.: E. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga lowndesii H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 126 (1958).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga mallae H. Ohba & Wakabaya., J. Jap. Bot. 62 (6): 165 (1987).
Distr.: C. & E. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga micans H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 126 (1958).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga mira H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 114 (1958).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga namdoensis H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 237 (1960).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga neopropagulifera H. Hara, J. Jap. Bot. 51(1): 7 (1976).
Distr.: W. & C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000.

Saxifraga poluninana H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 114 (1958).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga rhodopetala H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 124 (1958).
Distr.: W. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga rolwalingensis H. Ohba, J. Jap. Bot. 59: 360 (1984).
Distr.: C. & E. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga roylei H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 95 (1958).
Distr.: W. & C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga staintonii H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 118 (1958).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga williamsii H. Sm., Bull. Brit. Mus. (Nat. Hist.), Bot. 2: 100 (1958).
Distr.: C. & E. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Saxifraga zimmermannii Baehni, Candollea 16: 226 (1958).
Distr.: C. Nepal.
Ref.: Hara & Williams, 1979; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

SCROPHULARIACEAE

Scrophularia bheriensis Yamazaki, J. Jap. Bot. 46: 247 (1971).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Scrophularia laportiifolia Yamazaki, J. Jap. Bot. 46: 248 (1971).
Distr.: W. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

URTICACEAE

Pilea kanaii H. Hara, J. Jap. Bot. 49: 193 (1974).
Distr.: C. Nepal.
Ref.: Hara *et al.*, 1982; Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

ZINGIBERACEAE

Roscoea ganeshensis Cowley & W. J. Baker, Curtis's Bot. Mag. 13: 10 (1996).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Roscoea nepalensis Cowley, Kew Bull. 34: 811 (1980).
Distr.: W. Nepal.
Ref.: Shrestha & Joshi, 1996; Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

Roscoea tumjensis Cowley, Kew Bull. 36: 755 (1982).
Distr.: C. Nepal.
Ref.: Press *et al.*, 2000; Rajbhandari & Dhungana, 2011a.

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   - The font size for heading should be 12 (bold face letter) and for subheadings 12 (bold face letter).
   - The Scientific names should be in italics.
   - Equations and formulae should be preferably typed in 10 or 12 point font size.

5. **Tables and Figures:**
   - Should appear in the text closely following the point where it is discussed.
   - The table number and heading should be placed above the body of the table .
   - The figure number and the caption should be in general placed below the figure.
   - The text font size in the table and figure should be 10 and the font is Times New Roman.

   Example: **Figure 1(Bold):** …… (Title: Not bold)……
     - **Table 1(Bold):** …….. (Title: Not bold)……..
   - Figure and table numbering must be continuous throughout the articles.

6. **Spacing:**
   - Spacing throughout body of text : 1.5 spacing
   - Spacing for references: 1.5 spacing *within* each entry but double spacing *between* each entry.
   - Spacing for table of contents, list of tables, list of figure or illustrations and lengthy tables: 1.5 or even single spacing may be used.

7. **The original research paper should include the following headings:**
   - **Abstracts and Keywords:** Subtitle with bold face, text not bold and font size 10
   - **Introduction, materials and Methods, Results and Discussion, Acknowledgement and References :** Subtitle with bold face, text not bold and font size 12.

8. **Reference and Citation in the Text:**
   Figures, illustrations and other relevant materials reproduced from other publications must be fully cited. The author(s) will be completely responsible for the use of such references.

References should be cited alphabetically in the following pattern:

Journal articles

Bhattarai, S., Chaudhary, R.P., Quave, C.L. and Taylor, R.S.L. 2010. The use of medicinal plants in the trans-Himalayan arid zone of Mustang district, Nepal. *Journal of Ethnobiology and Ethnomedicine*, 6:14.

Das, A.N. and Seeley, J.A. 1996. Bamboo Use as the Basis for Wealth Ranking in Eastern Nepal. *Banko Janakari*, 6 (2): 89-92.

Vetaas, O.R. and Grytnes, J.A. 2002. Distribution of vascular plants species richness and endemic richness along the Himalayan elevation gradient in Nepal. *Global Ecology and Biogeography,* 11: 291-301.

Thesis and Dissertation

Das, A.N. 1998. Socioeconomics of Bamboos in Eastern Nepal. PhD Thesis, University of Aberdeen, UK.

Proceedings of Conferences

Bhattarai, N.K., Tandon, V. and Ved, D.K. 2002. Highlights and outcomes of the Conservation Assessment and Management Planning (CAMP) Workshop, Pokhara, Nepal. *In: Sharing local and national experiences in Conservation of Medicinal and aromatic plants in South Asia* (Eds Bhattarai, N.K. and Karki, M.). IDRC South Asia Regional Office, New Delhi, India. Pp. 46-53.

Book

Department of Plant Resources. 2007. Medicinal plants of Nepal (Revised), *Bull. Department of Plant Resources No. 28*, Thapathali Kathmandu, Nepal.

Hara, H., Stearn, W.T. and Williams, H.J. 1978 *An enumeration of the flowering plants of Nepal*, Vol. I. British Natural History Museum, London.

Press, J.R., Shrestha, K.K., and Sutton, D.A. 2001. *Annonated checklist of the flowering plants of Nepal*. The Natural History Museum, London.

Website

CITES Appendix I, II, III. http://w ww.cites.org/eng/resources/species.html.

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