



# INTERNATIONAL CONFERENCE ON **BIODIVERSITY AND BIOPROSPECTING**

22-24 June, 2022, Kathmandu, Nepal



Organized by:  
Government of Nepal  
**Ministry of Forests and Environment**  
**Department of Plant Resources**

In Collaboration With



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**ABSTRACT**

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Front Cover Photo: Rara Lake, Mugu District, West Nepal

Back Cover Photo: *Cyathea spinulosa* Wall. ex Hook. (Tree Fern)

## **Background**

Biodiversity, the diversity of life on Earth, underpins human wellbeing, livelihood and sustainable development. Yet, it is declining at an unprecedented rate. Globally, land-use change, resource use and exploitation, climate change, pollution, and invasive alien species are the direct drivers contributing to deterioration and loss of biodiversity. Transformative actions are required at local, national and global levels to reverse this trend taking into account the three objectives of the Convention on Biological Diversity (CBD): conservation of biological diversity, sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. If we are to achieve CBD objectives and the 2030 agendas for sustainable development, we must find better ways to manage human's footprints on Earth and hence manage biodiversity for the current and future generations.

Biodiversity, both plant as well as animal, is a resource for sustainable use and development. Plants are recognized as a vital component of biodiversity and healthy ecosystems. They provide food, fiber, fuel, shelter, medicine and a range of ecosystem services. The potentiality of biodiversity can be tapped through bioprospecting – an exploration of biodiversity for new resources of social and commercial values, has multiple goals including conservation and sustainable use of biodiversity for commercial purposes like medicinal drugs, biochemical, cosmetics. Bioprospecting has huge potential for conservation, sustainable use and the welfare of the society and humankind.

In the arena of biodiversity and bioprospecting, several scientific findings and innovations have been described and implemented in the recent years. In addition, local communities and indigenous people have biodiversity related rich traditional knowledge. Ethnobotany has evolved and contributed to advance our understanding of people plant interactions. Medicinal plants play an important role in curing various diseases and has immense value for economy. Sharing the existing research findings, innovations and experiences and exploring new opportunities on biodiversity and bioprospecting is important for a prosperous future. In this backdrop, an “International Conference on Biodiversity and

Bioprospecting” is planned under the leadership of the Department of Plant Resources (DPR) of the Ministry of Forests and Environment (MoFE), Government of Nepal in collaboration with Universities and prominent national and international organizations.

## **Aim and Objectives**

The conference aims to bring together academicians, scientists, researchers, experts, managers and policy makers to share and discuss existing problems, latest innovations, emerging opportunities and future priorities in the field of biodiversity and bioprospecting. It aims to open an avenue for enhancing understanding of different aspects of conservation and sustainable utilization of biodiversity. The main objectives of the conference are as follows.

- Share and exchange research findings, knowledge and experiences on biodiversity and bioprospecting among wider stakeholders;
- Encourage scientists and researchers by providing platform to present research findings to strengthen capacity in plant and allied science;
- Develop strategic direction for future research and development in the field of biodiversity and bioprospecting.

## **Conference Themes**

The conference covers biodiversity especially focused on plant diversity, major threats to plant diversity conservation, traditional knowledge, medicinal plants, plant based products, modern tools and technologies etc. There are several aspects of biodiversity and bioprospecting, hence some additional topics can be considered. The following are the major themes of the conference.

- Biological Invasion
- Bioprospecting and Innovations
- Climate Change
- Ethnobotany and Traditional Knowledge
- MAPs and Natural Products
- Plant Diversity Conservation
- Plant Systematics

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## Keynote Address

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# SWOT Observations on Biodiversity Conservation and Research in Nepal

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In the 21<sup>st</sup> century, biodiversity is a vital resource given increasing demand, emerging threats, and growing knowledge. In the last six decades, the global community has been alerted to environmental and biodiversity threats, with several landmark events organized and strategies framed to conserve biodiversity. There are numerous success stories of species recovery around the world, but rate of loss of species is faster than recovery. Biodiversity conservation is still a great challenge, and Nepal is no exception. A country in central Himalaya, Nepal boasts varied ecosystems and immense biodiversity within a narrow south–north belt of less than 200 km. The Government of Nepal has established a number of protected areas in different physiographic regions, prepared biodiversity conservation strategies, action plans, and policies, developed biodiversity academic courses at universities, and conducted several related research projects. While the population of a few endangered species has increased and many more achievements have been reached, the challenge persists. Strengths, Weaknesses, Opportunities and Threats (SWOT) observations or analyses have emerged as an important tool to identify gaps, understand needs, and plan to address emerging threats. In addition to conservation of biodiversity, Nepal needs to understand intricacies of ecosystems in depth, and conduct bioprospecting of biological resources. Research efforts and investments should be enhanced to better understand the benefits of a country's rich biological resources. SWOT observations on biodiversity conservation and the existing research environment will be presented. Threats to biodiversity due to climate change and invasive plant species will also be spotlighted.

**Keywords:** conservation strategies; bioprospecting; research efforts

## **Biodiversity Conservation and Bioprospecting: Values, Challenges and Opportunities**

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Biodiversity (Biological diversity) is the diversity of life at three levels, i.e. variability in genes (within species), diversity of different taxa among living organisms (different plants, animals, fungi and microorganisms) present on the earth, and the variety of ecosystems (terrestrial, aquatic and other ecosystems), in which they are part of. In practical sense, biodiversity is expressed as part of the “quality of life” and includes all of its manifestation. Biodiversity conservation is necessary for our existence as it provides the fundamental building blocks for the many goods and services that support a healthy environment to lead our current and future lives.

Bioprospecting is the research, collection and utilization of biological and genetic resources and indigenous knowledge, for purpose of applying the knowledge derived therefrom for scientific/or commercially valuable purpose and biochemical properties. It is considered as a tool for survival and a source of inspiration and innovation. Two schools of thought exist regarding bioprospecting. Many argue that when patents are linked to bioprospecting agreements, they can support local capacity building and conservation. On the other hand, indigenous peoples and local communities (IPLCs) and other sectors of society reject the idea of patenting life, and this position has had direct and indirect consequences that includes the cancellation of bioprospecting projects, particularly in developing countries. Evolving issues in bioprospecting in the developing countries include intellectual property rights (IPRs) regime, and access to genetic resources and benefit sharing (ABS) mechanism.

Developing countries in the tropics are rich in biodiversity. The importance of and global commitment towards the conservation of biodiversity is no longer questioned; however, of equal concern is the uncertain status of the indigenous knowledge, and fair and equitable benefit sharing. Therefore, if a developing country intends to undertake bioprospecting on a scale sufficient to create economic incentives for the conservation of biodiversity, it must be approached

and managed as a business strategy whose objective is to add value to the conservation of biodiversity, and associated traditional ecological knowledge.

In the paper, steps and complexities of business strategy for bioprospecting from perspective of developing countries will be presented. Further, values, challenges and opportunities of biodiversity conservation and bioprospecting will be discussed in perspectives of enabling environment, human resources and technical capacity with focus on Nepal, a country disproportionately rich in biodiversity and cultural diversity.

**Keywords:** biodiversity; bioprospecting; traditional ecological knowledge; intellectual property rights; access and benefit sharing.

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## Plenary Address

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# Bioprospecting Studies of Some Nepali Medicinal and Aromatic Plants

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Plants have been used as a medicine since the start of human civilization. Despite the low priority of big pharmaceutical companies to natural product-based drug discovery, around 30% of medicine has a natural origin. Only 10-15% of plants in the world have been explored and a huge number of plants are not studied yet. Nepal is rich in biodiversity but bioprospecting studies on plants, fungi, and microorganisms of Nepal have been done negligibly. My research mainly focused on bioprospecting studies on traditionally used medicinal and aromatic plants. Diabetes and cancer are big problems for human beings around the world, therefore most of my research works are targeted these two diseases. We have screened more than 20 traditionally used antidiabetic plants for insulin secretory activity. The isolation of pure compounds has been done from most active plants *Scoparia dulcis* L. (Chini Jhar), *Zanthoxylum armatum* DC. (Nepali pepper), *Artemisia macrocephala* Jacquem. ex Besser, and *Salvia mirzayanii* Rech.f. & Esfand. Insulin secretion activity of pure compounds on isolated mice islets and the pancreatic  $\beta$ -cell line was carried out. Similarly, some anticancer compounds and essential oils have been discovered from different medicinal plants. In this presentation, I will discuss insulin-secreting, anticancer, and vasorelaxant compounds from different traditionally used medicinal plants of Nepal.

**Keywords:** traditionally used; medicinal plants; insulin; anticancer

# **Plant Invasions in Nepal: Knowledge Gaps and Research Needs**

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Biological invasions is pervasive with range of direct and indirect negative impacts worldwide on most of the natural environments, production systems and human wellbeing. In Nepal, various global (e.g. climate change, trade) and local drivers (e.g. land use changes, habitat degradation, infrastructure development) have aggravated the problems of plant invasions, as indicated by continued detection of new invasive plants and expansion of established species to new areas. Although some policy documents of the Government of Nepal have identified plant invasions as one of the major drivers of biodiversity loss and environmental degradation, the policy and management responses at the national level is inadequate to prevent and control invasive plants. In last two decades, wealth of knowledge on diversity of alien and invasive plants, their spatial distribution, and ecological impacts have been generated. Current state of knowledge of plant invasions in Nepal, combined with global knowledge base, is sufficient to inform policy decisions and management interventions. However, it appears that the policy makers are not fully aware of the seriousness of the problems and future consequences of the lack of timely responses to prevent and control invasive plants. In addition, poor knowledge base on some of the aspects of the plant invasions such as the introduction pathways, economic cost, impacts on human wellbeing, and habitat/ecosystem specific control measures might have also contributed to the inadequate policy and management responses. Prioritization of these data poor topics in future research through interdisciplinary approaches can effectively inform policy and management decisions for the prevention and control of plants and other invasive alien species in Nepal.

**Keywords:** control measures; economic cost; invasive alien species; introduction pathways

## **Phytogeography and Distribution Pattern of Indian Himalayan Pteridophytes**

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The Indian Himalayan pteridophytes are mostly an admixture of European and Mediterranean (73 spp.), Sino-Himalayan (c.500- 550 spp.) and S.E. Asian or Indo-Malayan (100-150) elements. Some cosmopolitan species, a few Afro-Arabian, peninsular-Indian or Deccan, Siberian-Tibetan elements, its own endemics, couples of disjunct and few alien elements also contribute in the pteridophytic flora of Indian Himalayas. The Sino-Himalayan elements are thought to have migrated westwards along the Indo-Himalayan line from a centre of diversification in S.W. China, N. Myanmar and far N.E. India and a few of them also extends farther westward beyond to Himalayas. Towards east, these Sino-Himalayan elements migrated into S. E. China, Taiwan and a few also extended up to Japan. In the Indian Himalayas they constitute four subgroups (Widespread Sino-Himalayan subgroup, West Indo-Himalayan subgroup, East Indo-Himalayan subgroup, and Siberian-Tibetan subgroup). The European and Mediterranean elements are frequent in Jammu and Kashmir or far western Himalayas and many of them are restricted up to western or central Nepal. But some European elements may reach further east Indo-Himalaya, apparently through Tibet or China. Many Sino- Himalayan elements are frequent in the eastern Himalayas and Nepal and reach up to Uttarakhand. The Indo-Malayan or S. E. Asian elements are also frequent in the N. E. India and are still migrating westward and they are more in Uttarakhand (c. 70 spp.) but very rare in Himanchal Pradesh (10 spp.) and Jammu & Kashmir (8 spp.). Couples of Afro-Arabian and Deccan Pteridophytes are found in the outer rim or Siwalik and in Tarai region of the Himalayas and reached up to the drier parts of Central Nepal only. The endemism in the Himalayan Pteridophytes is very less, due to long distance dispersal of fern spores and well-connected land mass with neighbouring countries.

**Keywords:** phytogeography; Sino-Himalayan elements; pteridophytes; endemism

## Pteridophytes of Bhutan

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Preliminary details of checklist of pteridophytes of Bhutan (Fraser-Jenkins, Matsumoto, Wangdi & Pariyar 2022, in press) are given here. It contains full specimen-lists, brief diagnostic descriptions and nomenclatural details, along with a new species (*Diplazium phuntshoi* Fraser-Jenk.), and new combinations. The Bhutanese specimens in THIM, ASSAM, CAL, BM, K, UC and other herbaria have all been re-identified and listed to vouch for the contained species present in Bhutan. Nevertheless, collections by the author in 2005, 2009 and 2013, have revealed many previously unnoticed specimens. In addition the author re-identified the earlier Griffith, Cooper and Ludlow & Sherriff collections; followed by the Botanical Survey of India collections; the Japanese 3<sup>rd</sup> Himalayan Expedition collections; the Edinburgh Botanic Garden collections of Grierson, Long, Bigger & Broad, for their *Flora of Bhutan* (with some ferns listed); many interesting high-altitude collections were made by G. & S. Miehe at Marburg; and many useful collections, were made by Tandin Wangdi and colleagues then at the NBC, including by Dr. S. Matsumoto, Tsukuba, all identified and listed by the present author. The current checklist contains 557 verified species or subspecies, nearly 150 more than recently listed on the Bhutan Biodiversity Portal. A further 142 are placed on the Expected species list, known from each side. The majority of the known species are Sino-Himalayan elements and the approximately one quarter to one third remaining are S.E. Asian species. Only 3 species are endemic to Bhutan (*Asplenium rebecca* Fraser-Jenk & Wangdi, *Diplazium bouffordii* Fraser-Jenk. & Pariyar and *D. phuntshoi* Fraser-Jenk.).

**Keywords:** Bhutan; pteridophytes; checklist; collections; subspecies; phytogeography

## **Phytogeography, Diversity and Conservation of the Pteridophytic Flora of Jammu and Kashmir (West Himalaya)**

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Of the c.12000 living pteridophytes known today in the world, 1000-1200 species occur in India. Fraser-Jenkins (2013) reported 184 species of pteridophytes from Jammu and Kashmir state. In this paper, 180 species of pteridophytes belonging to 52 genera and 26 families have been enumerated with information on their diversity, status of occurrence and phytogeography. The study is based upon encounter with diverse taxa in field, visits to various Herbaria and scanning of available literature during last more than 50 long years. Of the 180 taxa, 73 species are frequent, 68 are occasional and 39 are rare. As many as 87 species comprising 48.3% are terrestrial, 41 taxa comprising 22.7% are lithophytes. They are followed by 23 species i.e. 12.7% inhabiting both forest floor and wet rocky slopes. Phytogeographically the Sino-Himalayan taxa accounting to 126 comprise 69.2 % are predominant. They are followed by 10.5% European with 19 species, and 7.2% as uncertain Sino-Himalayan or European elements. 12 species comprising 6.6% are S.E.Asian/Malesian, and just 3 taxa show Afro-Arabian affinity, and just 2 species are adventives. As many as 93 taxa occur in the temperate zone between c.1700-3000 m alt. They are followed by 46 species distributed above tree line between c. 3000-5000 m alt. As many as 38 species occur in plains and ascend to c. 1700m alt., of these 4-5 taxa even reach the high Himalayan zone above 3000 m alt. Some of the districts such as Kahtua, Udhampur, Doda, Kishtwar, Reasi, Poonch, Shopian, Baramulla, Anantnag, Kupwara and Budgam are floristically rich in Pteridophytes.

**Keywords:** Jammu and Kashmir; pteridophytes; phytogeography; high Himalaya

# **Biodiversity and Bioprospecting Research, an Avenue of Prosperity and Sustainable Development: History, International Experiences and Way Forward in Context to Nepal**

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More than 13,067 species of plants including 6,973 species of angiosperms, 41 species of gymnosperms, 580 species of pteridophytes, 1,213 species of bryophytes, 792 species of lichens, 2,467 species of mushroom, and 1,001 species of algae have already been documented in Nepal. Among them, 312 species of plants have been reported to be endemic to Nepal. More than 3% of world flora is available in the 0.03% of the world's land cover in Nepal. However, the documentation of microbial species including bacteria and fungi is still lacking. Several presently used active drugs-antibiotics, anticancer, antifungals, and preservatives of natural origin share 50-60% of the pharmaceutical market of the world. About 35 percent of medicines worldwide have originated from natural products. A total of 8 out of 10 drugs used to treat infection, cardiovascular disease, cancers, or as immunosuppressive, have come from plants, directly or as derivatives. Bioprospecting research starts based on either traditional knowledge or random screening. Nepal contains 126 ethnic communities with extensive traditional knowledge (TK) about plant biodiversity. Bioprospecting is a bridging point that joins TK to modern medicine. Artemisinin is a good example of Bioprospecting research in the Nobel Prize-winning category for malaria treatment worldwide. The development of bioprospecting needs policy support and long-term huge investment in human resources and infrastructures. In Nepal, significant work has been completed in the documentation of plant biodiversity and now the time of working on bioprospecting has been started. Several reports on preliminary research on bioprospecting in academia have started to appear. However, there needs more research and investment to translate those research results into commercial products. This presentation will cover all about these issues.

**Keywords:** traditional knowledge; documentation; natural origin; drugs

## **Flowering Plants of Nepal: A Taxonomic Discourse**

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Taxonomic studies of the flowering plants of Nepal started when J. E. Smith published in 1805 a plant collected by Buchanan-Hamilton from Nepal in 1802. Then Wallich's and Hooker's taxonomic studies added many plants from Nepal while D. Don's 'Prodromus Florae Nepalensis' became the first flora of Nepal. In this paper I want to discuss about the taxonomic studies of the flowering plants of Nepal carried out since the beginning of the nineteenth century based on published literature. The discourse is divided into three groups, British (European) contributions, Japanese contributions and Nepalese contributions. I also discuss about the activities for publications of 'Flora of Nepal' and 'A handbook of the flowering plants of Nepal' and future activities on the taxonomic studies of flowering plants.

**Keywords:** taxonomic studies; floral of Nepal; European contributions; Japanese contributions; Nepalese contributions

## Floristic Diversity in the Himalayas: Agenda 2030

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A preliminary assessment of the floristic diversity of the world, including Himalayas (*sensu stricto*), Hindu Kush Himalaya and Pan Himalaya is presented. Furthermore, a progress update on the publication of ‘Flora’ of the Himalayan countries (*sensu lato*), with emphasis on the ‘Flora of Central Himalaya: Nepal’ is discussed. The status of gymnosperms and angiosperms in Nepal representing native or indigenous species, uncertain species, and exotic species is also summarized. Agenda 2030 aims to initiate activities related to the floristic diversity in Nepal: Eflora Nepal (online database of flowering and non-flowering plants), and publication of the online and print versions of Flora of Nepal (ongoing Vols. 4, 7, 10; and three additional volumes). It is also proposed to publish ‘Comprehensive Flora of the Provinces’ (three provinces, representing East Nepal, Central Nepal, and West Nepal); and ‘Comprehensive Flora of the protected areas’ (representing one each from lowland, mid hill and high hill). The format of Eflora Nepal, Online Flora, Comprehensive Flora of the Province, and Protected area is presented. It is proposed that the Department of Plant Resources, MoFE will collaborate with Tribhuvan University (Nepal), Royal Botanic Garden Edinburgh (UK), University of Tokyo (Japan), Institute of Botany, Chinese Academy of Sciences (China), and Botanical Survey of India (India); and further collaboration with the Department of National Parks & Wildlife Conservation, Provincial governments of Nepal, ICIMOD, WWF Nepal, IUCN Nepal and concerned organizations, to accomplish the targeted activities within 2030.

**Keywords:** Hindu Kush Himalaya; Pan Himalaya; Flora of Nepal; online flora; protected areas

## Securing Economic Benefits through Product Development from Medicinal Plants of Nepal

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Many traditional herbs of Nepal have been shown to medicinal, cosmetic, cultural, and nutritional values among different ethnic communities. The extracts, oils, resins, ash or plant parts are used to prepare the medicine, supplement and cosmetic formulations due to several associated properties for various ailments of the skin, hair, stomach, liver and dental care as well as overall appearance. The prospect of herbal product development in Nepal in this era is very challenging. But current problems can generate new opportunity for future directions of international standard product development within the country. The private sectors, particularly Ayurvedic industries of Nepal, have been involved in developing value-added products that claim to be highly effective for daily usage and avoid the side effects. Medicinal plants from Nepal are mostly exported to India in crude form. Although, some Nepalese academic institutions have been working on medicinal plant-based research from various perspectives, paucity of pharmaceutical, agribusiness, cosmetics, personal care, fragrance, botanicals, food and beverage industries are involved in the bioprospecting of Nepalese medicinal plants. Therefore, Government of Nepal must create enabling environment for research and development and innovations for improving traditional medicines with value addition that opens the doors to improved financial avenues. National level trainings, industry-academia linkage, Nepalese herbal pharmacopoeia development, medicinal plants export policy, biotechnology and R&D, innovation and formulation development, classical product standardization are few key components that should be kept in priority for production and commercialization of herbal products within the country. Furthermore, researchers, scientists, academicians, industry professionals, and students should collectively work in a common platform to accomplish this target and to achieve the national prosperity through the conceptualization of value-addition ideas and bioprospecting.

**Keywords:** plant biology; ethnobotany; herbal formulation; doses form; bioprospecting

## Ethnobotany in Nepal: Patterns, Progress and Prospects

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Ethnobotany refers to the study of the processes and patterns of utilization of plants through traditional knowledge for a variety of human needs such as medicine, food, fodder, fiber, and goods required for their livelihood, culture, aesthetics, rituals and amenities. Its application for the global concerns including food security, climate change, biodiversity conservation and human health is hailed. It involves the indigenous knowledge of plant classification, cultivation, conservation, and use. Ethnobotany in Nepal probably started with the publications of a paper on medicinal and food plants by Banerji (1955). So far there are over 1000 ethnobotanical studies, with more than half are associated with medicinal plants. Ethnobotany in Nepal contributes to the management of livelihood, household economy, trade, research, development, conservation, drug discovery and climate change, the latter three are increasingly being recognized in Nepal. Documentation and quantitative ethnobotany are common agendas; however, the applied and conservation ethnobotany are yet to be advanced. Geographic distribution of ethnobotanical studies revealed that over half of the studies were carried out from mid-hills and mountains. The studies pertaining how ethnic groups use the plants and build resilience during the changes and crises hold greater prominence in Nepalese ethnobotany.

**Keywords:** traditional knowledge; medicinal plants; mountains; conservation; resilience building

# **Unlocking the Herbarium: Integrating Local and Indigenous Knowledge into Scientific Schemas**

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Herbaria have served over the last several hundred years to allow comparison of plant specimens and their associated metadata for plant systematics. More recently, herbaria have become widely used as sources of DNA for phylogenetics, and of geographical data for assessing current and future conservation status. Many more rich sources of information remain locked in herbaria, including data on local and indigenous knowledge associated with plants. Increasing the systematic curation and accessibility of this knowledge offers unique opportunities to identify plant resources while also supporting conservation of local and indigenous knowledge in partnership with communities. Knowledge of plant names, uses, cultivation techniques, and cultural values is commonly recorded information on the collection labels of herbarium vouchers. In some cases this has been recorded as a means to identify a plant or as miscellany; but even specimens associated with ethnobotanical studies often are disassociated from this context, and stored as part of a rigorous taxonomic categorization that may obscure ethnobotanical information. Building systems to unlock this knowledge and make it available online in free and accessible formats dramatically increases its potential to support community involvement and use and helps to center local and indigenous knowledge in botanical science. Such knowledge sharing undertaken by herbaria can also support communities in which knowledge transmission has been interrupted. Networks that connect institutions to communities offer great future promise for new relationships that may allow ongoing involvement and benefit sharing.

**Keywords:** herbaria; indigenous knowledge; communities

## **An Overview of Plant Diversity and Conservation in Nepal**

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The diversity of life forms, ranging from microorganisms to plants and animals, diversity of genetic materials within them, and the diverse ecosystems and habitats where they live, is called biological diversity or biodiversity. Biodiversity is the variation of life forms within a given ecosystem, biome, or the entire earth (biosphere). It is quite evident that the number of described or catalogued species and estimated number of species or predicted species varies widely. The Himalaya is one of the most dramatic examples of plate-tectonic forces in the world. Sandwiched between Tibetan plateau and Gangetic plains, Nepal Himalaya offers many niche climates with its very high altitudinal variation within short geographical distance. Although Nepal covers less than 0.1% of the earth's land area, it is disproportionately a species rich country with number of endemic species. Nepal with this rich plant diversity is the major resource that has been a part of subsistence living of majority of the Nepalese people. They also have greater role in maintaining and/or improving the environmental quality against its degradation. At the same there are several factors causing loss of plant diversity or threatening extinction also influence long-term evolutionary processes. Hence there is an urgent need to conserve the valuable but fast disappearing species for the sake of establishing ecological balance and saving the natural resources which have potential for discovery of novel molecules and new sources of active compounds for drug developments.

**Keywords:** biodiversity; resources; uses; threats; conservation

## Agri-business Opportunities through Medicinal and Aromatic Plants

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Medicinal and Aromatic Plants (MAPs) cultivation are gaining momentum in the country from last two decades. Due to diverse climatic conditions and availability of the resources in the country, there are great opportunities of MAPs based agri-business/entrepreneurship development in the country. CSIR-CIMAP with its continuous efforts has been promoting the cultivation of the MAPs and MAPs based enterprise development in different parts of country. Several MAPs are being cultivated in large area in the country especially Menthol mint in about 3,00,000 lakhs hectares, Vetiver in about 5000 hectares., Tulsi ( Basil) in about 6000 hectares., Lemongrass in about 10,000 hectares, Palmarosa in about 4000 hectares, Ashwagandha 10000, Isabgole 60000, Senna about 20,000 hectares, *Artemisia annua* 3000 hectares, Sataver 1500 hectares, Kalmegh 1000 hectares and Aloe-vera 3000 hectares, etc. It is estimated that more than five lakhs farm families are directly involved in cultivation of these plants. By adopting cultivation of these plants farmers are earning an additional income of Rs. 30,000 to 50,000 per hectare. Marginal farmers have also been benefited by integrating these crops in their cropping pattern. Some of the MAPs are also gives higher returns compare to traditional crops in underutilized and degraded lands. Apart from that, there is great scope in processing and value addition of MAPs. Many youth and women entrepreneurs now involved in the value addition and product development of these plants in various part of country. Some success stories and economical aspects of Maps in India will discuss in presentation.

**Keywords:** MAPs; farmers; hectares; entrepreneurs; value addition

# Fern Taxonomy

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Fern taxonomy is contentious, controversial at times involving heated arguments. The first attempt at Pteridophyte classification as we know today was made in the 16<sup>th</sup> century based on morphology, anatomy and palynology. Further advancement and progress in Fern Taxonomy received much help from cytological studies. Adding to the repertoire of Fern Classification was the advent of molecular studies in fern taxonomy. Synthesizing morphological and molecular data, attempts have been made to herald a new chapter in fern taxonomy. Three systems (to date) based on molecular studies have attempted to present an acceptable system of fern classification. Fallout of these systems: Too many new combinations, fewer families but with a large number of genera; too many fern genera and unnecessary splitting. The increase in number of both fern families and genera has been defended as a natural outcome of taxonomic progress and improved understanding of phylogenetic relationships. A few research questions that require answers are: Pteridophyta should not be replaced by lycophytes and euphyllophytes (spermatophytes + monilophytes). The reasons given were that the ferns are characterized by lateral root origin in the endodermis, usually mesarch protoxylem in shoots, a pseudoendospore, plasmodial tapetum, and sperm cells with 30-1000 flagella. Are these reasons enough for divorcing the lycophytes from the ferns? A well-known character of the Pteridophytes was (and still is) 'Independent gametophyte and sporophyte generations. Ferns have very little in common with the spermatophytes. But they have everything in common with the lycophytes and they should be kept together. The taxonomy of fern genera (*Cheilanthes/Aleuritopteris/Hemionitis* and *Onychium*) will be discussed.

**Keywords:** Pteridophyta; lycophyte; monilophyte; molecular studies; fern taxonomy

# **Twin Crisis on the Roof of the World: Knowns and Unknowns**

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Humanity is currently facing a triple planetary crisis: climate change, air pollution, and biodiversity loss. This talk mainly focuses on the twin crisis of climate change and biodiversity loss. By providing the most recent scientific findings on climatic change and biodiversity loss at the global, regional, and national scales, I will explore how these twin issues of climate change and biodiversity loss have intertwined each other through mechanistic links and feedback. Climate change exacerbates risks to biodiversity and at the same time, healthy biodiversity can help in supporting climate change mitigation and adaptation efforts. With a brief description of our efforts to combat climate change and biodiversity loss through legal frameworks such as the United Nations Framework Convention on Climate Change (UNFCCC) and the United Nations Convention on Biological Diversity (UNCBD), I will highlight our achievements and failures to halt climate change and biodiversity loss. In the end, the talk concludes with the highlights of knowledge gaps and the importance of research and innovation to tackle the twin challenges in the context of the mountainous country Nepal-the roof of the world.

**Keywords:** climate change; biodiversity loss; legal framework; research and innovation

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**Theme: Biological Invasion**

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ICBB 129 O

**Impacts of Forest Canopy Gap on Diversity and Abundances of Invasive Alien Plant Species in Subtropical Broadleaved Forests of Lamjung District, Central Nepal****Adarsha Subedi<sup>1</sup>, Ananda Adhikari<sup>1</sup> and Bharat Babu Shrestha<sup>1</sup>**<sup>1</sup> Central Department of Botany, Tribhuvan University, Kathmandu, Nepal

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Invasive alien species are a major threat to the biodiversity and ecosystem function worldwide. In particular, forests are one of the highly affected ecosystems by invasive alien plant species (IAPs) as they find favorable environmental conditions especially in canopy gaps. Various studies related to plant invasion in forest have been carried out but the role of canopy gaps in the establishment of IAPs is poorly understood. In this study, we examined the effect of canopy gaps on the diversity and abundance of IAPs in the *Shorea robusta* dominated mixed subtropical forest. Paired sampling (50 pairs) was carried out with the help of 10m × 10m quadrat, in which a quadrat was sampled in a canopy gap and its counterpart 20m away into the forest interior with tree-canopy. We found a high number of IAPs (9 species) and their cover (31%) in the canopy gaps than in the plots with tree canopy (6 species) and cover (5%). These differences imply that tree canopy in the forests greatly resist the process of plant invasions as they block large amount of sunlight reaching the surface, which is chief source of energy. Moreover, the average IAPs cover of large gap size (18 quadrats) was 34% and small gap size (32 quadrats) was 29%, shows large gap size have positive impact on the establishment of the IAPS. Canonical correspondence analysis (CCA) revealed that NTFPs collection, litter depth, and light intensity were other prominent environmental factors regulating the IAPs. Hence, monitoring forest gaps can help to detect IAPs in their early stage of invasion so that control measure can be implemented before the IAPs are widespread.

**Keywords:** canopy gaps, tree-canopy, *Shorea robusta* forest, middle mountain region

## Impact of *Ageratina adenophora* Invasion on Vegetation and Soil Properties in Central Nepal

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Invasive alien species are one of the major drivers of global environmental change including biodiversity. Impact assessments of the invasive alien species are crucial in prioritizing the species for management. In this study, we assessed the impacts of an invasive weed, *Ageratina adenophora* (Sprengel) R. King and H. Robinson on vegetation and soil chemical characteristics along the elevation gradient at two sites (Chandragiri and Simbhanjyang) in Middle mountain region of central Nepal. Changes in species richness, species diversity (Shannon diversity index and Simpson diversity index), species composition, and soil chemical characteristics (organic carbon, total nitrogen, phosphorus and potassium) due to *A. adenophora* invasion were analyzed by comparing 150 pairs of invaded and non-invaded plots in the study sites. *Ageratina adenophora* reduced the species richness as well as species diversity in the invaded sites. Shannon's diversity index in non-invaded plots was 1.9 times higher than that of invaded plots. Similarly, Simpson's diversity index in non-invaded plots was 1.6 times higher than in invaded plots. Invasion by *A. adenophora* also caused a significant change in species composition. Sorensen's similarity index revealed a 49% difference in species composition between invaded and non-invaded plots. Furthermore, *A. adenophora*'s invasion increased the carbon and nitrogen content in the invaded soil. However, *A. adenophora* invasion had no effect on phosphorus and potassium concentration. These results suggest that *A. adenophora* can modify plant species composition, reduce plant diversity, and alter soil chemical characteristics, with potentially negative impacts on ecosystem functions.

**Keywords:** invasive species; species diversity; species composition; soil nutrients

## Distribution of Invasive Alien Plant Species (IAPS) and their Influence on Habitat Utilization by Mammals in Shuklaphanta National Park, Nepal

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IAPS restrict the growth of native plant species and limit the availability of food for wild animals. There is very scarce knowledge on the distribution of IAPS in protected areas and their potential impact on herbivores. Our study was thus aimed to assess the spatial distribution of IAPS and their influence on mammalian herbivore in Shuklaphanta National Park, far western Nepal. Sampling was conducted along 69 grids of 2 km×2 km cells within the forested areas. Quadrats of 10 m×10 m along each grid were chosen at random points. In each quadrats vegetation type, dominant species, tree canopy cover, IAPs cover percent as well as animal signs (pellets, body marks, etc) were assessed. A total of 16 species of IAPS were recorded belonging to nine families. *Ageratum houstonianum* (50.72%) had the highest frequency followed by *Parthenium hysterophorus* (11.59%) and *Ipomoea carnea* (11.5%). Number of herbivores utilizing the specific habitat was influenced by IAPs coverage. Five out of seven of the predictor variables (tree canopy cover, distance to river, distance to fire lines) evaluated had significant effects. The presence of fire marks and proximity to the settlement was found to have significant effect on IAPs distribution. The occurrence of IAPs was higher closer to roads, settlements, and rivers, and lower below the tree canopies. However, the overall impact of invasion was not seen as significant enough to create negative effects on the presence/absence of herbivores. Species-specific in-depth studies are required to fully understand the impact of IAPS on herbivore habitat utilization.

**Keywords:** canopy; distribution; invasion; occurrence; species richness

## Grazing Exclusion: an Approach to Manage Invasive Alien Species *Parthenium hysterophorus* in Nepal

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Establishment of invasive plants has emerged as serious issue in biodiversity conservation, ecosystem services, and agriculture. Suppression and exclusion of invasive species is a major challenge for grassland management. *Parthenium hysterophorus*, an invasive species has emerged as a major threat in tropical and subtropical fallow lands, grasslands, and agroecosystems of Nepal. The present research was designed to study the implication of cattle grazing exclusion in the year 2017 and 2018 for the reduction growth of *Parthenium* in Nepal. Aboveground biomass, species richness, and species diversity were measured in the plots with and without *Parthenium* where grazing by cattle were excluded. Species richness was found higher in the plots without *Parthenium* than in the plots with *Parthenium*. Simpson's and Shannon's diversity indices have decreased from 2017 to 2018 in the plots with *Parthenium*. Biomass of *Parthenium* decreased by 57% in the year 2018 as compared to the year 2017 leading to increased biomass of other useful species. The overall importance of *Parthenium* in the study area has decreased to the fifth position in the year 2018 from the first position in the year 2017. The present study provides evidence that grazing exclusion might be helpful to reduce *Parthenium* invasion due to the growth of other palatable and useful plant species.

**Keywords:** disturbance; invasion; native species; naturalized species; restoration

## Impact of *Lantana Camara* L. on Associated Plant Species and Soil Chemical Properties in Central, Nepal

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*Lantana camara* is a noxious plant as one of the most invasive weed in the world. The present study assessed the impacts of *L. camara* on native plant species and soil chemical properties in different habitat type for two seasons (Pre-monsoon and monsoon) in Central Nepal including four districts (Makawanpur, Chitwan, Tanahun and Kaski). Paired sampling was used in selected habitat types (Forest-edge, Fallow land and Roadside) by taking 5m × 5m quadrat for shrubs and 1m × 1m quadrat for herbs. Soil samples were collected from the four corners and center of each quadrat to a depth of 15cm. We recorded altogether 137 flowering plant species, among them 16 species were Invasive Alien Plant Species (IAPS). Vegetative parameters and soil chemical properties in different habitat-type were analyzed using one way ANOVA and paired sampled t-test in order to show the difference between invaded and non-invaded sites. Pearson's correlation coefficients were calculated in order to show the impact of *L. camara* cover on different vegetative and soil parameters, further the relationship between species and soil parameters was evaluated by multivariate analysis (CCA). We found that there was the significant difference in vegetation characteristics (species richness and diversity indices) and soil properties (SOC, N, and K) between invaded and non-invaded plots in pre-monsoon and monsoon season except soil pH. In the monsoon season most of the soil parameters showed the highest value in comparison to the pre-monsoon season, but *L. camara* cover showed very weak correlation with most of the above parameters highlighting its low impacts on them. However, more detailed studies are recommended in order to identify key drivers of invasive properties of *L. camara* considering various environmental factors.

**Keywords:** invasive plant; *Lantana camara*; soil properties; habitat-types

## Germination Ecology of Congeneric Native and Invasive Mimosa Species

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Comparisons of germination behaviors between native and invasive congeners are potentially useful approaches for identifying characteristics that promote invasiveness. We compared germination ecology of highly invasive *Mimosa diplotricha* and its congeneric native *Mimosa himalayana* growing under the same climatic condition in south-eastern Nepal. Seed mass and size were measured. Seeds were germinated under two temperature regimes (low: 25/15 °C and high: 30/20 °C day/night alternating temperature), two light conditions (alternating light and complete darkness), and different levels of water stress (“0.1, “0.25, “0.5, “0.75, and “1.0 MPa water potential). Germination data was used to calculate Germination percent, Mean germination time, Timson’s index and Coefficient of germination velocity. Freshly collected seeds of both species did not imbibe water suggesting that seed coat was impermeable to water. Seeds germinated following hot water scarification which indicates physical dormancy. The scarified seeds of both species germinated under complete dark condition. In both species, there was no difference in germination of seeds maintained under low and high temperature regimes. Germination of both congeners declined as osmotic stress increased, but the decline was more pronounced in native species than in invasive species. Seeds of both congeners germinated well up to water potential of “0.5MPa and beyond this, no germination recorded in *M. diplotricha*, while 2% seeds germinated in *M. himalayana*. All of the analyzed parameters, with exception of Mean germination time, were comparatively higher in invasive species than in native species. The superiority of invasive over native congener in terms of germination performance under identical conditions suggests that the traits related to seed germination can be useful for the prediction of invasiveness of species in their introduced range.

**Keywords:** seed germination; water potential; congeners; seed scarification; invasiveness

ICBB 072 P

## Impact of *Chromolaena odorata* on Associated Plant Species and Soil Physicochemical Properties in Central Nepal

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*Chromolaena odorata*, one of the 100 worst invasive species of the world, is known to have its adverse impacts on native biodiversity through competition, monopolizing resources, shading, poisoning, rapid growth and rooting. In this study we assessed the impact of *Chromolaena odorata*, on species richness and composition of associated plant species along with physicochemical properties of soil across different land use types (roadside, fallowland and forest edge) during pre-monsoon and post-monsoon season in the Central Nepal. For this, paired sampling method was chosen as a sampling design through which paired sampling was done to compare the vegetation and physicochemical properties of soil between invaded and uninvaded plots. Altogether 92 quadrats were sampled establishing a rectangular plots of size 5m\*5m which is further subdivided into five plots each of 1m×1m located at four corners and center of the main plot. Vegetation sampling was done within these plots and soil parameters (soil pH, SOC, N, P and K) were analyzed between invaded and non-invaded plots. The results showed that, *Chromolaena odorata*, invaded plots had low plant species richness and diversity. The abundance of native species was also found to be reduced. *C. odorata* invasion have been found to have an influence on the species richness and diversity of native species in invaded areas by lowering the number of native species in invaded sites when compared to native species in uninvaded locations. There was a significant difference in physicochemical properties of soil among different habitat types. This result also showed that *Chromolaena odorata*, was found abundantly in areas with high soil nutrients contents as evident by high soil organic carbon, nitrogen and phosphorus than uninvaded sites. Its impact on native plant diversity seeks for the control and management of this species.

**Keywords:** *Chromolaena odorata*; ecological impacts; habitat types; invasive plant; physicochemical properties

## Composition and Spread of Alien Invasive Plant Species in Trashigang District in Eastern Bhutan

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Alien Invasive Plant Species (AIS) are non-native plants introduced to new habitats for different reasons. They become adapted in new habitats, grow vigorously, and over the time they invade the landscapes causing arrays of environmental and economic problems. This study aimed at investigating the composition and distribution of AIS in Trashigang district, Bhutan. AIS in the study sites were enumerated through a 1.5 m<sup>2</sup> quadrat at every five km distance along altitudinal gradient in transport corridors. The five km distance was considered as the elevational transect. At the spot, vascular plants occurring in the quadrat were identified and recorded along with altitude and GPS coordinates. Species that could not be identified on the spot were handpicked, ferried to the work station and identified using flora of Bhutan, and online resources. 56 quadrats were laid, maximum plants recorded were 47 at 1280 masl and least of 11 species at 2271 masl. The maximum number of AIS recorded were 41 at 1280 masl, while 5 AIS were recorded 2089 masl. The analysis showed 65 common invasive plants from the study area. *Segetsbeckia orientalis*, *Pennisetum clandestinum*, *Galinsoga parviflora*, *Drymeria cordata*, *Eleusine indica*, *Cynodon dactylon*, *Conyza canadensis* were recorded in 56 quadrats; while *Solanum nigrum* 54 times, and *Ageritina adenophora* and *Bidens pilosa* 52 times. By family, AIS in the study sites were asteraceae (17) > poaceae (9) > amaranthaceae (5). *Lantana camara* and *Eichornia crassipes* were also spotted at sites which were not recorded in any other location in the entire study area.

**Keywords:** distribution; quadrat; impacts; Bhutan Himalaya

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**Theme: Bioprospecting and Innovations**

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ICBB 168 O

**Bio prospecting of Some Lesser Known Forest Plants****Anita Tomar<sup>1</sup>, Anubha Srivastav<sup>1</sup>, Charlie Mishra<sup>1</sup>, Satyavrat<sup>1</sup> and V.K.Varshney<sup>2</sup>**<sup>1</sup> Forest Research Centre for Eco-rehabilitation, Prayagraj, U.P., India<sup>2</sup> Forest Research Institute, Dehradun, Uttarakhand, India

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The concept of ‘bioprospecting’ is based on recognition of the importance of natural product discovery for the development of new industrially usable products, often based on traditional knowledge. The purpose of bioprospecting is to tap renewable resources that have specific application to the production of “new products” in a nondestructive manner. Wealth of genetic diversity, including high numbers of endemic plants is a distinctive success factor for bioprospecting. The recent interest in bioprospecting for industrial utilization of renewable resources is vital for the potential contribution to the health and livelihood of people globally and the enhanced value of forest resources, which in turn promotes a greater incentive to protect and nurture forests in the short and long term. The proposed study aiming to promote the value addition and utilization of the Lesser Known Forest Plants (LKFPs) for production of industrially usable products such as essential oils from *Vitex negundo* leaves, fatty oils from *Pithecelobium dulce* seeds and dyes from *Mallotus phillipensis* fruits. A complete survey in Uttar Pradesh was undertaken where natural population of the species occurred and samples were collected and processed for Bioprospecting for industrial utilization of lesser known forest plants. All the stakeholders associated with the production and utilization of essential oils, fatty oils and dyes are expected to be benefitted from this study. Altogether, the outcome of this study will help to increase the value of our forests and help in conservation of biodiversity of selected LKPS.

**Keywords:** bioprospecting; natural product; *Vitex negundo*; *Pithecelobium dulce*; *Mallotus phillipensis*

## Utilization of Fruit Peels of Wild *Punica granatum* L. for Development of Colorants and Antioxidants

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*Punica granatum* L. (Family: Lythraceae), a wild pomegranate and commonly known as Daru, is a deciduous thorny shrub or small tree, which is distributed across the Himalaya. Processing of the fruits of *P. granatum* to produce 'Anardana' and other value-added products, generate a large quantity of peels as residue. These peels have no commercial value and as such remain underutilized. Because of the presence of phenolics in the peels, their utilization was explored for development of natural dyes and antioxidants. Using Box Behnken Design, conditions for production of natural dye from the peels were optimized to be material to liquid ratio 6gm; pH 5.7; and time 15.43 m in which could produce a brown colored dye in yield of 37.5%. Some fascinating shades on silk fabrics were obtained using this dye. Lyophilized and milled peels were also defatted and sequentially extracted with chloroform and 25% aqueous methanol (AM). AM extract *in vitro* DPPH free radical scavenging assay displayed concentration dependent potent free radical scavenging activity with IC<sub>50</sub> 0.43 µg/ml compared to ascorbic acid (IC<sub>50</sub> 0.52). Thus, peels of *P. granatum* could be utilized as a feedstock for development of natural dye and antioxidants.

**Keywords:** *Punica granatum*; peels; natural dye; antioxidant

ICBB 039 O

## Merger of Ayurveda and Biotechnology for study of anti cancer activity of Medicinal Plants of Nepal

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In the last twenty-five years, approximately half of all newly registered chemotherapeutics have been developed from natural products isolated from plants, fungi or microorganism. Nepal because of her geographical biodiversity, is home to flora and fauna of tropical, sub tropical and alpine origin. These herbs have been used since ancient time to treat numerous diseases. The present study was undertaken so as to find the phytochemical presence, antioxidant and antimicrobial activity and anticancer activity of methanol extract of Nepalese medicinal plants. Phytochemical screening of extracts revealed presence of various phytochemicals like alkaloids, flavonoids, terpenoids, coumarin, saponin, reducing sugar, glycosides, tannin, and steroid. The plant extract also showed antioxidant assay namely DPPH (Diphenyl-2-picrylhydrazyl) free radical scavenging activity. Antimicrobial screening showed sensitivity against *C. albicans*, *S. typhii*, *P. aeruginosa*, *Klebsiella pneumonia*, *Staphylococcus aureus*, and *E. coli* by the plants. We also looked at anti cancer activity in human normal and cancer cell lines and we see cytotoxic effect of the extracts against cancer cells lines as seen by MTT assay and CV staining and also looked at their target proteins through Western Blotting.

**Keywords:** antioxidant, ZOI (Zone of Inhibition), phytochemicals, cancer, cell lines

## Antioxidant and Antibacterial Activities of *in Vitro* Callus and *in Vivo* parts of *Piper longum* L.

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*Piper longum* is a tropical and subtropical medicinal and aromatic plant, mainly used in respiratory troubles, diabetes, indigestion, and antidepressant. This study aimed to evaluate the antioxidant as well as antibacterial activity of *in vitro* callus and *in vivo* parts of *P. longum* against 5 bacteria (*Acinetobacter baumannii*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Bacillus subtilis*) through agar well diffusion method. The antioxidant activity of crude methanol extracts and their fractions viz. DCM (Dichloromethane) and methanol were evaluated by DPPH (1,1-diphenyl-2-picrylhydrazyl) free-radical scavenging activity. In addition, the total phenol and flavonoid content of these extracts were determined. The lowest IC<sub>50</sub> value was found in the DCM fraction of root (134.81 µg/mL) followed by the DCM fraction of leaf (186.11 µg/mL), and the DCM fraction of fruit (194.89 µg/mL). The highest total phenolic content and total flavonoid contents in 1 mg of extracts were found in the DCM fraction of root 41.22±0.50 mg of GAE/g dry weight and 73.41±0.53 mg of QE/g dry weight respectively. The antioxidant activity of crude methanol extracts was lower than their DCM and methanol fractions. The DCM fractions of root showed the minimum inhibitory concentration at 5 mg/mL and minimum bactericidal concentration of 8.35 mg/mL against the *Staphylococcus aureus*. The antioxidant and antibacterial activity of the *in vitro* callus were comparable to those of the *in vivo* parts. These findings demonstrated that *P. longum* roots, fruits, and *in vitro* callus could be a valuable source of natural antioxidants and antimicrobials for better therapeutic uses.

**Keywords:** antibacterial, antioxidant, callus, extracts, IC<sub>50</sub>,

ICBB 104 O

## Bio-prospects of Tree Species in Bioremediation of Bauxite Residue

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Red mud or bauxite residue is a highly alkaline toxic by-product that is generated during the production of aluminium by Bayer's process. Roundabout 1.5 t of bauxite residues is produced for generating 1 t of alumina. The toxicity of red mud is a major catastrophe due to its disposal management, because of high alkalinity and salinity it limits the growth of plant species as well. As in present study, it is found that bio prospects carried through the cyanobacterial strains (viz. *Phormidium* and *Oscillatoria*) with planting of tree species, showed potentially successful outputs on the physical and chemical attributes of red mud. The cyanobacterial strains were combined along with the microbial cultures of VAM and PSB to enhance root length, leaf area, fresh and dry weight of shoot and root, plant height, chlorophyll content significantly. The inoculated seeds of few plant species namely, *Cassia siamia*, *Acacia auriculiformis*, *Dalbergia sisoo*, *Pithecellobium dulce* and *Prosopis juliflora* were raised to study the effect of bioremediation of red mud for revegetation. In the further study, it was found that *C. siamia*, *P. dulce*, *A. auriculiformis* and *P. juliflora* thrived well on the amended red mud with other useful inoculums.

**Keywords:** bio-prospects; bauxite residue; bioremediation; cyanobacteria; VAM; PSB

## Biomarker-Assisted Selection and Evaluation of Neem Chemotypes for Conservation and High-Yielding Commercial Plantation

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*Azadirachta indica*, is a multipurpose, tropical forest tree species well known for its biological properties. It possesses antiseptic, antipyretic, antiulcer, antiviral, anti-inflammatory, antifungal and, growth disrupting properties against large number of pests. Present studies mainly focused on to meet out and bridge the ever-growing demand of neem oil by selecting and evaluating chemically superior genotype. Therefore, 29 phenotypically superior tree with good crown best suited in cultivation along agricultural crops have been selected. Collected seeds were first used to measure seed related traits and chemical content and followed by progeny testing through multilocation evaluation trials in varying agro-climatic zones. Analysis of variance indicated presence of substantially high variation ( $p > 0.01$ ) among the selected genotypes for all seed and chemical traits. Oil content (%) varied from 30.40 – 43.45 with an average of 36.02. Similarly, azadirachtin content varied from 3393 – 17534 ppm with population mean of 8506 ppm indicating existence of ample amount of variation which could be exploited through either direct selection or in breeding programs. High genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), heritability (bs) along with genetic advance were recorded for 100-seed weight, and azadirachtin content. Seed length and seed kernel ratio possesses moderate GCV, PCV coupled with high heritability and genetic advance in percent of mean. Highly significant and positive association was observed between all the seed traits only and both chemical traits exhibit non significant correction with seed traits. Therefore, direct selection could not be practiced for oil and azadirachtin content.

**Keywords:** Azadirachtin; oil content; variance, GCV; PCV; heritability

ICBB 209 O

## Isolation and Identification of Pectinase Producing Bacterial Strains from Rotten Vegetable and Fruits Using Molecular Based Techniques

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Pectinase catalyzed the degradation of pectin substances and has been used in various biotechnological industries. In the current study, 23 bacterial strains were isolated from rotten vegetables. The isolated bacterial strains were qualitatively screened for pectinase production on pectin agar medium and only three strains HR 4, HR 21 and HR 23 were observed to produce extracellular pectinase. These strains were further screened quantitatively for pectinase production through submerged fermentation technology in pectin containing fermentation medium. Strain HR 4 from rotten brinjal (*Solanum melongena*) was found to produce higher pectinase as compared to others. The maximum pectinase producing bacterial strain was identified as *Bacillus licheniformis* on the basis of morphological, physiological and biochemical characteristics. For further confirmation of identification, 16S rDNA sequence analysis was performed. The 16S rDNA sequences were aligned and the phylogenetic tree was constructed. The phylogenetic tree confirmed that the strain was belonging to *B. licheniformis*. The 16S rDNA sequences of this new strain were submitted to GenBank and designated as *B. licheniformis* KIBGE-IB21 with the GenBank accession number JQ 411812. The newly isolated pectinase producing *B. licheniformis* used apple pectin as carbon and yeast extract as nitrogen source for maximum pectinase production.

**Keywords:** bacterial stain; medium; sequences

## Phytochemical Screening and Biological Activities of Extracts of Selected Species of *Swertia* L.

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Species of *Swertia* L. are medicinally important plants used for generations to treat different diseases. The methanolic extracts from roots and leaves of two alpine species of *Swertia* L. (*S. barunensis* Chassot and *S. multicaulis* D. Don) were evaluated for total phenolic content (TPC), total flavonoid content (TFC), antioxidant activity, antidiabetic activity and antibacterial activity *in vitro* and compared with that of standard herb *S. chirayita* (Roxb.)H. Karst. TPC was measured using Folin Ciocalteu Phenol reagent, TFC by  $AlCl_3$  colorimetric method, antioxidant activity by DPPH Radical Scavenging Assay, antidiabetic activity by  $\alpha$ -glucosidase inhibition assay and antibacterial activity by agar well diffusion method against five different bacterial strains. Highest amount of TPC and TFC was found in *S. barunensis* leaves ( $107.38 \pm 3.85$  mg GAE/g) and *S. multicaulis* leaves ( $54.13 \pm 0.004$  mg QE/g) which were significantly higher than that of *S. chirayita*. In DPPH assay, lowest  $IC_{50}$  value was observed in *S. barunensis* leaf extract ( $17.74$   $\mu$ g/mL). Highest  $\alpha$ -glucosidase activity was observed in *S. barunensis* leaves (36.65%). In antibacterial activity, *S. barunensis* leaves showed best antibacterial activity against *Bacillus subtilis* that was comparable with the standard drugs Gentamycin while other two species showed moderate to low activity. The result showed that *Swertia* species possess significant antioxidant, antidiabetic and antibacterial activity. Column chromatography method was used for separation into fractions of samples with high glucosidase inhibition. Different fractions from leaf extracts of both the species were evaluated for  $\alpha$ -glucosidase inhibition *in vitro* and fractions with high activity (>90% inhibition) identified for leaf extracts of both species.

**Keywords:** *Swertia*; antioxidant;  $\alpha$ -glucosidase; DPPH; TPC; TFC

*ICBB 206 O*

## **Phytopharmaceuticals and Phytonutrients Ingredients: Development and Product Formulation**

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The uses of plant based natural products are increasing in native and international markets. According to the data published by WHO approximately 70-80 % of developing countries population uses plant based traditional medicines directly as teas, raw or extract form of plant materials. The uses of plant based medicine in western market are well accepted and demand is increasing day to day. Phytopharmaceuticals and phytonutrients are recently new term that refers to certain group of natural bio marker of plant origin that has uses in dietary and pharmaceuticals products. This article help to provide specific and integrated knowledge to develop phytopharmaceuticals and phytonutrients ingredients through plant based raw materials.

**Keywords:** phytopharmaceuticals; phytonutrients; biomarker; traditional medicine

## Metal Ion Profiling, *In-Vitro* Antioxidant and Alpha-Glucosidase Inhibitory Potential of Shilajit (Black Asphaltum) of Nepalese Origin

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Shilajit is a prehistoric medicine documented in Ayurveda and currently has various applications globally. It is a Himalayan herbo-mineral drug that is deposited on rocks as a result of the progressive degradation of certain plants by microorganisms. The main objective of this study was to investigate an anti-diabetic and antioxidant properties. Quality control parameters of 3 different samples of Nepalese Shilajit were examined for its authentication. The anti-diabetic potential was determined by *alpha*-glucosidase enzyme inhibition assay and the antioxidant activity by 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity. The quality control parameters were evaluated for physicochemical parameters determination using FTIR, 96-Microplate reader, TLC, etc. and the heavy metal content was quantified using an energy dispersive X-ray (EDX) fluorescence spectrometer and humic acid by gravimetric analysis. Heavy metals such as Mercury(Hg), Lead (Pb), Cadmium (Cd), and Chromium(Cr) were absent, however biologically beneficial elements such as Potassium (K) up to 31.79 % and Calcium (Ca) up to 10.11% were abundant, as were organic matter (up to 72.54 %). The inhibitory concentrations (IC<sub>50</sub> Value) of alpha-glucosidase and DPPH were found to be 1.77 mg/ml and 6.98 mg/ml respectively. The physicochemical parameters were comparable, confirming its originality and the anti-diabetic and antioxidant activities were found to be significant compared to reference standard drugs. This research can be used to support Shilajit characterization and develop potential aspects of standardization and quality control techniques, as well as to develop novel medications.

**Keywords:** antidiabetic; antioxidant; physicochemical; shilajit

## Bioactive Constituents and Chiral Terpenoids of Essential Oils from Selected Lamiaceae Species of Nepal

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Nepal's Himalaya possesses a number of valuable medicinal and aromatic plants having certain bioactive components. This study has focused on six aromatic plants from Labiatae for their bioactive and enantiomeric components in the essential oils (EOs). The EOs were extracted by hydro-distillation method from the aerial parts of plants. These EOs were analyzed by Gas-Chromatography and Mass-Spectrometry (GC-MS) for their chemical constituents, and the enantiomeric composition by Chiral GC-MS. The GC-MS analysis for all EOs revealed that Pinocarvone (40.73%), Dihydrotagetone (49.08%), Camphor (51.30%), Geranyl- $\alpha$ -terpinene (31.90%), Isocaryophyllene (32.17) and  $\alpha$ -Pinene (29.07%) were the most predominant constituents in EOs of *Elsholtzia strobilifera* (Benth.) Benth., *Elsholtzia blanda* (Benth.) Benth., *Ocimum americanum* L., *Colebrookea oppositifolia* Sm., *Colquhounia coccinea* Wall. and *Leucosceptrum canum* Sm. The number of chiral terpenes found in the EOs of these plants ranged from seven to thirteen. The levorotatory (-)- $\alpha$ -Caryophyllene was found as major component in the EO of *E. blanda* (Benth.) Benth., *Colebrookea oppositifolia* Sm. and *Colquhounia coccinea* Wall., while  $\alpha$ -Pinene was observed as major component in the EOs of *Elsholtzia strobilifera* (Benth.) as levorotatory (-) form and *Leucosceptrum canum* Sm. as dextrorotatory (+) form. The EOs of *Ocimum americanum* L. showed dextrorotatory (+)-Camphor as major component. Finally, the results obtained from the GC-MS and chiral GC-MS investigations of these plants showed the presence of types of bioactive volatile components in EOs, and also useful as a fingerprint to identify the adulteration and authentication perspectives.

**Keywords:** labiatae; essential oil; bio-active components; chiral terpenoids; GC-MS analysis

## Bioprospecting of *Dendrobium transparens* Wall. ex Lindl. in Wild and *In-vitro* Developed Protocorms

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*Dendrobium transparens* protocorms is *in vitro* produced using seed-derived protocorms was established. *In vitro* developed protocorms were assessed for phytochemicals, antioxidant microbial and cytotoxic activity and compared with their wild counterparts. The maximum seed germination was observed full strength MS (FMS) medium. Induction of protocorms was achieved on basal full as well as half-strength MS medium. But former favored the high proliferation of protocorm mass. In the present study, the methanolic, extracts of *D. transparens* protocorms and wild samples were studied *in-vitro* for their antioxidant activity using DPPH assay, microbial activity and cytotoxic activity using MTT assay. The phytochemical analysis of the wild sample showed higher phenolic (61.889mg/gm, 56.889mg/gm) and flavonoid (82.0mg/gm, 72.33mg/gm) content than tissue culture-raised protocorms. Antioxidant activity was found similar in both *in vitro* raised protocorms (56.08%) and wild samples (64.908%). Microbial activity of the both wild and *in vitro* sample were potentially effective against tested strains at concentration ranging from 1mg-10mg/ml. The MTT assay of *in vitro* methanolic extract showed the most significant cytotoxicity against HeLa and U251 cell line with no evident cytotoxicity against normal cell line. Toxicity test showed no evident toxicity having LD value ranging above 2000mg/kg was found in the animal model tested according to OECD protocol. The regeneration and protocorm development protocol in this study provides a basis for germplasm conservation with the efficient production of phytochemicals from *in vitro* derived protocorms.

**Keywords:** orchids; genetic; protocorms; tissue culture; anticancer; antioxidant

## In Silico Molecular Docking Assisted Development of Chrysin Liposomes: Assessment of Bioavailability, Anticancer Activity and Stability

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Chrysin is a natural flavonoid with a proven therapeutic potential but poor solubility and bioavailability limits its therapeutic use. In the present investigation, chrysin liposomes (CLPs) were developed by electrostatic deposition using chitosan/lecithin nano encapsulation technique to enhance biocompatibility by protecting chrysin in nano-lipoidal shell. In the present investigation, our research group is the first to report *in silico* molecular docking assisted nano-complexation using biodegradable and biocompatible chitosan and lecithin for natural flavonoid as a model drug. Developed CLPs were extensively characterized by DSC, XRPD, FE-SEM, TEM, particle size, polydispersity index (PDI), zeta potential, percent encapsulation efficiency (% EE) and drug loading (% DL), *in vitro* dissolution, *in vivo* bioavailability, *in vitro* anticancer, stability study. The CLPs demonstrated acceptable particle size, PDI, and zeta potential implying stability. *In vivo* pharmacokinetic study demonstrated more than 5-fold increase in relative bioavailability of CLPs. The *in silico* molecular docking study results demonstrated that chrysin could be efficiently entrapped in the vicinity of two polymers. The present study suggests that chitosan could protect and encapsulate chrysin which eventually enhances its cytotoxicity as well as bioavailability.

**Keywords:** chrysin; chitosan; electrostatic deposition; liposomes; molecular docking

## Physico-chemical Properties, Proximate Composition, and Antioxidant Potential of Fresh Juice of *Elaeagnus latifolia* L. Fruits

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*Elaeagnus latifolia* L. is deciduous spiny shrub and distributed throughout Nepal between the altitude of 1300-3000 m. In this study, antioxidant, physico-chemical, and proximate analysis of the juice of *E. latifolia* fruits, collected from Gulmi district, western Nepal was carried out using standard protocols. The results revealed that the juice was acidic in nature with pH value of 3.48. Total soluble solid, total solid, specific gravity and viscosity were found to be 6.2°Bx, 6.55%, 1.030 and 1.49Ps respectively. The moisture and ash content of the sample was found to be 93.45% ± 0.5 and 1.2% ± 0.06 respectively. It contains 369 ± 0.08ig/mL of protein and 503.86 ± 0.07ig/mL of carbohydrate. The juice was found to be rich in phenolics (115.6063 ± 0.8ig/mL), flavonoids (25.46 ± 0.7 ig/mL) and ascorbic acid (265 ± 0.4 ig/mL). Similarly, the  $\beta$ -carotene and lycopene content of the juice was 0.0081ig/mL and 0.0042ig/mL respectively. It showed higher antioxidant activity with IC<sub>50</sub> value of 23.3ig/mL. The present analysis indicates that the fruit juice of *E. latifolia* is good source of nutrients and phytochemicals. Hence, further study should be focused on the micronutrient analysis and efforts need to be made on its value addition and product development.

**Keywords:** wild edible fruits; *Elaeagnus latifolia*; antioxidant activity; proximate analysis; phytochemicals

ICBB 207 O

## **Extraction of Santalol Oil from the Wood of *Santalum album* L.**

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*Santalum album* L. (White Sandalwood) is a valuable tree which grow Asiatic continent including Nepal. The Species is hemiparasitic, having photosynthetic capacity but water, mineral nutrients and organic substances are acquired via the host plant. In Indian tradition, sandalwood trees has a special place and it is used from cradle to cremation. The commercial value of sandalwood tree or oil is very high in the global market. The main methods to obtain essential oils from the plant materials are hydrodistillation, steam distillation, solvent extraction, supercritical fluid extraction (SC-CO<sub>2</sub>) and liquid CO<sub>2</sub> extraction have been used to obtain the volatile oil from sandalwood. Among these method, steam distillation is the most common method used by sandalwood companies. This process is much longer than any other essential oil's distillation, taking 14 to 36 hours to complete, but generally produces much higher quality oil. Hydrodistillation is the more traditional method of sandalwood extraction. This method is not used as much anymore because of the high costs and time associated with heating large quantities of water. We carried out a study to investigate the potential of microwave-assisted hydrodistillation for the extraction of essential oils from sandalwood. In addition, although in conventional extraction the heat is transferred from the heating medium to the interior of the sample, in microwave-assisted hydrodistillation the heat is dissipated volumetrically inside the irradiated medium. Thus micro-wave assisted hydrodistillation can be a new approach for extracting oil from sandalwood.

**Keywords:** sandalwood; hemiparasitic; hydrodistillation; microwave-assisted hydrodistillation

## **Bioprospecting of Lesser Known *Buchanania axillaris* (Desr.) Ramamoorthy: An Important Source of Dye**

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Forest is a great reservoir of phytodiversity. There are many plant species available in the forests which are considered as lesser known species. There is an imperative need to access these lesser known species in order to conserve and explore their bioprospecting potential. In India, Telangana state occupied an area of 24% forest cover and forest have many lesser known species. One such species is *Buchanania axillaris*, belongs to family Anacardiaceae, which is commonly known as Cuddapah almond in English and Peddamorli in Telugu. Based on the traditional knowledge, bark of the species could be a potential source of dye from this plant. Keeping this in view, present study aims to standardize the process of extraction of dye from the bark of *B. axillaris*. A Box-Behnken design has been developed to standardize the dye extraction process by considering three factors viz. bark quantity (3 to 9g), pH (acidic, neutral and basic) and time (15 to 45 min). All the extractions were done in 100 ml distilled water on boiling water bath. The absorption maximum of the extracted dye was recorded at 402 nm and yield was also recorded. The data was analyzed statistically and found that 3g in 100 ml at pH 11.0 for 15 min was the optimized process for extraction of dye with maximum absorbance (0.238) and higher yield (25%). Therefore present study revealed that alkaline extraction of *B. axillaris* bark for dye could be a potential process and provide path for future bioprospecting or value addition of the species.

**Keywords:** *Buchanania axillaris*; bark; dye; lesser known; box-behnken

ICBB 041 O

## Anticancer Properties of Selected Nepalese Medicinal Plants

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Cancer is a disease in which certain cells of living organisms grows abnormally and spread to different parts of the body. In many cases cancer leads to death. In 2020, more than ten million people across the world died due to various cancers. If proper preventive measures were taken and initial treatment was done, it would reduce fatality rate. Medicinal plants consists of various anticancer compounds so that it have been used to treat various cancer diseases. The anticancer compounds are phytosterols, flavonoids, alkaloids, phenolics, liminoids, etc. In the present study, MTT assay was used to assess cytotoxicity in Human Ovarian (2008) and Pancreatic (BxPC3) carcinoma cell lines from the extract of *Girardinia diversifolia*, *Tectaria coadunata* and *Melia azedarach*. Flavonoids,  $\beta$ -sitosterol,  $\alpha$ -sitosterol and fucosterol are considered to be cytotoxic phytochemicals found in *G. diversifolia*. An *in vitro* test of extract of *G. diversifolia* showed significant cytotoxic effect in Pancreatic (BXPC3) cell lines. The extract of *Tectaria coadunata* also exhibited effective against Human Pancreatic (BxPC3) cell lines. Apoptosis mechanism of *T. coadunata* is due to the presence of Procyanidin in the extract. Procyanidin is a potent chemo-preventive or therapeutic agent for pancreatic cancer treatment. Likewise, *Melia azedarach* extract is more potent in Human Ovarian (2008) cell lines. Due to the presence of rutin, phytol and  $\alpha$ -sitosterol in *M. azedarach* extract, demonstrated *in vitro* cytotoxic effects in 2008 tumor cells. Over all, most of the Nepalese medicinal plants with anticancer compounds could be used to treat various cancer cell lines.

**Keywords:** cancer; medicinal plants; MTT assay; human ovarian cell lines; phytosterol; procyanidin

## Rapid Propagation, GC-MS Analysis for Bioactive Compounds and Assessment of Genetic Fidelity Using RAPD and ISSR Markers in *Tinospora cordifolia*, a High-Value Medicinal Plant

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*Tinospora cordifolia* (Willd.) Hook. f. & Thomson (Gurjo) is an extensively spreading, glabrous, succulent, climbing shrub belonging to the family Menispermaceae and has been demonstrated to possess multiple ethnomedicinal, pharmacological and medicinal activities. The present investigation was carried out to optimize an efficient and rapid *in vitro* propagation system for *T. cordifolia*, using nodal segment explants. The nodal segment explants were cultured on Murashige and Skoog (MS) media supplemented with different combination and concentrations of plant growth regulators (PGR's). MS medium supplemented with 2mg/L of Benzyl amino purine (BAP) produced maximum shoot regeneration. However, the maximum response of the nodal segments was attained with the supplementation of MS +BAP (5mg/L) +10% coconut water with shoot numbers (23.0), mean shoot length (12 cm). The genetic fidelity of the *in vitro* raised plants were confirmed by analysis with RAPD and ISSR markers which confirmed genetic homogeneity for *in vitro* raised plants along with wild plant. Phytochemical assessment was also carried out for total phenolics, flavonoids and antioxidant activity between the *in vitro* and wild plants. GCMS analysis of the wild stem and *in vitro* plant revealed the presence of 40 compounds detecting a major bioactive compound palmitic acid. This is the first report of *in vitro* propagation of this species with supplementation of coconut water, assessment of the genetic fidelity and screening of bioactive compounds in context to Nepal. The protocol developed here will be useful in the future towards commercial production of therapeutic compounds at a large scale from *T. cordifolia*.

**Keywords:** secondary metabolites; phenolics; flavanoids; antioxidant activity; coconut water

ICBB 026 O

## Are Genes Responsible for Lovastatin Content in Basidiomycetous Mushroom?

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Lovastatin is a metabolite formed for the most part by mould fungi. In the present research work, efforts have been made to screen higher basidiomycetous species for the detection of commercially recoverable lovastatin concentrations. Total 38 higher basidiomycetous species cultures and 40 basidiomycetous fungal fruit bodies were investigated for the presence of lovastatin in this study. The bioassay experiments were conducted for all the 38 fungal species against *Neurospora crassa* and 6 *Pleurotus* species manifested positive results. For the validation of the above results, the HPTLC method was developed for the identification and estimation of lovastatin content. TLC densitometric analysis of these fungal cultures and fruit body extracts with various solvent systems (Chloroform: Methanol- 95:5; Dichloromethane: Ethylacetate- 70:30) on two different pH viz., 3.3 and 7.7 were studied. However, none of the tested fungal cultures extracts/fruit bodies matched with the reference standard of lovastatin. The bioinformatics analysis provided evidence that the apparent inability of basidiomycetes fungi to produce lovastatin is due to the lack of DNA sequences that are identical or homologous to lovastatin gene present in lovastatin producing fungi (eg NCBI Accession no. AF141924.1 *Aspergillus terreus*). In order to identify the various factors affecting the growth of *Pleurotus* species, two experiments were performed. The conventional protocol for *Pleurotus ostreatus* fruiting body production was modified by adding bamboo chips to the substrate. Enhancement of mycelial growth rate and reduction in fruit body production cycle was recorded, thus ensuring better yield in shorter rotation. The findings of the present study indicate that lovastatin production is a strain-specific trait, hence, cannot be attributed to a fungal species in general.

**Keywords:** hypercholesterolemia; lovastatin; basidiomycetous mushroom; gene

## **Galangin Restrictthe Proliferation of Androgen-Independent Human Prostate Adenocarcinoma cells by Inducing ROS-Mediated Apoptosis**

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Flavonoids are amongst the largest group of secondary metabolites, and galangin belongs to the flavone class. It is present in the rhizome of *Alpinia officinarum*, *Alpinia galanga*, *Helichrysum aureonitens* and propolis (1). In this study, we examined the antiproliferative potential of galangin in PC-3 cell line. Previously it has shown potent anti-proliferative potential on several types of cancers, including colon (2), hepatocellular carcinoma (3,4) and ovarian carcinoma (5). However, its effect on PC-3 cell line has not been explored. In PC-3 cell line it inhibited the cell growth with the IC<sub>50</sub> of 64.30 μM (MTT), 81.22 μM (NRU) and 25.81 μM (SRB), further these results are supported by cell migration assay. The cell cycle analysis revealed that galangin arrests G2/M phase and increases the sub-diploid population. Moreover, annexin-V-FITC assay evoked a significant induction of late apoptosis at a higher concentration of galangin. Besides, strong interaction with Cyclin A, Cyclin B and CDK1 was observed. It also disrupts MMP, caused by an increased generation of ROS. Hence, it is concluded that galangin might execute its antiproliferative effect via inducing ROS generation and could be taken up as a promising lead for pre-clinical and clinical validations.

**Keywords:** galangin; PC-3; ROS; cell cycle; flavonoids; cancer

ICBB 210 O

## Anti-Inflammatory and Anti-Cancer Potency of Pssential Oil Extracted from *Cleistocalyx operculatus*

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*Cleistocalyx operculatus* (Roxb.) Merr. & L.M. Perry is a well-known evergreen perennial tree. The leaves of *C. operculatus* were collected from Chitwan National Park, in August 2018. The percentage yield of oil was 0.25%. The GC-MS analysis of oil showed a total of 20 compounds and essential oil mainly composed of myrcene (56.6%), followed by (E)- $\alpha$ -ocimene (6.9%), linalool (5.27%), (Z)- $\alpha$ -ocimene (4.79%), cis- $\alpha$ -farnesene (4.58%) with other minor constituents (less than 3%). Essential oil showed potent anti-inflammatory activity in RAW264.7 cell lines. LPS stimulated RAW264.7 cell lines were treated with 3, 10, 30, 50  $\mu$ g/ml. Proinflammatory cytokines IL-1 $\beta$  and TNF- $\alpha$  were completely inhibited with 10  $\mu$ g/ml and pro-inflammatory protein iNOS and COX-2 was inhibited in concentration dependent manner. Nuclear p65 expression was inhibited by 3  $\mu$ g/ml of essential oil in 1 hour. Cell viability of different cancer cell lines A549, A431, MCF7 and PC-3 was inhibited at lower concentrations with lower cytotoxicity in normal HEK293 and PNT2 cell lines. Colony formation potential of A549 cells was inhibited by essential oil. Flow cytometry analysis on A549 cells showed a significant amount of cells undergoing apoptosis on treatment with EO relative to the vehicle control. Protein expression analysis showed a decrease in the level of pro-apoptotic protein PARP and pro-caspase, which might be attributed to an increase in p38 expression. Cell cycle arrest of A549 cells in G0/G1 phase with increasing dosage. p21 protein expression level was increased and a decrease in the expression level of p-Akt with the treatment of essential oil in A549 cell lines. Superimposition of docking with the component of essential oil beta-ocimene, beta-ocimene and myrcene with Akt/protein kinase showed moderate to significant binding.

**Keywords:** *Cleistocalyx operculatus*; anti-inflammation; lung cancer

## Variation in Berberine and Tinosporaside Content in *Tinospora cordifolia* with Season, Storage Condition and Duration

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*Tinospora cordifolia* is a medicinal plant that contains berberine and tinosporaside and is used to treat diabetes, heart disease, cancer, and as an immunomodulator. This study was carried out at Odisha University of Agriculture and Technology, Bhubaneswar, India, during the period 2018-2019 to assess variation in berberine and tinosporaside content in different seasons and different storages condition and duration from the leaves and stems of *Tinospora cordifolia*. Completely dried samples of branches and leaves harvested in November, March, May, and August were analysed for berberine and tinosporaside content by UV-VIS Spectrophotometer method. Powdered samples were stored in polythene bags in different storage conditions for different durations, which were then extracted and estimated for berberine and tinosporaside content by preparative TLC- UV Spectrophotometric method. Maximum berberine content was found in both Stems and leaves when harvested in March. Similarly, maximum tinosporaside content was observed in stems harvested in November and leaves harvested in the month of March. Minimum degradation and higher berberine and tinosporaside content in stem were recorded when stored in open polybags in dark, while, leaves stored in closed polybags in dark showed minimum degradation and higher berberine and tinosporaside content.

**Keywords:** alkaloids; giloy; *Tinospora*, pharmaceuticals; storage; medicinal plants

ICBB 188 P

## Enumeration of Lichen Species of Makalu Barun National Park, Eastern Nepal

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Lichens grow in a wide range of climates, from the lowlands to the Himalayas. The study was conducted in the autumn of 2021 at Makalu Barun National Park in eastern Nepal, where lichens were collected from 1200 to 4870 meters above sea level. A total of 69 lichen species belonging to 29 genera and 18 families were identified. The details on their habitat, growth forms and ethnic uses, if any, have all been provided. The vast majority (43) are foliose, while 15 are fruticose and 11 crustose. *Parmotrema* genus is found to be dominant with six species, followed by *Physcia*, *Peltigera* and *Lobaria*, each with five species. Furthermore, foliose lichen outgrew crustose and fruticose lichen in terms of growth morphology. Further explorations integrating more in-depth ecological knowledge together with local lichenological perception are also recommended

**Keywords:** diversity; ethno-lichenology; explorations; lichen; taxonomy

## Borneol Prevents Lung Cancer by Inducing ROS Independent Apoptosis and Targeting AKT

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Phytochemicals are used to treat lung cancer in contemporary and traditional medicine. The limitations of known chemotherapeutic drugs, such as non-specificity, resistance, and toxicity, restrict their use for lung cancer treatment. Therefore, search for target-specific novel entities is required continuously. Borneol, is a monoterpene alcohol that possesses antiviral, anti-inflammatory, and antibacterial properties. It is present in several species of *Heterotheca*, *Artemisia*, *Callicarpa*, *Dipterocarpaceae*, *Blumea balsamifera* and *Kaempferia galangal*. Previous reports revealed its anticancer potential against glioma and esophageal cancer. In this study, borneol's cytotoxicity potential against lung cancer has been explored. The borneol cytotoxicity was evaluated on lung cancer and normal cell-line by performing three different assays MTT, NRU, and SRB. Further ROS, MMP and apoptosis were estimated by flow cytometry, and *in silico* molecular docking analysis was done to explore drug-receptor interaction for various targets by using autodock vina. Besides, the toxicity profiling of borneol was performed by ADMET using swissADME online software and was confirmed on human RBCs by performing osmotic fragility assay. In SRB analysis, borneol significantly reduces the cell viability by 24.41% at 100iM and prevents ROS generation and supports mitochondrial membrane potential. It induces early-apoptosis in A549 cells in a mitochondrial independent manner. Borneol revealed an excellent binding affinity with the selected targets. It showed the highest interaction with Akt with binding energy -5.9 kcal/mol. The osmotic fragility and morphology assay on RBCs showed that borneol prevents RBC hemolysis and morphology. These results concluded that borneol possesses chemopreventive potential against lung cancer by inducing early apoptosis and targeting Akt.

**Keywords:** phytochemicals; monoterpene; lung cancer; biomarkers

ICBB 153 P

## Bioprospecting for Utilization of Seed Oil of *Prinsepia utilis* Royle

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*Prinsepia utilis* Royle (Rosaceae), a deciduous shrub, occurring mainly in Himalayan mountains up to 3000 msl has been utilised in Chinese and Indian folk medicine. In China, its seed oil is used in making medicines, food and cosmetic items. In India, however, the seed oil lacks in commercial recognition owing to limited scientific investigations on the plants of Indian origin. Fatty oils from seeds of *P. utilis* growing in six different locations namely Chakrata, Kanasar and of Uttarakhand and Greater Himalayan National Park (GHNP), Riehana forest and Shilarru of Himachal Pradesh, India were isolated in yield varied from 29.59±0.97 to 43.31±2.49%. Seed oil isolated from Kanasar, being of the highest yield was examined for its chemical composition, *in vitro* antioxidant and anti-inflammatory activities. Palmitic acid (19.33±0.71)%, linoleic acid (32.18±1.50)%, oleic acid (44.01±1.35)% and stearic acid (4.48±0.42) % were identified in the oil by GC-MS analysis. Unsaturated fatty acids (76±0.53)% were higher than the saturated fatty acids (23±0.52)%. In DPPH and ABTS assays, the oil showed strong free radical scavenging capacity (IC<sub>50</sub> value (µg/mL) 67.00 and 17.65, respectively for the seed oil and 55.43 and 27.66, respectively for ascorbic acid). The oil also displayed good anti-inflammatory activity in trypsin inhibitory and bovine serum albumin denaturation assay (IC<sub>50</sub> value (µg/mL) of 63.57 and 518.14, respectively for oil, and 54.72 and 485.45, respectively for sodium diclofenac). The oil was formulated in a good quality soap using cold process. Thus, *P. utilis* seed oil holds promise for industrial utilization.

**Keywords:** *Prinsepia utilis*; seeds; fatty oil; antioxidant; anti-inflammatory

## Anti-dandruff Mechanism and Safety Profiling of *Cymbopogon martini* Essential Oil

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We have investigated the anti-dandruff mechanism of selected essential oils from five different families (*Poaceae*, *Asteraceae*, *Cyperaceae*, *Lamiaceae*, *Zingiberaceae*) against dandruff associated microbes. The antimicrobial susceptibility and efficacy of the selected essential oils were examined by agar diffusion and broth micro-dilution assay methods. The results revealed that two essential oils inhibit the growth of dandruff associated microbes (ZOI:  $5 \pm 1.81$  mm to  $29.4 \pm 2.70$  mm diameter). *Cymbopogon martini* showed better efficacy with minimum inhibitory concentration (MIC) of 0.03 to 0.06% (v/v) against the tested fungi (*Malassezia furfur*, *Candida albicans*) and bacteria (*Staphylococcus epidermidis*). The fungicidal and bactericidal activity was found to be 0.06 to 0.25 % (v/v) and 0.06% (v/v) respectively. *In vitro* post-treatment effect was evaluated by estimating the re-growth of essential oil exposed fungal and bacterial cells and the results exhibit that it retards the growth of *Malassezia furfur* for 7h at  $2 \times$  MIC and in *S. epidermidis* for 1, 4 and 5h at  $0.5 \times$  MIC, MIC and  $2 \times$  MIC respectively. Further, it was observed that the essential oil induces ROS production and altered the membrane integrity of the microbes but did not affect ergosterol and sorbitol concentrations. The topical application of *Cymbopogon martini* essential oil at 0.125%, 1.25% and 2.5% concentration does not induce any irritation in rat and rabbit or any sub-acute adverse effects on the skin or systemic toxic reactions. The observed results demonstrate that *Cymbopogon martini* essential oil could be used in formulations for dandruff treatment associated with microbial infection.

**Keywords:** essential oils; dandruff; antimicrobial; *Malassezia furfur*; *Candida albicans*; *Staphylococcus epidermidis*

ICBB 156 P

## Assessment of Climate Change Impact on *Pinus wallichiana* Through Annual Ring Analysis

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This study was objectively conducted to assess impact of climate change on ring-width of *Pinus wallichiana*. Bethan chock -3, Kavreplanchok district was selected as study site. Total 45 core samples were collected from 23 trees to analyze the tree ring. Temperature and rainfall data of over 30 years were collected from the meteorological stations of respective district. Later, sample cores were air-dried and sanded by using different grades of sand paper ranging from 80 to 320 grits so that the optimal surface resolution showed annual rings clearly visible in the microscope. The rings were counted and each ring was cross-dated which was used to determine the age of the tree. The individual ring was measured by Lin-tab measuring system attached to the PC having TSAP and the quality of dating was checked using the program COFECHA. The results showed that the average annual temperature and rainfall was varying. *The inter-correlation between core samples was 0.69. Average mean sensitivity of the core series was 0.27.* The highest record of total annual rainfall was 2345.40 mm in 1985 and the highest ring width was 6.61 mm but annual rainfall was lowest 916.60 mm in 2012, so ring width was only 1.13 mm. ANOVA and t-test showed that there was significant correlation between annual rainfall and ring width as well as average annual temperature and ring width at 95% confidence level. This study will be useful to understand the impacts of climate change.

**Keywords:** dendrochronology; climate change; impacts; tree ring; *Pinus wallichiana*

## Ethnobotany of Traditionally Medicinal Plants of Madawara Forest Range, Lalitpur District, Uttar Pradesh, India

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Plants are used to cure nearly 80% of the world's population, of which medicinal and herbal plants account for ~25% of medicines. Among the plants, tropical medicinal plants are well-known as the “miracle trees” because each and every plant parts are consumed in form of either direct consumption or any formulations for fruit, feed, medicine and other purposes. These are consumed for human and animal nutrition because of its high nutritional value and common use in Asia and Africa. The present study was carried out on tribal people of Madawara forest range lies in 380-470m AMSL of tropical dry deciduous forest of India. The purpose of this study was to generate information regarding traditional medicinal usage of plants to treat the different ailments. A total of 51 medicinally important plants were documented through taxonomic surveys and categorized into different groups based on their traditional uses according to different plant parts. Interviews, group discussions, and participatory observations were used to collect traditional knowledge information from 98 respondents of the Madawara forest range. The common medicinal plants frequently used in the study area were *Emblica officinalis* Gaertn., *Acacia catechu* (L.f.) Willd., *Syzygium cumini* (L.) Skeels, *Azadirachta indica* A. Juss., *Ficus religiosa* L., *Acacia nilotica* (L.) Delile, *Asparagus racemosus* Willd. Ailments, viz., fever, cold, cough, stomach problem, stomach worm, asthma, toothache, pain, swellings, ulcers, infection, blood purifier, skin disease, diabetes, vomiting and itching were the most commonly treated by using different parts of medicinally important plant in the region. Over-exploitation, natural and anthropogenic pressures have made them vulnerable. Protecting traditional knowledge about plants and plant-based healing practices requires the conservation and sustainable use of these important medicinal plant species.

**Keywords:** ethnobotany; taxonomic surveys; medicinal plants; traditional knowledge

ICBB 104 P

## Duckweeds –An Opportunity for Research and Commerce in Nepal

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Duckweeds have been traditionally used as human food in South East Asian countries, i.e. Cambodia, Laos, Myanmar, Thailand and Vietnam. This plant is regarded as ‘‘water eggs’’ by Thai people and call locally ‘‘Khai-nam’’. Recently commercial product like ‘‘water lentil super food’’ has been launched using duckweeds as the main ingredient. Interestingly, scientists are doing research on these species as multifunctional life support system in space craft due to their rapid growth, ease in harvesting along with nutrient or waste removal. Since, long duckweeds serve as ‘model plants’ to understand plant physiological process. Moreover, duckweeds are getting popular for their broad range of applications as human food with high content of protein, starch and flavonoids with low fibre, animal feed, biofuel and biofertilizer. Duckweeds are aquatic, the smallest angiosperms on the earth in the family Araceae. They are free floating or submerged, fresh water, cosmopolitan, and rapidly growing species. They comprise 37 species under 5 genera (*Spirodela*, *Landoltia*, *Lemna*, *Wolffia* and *Wolffiella*). In Nepal, the study of herbarium collections (1963-1983) has shown 4 species of duckweeds under three genera distributed in different parts of the country. *Lemna aequinoctialis*, *Lemna minor*, *Spirodela polyrhiza*, and *Wolffia globosa* are reported so far. Duckweeds are largely ignored and underutilized in Nepal. They can be utilized for domestic, agricultural and dairy waste water management by tapping their immense nutrient recovery system. The biomass can also replace the poultry and aqua feed ingredients for reducing the feed cost. Therefore, in Nepal systematic investigations and commercial interventions should focus on chemical and molecular profiling, protein rich clone selection and commercial production of duckweeds to obtain their food and feed potentialities along with multiple benefits.

**Keywords:** duckweeds; nutrient recovery; protein; feed; commercialization

## **Ethnomedicinal Practices of Plants in Danuwar Community of Dudhauri Municipality, Sindhuli District, Central Nepal**

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The study was aimed to document the indigenous knowledge and practices of using plants for medicinal purposes by Danuwar community in Dudhauri municipality of Sindhuli District, central Nepal. Primary data were collected between October 2016 and January 2017 and revisit in 2021. We interviewed local healers and various age groups of men and women from five wards using Key Informant Interviews and Focus Group Discussions through semi-structured questionnaire. Information was then analyzed by descriptive analysis. A total 157 plants species belongs to 153 genera and 78 families were used in treatment of 47 different ailments. The highest numbers of plant species were used to treat digestive system disorder followed by Skin & integumentary ailments. Herbs were highly preferred for medicinal purposes mostly prepared from leaves and stems. Common mode of application was oral and poultice as juice and paste. Among documented plants ethnomedicinal use of two species were reported as new and eight species with novel medicinal uses for Nepal. Study showed that Danuwar people still have good traditional knowledge among local healers and elderly people. They preferred conventional medication methods using plant remedies to treat various ailments. However, modern medicine and urbanization have slight impact on their health care system and lifestyles of Danuwar. Transference of traditional knowledge is declining slowly among young generations due to less practice and interest. The plants are under great threat due habitat degradation, deforestation, and people have less conservation knowledge. Hence, it calls for urgent initiation in conservation and sustainable harvest of plants.

**Keywords:** ailments; ethnomedicinal use; key informant; sustainable harvest; traditional knowledge

ICBB 163 P

## Evaluation of Nutritional, Phytochemical and Antioxidant Properties of *Heracleum nepalense* D. Don Seeds

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*Heracleum nepalense* D. Don (Apiaceae) is a biennial or perennial herb found throughout Nepal between the range of 1700–4000 m. The seeds of the plant are traditionally used as food additive, spices and flavoring agents in Nepal. The study was carried out to assess the nutritional, phytochemical, and antioxidants, activities of the seeds of *H. nepalense*, collected from Panchthar district of eastern Nepal. The results showed that moisture, carbohydrates, protein, fat, fiber and ash content of the seeds was  $11.3 \pm 0.68\%$ ,  $46.77 \pm 0.8\%$ ,  $6.50 \pm 0.76\%$ ,  $18.022 \pm 0.05\%$ ,  $10.5 \pm 0.1\%$ , and  $7.73 \pm 0.1\%$  respectively. The sample contained abundant amount of phenolics ( $140 \pm 1.5 \mu\text{g/mL}$ ) and flavonoids ( $121 \pm 1.7 \mu\text{g/mL}$ ), moderate amount of ascorbic acid ( $69.54 \pm 2.1 \mu\text{g/mL}$ ) and trace amount of  $\beta$ -carotene ( $0.029 \pm 0.02 \mu\text{g/mL}$ ) and lycopene ( $0.0093 \pm 0.03 \mu\text{g/mL}$ ). It showed moderate antioxidant ability with  $\text{IC}_{50}$  value of  $711 \mu\text{g/mL}$ . The findings of the present study show that the seed is a good source of carbohydrates, protein, fat, and fiber and also rich in phenolic and flavonoid content.

**Keywords:** *Heracleum nepalense*; seeds; antioxidant activity; phytochemicals; proximate composition

## **Cinchonine Targets Lung Cancer Biomarkers: An *in Silico* and *in-vitro* Investigation**

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Natural product as a drug candidate plays a prominent role in the pharmaceutical world. *The limitations associated with known chemotherapeutic drugs such as non-specificity, resistance and toxicity limit their use for treatment. Therefore, target specific novel entities is constantly been explored for promising leads.* Cinchonine is an alkaloid found in the barks of *Cinchona officinalis* which is light sensitive, readily converted into novel cyclometalating and coordinating ligands that can be used to prepare phosphorescent Ir(III) complexes. Cinchonine possess anti-malarial, anti-inflammatory, anti-obesity potential. Previous studies revealed its anticancer potential against cervical cancer, lymphocytic leukemia, liver cancer and lung cancer (adenocarcinoma). Herein, the efficacy of cinchonine in targeting biomarkers associated with different stages of lung cancer (NCI-H460) has been investigated by molecular docking analysis and cytotoxicity (SRB, MTT, NRU) assays. The toxicity profiling of cinchonine was performed using ADMET analysis. Cinchonine showed good binding affinity and highest interaction with MEK1 (7JUT) with binding energy and  $K_i$  value of -8.5 kcal/mol and  $5.81612E-07$  M respectively. At 50  $\mu$ M, cinchonine revealed 33% growth inhibition of NCI-H460 cells. These results conclude that cinchonine possess chemopreventive potential by targeting selected biomarkers associated with initiation, progression, and proliferation.

**Keywords:** cinchonine; lung cancer; NCI-H460; MEK1; molecular docking; biomarker

## Hesperidin Potentiate ROS-Dependent Cytotoxicity with Sorafenib in Hepatocellular Carcinoma Vells

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The synergistic drug therapies exert an effect against cancer cells by targeting supplementary cell carnage pathways and impede drug resistance mechanisms. The treatment also produces toxicity to healthy cells, which further worsens the health of acancer patients. Hence, there is an urgent need to discover new alternatives which could spare healthy cells and potentiate the effect of first-line drugs. Hesperidin is a natural flavonoid that produces mild anticancer activity by regulating the caspase pathway in different types of cancer (1-3). Hence, the cytotoxicity of hesperidin was investigated with sorafenib on the liver cancer cell line (HepG2). Using MTT assay and Chou-Talaly algorithms, dose reduction and combination index wererecalculated, which thenfurther investigated for cellular and molecular targets. Hesperidinreduced the IC<sub>50</sub> value of sorafenib to 3.16, 1.32 and 1.19  $\mu$ M dose-dependently in the HepG2 cell line. At 25, 50 and 100  $\mu$ M, it demonstrated a synergistic effect with sorafenib (0.1-100  $\mu$ M). The combination index was found significantly reduced. Synergistically, hesperidin with sorafenib imparts its cytotoxic effect by participating in reactive oxygen species (ROS) generation and reducing mitochondrial membrane potential (MMP), thereby promoting cell death. These results conclude that hesperidin divulges synergistic effect with sorafenib against liver cancer cells by inducing ROS production and reducing MMP.

**Keywords:** liver cancer; sorafenib; hesperidin; synergy; phytochemical

ICBB 162 O

## Climate Sensitivity of Carbon Dioxide Emission from the Soil of Different Land Types Used in Nepal

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Climate change is a global issue caused by the environmental degradation owing to the greenhouse-gas emission such as carbon dioxide release in the atmosphere with over exploitation of resources and land type to be used, causing a temperature rise. The level of carbon dioxide release from the soil known as soil respiration which is a key ecosystem process where the soil releases carbon from the biological activities of root and microbes, are the major flux and the most accountable in the carbon cycle process. Different land use type behaved alter carbon emission from the soil caused by the sensitivity effect of the climatic factors like temperature, precipitation, solar light and the growth. The research were conducted in different land use type and ecological niches such as forest, grassland and agricultural land in Nepal by the direct measurements using chamber method to elucidate the soil respiration and its sensitivity analysis towards the climatic factors. The separate evaluation in the research revealed that the temperature became the most significant constructive parameter/factor to define the soil carbon release (soil respiration) then after soil moisture and light. The maximum soil respiration in the forest was 1319.5, grassland was 1053.3, and agricultural land was 315.3 mg CO<sub>2</sub> m<sup>-2</sup> h<sup>-1</sup>. However, quantifying the soil carbon release and its sensitivity towards the climatic factors were discrete to define simultaneously in every land use type. The analysis of the study could better use to compute the carbon balance, and outlines in the estimation of carbon budget and its modeling in future.

**Keywords:** climate change; land use type; soil respiration; carbon dioxide; climatic factors

## Indigenous and Local Knowledge of Climate Change and Their Uses in Ecosystem Based Adaptation along the Elevational Gradients in Gandaki River Basin of Nepal

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Global climate change has threatened both ecosystem functions and structures impacting vital ecosystem services and human well-being. Historically, people in the rural Mountains, Mid Hills and Tarai plains of Nepal have adapted to seasonal weather variability that result in either too much or too little water at certain points every year. Local and indigenous knowledge and skills as climate change adaptation actions are being used by Indigenous Local communities in different ecoregions and for various ecosystems in Nepal. However, documentations are scanty and isolated to either out-scale or up-scale. Therefore, the gap was fulfilled through documentation of such knowledge and skills of indigenous communities of Gandaki River Basin of Nepal. The study adopted an analytical and consultative approach, examining both secondary data gathered through literature review and primary data collected through group discussions with six ethnic groups namely Tharu and Majhi communities of Chitwan; Brahmin/Chhetri communities of Dhading; Magar communities of Tanahun, Gurung and other mixed communities at Myagdi Thakali communities of Mustang and Gurung communities of Kaski, Nepal. Informal meetings, key informant interviews, and household questionnaires surveys were used following purposive sampling. Climate and weather data of the last 30 years were used for analysis of climate change variability. Almost all respondents of the study area agreed that they were experiencing notable changes in rainfall and temperature, and using indigenous knowledge while adapting to the climate change. Ecosystem based Adaptation (EbA) practices were increasingly measured and traditional knowledge-base corresponded with the community based adaptation initiatives.

**Keywords:** climate change; ecoregion; ecosystem; indigenous knowledge; climate change variability; ecosystem based adaptation.

## **Ramification of Climate Change on Biodiversity and Population Dynamics of Weeds/Crops in Pakistan**

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The catastrophe of climate change is a global marvel, though its waves are widely fondled in the least developed countries, because of their grander vulnerabilities and lesser capacity to mitigate the climate change consequences. Pakistan, being a highly vulnerable country to climate change, needs attention to cope with the challenges of climate change. Global Climate Risk Index (GCRI) 2019 ranked Pakistan in 8<sup>th</sup> position as the most seriously affected country from climate change. Drastic temperature changes and CO<sub>2</sub> levels are the main indicators of climate change in Pakistan. The World Bank's Climate Change Knowledge Portal (CCKP) revealed that by 2100, the expected temperature in Pakistan will be more compared to the global average temperature. With increasing temperature, the biodiversity in Pakistan, especially weed species, will be severely affected and it will have serious consequences on food security in Pakistan because of its agriculture-based economy. According to the literature, the contribution of agriculture in Pakistan's GDP is 24% which is being reduced recently (21%) due to the factors under consideration. Among other yield-limiting factors, weeds are the principal cause that creates huge losses in field crops. According to a recent survey, the weed losses in Pakistan amounting to 2-3 billion USD annually in major crops. To get insight into the climate change and its consequences on weeds in Pakistan, a comprehensive review was delineated to get the real image of various weeds species and their population dynamics in various climatic zones of Pakistan for better understanding and management for the larger interest of the community.

**Keywords:** biodiversity; climate change; weeds; dynamics; management

*ICBB 055 O*

## **Role of Agroforestry Mitigation of Climate Change**

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Agroforestry is one of the world's biggest visible land use systems, covering landscape and agroecological regions. With food scarcity and climate change concerns on the rise, agroforestry is gaining popularity for its ability to meet a variety of on-farm adapting demands and play a variety of roles in Agriculture, Forestry and other land use system related mitigation pathways. Agroforestry generates assets and revenue from carbon, wood energy, increased fertility of the soil, growing tree cover outside of forests, improved local climatic conditions, growing tree cover outside of forests, it delivers ecosystem services while reducing human effects on natural forest. The majority of these advantages are directly beneficial to local adaptation while also helping to global efforts to reduce greenhouse gases in the atmosphere concentrations. The following are the negative environmental impact on agriculture and forestry loss of natural assets, prevalence of pests, diseases and invasive species, agriculture and forest destruction and high impact on food instability. As crucial policy initiatives, changing rules and legislation, raising knowledge capacity, designing for climate-smart agroforestry landscapes, providing no-regret alternatives, and establishing climate change adaptation programmes are considered. It is concluded that agroforestry, in conjunction with favourable policy, plays a significant role in adaptation to climate change by increasing farm system resilience to climatic shocks. Because of the world's diverse conditions, screening of suitable species along with particular agroforestry models should be decided on the basis of local requirements and provide benefits in socioeconomic and environmental dimensions to people in rural areas, and thus can be suggested as the most appropriate strategy to work on during climatic changes.

**Keywords:** agroforestry; biodiversity; climate change; ecosystem; phytoremediation

## **Insights from Local Community on Changing Availability of Non-Timber Forest Products under Climate Change in Panchadeval Binayak Municipality, Achham District, Nepal**

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Local people in the hilly area depend upon different varieties of Non-Timbers forest products (NTFPs) such as foods, medicines, spices etc. for income generation except timber. This paper highlights the perception of local people over current situation including status of availability of NTFPs under changing climate. Data were collected by questionnaire survey and Key Informant Interview (KII) in 9 wards of Panchadeval Binayak Municipality during April, 2022. Altogether 225 interviews were taken with the oldest family member of each household. Total 84 species of NTFPs were noted. Maximum species were used for the medicinal purpose (56.62%), followed by edible (24.19%) whereas 20% species were used for fodder, fuelwood and others. Climate change and availability of NTFPs were analyzed according to people perception. This study showed that, about 96% people responded raising of temperature, 84.83% were in favor of decreased rainfall and 13.33% as unpredictable rainfall. Due to those climatic changes the availability of NTFPs is going to be decreased and the dependency of people on NTFPs is in critical condition in this Municipality. Therefore, its urge to develop some climate change coping strategies in local and national level which will ensure the NTFPs dependency of local people.

**Keywords:** climate Change; NTFPs; availability; local people

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Theme: Ethnobotany and Traditional Knowledge

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*ICBB 112 O*

## **Important Ethno-Medicinal Arboreal Flora in Nogli Watershed of Sutlej River Catchment, District Shimla, North-West Himalaya, India**

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India is one of the foremost countries not only in Asia, but worldwide famed as far as the wealth of traditional knowledge, and floristic richness is concerned. Within India, the state of Himachal Pradesh, in the North-Western Himalaya, is rich in plant diversity and in addition is also gifted with rich and diverse heritage of cultural traditions. Arboreal plants form an integral source of readily available, traditional medicines to the indigenous communities of the far-flung remote regions. This study pertains to the important woody flora in the Nogli watershed area of Sutlej River Catchment, which are being utilized by the local communities residing. Ethnobotanical surveys carried between years 2020 and 2022 were based on semi-structured questionnaires and group discussions, while reconnaissance survey in all seasons were carried out to understand and analyse the vegetation of the region. Response from 50 respondents covering all age groups was recorded. As an outcome, 44 plant species (26 trees and 18 shrubs) of ethno-medicinal importance were identified from the study area. The plant species are spread across 25 families with Rosaceae being the most dominant. The outcome from this study shall form the baseline data for ethnopharmacological research in future. In addition to this a conservation and management plan can also be chalked out for the species which are heavily extracted from the forests. Such systematic and researched information will add up to an extensive database of the plants used by native communities, and this information could be dispersed to the new generation for awareness and sustainable utilization of plants.

**Keywords:** traditional knowledge; North-Western Himalaya; indigenous communities; conservation; sustainable utilization

## **Ethnobotany on Uranw Community of Sundarharaicha and Gramthan Rural Municipality, Morang District, Nepal**

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Ethnobotany is the study of plant used by a particular group of people with their culture, religion and traditional. It is made of two words: ethno-study of people and botany – study of plants. The present study was taken to explore the medicinal plants used by Uranw community of Sundarharicha Municipality and Gramthan Rural municipality of Morang district, Nepal. The study was conducted in two villages' jhagad tole and motipur for data or information collection. Information on plant species were recorded through interviewing the local participants or respondents using semi-structured questionnaires. The data was collected on the month of November 2021. Primary data was collected by using focus group discussion, transcendent walk, rapid botanical appraisal, and interviews. Some key informants were selected for interviewing in order to collect information about plants resources. A total of 54 plant species were identified belonging to 52 genera and 36 families which were used for the treatment of 30 different ailments and diseases such as cough, diarrhea, dysentery, fever, common cold, jaundice and so on. Among these species, Herbs (23) were used most frequently as medicinal plants followed by trees (16), shrubs (9) and then climbers (6). It was found that different parts of plants such as roots, leaves, fruits, stems, barks, latex etc were used as medicine. The plant specimens were also collected dried, pressed, mounted on herbarium sheets and deposited to the Department of Botany, Mahendra Morang Adharsha Multiple Campus, Biratnagar.

**Keywords:** ethnobotany; Uranw community, Morang district; medicinal plants

ICBB 022 O

## Traditional Knowledge Documentation on Medicinal Use of Plants by Kathariya (Tharu) Community in Kailali District

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This study aims to document the traditional knowledge on medicinal use of plants by Kathariya (Tharu) community in Kailali district. Kathariya is one of the sub-group of the Tharu community whose culture and language is slightly different from other sub-groups. Traditional healers (Guruba, Vaidhya) of Kathariya community from five study sites viz. Sisaiya, Tappa, Udasipur, Pawera and Joshipur of Kailali were identified as key informants. Exploratory research design was adopted and interview method was used to collect the primary information through Semi-structured open-ended questionnaire. Altogether 70 species of plants used for medicinal purposes were documented. 16 species were found useful in cuts, wounds and swelling which is one out of ten health issues categorized in the present study. 13 and 12 species were recorded to be used in abdominal disorders and skin diseases respectively. The community usually mixes powder in measurement of two and half grains of each Barley and Black Pepper in the medicinal preparations for oral consumption. Based on habit, highest number of plant species belongs to herbs (30 species). Among five study sites, highest number of species were recorded in Udasipur with 35 species. Among parts of plant, roots and leaves were found to be used often, which were represented by 24 species each. *Achyranthes aspera*, *Euphorbia hirta*, *Azadirachta indica* and *Clerodendron infortunatum* were the most frequently used species. This study generated preliminary but crucial information which may open the avenue for utilization of biological resources. Further research leading to bio-prospecting is needed to utilize these resources.

**Keywords:** ethnic group; health problem; life form; medicinal purposes; plant species

## Ethnomedicinal Plants Used in Gynecological Problems in Nepal

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Gynecological problems is one of the common problems of women in Nepal. Documenting the list of medicinal plants and their associated traditional knowledge of local peoples of different districts for the gynecological problems is the objective of this paper. Data were collected from secondary sources. About 32 papers published in 1980 to 2019 related to ethno botanical study of medicinal plants from different 33 districts covering east to west Nepal were reviewed. The plants used for different gynecological problems like menorrhagia, leucorrhea, menstrual disorder, postpartum hemorrhage, abortion etc. were extracted from secondary literature. A total of 84 plant species belonging to 48 families were reported to be used for 18 different gynecological problems. The most frequent used part was root (30%) followed by bark (17%), seeds (11%), whole plant (10%), Leaves (8 %), flower and tender shoots (6%), rhizome and fruit (4%), tuber (2%), aerial parts and gum (1%). The mostly cited species was *Asparagus racemosus* Willd (7) followed by *Achyranthes aspera* L. (5), *Cissampelos pareira* L. (4), *Astilbe rivularis* Buch.-Ham. ex D. Don (4), *Asparagus officinalis* L.(3), *Alstonia scholaris* (L.) R. Br. (3), *Amaranthus spinosus* L. (3). The literatures review shows that a total of 21 plant species were used for menorrhagia followed by menstrual disorder (16 plants), postpartum recovery (15 plants), abortion (10 plants), lactation (8 plants), easy delivery (6 plants), Leucorrhea (6 plants). This documentation will be helpful for bio prospecting and discovery of new drug against gynecological problems.

**Keywords:** gynecology; plants; traditional knowledge; women; Nepal

*ICBB 114 O*

## **Indigenous and Traditionally Important Herbaceous Medicinal Plants of Majathal Wildlife Sanctuary, District Solan, Himachal Pradesh, North Western Himalaya, India**

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Himalayas is a one of the mega diversity hotspot of the world, which contribute a great for the biodiversity wealth of the world. Among the biogeographic provinces of India, the Indian Himalayan Region (IHR) is well known for its diversity of ethnomedicinal plants. Majathal Wildlife Sanctuary is situated in District Solan, Himachal Pradesh, North Western Himalaya, India. In the present study, social surveys were conducted through application of semi structured questionnaire. All the 39 villages inside and near to the boundary (up to 2 km) were selected for the survey in the sanctuary. All the houses were surveyed and people from different ages and sexes were asked and their responses were recorded. Reconnaissance survey was conducted for the floristic diversity in the area and plant samples were collected for identification and herbarium preparation. In the sanctuary, there were 51 species of herbaceous medicinal plants identified which were used by local people. The results showed that the knowledge regarding medicinal plants were very less in new generation as compared to the old age and middle age people. This study will help to know more medicinal plants from the villages and procure knowledge for future studies. This documented information will be preserved and utilized for the mankind and make local communities economically stable and healthy.

**Keywords:** diversity; medicinal; therapeutic; ethnobotanical; herbaceous; economically

## **Ethnobotanical Study of Traditional Food in Newar Community of Kathmandu valley, Nepal**

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Socio-culture plays significant role in conservation of indigenous knowledge and ethnic food in Nepal. Ethnic food makes the basis of diversified food which improves the health, food and nutrition security. Documentation of plant based traditional food is one of the crucial contribution to enhances intercultural relations. Most of the traditional foods are prepared to celebrate rituals and culture using plants and plant products. This study gives a general overview of plant based traditional foods and ritual of Newar ethnic group inhabiting Kathmandu Valley, Central Nepal. Data were gathered through ethnobotanical inventory through interviews, participant observations of festivals and ceremonies to document plants type, types of traditional food, consumption of traditional food in rituals and challenges for indigenous knowledge preservation. Altogether 18 wild and 38 cultivated plant species were used for preparation of 44 types of traditional food. These traditional foods are consumed during celebration of more than 25 rituals and cultures of Newar ethnic group. Wild plants such as *Blumealacera*, *Centnella asiatica*, *Choerospondia saxillaris*, *Urticadioica* etc. in particular occurred close to the Newar community were used most for traditional food preparation. Other important plants were resource based from domestication, cultivation and market. Young generation showed little interest of consumption traditional food. There is a great challenge to conserve traditional food and culture. Documentation of traditional knowledge of ethnic foods consumption in rituals will have huge contribution for sustainable conservation of traditional food and culture for future generation.

**Keywords:** culture heritage; ethnic food; health care; indigenous knowledge; rituals

ICBB 043 O

## Ethnobotanical Uses of *Lasia spinosa* (L.) Thwaites by Different Ethnic Communities of Eastern Nepal

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*Lasia spinosa* locally known as “Morange saag” is a common aquatic plant occurring in wetlands and marshy places near tropical forests of east Nepal. The young leaf, petioles and rhizomes are used as vegetable and medicine in several parts of the Indian sub-continent countries. Though it is an important wild plant used by different communities of Nepal, only a few ethnobotanical studies hold information about the uses of *L. spinosa*. So, the present study aims to provide details on ethnobotanical uses and ethnotaxonomy of the plant. This study is based on field visits, and interviews with ethnic communities of east Nepal. Dhimal, Rajbanshi, Sattar and Khawash tribes in different localities of lower east Nepal were selected for the study. *L. spinosa* is commonly used as wild vegetables, medicine by different communities of east Nepal and also generates income in these communities. It is also found that the plant has religious and cultural values in Dhimal and Khawas tribes. *L. spinosa* is an underutilized wild plant. It has a vital role in the food security of the major ethnic communities of east Nepal and also provides income source. The socioeconomic changes in society are drivers for the loss of ethnobotanical knowledge in young generations. Detail ethnobotanical studies should be undertaken for documentation of ethnic knowledge on plants, plant conservation, food security, medicines and commercialization.

**Key words:** ethnobotany; ethnotaxonomy; food security; *Lasia spinosa*; medicine

## **A Review of Traditional knowledge of Ethnomedicinal Plants in Tribes of North-Eastern state Tripura: A Confluence of Indo-Burma Hotspot**

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Medicinal plant diversity is abundant in northeastern India due to variances in terrain and physiognomy. There is a scarcity of information about ethnomedicinal plants utilized by indigenous groups in Tripura, India. The necessity to preserve traditional knowledge has emerged as the state's traditional knowledge is rapidly eroding. Various researchers have attempted to investigate the herbal medicines used by tribal people from various communities in Tripura, India, and document the associated traditional knowledge on the use of medicinal plants, as it is critical for the survival of those who live in rural hilly terrain and cannot afford expensive allopathic drugs. This review article sheds some insight on the documentation of medicinal plants, their preparation, and the disorders linked with them. To ensure that these unique plants are preserved for future generations, conservation is prioritized. The possibilities for expanding existing knowledge and improving traditional medicinal plant use are highlighted.

**Keywords:** ethnomedicinal plants; Tripura; North-Eastern India; indigenous knowledge; ethnobotany

*ICBB 101 O*

## **Ethno-Medicinal and Ceremonial Plants of Kukshow- Veiled Village of the Trans-Himalayan Cold Desert of Ladakh**

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Cold desert landscape of Ladakh holds endemic and unique biodiversity of ethnobotanically important medicinal plants. These medicinal plants have been regarded as rich resources of traditional medicines since the advent of human civilization. As a result of rugged terrain, inaccessible landscape, harsh climate and lack of medical facilities in the region, the indigenous community is totally dependent on the local flora for healing. Study was based on seasonal reconnaissance surveys in years 2021 and 2022. 35 villagers were questioned based on semi-structured questionnaire to record ethnobotanical information. It enumerates 32 important and unique plant species. Asteraceae (6) is the most dominant family followed by Polygonaceae (3), Scrophulariaceae (3), Apiaceae, Fabaceae, Ranunculaceae and Rosaceae, each representing 2 plants; whereas the other families were represented by single *taxa*. The habit of the plants comprised a majority of 27 herbs, 3 shrubs and 2 trees. 15 plants among them were exclusively utilized for medicinal purpose only. Enumeration of the medicinal plants along with their usage will act as the baseline data for further chemical investigation of plant constituents in pharmacological industries. This current information on plants used by native communities could be promulgated to the new generation for awareness and sustainable utilization of plants. The festivity with which they celebrate the flowers in spring time is a valuable heritage and conservation ethos, which needs to be understood by the new generations.

**Keywords:** biodiversity; documentation; traditional knowledge; medicinal plants; sustainable utilization

## **Germination Responses of *Aconitum spicatum* to Environmental Gradients**

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Germination studies of medicinally important high altitudinal plants under different environmental conditions is potentially important to understand the impacts of climate and other environmental changes. In this study, we examined germination of *Aconitum spicatum* seeds collected from low (3540 m asl), mid (3935 m asl) and high (4260 m asl) elevations of its distribution in Annapurna Conservation Area, under different environmental conditions such as complete dark, low (25/15! day night alternating temperatures) and high temperature (30/20!) regimes and varied osmotic stresses (–0.1, –0.25, –0.5, –0.75 and –1 MPa). Experimental data were used to calculate germination percentage, Timson index, Mean germination time (MGT) and Coefficient of germination velocity. The preliminary results showed that the germination percent was the highest (86.67%) in the seeds collected from the highest elevation under control condition. Seed germination percent was slightly higher at low temperature (78.67%) than at high temperature (64.22%). Germination of seeds maintained under complete dark condition was fairly high (50.22%). Seeds germinated even when they were subjected to mild water stress (0.75 MPa) but there was no germination at high water stress condition (1.0 MPa). Fairly good germination of *A. spicatum* seeds under a wide range of light, temperature and water stress conditions suggests that the species may grow under a wide range of environmental conditions. However, additional laboratory and field experiments are needed to validate this assertion.

**Keywords:** environmental stress; high altitudinal plants; climate change; Annapurna Conservation Area

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**Theme: MAPs and Natural Products**

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ICBB 094 O

**Essential Oil Diversity in Different Populations of *Juniperus communis* L. Growing in Western Himalayan Region, India****Abhishek Gupta<sup>1,3\*</sup>, Devendra Singh<sup>2</sup>, A. K. Dwivedy<sup>3</sup>, and Baleshwar<sup>4</sup>**<sup>1</sup> Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001<sup>2</sup> Botanical Garden Plant Conservation and Agrotechnologies Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001<sup>3</sup> Department of Botany, Banaras Hindu University, Varanasi-221005<sup>4</sup> CSIR- Traditional Knowledge Digital Library, New Delhi- 110067

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The present investigation aimed to analyse the essential oil diversity in *Juniperus communis* L. commonly known as ‘Common Juniper’ populations occurring naturally in western Himalayan regions of India. The female cones commonly called juniper berries, and needles were sampled at mature stage during post rainy season from different habitats in Himachal Pradesh and Uttarakhand states of India. Berries and needles were separated, air dried, crushed and individual samples were employed for hydro-distillation of essential oils (EOs). The EOs yield ranged between 1.9-2.6% and 2.5-3.2% (v/w dry weight basis) for berry and needle samples, respectively. GC/MS analysis of six EOs cumulatively revealed presence of a total 74 chemical constituents, representing over 95-99% oil compositions. Significant variability among and within the two oil types (berry and needle) was characterized by high concentration of monoterpenes comprising  $\alpha$ -Pinene (16.0-27.1% and 15.5-27.2%), D-Limonene (20.0-29.7% and 22.7-23.2%),  $\beta$ -carene (1.5-11.3% and 1.8-12.8%) followed by oxygenated sesquiterpenes comprising Germacrene B (0.5-2.8% and 2.3-2.5%),  $\alpha$ -Bisabolol (1.0-6.7% and 2.1-3.9%) as major constituents. The distinct chemical profiles of the EOs were also evidenced by PCA analysis. Moreover, EOs from Indian Himalayas established their separate identity on account of comparatively low  $\alpha$ -pinene,  $\beta$ -myrcene and sabinene content than European counterparts. This high predominance of monoterpene hydrocarbons makes the common Juniper EOs from Indian Himalayas a natural resource of high commercial significance towards its application in pharmaceuticals, flavouring, perfumery, and food industry.

**Keywords:** essential oil; Himalaya; common Juniper; terpenes; GC/MS

## Assessment of *Moringa oleifera* Germplasm for Nutritional Adaptability under Subtropical Climatic Conditions: a Highly Nutritive Medicinal Plant

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The present study aimed to assess adaptability of fourteen ecotypes of *Moringa oleifera* procured and collected from diverse agro-climatic regions of India for nutritional and fodder values under subtropical conditions. For this, genotypic variability, effect of maturity stage and different phenophases were assessed. Tender leaves, mature leaves and twigs were collected during rainy season. Studies on nutritional, fodder traits and secondary metabolites were carried out using standard protocols of AOAC (2005). Significant differences were observed for all traits and concentrations of traits were significantly affected by maturity stage. Maximum DM, protein and energy was recorded in S13 (PAU local), S9 (ODC-3) and S14 (PAU local) ecotypes, respectively. Maximum DMI and digestibility was observed in S5 (PAU local). Source S14 was observed best for nutritional value. In general, S9 was found best for fodder traits and S5 had very less amount of anti-nutrients. Antinutrients were observed in low concentration with permissible limits and may consider as supporting ingredients for moringa feed digestion. Tender leaves were observed best for carbohydrates, NFE, NDF, ADF, ADL, DMI, DDM, RFV and nitrates; mature leaves for protein, fats, fibre, total energy value, IVDMD and pH; and twigs for DM, TSS, hemicellulose, cellulose, phenols, flavonoids, tannins, saponins and oxalates. All traits were strongly genetically controlled as ECV was very low. Thus, ecotypes were found adaptive by their unique nutritional and fodder values. This supports the prospect of cultivating improved germplasm of *Moringa oleifera* as food and feed crops in subtropical conditions.

**Keywords:** *Moringa oleifera*; ecotypes; nutritional values; fodder traits; mineral composition; secondary metabolites

## Assessment of Antimicrobial and Antioxidant Activities of Four Ethnomedicinal Plants used by Magars in Nawalpur District, Nepal

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Ethnobotanical survey in the Magar villages in Nawalpur district, Gandaki province, Nepal revealed that root of *Bauhinia vahlii* Wight & Arn., bark of *Rhododendron arboreum* Sm, flower of *Woodfordia fruticosa* (L.) Kurz, have been using for diarrhea and dysentery and root of *Thalictrum foliolosum* DC. has been using for the treatment of rheumatic pain. Total phenol content (TPC) was estimated using Folin-Ciocalteu method. 2,2-Diphenyl-1-picrylhydrazyl (DPPH) free radical and hydrogen peroxide scavenging assays were used to evaluate the antioxidant capacity. Antibacterial effect was established by the Agar well diffusion assay. The minimum TPC value of 65.78±3.44 mg GAE/g dry extract was estimated in 70 % methanolic extract of *Thalictrum foliolosum* and maximum TPC value of 258.40±6.26 mg GAE/g dry extract was estimated in 70 % methanolic extract of *Woodfordia fruticosa*. IC50 value range 21.59±0.26 µg/ml in *Rhododendron arboretum* to 1124.79±3.69 µg/ml in *Thalictrum foliolosum* was calculated in DPPH free radical scavenging assay. Scavenging of DPPH free radical range from 12.40% to 94% at 100 µg/mL concentration of 70% methanolic extracts were estimated and scavenging of hydrogen peroxide range from 36% to 73%. The maximum zone of inhibition (ZOI) against *Escherichia coli* at loading dose of 5 mg of the extract observed was 18±0.73 mm by 70% methanolic extract of *Woodfordia fruticosa* and its minimum inhibition concentration (MIC) was <1.56 µg /mL. The extracts efficiently inhibited the growth of *E. coli* verifying the rural knowledge. At the same time, the extracts displayed efficient antioxidant activity.

**Keywords:** antibacterial susceptibility assay; DPPH radical scavenging assay; ethnobotany; total phenol content

## Resource Assessment and Marketing of Yarsagumba in the Buffer Zone of Makalu Barun National Park, Nepal

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Yarsagumba (*Ophiocordyceps sinensis*) is one of the highly expensive and potential medicinal mushrooms in the world. The study has attempted to gather information regarding Yarsagumba, its associated species, various medicinal uses, and marketing channel. Out of 15 plots, only 3 plots were recorded the Yarsagumba with a frequency of 0.2 which was very low compared to other medicinal plants. We randomly recorded the Yarsagumba with a density of 833 (No)/ha equal to 0.5 kg/ha (green weight) in the effective area. There was an imbalance between the population of moths and the spores of Caterpillar fungus. There were increasing trends in the Yarsagumba market, heavily dependent on Chinese buyers. The Chinese companies send agents to collect Yarsagumba directly from the fields. And they pay US\$ 10/piece to villagers (According to the latest field study, June 2019). China is the largest producer of Yarsagumba and meets 95 percent of the world's demand. Nepal is the second largest supplier of fungus. Expansion of marketing channel is essential for getting more benefits focusing on local Yarsagumba collectors. It was observed that only 14.51 percent of men participated to collect the Yarsagumba. Different pharmacological actions such as antiasthma, antineoplastic, and antibacterial as well as actions on the heart and blood vessels, and on the smooth muscles of the intestine and uterus have been reported. The government of Nepal should prepare a national Yarsagumba management policy and local Yarsagumba management guidelines to address conflicts by clearly defining the roles, responsibilities, and rights of local institutions and actors. The Park should also prepare a separate management plan of Yarsagumba for sustainable harvesting so that local people would enhance their income, and the government would also increase income through royalties.

**Keywords:** Yarsagumba; production; collection; sustainable harvesting; marketing, policy

ICBB 083 O

## A Comparative Study on Chemical Compositions and Physico-chemical Parameters of Selected Commercial Essential Oils from Nepal

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This study investigated the physico-chemical parameters and chemical compositions of essential oils from Eucalyptus, Mentha, Xanthoxylum, and Cinnamon. Samples were purchased from different traders and were authenticated against the laboratory's reference standard. Gas Chromatography-Mass Spectroscopy (GC-MS) was performed for the chemical profiling and physico-chemical parameters like specific gravity, optical rotation and acid value were determined following the standard protocols for the comparative evaluation of different essential oils. GC-MS analysis of essential oils revealed D-linalool (27.29-40%) in Xanthoxylum, linalool (27.35-29.86%) in Cinnamon, eucalyptol (37.59-42.29%) in Eucalyptus and levomenthol (57.63-64.88%) in Mentha oil to profuse extent. Physico-chemical analysis revealed that among the selected essential oils, Xanthoxylum oil has the highest acid value ranging from 1.6320 to 3.7127, eucalyptus oil has the highest specific gravity ranging from 0.9036 to 0.9438, and Mentha oil has the highest optical rotation value ranging from 37.44 to 34.03. Moreover, the three set of each essential oil had comparable physical and chemical properties, with minor differences in chemical compositions. Geographical variance, harvesting procedures, and storage conditions might all contribute to these differences. The GC-MS and physico-chemical characteristics were investigated as they are recommended for essential oil authenticity and quality management. This research aids in the development of quality control standards to facilitate its commercialization.

**Keywords:** essential oil; GC-MS analysis; physico-chemical property

## Chemical Screening and Identification of Picroside-I and Kutkoside Containing Accessions of *Picrorhiza kurroa* Royle ex Benth. Growth in Different Province of Nepal

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*Picrorhiza kurroa* Royle ex Benth. (family Scrophulariaceae), commonly known as Kutki, is a medicinally revered herb in the Himalayan region where its rhizome is used extensively in traditional and modern medicine. The plant is used by many community in Nepal. As a consequence of over harvesting of wild stock and shortage of natural populations, Kutki is listed as a threatened plant species of Nepal. Picroside-I and kutkoside are the bioactive marker metabolites of kutki. 36 accessions of Kutki samples from different altitudes (3170- 4414m) Far Western and Karnali Province in Nepal were screened for picroside-I and kutkoside. The rhizomes collected were shade dried, milled, defatted, and extracted with hot methanol. The extracts for picroside-I and kutkoside content were analyzed by HPTLC method validated for linearity, precision, specificity and accuracy according to ICH, 1995 Guidelines. Separation and quantification of picroside-I  $R_f$  (0.55) and kutkoside  $R_f$  (0.41) was achieved on precoated silica gel 60F<sub>254</sub> aluminium plates using mobile phase chloroform-methanol (75:25, v/v) in a twin trough chamber saturated for 20 minutes. In this study Picroside-I, kutkoside and kutkin ranged from 0.77-4.88%, 0.52-8.91%, and 2.10-11.37% respectively. ANOVA analysis revealed significant variation in the content of kutkoside and kutkin with altitude. However, no significant variation in the content of picroside-I with the altitude was observed. We identified six chemically superior accessions of Kutki containing high kutkin content that are recommend for management of their conservation and cultivation.

**Keywords:** medicinal plant; rhizome; HPTLC; retention factor

ICBB 178 O

## Anti-viral medicinal plant species in western Nepal: potential for COVID-19 treatment

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Studies show that the mid and western hills and mountains are more sensitive to and affected by global warming. Conservation of medicinal plants and their associated traditional knowledge is in jeopardy in western Nepal in nexus to regional poverty, migration, land use change and climate change. Changing environmental and social conditions has fomented traditional knowledge system of medicinal plant use and conservation in Nepal. This study followed snowball sampling and interviewed total 36 traditional healers including 12 from Kaski, 10 from Syangja, two from Tanahun, six from Kanchanpur and six from Kailali. A total of 173 plant species including 58 plant families were found antiviral, however the number of species varied at district level. These species were used in 14 different viral diseases such as common cold (46), cough (47), asthma (42), respiratory problems (12), measles (15), mumps (23), small pox (32), chicken pox (21), cold sores (33), rubella (11), hepatitis (45), polio (48), AIDS (1), rabies (19). Among the plant families, Moraceae, Fabaceae and Lamiaceae contributed the most. In addition to ethnomedicinal practices, some other traditional way of treatments were also prevalent.

**Keywords:** ethnomedicinal plants; traditional healers; ethnic groups; diseases; dominant families

## Effects of Pre-sowing Treatments and Harvesting Period on the Seed Germination of *Zanthoxylum armatum* DC.

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This study was carried out to determine the effects of different treatments and harvesting period on the germination behavior of seeds of *Zanthoxylum armatum*. Treatments including mechanical stratification, acid treatment, gibberellic acid (GA<sub>3</sub>) and sowing seeds harvested at different time period were evaluated. Several experiments were conducted during 2018 and 2019 at the Laboratory of Dabur Nursery, Banepa to study the seed germination of *Z. armatum*. It was found that the seeds of *Z. armatum* do not germinate easily. The germination rate for control seeds was 2-4%, while it was 54.67% for GA<sub>3</sub> 1500 ppm treated seeds. Chemical and hormonal treatments had relatively some effects on the germination rate, while the hot water, cold water and chilling treatment did not induce germination. Nitric acid (60 %) had comparatively better germination rate than hydrochloric acid (36 %) and sulfuric acid (60 %). Among the mechanical treatments, sand scarification was the most effective with germination rate of 35.33%, which is comparatively higher than that of chemical treatments. Germination percentage increased with the increase in concentration of GA<sub>3</sub> with the highest 54.67 % at 1500 ppm and decreased thereafter. Among all the methods for inducing germination in *Z. armatum*, the most effective was sowing freshly harvested seeds at proper time. Seeds germinated better during mid-phase of harvesting. A maximum of 62.44% germination was obtained for the seeds collected during 16 September-15 October. Sowing seeds immediately after harvesting is a simple, safe, reliable, low-cost efficient way to obtain higher germination rates in *Z. armatum*.

**Keywords:** mechanical; chemical; hormonal; GA<sub>3</sub>; treatment

## Variability in Content and Chemical Composition of Essential Oils of *Neolitsea pallens* Leaves Collected from Different Locations of Himalaya

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*Neolitsea pallens* (D. Don) Momiyama & H. Hara, an evergreen tree of family Lauraceae is traditionally ascribed for various therapeutic properties. In consideration of its use in commercial applications, contents and composition of essential oils of leaves of *N. Pallens* growing in thirteen locations of Himachal Pradesh were determined. Contents of the oils isolated by hydro-distillation of the leaves varied from 0.09% (Bharana link road) to 0.68% (Dalhousie). ANOVA analysis was performed and results showed that contents of these essential oils varied significantly ( $P < 0.05$ ). Populations of *N. pallens* growing in Dalhousie, Jahal-devidarh road and Khajjiar, being of highest essential oil content, were found to be chemically superior populations. 10-33 compounds were identified in GC-MS analyses of the oils of these populations. All these oils were rich in sesquiterpenoids with  $\alpha$ -sabinene (3.17-3.40%),  $\alpha$ -caryophyllene (25.48-44.62%), germacrene-D (17.30-17.74%),  $\alpha$ -elemene (4.84-4.90%) and  $\alpha$ -humulene (2.20-2.46%) (52.99-73.12% of concentrations of these compounds observed in 3 chemically superior populations) as major constituents. Based on these findings, essential oils of *N. pallens* growing in Dalhousie, Jahal-devidarh road and Khajjiar could be of use in aroma industry.

**Keywords:** *Neolitsea pallens*; essential oil; GC-MS analysis

## ***Cupressus torulosa* Needles Essential oil: Chemical Composition and its Biological Activity**

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In view of the growing interest in developing new antimicrobial agents of natural origin to combat increasing microbial resistance against multi drugs, the present study aimed to evaluate the potential of essential oil isolated from the needles of *Cupressus torulosa*(CTEO) widely distributed in the north western Himalayan region of India. Hydro-distilled CTEO (greenish-yellow, 0.6%) was analysed using GC/MS. A total of 36 compounds amounting to 92.76% of the oil were identified. CTEO was rich in monoterpenoids (56.4%) with terpinen-4-ol (17.69±1.32%) and sabinene (9.97±1.7%) as major components. Antimicrobial potential of CTEO was evaluated using the agar disc diffusion method. The oil showed good concentration-based antibacterial activity against gram positive *Micrococcus luteus*, *Streptomyces griseus*, *Staphylococcus aureus* and gram negative *Salmonella typhimurium* at 100 µg/mL compared to control (Ciprofloxacin and Ampicillin at 10 µg/mL). However, the oil remained inactive against fungal strains *Aspergillus flavus*, *A. fumigates* and *Candida albicans*. CTEO also exhibited good antioxidant activity in DDPH free radical scavenging assay (IC<sub>50</sub> of oil and ascorbic acid, 20.50 and 11.12 µg/mL) and in reducing power assay (absorbance of oil and ascorbic acid, 0.448 and 0.618 at 60 µg/mL). The promising results exhibited by CTEO, with further in-depth exploration, will help in establishing the oil as antioxidant and antimicrobial agent in various industrial formulations.

**Keywords:** *Cupressus torulosa*; essential oil; GC/MS; antimicrobial activity; antioxidant activity

ICBB 151 O

## Anti-inflammatory Potential of Needles of *Cupressus torulosa* D. Don ex Lamb.

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*Cupressus torulosa* is an aromatic plant used traditionally as medicine. Its leaves are reported to contain terpenoids and phenolics. In our study we aim to validate the traditional usage of leaves to possess anti-inflammatory (AI) activity. For the study *C. torulosa* leaves were collected from 10 different locations namely Gopeshwar, Chirbatya, Bhatwari, 2 locations of Chakrata, Mussoorie, Jhala, Dugar, Dhanolti (Uttarakhand), Shimla (Himachal Pradesh). They were further lyophilized, milled, defatted with hexane and sequentially extracted with chloroform and 25% aqueous methanol (AM). Since the phenolics were detected in the AM extracts only, total phenolics contents (TPCs) and total flavonoid contents (TFCs) in these extracts were determined to be 176.3 to 208.21 mg GAE /g and 75.11 to 85.19 mg QE/g, respectively. From the results of TPC we found that extract isolated from the leaves of *C. torulosa* growing in Gopeshwar contained the highest TPCs (208 mg GAE /g) and TFCs (78 mg QE/g) therefore it was evaluated for *in vitro* anti-inflammatory activity by protein denaturation assay and taking diclofenac as the positive control. The IC<sub>50</sub> value of AM extract and that of diclofenac was found to be 160.01, 73.94 respectively. The extract was further evaluated for *in vivo* AI activity by carrageenin and formalin induced models. The extract displayed 57.28%, 51.04% percentage inhibition prevention of paw edema respectively with a dose of 400 mg/kg p.o. after 4 hours while the standard diclofenac sodium displayed inhibition of 61.39% (for carrageenin), 52.90 (for formalin), at a dose of 10 mg/kg p.o. after 4 hours. This activity exhibited by the extract can be accounted by lowering release of cytokines and inflammatory enzymes due to phenolics. Thus, the *C. torulosa* leaves hold therapeutic potential in management of inflammation related diseases.

**Keywords:** *Cupressus torulosa*; anti-inflammatory; phenolics; carrageenin; formalin

## **Medicinal and Aromatic Plants: Status, Issues and Challenges in Makawanpur District, Central Nepal**

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Medicinal and aromatic plants (MAPs) are one of the most important constituents of non-timber forest products that have played a crucial role in the local people's livelihood as well as the national economy. A total of 15 field observations and 27 key informant interviews with farmers, collectors, processors, traders, and government officials were carried out for the collection of information. Out of a total of 194 MAPs species recorded in the study area, some 30 species were having trade value. The majority of the species were collected from the wild though a few species like *Asparagus*, *Cinnamomum*, *Myrsine*, etc. were practiced for cultivation. *Asparagus*, *Myrsine*, *Paris*, etc. were the top most species being traded mainly to the Indian market. Almost all species were traded without value addition though very little effort was made for simple value addition for a selected species like *Taxus*, *Berberis*, etc. The trade scenario showed a decreasing trend in both volume and value in the last five years. The unpredictable fluctuation in the market price of the products, the trader-controlled market, and the weak bargaining power of the farmer was found to be the major challenges faced by the local farmers. Moreover, disease and pestshave also become serious threats to commercial cultivation in the last few years. So it is of utmost need to go through the massive value addition of MAPs and trade of final/semifinal product along with proper dissemination of market information and training to the locals to uplift the livelihood of the locals and national economy.

**Keywords:** cultivation, distribution, livelihood, MAPs, trade, value addition

ICBB 097 P

## Assessment of Species Composition and Natural Regeneration of Important Plant Species in a Very Moist Forest of Coastal Eastern Ghat of Odisha, India

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This study was carried out in very moist forest (3C/C<sub>1d</sub>) of Balugaon Range, Rajini-Tamana Reserved Forest, Khordha Division, Odisha, India during 2018-19 by following nested sampling. Floral composition, number of species, and regeneration (<10 cm gbh) of tree species were recorded. Total 110, 33, 53, 38, and 12 species of trees, shrubs, climbers, herbs, and grasses respectively were reported. The ranges of frequency, relative frequency, density, relative density, abundance, relative abundance, and IVI of shrubs were 6.66-56.66, 1.4-12.14, 40-1200, 0.6-18.75, 1.50- 6.00, 2.59-10.39 and 4.65-39.95 respectively. With regard to herbs, it was 3.33- 66.66, 0.63-12.74, 333.33- 17000, 0.35- 18.02, 1.00- 2.55, 1.15- 4.60, and 2.14- to 33.69 respectively. While, 3.33- 46.66, 0.40- 5.69, 26.66- 613.33, 0.32- 7.44, 1.66- 3.80, 1.28- 3.25, and 3.17- 15.94 among climbers. Frequency, density, basal area, and IVI of different tree species ranged between 33-79.92 %, 2.5- 97.5 ha<sup>-1</sup>, 0.06-10.54 m<sup>2</sup> ha<sup>-1</sup>, and 0.85-51.69 respectively. *Tectona grandis* and *Shorea robusta* among tree species, *Desmodium triangulare* among shrub species, *Combretum roxburghii* among climber species, and *Barleria strigosa* among herb species were found dominating, securing significantly higher IVI. *Mallotus phillippensis* and *Shorea robusta* were maintaining good regeneration, while, *Tectona grandis* exhibited very poor regeneration.

**Keywords:** composition; diversity; dominance; IVI; frequency; regeneration

## Impact of Forest Fire on Floristic Diversity and Stand Structure in Chirpine (*Pinus roxburghii*) Forest Ecosystems of North-Western Indian Himalayas

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Forest fire is one of major environmental disaster to all ecosystems. It is a good servant but a badmaster also. Forest fires occur every year in Indian Himalayan region and causes great impact on the country's ecological, social, and economic conditions. Forest fire also affects animals through its effect on habitat. The present study was carried out in *Pinus roxburghii* dominated forest ecosystems affected by fire. The sample plots were laid out as per data acquired from State Forest Fire Management Information System in conjunction with data from Forest Survey of India and National Remote Sensing Centre, India based on the frequency of forest fire damage. The fire affected areas were divided into two strata's i.e., burnt and un-burnt sites. Stratified random sampling was used by laying four quadrates (31.62m×31.62m) for measuring trees and saplings. Within 31.62m×31.62 m quadrate another four 5m×5m and 1m×1m quadrates laid for measuring shrubs and herbs. It was observed that the diversity of trees and shrubs were high in un-burnt sites whereas diversity of herbs were recorded high in burnt sites. A total number of 15 to 17 species of herbs were recorded in burnt sites whereas 10 to 12 species of herbs were recorded in un-burnt sites. The diversity index (H) for herbs was recorded 2.72 and 2.38 for burnt and un-burnt sites. Controlling such fires is necessary in order to allow natural recovery processes to enhance biological diversity and sustainable development.

**Keywords:** flora; fauna; FSI; NRSA; herbs

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Theme: Plant Diversity Conservation

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ICBB 172 O

## **Diversity of Epiphytic Orchids and Phorophytes in the Foot-Hill of Himalaya in Tea Garden Area of Terai (WB, India) and its Conservation**

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The Himalayas are rich in orchid diversity and the Foot- hills of Himalaya of West Bengal (India) is a miniature paradise of orchids. Different types of epiphytic orchids have been found in the tea garden area of Terai region (W.B., India). Fourteen (14) tea gardens were randomly selected for the field study. Epiphytic orchids need phorophytes to survive. Twenty different species of phorophytes and 12 species of epiphytic orchids were recorded. Epiphytic orchids have some preference for the phorophytes. The highest number of epiphytic orchids is found on the stem of *Albizia procera*. Papilionanthe trees has been recorded in the most tea gardens. Epiphytic orchids are under threat because their native environment has been severely damaged in various ways. There is an urgent need to raise awareness among the local people of this region and to adopt conservation measures to increase the diversity and abundance of epiphytic orchids.

**Keywords:** epiphytic orchids; phorophytes; conservation; India; tea gardens

## Assessment of Tree Related Micro Habitats on Trees Outside Forest in Kathmandu Valley

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Study was conducted for assessment of the Tree Related Micro Habitats (Tree Mshereafter) as a part of supporting services on Trees Outside Forest (TOF hereafter) of Kathmandu valley, central Nepal. Inventory was performed in 209 randomly selected points by Excel using circular plots with 20 m radius. In total 6,210 (236.38/ha) individuals of 150 tree species were recorded from the study area that belonged to 111 genera and 57 families. 1106 TOF (0.18%) were found to serve as TreMs. Out of seven forms, 15 groups and 47 types of TreMs (Larrieu et al., 2018), four forms, five groups and 12 types were recorded. Habitat types per tree varied from one to six. One, two, three, four and five habitat types were found in 717 (64.89%), 293 (26.52%), 67 (6.06 %), 8 (0.72 %) and 4 (0.36%) trees respectively. Six habitat types were found in one *Cinnamomum camphora* tree (0.09%) with 8.6 m height and 75 cm dbh. TOF were found as the habitat for plants like fungi, lichens, mosses, ferns, orchids, parasitic plants and angiosperms, support for climber plants, habitat for birds like crows and other animals like ants, squirrels, snails, spiders, caterpillars, bees, etc. The study explored the TreMson TOF in Kathmandu valley and provides the baseline data useful for biodiversity conservation planning suggesting a need for appropriate species selection for plantation.

**Keywords:** cavities; co-occurrence; exudates; polypore; pulpy agaric; nests

*ICBB 208 O*

## **Are Agriculture Subsidies Harmful to Biodiversity in Nepal?**

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Government is providing agricultural subsidies valuing NRs 1400 million annually to boost agricultural production and reduce imports. These subsidies can positively or negatively impact biodiversity and ecosystems, depending on how they are designed and implemented. Hence, this study aimed to understand the consequences of the agricultural subsidies (incentives) on biodiversity, focusing on land-use conversion, loss, and threats to biodiversity. The study followed an exploratory and inductive approach, reviewed secondary sources of information, and conducted in-depth interviews with the stakeholders, along with the field observation. Of the 18 agricultural subsidies, 11 had direct or indirect adverse consequences on biodiversity. Among these 11 subsidies, three subsidies, namely chemical fertilizers, insurance premium subsidy and interest subsidies are high impacting in nature, given their financial value, geographical reach, and resultant adverse biodiversity impacts. These subsidies motivated farmers to change their farming practices, which impacted biodiversity either directly or indirectly. Direct impacts include loss of plant and animal species or genetic diversity, pollinators, habitat conversion and degradation. Indirect impacts include exploitation of resources and services, pollution, or unsustainable land-use practices. Surprisingly, agricultural growth after subsidy is not encouraging. The study concludes that subsidies promoted unsustainable agriculture practices, resulting in adverse biodiversity consequences, especially by increasing biodiversity threats and loss of biological resources. However, withdrawal of subsidies might not be a right choice given the likely political economic consequences of reforms in the changing context of farming system in Nepal. Hence, the study argues for creating a win-win situation for conservation-friendly economic growth by “greening agricultural subsidies,” focusing on avoiding adverse consequences and incentivizing conservation.

**Keywords:** agricultural incentives; farming practice; biodiversity impacts

## Propagation of *Tectaria coadunata* (J.Sm.) C.Chr. from Spores

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*Tectaria coadunata* locally known as ‘Kalo niuro’ is a perennial evergreen edible fern belonging to the family Tectariaceae. Though the species is widely used as a popular vegetable, its commercial production is still lacking. This paper gives details of its successful propagation from spores using two different propagating media, coco-peat and soil mixture (soil, sand and compost manure). It was regularly monitored and maintained to keep the propagating media humid and moist. The recorded range of temperature was 18-27°C during the period of spore sowing, germination and the development of sporophytes and the florescent light regime was adopted daily for 14-16 hours. This research has now reached the acclimatization phase and the final output of the study will be discussed in the near future. Our work has been successful in the laboratory under controlled conditions of factors such as light and moisture and young plants are now in the process of being planted out for cultivation to study their survival and the viability of using them for production.

**Keywords:** edible fern; *Tectaria coadunata*; spore propagation; cultivation

ICBB 123 O

## Canopy Dynamics of Nepalese Forests

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Spatial variations of canopy composition, density and height are useful to reveal many ecosystem processes such as above ground biomass, carbon sequestration, forest health, diversity, primary productivity, status of biological invasion and so on. With rapid advances in remote sensing techniques, canopy height, density, species composition, and canopy gaps can be mapped from local to global scales. ETM imagery, bioclimatic data, global forest canopy height data, forest canopy density and forest type maps were used to analyse canopy dynamics of Nepalese forests. Data analysis revealed that Hill *Shorea* forest was the most dominant forest type followed by *Schima-Castanopsis*, Terai *Shorea*, Chir-Pine-broad-leaved and Lower temperate Oak Forest. Only few scattered forests patches attended a maximum canopy height of 35 meters and above and mostly observed between 2200-3400 m altitude and inside national parks and conservation areas. A greater abundance of shorter canopies were observed throughout the middle mountains and high Himalayan regions. Forest type, pure or mixed with Blue pine, Cedar, Maple, Magnolia, Walnut, Fir, Oak and *Shorea* formed relatively high canopy than the other associations. Canopy height and density were strongly correlated to distance from forest edge, settlement and canopy gaps. Distribution pattern of forest types exhibited a hump-shaped relationship with elevation, with the peak value at altitude (2300-3400 m). Forest canopy density was high at lower altitude and isolated high density patches were observed between 2300 and 3500m elevation. This study provides a useful tool for understanding taxonomic, structural and functional dynamics of canopies of Nepalese forests and their management.

**Keywords:** forest canopy dynamics; remote sensing; bioclimatic data; mapping; canopy height; density

## Edible Ferns of Nepal

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The coiled crosiers, young tender shoots and young fronds of certain ferns are widely collected from the wild and cooked as vegetables in Nepal. These edible ferns have been misidentified in many articles and books published by researchers. The aim of this study is to document the edible ferns of Nepal and provide the correct scientific and local names for them. This study is based on study of herbarium specimens in KATH and international herbaria, field visits and interaction with local people in different parts of the country, and market survey. Of 583 taxa of pteridophytes reported from Nepal, 18 ferns are edible. Crosiers or tender shoots of *Diplazium esculentum*, *Diplazium maximum*, *Tectaria coadunata*, *Helminthostachys zeylanica*, *Ophioglossum petiolatum*, *Ophioglossum reticulatum* and *Blechnum orientale* are sold in local markets in Nepal. Crosiers of *Cyathea spinulosa*, *Dryopteris cochleata*, *Diplazium esculentum* and *D. maximum* are blanched in water for 10-15 minutes before cooking. The study provides the correct scientific names, distribution and diagnostic characteristics of these edible ferns to help in their identification and in further research. Two poisonous ferns (*Thelypteris arida* and *Pteridium revolutum*) are emphasised to be avoided.

**Keywords:** crosiers; ethnobotanical knowledge; herbarium specimens; identification; poisonous ferns

ICBB 082 O

## Macrofungal Diversity in Midhill, Nepal Himalayas

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Macrofungi have diverse impacts on biology, ecology and economy. Studies related to the floristic composition in Nepal are enormous, but the mycospecies component is always neglected. A large number of macrofungal species are distributed throughout Nepal in different climatic zones having edible, medicinal and poisonous values. Local people have traditional knowledge to distinguish the poisonous and edible mushrooms, however, mushroom poisoning incidences are frequent due to misidentification. This study has been conducted in Palpa district, Lumbini Province, Nepal to know the ecological and ethnomycological status of macrofungi found in the region. Ecological survey was conducted by sampling plots along the elevation gradient (<500m, 500-1000 m and >1000 m) from eastern to western regions of the Palpa district. Ethnomycological survey was conducted by interviewing knowledgeable people using a standard questionnaire. A total of 140 macrofungal species belonging to 19 orders, 45 families and 82 genera were recorded under the classes of Ascomycetes and Basidiomycetes. The elevation range 500 to 1000 was rich in the macrofungal diversity. The most important genera based on the important value index (61.14) *Termitomyces microcarpus*. Among the macrofungi documented, 26 species were edible, 23 species were medicinal, 23 species were poisonous and rest 68 species were not edible. The local people have expertise on identification of edible and poisonous macrofungi based on their traditional knowledge. This study has contribution in understanding of macrofungal diversity and ethnomycological approaches of local people in Nepal.

**Keywords:** mycospecies; elevation gradient; ethnomycology; edible value

## **Diversity of Naturalized Plant Species in Lake Cluster of Pokhara Valley, Central Nepal**

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The diversity of naturalized plant species is often influenced by the diversity of native plants and the nutrients, among other factors, in wetlands. This study aimed to determine the relationship between 1) native plant diversity with naturalized plant diversity, 2) naturalized plant diversity, with nutrients, and 3) the relationship between plant diversity and environmental variables in the Lake cluster of Pokhara valley (LCPV). For this, 89 plots of 20×5m<sup>2</sup> were established on the shore of lakes. Flowering plants were recorded in each plot and their cover was estimated by visual method (Daubenmire cover class). Water samples collected from each of the 89 sample plots were analyzed for the nitrate-nitrogen (Brucine method) and total phosphorus content (Kjeldahl method). Canonical Correspondence Analysis was carried out to determine the relationship between species richness with the environmental variables. Relations between species richness of native and naturalized species were analyzed by the Generalized Linear Model. The naturalized species accounted for 20 to 30% of the flowering plants in the individual wetlands. The Phewa lake had the highest value of species richness of naturalized plants among the nine wetlands. The result showed that nutrients had no effect on the abundance (cover) and species richness of native and naturalized species. However, species richness of naturalized species increased with increasing species richness of native species ( $R^2 = 0.15$ ,  $p < 0.001$ ). The results suggest that the diversity of naturalized species was influenced by the diversity of native species but not by nutrients in the water of the study wetlands.

**Keywords:** native and naturalized diversity relations; nitrogen content; phosphorus content; wetland; Ramsar site

ICBB 001 O

## Long Term IWM (Integrated Weed Management) for Controlling Noxious Wild Onion: A Major Threat to Biodiversity

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Chickpea (*Cicer arietinum* L.) yield is adversely affected by the weeds competition especially *Asphodelus tenuifolius* CAV. a noxious and troublesome weed in southern districts of KP province-Pakistan. In some chickpea fields, the *A. tenuifolius* density was recorded so high that farmers leave their fields unharvested. The instant trials were conducted for three consecutive years during 2015, 2016 and 2017 to manage the weeds especially *A. tenuifolius* in chickpea, at the Agriculture Research Station (ARS) District Karak, Khyber Pakhtunkhwa-Pakistan. The treatments included Bromoxynil + MCPA 40 EC, Starane-M 50 EC, Stomp 330 EC (PRE) @ 2.5 L ha<sup>-1</sup>, Fenoxaprop-p-ethyl 6.9 EC, *Sorghum halepense* allelopathic extracts, *Cyperus rotundus* allelopathic extracts, Mulching (Wheat straw), Mulching (Eucalyptus leaves), *A. tenuifolius* allelopathic extract + Stomp and untreated check for comparison. The data were collected on nitrogen free content, crude protein %, ash %, crude fats and the oil contents of the chickpea seeds. The experiments were laid out in a RCB design. The means data showed maximum nitrogen free content %, crude protein %, ash %, crude fats and oil content (68.95%, 17.76 %, 2.96%, 4.90 %, and 5.96% respectively that were observed in the treatment of Stomp 330 EC and the minimum values of 59.65, 15.41, 2.38, 4.04 and 5.04%, respectively were found in all the five untreated check plots. Thus it was concluded that Stomp 330 EC increased the nutritional composition of chickpea seeds.

**Keywords:** wild onion; threat; biodiversity; nitrogen content; crude protein; chickpea

## ***In-vitro* Propagation of *Dendrobium chryseum* Rolfe**

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*Dendrobium chryseum* Rolfe is an endangered epiphytic and lithophytic orchid species having medicinal and ornamental value. The objective of the present study is to develop a micropropagation protocol for *D. chryseum*. The immature seeds of *D. chryseum* were used as explant for the micropropagation. Protocorms were developed in 90 days in MS (Murashige and Skoog) medium without plant growth regulators. Protocorms were differentiated into micro shoots after 30 days of transfer to MS medium supplemented with 2 mg/l BAP (Benzyl amino purine), 1 mg/l kinetin and 10% coconut water. Among eleven different combinations of plant growth regulators (BAP, NAA, Adenine Sulphate, Kinetin and coconut water) treated for shoot multiplication, maximum number of shoots were obtained at 0.5 mg/l BAP + 0.5 mg/l NAA ( $5.8 \pm 0.53$  SE shoots per explant). Longest shoot length was recorded in MS medium with Adenine Sulphate (1 mg/l) ( $2.54 \pm 0.03$  cm SE). Root induction was carried out using MS medium with different concentrations (0.5, 1, 1.5, 2.0 mg/l) of Indolebutyric acid (IBA) and NAA. The highest numbers of roots and longest root length, both were observed at 2 mg/l IBA ( $4.63 \pm 0.56$  SE and  $2.09 \pm 0.25$  cm SE respectively). 2 mg/l NAA showed poor response for root number ( $0.94 \pm 0.21$  SE) and root length ( $0.43 \pm 0.07$  cm SE). *In vitro* grown plantlets were successfully acclimatized in hardening medium containing coco-peat and moss mixed in 2:1 ratio, with a survival rate of plantlet up to 90% after 30 days.

**Keywords:** *Dendrobium chryseum*; micropogation; MS medium; plant growth regulators; protocorms

ICBB 005 O

## Land-use Rather than Direct Effects of Climate is Negatively Affecting Functional Connectivity and Fecundity of Himalayan Yew (*Taxus wallichiana*)

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Mountainous region has highly variable levels of gene flow between and within population. Both climate as well as land-use changes can affect the connectivity of populations via gene flow. It is important to understand whether land-use change or climate is affecting the gene flow in *Taxus wallichiana* Zucc., which is important endangered medicinal plant. The objective of this study was to find if the migration is affected by different land-use types, and if the climate variables across the river valleys affect the functional connectivity and their fecundity. This study was carried out at six valleys belonging to Manaslu Conservation Area, buffer zone of Sagarmatha National and Kanchenjunga Conservation Area (along the trail and vertical transects of 2400 m a.s.l. to 3450 m a.s.l.). The overall pairwise  $F_{st}$  showed high levels of population differentiation among the study sites. This study showed that gene flow in *Taxus wallichiana* will be affected by climate change as well as land-use and altitude. When the leaf data was treated as resident population and seed data as potential migrants, migrants were found between valleys. Similarly, there was also long-distance pollen flow and some first-generation migrants were within valleys and between valleys. The directionalities of historic gene flow obtained from Migrate-n were mostly from Far Eastern to Western and from Central to Far Eastern. It was found that the average number of candidate fathers per offspring was less during parentage analysis. The general linear model revealed that temperature affect the functional connectivity between the populations.

**Keywords:** functional connectivity; parentage analysis; land-use types; climate change; Himalayan Yew

## Ecological Wood Anatomy of *Pinus roxburghii* in Central Nepal

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*Pinus roxburghii* Sarg. is a gymnosperm tree belonging to the family Pinaceae, that occurs in subtropical region of Nepal at an elevation range from 500 to 2700 m. Nine wood block samples were collected from outermost part of the trunk of matured canopy trees at three different localities between 1100 and 1350 m above sea level. The study was done to determine the variation in wood anatomical characters with non-anatomical characters such as Diameter at Breast Height (DBH), Tree height and Elevation. Correlation and regression analysis was carried out to study variation in wood anatomical characters. Multiple regression analysis was done using non-anatomical factors as independent variables and anatomical features as dependent variables. Quantitative wood characters were found to be affected by the change in ecological factors but not in its qualitative wood characters. A weak correlation was found between wood anatomical characters and non-anatomical parameters. Tracheids length as well as tracheid's pit significantly vary with elevation. Tracheids length exhibited positive correlation whereas tracheids pit exhibit negative correlation with altitude. Since tracheids are the main conducting tissues in xylem of Pines, increasing length and decreasing pit size of tracheids is of ecological importance.

**Keywords:** altitude; DBH; tree height; *Pinus roxburghii*; central Nepal; wood anatomy.

ICBB 190 O

## DNA Barcoding of *Dendrobium moschatum* (Banks) Sw. Specimen from Makawanpur, Central Nepal

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The genus *Dendrobium*, with sparse distribution in nature demanding immense efforts with conservation, is also one of the largest genera of Orchidaceae. DNA barcoding could be the best option for rapid and accurate identification of the *Dendrobium* species. The objective of the present study is to optimize the DNA barcoding protocol particularly useful to delineate the *Dendrobium* species. Here, we used a specimen of *Dendrobium* sp. collected from Brindaban Botanical Garden, Makawanpur (500 m asl) as a test object. We amplified and sequenced three chloroplast loci *rbcL* (Ribulose-1,5- biphosphate carboxylase), *matK* (Maturase K) and *psbA-trnH* (intergenic spacer) from the specimen. We retrieved twelve accessions of plastome sequences from NCBI, representing six *Dendrobium* species (*D. moschatum*, *D. fimbriatum*, *D. crepidatum*, *D. chrysanthum*, *D. candidum* and *D. denneanum*) reported in Nepal. Similarly, one accession of plastome of *Bulbophyllum epiphytum* was also retrieved, to be used as an out group. Respective aligned sequences of *rbcL*, *matK* and *psbA-trnH* were extracted from each accession. Evolutionary analysis was performed following the Maximum Likelihood approach using MEGA X. The result showed that the evolutionary tree generated with combined sequences of all three loci was well resolved with distinct clades compared with that generated with sequence of single locus, demonstrating that three markers (*rbcL*, *matK* and *psbA-trnH*) are sufficient for molecular identification of the *Dendrobium* species. Furthermore, the identity of our test object was confirmed as *D. moschatum* with the sequence clumped at the clade of *D. moschatum*.

**Keywords:** *Dendrobium*; plastome; accessions; molecular markers; evolutionary tree

## ***Ex-Situ* Conservation Practice at National Botanical Garden, Lalitpur, Nepal**

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*Ex-situ* conservation refers to the conservation of components of biological diversity outside their natural habitats. Since biodiversity is currently being lost at an unprecedented rate in its natural habitats, *ex-situ* conservation has become a suitable approach in their conservation. Botanical gardens are institutions or places that provide a suitable environment for the survival of threatened plant species. Through living plant collection, the botanical gardens have done tremendous contribution to *ex-situ* conservation of plant diversity which is in dire need for their conservation. With the establishment of National Botanical Garden (NBG) in Nepal in 1962, *ex-situ* conservation and protection of wild and threatened plant species has been properly addressed. NBG's flora was first published in 1975, later revised twice in 2003 and 2016. There were 142 *ex-situ* plant species reported in 1975, and 21 more species were added in 2003. A book published in 2016 revealed the addition of 229 plant species, and till date a total of 516 *ex-situ* species belonging to 133 families are conserved. NBG harbors five endangered, five vulnerable and three near threatened plant species according to the IUCN Red List categories, while five are endemic species to Nepal. It has also conserved CITES listed plant species (Appendix I-one species, Appendix II- 39 species and Appendix III-two species). Therefore, NBG plays a critical role in the conservation of threatened species and habitats, educating the public and supporting them in understanding that conservation is a shared responsibility.

**Keywords:** biodiversity; endemic; *ex-situ* conservation; National Botanical Garden

ICBB 204 O

## Soil Properties in Two Different Tropical Forests Located along Elevational Gradients in Eastern Nepal

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The present study was carried out in two forests situated at two different altitudes in eastern Nepal. Low altitude Rajarani forest (380-600 m asl) is dominated by *Shorea robusta* while high altitude Sakma forest (above 1100 m asl) is dominated by *Schima-Castanopsis*. This research discovers the variation in soil properties along difference in elevations and soil depth in these two forests. The soil texture was sandy loam at both depths in both the forests. Soil moisture was higher in upper layer (21.29 %) in Rajarani forest, while in Sakma forest there was no distinct variation. Water holding capacity was higher in upper layer in both forests. Soil pH, soil organic carbon and total nitrogen were higher in the 0-15 cm soil depth in Rajarani forest, while there was no variation in total nitrogen depthwise in Sakma forest. Phosphorous content was higher at lower depth in Rajarani forest, whereas there was no distinct variation in Sakma forest. In Rajarani forest potassium content was almost same in both depths, whereas in Sakma forest, potassium content was higher in upper depth. Thus, the variation in altitudes affects the concentration of soil organic matter, which has shown increasing trends as altitude rises.

**Keywords:** altitudinal variation; *Schima-Castanopsis*; *Shorea robusta*; soil nutrients; tropical region

## Variation in Plant Functional Traits in Two Dwarf Shrubs along a Subalpine-Alpine Gradient in Manang, Central Nepal

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Plant functional traits (PFTs) vary along the environmental gradient, and this variation can be applicable for understanding the assembly of plant communities and their responses towards global and local environmental drivers. A systematic investigation of inter- and intra-specific variation in PFTs in two dwarf alpine shrubs viz, *Rhododendron lepidotum* and *Cotoneaster microphyllus* was carried out. Eight different PFTs- plant height, size, stem girth, specific leaf area (SLA), leaf dry matter content (LDMC), leaf thickness (LT), reproductive output (RO) and fruit dry matter content (FDMC) were considered for this study. The variation of individual traits with elevation was assessed through generalized linear model in R Studio. In both studied species, plant height decreased with increasing elevation. In *Rhododendron lepidotum*, plant size, stem girth, specific leaf area and reproductive output decreased with increasing elevation whereas, leaf dry matter content increased with increasing elevation. Contrary to this, in *Cotoneaster microphyllus*, specific leaf area, reproductive output and fruit dry matter content increased with increasing elevation whereas, leaf dry matter content, leaf thickness decreased with increasing elevation. This study revealed that there is inter- and intra-specific variation in PFTs along the elevation gradient. Thus, plants exhibit adaptive response to the existing environmental filters. Therefore, prime focus should be given for documenting the variation of PFTs along a natural gradient like elevation in order to understand the response of individual plants and community as a whole towards changing climatic condition.

**Keywords:** *Cotoneaster microphyllus*; elevation gradient; generalized linear model; PFTs; *Rhododendron lepidotum*; variation

ICBB 120 O

## Exploration of *Gnetum montanum* in Makawanpur and Sindhuli District, Central Nepal

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*Gnetum montanum* is a gymnospermous plant belonging to family Gnetaceae. It is a CITES Appendix III listed plant. It was also suspected as missing species from Nepal. It had herbarium collection records from different districts including Makawanpur. However, during the period of last 3 decades, its natural existence was not reported from Makawanpur district. Present study was carried in 2021-2022. While exploring the natural existence of *G. montanum* several field trips were carried out in different parts of Makawanpur and Sindhuli districts along with local people consultation. From the study total 13 lianas of *G. montanum* (10 lianas at first from Bakaiya Rural Municipality, 1 liana from Bagmati Rural Municipality, and 2 lianas from Manahari Rural Municipality) were recorded from Makawanpur district. Similarly, 1 liana was recorded from Marin Rural Municipality, Sindhuli District. These studies reveal that surveys and explorations on *G. montanum* are to be maximized for its population study. We have tried to propagate it by asexually and sexually in Brindaban Botanical Garden, Hetauda. But the results are not being in success till now. This study needs to be continued regarding its population study and breeding. However, this study is significant at least to locate the findings in natural habitat which was thought earlier probably missed from Nepal.

**Keywords:** *Gnetum montanum*; gymnosperm; population; climbing plant, CITES

## **Trees Species Diversity and Regenerating Potential along Disturbance Gradient in Chandragiri Hill, Kathmandu, Central Nepal**

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The study examined the tree species diversity and their regenerating potential along anthropogenic disturbance. Five disturbance classes were categorized based on anthropogenic activities. Vegetation data were collected from 75 sample plots (15 for each disturbance class) from the elevational ranging from 1560 to 2290 m asl by random sampling method in the year 2020-2021 along two gravel roads on the Chandragiri Hill. Circumference at breast height was used to broadly categorize plant growth form into tree, sapling and seedling measuring at 1.37m height above the ground for trees and saplings and 10 cm above the ground for seedlings. This study has found a total of 47 tree species belong to 42 genera and 26 families. The highest species richness of sapling and seedling were found in disturbed area and tree species richness in undisturbed area. Tree biomass was also lower in disturbed area. The tree stand density varied between 120 to 827 individuals per hectare with total basal area between 7.05 to 68.38 m<sup>2</sup> per hectare with highest in intermediately disturbed area and least in highly disturbed area. The highest values of the Shannon Weiner index, Margalef index and the lowest value of the Simpson index were noticed at intermediately disturbed area for sapling and seedling and lower value for mature trees. About 83, 61 and 21% species were found to be regenerating in the undisturbed, intermediately disturbed and fairly disturbed area with no regeneration on highly disturbed areas. The variation of species richness, biodiversity index, basal area and regeneration potential indicated the study area, one of the closest mountains from the capital city, was fairly disturbed by anthropogenic activities along all elevational ranges.

**Keywords:** species richness; disturbance gradient; Chandragiri Hill; central Nepal

ICBB 036 O

## Population Structure and Forest Regeneration in Bhardew Village, Lalitpur District

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The temperate forest (1817-2627 m above sea level) of Bhardew village, Lalitpur was quantitatively analyzed to find the population structure and regeneration status of tree species within it. The study was carried out by laying down twenty-eight concentric circular plots of 8.92 meter radius randomly during 2021-2022. Altogether 28 tree species belonging to 23 genera and 18 families are recorded in the study area. However, five species (*Miliusa velutina*, *Cinnamomum camphora*, *Rhaphiolepis dubia*, *Maesa chisia*, and *Saurauia napaulensis*) are only recorded in seedlings or saplings form but not in adult form. The forest is found to be dominated by the species of *Pinus* and *Quercus* with the IVI values ranging from 49.91 to 35.24. The average Simpson's diversity (1/D) is 2.88, Shannon Weiner's index is 0.85, species evenness is 0.57 and species richness is 4.68 in the study area. Individuals were divided into three groups based on their girth classes viz. seedlings, saplings and adults and the status of natural regeneration of species was determined based on population size of each species. The overall regeneration of the different species presently in the forest are seedlings 6484 individuals/ha, saplings 533 individuals/ha and adults 1198 individuals/ha showing fair regeneration. The majority of tree species show fair regeneration status (32.14%) followed by none regeneration (25%), new regeneration (17.85%), poor regeneration (14.28%) and good regeneration status (10.71%). The density diameter curve of the forest shows slightly flat reverse j-shaped structure indicating that majority of tree species are not in good regenerating status. The present analysis thus revealed that the population structure may get altered in future. Those species with none to poor regeneration status should be prioritized for the conservation and the proper management strategies need to be developed for sustainability of tree species in the forest.

**Key words:** temperate forest; diversity index; species evenness; species richness; girth class

## **Seasonal Variation of Algae in Relation to the Water Quality at Kingfisher Lake, Central Nepal**

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Most algae are microscopic, but some are large and can be found in the sea, freshwater, and wastewater all around the world. In this study, 44 algae samples were collected in pre-monsoon and post-monsoon in 2021 and 2022 from Kingfisher Lake, located in Bharatpur, Chitwan at 27°37.108'N, 84°25.105'E, and 171 m. The physicochemical parameters of water were measured by a digital portable multiparameter (HI98194) in the field. The average values of pH, temperature, conductivity, total dissolved solids, atmospheric pressure, oxidation-reduction potential, dissolved oxygen, and resistivity were 8.26, 33.15°C, 70.55 s/cm, 35.54 mg, 0.9832 atm, 93.436 mv, 0.10 ppm, and 0.0141 M ohm/cm in the pre-monsoon season, whereas in the post-monsoon season, 7.33, 31.09°C, 83.22 µs/cm, 43 mg, 0.9830 atm, 210.39 mv, 6.36 ppm, and 0.0113 M ohm/cm, respectively. Information on the distribution of algal flora from Kingfisher Lake was collected, and the data revealed that the dominant members belonged to Chlorophyceae, followed by Bacillariophyceae. The number of algae species in the post-monsoon season is less than in the pre-monsoon season. It is the preliminary work on algae at Kingfisher Lake, and the study showed that the lake is rich in algal species. Thus, further investigations are needed.

**Keywords:** multiparameter; phisico-chemical; post-monsoon; pre-monsoon

ICBB 030 O

## Population Structure of *Nardostachys jatamansi* along a Fire Gradient: Implication for Conservation

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In this study, we analyzed effects of habitat burning on population ecology of *Nardostachys jatamansi*, a Himalaya endemic and critically endangered medicinal plant species with high socioeconomic and pharmacological value. Present study was carried out in Langtang National Park of Central Nepal between 3800 – 4250m asl, in three habitats i.e., rocky grassland, shrub land and tree line with different fire gradients. Based on frequency and area burned, fire disturbance has been categorized as burned (MFB), burned escaped (LFB) and control (UB); and populations were studied based on homogenous purposive methods using standard protocols. Burning increased openness of habitat which extend graminoids but substantially reduced shrub and moss cover. The associated plant diversity was high in burned than in control habitats. Increasing proportion of young ramets shows sprouting ability of clonal herbs increase after burning disturbance, apart from which the overall density has sharply declined by 20-40 percent shows populations was negatively impacted with burning. In context to habitats, rocky grassland severely affected by fire resulted in drastic reduction total ramet density in MFB while slightly increased in shrubland of LFB habitat. The continued declined of vegetative and reproductive adults severely impacted on mean density with regular burning. Among environmental variables studied using combined effect (GLMM) model, slope and moss cover had a positive effect while shrubs and graminoids had negative effects on ramet density. Thus, this study proves burning at alpine habitat has negative effects on *N. jatamansi* population and ramets are not adaptive to resilient form such disturbance, however rationalize the result for broadscale conservation from single species is of inadequate because species response to interactive effects of conjoint disturbance is unpredictable and taxon dependent.

**Keywords:** alpine burning; spikenard; rhizome biomass; ramet density

## **Wild Seeds Conservation in National Botanical Garden, Lalitpur, Nepal**

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Global biodiversity crisis is a major threat to our (or future) generation, with species extinction rate tens to hundreds times higher than in the previous 10 million years. In this context, a seed bank serves as the insurance policy of threatened species. The necessity of the seed-gene bank has recently been realized in relation to conservation and sustainable use of plant genetic resources for the welfare of the present and future generations. In this perspective, botanical garden's seed banks play a crucial role in ex-situ conservation of wild plants. However, efficient management of genetic resources in ex-situ conservation is a big challenge with limited resources. As a result, we here present a standardized seed banking procedures practiced at the seed bank of National Botanical Garden (NBG), from seed collection to storage including germination test, which are important steps in achieving the goal of conserving intact genetic diversity for future regeneration. Seeds of 140 species belonging to 116 genera of 59 families are preserved and 43 species belonging to 40 genera of 35 families are under processing in the NBG. Such research is beneficial in building a database on genetic resources and long-term seed storage of threatened wild species. Seed banks provide material for research and knowledge that support broader plant conservation goals, as well as contribute to education and public awareness about plant conservation. Therefore, botanical gardens are important initiatives for the establishment of seed bank. Hence, in an era when wild areas and biodiversity are dwindling, seed banks are where we can bank planet's wealth.

**Keywords:** botanical garden; conservation; ex-situ; seed; seed banking procedures

ICBB 102 O

## Ethnobotany and Traditional Knowledge to Cure Human Health

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Traditional medicine is defined as indigenous medicine that is used to maintain human health and to prevent, diagnose, and treat physical and mental illnesses differently from allopathic medicine based on theories, beliefs, and experiences. Traditional medicine has been used for thousands of years with great contributions made by practitioners to human health, particularly as primary health care providers at the community level and has maintained its popularity worldwide. The practitioners are generally individuals or group of families who had acquired their knowledge orally by words of mouth over generations. Ayurveda has received little official support and hence less attention from good medical practitioners and researchers. The value of ethnomedicine has been realized by the new generation's peoples, they want to learn and take the traditional medicinal knowledge for cure the human health. This is a romantic allure to the life of an explorer and the promise of finding 'gold' in the form of plants or animals as potential sources for lifesaving drugs that could become important in the treatment of serious diseases such as AIDS (*Rheum palmatum*) and cancer (*Tulbaghia violacea*). Ethnobotany has played important role in the development of new drugs for many centuries and becoming increasingly important in defining strategies and actions for conservation or recuperation of residual forests. There is greater interest in ethnobotany today, than at any time in the discipline's history. This article analyses the relevance of ethnobotany in current scenario. It is anticipated that, in the future, ethnobotany may play an increasingly important role in sustainable development and biodiversity conservation.

**Keywords:** ethnobotany; traditional knowledge; medicinal and aromatic plants; conservation; human health; folk system

## Can Nagoya Protocol Contribute to Biodiversity Conservation and Genetic Resources Utilization in Nepal?

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The Convention on Biological Diversity and its Nagoya Protocol provide clear guidelines for establishing *sui generis* systems to regulate access to genetic resources and associated traditional knowledge and benefit sharing. The access and benefit sharing (ABS) has been regarded as a market based approach aimed at conservation and sustainable use of biodiversity. However, its implementation has been slow and in many countries, including Nepal, painful. This paper presents the prospects of ABS for Nepal and suggests for proactive implementation so that it contributes to biodiversity conservation and sustainable use of genetic resources while respecting the rights of the custodians.

**Keywords:** benefit sharing; biological diversity; genetic resources; Nagoya Protocol

ICBB 103 O

## Biodiversity of the Medicinal Plant in the Ghoti Region, District Nashik, India

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World Health Organization appreciated the importance of medicinal plants for public health care in developing nations. The tribal region of Ghoti Tahsil-Igatpuri, District Nashik is rich in medicinal plants and which are frequently used as important resources to cure the ailments. The *Jatropha curcas*, *Tagetes erecta*, *Erythrina indica*, etc. plants are some of them. The present study highlights the pharmacognostical as well as phytochemical studies including parameters such as macroscopic, microscopic characters, physical evaluation and preliminary phytochemical studies of medicinal plants used in Ghoti Region of Nashik district. The pharmacognostic study of these medicinal plants used in Ghoti tribal region can help to discover new drugs to cure various ailments provided the data given is scientifically evaluated. In addition, these observations will help in the pharmacognostical identification and standardization of the drug in the crude form and also to distinguish the drug from its adulteration.

**Keywords:** medicinal plants; pharmacognostic study; *Jatropha curcas*; *Tagetes erecta*; *Erythrina indica*

## ***Dalbergia latifolia* (Satisal): Unbundling the Threats and Issues for Establishment to Conserve the Biodiversity**

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*Dalbergia latifolia*, locally known as Satisal, is a keystone tree species producing quality and commercial timber. Because of its strength, good nature and durability, it is highly exploited in the natural forests which resulted in the loss of its stands throughout the world. *D. latifolia* was listed in Appendix II of CITES in 2016 and considered as a vulnerable species according to IUCN Red List. This paper highlights the ecology, status, different threats and issues of *D. latifolia*. Human encroachment during Nepalese civil conflict period had been the primary cause of its habitat degradation. Likewise, forest fire, illegal felling, open grazing, human encroachment, and tree die-back were seen as major threats and issues in its conservation in the study area. The status of *D. latifolia* in two different community forests; one with plantation stands and another natural pocket area; of Kapilvastu district was recorded and their growing stock was calculated. The total growing stock in natural pocket area was recorded to be 86.30 m<sup>3</sup> per ha. and it showed good regeneration with 1,600 (per ha.) seedlings and saplings.. Similarly, the analysis shows presence of 1,334 (per ha.) seedlings and saplings of *D. latifolia* in the plantation stands which concludes that both the forests are in moderate condition. The result shows that conservation and management practices from both local and government level can prevent the species from facing the verge of extinction in the future. The information in this paper can provide a framework for conservation planning, monitoring, habitat management and establishment of this species.

**Keywords:** conservation; threats; issues; establishment; plantation

## Macrofungal Diversity of Brahakshetra Community Forest, Ghorahi, Dang

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Fungi are a diverse group of organisms ranging from microscopic to macroscopic mushrooms. Being a major group of decomposers they are essential for the survival of other organisms in the ecosystem and important for the degradation of organic matter. The main aim of this study was to study the macrofungal diversity of Brahakshetra Community Forest, Ghorahi, Dang. The forest is mainly dominated by *Shorea robusta* and other associated species. The study was made from June to September 2020. The sampling was done by using a 10×10m<sup>2</sup> quadrat in three transects. A total of 30 quadrats were sampled by using a stratified random sampling method and samples were collected during the rainy season from different habitats of the forest. Mushrooms were photographed in their natural habitat and preserved in dry and liquid preservation. The specimens were identified by examining their macroscopic and microscopic features, by using references from standard literature and websites. In the study, a total of 66 species were recorded under 30 genera belonging to 21 families, and 8 orders. Among them, 65 belong to basidiomycetes and 1 belongs to Ascomycetes. Agaricales was found as the largest order followed by Russulales and Boletales. The diversity indices, the Shannon weiner index and Simpson diversity index were found to be 3.59 and 0.93 respectively, which was a higher value of the diversity index. The result of this study concludes that the Brahakshetra community forest was rich in macrofungal diversity especially ectomycorrhizal. There was a positive trend between species richness of macrofungi and environmental variables i.e. tree canopy, soil pH, soil moisture, and leaf litter which means species increased with increasing these environmental variables.

**Keywords:** macrofungal diversity; Brahakshetra; edible; ectomycorrhizal; environmental variable.

ICBB 189 O

## Floristic Diversity of Vascular Plants in Annapurna Conservation Area (ACA), Gandaki Province, Nepal

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The Annapurna Conservation Area (ACA) is the first and largest conservation area in Nepal. It has been managed by National Trust for Nature Conservation (NTNC) since its establishment. The ACA is one of the richest protected areas of Nepal in terms of biodiversity. The present study was done through a review of the published and authentic works of literatures such as journals, books, reports etc. to explore the diversity of vascular plants in the entire ACA. This study documented 1,739 species of vascular plants belonging to 771 genera and 154 families, comprising 118 species of fern and fern allies, 16 species of Gymnosperms and 1,605 species of Angiosperms respectively. Asteraceae with 56 genera and 149 species was found to be the largest family, followed by Poaceae (61 genera, 91 species), Fabaceae (42 genera, 83 species), Rosaceae (23 genera, 82 species), Orchidaceae (43 genera, 81 species), Ranunculaceae (11 genera, 73 species) and Lamiceae (29 genera, 58 species) respectively. Similarly, *Saxifraga* was found to be the largest genera with 28 species followed by *Primula* (26 species), *Potentilla* (19 species), *Pedicularis* (18 species), *Saussurea* and *Gentiana* (17 species each) and *Berberis* (16 species) respectively. In terms of growth form (habits) of the species found in ACA, trees (11 % species), shrubs (14 % species), herbs (69 % species) and climbers (6 % species) respectively. The rich diversity of vascular plants reflects that ACA is the central point for wide range of compositions of eastern and western Himalayan floristic components.

**Keywords:** diversity; vascular plant; Annapurna Conservation Area

ICBB 173 O

## **$\beta$ -Diversity Pattern of Vascular Plant at Varied Elevations in Arghakhanchi, West Nepal**

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The genuine image of biodiversity, as well as their germplasm, is visualized by the turnover of species rather than their similarities in each location. The major goal of this study was to determine the  $\hat{\alpha}$ -diversity of vascular plants growing at elevation of 100 m contour intervals and to explore its association with  $\alpha$ -diversity and elevation. Primary data was collected using 2-3 10 x 10 m quadrats at 100 m contour interval from 200-2300 m elevation on both south and north at two landscapes in Arghakhanchi district ((27°45'- 28°06' N and 80°45'- 83°23' E), west Nepal.  $\alpha$ -diversity is defined as the total number of species present in all quadrats of each 100 m contour intervals.  $\beta$  diversity or turn over species represents the change in diversity of species between two contour intervals. The  $\tilde{\alpha}$ -diversity represents the total species of the study area. Bray-Curtis method was used to assess the  $\hat{\alpha}$ -diversity between two contour intervals. Jaccard similarity index was used to compute the similarity indices between species of sampled points in Vegan package of R 4.03 version. The relations among  $\alpha$ -diversity,  $\hat{\alpha}$ -diversity and the similarity index with elevation was estimated by generalized linear model (GLM) regression. The  $\alpha$ -diversity ( $R^2=0.78$  and  $p < 0.05$ ) and similarity index ( $R^2=0.86$  and  $p < 0.05$ ) suggest a statistically significant unimodal structure with elevation; however,  $\hat{\alpha}$ -diversity suggests statistically significant ( $R^2=0.82$  and  $p < 0.05$ ) but reverse unimodal pattern. As a result, the peak region of a unimodal species pattern is typically created by more species similarity rather than species turnover. A high beta diversity area suggests a diverse range of species and aids in the management of conservation projects.

**Keywords:**  $\alpha$ -diversity;  $\beta$ -diversity pattern; Bray-Curtis method; similarity index

## Cladistic Analysis of Sub-tribe Coelogyninae of Nepal Himalaya

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A cladistic analysis of sub-tribe Coelogyninae is based on 13 morphological, and 16 anatomical characters scores from 20 species of *Coleogynae*, *Pholidota*, *Panisea*, and *Pleione* from the Nepal. Most parsimonious trees were traced using computer assisted software NONA (123 trees with CI = 35 and RI = 57.). The analysis also confirms the monophyletic origin of the sub-tribe Coelogyninae and species assorted into at least two different clades. The key characters for species delimitation: Mesophyll cell shape oval presence of some clade and another clade separate from the character, Stomatal index 5-10. It has been concluded that the morphological characters also play an important role in the cladistic analysis for reconstruction of the groups within subtribe too.

**Keywords:** cladistics; Coelogyninae; morphological; anatomical characters

ICBB 134 O

## Aquatic Vascular Macrophytes Diversity and Composition in Raja-Rani, a Tropical Lake, Eastern Nepal

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Macrophytes dominated freshwater lakes are one of the most productive ecosystems. Freshwater lakes play a key role in environmental protection where aquatic vascular macrophytes are integral part of it. Present study has been conducted in Raja-Rani lake of Letang-Bhogateni municipality, Morang, eastern Nepal. This study aims to decipher aquatic vascular macrophytes species diversity and composition pattern in the lake. Macrophytes were sampled by placing six transects of 100m each at a regular interval of 100m, parallel and 1m away from the shore. In each transect, five quadrats (1m×1m) were laid down at 20m interval each. A total of 16 species of aquatic vascular macrophytes were recorded from a total of 30 quadrats. This study revealed that the lake harbors aquatic vascular macrophytes of all ecological niches. *Eichhornia crassipes* and *Ottelia alismoides* were the most abundant species. Since macrophytes are indicators of lake health, this study may help in developing management plans to conserve aquatic ecosystems including aquatic vascular macrophytes.

**Keywords:** aquatic ecosystems; conservation; ecological status; growth forms; hydrophytes; limnology

## Scientific Botanical Illustrations as a Taxonomic Tool for Flora Writings

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Scientific botanical illustration is considered as an effective visual communication in plant science for the purpose of research, conservation and education of biodiversity. Instead of speaking hundreds scientific words, scientific illustrations in the form of line drawings, sketches and different medium such as pen/ink line drawings in scale bar is widely known. It is practiced and implemented worldwide as one of the valuable method of taxonomic tool in modern botany. Scientific botanical illustrations require special skill of observation, description, analysis and depiction in sketching by hand and other instruments. The main objective of this paper is to draw an attention and stimulate an interest among botanists, taxonomists, researchers, other stakeholders and policy makers about the innovative scientific technology in present day. This technology is applied to describe the plant genus to species level with accurate line drawings of morphological structures to key characters of a plant. The comparative study of specimens thus aid to identify and findings of the possibilities of new species of a plant. The illustrations are prepared after extensive study under the lenses directly from the live specimens from the field or dried specimens of Herbarium. Rules and techniques needs to be followed while drawing diagrams. This paper accounts some few examples of scientific illustrations including *Sorbus himalaica*, *Sorbus arachnoidea* (Flora of Nepal VOL III) *Amplelocissus rugosa* (Isotype of *Vitis rugosa*), *Ziziphus budhensis* (New record), *Pleione hookeriana* (CITES listed plants) and *Lilium nepalensis* (Indigenous plant) in the flowerings plants in Nepal.

**Keywords:** isotype; line drawings; new record; visual communication; flowering plants

## Cyperaceae in Nepal: Diversity and Distribution

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The sedge family, Cyperaceae are annual or perennial herbs, having a predominantly triangular stem and florets arranged in a spikelet, producing an achene fruit. Sedges in Nepal dominate many ecosystems, including agricultural lands, wetlands and rangelands from as low as 60 meters to above 5700 meters. This study attempts to document the Cyperaceae diversity and distribution in Nepal through analysis of taxonomic literature, herbarium records and fresh collection. Altogether 221 species and 5 infraspecies of Cyperaceae are reported in Nepal, of which seven taxa are endemic to the country. Of the 19 genera recorded, *Carex* is the most diverse genus with 109 species, followed by *Cyperus* (51 species), and *Fimbristylis* (23 species). The majority of the genera (*Actinoscirpus*, *Bolboschoenus*, *Bulbostylis*, *Cyperus*, *Eleocharis*, *Erioscirpus*, *Fimbristylis*, *Fuirena*, *Macherina*, *Rhynchospora*, *Schoenoplectiella*, *Scleria*, *Scirpus*) are primarily found in tropical and subtropical regions, while *Blysmus*, *Carex*, *Cladium*, *Isolepis*, *Schoenoplectus* and *Trichophorum* are dominant in the temperate and the alpine regions of Nepal. The overall Cyperaceae species richness showed a maximum species richness between 1800-2000 meters. Cyperaceae species provide diverse ecosystem services and many of them have key ecological roles. However, the taxonomy, ecology and distribution of Cyperaceae in Nepal are poorly understood. These gaps can be fulfilled by intensive field visits, adequate collection of specimens and a thorough study of herbarium materials.

**Keywords:** endemic; sedge family; species richness; taxonomy

## Gentiana L. (Gentianaceae) in Nepal: Diversity and Distribution

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The present work is an overview and critical assessment of herbarium study and published data on the diversity and distribution of the genus *Gentiana* L. (Gentianaceae) in Nepal. Out of 50 recognized taxa (48 species and 2 varieties) 17 species occur in West Nepal, 34 in Central and 32 in East Nepal. The alpine zone of Nepal has 41 species, the subalpine zone 26, and the temperate zone has 10 species. The high diversity of *Gentiana* species occurs in the alpine zone of East and Central Nepal with 29 and 31 species respectively, while West Nepal of the tropical and subtropical zone has only 2 species and one variety (*Gentiana decemfida*, *G. decemfida* var. *aprica* and *G. pedicellata*). East Nepal of the tropical and subtropical zone has only one species (*G. pedicellata*). *G. pedicellata* has wide distribution from tropical and subtropical to alpine zones. Three species (*G. radicans*, *G. sagarmathae* and *G. tetramerus*) are endemic to Nepal and many species are rare in distribution. Hence prioritization of the conservation is considered essential for many of them.

**Keywords:** *Gentiana*; Nepal; diversity; distribution

ICBB 007 O

## ***Habenaria* of Nepal: An Annotated Checklist**

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The genus *Habenaria* Willd. consists of about 890 species worldwide, distributed mostly in the pantropical regions, however this number is variable because of different taxonomic approaches considered for its classification. Worldwide revision of the genus was undertaken by Kränzlin (1892, 1901), where more than 300 species of *Habenaria* were given the sectional treatments in 34 overall sections. Recently, the genus was revised for Nepal through the extensive herbarium consultation and thorough examination of literature and online databases, and an updated list of 22 taxa including 21 species and one variety belonging to the genus has been ascertained; three taxa are endemic to Nepal. This paper contains the annotated checklist of *Habenaria* of Nepal that includes the accepted name, basionym, synonym, distribution and specimen citation for each of the taxon.

**Keywords:** checklist; *Habenaria*; Nepal; revision; taxonomy

## **Digitization of Herbarium Specimens in National Herbarium of Nepal**

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National Herbarium and Plant Laboratories (KATH) houses more than 1,65,000 specimens of flowering and non-flowering plants. Herbarium specimens are irreplaceable resources of floral diversity used for research purposes. Thus, it becomes important to safeguard them from various disasters and make them accessible to the scientific researchers, students as well as the general public. In such cases, online herbaria play an important role in sharing the information of housed specimens around the world. The digitization of herbarium specimens makes it easier to retrieve specimen data, and to keep species distribution up to date, which helps conservationists in making better decisions. Digitization in KATH began in 2010 using the Herb Scanner with an aim to digitize the type specimens. Now, all the herbarium specimens are digitized using full-frame DSLR camera setup, as well as Herb Scanner which gives high resolution images (600ppi), and over 1,26,000 specimens have already been digitized including specimens of lichens and mushrooms. Those digitized specimens can be accessed online through [plantdatabase.kath.gov.np](http://plantdatabase.kath.gov.np). KATH is one of the leading herbaria in south Asia regarding online resources and digitization of specimens.

**Keywords:** digitization; plant database; herbarium; imaging; online

ICBB 128 O

## Floristic Study of Remnant Tropical Forest of Eastern Nepal

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Most of the floristic works in eastern Nepal were focused on temperate and alpine regions. Very few works have been done in forested areas of lowlands. Jalthal forest is a tropical forested area located in south-east part of Jhapa district in eastern Nepal. It is a remnant of once widespread and continuous Charkoshe forest. The preliminary works done in Jalthal suggested the need of a comprehensive account of the flora. The present work is an attempt to document the flowering plants of Jalthal forest. Five field trips of altogether 72 days covering all seasons were conducted for collecting plant specimens. This study reveals that Jalthal forest is remarkably rich in flowering plant diversity at all levels (species, genus and family). A total of 455 species belonging to 306 genera and 89 families were recorded. Eight species were recorded as new for the flora of Nepal. Poaceae with 31 genera and 45 species was the most dominant family. Fabaceae was the most dominant family among eudicots with 27 genera and 40 species, followed by Rubiaceae and Asteraceae. Out of 455 species, there were 214 herbs, 116 trees, 75 shrubs or subshrubs, 49 climbers and one bamboo. Among 116 trees, 63 were bisexual, 32 were dioecious and 21 were monoecious. Presence of elements of sub-tropical forest like *Castanopsis indica*, *Castanopsis tribuloides*, *Schima wallichii*, *Engelhardia spicata* and *Brassaiopsis hainla* in Jalthal makes it a unique forest. Jalthal forest houses four CITES Appendix II listed species and three IUCN listed threatened species.

**Keywords:** Jalthal; floristic work; tropical forest

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