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Introduction

Dear Readers,

You have now volume 11(2) of Lyonia in front of you. This volume still presents articles from a wide geographical range, covering important topics from around the globe.

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What is Lyonia?

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In its research section Lyonia published peer-reviewed scientific papers that report original research on ecology, conservation and management, and particularly invites contributions that show new methodologies employing interdisciplinary and transdisciplinary approaches. The sustainable development and environmental education section contains reports on these activities.

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Morel collection and marketing: A case study from the Hindu-Kush mountain region of Swat, Pakistan

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Morel collection and marketing: A case study from the Hindu-Kush mountain region of Swat, Pakistan

Abstract

Morel comprise the most delicious and prized group of edible fungi. In Pakistan, morels are collected traditionally from the northern mountain ranges of Hindu-Kush, Himalayas and Karakorum. Seven species of morels are collected from the temperate forests of Hindu-Kush mountain region of Swat. The morel collection is a seasonal and part time activity in the area. The collectors are poor people and include 33% women, 27% men and 40% children. The morels are sold in the local market, from where they are exported to Europe and Middle East. Morel exports thus play a significant role in the socioeconomic condition of Swat. Huge quantities of morel are lost each year due to improper collection, storage and processing techniques.

Key Words: Morel; Marketting of morel; Hindu-Kush mountains; Swat

Introduction

Forests comprise 4.8% of the total area of Pakistan and about 80% of livelihood of people living in extreme poverty depends upon the forest resources (Latif *et al*, 2004). The important non timber forest products include morels, honey, fruits and nuts, vegetable, condiments and spices, mazri palm, silk cocoon. Morel make top of the list and contribute most to the local economy as it fetch high prices in the international markets and thus most of the morels collected from the temperate forests of Pakistan are exported abroad. The collectors use traditional methods of collection, processing, packing, drying, marketing of morels. The morels, after collection, cleaning and drying are sold to the middlemen who then sell it into main market of Lahore, Karachi, Peshawar and swat. More than 65% of the product is lost during the processing from raw to finished product (Latif *et al*, 2004). Extensive research is needed to study market trends and monopolies, wastage and unsustainability during different steps of processing, and government attitude toward morel and mushrooms. Bottom line studies should be conducted to ensure proper planning, better quality and quantity of morels, sustainable income through sustainable utilization, training and capacity building of people involved in morel business, sustainable marketing and community involvement for sustainable harvest. In North West Frontier Province of Pakistan, local people collect about 55 to 65 tons of dried morels, which equals to the weight of 500 tones of fresh morels. It was reported that more than 70% of mushrooms are produced in NWFP (Iqbal, 1991).

Morels are normally found in temperate forest. Their mycelium connects with tree roots; these relationships can be mycorrhizal or saprobic. Morchella typically form relationships with hardwood and conifer trees. They can often be found around ash, dying elms and apple orchards.

Swat Valley

The Hindu-Kush mountain region of Swat is one of the most scenic places of sub-continent and is some times called mini Switzerland of Pakistan. The valley lies adjacent to the meeting point of three big mountain viz. Himalayas, Hindu-kush and Karakorum and thus exhibit diverse and unique flora and fauna. The valley of Swat is situated at the northwest corner of Pakistan. It lies from 34° 34’ to 35° 55’ north latitudes and 72° 08’ to 72° 50’ east longitudes. It is surrounded on the north by Chitral and Ghizer valleys, on the east by Kohistan and Shangla, on the south by Buner and Malakand protected area and on the west by Dir. The total area of the district is 5337 square kilometers (Hamayun *et al*. 2003).

Fig. 1: Map of Swat

Swat can be divided into two regions i.e., Swat-Kohistan and Swat Proper. Swat-Kohistan is the mountainous country on the upper reaches of the Swat River up to Ain in the south. The whole area south of Ain is Swat proper, which can be further divided into: Bar Swat meaning upper Swat and Kooz Swat meaning lower Swat.

Swat has predominantly rural population. Pashtuns (mainly Yousafzai tribe), Kohistanis, Gujars and Pirachas inhabit the valley of Swat. The Pashto speaking Yousafzai Pashtuns are the descendants of Pashtuns from Afghanistan. They inhabit the lower fertile valleys and farming, orchards are their prime sources of income. The Kohistanis belong to the Kohistani Dard tribe and they inhabit the mountainous areas called Swat Kohistan. They speak Kohistani language. They are land owners and share holders in forest revenues. The Gujars live in the upper inhospitable valleys. They belong to Gujar clan and speak Gujro language. The Gujars are mostly farmers but they do not enjoy any share in forest revenues. The nomadic Gujars (also called Ajars) form a substantial part of the Gujar population. The Ajars rare livestock and also work as peasants. The Piracha is the business class and they occupy almost all business in the main city of Mangora.

Materials and Methods

Present project was carried out in 2003 with the objective to investigate morel collection in the remote Hindu-Kush region of Swat. The project area was surveyed extensively. 70 morel collectors were interviewed from different parts of Swat. The information obtain from the collectors was crossed checked in order to get a more representative data. Questionnaire method was employed during the field study. The traditional collection, cleaning, drying, storage was observed. The dealers involved in the business of morels were visited and interviewed. The collected species of morels were identified in the herbarium of Quaid-i-Azam University Islamabad. The data was checked with available literature.

Results

Morels grow naturally in the temperate forests of Hindu-Kush, Himalayas and Karakorum mountains. In Pakistan, the morel are collected from Swat, Dir, Chitral, Mansehra, Afridi Tirah, Orakzai Tirah, Kurram Agency (NWFP), Murree (Punjab), Bagh and Chakoti (Azad Jamu & Kashmir), Zayarat (Baluchistan). Most of the morel collected from the forests is sold in the market from where they are exported to different parts of the world. In Swat, morels are collected from mid March to June. The local name used for different species of *Morchella* is Gujai. The Kohistani some times call it Kasee.

During the study, it was found that seven species of Genus *Morchella* are collected from Swat. The species with a brief description are given.

***Morchella conica* Fries** (Conical morel)

This is the most abundant species in the Hindu-Kush mountains of Pakistan. This species of *Morchella* is endowed as queen of edible mushrooms. In Swat, it is primarily collected from Kohistan, Chail valley, Miandam and Malam Jabba (from 2000 m to 4500 m). The local name of *Morchella conica* is Kohistani Kasee/Gujai. The body ridges of *Morchella conica*extend longitudinally and run parallel from base to top. *Morchella conica* exhibit grayish color in the beginning but on maturity it attain somewhat blakish color. *Morchella conica* mainly grows in pine forests, under *Pinus willichiana*. It makes 48 % of the total morels collection of Swat. When fresh, its size ranges from 4 cm to 25 cm but after drying the size reduces and ranges from 0.1 cm to 11 cm.

***Morchella esculenta* (L.) Pers**. (Common morel)

Morchella esculenta is collected from the temperate forests of Kohistan, Chail, Miandam, Midyan, Chuprial and Shangla. Local people called it Speena Gujai (Speena means white). This species is found under thick mixed coniferous vegetation. The color is somewhat creamy white in early stages but changes to yellow at maturity. It makes 32 % of the total collection of morels in the area. In fresh form its size varies from 2 cm to 25 cm while on drying the size reduces to 0.1 to 10 cm.

***Morchella rotunda* (Fr.) Boud.**(Rounded morel)

Morchella rotunda is collected in small amounts from the temperate forests of Swat. Commercially it is not as important as *Morchella conica* or *Morchella esculenta*. Locally it is called Ghounda Gujai (Ghounda means rounded). The color of the fruiting body is yellow but became blakish when come in contact with any substance. It amounts only 6 % of the total collection of morels in Swat. In fresh form, its size varies from 5 cm to 25 cm but after drying the size reduces (3 cm to 9 cm).

***Morchella deliciosa* Fr.** (Tulip morel/white morel)

This medium sized morel is locally called Pashakalai Gujai (Pashakal means month of July) as it is collected during the months of July. The fruiting body is pencil shaped, with sparse ridges and pits that are usually arranged more or less vertically. It is usually found under apple trees and sides of streams and rivers but rarely found near coniferous trees. *Morchella deliciosa* is of yellowish color. It makes about 7 % of the total collection of morels. When fresh, its size varies from 6 cm to 30 cm but on drying the size ranges from 4 cm to 15 cm.

***Morchella semilibera* DC.** (Half-free morel)

This morel is locally called Topai Sawree (capped) Gujai. It grows rarely under the pine trees. These morels are collected during spring and rainy season. The ascocarp is pitted and ridged while the stalk is of larger size compared to cap. When young, its color is pale but on maturity changes to black. This morel is not important commercially and is produced in small quantities. ***Morchella semilibera*** makes 3 % of the total morels collection from Swat. Fresh and dried size of *Morchella semilibera* varies from 2 cm to 10 cm and 0.1 cm to 4 cm respectively.

***Morchella elata* Fr**. (Black morel)

This morel is similar to *Morchella deliciosa* or *Phallus impudicus* morphologically. Locally it is called Da Khawar Gujai. The pileus is blackish brown with deep elongated pits running down the cap.
Morchella elata grow in shady and damp places and near the river. It makes about 2 % of the total morels collected in the area. When young, its size ranges from 5 cm to 25 cm but on maturity the size reduces i.e. from 3cm to 13 cm.
***Morchella crassipes* (Vent.) Pers.** (Thick-footed morel)
This morel is locally called dabbala Gujai. The pileus and stipe of ***Morchella crassipes*** are thick as compared to other morels. *Morchella crassipes* grow on soils with rich organic components. This morel constitutes 2 % of the total collection of morels in Swat and thus not significant commercially. The size varies from 4 cm to 15 cm when fresh but reduced to 2 cm - 12 cm after drying.

Traditional uses of morel in Swat

Morels are collected in Swat for marketing purposes but sometimes, they are used as traditional medicine and flavoring agent. Morels are fried in Desi Ghee and taken after meal as general body tonic. The plant is also crushed to powder and used as bandage for stopping extensive bleeding from an injured part of the body. In some areas, the plant is boiled in milk with Cow Ghee and used for joins aches or potency. Morels are believed to be helpful in the treatment of insomnia, enterogastritis, indigestion and poor appetite.

Traditional Drying and Storage Methods

Fresh morels contain huge amounts of water. It is clear from the fact that one kg fresh morels reduces to 100 gm after drying. Drying is done by collectors or local dealers called Pansaris. The traditional method of drying is to make a garland of morels and hang it to the wall or house rafters. The morels are first clean from mud as mud is attached to the stalk in some instances and are kept for drying for 2 to3 days in sunlight. After drying the morels are stored.
Morels need a lot of care in storage as their quality deteriorates very quickly. The successful storage technique is to keep morels dried and cool with a little ventilation. They are kept in closed chambers as in open they may absorb moisture and start to decompose. Occasionally, insect larva infests the morel during storage. In such cases, morels are properly fumigated with insect killing tablets in a separate chamber. Some times, morels get spoiled by mosses which grow on morels in hot humid conditions. The spoiled morels are washed with water but it deteriorates the quality of morels as they become black.

Causes of Morel Spoilage

Main causes of morel spoilage are the following.
1. Hot and humid conditions cause great loss to morels as hot conditions and increased moisture contents make the morels susceptible to insect attacks and moss growth.
2. When fresh morels are kept in air tight plastic bags, spoilage take place as a result of suffocation.
3. While growing, the morels got injured due to storms, running water or a piece of wood. Such morels become black after drying and counted as inferior quality.
4. Insects and ants also cause great damage to morels.

Morel Collectors

Morel collectors are usually poor villagers. Morel collection is there part time activity besides farming and live stock keeping. The collectors include 33% women, 27% men and 40% children. They collect morels during spring and early summer season which starts from March to July and sell it in the local market to earn their living hood. Morel collection is a hectic job and requires a lot of physical exertion, devotion and passion. Some times the collectors spent days in the forest collecting morels and other plants of economic importance, especially medicinal plants like *Acorus calamus, Podophyllum emodi, Paeonia emodi, Valeriana jatamansi* and *Bistorta amplexicaulis.* In most cases, the collectors sell morels in fresh form to the local dealers or in the markets of Madyan and Mingora after drying the morels. The collectors sold it to local shopkeepers or in the markets of Madyan and Mingora. *Morchella* fetch high prices and thus play an important role in the economy of Swat.

Marketing of morels

The collectors sold it to local shopkeepers or in the big markets of Madyan, Matta and Mingora. *Morchella* fetch high prices and thus play an important role in the economy of Swat. Morels collected from the forests of Swat are exported to France, Belgium, Switzerland, Austria and Germany. The main species exported are *Morchella conica* and *Morchella esculenta*. About 90% of the total morel produce of Pakistan is collected from the HinduKush and Himalayan mountain

ranges. Morels are actually the growing gold of these mountains.
The trade and earnings depends upon the export of morels, which is based on quality control. The shopkeepers buy morels from the collectors. These purchases are made under certain rules made by dealers of morels. The shopkeepers pay differently to the collectors depending on the quality of morels. When the shopkeepers or middlemen have sufficient stock, they sold it to exporters in the markets of Mingora, Madyan and matta. The same rule of gradation is yet again followed.

Prices of Morels

Prices of morels greatly depend upon the quality, processing and area of collection. The prices also vary from species to species. The price of *Morchella conica* is always higher than other species. One kilogram of dried morel fetches Rs.3000 to collector, Rs.10000 to the wholesaler, Rs. 13000 in the National market and Rs. 20000 to 25000 in the International markets (1 US dollar = 60 Pak Rupees). Thus the exporters are the main beneficiaries followed by middlemen. The collector get nominal benefits as prices are very low in the area as compared to international markets.

Table 1: Different categories of *Morchella* and their prices in the local market (2003)

No.	Category	Parts Sold	Price per Kg (Rupees)
1	Special	Heads only	5000
2	Extra	Heads with 2cm stalk	4600
3	Standard	Sold as collected	4200
4	Tail	Pieces of stalk only	200

Main Exporters of Morels in Pakistan

There are four main exporters of morels in Pakistan. They are

1. Rehman Traders, Mingora, purchase and export about 12000 to 17000 kg of morels per year.
2. Salman Traders, Islamabad, purchase and export about 15000 to 17000 kg of dried morels per year.
3. M. Hussain and Co. Mingora, purchase about 7000 to 10000 kg of morels each year.
4. Essa Jaffer and Co. Karachi, purchases about 5000 to 8000 kg of morels from Peshawar and exports it abroad.
5. Umer and Haji trading companies in Peshawar purchases about 4000 to 6000 kg morel and supply it to Lahore and Karachi.

Discussion

Pakistan has 56 edible species of edible fungi. These include 4 species from Baluchistan Province, 3 from Sindh Province, 5 from Punjab Province and 44 from NWFP Province and Azad Kashmir (Sultana *et al*., 1996). Morels are found in the northern areas, in the Himalayan, Karakoram and Hindukush mountain ranges. The altitudinal limits for morel ranges from 1,800 to 3,000 meters above sea level (Rehman, *et al.* 2000). In Asia, morels are mainly found in Turkey, Pakistan, India and China from where they are exported to other countries. According to Latif *et al* (2005), small quantities of morels from Afghanistan are exported via Pakistan. They grow in temperate latitudes around the world, in both conifer and hardwood forests.

In Swat, the collectors include 33.0% women, 27% men and 40% children. However, Iqbal (1991) reported that in NWFP, local people (children 54%, women 24%, men 22% in NWFP) collect them in fresh form from the forest. About 289,000 forest dwellers, mainly children and women, are involved with collection and processing of morels in NWFP. Many people in local communities collect part time in addition to their regular jobs, such as grazing animals, collecting fodder and fuelwood etc. The role of women is really crucial in all the processes like collecting, cleaning and drying (Shah, 1991). Morels are collected in Swat during spring season. The collectors are poor local people and morel collection is their part time activity.

Present investigations confirmed that seven species of *Morchella* are collected in Swat. However, present findings are different from those of Ali (2002), who reported that 9 different types of morels are collected from the Hindu Kush-Himalayan region of Swat. They either sell their collected morels to a local shopkeeper or in the big markets of Madyan and Mingora where morels fetch comparatively

high prices. Morel business is growing in Swat as it provides economic relief to the poor population of the area. The other reason of morel collection is mythical as people in the Swat believe that morel collectors are fortunate people. The collector some times put Mamera (*Corydalis govaniana*) in his/her eyes as there is a myth that such collectors will collect more morels. Iqbal (1993) observed that NWFP, the dried mushrooms are traditionally sold on barter trade basis or for money to the near by local grocers. The grocers sell these dried mushrooms to "Middle Men" in to the main trading markets that supply mushrooms to main trading centers like Lahore, Karachi and Rawalpindi or even directly exported abroad from Mingora in Swat. In main trading centers, they are well processed according to the demand of importer, which cost 90 to 110 rupees/Kg (Iqbal, 1993). The annual production of dry morels in Pakistan is approximately 100,000 kg. Most of this collection comes from the Hindukush mountain region of Swat.

Morels are highly priced of all wild harvested mushrooms because of their marvelous flavor and superb taste. Rotzoll *et al*. (2005) conducted interesting experiments using taste dilution analysis (TDA) technique to understand what causes the unique taste of morels, as well as the mouth-drying sensation they cause. It was found that gamma-aminobutyric acid is the agent responsible for the mouth-drying sensation. A mixture of (S)-malic acid 1-O-alpha-d-glucopyranoside and (S)-malic acid 1-O-beta-d-glucopyranoside was investigated to be involved in the taste. This mixture works along with l-glutamic acid, l-aspartic acid, and succinic acid, which were already known to be important components of the taste.

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NTFPS: An alternative to forest logging in Minadam and Sultanar Valley Swat

Non Timber Forest Products: An alternative to forest logging in Minadam and Sultanar Valley Swat

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NTFPS: An alternative to forest logging in Minadam and Sultanar Valley Swat

Abstract

Forest associated communities collect non-timber forest product as alternate sources of income. In Miandam and Sulatanr valleys of District Swat, the use of non-timber forest product (NTFPs) as marginal sources of income is a common practice. Medicinal plants like *Aconitum violaceum*, *Adiantum* spp., *Paeonia emodi*, *Podophyllum emodii* and *Valeriana jatamansui* etc. are collected for earning benefits. Beside medicinal plants, mushrooms, wild fruits, vegetables, thatching plants etc are collected and sold for marginal earnings by the communities. During summer these products provides 70% of income to the marginal communities beside agriculture. In winter seasons when NTFPs are not available for collection, the poor communities satisfy their economic needs through the sale of timber and fuel wood. The cultivation, commercialization and value addition of the selected NTFPs for conservation of plant resources and improved livelihood of the communities, as substitute of logging in both the valleys is evaluated and presented here.

Key words: NTFPs, Alternative source for income, forest logging, Miandam and Sulatanr Valleys

Introduction

With the quantum rise in population, forest cover and natural resources have been depleted. Over exploitation of timber compelled the policy makers to impose ban or restrict timber harvesting. Minor produce or Non-Timber Forest Products (NTFPs) has been globally considered as an alternative source of earnings from the forests. Forests and its products satisfy both the domestic and commercial needs forest associated communities. These forest resources are under severe threat of logging and depletion. Pakistan has 3% annual rate of deforestation with 23 years half-life. Miandam Valley is situated on northeastern side of Siadu Sharif, the capital city of Swat Valley. It is located at 350.02' N and 720, 33' E (Rehman, 2000). Miandam Valley comprised of Barhampatai, Saney, Khairabad, Miandam and Jukhtai villages. A single perennial stream, the Miandam Khawar, drains the whole valley. Total area of the valley is 17166 acres with a population of 20529 individuals. Sulatanr Valley is located in the Northwestern territory of Swat Valley, stretches over an area of about 50km2, located at 35o 06' to 35o 20' N and 72o 30' to 72o 40' E on the globe (Ahmad, 1997; Adnan, 2003). Elevation of the area varies from 1800m to 4100m, from sea level, giving rise to diverse vegetation setup and good climatic condition in summer. Total population of the area is 17981 (Anonymous, 1998).The study areas lies in Sino-Japanese (Ahmad and Sirajuddin, 1996) has established the moist temperate forest (Champion et al., 1965; Beg and Khan 1974) extending to sub alpine and alpine areas. Various products like honey, morels, and handicrafts extracted by the local people are excluded in the present study.

Materials and Methods

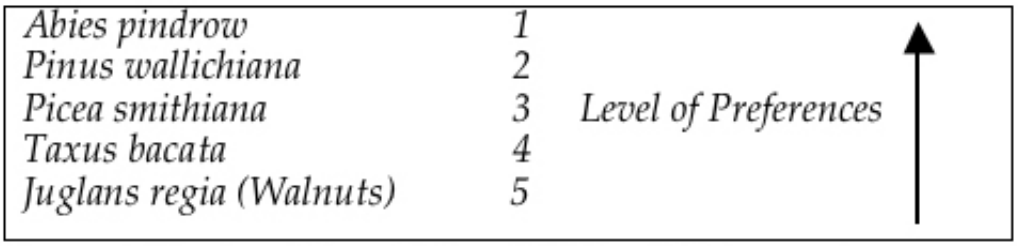
For primary data collection, personal observation, organized survey and community meetings were undertaken. For survey, questionnaire was used to get baseline information. Three questionnaires were developed for local community, collectors/producers and traders. Stratified sampling technique was used for analyzing the area in terms of NTFPs. Random sampling techniques were used to interview the target groups. Nearly 10% of the selected population was the sample size for data collection. Secondary data was collected from various libraries and departments. The data collected was analyzed statistically. New techniques like willingness to pay and preference ranking of specific species/products were used to present the data.

Results and Discussion

1. Forest Logging

Timber is of main concern in both the valleys. Miandam's total area comprised of 60% of forest. In Sulatanr Valley, only Sulatanr village has thick forest protected by community; while in other villages of the valley it is under sever threats. The density of forest has been decreased up to 90%. 9-12 trees are cut down per day in Miandam Valley. The forest dwellers of valleys prefer

following timber species.



Key: 5-Very low, 4-Low, 3-Nomal, 2-Good, 1-Very good

Timber is sold in main markets like Mandal Dag, Gawalerie, Miandam and Fatihpur in the valleys. According to respondents, in summer only 5% of people are involved in timber trade while in winter 25% of local people are involved, except from Sulatanr Village, where commercial exploitation is completely banned. People involved in the timber cutting are mostly from communities. Shepherds are involved in timber cutting only on wages. Increasing population and lack of alternative livelihood opportunities has led to the accelerated deforestation.

NTFPs of Miandam and Sulatanr Valleys

2. Medicinal Plants of the Valleys

Various medicinal plants, which are commonly used locally and are commercially important, are listed in Table 1.

Table 1. Important Medicinal Plant of the Valleys

Table 1. Important Medicinal Plant of the Valleys

S. #	**Botanical name**	**Local name**	**Part used**	Uses For/As	**Usage trends**	**Market Price /kg**
1	*Aconitum violaceum*	Zaharmora	Rhizome	Rheumatism and arthritis.	*M*	*Rs. 135*
2	*Acorus calamus*	Sakha Waja	Rhizome	Cough, remedy for flatulence, colic and diarrhea and also against snake bites	*M*	*Rs. 130*
3	*Adiantum venustum*	Sumbal	Leaves	Sexual disability, fever, backache and used as blood purifier	*N*	*Rs. 32*
4	*Aesculus indica*	Jawaz	Fruit, oil	Fruits are used as anathematic and given to horses in colic.	*M*	*Rs. 20*
5	*Ajuga bracteosa*	Boti	Whole plant	Throat sore treatment and purifying blood, used in epilepsy act as coolant	*N*	*Rs. 50*
6	*Artimisia brevifolia*	Terkha	Shoots	Antispasmodic and stomach-ache	*M*	*Rs. 20*
7	*Arisaema flavum*	Marjarey	Rhizome	-	*N*	*Rs. 45*

8	*Atropa acuminata*	Bargak	plant	Pains and rheumatism as poultice	*L*	
9	*Berberis lycium*	Kowarey	-	Jaundice, sore mouth stomach problems	*M*	*Rs. 65*
10	*Bergenia ciliata*	Gat Panra	Rhizome	Used as anti-diabetics and expectorant	*L*	*Rs. 80*
11	*Bistorta ampilexicaulis*	Tarwa Panara	Rhizome	Rheumatism and gout	*N*	*Rs.15*
12	*Caltha alba*	Makan Path	Floral shoot	Laxative	*N*	*Rs. 12 (fresh)*
13	*Corydalis stewartii*	Mamera	Floral shoot	Eye drops for curing eye diseases	*L*	
14	*Dioscorea deltoidea*	Qanris	Rhizome	Used for treatment of jaundice and ulcers	*N*	*Rs. 80*
15	*Dryopteris jaxtaposta*	Kowanjey	Whole Frond	Enhance digestion	*M*	*Rs. 20*
16	*Feoniculum vulgare*	Kaga Velaney	Fruit	Used for curing urinary, dried fruits are used as carminative and laxative	*M*	*Rs. 175*
17	*Fumaria indica*	Papra	Whole plant	Used for jaundice, also used as blood purifier and coolant	*N*	*Rs. 22*
18	*Hedera nepalensis*	Prewatei		Anti-diabetics, blood purifier	*N*	*Rs. 40*
19	*Hypericum perforatum*	Shin chey	Stem and leaves	Used as diuretic and its tea is stimulant and analgesic	*M*	*Rs. 90*
20	*Indigofera heterantha*	Ghorejey	Root, leaves	For scabies, leaves are used for stomach problems	*N*	*Rs. 20*
21	*Isodon rugosus*	Spirkey	Stem and leaves	Remedy for toothache	*M*	*Rs. 40*
22	*Juglans regia*	Ghuz	Fruit, bark	General body tonic, bark is used for cleaning teethes and antiseptic	*M*	*Rs. 45*
23	*Mentha longifolia*	Velaney	Shoots	Used in diarrhea in children and prevention of vomiting. Also used in dyspepsia	*M*	*Rs. 30*

24	*Mentha spicata*	Podina	Leaves and stem	Used as carminative and refrigerant also used as Carminative	*M*	*Rs. 25*
25	*Paeonia emodi*	Mamekh	Rhizome	Backache and general weakness	*M*	*Rs. 20-25*
26	*Primula denticulate*	Mamera	Flower,	Eye irritant	*M*	*Rs. 60*
27	*Podophyllum emodii*	Kakora	Rhizome	Used to control jaundice and other liver disease	*N*	*Rs. 165*
28	*Polygonatum verticilatum*	Noor-e-alam	Rhizome	Used for treatment of joint pain	*N*	*Rs. 120-130*
29	*Rheum australe*	Chotial	Roots, Rhizome leaves	Purgative, astringent, alexiterix, emmenagogue, diuretic and act as blood purifier	*N*	*Rs. 60*
30	*Skimmia laureola*	Nazar Panra	Leaves	Tea made from the leaves as used for dyspepsia, smoke is considered as antiseptic	*M*	*Rs. 32*
31	*Solanum nigrum*	Kamachoo	Leaves and fruit	Treat eczema, fruits edible and are used in fever	*N*	*Rs. 12*
32	*Taxus buccata*	Banerya	Bark	Emmenagogue and antispasmodic	*M*	*Rs. 60*
33	*Valeriana jatamansi*	Mushk-e-Bala	Rhizome	Unknown local uses	*M*	*Rs. 90*
34	*Viola odorata*	Banafsha	Flower	Used for throat sore and carminative agent	*M*	*Rs. 230 (dried)*

Key: L-Less, N-Normal, M-More

3. Wild Fruits

Various wild fruits like *Viburnum grandiflorum*, *Morus alba*, *Ficus palmata*, *Diospyros lotus*, *Diospyros kaki*, *Juglans rejia*, *Prunus persica*, *Viburnum grandiflorum*, *Quercus dilatata*, *Zizyphus vulgaris* and *Fragaria vesca*. Some of the species are domesticated for commercial purposes like *Diospyros lotus* and *Z. vulgaris* but it is on very small scale. These fruits contribute a lot to the economy of local communities.

4. Wild Vegetables

Communities use wild vegetables like *Atropa acuminata*, *Allium cepa*, *Urtica dioica*, *Solanum nigrum*, *Dryopteris* spp., *Berberis lyceum*, *Caltha alba*, *Medicago* spp., *Allium sativum*, *Malva officinalis*, and *Rumex dentatus* etc. Women and girls mainly collect and cook these vegetables. All the vegetables are used for domestic purposes. Recently, *Catha alba*, and *Dryopteris* spp. are collected for market selling.

5. Condiments

Five species *Bunium persicum*, *Mentha spicata*, *Carum carvi*, *Rosa webbiana*, [[i=]]Feoniculum

vulgare are common condiments of the area. Availability of some of the species like *Bunium persicum* and *Carum carvi* is diminished during the recent years.

6. Gums and Resin

In past the resin taping was more common but due to ban by forest department people are presently not using it. Although, some of people are involved in gum extraction but they use gum only for domestic purposes. Torchwood is however extracted in huge amount.

7. Walnut Bark

Though after the ban by forest department in 1992, the walnut bark is not commercially traded. Its illegal extraction and smuggling has, however, caused decrease in availability of walnuts population in the valley. Locally the bark and leaves are used for tooth cleaning.

Collection trends of various plants in Sulatanr and Miandam

The collected data revealed that 80% of the respondents adapted to plant collection as part time profession in spring, while 20% were completely dependent on collection of forest products for their income. In 80%, 55% were farmers, 20% businessmen, 20% shopkeepers and 5% were from other professions.

A collector collects 2-3 products. Average 1 trip/day in a season is made to the collection areas. Collection is done throughout the summer season but best season for collection/production for commercial purpose is March to June. Most of the produce is sold in fresh form on the local vendors in Miandam valley while mostly dry produce in Sulatanr Valley.

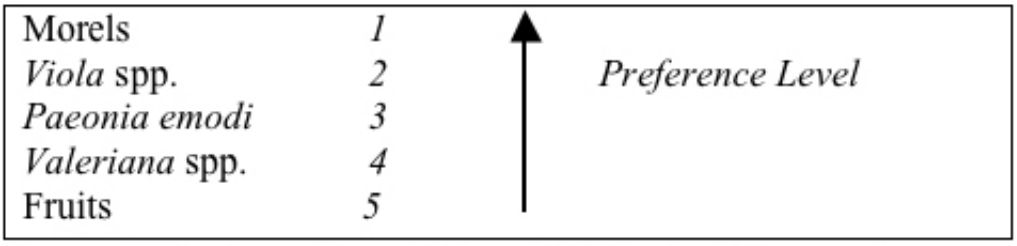
According to 60% respondents, trend of collection from the wild is decreasing. The decreased production is due to lesser economic value of the produce, lack of proper marketing, lesser accessibility to main markets, increase in population and lesser availability of the produce.

Products collected for commercial purposes:

Two produce are frequently collected by the collectors i.e. Valeriana jetamansai and *Viola odorata*, while other medicinal plants are collected and sold in small quantities. Each collector brings produce with following quantities:

- *Morchella esculenta* 0.5-1kg in fresh form
- *Voila* spp. 0.5-1kg in fresh form
- *Valeriana* spp. 100-200 g
- *Dioscorea* spp. 300-500 g (Collected in lesser quantities)

These 3 products are main income source especially for Gujers, who are mostly involved in timber cutting. The only cost suffered by respondents is the traveling to collect the produce, previously present at the doorstep. The purchase of product depends on the market value, and demands. Preferences for other products are given in below.



Key: 5-Very low, 4-Low, 3-Normal, 2-Good, 1-Very good

The quantity of the produce is decreasing day by day. For example, *Paeonia emodi*, *Valeriana* spp., *Polygonatum* spp. *Taxus baccata* and *Podophyllum* spp. etc. important species. Their level of abundance is decreasing and requires efficient product conservation strategy. The production size of various products is different. *Viola* spp. is collected more, followed by *Valeriana* spp. from the valleys. Further detail obtained from selected respondent is given in Table2.

Table 2. Production of selected NTFPs

Table 2. Production of selected NTFPs

Name	*Quantity purchased/ collected (kg)*	*Value in Rs.*
Morels	*350*	*1,330,000*
Viola spp.	*1600*	*368,000*
Valeriana spp.	*1100*	*99,000*
Artemisia spp.	*300*	*6,000*
Paeonia emodi	*120*	*3,000*
Berberis lyceum	*425*	*27,625*
Total	*3,820*	*1,833,625*

There are many products, which are used domestically and need proper evaluation. Due to lack of market value of the products, people are more converging on trade of timber & fuel wood.

Market Chain

The market analysis shows that economic benefits are unequally distributed. From collector level to primary/secondary middlemen more than 50% of the material or the actual constituents are wasted during collection, drying, cleaning, packing, storing and transportation. Till reaching its end user industries/Dawakhanas or exports, 10-15% is lost more in further refining. Thus out of total collection only 40% of the produce reaches to the consumers. Detail of the market chain is given below:

[IMAGE]

NTFPs for domestication

Hundred percent of people interviewed were willing to go for domestication of economically important species. Their opinion was if government or other agencies provides some technical and financial support it can be developed as a good income source for the area.

Conclusions

Insight of the people, resources and analysis revealed that the local people are tremendously relying on the plant resources. The forest logging is more when there is no other livelihood opportunity. If the Non Timber Forest Products, sustainably collected and properly marketed, it will provide high profit to the forest dwellers. The people are 100% willing to domesticate the minor produce, as off-season crop. If these are cultivated on marginal lands, it will reduce forest logging.

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Improvement of seed germination in three important conifer species by Gibberellic acid (GA3).

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Improvement of seed germination in three important conifer species by Gibberellic acid (GA3).

Abstract

Results pertaining to the germination percentage of pre-soaked seeds in a series of temperature regimes *viz*., 100C, 150C, 200C and 250C have revealed significant increase among seed sources in each of the three conifer species of Garhwal Himalaya. Soaking of the seeds for 24 hours in GA3 solution had shown maximum germination in *A. pindrow* (45.0±4.19%), *C. torulosa* (57.0±3.40%) and *P. smithiana* (56±6.01%) as compared to untreated (control) seeds. It has also been observed that GA3 treatment caused an appreciable shortening of the germination period by 10 days. Therefore, seeds of these commercially important tree species should be pre-treated particularly with GA3 for 24 hours for getting enhanced germination. It is important to point out here that the seeds of each of the three species reflect poor germination in nature due to snow cover, seed decay, prevalence of excess water and lack of maintenance, however, because of increasing demand for large quantities of tree seeds for reforestation programmes, pre-sowing treatments are useful to improve the rate and percentage of germination.

Key words:Germination percentage, Gibberellic acid, Conifers species, Himalaya, Germination value

Introduction

Genetic variation is manifested through provenance tests, designed to assess the degree and pattern of variation across species ranges. The typical experimental approach consists of collecting open-pollinated seeds in a single season, from trees within portions of the range and evaluating the performance of the resulting seedlings in formal "common garden test" at several locations within the range. Frequently as a first investigative step, the germination characteristics of these seeds are evaluated under conditions, which allow comparison of geographical provenances, or families within provenance. Provenance differences are sometimes assumed to have a genetic basis. However, such tests are actually based on the phenotypic variations among seed lots from provenances, and not on genetic variation. Rowe (1964), and Baskin & Baskin (1973) have noted, that the difference in seed characteristics of ecologically important provenances may also be due to genetic variability.

The primary consideration in bringing out genetic improvement in a particular species is the development of a sound scientific breeding programme, based upon the available genetic variability. However, progress in improvement in many species has been poor due to failure in utilising the existing variability in tree improvement. The success of tree breeding programmes relies mostly on the ability to identify and deploy superior trees. Decisions on how, when, and what to select, are made (or should be made) taking into account genetic and economic information. Selection in tree breeding programmes, therefore should be based upon genetic information generated from progeny tests. Plant growth substances are involved in seed germination and subsequent growth; their specific roles are still obscure. In order to have a better understanding of the functions of plant growth, subsequent during these processes, it is important to identify and quantify them through imbibitions, from growth of the seedlings. Gibberellic acid (GA3) has been shown to promote germination of seed (Vogt, (1970); Krishnamurthy, (1973); Chandra & Chauhan, (1976)) however, the germination percent increased in the seeds of *Nothofagus obliqua*, when they were pre-chilled after soaking in GA3 Solution for 24 hours (Shafiq, 1980). Singh (1973) reported that spruce seeds germinated comparatively more profusely than silver fir, and further recorded that enough seeds become available for raising sufficient planting stock. Keeping this in view the present study was aimed at understanding the role of GA3 treatment for seed germination in different provenances of *Abies pindrow*, *Cupressus torulosa* and *Picea smithiana*.

Materials and Methods

The present study was undertaken in five provenances each of three important coniferous species (15 provenances) i.e., *Abies pindrow*, *Cupressus torulosa* and *Picea smithiana* from three districts *viz.* , Pauri, Tehri and Chamoli of Garhwal Himalaya. The details of the study areas have been presented in Table-1.

Provenances	District	Altitude (m)	Latitude (N)	Longitude (E)	Temperature (^{0}C) Min.	Max.	Mean annual rainfall (mm)
Bharsar	Pauri	2697	30^{0}24'	79^{0}31'	-0.70	27.5	1084.00
Dudhatoli	Pauri	3122	30^{0}5'	79^{0}12'	-0.65	25.8	1935.00
Ransolikhal	Tehri	2750	30^{0}25'	79^{0}17'	-0.56	26.9	1475.00
Surkanda	Tehri	3030	30^{0}27'	79^{0}18'	-0.75	25.3	1595.00
Tapovan	Chamoli	3798	30^{0}31'	79^{0}36'	-0.84	24.5	1892.00
Gwaldam	Chamoli	1960	30^{0}20'	79^{0}34'	-0.53	29.6	1336.00
Mandal	Chamoli	1768	30^{0}23'	79^{0}15'	-0.60	28.9	1750.00
New Tehri	Tehri	1675	30^{0}33'	78^{0}29'	1.23	29.7	1632.00
Pauri	Pauri	1660	30^{0}9'	78^{0}48'	-0.48	26.30	1792.00
Banjbagad	Chamoli	2775	30^{0}15'	79^{0}34'	1.13	30.8	1276.00
Hanumanchatti	Chamoli	2880	30^{0}41'	79^{0}30'	-0.10	25.3	2098.00
Helang	Chamoli	2595	30^{0}33'	79^{0}37'	1.34	28.9	1860.00
Pandukeshwar	Chamoli	2657	30^{0}31'	79^{0}32'	-0.91	27.0	1932.00

Table 1: Geographical and meteorological descriptions of the seed sources of *A. pindrow, C. torulosa* and *P. smithiana*.

The studies pertaining to provenance variation and seed germination after pre-soaking treatment were carried out under laboratory conditions at various temperatures *viz.* , 100C, 150C, 200C and 250C, inside a seed germinator (Model No. 8LT-SGL CALTAN). The seeds of all the provenances of each species were germinated at similar temperatures after applying following treatment to each set:

Treatment 1- Soaking of the seeds in distilled water at room temperature (250C) for 24 hours (as control). Treatment 2 -Soaking of the seeds in Gibberellic acid (GA3 100ppm) at room temperature for 24 hour (treatment).

For germination, the seeds in five replicates of 100 seeds each were placed in Petri dishes containing two filter papers, kept in the germinator, and maintained at desired temperature. Observations were recorded daily for germinated /non-germinated seeds up to 21 days. Radical emergence was taken as the criteria for germinability. The germinated seeds after cessation of the experiment were transplanted to the polythene bags in the nursery.

The data on seed germination was recorded and quantified in terms of percent germination and germination value. Percent germination was the value of seeds germinated at the completion of the germination period, whereas, germination value is an index, combining speed and completeness of germination; which according to Czabator (1962) can be expressed as: GV= PV X MDG, where, GV is germination value, PV is the peak value of germination, and MDG is mean daily germination.

Statistical Analysis:

The statistical analysis of each parameter was carried out on mean values and the analysis of variance (ANOVA) was performed using SPSS package. The critical difference (CD) was calculated as: CD = SEd X t0.01, where, SEd is the standard error of differences calculated as SEd = 2Me/2

Results and Discussion

Germination of seeds of various provenances after pre-soaking treatment with GA3 under different temperature regimes, (i.e., 100C, 150C, 200C and 250C) has yielded significant differences in seed germination. The data analysed for its variance, has revealed remarkable variation amongst different seed sources, which have been presented in (Table-5). The detailed treatment-temperature interactions are given below:-

[[saubheading text="Soaking of seeds in distilled water (as control):]] In *Abies pindrow* the maximum germination of seeds at 100C (32.0 ± 2.00%) and 150C (18.0 ± 4.37%) was recorded in Tapovan provenance, whereas, at 200C (22.0 ± 9.59%) and 250C (19.0 ± 1.0%) in Ransolikhal provenance. On the other hand maximum germination values at 100C, 150C, 200C and 250C was observed for Tapovan (0.67 ± 0.15), Surkanda (0.39 ± 0.09), Ransolikhal (0.49 ± 0.38) and Bharsar (0.30 ± 0.28) provenances respectively. The minimum germination of seeds at these temperatures were recorded in Surkanda (21.0 ± 2.92%), Bharsar (14.0 ± 4.01%), Dudhatoli (15.0 ± 3.54%) and Tapovan (10.0 ± 2.74%) provenances and minimum germination values for Dudhatoli (0.26 ± 0.05), Ransolikhal (0.22 ± 0.06), Tapovan (0.11 ± 0.01) and Surkanda (0.09 ± 0.03) provenances respectively (Table-2).

	Provenance				
Treatment	**Bharsar**	**Dudhatoli**	**Ransolikhal**	**Surkanda**	**Tapovan**
			10°C		
Control	22±3.75 *0.34±0.08*	26±4.86 *0.26±0.05*	26±4.01 *0.54±0.18*	21±2.92 *0.41±0.08*	32±2.00 *0.67±0.15*
GA_3 (100ppm)	28±2.55 *0.39±0.04*	41±4.86 *0.64±0.14*	45±4.19 *0.69±0.12*	33±3.40 *0.48±0.11*	34±4.86 *0.47±0.14*
			15°C		
Control	14±4.01 *0.30±0.10*	17±2.55 *0.25±0.07*	17±1.22 *0.22±0.06*	17±2.55 *0.39±0.09*	18±4.37 *0.25±0.14*
GA_3 (100ppm)	27±5.16 *0.47±0.15*	25±1.58 *0.35±0.03*	21±2.92 *0.38±0.13*	21±4.31 *0.29±0.07*	31±2.92 *0.44±0.05*
			20°C		
Control	15±3.17 *0.15±0.04*	15±3.54 *0.29±0.11*	22±9.59 *0.49±0.38*	21±7.50 *0.12±0.02*	17±2.00 *0.11±0.01*
GA_3 (100ppm)	23±6.26 *0.44±0.08*	28±3.40 *0.47±0.17*	25±2.74 *0.27±0.07*	18±4.07 *0.20±0.06*	25±1.58 *0.26±0.03*
			25°C		
Control	10±8.28 *0.30±0.28*	12±2.00 *0.19±0.05*	19±1.00 *0.26±0.05*	10±3.17 *0.09±0.03*	10±2.74 *0.10±0.05*
GA_3 (100ppm)	20±6.53 *0.20±0.09*	16±4.31 *0.16±0.05*	23±2.00 *0.29±0.05*	26±4.86 *0.46±0.17*	21±2.45 *0.28±0.05*

Table 2: Effect of treatment and temperature on seed germination and germination value of different provenances of *Abies pindrow*.

In *Cupressus torulosa* maximum seed germination at 100C (42.0 ± 2.55%), 15°C (35.0 ± 6.72%), 20°C (39.0 ± 3.32%) and 25°C (31.0 ± 1.0%) was noticed in Pauri provenance. However, maximum GVs were also recorded for Pauri provenance in these temperatures. Contrary to this the minimum germination percentage (14.0 ± 1.0%) and germination value were recorded at 20°C in Mandal provenance (Table-3).

	Provenance				
Treatment	**Gwaldam**	**Mandal**	**New Tehri**	**Pauri**	**Tapovan**
			10°C		
Control	18±1.22 *0.17±0.02*	25±1.58 *0.24±0.03*	25±3.40 *0.31±0.05*	42±2.55 *0.49±0.06*	37±9.97 *0.50±0.22*
GA_3 (100ppm)	51±3.68 *0.75±0.18*	47±6.05 *1.07±0.29*	57±3.40 *1.00±0.23*	56±2.45 *1.31±0.30*	53±7.19 *1.06±0.30*
			15°C		
Control	21±1.87 *0.32±0.07*	22±1.22 *0.27±0.04*	23±1.32 *0.24±0.03*	35±6.72 *0.45±0.11*	30±3.17 *0.44±+0.06*
GA_3 (100ppm)	37±3.40 *0.58±+0.06*	31±2.49 *0.44±0.11*	42±3.40 *0.42±0.06*	38±3.40 *0.53±0.12*	41±3.32 *0.71±0.41*
			20°C		
Control	21±2.92 *0.34±0.05*	14±1.00 *0.15±0.03*	20±4.19 *0.35±0.06*	39±3.32 *0.61±0.06*	22±4.64 *0.25±0.06*
GA_3 (100ppm)	36±2.45 *0.43±0.07*	35±3.17 *0.59±0.11*	34±5.80 *0.36±0.09*	40±4.75 *0.67±0.20*	35±5.25 *0.55±0.12*
			25°C		
Control	18±1.22 *0.26±0.08*	17±1.22 *0.18±0.01*	17±4.64 *0.19±0.06*	31±1.00 *0.29±0.02*	17±2.00 *0.20±0.06*
GA_3 (100ppm)	34±4.31 *0.44±0.07*	36±3.41 *0.57±0.15*	32±5.08 *0.03±0.05*	37±9.59 *0.87±0.48*	29±2.45 *0.40±0.04*

Table 3: Effect of treatment and temperature on seed germination and germination value of different provenances of *Cupressus torulosa*.

In *Picea smithiana* the maximum seed germination percentage oscillated significantly. For example, at 100C maximum seed germination (37.0 ± 2.25%) was recorded in Helang provenance. However, at 15°C (30.0 ± 1.58%), 20°C (30.0 ± 2.74%) and 25°C (26.0 ± 4.01%) the maximum seed germination was reflected by Pandukeshwar, Tpovan and Banjbagad provenances respectively. The minimum germination percentage of seeds (15.0 ± 5.71%) was found in Tapovan provenance at 25°C. On the other hand the maximum GV (1.26 ± 0.30 at 100C) was recorded for Pandukeshwar provenance, whereas, minimum (0.22 ± 0.10 at 25°C) for Tapovan provenance (Table-4).

Treatment	Provenance				
	Banjbagad	Hanumanchatti	Helang	Pandukeshwar	Tapovan
			10°C		
Control	31±1.86 *0.54±0.11*	31±6.61 *0.83±0.29*	37±2.25 *0.69±0.09*	36±3.68 *1.26±0.30*	27±3.75 *0.68±0.09*
GA_3 (100ppm)	42±5.62 *0.83±0.29*	53±4.07 *0.93±0.18*	45±5.01 *1.05±0.24*	52±3.75 *1.07±0.25*	56±6.01 *1.29±0.07*
			15°C		
Control	29±2.92 *0.49±0.09*	22±2.55 *0.41±0.10*	29±1.12 *0.59±0.05*	30±1.58 *0.61±0.05*	22±2.00 *0.82±0.17*
GA_3 (100ppm)	38±3.00 *1.07±0.22*	30±4.48 *0.64±0.13*	38±6.65 *0.59±0.12*	38±2.00 *0.78±0.13*	36±5.58 *0.61±0.05*
			20°C		
Control	29±6.22 *0.57±0.13*	26±4.31 *0.55±0.09*	26±4.31 *0.46±0.08*	25±1.58 *0.42±0.06*	30±2.74 *0.71±0.21*
GA_3 (100ppm)	36±3.68 *0.85±0.18*	43±3.75 *1.02±0.13*	43±3.75 *1.16±0.39*	54±11.90 *1.57±0.53*	42±2.00 *1.22±0.13*
			25°C		
Control	26±4.01 *0.42±0.10*	21±1.87 *0.35±0.15*	21±1.87 *0.30±0.09*	25±3.54 *0.41±0.15*	15±5.71 *0.22±0.10*
GA_3 (100ppm)	30±2.74 *0.41±0.07*	28±4.37 *0.70±0.24*	28±4.37 *0.45±0.12*	35±4.48 *0.84±0.23*	24±2.45 *0.46±0.11*

Table 4 : Effect of treatment and temperature on seed germination and germination value of different provenances of *Picea smithiana*.

Soaking of seeds in GA3: In *Abies pindrow* highest seed germination (45.0 ± 0.19%) and germination value (0.69 ± 0.12) were recorded for Ransolikhal provenance at 100C and minimum seed germination (28.0± 2.55%) and germination value (0.39 ± 0.04) for Bharsar provenance. At 15°C (31.0 ± 2.92%), 20°C (28.0 ± 3.40%) and 25°C (26.0 ± 4.86%) maximum germination percentages were recorded in Tapovan, Dudhatoli and Surkanda provenances. The GVs were almost highest in these provenances at these temperatures. The least germination value (0.16 ± 0.05) was recorded in Dudhatoli provenance at 25°C (Table-2).

In *Cupressus torulosa* maximum germination of seeds at 100C (57.0 ± 3.40%), and 15°C (42.0 ± 3.40%) was recorded in New Tehri provenance and at 20°C (40.0 ± 4.75%) and 25°c (37.0 ± 9.59%) in Pauri provenance. However, the minimum seed germination at 100C (47.0 ± 6.05%) and 15°C (31.0 ± 2.49%) was recorded in Mandal provenance, at 20°C (34.0 ± 5.80%) in New Tehri provenance and at 25°C (29.0 ± 2.45%) in Tapovan provenance respectively. The maximum GVs at 100C (1.31± 0.30), 20°C (0.67 ± 0.20) and 25°C (0.87 ± 0.48) were observed for Pauri provenance, however, at 15°C (0.71 ± 0.14) for Tapovan provenance. The overall minimum GV (0.03 ± 0.05) was found for New Tehri provenance at 25°C (Table-3).

In *Picea smithiana*, at 100C temperature, maximum seed germination (56.0 ± 6.01%) and GV (1.29 ± 0.07) were recorded for Tapovan provenance. At 150C Banjbagad (38.0 ± 3.00%), Helang (38.0 ± 6.65%) and Pandukeshwar (38.0 ± 2.0%) provenances have shown equal germination of the seeds, however maximum GV (1.07 ± 0.22) was observed for Banjbagad provenance. At 200C and 250C temperatures, maximum seed germination (54.0 ± 11.90% and 35.0 ± 4.48%) and GVs (1.57 ± 0.53 and 0.84 ± 0.23) were reflected by Pandukeshwar provenance. The overall minimum seed germination (24.0 ± 2.45% in Tapovan provenance) and GV (0.41± 0.07 for Banjbagad provenance) were found at 250C temperature in the seeds which were soaked in GA3 prior to germination at various temperatures (Table-4).

Thus, basing on the present study the Ransolikhal provenance of *Abies pindrow*, Pauri provenance of *Cupressus torulosa* and Pandukeshwar provenance of *Picea smithiana* were the most successful amongst all the provenances under the observed treatments. In all the selected temperature treatments (i.e., 100C, 150C, 200C & 250C), 100C was the best temperature for the germination of seeds in the selected species, as the highest germination was observed at this constant temperature, whereas, the least germination of seeds was recorded at 250C. On the other

hand the seeds soaked with distilled water (as control) have exhibited lesser germination in all the provenances of *A. pindrow*, *C. torulosa* and *P. smithiana*. An increase in the seed germination of spruce, fir and Himalayan cypress by gibberellic acid treatment was observed probably due to enhancement of hydrolase (especially amylase) synthesis, as was also stated by Paleg (1960(a) & (b)), Amen (1968) and Galston & Davies(1969) or due to initiation of the embryo growth, as a result of which more gibberellic acid is synthesized by the growing embryo, which induced hydrolase synthesis (Chen & Varner, 1973).

The data shown in Table-5 have revealed the significant effect of temperature and treatment on seed germination percent; however a non-significant effect of treatment x temperature interaction was also noticed. It was also observed that seed sources, which had higher values for cone and seed parameters, also showed better performance in germination. These findings have been supported by the concept of Baldwin (1942) and Dunlap & Barnett (1983), according to which, seed size and weight have pronounced effects on seed germination. Generally, large seeds have fast and uniform germination, due to more endosperm nutrient pool (Kandya, 1978). Therefore, seed source variation in germination percent and related traits may be ascribed to the significant differences, observed in seed dimensions and weight. Germination values varied considerably among seed sources and exhibited a random pattern, which is an index of combining speed and completeness of germination and itself is a function of seed size and weight (Czabator, 1962) and (Dunlop & Barnett, 1983). On the other hand, variation observed in time taken to complete germination could be attributed to the differences in germination rate and germination value of the selected provenances of all the three species.

Source of variation	d. f	SS	MSS	F-ratio	CD 5%	CD 1%
(a) *Abies pindrow*						
Provenances	4	0.79	0.1975	5.64**	0.26	0.36
Temperature	3	1.89	0.63	18**	0.28	0.40
Error[a]	12	0.42	0.035			
Treatment	3	1.56	0.52	4.7**	0.47	0.63
TreatmentX Temperature	9	2.16	0.24	2.16*	0.29	0.39
Split plot Error[b]	48	5.31	0.1106			
(b)Cupressus torulosa						
Provenances	4	0.94	0.235	10.44**	0.21	0.29
Temperature	3	1.12	0.3733	16.54**	0.23	0.32
Error[a]	12	0.27	0.0225			
Treatment	3	1.78	0.5933	3.93*	0.55	0.74
TreatmentX Temperature	9	3.46	0.3844	2.54*	0.34	0.46
Split plot Error[b]	48	7.24	0.1508			
(c) *Picea smithiana*						
Provenances	4	1.46	0.365	6.08**	0.34	0.47
Temperature	3	3.14	1.0466	17.43**	0.37	0.53
Error[a]	12	0.72	0.06			
Treatment	3	1.46	0.4866	1.87	0.72	0.95
TreatmentX Temperature	9	7.45	0.8277	3.19**	0.46	0.61
Split plot Error[b]	48	12.4	0.2593			

*Significant at 5% and **significant at 1%

Table 5 : Analysis of variance for germination percent of various provenances of (a) *Abies pindrow*, (b) *Cupressus torulosa* and (c) *Picea smithiana*.

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[[List of special symbols]]
±; plus/minus symbol. °C; Degree Celsius symbol. √; Square root symbol.

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Seed oil content variation in *Jatropha curcas* Linn. in different altitudinal ranges and site conditions in H.P. India.

Seed oil content variation in *Jatropha curcas* Linn. in different altitudinal ranges and site conditions in H.P. India.

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Seed oil content variation in *Jatropha curcas* Linn. in different altitudinal ranges and site conditions in H.P. India.

Abstract

The present study was conducted to determine the variation in yield and oil content by taking composite sample of six *Jatropha* trees selected randomly from two cultural site conditions *viz.* arable (T1), non-arable (T2) and three altitudinal ranges E1 (400-600m)), E2 (600-800m) and E3 (800-1000 m) in Himachal Pradesh. The oil was extracted from the dried seed using steam distillation method of oil extraction. The highest oil was recovered in T2 E2 (non-arable site with low altitude) various morphological and yield attribute like number of fruits/branches, number of fruits/tree, number of seeds/tree were also studied. Arable site with high altitude (T1E3) recorded the highest value for these parameters.

Keywords: Biodiesel, energy demand, yield attributes, growth pattern, pollution reduction.

Introduction

The developing world in today encountered with near crisis situation both economic and environmental. This region with barely 56 per cent of the land area has to support around 77 % of the total population at the global level. India consumes about 111 millions tons of petroleum products annually. About 33 million tons in produced in the country as crude oil meeting less than 30 per cent of the needs. India ranks sixth in the world in term of energy demand. Accounting for 3.5 percent of the world commercial energy demand in 2001. India is witnessing a serious threat at of its resources as well as various concomitant environmental disasters. The impacts of degradation are though visible in all renewable and non-renewable resources at the forest and the lands which are very vital for sustenance have been previously affected. The largest resource liability for India lies in its input of petroleum product. These are essential to maintain the tempo of the high growth rate of Indian economy. Both transport and industry consume million tons of diesel every year, which is produced from crude oil. Reserves of crude oil rapidly diminishing and the reliability and security of oil supplies has been of global concern since the energy crisis of the 1970. Depleting reserves of fossil fuels and increasing effects of pollution from these fuel demand eco-friendly alternatives, which can supplement or replace fossil fuels: In recent years research has been directed to explore biofuels -plant based fuel sources as a supplement or substitute of fossil fuel. Biofuels are renewable and environmentally safe. Biodiesel is fatty acid ethyl or methyl ester made from virgin or used vegetable oils (both edible and non edible) and animals fats. The main commodity source for biodiesel in India can be non- edible oils obtained from plant species such as *Jatropha curcas* (Ratanjyot), *Pongamia pinnata* (Karanj), *Calophyllum inophyllum*, *Hevea brasilensis* etc. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend or can be used in its pure form. Just like petroleum diesel, biodiesel operates in compression ignition engine which essentially require very little or no engine modification, because biodiesel has properties similar to petroleum diesel fuels. Biodiesel is considered clean fuel since it has almost no sulphur, no aromatics and has about 10 percent built -in- oxygen which helps into burn fully. Among the oil seeds of forest origin *Jatropha curcas* popularly known as Ratanjayot have an immense potential for producing oil, which finds large scale industrial uses. *Jatropha curcas* is a large soft wooded, deciduous, multipurpose tree of 47-meter height, which belongs to the family Euphorbiaceae. Plant display vigorous growth in early periods. Plants from seed develop a taproot and four lateral roots where as cutting do not develop a tap root (Heller, 1996). It flowers in hot and rainy season and set fruits in winter. In field condition this may produce the seed yield as high as 12th/ha/year after five year of plantation (Jones and Miller, 1992), while 0.8 to 1.0 Kg of seed per meter of live fence can be obtained if it is planted for hedge (Henning, 1996). Flower and seed production positively to rainfall/moisture and fertility of soil. The oil content of seeds represents a reasonable opportunity for renewable fuel Schultz and Morgan, 1985; Princen, 1983) and (Harrington, 1986). A study on energy yield from different plants in terms of the liquid fuel / acre/year inch of water among many processes under test (Calvin, 1987). The seed of Jatropha contains about 38-40 per cent non-edible oil. Curcas oil contains a fatly acid and one of its profitable uses is as raw material for making soap. Oil is also used for manufacturing candles and varnishes.

Materials and Methods

The experiment was conducted in the laboratory of department of Silviculture and Agroforestry, Dr. Y.S. Parmar university of Horticulture and Forestry Nauni, Solan, H.P. India. Oil content variation studies were under taken according to distribution ranges of the species and cultural conditions (arable & non- arable). The whole distributional range of the species divided in to three elevation i.e. E1 (400-600 m), E2 (600-800 m) and E3 (800-1000m). The seeds collected from all the three altitudinal ranges and two sites were processed for oil content variation. Generally three seeds were obtained from single fruit. Simultaneously morphological parameter like number of branches/trees, number of fruits/branch, number of fruits/tree (number of fruits/tree was approximately calculated by multiplying the total number of branches and number of fruits/branch) and number of seeds/tree (calculated by multiplying the total number of fruits/tree by number of seeds/fruit) were recorded.
The shade-dried seeds (100 g) from each sample were taken and kernels were separated manually. The separated kernels were crushed in pressler mortar. After crushing a composite sample of 30gm weighed in thimble then soxhlet extracted on a heating mantle.
The oil from the sample was extracted by using soxhlet apparatus. The prepared sample is put in to soxhlet appratus. The prepared sample is put in to soxhlet apparatus places over heating mantle. The oil was extracted from sample with the help of petroleum either followed by continuous distilling for 4 hours. The oil was recovered by complete distilling of most of the solvent on a heating mantle. The oil is then transferred to measuring cylinder. The measuring cylinder is then placed over water bath for complete evaporation of solvent for about 2-3 hrs and volume of oil was recorded and expressed as oil content (%) as follow

$$\text{Oil content (\%)} = \frac{\text{Oil weight}}{\text{Sample weight}} \times 100$$

Results

Numbers of branches/tree:
Maximum numbers of branches were recorded in T2 (8.59) and E2 (9.50) (Table1). However T1 & T2 are statically at par with each other. E1 and E3 significantly differ from E2. Among the treatment combination maximum number of branches were recorded in T2 E2 (10.83) and minimum in T1 E1 (7.00) whereas all the combination are at par with each other.
Number of Fruits/branch: -
Both altitude and site condition have a non-significant effect on number of fruits per branch however maximum number of fruits per branch were recorded in T2 (19.17) and E3 (27.17) and minimum in T1 (19.06) and E2 (14.25) (Table1). Among the treatment combinations maximum fruit per branch were recorded in T1E3 (19.06) and minimum in T1E2 (13.83).

Treatment / Elevation	No. of branches/tree			No. of Fruits/branch			No. of fruits/ tree			No. of seeds/ tree			oil content		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
(E_1) 400-600	7.00	7.33	7.17	14.83	17.00	15.00	102.00	125.30	113.70	327.50	376.70	351.70	41.38	45.00	43.19
(E_2) 600-800	8.18	10.83	9.50	13.83	14.67	14.25	132.30	160.00	146.20	347.00	480.00	413.50	40.85	43.38	42.12
(E_3) 800-1000	7.50	8.50	8.00	28.50	25.83	27.17	217.00	215.80	216.40	651.00	647.50	649.20	22.68	38.63	30.66
Mean	7.56	8.59	8.23	19.06	19.17	19.12	150.40	167.10	158.75	441.80	501.20	471.50	34.97	42.34	38.66
CD 0.05															
Treatment		NS			NS			NS			NS			3.52	
Elevation		1.91			3.55			48.70			129.71			4.32	
T*E		NS			NS			NS			NS			6.10	

T_1: arable
T_2: Non-arable

Table1: - Effect of sites and elevation on yield and oil content from seed of *Jatropha*

Number of fruits/tree:-

The highest number of fruits/tree were recorded in T2 (167.10) and E3 (216.40) and minimum in T1 (150.40) and E3 (113.70). Among the altitudinal ranges, E3 registered significantly higher fruit yield per plant than E1 & E2 and among the treatment combinations fruit yield was recorded maximum in T1E3 (217) and minimum inT1E1(102.00) (Table 1).

Number of seeds/tree

It is evident from the data that elevation and site conditions had significant effect on number of seeds/tree. Maximum seed yield was recorded in T2 (501.20), E3 (649.20) and minimum in T1 (441.80) and E1 (351.70). Among the treatment combinations maximum seed yield was recorded inT1E3 (651.00) and minimum in T1E1 (327.5).

Oil contents %

Both elevation and site condition have significant effect on oil content. The maximum oil was recorded in T2 (42.34%) and E1 (43.19%) and minimum in T1 (34.97%) and E3 (30.66%). Among the treatment combination maximum oil yield was recorded in T2E1 (45.00%) and maximum in T1E3 (22.68%). However all the treatment combinations except T1E3 register significantly higher oil content.

Discussion

Elevations have a significant effect on all the yield attributes of *Jatropha curcas* growth table1. Maximum number of branches/tree, number of fruits/branch, number of fruits/tree was recorded maximum at higher elevations (800-1000m). Similar findings were reported by Manian and Gopalakrishan (1995) that at higher altitude there was a dominate utilization of the photo assimilation for growth as compared to production of oil. Maximum oil content (%) was recorded in T2 (Non arable lands) 45.00 % on kernel weight basis in lower altitudinal range of (400- 600m) whereas minimum was recorded in arable lands (22.68%) at higher altitudinal range (800-1000m). According to Tewari (1964), Diwaker (1993) *Jatropha curcas* is a well-suited species and wild growing hardy plant, well adapted to harsh condition of soil and climate whereas, the oil content variation with respect to soil site condition has not been reported so far and this variation might be because of edapho-climatic factors. The experimental results on oil content percent were also in context to the finding of Sehgal *et al* (1989) that the seed oil content of *Pinus roxburghii* yielded higher percentage of oil at lower altitude than at higher altitude.

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Plant establishment patterns in relation to microtopography on grassy marshland in Ruoergai, central China

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Plant establishment patterns in relation to microtopography on grassy marshland in Ruoergai, central China

Abstract

Ruoergai Plateau (>3000 m in altitude) holds the largest peatland in Chaina, although the vegetation has been deteriorated mostly by cattle grazing. To determine how plant zonation patterns differ between sites with different topography in the alpine grassy marshland, plant establishment height above the water surface was measured for each species in two sites, Ouhailao and Kaharqiao, using a point transect method. In both sites, hummocks were well-developed, but their sizes were larger in Kaharqiao. Graminoids, primarily *Kobresia tibetica* and *Blysmus sinocompressus*, dominated in both the sites, while forbs were sparse. Distinct plant zonation patterns were observed. Patterns of hollow-hummock variation develop in both sites, although the ranks of species establishment height differed. Graminoid species at the two sites displayed markedly different ranges and ranks of establishment heights, and the individuals rarely were associated closely with other species. In contrast, little change of the extent of establishment heights was observed for forbs such as Potentilla anserina and Caltha scapiosa, which seemed not to exclude the cohabitants. The different responses to microtopography between forbs and graminoids resulted in different plant zonation patterns between sites. The differences of plant plasticity between graminoids and forbs seem to have a key role on the zonation patterns.

Key words: China; Grassy marshland, Hummock, Life form, Microtopography, Ruoergai, Water depth

Introduction

Relationships between topography and plant establishment pattern in wetlands have been examined via various ways, although the relationship has been still controversial (Keddy 2000). In particular, water depth, which is related to topography, strongly affects species establishment patterns in wetlands (Tsuyuzaki 1997, Bragazza & Gerdol 2002). In addition, the response and interaction of wetland species vary with environmental fluctuations (Keddy 2000; Miller & Zedler 2003). Although the Ruoergai marshland, north Sichuan Province, China, is the largest peatland of the country, few studies of vegetation development patterns have been reported with reference to topography and water depth. In this area, I suspected that zonal distribution occurred, but that the patterns would differ among sites with different topography because of the differences of plant response to the topography. In parts of Ruoergai marshland, hummocks are well-developed (Nagasawa et al. 1994). The biodiversity of this bwetland is now threatened due mostly to cattle grazing and, and may be altered by global warming (Miehe & Miehe 2000). Furtheremore, the privatization of the wetland has recently allowed because of the national policy of China, and grazing and the other human activities have been allocated. (Zhaoli & Ning 2005). To clarify the changes of zonal distribution patterns, I surveyed both species and microtopography patterns, based on plant establishment heights above the water surface. Major questions posed in this study are: 1) is zonal distribution observed? 2) does zonation differ among habitats with different microtopography? and 3) if this difference is observed, how do the species respond to the habitat differences?

Materials and Methods

Two study sites, Ouhailao (3,570 m in altitude) and Kaharqiao (3,450 m), were selected for study in Ruoergai marshland in Sichuan Province, central China (32o20'-34o10'N, 102o15'-103o50'E) (Fig. 1). About 2,696 km2 of this marshland is covered with peat. The Ruoergai marshland is surrounded by mountains, some of which are over 4,000 m in height. Mean annual temperature is 0.6-1.5oC, and annual precipitation is 560-860 mm (Zhaoli & Wu 2005). Peat thickness is more than 1 m in Ouhailao and varies from 65 cm to more than 150 cm in Kaharqiao, with a maximum depth of 4 m (Kamiya et al. 1990). In both areas, hummocks are well-developed (Nagasawa et al. 1994). In this wetland, there is conspicuous yak-grazing (Tsuyuzaki & Tsujii 1990). The other major livestock are horses and sheep. Using a point transect method (McMahon 1995), five 20-m line transects were sampled across the hummocks in each study site and 1,005 points were

marked at 10-cm intervals. At each sample point, I recorded the species present and the distance between the establishment point was above the water level at the time of establishment. Negative values indicate that establishment was below the current water level. When the water depth was lower than the ground surface, I determined the depth by soil excavations. In addition, a 2-m in length within a 20-m transect was sketched on a section paper in Ouhailao and Kaharqiao, respectively, to grasp a representative plant establishment pattern. The mean, standard deviation, and variance of the establishment height from the water surface were calculated for each species in each site. An F-test was performed on the comparison of variance, i.e., the extent of establishment heights, on the species observed in both sites (Zar 1999). To compare the difference of species ranks of establishment heights between two sites, Kendall's rank correlation test was conducted.

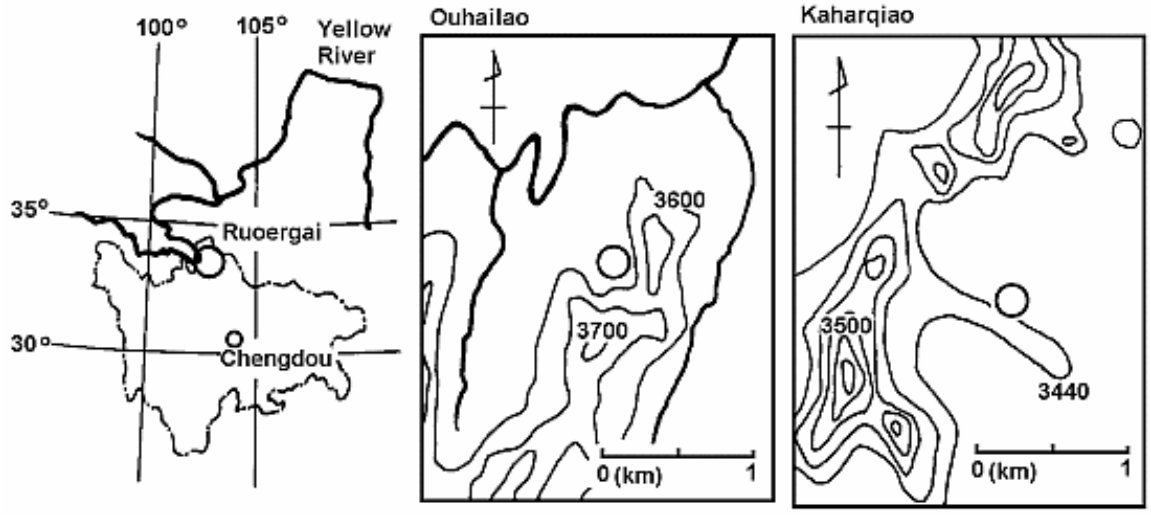

Figure 1: Study area. Left: Location of Ruoergai wetland in Shichuwan Province, China. Center: Location of study site on Ouhailao. Right: Location of study site on Kaharqiao. Open circles denote the locations of study sites.

Results

Topography

The heights of hummocks above the ground surface averaged 30 cm in Ouhailao and 50 cm in Kaharqiao. The maximum differences of plant establishment height in transects were 13.5 and 46.0 cm in Ouhailao and Kaharqiao, respectively. Therefore, topographic variation was greater in Kaharqiao than in Ouhailao. The widths of the upper parts of hummocks ranged from 20 cm to 60 cm in Ouhailao, while those in Kaharqiao were relatively large, i.e., 40-120 cm. The widths of hollows were also 30-100 cm, therefore, each line contains ca 20 hummocks. The water table was nearly at the bottom of the ground surface. Water depth ranged from -2.5 cm to +16.0 cm in Ouhailao and from +24.0 cm to +70.0 cm in Kaharqiao. The water table was essentially at the level of the hollow bottoms at the time of the survey at Ouhailao. At Kaharqiao, it was 20 cm below the surface of the hollow bottoms.

Species patterns

Eleven species were recorded in Ouhailao and fourteen species were recorded in Kaharqiao. In total, 18 taxa, consisting of 12 forbs, and 6 graminoids, were recorded. Nine species occurred in both the sites (Table 1). Only 37.9% of the sample points hit plants at Ouhailao. Plant density was higher at Kaharqiao, where 67.3% of the sample points hit plants. Therefore, plant frequency at Ouhailao was about half that of Kaharqiao. Two sedge species *Kobresia tibetica* and *Blysmus sinocompressus* dominated both sites. A few species, e.g., *Caltha scapiosa* and *Blysmus sinocompressus*, established in the hollows. In contrast, there was little vegetation on the slopes of hummocks and in hollows at Kaharqiao. The forbs *Cremanthodium pleurocaule* and *C. scapiosa* were present on the slopes, although they were never dominant. *Carex meyeriana* and *Potamogeton perfoliatus*, which only were found in Kaharqiao, occurred in shallow sites, while Trollius ranuncloides established in deep sites. Mean species establishment heights differ greatly between the species on each site (Table 1). Three species, *Carex meyeriana*, *Potamogeton perfoliatus*, and *Carex* sp., which appeared only in Kaharqiao, showed the lowest establishment heights, and *Trollius ranuncloides* showed the highest establishment height (Fig. 2). Therefore,

there appears to be zonation and specialization with respect to establishment requirements at each site.

Species	Life form	Ouhailao			Kaharqiao			Difference of variance
		Establishment height (cm)	Frequency (%)	Rank	Establishment height (cm)	Frequency (%)	Rank	
Trollius ranunculoides	F	-			+70.5 ± 1.6	2.0	1	
Chamaesium paradoxum	F	+10.2 ± 3.8	2.4	1	+57.2 ± 6.1	1.3	7	NS
Pedicularis oederi	F	-	0.0		+68.6 ± 1.8	1.1	3	
Thalictrum alpinum	F	+9.5 ± 2.3	2.9	2	+69.9 ± 0.1	0.4	2	NS
Poa chalarantha	G	+9.2 ± 1.1	1.7	3	+45.6 ± 15.2	3.2	12	**
Ranunculus oederi	F	+8.2 ± 2.0	2.0	4	-	0.0		
Stellaria sp.	F	+7.8 ± 1.1	0.4	5	-	0.0		
Kobresia tibetica	G	+6.8 ± 3.8	6.4	6	+58.9 ± 10.5	33.2	6	**
Potentilla anserina	F	+6.4 ± 2.6	1.9	7	+67.5 ± 0.3	0.4	4	NS
Polygonum amatum	F	-	0.0		+59.6 ± 7.4	1.5	5	
Cremanthodium pleurocaule	F	+5.6 ± 2.2	7.1	8	+51.2 ± 10.1	5.3	11	**
Juncus concinnum	G	+5.6 ± 4.3	6.1	9	-	0.0		
Caltha scapiosa	F	+3.0 ± 3.7	3.1	10	+54.2 ± 6.9	5.0	8	NS
Blysmus sinocompressus	G	+1.0 ± 2.4	9.4	11	+52.9 ± 11.5	19.8	9	**
Ranunculus pedicularis	F	-2.0	0.1	12	+53.5 ± 1.8	0.3	10	**
Carex meyeriana	G	-	0.0		+40.0	0.1	13	
Potamogeton perfoliatus	F	-	0.0		+37.8 ± 1.7	0.8	14	
Carex sp.	G	-	0.0		+36.7 ± 4.8	5.6	15	

Table 1. Mean water depth of establishment height, frequency and elevation rank of each species. Each numeral shows mean establishment height above or below water surface with standard deviation. -: no individuals observed. Difference of variance between the species in Ouhailao and Kaharqiao is determined by F-test. **: significant at P<0.01. NS: non-significant. Kendall's rank correlation test confirmed that the rank between two sites was not significant. F indicates forbs and G indicates graminoids.

The establishment height of total species was ca 30 cm higher in Kaharqiao than in Ouhailao. However, water depth declined during the survey period, due to the lack of precipitation. Thus, the ranks of establishment height and the standard deviation of establishment height were used to compare species and habitat differences. The order of establishment heights differed significantly between the sites (Kendall's rank correlation, r = +0.278, non-significant), indicating that the zonal distribution patterns of species differed between the two sites. The extents of establishment height, expressed as variance, of three graminoids, *Poa chalarantha*, *Kobresia tibetica* and *Blysmus sinocompressus*, were significantly wider in Kaharqiao than in Ouhailao, while those of forbs except for *Cremanthodium pleurocaule* showed non-significant difference between the two sites (Table 1). When topography was diverse, graminoids could extend their range of establishment heights more than the forbs. There were 47 (12.3%) points on the lines that recorded more than one species in Ouhailao and 130 (19.2%) in Kaharqiao. Only a few graminoids co-occurred with any species in either sites (Table 2), while they often co-occurred with forbs. Forb species co-occurred with other forb species in Ouhailao, but co-occurred with graminoids in Kaharqiao. Although forbs had low cover and did not alter extent of their establishment heights, they co-occurred with the other species more than the graminoids.

	Ouhailao			Kaharqiao		
	Graminoid	Forb	Total	Graminoid	Forb	Total
Graminoids *						
Blysmus sinocompressus	1.1(1)	8.5(3)	8.5(4)	12.1(1)	12.1(4)	23.6(5)
Poa chalarantha	23.5(1)	58.8(3)	64.7(4)	3.1(1)	15.6(2)	18.8(3)
Juncus concinnum	9.4(1)	18.8(3)	25.0(4)	-	-	-
Kobresia tibetica	1.6(1)	20.3(4)	20.3(5)	7.8(2)	16.5(4)	24.3(6)
Carex meyeriana	-	-	-	0.0(0)	0.0(0)	0.0(0)
Carex sp.	-	-	-	0.0(0)	0.0(0)	0.0(0)
Forbs						
Trollius ranunculoides	-	-	-	50.0(2)	10.0(1)	60.0(1)
Chamaesium paradoxum	0.0(1)	8.3(3)	8.3(4)	53.8(3)	23.1(1)	69.2(4)
Pedicularis oederi	-	-	-	0.0(0)	27.3(2)	27.3(2)
Thalictrum alpinum	20.7(1)	10.3(3)	24.1(4)	100.0(1)	0.0(0)	100.0(1)
Ranunculus oederi	40.0(2)	30.0(3)	65.0(5)	-	-	-
Stellaria sp.	25.0(1)	50.0(1)	50.0(1)	-	-	-
Potentilla anserina	26.3(1)	9.9(1)	31.6(2)	75.0(1)	0.0(0)	75.0(1)
Polygonum amatum	-	-	-	20.0(1)	0.0(0)	20.0(1)
Cremanthodium pleurocaule	8.5(2)	15.5(2)	18.3(4)	17.0(1)	0.0(0)	17.0(1)
Caltha scapiosa	16.1(3)	19.4(3)	35.5(6)	81.0(4)	17.0(1)	84.5(5)
Ranunculus pedicularis	0.0(0)	0.0(0)	0.0(0)	33.0(1)	0.0(0)	33.0(1)
Potamogeton perfoliatus	-	-	-	75.0(1)	0.0(0)	75.0(1)

Table 2: Percent frequency of coexistent species in the points where any species were observed. In parentheses, the number of species which were recorded at the same point are given. -: no individuals observed. *: graminoids include sedges.

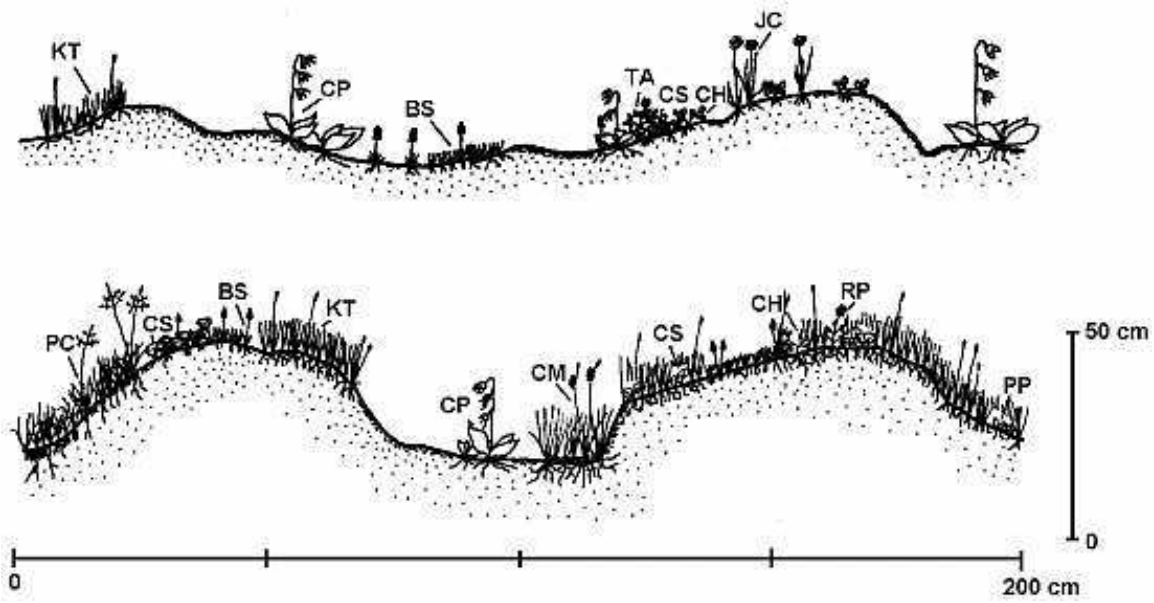

Figure 2: Schematic illustration of plant establishment patterns with reference to topography. Top: Microtopograhy and plant establishment pattern in Ouhailao. Bottom: Kaharqiao. BS = *Blysmus sinocompressus*. CH = *Chamaesium paradoxum*. CM = *Carex meyeriana*. CP = *Cremanthodium pleurocaule*. CS = *Caltha scapiosa*. JC = *Juncus concinnum*. KT = *Kobresia tibetica*. PC = *Poa chalarantha*. RP = *Ranunculus pedicularis*. TA = *Thalictrum alpinum*.

Discussion

The zonal distribution developed on microtopographical scale, i.e., in the hollow-hummock complex, but the establishment height ranks of plant species differed between the two sites. Species establish along water depth gradient in most wetlands (Miller & Zedler 2003, Bowles et al. 2005), and are often distributed sympatrically due to disturbances such as exposure, fire, flooding and grazing (Tsuyuzaki & Tsujii 1990, Keddy 2000). Exposure, fire, and flooding are rare in the Ruoergai marshland but grazing is intense. The grazing is heavier in Ouhailao than in Kaharqiao, and thus influenced species establishment patterns differently between the sites. Yak-grazing decreases species richness and vegetation cover (Tsuyuzaki & Tsujii 1990, Tsuyuzaki et al. 1990). In addition, grasses such as *Blysmus sinocompressus*, *Kobresia tibetica*, and *Elymus nutans* are palatable to yak and are often overgrazed (Zhigang & Wuping 1987). Not only microtopographical characteristics but also hydrological and pedological factors such as peat compaction and frost heaving are related to the species establishment patterns (Johnson et al. 1987, Tsuyuzaki 1997). The peat was somewhat compacted in Ouhailao due to grazing, while the peat in Kaharqiao is virgin peat (Kamiya et al. 1990). In the Ruoergai marshland, the sizes of hummocks seem to increase with the increase of frost heaving intensity (Nagasawa et al. 1994). Frost heaving produced a diverse hollow-hummock complex microsite at Kaharqiao but less so at Ouhailao. Therefore, only at Kaharqiao, *Carex meyeriana*, *Potamogeton perfoliatus*, and *Carex* sp. could establish on hollows, and *Trollius ranuncloides* appeared on the top of hummocks. In Ouhailao, the microhabitats for those species may be lacking since hummocks are smaller. It appears that grazing, less complex microtopography, lower species richness and plant frequencies were observed in Ouhailao. To manage and conserve the wetland vegetation intense yak-grazing should be avoided. Disturbances stimulate the sympatric establishment of species, i.e., coexistence can be maintained by niche shift when environmental conditions fluctuate (Bowles et al. 2005). The extents of establishment height were varied among the graminoids between sites, but not among the forbs. The forbs co-occurred with more species than the graminoids. These facts suggest that the strategies differ between these two life forms. Graminoids have highly-plastic morphological traits and changes the growth forms along environmental gradients such as water depth (Bernard 1990). Therefore, graminoids could expand their establishment heights in Kaharqiao. However, disturbances such as grazing were unlikely to differ between the two sites and to change the rank order of species establishment heights between the sites. Ground water level regulates frost heaving intensity which determines hummock development (Nagasawa et al. 1994). The frost heaving patterns are different with the ground water level. The size of hummocks was conspicuously larger at Kaharqiao than at Ouhailao. The water depth fluctuation and frost heaving may greatly differ between the sites and affected differently to plant species. The effects of water depth on vegetation development differ among hill slopes in the Ruoergai marshland (Tsuyuzaki et al. 1990). Therefore, the rank order of species establishment heights should be changed by water depth and its related factors.

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Plant Biodiversity and Conservation of Forests in Foot Hills of Garhwal Himalaya

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Plant Biodiversity and Conservation of Forests in Foot Hills of Garhwal Himalaya

Abstract

Floristic diversity, dominance and abundance to frequency ratio of tree, sapling, seedling, shrub and herb species were studied in two different forest sites of a tropical foot hill region of Garhwal Himalaya. In tree layer on both the sites the dominant species recorded were *Lannea coromandelica* (IVI-39.80) and *Anogeissus latifolia* (IVI-29.50) on site I and site II respectively. The ranges of diversity for tree layers was 4.580 to 4.643. Most of the species on both the sites were contagiously distributed except few species which were distributed randomly.

Introduction

The temperate forests of western and central Himalaya are usually distributed between 1200 and 3000 m asl which is the preferred zone by habitation and characterized extensive oak and coniferous forests. Puri (1960) considered that these forests represent climatic climax of one or other species of *Quercus* in upper altitudinal zones. The lower elevations of the temperate forests are occupied by oak-pine mixed forests and *Quercus semicarpifolia* with other coniferous at higher altitudes, normally form the climax vegetation. Other species of oak are found above the oak-pine mixed forests of Garhwal Himalaya (Osmostan 1922). The oaks are the most preferred tree species in the entire region and used mainly for fuel, fodder and small timber. In the lower altitudes (upto 1000m) generally the forests are dominated by *Shorea robusta*, alogwith *Anogeissus latifolia, Terminalia species* and *Adina cordifolia* (Kumar et al. 2004).

The various changes in the Himalayan forests are appearing in their structure, density and composition due to global warming (Gaur 1982), uncontrolled lopping and felling of trees for fuel wood, fodder and grazing (Bargali et al. 1998; Kumar et al. 2004). These biotic pressures which play an important role in forest community dynamics (Whitemore 1984; Pickett and White 1985) often regulate the recruitment and survival pattern of tree seedlings (Canham and Marks 1985). Each form of biotic pressure has different effects on the subsequent development of vegetation (Loucks et al.1980; Pandey and Singh 1985).

Several workers reported the status of forests and their management in the Himalayan region (Singh et al. 1981; Ralhan et al. 1982; Saxena and Singh 1982; Saxena et al. 1984) however, these studies are very limited to population structure in the part of Garhwal Himalaya and other parts of Central Himalaya. Therefore, the present paper deals with the analysis of vegetation and biotic pressure on forest in Kalsi range of Chakarata Forest division of Garhwal Himalaya.

Materials and Methods

Location and climate

The present study was carried out in Kalsi range of Chakarata Forest division (Yamuna valley), in two different sites i.e., site-I and site-II for comparative study of community composition and plant diversity, which is the part of the undulating terrains of Garhwal Himalaya (latitude 30 degrees 31' N and longitude 76 degrees 56' E) in District Dehradun of the Uttaranchal State in India. Altitudinally the region stretches from 700 to 1200 m asl, the Jaunsar-Bawar region which is remote and mysterious virtually isolated from rest part of the world. Since time immemorial, this mountainous region in the northern part of Uttaranchal has nurtured a unique life style.

Climatically spring, summer, rainy and winter seasons are well marked in this region. The maximum average rain fall is experienced during July and August. The region receives an average rainfall 1610 mm annually. The temperature reaches up to 40 degrees C in the months of May to June whereas, the higher peaks of the area receive frequent snowfall during winter season.

Vegetation Sampling and Analysis

The phytosociological analysis of the forests of study area (Yamuna valley) was carried out during June to August 2004 by using 10 x 10 m quadrats for trees. Each quadrat was subdivided in to 5 x 5 m sample plot for recording shrubs+saplings and 1 x 1 m for herbs+seedlings. The quadrats were laid out randomly throughout the study area. The size and the number of quadrats were determined by the species curve (Misra 1968) and the running means methods (Kershaw

1973). Thirty quadrats were randomly placed in the entire area, representing all the vegetation type and localities. In each quadrat, trees were recorded with >31.5 cm cbh (circumference at breast height i.e., 1.37 m above the ground) individually measured. Individuals within the cbh range of 10.5 to 31.4 cm were considered as shrubs+saplings and individuals < 10.5 cm cbh were considered as herbs+seedlings. The vegetation data were quantitatively analysed for abundance, density and frequency according to the formulae given by Curtis and Mc Intosh (1950) and Mishra (1968). The relative values were summed up to represent Importance Value Index (IVI) as per Curtis (1959). The distribution pattern of species was studied using the ratio of abundance to frequency if below 0.0 25 indicates regular distribution, between 0.025 - 0.050 indicates random distribution and when exceeds 0.050 indicates contagious distribution (Whitford 1949). The diversity index (H) was computed by using Shannon-Wiener information Index (Shannon and Wiener 1963).The concentration of dominance (CD) was computed by Simpson's Index (Simpson 1949). The dominance-diversity curves for trees, shrubs+saplings, and herbs+seedings were drawn on the basis of importance value index (IVI). The utility index of important species of the sites were collected with concerned literature as well as the information collected from villagers.

Results and Discussion

Dominance

In the site-I of tree layer, a total of 33 species were observed. The dominant and co-dominant species were *Lannea coromandelica* and *Terminalia bellirica*, showing their values of IVI of 39.80 and 30.90 respectively, whereas, the highest (117 plants / ha) value of density was also recorded for *Lannea coromandelica*. Most of the species on the site showed contagious distribution pattern, except *Lannea coromandelica* which was randomly distributed (Table 1).

Species	Site-I			Site-II		
	Density (plant ha^{-1})	IVI	A/F ratio	Density (plant ha^{-1})	IVI	A/F ratio
Lannea coromandelica	117	39.80	0.04	67	23.60	0.03
Terminalia bellirica	87	30.9	0.05	90	29.0	0.03
Mallotus philippensis	83	29.1	0.06	67	20.20	0.12
Anogeissus latifolia	40	17.0	0.07	100	29.5	0.05
Ougeinia oojeinensis	33	14.6	0.12	7	4.36	0.15
Toona serrata	27	13.0	0.07	-	-	-
Albizia lebbeck	27	12.6	0.15	10	5.69	0.23
Boehmeria rugulosa	20	11.80	0.45	3	3.05	0.30
Litsea chinensis	17	10.18	0.38	10	5.67	0.10
Termianalia chebula	17	9.63	0.06	33	13.6	0.05
Terminalia alata	17	9.26	0.17	23	9.67	0.13
Moringa oleifera	10	6.85	0.23	3	3.05	0.30
Sapium insigne	10	6.85	0.23	17	8.29	0.06
Cordia vestita	10	6.66	0.10	-	-	-
Emblica officinalis	10	6.66	0.10	7	4.36	0.15
Schleichera oleosa	7	6.48	0.06	-	-	-
Bauhinia variegata	7	5.18	0.15	10	5.69	0.23
Ficus semicordata	7	5.18	0.15	3	3.05	0.30
Toona ciliata	7	5.18	0.15	37	14.0	0.37
Wrightia arborea	7	5.18	0.15	3	3.04	0.30
Bombax ceiba	3	3.70	0.30	3	3.05	0.30
Casearia graveolens	3	3.70	0.30	3	3.05	0.30

Table 1. Phytosociological analysis of tree species on site-I and site-II

Cassine glauca	3	3.70	0.30	13	6.71	0.13
Engelharditia spicata	3	3.70	0.30	-	-	-
Erythrina suberosa	3	3.70	0.30	-	-	-
Ficus auriculata	3	3.70	0.30	-	-	-
Flacourtia indica	3	3.70	0.30	-	-	-
Holoptelea integrifolia	3	3.70	0.30	3	3.05	0.30
Jacaranda mimosifolia	3	3.70	0.30	-	-	-
Madhuca latifolia	3	3.70	0.30	3	3.05	0.30
Pinus roxburghii	3	3.7	0.30	-	-	-
Sterculia villosa	3	3.7	0.30	-	-	-
Adina cordifolia	3	3.52	0.08	7	4.36	0.15
Acacia catechu	-	-	-	80	23.7	0.29
Shorea robusta	-	-	-	30	20.60	2.70
Dalbergia sissoo	-	-	-	33	13.0	0.33
Toona serrata	-	-	-	10	5.69	0.23
Sterculia vilosa	-	-	-	10	5.67	0.10
Syzygium cumini	-	-	-	10	5.67	0.10
Cassia fistula	-	-	-	7	4.36	0.15
Ficus locar	-	-	-	3	3.05	0.30
Ficus religiosa	-	-	-	3	3.05	0.30
Legerstromia parviflora	-	-	-	3	3.05	0.03
Premna barbata	-	-	-	3	3.05	0.30
Total	**599**	**300.01**		**714**	**299.99**	

Table 1. Phytosociological analysis of tree species on site-I and site-II contd.

In the tree layer of site-II a total of 34 tree species were recorded. Amongst the trees the highest value of density (100 plant ha-1) and IVI (29.50) was recorded for *Anogeissus latifolia.* The co-dominant species of the site was *Terminalia bellirica* which showed their values of IVI (29.0) and density (90 plants / ha). The distribution pattern of all the species on the site was contagiously distributed except *Lannea coromandelica* and *Terminalia bellerica*, whose indicated random pattern of distribution.

In the shrub layer of site-I the highest value of IVI (26.70) was recorded for *Adhatoda vasica*, whereas, lowest (IVI-1.77) for *Agaveamericana*. In sapling layer the highest (140 plants / ha) value of density was recorded for *Boehmeria rugulosa* and the lowest for *Pyrus pashia* 2.0 plant / ha (Table 2).

Species	Site-I			Site-II		
	Density (plant ha^{-1})	IVI	A/F ratio	Density (plant ha^{-1})	IVI	A/F ratio
Murraya koenighii	233	27.6	0.11	163	22.79	0.06
Adhatoda vasica	230	26.7	0.14	190	24.80	0.07
Woodfordia fruticosa	173	22.5	0.09	163	21.99	0.08
Colebrookia oppositifolia	177	22.4	0.11	153	20.49	0.1
Spermadictyon suaveolens	160	20.7	0.12	13	18.6	0.1
Boehmeria rugulosa (Sapling)	140	18.3	0.2	-	-	-
Rhamnus virgatus	47	13.81	0.02	83	13.9	0.06
Carissa spinarum	77	12.0	0.19	97	14.49	0.11
Lantana camara	3	10.40	2.7	63	10.79	0.12
Rhamnus procumbens	3	10.40	2.7	27	5.89	0.27
Desmodium cephalotes	43	9.67	0.98	23	8.39	2.1
Caesalpinia pectinata	47	8.9	0.12	13	3.85	0.3
Mallotus philippensis (Sapling)	47	8.63	0.17	3	6.41	0.3
Indigofera hexendrum	47	8.56	0.26	-	-	-
Rhus parviflora	43	8.43	0.43	-	-	-
Berberis asiatica	27	5.98	0.27	3	1.71	0.3
Ziziphus mauritiana	23	5.84	0.53	10	3.18	0.23
Pyrus pashia (Sapling)	2	5.09	0.2	3	1.71	0.3
Euphorbia royleana	13	4.91	0.05	20	5.76	0.05
Casearea graveolens (Sapling)	10	3.93	0.9	13	5.05	1.2
Ficus semicordata (Sapling)	10	3.93	0.9	3	1.71	0.3

Table 2. Phytosociological analysis of shrub+sapling species on site-1 and site-II

Nyctanthes arbor-tristis	10	3.93	0.9	10	3.94	0.9
Toona ciliata (Sapling)	10	3.93	0.9	3	1.71	0.3
Adina cordifolia (Sapling)	7	2.85	0.6	-	-	-
Bauhinia variegata (Sapling)	7	2.85	0.6	7	2.83	0.6
Cassia fistula (Sapling)	7	2.85	0.6	7	2.83	0.6
Emblica officinalis (Sapling)	7	2.85	0.6	-	-	-
Pogostemon benghalensis	7	2.85	0.6	-	-	-
Premna barbata (Sapling)	7	2.85	0.6	-	-	-
Toona serrata (Sapling)	7	2.85	0.6	-	-	-
Debregeasia latifolium	7	2.65	0.15	13	3.84	0.13
Millttia extensa (Sapling)	3	2.01	0.08	7	2.83	0.6
Agave americana	3	1.77	0.3	-	-	-
Ficus auriculata (Sapling)	3	1.77	0.3	-	-	-
Ficus palamata (Sapling)	3	1.77	0.3	-	-	-
Ougeinia oojeinensis (Sapling)	3	1.77	0.3	7	2.83	0.6
Sterculia villosa (Sapling)	3	1.77	0.3	13	3.85	0.3
Boehmeria platyphylla	-	-	-	67	11.19	0.38
Anogeissus latifolia (Sapling)	-	-	-	33	7.82	0.75
Eupatorium odoratum	-	-	-	33	6.91	0.12
Bauhinia vahlii (Sapling)	-	-	-	30	6.52	0.11
Artemisia vulgaris	-	-	-	17	6.17	1.5
Lannea coromandelica (Sapling)	-	-	-	23	5.38	0.23

Table 2. Phytosociological analysis of shrub+sapling species on site-1 and site-II contd.

Acacia catechu (Sapling)	-	-	-	20	4.87	0.2
Rubus ellipticus	-	-	-	10	3.94	0.9
Rubus nivens	-	-	-	10	3.94	0.9
Callicarpa macrophylla	-	-	-	13	3.85	0.3
Terminalia bellirica (Sapling)	-	-	-	13	3.84	0.13
Ficus locar (Sapling)	-	-	-	7	2.89	0.6
Cocculus laurifolius	-	-	-	7	2.83	0.6
Urtica dioca	-	-	-	7	2.83	0.6
Vitex negundo	-	-	-	7	2.83	0.6
Ficus religiosa (Sapling)	-	-	-	3	1.71	0.3
Sapium insigne (Sapling)	-	-	-	137	1.71	0.3
Syzygium cumini (Sapling)	-	-	-	3	1.71	0.3
Terminalia chebula (Sapling)	-	-	-	3	1.71	0.3
Erythrina suberosa (Sapling)	-	-	-	3	1.17	0.3
Total	**1649**	**300**		**1546**	**299.99**	

Table 2. Phytosociological analysis of shrub+sapling species on site-1 and site-II contd.

In the shrub layer of site-II, a total of 25 species were recorded. Amongst the shrub species *Adhatoda vasica* showed highest value of density (190 plants / ha) and IVI (24.80). The lowest value of density (3.0 plants / ha) and IVI (1.71) was recorded for *Berberis aristata*. For the sapling layer, the maximum value of IVI was recorded for *Anogeissus latifolia* (7.82) and minimum (1.17) was recorded for *Erythrina suberosa* (Table 2)

In the herb layer on both the sites-I and II, the most dominant species was *Chrysopogen fulvus* while the least dominant species on site-I was *Artemisia vulgaris* and *Thalicturm foliolosum* and on site-II *Artemisia vulgaris* (Table 3). For seedling, in site-I only two seedlings (*Lannea coromandelica* and *Ougeinia oojenensis*) were recorded whereas, in site-II the total number of seedling were eight (Table 3).

Species	Site-I			Site-II		
	Density (plant ha^{-1})	IVI	A/F ratio	Density (plant ha^{-1})	IVI	A/F ratio
Chrysopogon fulvus	373	27.70	0.31	217	21.08	0.16
Dioscorea bulbifera	160	18.0	0.07	137	19.00	0.04
Euphorbia hirta	200	18.0	0.18	133	14.6	0.19
Achyranthes aspera	160	15.90	0.14	57	8.58	0.1
Nepeta elliptica	140	13.5	0.26	47	8.08	1.05
Desmodium cephalotes	127	12.60	0.71	50	7.31	0.28
Chrysopogon aciculatus	117	12.10	0.21	50	7.7	0.13
Parthenium hysterophorus	117	11.7	0.42	230	22.1	0.14
Apluda mutica	97	10.30	0.54	-	-	-
Aster thomsonii	83	9.57	0.83	10	3.07	0.9
Poa annua	80	9.27	0.80	270	25.3	0.12
Organum vulgare	83	9.25	0.47	73	10.28	0.73
Pogostemon benghalensis	33	9.23	0.75	30	5.67	0.11
Themeda arundinacea	7	8.48	0.41	-	-	-
Cassia tora	60	8.27	1.35	60	10.0	1.35
Euphorbia prostrata	40	8.25	3.6	130	14.42	0.24
Saccharum spontaneum	63	7.96	0.23	90	11.8	0.1
Reinwardtia indica	53	7.51	1.2	-	-	-
Tridex procumbens	53	6.9	0.53	-	-	-
Boehmeria platyphylla	30	6.37	2.7	10	3.07	0.9
Abrus precatorius	40	5.99	0.9	-	-	-
Viola serpens	37	5.61	0.83	7	2.2	0.15

Table 3. Phytosociological analysis of herb+seedling species in site-I and site-II

Ageratus houstoninnum	37	5.41	0.37	-	-	-
Malva parviflora	37	5.41	0.37	10	3.07	0.9
Arisaena flavum	27	4.90	0.15	37	7.06	0.07
Thysanolaena maxima	20	4.48	1.8	-	-	-
Galatinsonga parviflora	27	4.47	0.6	-	-	-
Euphorbia hinata	27	4.40	0.6	-	-	-
Anemone sp.	23	4.09	0.53	-	-	-
Oclis corniulata	23	4.09	0.53	50	7.42	0.18
Roscoea capitata	23	4.09	0.53	-	-	-
Cassia occidentalis	17	3.85	1.5	17	4.71	1.5
Salvia lanata	10	2.60	0.9	-	-	-
Staphania glabra	10	2.60	0.9	30	5.36	0.17
Artemisia vulgaris	7	1.97	0.6	-	-	-
Lannea coromendalica (Seedling)	7	1.97	0.6	3	1.43	0.3
Thalictrum foliolosum	7	1.97	0.6	-	-	-
Ougeinia oojeinensis (Seedling)	3	1.34	0.3	3	1.43	0.3
Clematis goriana	-	-	-	30	7.99	2.7
Phyllanthus armarus	-	-	-	30	7.99	2.7
Cyperus niveus	-	-	-	53	7.91	0.53
Cynodon dactylon	-	-	-	53	7.63	0.3
Ipomoea nill	-	-	-	40	6.55	0.14
Cannabis sativa	-	-	-	20	5.53	1.8
Solanum nigrum	-	-	-	27	4.87	0.27
Rumex hastatus	-	-	-	17	3.67	0.38
Cymbopogon jwarancus	-	-	-	10	3.07	0.9
Ficus religiosa (Seedling)	-	-	-	10	3.07	0.9

Table 3. Phytosociological analysis of herb+seedling species in site-I and site-II contd.

Urtica dioica	-	-	-	10	2.69	0.23
Ficus locar (Seedling)	-	-	-	7	2.25	0.6
Holarrhena pubesecens (Seedling)	-	-	-	7	2.25	0.6
Ziziphus mauritiana	-	-	-	7	2.18	0.60
Woodfordia fruticosa	-	-	-	7	2.05	0.60
Acacia catechu (Seedling)	-	-	-	3	1.43	0.3
Anogeisuss latifolia (Seedling)	-	-	-	3	1.43	0.3
Milletia extensa (Seedling)	-	-	-	3	1.43	0.3
Total	**2458**	**300.01**		**2088**	**300**	

Table 3. Phytosociological analysis of herb+seedling species in site-I and site-II contd.

Species diversity (H) and concentration of dominance (CD")

The diversity of study sites have been described in Table 4. The maximum (4.643) value of diversity for tree layer was recorded on site-II, whereas, minimum (4.580) was observed for site-I. In the shrub+sapling layer the maximum (5.021) and minimum (4.695) values of diversity were recorded on site-II and site-I respectively. In the herbs+seedlings layer, the minimum and maximum values of diversity were recorded on site-I and site-II respectively.

The lowest (0.053) and the highest (0.114) values of CD for tree layer was recorded on site-II and site-I. The ranged values for shrub+sapling and herb+seedling species were 0.040 to 0.049.

Dominance-diversity curve

Dominance-diversity curves plotted between importance value index and species sequences of trees, shrubs+saplings, herbs+seedlings (Figure 1-3) indicate a relationship between different species showing importance value on both sites.

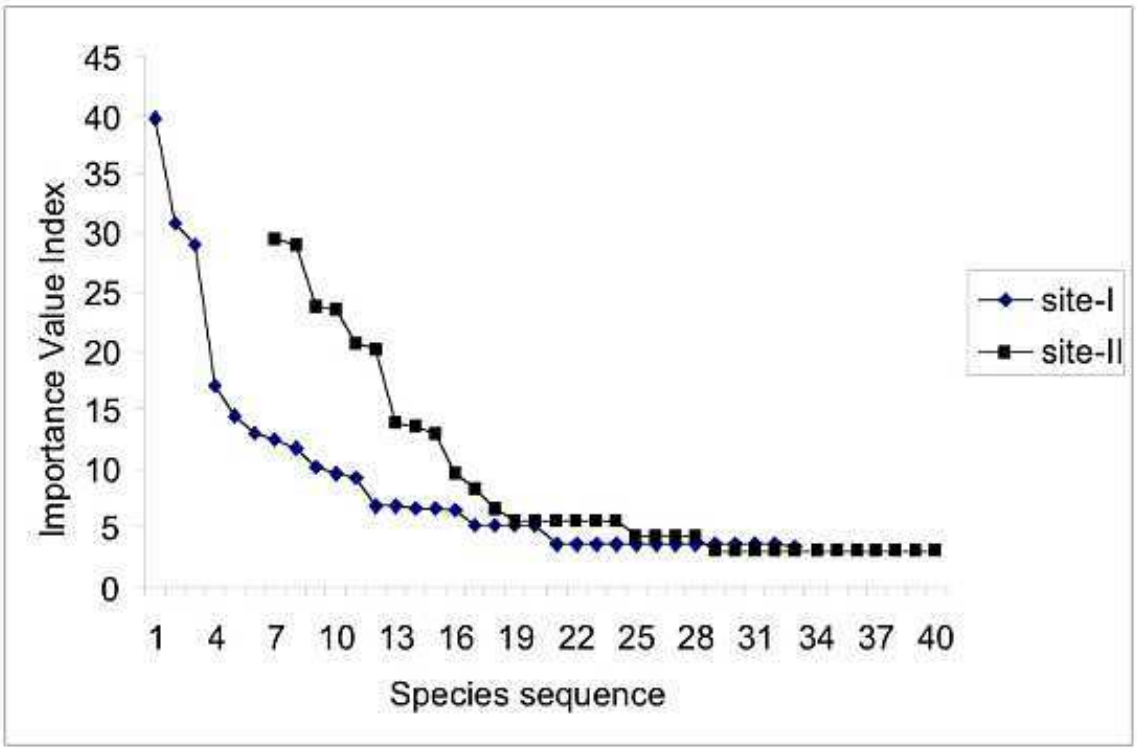

Figure 1. Dominance-diversity curves for trees

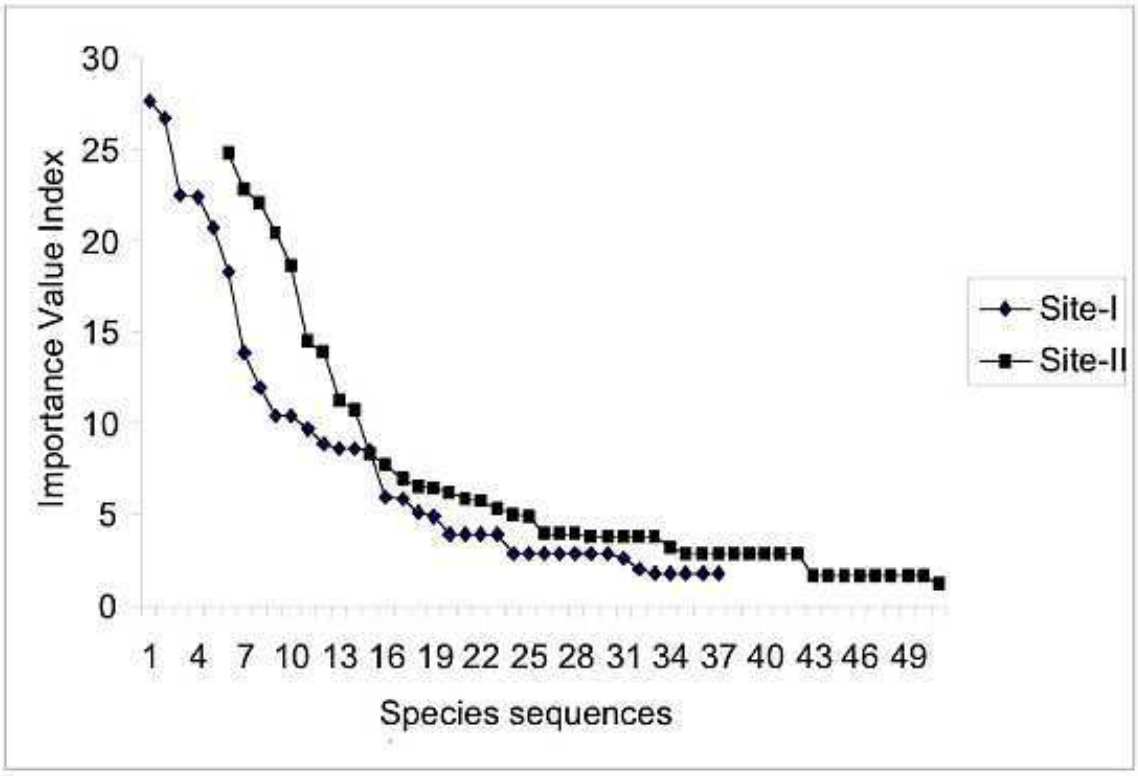

Figure 2. Dominance-diversity curves for shrubs and saplings

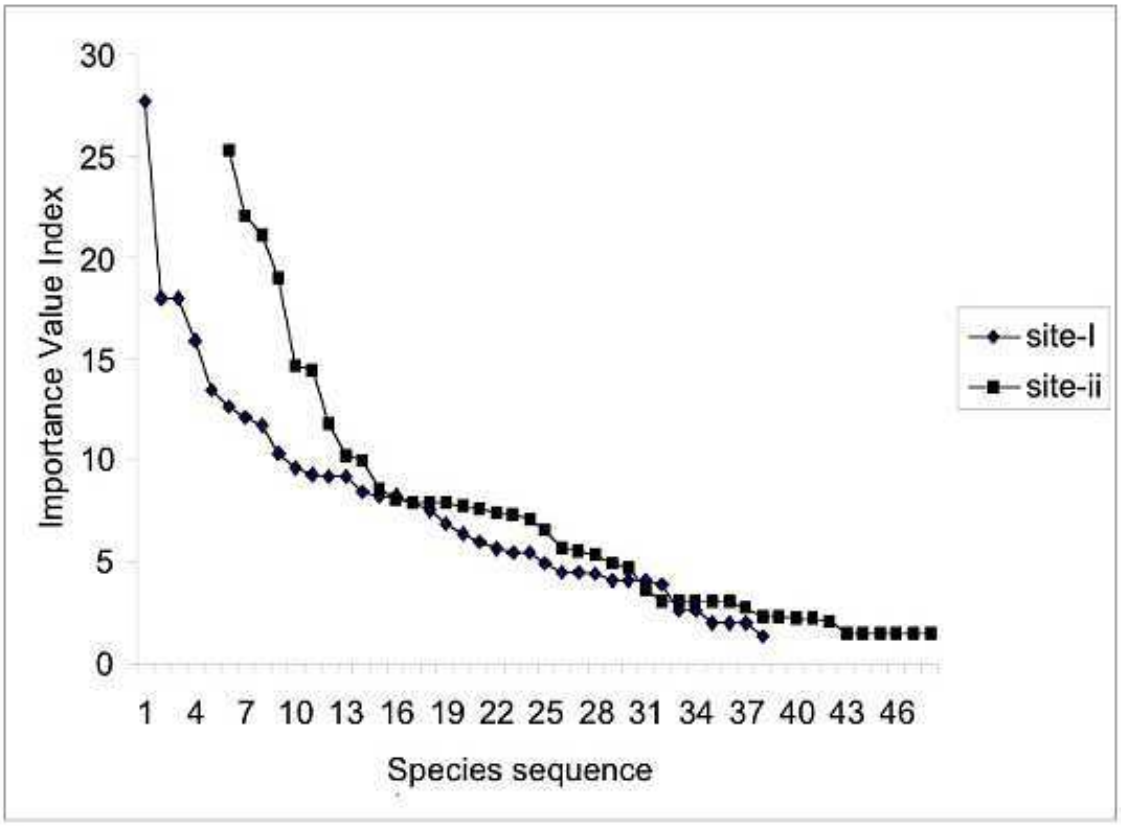

Figure 3. Dominance-diversity curves for herbs and seedlings

In the present study two sites i.e. site-I and site-II were recorded because foothill belt of Garhwal Hiamalaya consist of thickly populated village and each village exploits forest resources for their basic needs from these forests (Kumar et al 2004). Due to over-exploitation and illicit felling as well as ruthless exploitation, most of the valuable species are either disappearing or rarely available.

The total density on site-I and site-II for trees were recorded 599 plants / ha and 714 plants / ha respectively. These values were quite lower than the values reported by Kumar et al (2004) to sub-tropical forests of Garhwal Himalaya. Some other tropical forests range of density 656 to 888 plants / ha was also reported by Kumar et al (2004). Several other workers also reported similar values for different forests of Garhwal Hiamalaya (Rajwar and Gupta 1992; Mishra et al. 2002)

The abundance to frequency ratio indicated that most of the species of shrub+sapling, herb+seedling and trees were contagiously distributed except few species of trees, which showed random distribution pattern. Contagious distribution in natural vegetation has been reported by Greigh-Smith (1957), Kershaw (1973). Similar finding also reported by Kumar et al (2004) for tropical forests of Garhwal Himalaya.

In present study the range of diversity were 4.580 to 4.643 (for trees), 4.695 to 5.021 (for shrubs+saplings), and 4.962 to 4.986 (for herbs+seedlings). The ranges of diversity were high on the sites due to disturbance and invasion by new species. In Table 4 indicates that increasing diversity and reduced concentration of dominance has been shown to be associated with increased stability (Mc Naughton 1967). Pandey and Singh (1985) have also reported increasing species diversity in disturbed ecosystem of Kumaon Himalaya. Disturbance has always been considered causes invasion and species replacement, altered, growth, establishment, germination etc. the disturbance affects the stability of the ecosystem and the successional process of the area. Disturbance caused by sever grazing arrests the ecological determinations. However, grazing animals which consume the ground vegetation plays positive role in dispersal, establishment and growth of such species by scarification and pelletization of seed (with dung).

The dominance diversity (d-d) curves (based on IVI) approach a geometric series for all the strata. Mostly these curves follow the geometric series in conformity with niche pre-emption hypothesis (Motonura 1934). The geometric form in often shown by vascular plants having lower density (Whittaker 1975)

Uses and Conservation Methods

Forest is a living resource. A large number people of the hill and plain area depends on forest resources. Forest constitutes the richest resources amongst the other resources of the world. They are the vital component to sustaining the life support system on earth. Forests have been playing a pivotal role in the socio-economic development of a country or region. They are the important source of subsistence, employment, revenue earning and raw material to various Industrial uses. There role in ecological balance, environmental stability, biodiversity conservation, food security and sustainable development have been widely recognized. Forests are the source of various components, e.g., food, fodder, fiber, medicinal, tannin and oils, gum and many other things for human benefits. Generally it is observed that the forest areas in the vicinity of the villages have been degrading much faster rate than the forests growing far from the village locality. It is due to easily accessible to the villagers for their basic needs. As per the data collected from local inhabitants and concern literature revels that the forest resources of the area is rich for human benefits (Table 5). Therefore, there is an urgent need to conserve the forest resource both macro and molecular level for human and sustainable development of environment, besides that awareness to the villagers is essential how they can develop suitable techniques for sustainable utilization of forest resources.

Table 4. Species diversity, concentration of dominance of different layers on site-I and site-II

Sites/Layers	Species diversity	Concentration of dominance
Site-1		
Tree	4.580	0.114
Sapling+shrub	4.695	0.049
Seedling+herb	4.962	0.039
Site-II		
Tree	4.643	0.053
Sapling+shrub	5.021	0.040
Seedling+herb	4.986	0.039

Table 5. Utility Index of plant species recorded form the site-I and site-II

Species	Utility Index
Acacia catechu	Medicinal, Fodder, Dye, Gum, Lac, Kath formation
Achyranthes aspera	Local beverage, Medicinal.
Adhatoda vasica	Young leaves for cough and cold
Adina cordifolia	Toy and handicraft.
Albizia lebbeck	Fodder, Paper and pulp, Lac, Medicinal
Anogeissus latifolia	Fodder, Fiber
Apluda mutica	Thatching huts and brooms
Artemisia vulgaris	Medicinal (leaf juice use intestinal problem)
Bauhinia variegata	Fodder Dye, Ornamental, Oil and fat
Berberis asiatica	Medicinal plant, Fodder
Bombax ceiba	Fodder Fiber, Forage Ornamental, Oil and fat
Carissa spinarum	Commercial, Tanning
Cassia fistula	Dye, Ornamental, Medicinal
Colebrookia oppositifolia	Leaves used as medicinally
Cynodon dactylon	Plant used un several religious ceremonies
Dalbergia sissoo	Fodder, Toy and handicraft, Paper and pulp, Resin used in skin ailments
Emblica officinalis	Fodder, Dye, Oil and fat, Source of Vitamin and ingredient of Trifala
Erythrina suberosa.	Fodder, Fiber

Ficus auriculata	Fodder Fiber
Ficus religiosa	Fodder, Fiber, Commercial, Lac, Religious plant
Holoptelea integrifolia	Fodder, Bark used as rheumatic pain
Jacaranda mimosifolia	Ornamental purpose
Lannea coromandelica	Fiber. Dye, Gum
Lantana camara	Leaves insecticidal or germicidal
Madhuca longifolia	Fodder, Medicinal
Mallotus philippensis	Dye, Fruit, Fodder, Medicinal
Moringa oleifera	Fodder, Fiber Oil and fat, Fruit edible, Medicinal
Murraya koenighii	Fodder, Toy and handicraft, bark, root and leaves used medicinally
Nyctanthes arbor-tristis	Fodder, Medicinal, Dye
Organum vulgare	Medicinal (carminative, diuretic , diaphoretic)
Ougeinia oojeinensis	Fodder, Gum used as digestive troubles
Pinus roxburghii	Fodder, Dye
Rhus parviflora	Fodder, Medicine (cholera)
Schleichera oleosa	Fodder Lac, Oil and fat Medicinal
Shorea robusta	Fodder, Commercial, Dye, Resin, Silk
Syzygium cumini	Fodder, Dye, Silk
Terminalia chebula	Medicinal, fodder, dye.
Terminalia alata	Dye, Silk, Paper and pulp
Terminalia bellirica	Medicinal, Fodder, Dye, Resin, Silk
Toona ciliata	Fodder, Fuel Oil and Medicinal
Vitex negundo	Medicinal (roots, leaves, fruits)
Woodfordia fruticosa	Fodder, Medicinal, dried flower as tonic
Ziziphus mauritiana	Fodder, Fruit edible

The methods basically used for conservation of biological diversity both (animals and plants) are *in-situ* and *ex-situ* conservation. *Ex-situ* conservation of species done outside the area where they are naturally growing (e.g., botanical, horticulture and recreational gardens) while, *in-situ* conservation is done in the natural habitats (e.g., area demarcated by under rules are National Parks, Sanctuaries, Biosphere Reserve, Preservation plots etc.). Besides this several other traditional methods are used by peoples can also considered i.e., (1). Sacred groves forest should be declared (2) Large scale cultivation of economic and medicinal valuable species should be encouraged to local inhabitants (3) Public awareness (4) Encouragement of social forestry programme for some essential species, for fuel, fodder and other purposes (5) Deforestation must be stopped by adopting law and regulation, should be developed by local village community and government level. (6) Plantation

programmes should be made as compulsory for all villagers of the area.
Keeping all the consideration for sustainable development of forest resources, emphasize should be given to develop suitable agroforestry, models specially selected multipurpose tree species in conjunction with agricultural crops over the same unit of land to maximize productivity and sustainable utilization of these resources.

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Olorien Online peer-reviewed journal software for low-cost international organizations

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Olorien Online peer-reviewed journal software for low-cost international organizations

Abstract

Current peer-reviewed journal software does not meet the needs of NGOs and institutions in developing countries. Olorien is a new software package to meet this need. Olorien provides an automated system for article submission, tracking, peer review, and publication. It publishes volumes online, and creates print-ready PDF files automatically. To meet the needs of NGOs and developing institutions, Olorien is free to use, and open source. The system supports publication in almost any known language, and is low cost to maintain. The architecture is built on open-source components, and incorporates modern web standards. Olorien is actively developed, and features continue to be added.

Background

The shift from paper to the screen Traditionally, scientific journals have been paper-based publications, released between quarterly and yearly. However, the advent of the Internet has made much more rapid dissemination possible. The Internet and the associated idea of Open Source have also brought about more open access to research for the general public. With this shift in how information is published and accessed, a variety of tools have been developed to allow institutions to leverage the Internet in their peer-reviewed journals. More than 15 applications for publishing are currently available.

Among these programs, a common core of features has developed:

- Automated Submission: Allows users to submit articles that are formatted and prepared for the editorial staff without any work from the journal staff.
- Automated Notification: Keeps all parties up to date on the progress of a submission, by email or other means.
- Article Assignment and Tracking: Allows tracking of a submitted article, assignment to peers for review, and online review.
- copyediting: Allows the editors to edit the article for better formatting without resubmission.
- Automatic formatting and online publishing of reviewed articles: Articles are automatically formatted by the software to display correctly online, and can be published on an external web site without work.
- Secure Access: Users must log into the site to access articles and reviews. Certain functionality is limited to the Editor-in-Chief.

Fee-based access

There is some debate on fee-based journals. Proponents point out that charging for access allows them to fund and maintain a high-quality body of work. Opponents argue that information should be free and open, and limiting research to a select few who can afford access increases the social divide between wealthy and poor. Free-information advocates also argue that fee-based publications limit cross-disciplinary advances, and ultimately, scientific progress. While both of these arguments have merit, well-derived technology has the potential to make the debate moot. If computer software can reduce the cost and labor of producing a high-quality journal, fees can be greatly reduced, or outright eliminated. Clearly this would be the best of both worlds. NGOs and Developing Institutions Existing software can work well for established institutions, but Non-Governmental Organizations (NGOs) and institutions in developing countries have an additional set of needs that are not currently addressed by existing applications.

- Multilingual publishing: Journals should be able to be published in any known language.
- Low or No Cost licensing: The software should be free, or have a low-cost option on its license.
- Low cost maintenance: The software must be easy to use, and have low requirements for hardware and time needed.
- Automatic creation of print-ready publications: The software should create print-ready files to reduce print preparation costs and time.

These needs are not addressed by an existing software package. In many cases, organizations can get caught in a downward spiral - lack of financial resources keeps them from publishing, which limits their financial resources. The Olorien project aims to reverse that spiral.

Olorien - a peer-reviewed journal, for free

Olorien is a framework designed to meet the needs of NGOs and institutions in developing

countries. It is a fully automated system for the creation of a peer-reviewed journal for both print and web. Olorien natively supports publication in any language, and it is completely free to use. Olorien was developed to provide a journal for Lyon Arboretum at the University of Hawai'i, and has been extended and opened for use by the general public. Olorien was created by the company Quantum Imagery, and is available for download at their site http://www.quantumimagery.com/olorien. It is an actively maintained and developed project, and will continue to add features in the years and months ahead.

Framework Features

First and foremost, Olorien is a complete solution for management, peer review, and publication of a Journal. It supports all of the core features common to online peer review software, and also contains a few extra features of its own.

Publication Cycle overview

Olorien follows a traditional cycle for peer-reviewed publications, but allows the software to replace some of the repetitive tasks. Figure 1 shows the flow from submission to publication.

Automated article submission

Olorien allows article submissions from anyone who has signed up for a free account. To submit an article, users go to "Submit an Article" page. On the submission page, they first type in their article title, abstract, and author attributions. Next, the user attaches the body text as either a plain text or HTML file. For convenience, Olorien can process the HTML generated by most popular word processors. Finally, the user attaches all of the images, figures, and tables used in the article. There is no limit to the number of full-color figures, diagrams, photographs, and tables allowed.

Once submitted, Olorien automatically manages the typesetting and formatting. To begin, Olorien re-formats the submitted article to be consistent with the look and feel of the journal, inserts any attached figures or images, and translates any Olorien-specific markup used. From that "cleaned up" document, the application then creates a formatted HTML page for viewing online, and a print-ready PDF file for proofing. Both are immediately available for access by the author, and editor-in-chief. Once the typesetting is complete, an email is sent to the editor-in-chief notifying them of the new submission.

Peer review (Assignment and Tracking)

All new submissions are immediately available to the editorial staff for assignment. Editors can easily assign article to qualified reviewers for review, comments, and recommendations. Olorien immediately emails the reviewer(s) that they have a new article for review, and the submitted article appears in the reviewer's Olorien inbox. The reviewer can then download the article in PDF format or view it online, then submit their review using the web site. Notification then is sent back to the editors and editor-in-chief that a review is in. This process can be repeated with several reviewers, and can run in parallel, with several reviewers assigned to a given article simultaneously. Finally, once the editors have enough information to make a decision, the editor-in-chief submits the publication decision, and the author is notified. If the article is accepted, it is then assigned to a volume-in-progress in preparation for publication.

Copyediting

In many cases, this generated PDF is immediately suitable for print. In other cases, editors may prefer to use the copyediting features to fine-tune placement of page breaks, etc. In these cases, Olorien allows the Editor-in-Chief (EIC) to edit the text of any submitted article, and to edit and re-upload any images or diagrams. Since much of the copyediting emphasis is on how the article will look in printed form, Olorien allows the Editor-in-Chief to "regenerate" the PDF for edited articles and volumes at any time.

Secure access and user management

In traditional journal review processes, there is a clear delineation between authors, reviewers, and editors. In Olorien, we have used the same ideas in defining user classes. Olorien supports five "classes" of users: the general public, "normal" users (can submit manuscripts), reviewers, editors, and editors-in-chief. Figure 1 shows the abilities of each of these classes.

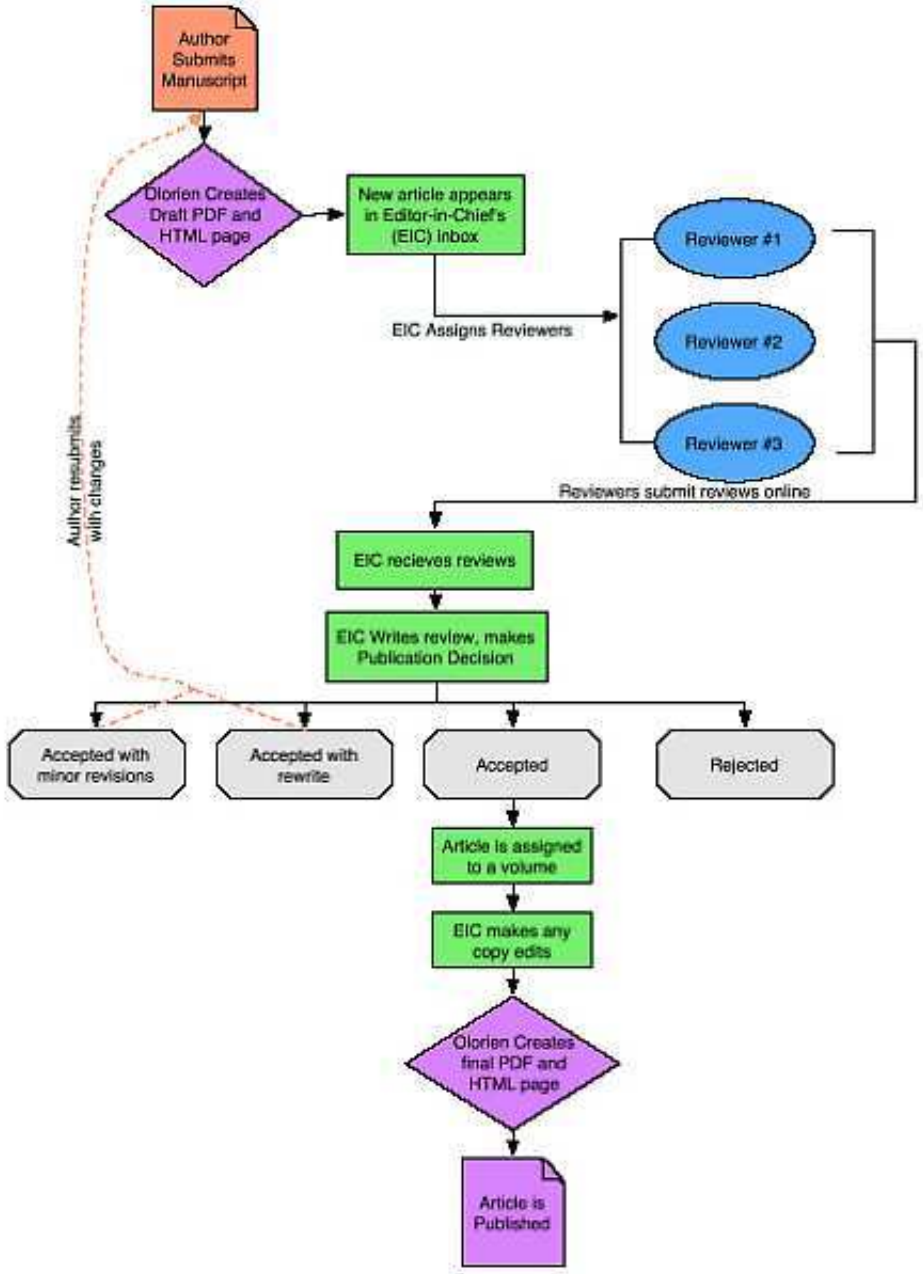

Figure 1: Olorien publication flow

The assignment of a user's class is controlled completely by the editor-in-chief, using an online interface.

Automated notification

Whenever an important event occurs, Olorien automatically notifies users via email and their Olorien inbox. Currently, users are notified for the following events:

- New article submitted (EIC only)
- New review assigned (EIC and reviewer)
- Review returned (EIC only)
- Publication decision made (Author)
- New volume published (Authors)

Table 1: User class restrictions

	View published articles	View unpublished articles	Review Articles	Assign Reviewers	Copyedit	Manage Users	Manage Volumes
General Public (no account)	X						
Normal users	X						
Reviewers	X		X				
Editors	X	X	X	X			
Editor-in-Chief	X	X	X	X	X	X	X

Table 1: User class restrictions

Volume management

To be a viable solution for scientific journals, Olorien includes full volume management. The editor-in-chief can create any number of volumes, and assign submitted articles to any of these volumes. Since volume creation, distribution, and archiving is an ongoing process, Olorien supports a "life-cycle" of volume development. Volumes have a range of five states into which they can be placed:

- In Progress, Private
- In Progress, Public
- Published
- Published, Featured Issue
- Archived

Each of these states changes the way the volume is displayed on the public site, and who can view the volume. The editor-in-chief can change the state of volumes at any point, and articles can be edited and revised for typographic errors throughout the process. However, once a volume is archived, neither it nor its constituent articles can be changed.

Enhanced markup for web-specific features one advantage of an Internet-based journal is that it can take advantage of the unique capabilities offered by an HTML based system over its print counterparts. In Olorien, we have developed a simple markup set that authors can use to insert "tags" into their documents for advanced features like automatic cross-reference links, linked citation references and directly linked URLs for online sources. A complete list of Olorien tags is available in the online manual http://www.quantumimagery.com/olorien/manual. Authors simply have to type the tags into their documents before upload, and Olorien automatically processes and creates all the HTML and PDF code needed. Olorien also has a list of tags for standard document elements, such as section headers, subheadings and figures. Finally, for authors who choose to write their articles in plain text, as is recommended, there are also Olorien tags for most standard word-processor markup like bold and italics.

Integrated mailing list

To simplify deployment of a full journal-focused web site, Olorien also includes a simple mailing list manager. It allows members of the public to sign up for notifications of new volumes. Messages can be sent to the list by the editor-in-chief using a web-based interface. Notably, the email interface includes pre-made templates that include the table of contents for recently published issues, and direct links to the articles. This allows the Editor-in-chief to efficiently publish and promote a new volume. Figure 2 shows the email interface and the resulting email message.

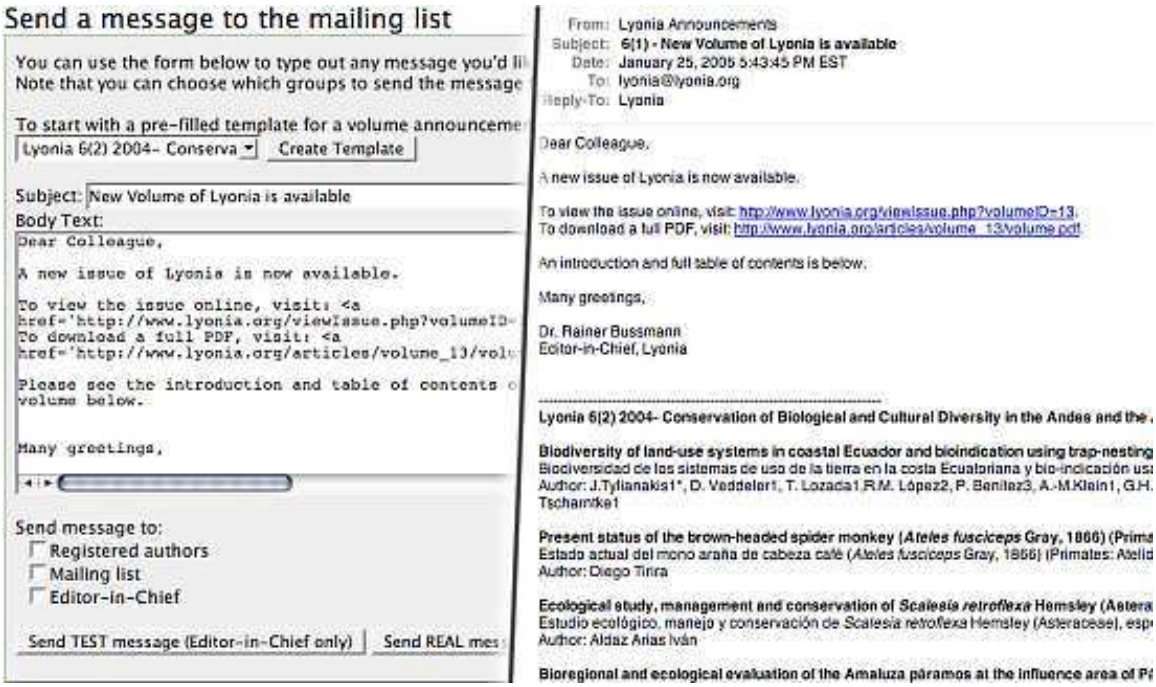

Figure 2: Screen shot of the email interface and resulting email message.

Multilingual Support

In a global research environment, it is critical that publishing software supports languages outside the Latin character set. Olorien is based on the UTF-8 subset of Unicode. Using UTF-8, Olorien to supports article submission in almost every language used in the world today. This includes over 650 languages, including German, Chinese, Russian, and less well-known languages like Oromo and Dzongkha. The UTF-8 specification is maintained by http://www.unicode.org/consortium/consort.html TheUnicodeConsortium, and full specifications are available at http://www.unicode.org

Because most modern computer operating systems and word processors supportUTF-8, authors do not have to make any changes to their systems to take advantage of this functionality. A brief list of UTF-8 and Unicode-enabled products is below.

• Microsoft Windows 98 and above
- Open Office
- Microsoft Office
- WordPad (Plain Text, included in windows)
- EditPlus (Plain Text)
• Mac OS X
- Open Office / Interoffice
- Microsoft Office
- Apple Pages
- Text Mate
• Linux
- Kate / KEdit
- Open Office
- Emacs

Olorien also supports titles and abstracts in two languages for all articles. This allows organizations to publish the full article in its original language, and provide an abstract and title in a common language, such as English or Spanish. In future versions, Olorien will allow full versions of an article in an arbitrary number of languages.

No Cost Licensing

Olorien is completely free for use by the general public. There is no charge to download, install, or use the software in any environment. Since one of Olorien's key goals is to provide a no-cost solution for publishing academic research, there will never be a charge to use Olorien.

Users are free to use Olorien for a journal that requires a subscription fee, but the software itself

has no support for monetary-based access restrictions, and there are no plans to add that ability in the future.

Low institutional costs

In addition to licensing, institutions also face the "hidden" costs of hardware, software support, and adapting existing practices. For organizations seeking to publish their research in print, preparation costs can be immense. Olorien tries to reduce all of these costs in a variety of ways:

Hardware costs

The computer to run the Olorien software and a constant Internet connection are one obvious institutional cost. Olorien has been built to run on a variety of operating systems, including Linux (free), FreeBSD (free), and Mac OS X (not free).

One advantage to this approach is that new, high-speed hardware is not needed. The processor-intensive tasks of PDF and volume generation only happen once, then the results are saved onto the hard drive. As a result, a used, older computer running Linux makes a fine (and inexpensive) Olorien server.

Software Support Since Olorien is open-source, it gains support from a community of users and developers as the project gains popularity. As more institutions deploy Olorien-based sites, similar snags in the setup and management process will be documented, as well as the solutions to those problems. The choice of open standards and common languages for the construction of Olorien also aids in software support costs. If an institution wishes to extend the Olorien architecture, they will have little trouble finding skilled programmers.

Adapting existing practices Olorien has been designed to mimic a traditional peer review process as closely as possible. As a result, organization, which already has a peer-reviewed publication, should find the transition painless.

Preparation for print for many publications, the typesetting, organization, and preparation of print-ready files is the most expensive and time-consuming part of the publication process. Olorien greatly reduces these costs by automatically preparing a PDF file that can be handed off to a press for printing without changes.

Open source

Olorien is open source software. This means that the source code of Olorien is free for users to download, use, and change. Olorien is released under the full GNU Public License (GPL)[4]. In essence, the license says that the software is released freely, with all source code for anyone to use as they

please. The one stipulation is that if anyone makes changes to the Olorien source, and

then uses the modified version in a public context, they are required to release their

changes publicly, for no cost. We have chosen the GPL as a license since innovation is likely to occur on Olorien outside the bounds of Quantum Imagery, and it is in the best interests of everyone in the scientific community if those changes are shared. This means that Olorien is "free" in both senses of the word. There is no cost to use the software, *and* its source code can be modified without restriction, as long as those changes are shared. In classic Internet terminology, Olorien is both "free like speech" and "free like beer."

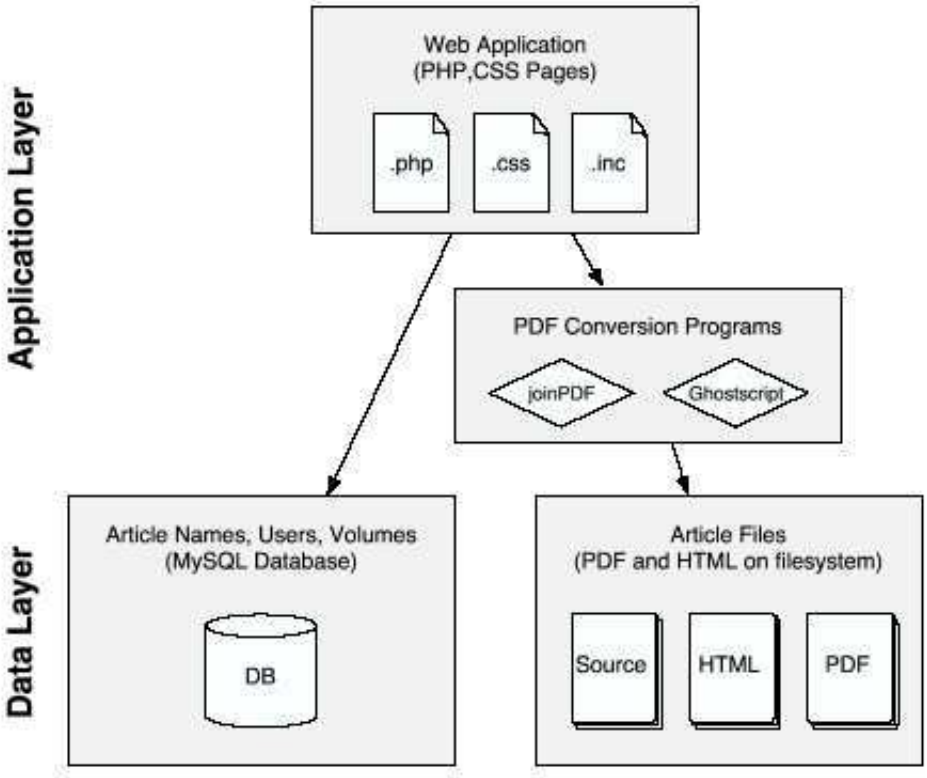

Figure 3: Olorien System Architecture

Technical details

System Architecture

Olorien is built using a variety of widely available open-source technologies. It has been designed to be as portable as possible across platforms and systems, and all of the code used is platform independent. Olorien is made of three primary parts: the database, the web application, and the supporting article folders.

The Olorien database contains all the content, review information, volume information, and user tables for a journal. It does not contain any of the content for the actual articles submitted, any attached images or figures, or the generated PDFs. The web application is a set of PHP pages that link to several external programs during PDF creation. The article folders house the original submissions from the author, as well as all generated HTML, PDF, and image files. This system is more efficient than keeping all of the information in a single database because it lets each parent system (the database and the file system) do the task it is good at. Databases were not designed to manage large, binary files like PDFs, and file systems were not designed for quick searching and retrieval of small bits of data. It is also useful to note that on operating systems where file access control is possible (Microsoft windows is the notable exception), access to the files is exclusively limited to the system user that runs the web server process. Since the data for Olorien is split into two areas (the file system and the database), it is important to make backups of both data stores. The Olorien package comes with a sample shell script that should work well for most backup needs. Interface Design Olorien is designed to be lightweight, accessible, and easy to use.

Olorien uses Cascading Style Sheets (CSS http://www.css.org) for its visual formatting and layout, which allows users to quickly customize the look and feel of their own journal to match their institutional needs. Since CSS is designed to be backwards compatible, is completely accessible and usable in a text-only environment.

Software requirements to use Olorien

Olorien requires all of the following packages to be installed on the server it runs on.

- PHP 4.3.4 or greater
- Download from PHP.net http://www.php.net
- A web server that supports PHP (Future versions of Olorien will probably require Apache)
- Download fromapache.org http://www.apache.org/apache/download

• MySQL 4.1 or greater
- Download from MySQL AB http://www.mysql.com/downloads
• Ghostscript 8.0 or greater
- Download from University of Wisconsin http://www.cs.wisc.edu/~ghost/
• JoinPDF 1.0 or greater (optional)
- Download JoinPDF http://www.iis.ee.ic.ac.uk/~g.briscoe/joinPDF/
• Supported server operating system:
- Mac OS X 10.2 or higher
- *nix variants, like Linux and FreeBSD
- No packages currently available for windows.

Note that several of the platform-specific "QuickPackages" available on Quantum Imagery already contain much of the above software pre-configured, and is a good solution for most use needs.

How to use it:

Complete step-by-step setup instructions, QuickPackages, and user tutorials are available from The Olorien web site http://www.quantumimagery.com/olorien. Questions about setup and configuration can be sent to the author.

Future work needed

Olorien is in active development, and has a set of features planned to address current shortcomings. Work is active on all of the following issues.

Limited Support for Article types Olorien allows authors to upload plain text and HTML files, but more direct conversions from popular programs are not possible at the moment. In the future, Olorien should support:

• LATEX and LYX files
• Rich Text Format (RTF)
• Microsoft Word Document (DOC) files, produced by Microsoft and Open Source programs
• XML files, with a schema definition for Olorien.

Limited Operating System support

At the moment, Olorien is only supported on *nix-based operating systems, such as Mac OS X and Linux. While this reaches the majority of the computers that act as web servers, it may desirable to have support for other operating systems, such as Microsoft's Windows TM. There is no code in Olorien that prevents a quick and easy port to Windows, but at the moment, that effort has not yet been undertaken. It is hoped that the user community for Olorien will assist in porting the software to other platforms Interface localization Though Olorien supports localization of the entire site, the only language that is currently translated is English. As users set up Olorien-based sites in their own languages, we encourage them to send the translation files back so that pre-built packages for various languages can be provided.

Multilingual support for full body text Currently, users can specify an abstract and title in two languages. However, this is not a complete solution for multilingual publication. To truly meet this need, Olorien will support an arbitrary number of languages for the title, abstract, and body text of an article. Editors will be able to choose which language or set of languages to publish for print, and all translations will be available online.

Hosting services

For institutions that do not want to host their own copy of Olorien, a hosted version of Olorien will also be offered in the future. This will allow subscribers to host and manage their journal from a central server, without having to manage the hardware and Internet connection. However, given the costs of running a server, this service will probably not be free.

Conclusions

While several software frameworks for journal management exist, none fully address the needs of NGOs and institutions in developing countries. For these groups, Olorien is an optimal solution. The management of journal creation from submission all the way through archiving allows these organizations to have a quality, peer-reviewed journal that might otherwise not be affordable. Low publication costs allow institutions to publish more research, allowing an increase in research funding, and turning the 'downward spiral' that can characterize low-budget organizations around. While obviously geared toward NGOs and developing institutions, Olorien is a complete solution for established research organizations looking to move to a more automated system with a web-based

presence. It is feature complete, and undergoing active development for future improvements. Over the next year, Olorien will add support for Windows servers, more document upload formats, and interface localization. The community of organizations deploying Olorien will help accelerate this process.

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http://www.library.unr.edu/ejournals/editors.html
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Unicode Language List http://www.unicode.org/unicode/onlinedat/languagesscripts.html

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ebDB - Filling the gap for an International Ethnobotany Database

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ebDB - Filling the gap for an International Ethnobotany Database

Abstract

Today, there are a few primary repositories for Ethnobotanical data, including the University of Riverside's Ethnobotany Database, Dr. Duke's Databases, and NAPRALERT, and several more specialized databases. Each of these systems fills a valuable role, but each also has shortcomings in accessibility and use in international applications. The International Ethnobotany Database (ebDB) is a new, public database that fills in the existing gaps in functionality, and provides a standardized, secure, independent, and non-commercial repository for ethnobotanical data. In this system, individual researchers maintain complete control over the access to their data, and can choose to keep it completely private, or securely share the information with selected colleagues. The database is fully multilingual, and supports translation, data entry, and viewing for any language. Most importantly, the database is open to any researcher to add new data, datasets, and languages. The ebDB is managed by the Foundation for Open EthnoBotany Research (FOER), an organization dedicated solely to managing the database, and providing an international repository for ethnobotanical data. As a result, it is insulated from institutional political turmoil and commercial interests, and provides a safe home for data for those concerned about bio-prospecting. Built over four years of field research in Peru, the ebDB contains a broad feature set, and is designed specifically for ethnobotanical research. It is fully multilingual, has a glossary, more than 20 categories of data, complete location information, strong searching, and data export features. Currently, the database houses data from Ecuador, Peru, Kenya and Hawai'i. It is the hope of this project that the ebDB becomes an international standard for storing ethnobotanical data.

Background

There are several widely-known ethnobotanical databases already in existence. While each of these repositories has its own strength, none has become a standard for international research. The reason for this is quite simple: none of these databases allow researchers to add their own data. There are also several other weaknesses and strengths of each of these applications. To their credit, none but NAPRALERT were designed to be an international standard, so it is not surprising that they do not meet this need. We shall examine each of the largest in turn.

Dr. Duke's Phytochemical and Ethnobotanical databases

http://www.ars-grin.gov/duke/ This database houses research compiled by Dr. Jim Duke of the Green Farmacy Garden and the United States Department of Agriculture (USDA). The USDA's Agricultural Research Service provides support for the database. Dr. Duke's database has several key strengths: a large number of plants, complete data on most database entries, and chemical information on a variety of plants. It also has several critical weaknesses, most notably the lack of public input, and limited support for a variety of ethnobotany data. The "EthnobotDB" itself only has fields for botanical description and use. While this makes the database an effective tool for disseminating Dr. Duke's work, it does nothing to assist other researchers to effectively detail the fruits of their research. With the USDA backing, Dr. Duke's database also raises a thorny question: if it were possible for researchers to add their data, to whom would it belong?

UC Riverside's Ethnobotany Database

http://maya.ucr.edu/pril/ethnobotany/database/database.html. This database provides a much more generalized approach to ethnobotany. The University of California, Riverside (UCR), provides support. UCR's database is well-designed in the breadth of fields and information types it covers. However, it too suffers shortcomings as a central, international database. First, it is a completely off-line tool. While this has advantages in portability, a non-internet based tool can not function effectively as a central storehouse for ethnobotanical data. Second, like Dr. Duke's database, UCR Ethnobotany Database is a closed system: we are unable to add our own data to a shared repository. Finally, the database interface is in English only. Importantly, the database is not freely available for download online. While the team at UCR has developed an excellent tool, it does not meet the needs of international researchers.

NAPRALERT http://www.cas.org/ONLINE/DBSS/napralertss.html

NAPRALERT is in many ways, the antithesis of what we believe an Ethnobotany database should be. To its favor, it does contain information on a wide variety of plants and their uses, but its use to researchers begins and ends there. Unlike the other databases, NAPRALERT is a pay-per-use system, with a cost at writing of 8.90USD per search. While the University of Illinois

at Chicago is entitled to fund its research, clearly this is no generalized storehouse for ethnobotanical knowledge. It's important to also note that NAPRALERT focuses on the phytochemical information for the plants in its database. While phytochemistry is an important science, with the concerns of bio-prospecting it is more responsible to keep phytochemical data separate from pure ethnobotanical data. Finally, like the aforementioned two databases, NAPRALERT is a closed, monolingual system.

Specialized Databases

In addition to the three mentioned above, there are also a handful of specialized ethnobotanical databases. Dan Moerman of the University of Michigan has an excellent Native American Ethnobotany database located at http://herb.umd.umich.edu/ http://herb.umd.umich.edu/. Moerman's database references USDA plant descriptions, and provides preparation method, plant part, and use data. All told, it contains a staggering 44,000 items from 4,029 species. Fort Lewis College also provides an accessible database http://anthro.fortlewis.edu/ethnobotany/database.htm, http://anthro.fortlewis.edu/ ethnobotany/database.htm that focuses on the Southwestern American Indians. While smaller than Moerman's database, the Fort Lewis database still contains use and preparation information for 293 species. Both of these databases (and others) are valuable tools, but fall short in providing services to the larger research community. Once again, the missing keys of public input, international language support, and clean intellectual property rights are still wanting. It should of course be noted that the main reason these smaller databases do not fill this role is that they were never designed with that purpose in mind!

International Ethnobotany Database (ebDB)

The ebDB was created out of a need for an independent, public, open database that provided data security and support for many languages. It was completed in July of 2004, and is currently open to the public. The database is located at: https://olorien.org/ebDB. The database was developed with private funding, and the researchers who submitted it own the data it contains. The ebDB took shape over four years of field research in Peru. As a result, its feature set has been shaped by the real problems faced in field research, data storage, and retrieval. The result is a robust, scalable system that can easily accommodate data from anywhere in the world.

Database and data ownership

The ebDB is owned and managed by the Foundation for Open Ethno Botanical Research (FOER). FOER is an organization formed solely to maintain and ensure access to the database. At the time of writing, the Foundation is still being formed, but should be finalized by the end of 2006. Details will be available at https://olorien.org/ebDB as soon as they are finalized. Steven Skoczen, who will release the copyrights to FOER upon its formation, wrote the database itself. There are no other corporate or institutional interests in the creation or maintenance of the database. Data submitted to the ebDB remains under the copyright of the dataset's owner, and any relevant informants. FOER serves only as a storehouse for the information, and retains no publication rights, copyrights, or even access to submitted data. Dataset owners can specify global and user-by-user permissions for data access, and protect or share any data as appropriate.

Database features

What it is and What it's not:

First and foremost, the ebDB is an Ethnobotanical database. It is not a botany database, and does not have a focus on traditional botanical tools for plant identification. It is also not a phytochemical database, and as such, does not contain any chemical information for plants. The goal of the ebDB is simply to provide a complete solution for ethnobotanical data storage, and as a result, neither of those two tertiary ideas is ever planned for the database. With the intellectual property complications arising from phytochemical data, and completely different scope and feature set of a botany database, this seems a reasonable and good idea.

Features

The ebDB has several unique features that make it a particularly good choice as an international repository.

Multilingual

First, it is fully multilingual, supporting an unlimited number of languages for both the data itself and the web site. For data storage, the database can accept any language contained in the UTF-8 character set. This includes over 650 languages including English, German, Chinese, Russian, and less well-known languages like Oromo and Dzongkha. Leveraging internet standards, users can input their data in their native language without any extra software or changes - just as they'd type in any

word processor. After data has been entered, it can then be translated into any or several other languages. 1 The site itself can also be displayed in any language. Currently, users can view the site in English, Spanish, and Hawaiian. While data input is possible in any language, we currently need user support in translating the interface to languages other than the aforementioned. If you are interested in translating the ebDB interface into your language, please contact any of the authors. The ebDB also allows for the *translation* of all data in the database into any number of other languages. As entries are translated, users are able to view the data within the database in an ever-broadening range of languages. This also allows international researchers to easily provide their findings to the informants if the publication and informant's languages differ.

Datasets

The second key feature that differentiates the ebDB from other solutions is the idea of *datasets.*A *Dataset* is the term used in the ebDB nomenclature to denote a group of plant samples that share a common owner and copyright. The database uses *datasets* to define access permissions, and allow users to control the visibility and availability of the data they submit. When a dataset is created, users specify a name, description, and the language in which data will be entered. Dataset owners also define which users of the ebDB should be able to access their dataset, and what privileges those users should have. Owners can choose to allow users one or more of the following permissions:

No Access, Read, Print, Add, Edit, Translate, Delete, and Own. In addition, owners can set a default set of permissions for everyone not specifically given permissions. Since these permissions can be changed at any time, there is a great deal of flexibility for dataset owners in security and publication.

Broad Ethnographic Information

An Ethnobotany database would be of little use if it did not provide fields for capturing all the relevant data for a particular sample. With that in mind, the ebDB contains fields for a wide variety of information, including the following:

Figure 1: Translation dialog for the word "Leaf"

Figure 1: Translation dialog for the word "Leaf"

Figure 2: Dataset Management screen

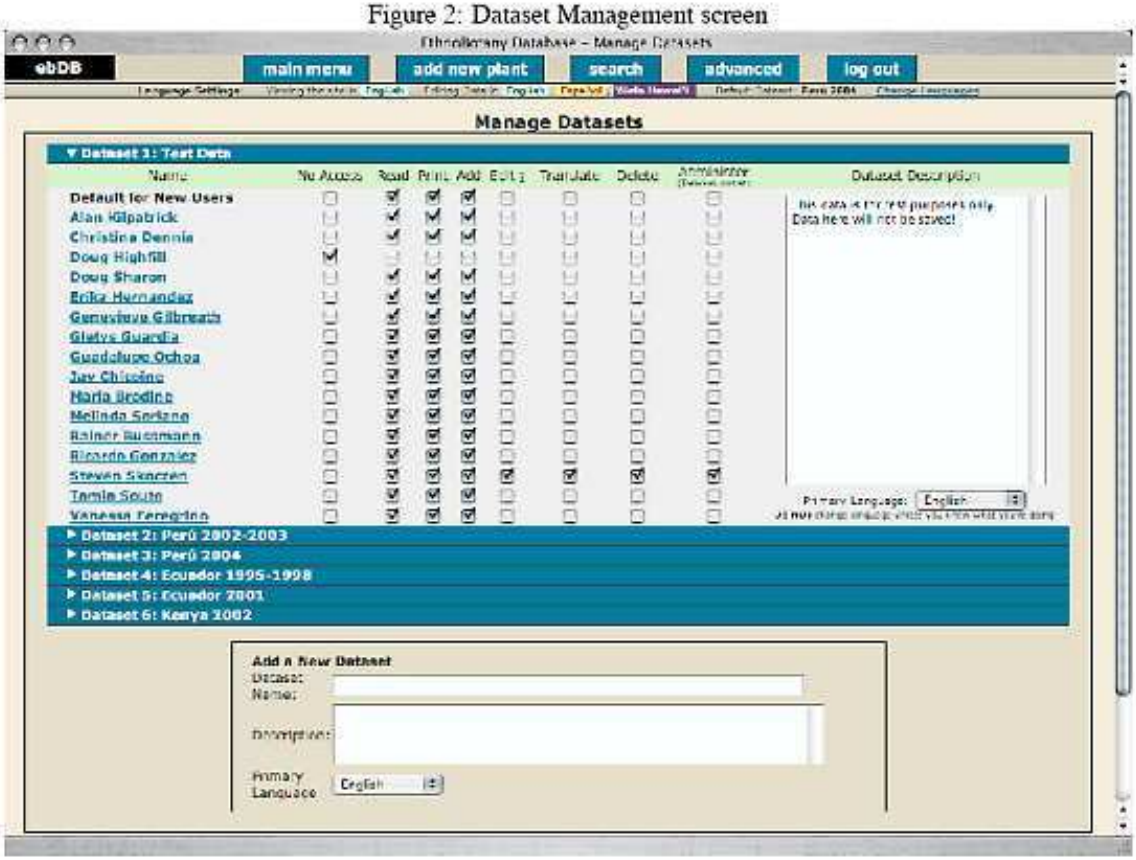

Figure 2: Dataset Management screen

• Plant Information
- Kingdom
- Family
- Genus
- Species
- Description
- Origin(s)
- Other scientific names
• Sample Information
- Picture(s) (An unlimited number of high-resolution pictures are allowed)
- Collection Number (User-specified to match researchers' own numbering methods)
- Collection Date
- Informant (with an associated mini-biography about the informant)
- Indigenous Name(s)
- Location researcher collected the sample
- Location(s) the informant collects or purchases the sample
- Location(s) where the sample grows
- Time of day (AM/PM/Both) the sample is generally collected
- Temperature classification (Four Humors)
- Uses:
Part(s) of plant used
Used fresh, dry, or both
General preparation method
Preparation details
General administration method
Administration details
Dosage

What thing(s) the sample (prepared with the above method) is used for

General use notes

As indicated by the list above, the Plant, Sample, Use, and Used For data are nested inside each other. Any plant species can contain an unlimited number of samples from any number of individual researchers, and any Sample can contain an unlimited number of Uses, etcetera.

Glossary

Also important in the ebDB's applicability is the glossary. For many ethnobotanic projects (or any cross-cultural project, for that matter), there are often words or phrases that are difficult to translate into another language. For example, in coastal Peru there is a condition called "*Mal Aire*". Translated literally into English, this would mean "bad air" or "bad wind". Unfortunately, neither definition has really much to do with *Mal Aire*, since its definition is grounded in Latin American culture (Calderon & Sharon). In these instances, it is desirable to be able to define a term more fully in a linked glossary. To that end, the ebDB has a built-in glossary that can have an entry attached to any translated word or phrase. Glossary definitions can be defined globally, per dataset, or per informant. For example, if two informants both specify that they prepare a particular plant as a tea, but have greatly differing views on how

to make a proper tea, the glossary categorically captures those ethnographic differences for each informant.

Locations

Location information is important for many aspects of ethnobotany, from market flow analysis to retracing cultivation history. Consequentially, the ebDB has strong support for location data. Each sample can have an unlimited number of locations for the place it originates, the place the informant collected the sample, and the place the researcher collected the sample. Any location in the database can contain information for any or all of these fields:

- Continent
- Country
- Region
- City
- Location
- GPS Longitude and Latitude
- Location Notes

The variety and specificity of location information greatly improves the ease of analysis for location-based data. With detailed data in each of these categories, it is easy to determine trends from the continent down to the city. In addition, GPS-based data provides a precise long-term solution for location tracking. "Used for" categorization The ebDB also allows dataset owners to categorize what various plants are used for into broad categories. With this technique, the original ethnographic data is retained, but the researcher can easily analyze broad trends in what plants are used for. The ebDB provides a default set of categories that fit most ethnobotanical data, or dataset owners can specify their own. There is an easy-to-use interface for dataset owners to categorize the uses in their datasets.

Figure 3: Location fields

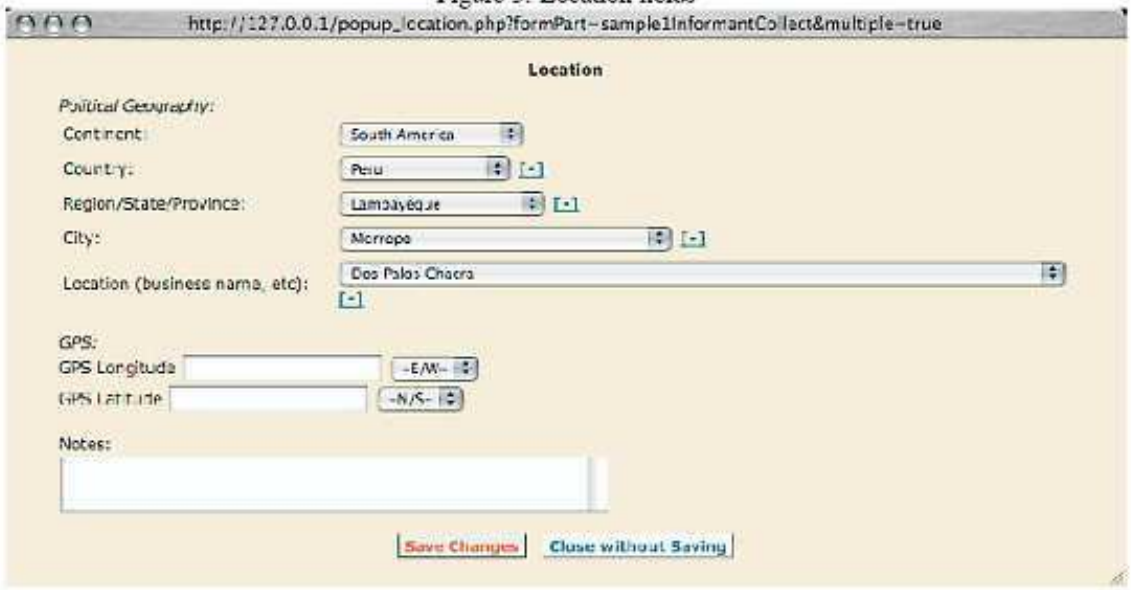

Figure 3: Location fields

Data export

As might be expected, a database is of limited use unless users can export relevant data for analysis. To that end, the ebDB supports the export of an entire datasets by the dataset owner. Datasets are exported as .csv (comma separated value) files that can be opened with most spreadsheet and statistical packages.

Field research

In keeping with its field-based development, the ebDB has printing features designed specifically for in the field research. The database has a page to "Print Field Sheets" that allows authorized users to enter collection numbers and print out pre-formatted data collection sheets that contain all the current data and pictures, and blank lines for any missing data. The ebDB also has a "Print Manuscript" page that allows authorized users to print a formatted manuscript draft of all the data in a particular dataset. Since the output is in HTML, it serves as a very good starting point for a book or other publication.

Standard tools

As should be expected, the ebDB also has all the standard tools and features of most databases. This includes internal data integrity checks, regular backups, a strong, flexible search capable of searching any field in the database, user management, and strong security. It is important to note that the ebDB can only be accessed over a secure HTTP connection (https://), so users with very old browsers will need to upgrade. The secure HTTP connection ensures that all data sent to the database is encrypted, and can not be read while it is being transmitted from the user's computer to the server.

Figure 4: Search Screen: any field in the database is searchable.

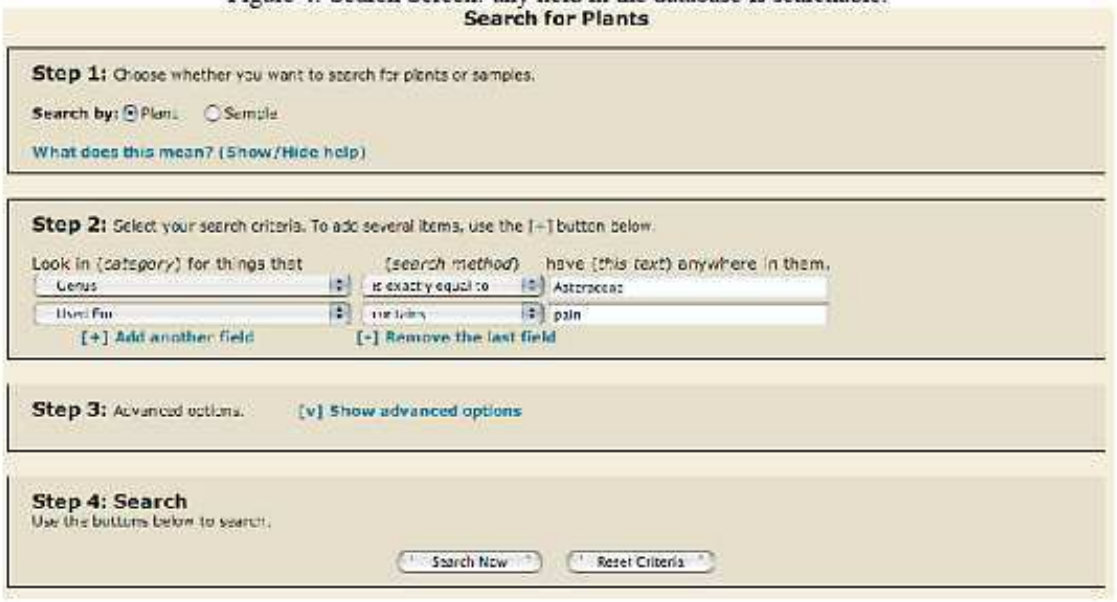

Figure 4: Search Screen: any field in the database is searchable.

Database structure

In the database, the hierarchy begins with unique plant species. Each species can then contain an unlimited number of samples, in which specific ethnographic information is stored. Samples are grouped as *datasets*, where each dataset has an owner and specific set of copyrights. Figure 5 shows the overall hierarchy of data. As shown, by default users Siani and Zelma have access to only the plants in their datasets, even though Siani's "Sample 2" and Zelma's "Sample 3" are botanically the same plant. Dataset owners can completely control the level and type of access to the data in their dataset.

Technical details

The International Ethnobotany Database has been designed from the ground up to be reliable and scalable. As a result, it is built on the best of established, tested web technologies. The database itself is built in MySQL http://www.mysql.org, a freely available database developed by MySQL AB. MySQL has been established as a premiere database for large projects, both in reliability and speed. The site is built in PHP http://www.php.net, an open source web scripting language that draws its structure from Perl and C.

PHP has been proven to be reliable, is well documented, and is one of the most actively maintained projects on the internet. Finally, to host the site, the ebDB relies on Apache, the most widely-used and stable web sever available. Apache is also stable, fast, and open. As would also be expected from any critical database, regular backups are made of the ebDB both on and off-site.

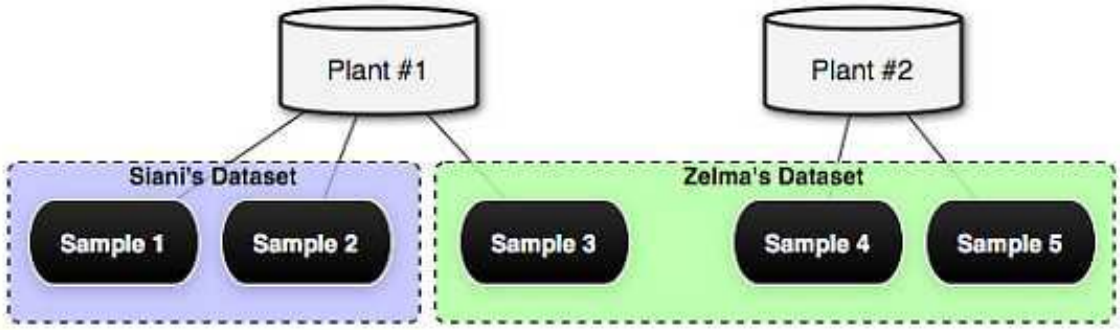

Figure 5: Datasets, Plants, and Samples: Each user has control of only their samples, even if another user has samples that are botanically the same plant.

A unique solution for internationalization

In building the multilingual features of the ebDB, we ran into a common problem, and have developed a unique solution that works well. This problem has been the subject of much discussion in the internationalization and localization communities, so the result may be of some interest. A challenge arises when trying to create a database structure that supports multiple languages for any given field. Two solutions come quickly to mind, and have been covered in detail online. However, the consensus is that neither solution is truly a "fix". Both seem to be "hacks" to work around databases that are not inherently multilingual. In this project, we have come upon a solution that seems to be a real "fix", is elegant, and works well.

The first generally accepted solution is to add multiple fields for each field's language within one table.

Part of Plant Used Table

PartID	Partname_en	Partname_es	Partname_??
1	leaf	hoja	??
2	apple	manzana	??

Figure 6: The first generally accepted localization solution. New languages must be hard-coded as new columns into the table structure.

While this idea clearly works, it becomes quite difficult to manage once more than a few languages are required. Adding new languages requires manual changes to the database *structure*, when language is best served as an *attribute* of a well-defined structure. This solution requires the database table to have explicit knowledge of the language of its data, an idea of poor design.

The second obvious idea is to use a delimiter to separate data within a given field.

Part of Plant Used Table

PartID	Partname
1	leaf;hoja;????
2	apple;manzana;?????

Figure 7: The second generally accepted localization solution. New languages are concatenated onto the list string with a delimiter.

While this idea does a good job of keeping the database structure clean (the table structure is now agnostic to the languages it contains), it has two key flaws. First, adding another language is a difficult task that requires an update of every piece of internationalized data with the new delimiter sets. While this is not impossible, it is highly inefficient. Second, the operation of viewing and writing

data to these fields is fairly expensive. Each data read requires parsing of the data, and each writes a concatenation.

Both these solutions also have another flaw: neither can inherently take translation knowledge from one table and apply it to another table. For example, if a user has translated the English *apple* to the Spanish *manzana* in "Part of Plant Used" table, there is no good reason that an internationalized field with the data *apple* in another table shouldn't be able to take advantage of that knowledge.

A new solution: Internationalized Reference Tables. The solution we've devised produces an elegant database, is scalable, and when used in a database with good indexing, is exceptionally fast. Three tables are used: the data table and two reference tables for language and localized text. The result can be seen in figure 8.

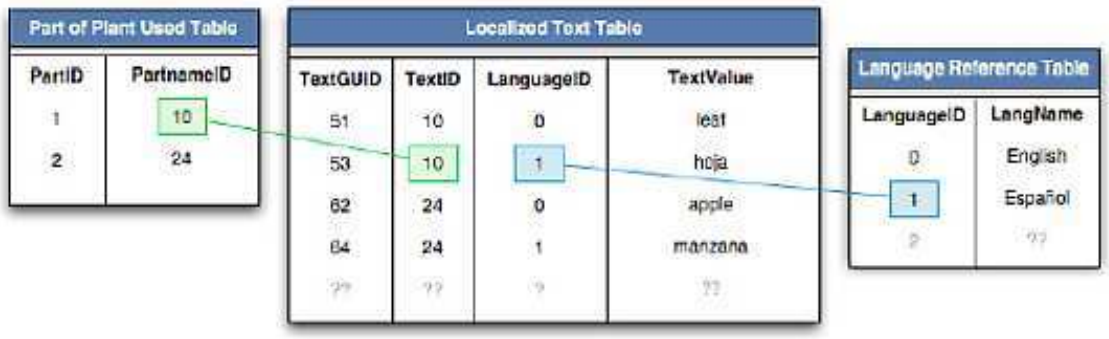

Figure 8: The localization scheme used in the ebDB. The database is completely agnostic to the language of any given data point.

At first glance, this schema seems more complex. However, looking closer, it is apparent that the database structure accommodates any number of languages without a structural change, and without any real hits in performance. The system does require a procedure to link the tables and languages as relevant to the context, but since this is a consistent operation, a generalized function with low performance cost can be easily created. Perhaps more importantly, the reference table solution above allows other tables in the database to take advantage of the "translations" offered by the localized text table. For instance, with the data listed in the figure, any future entries by any user of the English *apple* are automatically translated to the Spanish *manzana*without any work (or knowledge of Spanish) on the part of the user. Overall, this schema produces a system that can easily support an unlimited number of languages, leaves the data tables agnostic to the language of the data they contain, and allows for translation information to be applied across tables. For many applications that require internationalized data, this would seem an excellent solution.

Database Access

The ebDB is open for any member of the public to use. As discussed above, access to data is limited by dataset, where the dataset owners have complete control of their data. Consequently, any member of the public with an account is authorized to create their own dataset and add ethnobotanical data for their projects.

To obtain an account, email your full name and desired username to accounts@ebdb.org accounts@ebdb.org. Also specify if you would like an account with dataset creation privileges. Please note that though accounts are freely available, an account is needed to log into the database. No member of the public can browse the database or create datasets without an account.

How to use it, and how it should be used

How to use it

To access the database, simply visit http://www.olorien.org/ebDB. The application has been built using web standards, so a recent, standards-compatible browser is preferred. Mozilla Firefox, Konqueror, Safari, and Opera are all good choices. Microsoft Internet Explorer does not correctly support web standards, so one of the other browsers should be used if available.

For information on how to use the database itself, the reader is referred to the official documentation:

- The complete online manual located at http://ebdb.org/manual http://olorien.org/ebDB/manual.
- A PDF can also be downloaded from http://ebdb.org/manual/manual.pdf

http://olorien.org/ebDB/manual/manual.pdf.

How it should be used

A researcher's data is theirs to control, but sharing helps the larger ethnobotany community. Depending on the specifics of a given project, researchers are encouraged to share their data with selected colleagues, or possibly even all users of the database. The FOER is simply another user on in the database; you can choose to share your data with the foundation or keep it private, just as you would with any other colleague. In general, we suggest that dataset owners provide read-only access to all users, and reserve other access permissions to specified, trusted users. This allows all database users to share the wealth of knowledge across the variety of projects, and gives owners the greatest flexibility. It bears repeating that the database is not viewable by anyone without an account, and that ultimately, access control for a given dataset resides exclusively with its owner.

Future Research

While the ebDB as it currently exists is an excellent solution, there is always room for improvement. Our plans for the future include:

- Reaching out to ethnobotanical researchers to make them aware of the International Ethnobotany Database, and how it can work and help with their projects.
- Providing a generic framework for dataset owners to add their own cultural or project-specific fields.
- Continual improvements in database speed, responsiveness, and search functions.
- Possibly integrating the scientific name descriptions with the Standard of the International Taxonomic Databases Working Group.
- Translation of the interface into as many languages as possible. We will need the support of users to make this happen, so please contact any of the authors if you are interested in help translate text into your language.

Conclusions

While several ethnobotany databases exist, none are adequate solutions for international work, and none allow researchers to add their own data. A need clearly exists for a centralized, independent database that facilitates ethnobotanical research. The International Ethnobotany Database is a proposed solution to this need. It is supported by an independent organization dedicated to maintaining it as a neutral, secure repository, free from commercial or political influences. The ebDB provides complete control to researchers over their own data, and natively supports almost every language used in the world today. It provides a system for user translation of all data into any language, and leverages those translations for future data entry. In addition, it has a set of features directed specifically for ethnobotany research, including a glossary of culturally-specific terms, detailed location data on the sample's origin and market flow, and field sheet printouts to assist research in the field. With its feature set, organizational backing, and robust function, the ebDB is a solution of use to anyone doing ethnobotany anywhere in the world.

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Phytotoxic effects of agroforestry tree crops on germination and radicle growth of some food crops of Mizoram

Phytotoxic effects of agroforestry tree crops on germination and radicle growth of some food crops of Mizoram

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Abstract

The phytotoxic influences of *Alnus nepalensis*, *Artocarpus heterophyllus* and *Emblica officinalis* were tested by growing test crops of *Oryza sativa*, *Phaseolus vulgaris* and *Pisum sativum* for bioassay culture. The germination of *Oryza sativa* was stimulated in *Alnus nepalensis* whereas, *Pisum sativum* was restrained in all the tree crops. However, *Phaseolus vulgaris* was found most resistant crops for all trees aqueous extract. The radicle growth of all the food crops depressed significantly ($P>0.05$, $P>0.01$) in aqueous extract of all the tree crops.

Key Words: Allelopathy, bioassay culture, inhibition, stimulation, tree crops, test crops

Introduction

Allelochemicals refer mostly to the secondary metabolites produced by plants and are by-products of primary metabolic processes (Levin, 1976). They have allelopathic effect on the growth and development of the same plant or neighboring plants. Allelochemicals most often impart plant resistance to insects, nematodes and pathogens. There release into environment, some may regulate the distribution and vigor of plants. Usually plants came in contact with the allelochemicals in soil and their effect on crop plants may be modified by soil moisture, soil temperature and other soil factors (Patrick and Koch, 1958; Einhelling and Eckrich, 1984). The effects of secondary substances released by these mechanisms can be long lasting (Patric, 1971) or quite transitory (Kimber, 1973) and can ultimately influence practices like fertility, seeding and crop rotations.

The allelopathic effects are selective (Stowe, 1979; Melkania, 1983) and vary with different trees since these plants will vary in the amount of indigenous secondary metabolites and would release different amounts of the phytotoxins. Generally leaves are the most potent source of allelochemicals, however, the toxic metabolites are also distributed in all other plant parts in various concentration. The secondary compound released from litter or formed by microbes decomposing the litter will be influenced by the type of crop being leached or decomposed (Putnum and Duke, 1978). In fact, litter leaching and decay are the major pathways of the release of allelochemes form plants. Harborne (1977) proved that higher plants (tree crops) release some phytotoxins into soil, which adversely affect the germination and yield of crops. Such type of tree crop interactions called phytochemical ecology/ecological biochemistry.

In the traditional agroforestry system of country people are growing several tree species in or around the agricultural fields. However, although recent attempts have been made to use available land more efficiently, agricultural losses are being experienced by marginal and sub-marginal farmers, who are concerned about the adverse effect of farm trees on cultivated land and standing crops (Bhatt *et al*, 1993). Due to the adverse effect of trees most of the farmer are now neglecting to grow the tree species in agricultural field because, to grow food crop is essential for subsistence. Therefore the planting of tree crops has not been practiced on large scale.

In agroforestry importance of multipurpose tree species cannot be overlooked as they provide food, fodder, fuelwood and social security to the growers. Some species improve the soil but at the same time some species may cause adverse effect on long-term basis (Gill, 1992; Mughal, 2000).

The component plant species in agroforestry system depends on the same reserve of growth resources such as light, water and nutrients and hence there will be influence of one component of a system on the performance of the other components as well as system as a whole. These are referred to as tree-crop interactions. These interactions may be positive or negative (Basavaraju and Gururaju, 2000). The balance between these positive and negative effects determines the overall effects of the interactions in a given agroforestry combination

In the agroforestry systems of Mizoram number of principle trees (*Alnus nepalensis, Artocarpus heterophyllus, Emblica officinalis, Aporosa octandra, Anthocephalus chinensis, Albizzia procera, Melia azadirchta Bauhinia variegate, Erythrina indica, Gmelina arborea* etc.) and agricultural crops (*Oryza sativa, Phaseolus vulgaris, Pisum sativum, Glycine max, Brassica campestris, Zea mays, Cajanus cajan, Vigna sinensis etc.*) are grown. Production of agricultural crops is the main

sources of subsistence in Mizoram, because 80% population of this region dependant upon agriculture. Combining of trees, crops and livestock is in practice since long and getting benefits on sustained basis.

Materials and Methods

In Mizoram under managed agroforestry system the farmers in several combinations frequently grow trees and crops. Keeping in view the above introductory background and stimulatory and inhibitory effects of trees on crops, in the present study an attempt has been made to analyses the phytotoxic effects of multipurpose agroforestry trees (*Alnus nepalensis, Artocarpus heterophyllus* and *Emblica officinalis*) on the germination and radicle growth of test crops (*Oryza sativa, Phaseolus vulgaris* and *Pisum sativum*) of this region. Therefore, to examine the allelopathic influences of trees on crops the following experiment was conducted for bioassay culture in laboratory.

In bioassay studies, mature leaves were collected from natural growing trees of selected tree species. The leaves were sun-dried and ground separately in a mechanical grinder. A sample of 1 and 2 gm (for 1% and 2% concentration) of each component was weighed and added to 100 ml of double distilled water and kept for 24 hours at room temperature. The resulting brownish and dark extractions were filtered through three layers of whatman no.1 filter paper and stored in the dark place in conical flasks until required. The effects of aqueous extract on seed germination and radicle length were tested by placing 10 seeds of each test crop in Petri dishes (five replicates) containing three layers of whatman no.1 filter paper saturated with the leachate. A separate control series was set up using doubled distilled water. Moisture in the Petri dishes was maintained by adding about 1 ml of aqueous extract or doubled distilled water as required. The number of seeds germinated was counted everyday for 7 days after which the observations were stopped.

Results

The allelopathic effects of leaf aqueous extract (1% and 2% concentration) of *Alnus nepalensis*, *Artocarpus heterophyllus* and *Emblica officinalis* tested on test crops *Oryza sativa*, *Phaseolus vulgaris* and *Pisum sativum* and compared with control. The observations have been presented in Table-1 (germination percentages) and 2, 3, and 4 (radicle length).

Germination percentage

The percentage germination of *Oryza sativa* in 1% and 2% aqueous extract of *Alnus nepalensis* were stimulated 2.13% and 4.25% respectively, the germination values were 96% and 98% in 1% and 2% aqueous extract respectively. The germination of *Oryza sativa* depressed 4.25% (*Artocarpus heterophyllus*) and 10.64 % (*Emblica officinalis*) in 2% aqueous extract. However, the germination was inhibited 1.06% in 1% aqueous extract of *Artocarpus heterophyllus* and did not show toxic effect in 1% aqueous extract of *Emblica officinalis* compared with control (Table 1).

Test crops	*Source of extracts*		*Time (Days)*					
			1	2	3	4	5	6
Oryza sativa	Control		00	88	94	94	94	94 (00)
	Alnus nepalensis	1%	00	20	90	92	94	96 (2.13†)
		2%	00	10	90	94	98	98 (4.25 †)
	Artocarpus heterophyllus	1%	00	82	93	93	93	93 (1.06)
		2%	00	68	84	86	90	90 (4.25)
	Emblica officinalis	1%	00	78	80	84	90	94 (00)
		2%	00	54	58	66	78	84 (10.64)
Phaseolus vulgaris	Control		08	84	92	98	100	100 (00)
	Alnus nepalensis	1%	06	46	98	98	100	100 (00)
		2%	06	28	54	92	94	96 (4.0)
	Artocarpus heterophyllus	1%	00	52	88	100	100	100 (00)
		2%	00	22	70	98	100	100 (00)
	Emblica officinalis	1%	12	60	70	96	96	96 (4.0)
		2%	00	62	92	92	94	96 (4.0)
Pisum sativum	Control		00	16	60	80	86	86 (00)
	Alnus nepalensis	1%	00	00	06	28	32	34 (60.46)
		2%	00	00	00	08	10	10 (88.37)
	Artocarpus heterophyllus	1%	00	00	06	32	42	52 (39.53)
		2%	00	00	00	06	20	48 (44.19)
	Emblica officinalis	1%	00	00	12	48	60	66 (23.25)
		2%	00	00	06	34	38	46 (46.51)

Table 1: Effect of aqueous extracts of tree species on germination (%) of test crops at 7 days after sowing (Data in the parenthesis indicate percent inhibition/stimulation† over control)

Similarly, *Phaseolus vulgaris* was also grown under same tree species and no toxic effect was found in 1% aqueous extract of *Alnus nepalensis* and 1% and 2% aqueous extract of *Artocarpus heterophyllus* (Table 1). Only the germination reduced 4.0% in 2% aqueous extract of *Alnus nepalensis* and 1% and 2% aqueous extract of *Emblica officinalis*.

Pisum sativum showed that there was high adverse impact of various tree components on percent germination in 1% and 2% aqueous extracts. The percent germination of *Pisum sativum* was 34%, 52% and 66% in 1% aqueous extract of *Alnus nepalensis*, *Artocarpus heterophyllus* and *Emblica officinalis* while, in 2% it was 10 % 48% and 46% under same species respectively. The maximum reduction (74.42%) (Irrespective of percent concentration) was observed to *Alnus nepalensis* and minimum (34.88%) was in *Emblica officinalis.*

The Germination of *Phaseolus vulgaris* (irrespective trees and percent concentration), was found most toxic followed by *Oryza sativa* and *Pisum sativum* was the most sensitive crop for these tree species.

Radicle length

For radicle length each test crop was also tested under same trees and control. The radicle length of *Oryza sativa* was measured and compared with that of control for six days (Table 2). In first day no radicle growth of *Oryza sativa* was recorded under all the treatments of *Alnus nepalensis*, *Artocarpus heterophyllus* and *Emblica officinalis*. Onward second day, the radicle growth was produced under all the treatments. Among the tree species and percent concentration, in sixth day the maximum reduction in radicle length of *Oryza sativa* reduced significantly (P<0.05, P<0.01) in 2% aqueous extract of *Emblica officinalis* as 1.29±0.15 cm. The value of radicle length in aqueous extract of *Artocarpus heterphyllus* and *Alnus nepalensis* were 4.03±0.21 cm and 3.54±0.23 cm; 4.71±0.20 cm and 3.30±0.15 cm for 1% and 2 % aqueous extracts respectively (Table 2). Thus, the radicle length of *Oryza sativa* restrain significantly (P<0.05, P<0.01) in all the aqueous extract of trees compared with control value (4.78±0.20 cm).

Source of extracts		*Time (Days)*					
		1	2	3	4	5	6
	00	0.82±0.08	1.71±0.06	3.32±0.17	4.17±0.21*	4.78±0.20	
Alnus nepalensis	1%	00	0.69±0.12 (15.85)	1.11±0.12** (35.09)	2.40±0.12** (27.71)	3.60±0.16* (13.67)	4.17±0.20 12.76
	2%	00	0.56±0.08 (31.71)	0.94±0.07** (45.03)	1.98±0.14** (40.36)	2.55±0.13** (38.85)	3.30±0.15** (30.96)
Artocarpus heterophyllus	1%	00	0.92±0.06 (12.19)†	2.08±0.10** (21.64)†	3.30±0.13 (0.60)†	3.37±0.14** (19.18)	4.03±0.21** (15.69)
	2%	00	0.67±0.05 (18.29)	1.46±0.11 (14.62)	2.28±0.17** (31.32)	2.82±0.18** (32.37)	3.54±0.23** (25.94)
Emblica officinalis	1%	00	0.59±0.08* (28.05)	0.87±0.10** (49.12)	1.55±0.09** (53.31)	1.81±0.13** (71.70)	2.37±0.16** (50.42)
	2%	00	0.51±0.01** (37.80)	0.84±0.07** (50.88)	1.07±0.12** (67.77)	1.11±0.13** (73.38)	1.29±0.15** (1.29)

**Significant P<0.01 level* *Significant P<0.05 level; ± indicates standard error of the mean values

Table 2: Effect of aqueous extracts of tree species on radicle length (cm) of *Oryza sativa* at 7 days after sowing (The data in the parenthesis indicate % inhibition/stimulation† over control)

The radicle length of *Phaseolus vulgaris* in 1% and 2% aqueous extract of *Artocarpus heterophyllus* and 2% aqueous extract of *Emblica officinalis* for first day reduced completely (100%). All the radicle length was observed in increasing order onward second day (Table-3). The radicle length of *Phaseolus vulgaris* was depressed significantly (P<0.05, P<0.01) in aqueous extract of *Alnus nepalensis* 1% (7.88±0.27 cm) and 2% (7.21±0.32 cm), *Emblica officinalis* 1% (8.93±0.63 cm) and 2% (6.92±0.32 cm) and *Artocarpus heterophyllus* 1% (8.78±0.55) and 2% (8.52±0.21), compared with control (9.99±0.56 cm).

Source of extracts	*Time (Days)*						
	1		2	3	4	5	6
Control		0.87±0.14	1.74±0.091	3.32±0.19	6.06±0.35	7.93±0.57	9.99±0.56
Alnus nepalensis	1%	0.56±0.12 (35.63)	1.61±0.13 (7.47)	3.81±0.17† (14.76)	5.42±0.24 (10.56)	7.07±0.30 (10.84)	7.88±0.27* (2.12)
	2%	0.46±0.03 (47.13)	0.81±0.07* (53.45)	2.53±0.24* (23.79)	4.85±0.24* (19.97)	6.16±0.30 (22.32)	7.21±0.32* (27.82)
Artocarpus heterophyllus	1%	00 (100)	1.41±0.11* (18.96)	2.75±0.21* (17.17)	5.63±0.28 (7.09)	7.26±0.37 (8.45)	8.78±0.55 (12.11)
	2%	00 (100)	1.37±0.14 (21.26)	2.43±0.23* (26.81)	4.96±0.31* (18.15)	6.38±0.35* (19.55)	8.52±0.21* (14.71)
Emblica officinalis	1%	0.83±0.33 (4.5)	2.11±0.15* (21.26) †	2.86±0.21 (13.85)	4.46±0.28* (26.40)	6.65±042* (16.14)	8.93±0.63 (10.61)
	2%	00 (100)	1.20±0.09* (31.03)	2.52±0.16* (24.09)	4.20±0.19* (30.69)	5.21±0.26* (34.38)	6.92±0.32* (44.36)

*Significant P<0.01 level *Significant P<0.05 level; ± indicates standard error of the mean values

Table 3: Effect of aqueous extracts of tree species on radicle length (cm) of *Phaseolus vulgaris* at 7 days after sowing (The data in the parenthesis indicate % inhibition/stimulation† over control).

Pisum sativum was also tested for aqueous extract in different tree species and none of the seed produced radicle growth for first and second day (Table 4). In third day except 2% concentration of *Alnus nepalensis* and *Artocarpus heterophyllus*, other treatments exhibited radicle growth. In sixth day the radicle length of *Pisum sativum* was reduced significantly (P<0.05, P<0.01) compared with control. The maximum and minimum radicle length of *Pisum sativum* in aqueous extract of *Alnus nepalensis* was 2.66±0.44 cm and 2.64±0.23 cm for 1% and 2 % aqueous extract respectively. Similarly other values of radicle length decreased with increasing aqueous concentration as 2.25±0.22 and 1.57±0.18 for 1% and 2% of *Artocarpus heterophyllus* and 2.65±0.30 and 2.31±0.26 for *Emblica officinalis* (Table 4).

Source of extracts		*Time (Days)*					
		1	2	3	4	5	6
Control		0.0	0.0	1.25±0.13	2.14±0.19	2.89±0.23	*3.64±0.32*
Alnus nepalensis	1%	0.0	0.0	0.50±0.05 (60)	1.45±0.54 (32.24)	2.04±0.21* (29.41)	*2.66±0.44 (26.92)*
	2%	0.0	0.0	00 (100)	1.37±0.19* (37.98)	1.90±0.45 (34.25)	*2.64±0.23* (27.47)*
Artocarpus heterophyllus	1%	0.0	0.0	0.43±0.03* (65.60)	1.50±0.16* (29.90)	1.95±0.17* (35.52)	*2.25±0.22*† (38.19)*
	2%	0.0	00	00 (100)	0.76±0.26* (64.48)	1.06±0.20* (63.32)	*1.57±0.18*† (56.87)*
Emblica officinalis	1%	0.0	0.0	1.15±0.24 (08)	1.42±0.16* (33.64)	2.28±0.15 (21.11)	*2.65±0.30*† (27.19)*
	2%	0.0	0.0	0.56±0.08 (55.20)	1.31±0.19* (38.78)	2.22±0.25* (23.18)	*2.31±0.26*† (36.54)*

*Significant P<0.01 level *Significant P<0.05 level; ± indicates standard error of the mean values

Table 4 Effect of leaf aqueous extracts of tree species on radicle length (cm) of *Pisum sativum* at 7 days after sowing (The data in the parenthesis indicate % inhibition/stimulation† over control)

Discussion

In the crop fields, at any given time there are at least more than one plant species growing together. In crop mixture or inter cropping systems, the major plant species are crops, besides, some weeds may also be presented. When the two plant species grow together they interact with each other either inhibiting or stimulating their growth or yield through direct or indirect allelopathic interaction.

Among the studies conducted for several species, Baker (1966) reported the *Eucalyptus globulus* produces volatile emanations that inhibit root growth of *Cucumis* species seedlings and also the

growth of hypocotyls, but not the roots of *Eucalyptus* seedlings. Singh and Bawa (1982) found leaf leachates of *Eucalyptus globulus* to be inhibitory to seed germination of *Glaucium flavus*. Many other species also reported for allelopathic to plant growth are *Celtis laevigata*, *Rhododendron albiflorum*, *Grevillea robusta*, *Quercus falcata*, *Quercus alba* (Rice, 1974, 1979), *Pinus roxburghii*, *Cedrus deodara*, *Quercus leucotrichophora*, *Myrica esculenta* (Melkania, 1983). Various workers have been reported allelopathic influences on certain tree crops (Saxena and Singh, 1987; Melkania, 1984; Suresh and Vinaya Rai, 1987; Bhatt and Todaria, 1990*)* for the different parts of the country.

Kaletha *et al* (1996) also done the similar study for aqueous extract of leaves and bark of *Grewia oppositifolia*, *Ficus roxburghii*, *Bauhinia variegata* and *Kydia calycina* on test crops *Echinochloa frumentacea, Eleusine coracana*, *Zea mays*,*Vigna unguiculata,* and *Glycine max* and found that the bark and leaf aqueous extracts of tree species were most toxic to food crops. Similarly Bhatt and Chauhan (2000) found allelopathic influenced of *Quercus* species on *Triticum aestivum*, *Brassica campestris* and *Lens culinaria* and found leaf and bark extract suppressed the germination, plumule and radicle length of all food crops.

Conclusions

As literature revealed that numerous plant species released organic compounds in the soil. Although these toxic substance may be useful to control weed, insect nematodes and disease pathogens. Therefore, some preventing measures should be taken to minimize the deleterious effects for plants especially as the earlier finding given by some workers as water drainage specially for *Oryza sativa* field which release phytotoxic substances out from poorly drained soil and increase soil productivity. Crop-rotation in monoculture soil sickness often occur due to imbalance of soil micro-organism leads accumulation of soil toxins mineral deficiency or abnormal soil pH which reduced soil productivity. Some time application of nutrient also found suitable to reduced phytotoxic effect. Besides that the tree species provides harmful effects especially leaves, should be lopped, at the time of growing crops which will reduced the toxic effects from the place.

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Threats to the sustainability of Ethno-Medicinal uses in Northern Pakistan (A Case Study of Miandam Valley, District Swat, NWFP Province, Pakistan)

Threats to the sustainability of Ethno-Medicinal uses in Northern Pakistan (A Case Study of Miandam Valley, District Swat, NWFP Province, Pakistan)

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Abstract

Miandam valley is best reprehensive of moist temperate forest geographically located 35, 02 N and 72, 33 E. The valley has over 300 plant species of which majority plants species are reported to be medicinal. The local community prepares medicines from these species through traditional way by using their indigenous knowledge for curing variety of disease. Decrease in medicinal plants has been observed in the last 30 years due to various threats and issues. Deforestation has been reported the main threat behind the declining trends of medicinal plants. The results shows that due to external pressures many plant species have been found endangered, rare and vulnerable. A high deforestation rate of 2% per year has been recorded over the last 30 years. Each year 8,053 trees are cutting in the valley for domestic and commercial consumption which is more than the actual yield provided by working circles and outside working circles areas. Current deforestation rate is leading towards substantial decrease in medicinal plant's wild production and hence can affect ethno-medicinal uses and the socio-economic condition of the associated people. It is necessary to find out ways and means for effective domestic and commercial uses of medicinal plants to ensure its sustainability.

Introduction

Medicinal plants are considered very important in primary health care system. A large number of plants are known for their medicinal properties. There is a large demand for medicinal herbs due to increase in the use of herbal formulations. Herbal medicines are used by about 75-80% of the world's population for primary health care because of better cultural acceptability, better compatibility with human body and lesser side effects. (Prajapati. N. D & Tarun Prajapati, 2002)

Earlier, medicinal plants were obtained from the forests. At that time in the forests they were in abundance and the consumption was in milligrams or grams. But now, the situation has reversed due to deforestation, uprooting of the plants for fulfilling the requirements and the craze for herbal globalization. So the medicinal plants have become endangered. Therefore, the rates have also increased and are unable to fulfill the requirement of the genuine material in the world.

People living in the mountainous ranges of Pakistani Himalayas, Hindukush and Karakuram are greatly dependent on medicinal plants for variety of uses. It proved to be a good income source and cheep source of curing diseases at local level. Currently medicinal plants are under severe threat of extinction due to rapid deforestation, over and improper collection, over grazing etc. The present study is an effort to analyze the current status of medicinal plants in the context of its value for the local people of Miandam valley, District Swat, NWFP-Pakistan.

Study Area

Miandam valley (Miandam watershed) is a 70km2 area and best representative of moist temperate forests. The valley is a beautiful summer resort about 56 km from Saidu Sharif, the capital of Swat with an altitude of about 2000 m. Most of the area is mountainous belonging to the Hindu Raj series of the Hindu Kush region. Geographically, the area can be traced on 35, 02 N and 72, 33 E. Total area of Miandam valley is 6,949 ha of which 638 ha is irrigated agricultural area, 1,081 ha un-irrigated agricultural area, 4,388 ha are under forest and 842 ha other area. The watershed of Miandam valley having 4388 ha forest area is the biggest watershed of Miandam Planning unit of District Swat Forest range. The forest area of Miandam watershed is having 25 compartments active with three working circles i.e. 2621 ha of timber production working circle, 460 ha of conservation working circle and 1307 ha of community use working circle. Most of the forest area has been covered by more than 10% conifer forests.

Materials and Methods

The study was conducted between the months of July and October. In the first month available literature was reviewed, relevant line departments and organizations were visited, and questionnaires were developed. Questionnaires were of two types i.e. for plants survey and social survey. Data was collected in the second and third month. In this regard individual and

group meetings were held to gather information from the representatives of 10% of total 2,380 households of the valley. Group data was collected through random sampling by interviewing 250 respondents from different walks of life. Individual questionnaires were filled from 50 locals selected on the basis of their knowledge regarding people, plants and their uses. They were plant collectors, hakeems, shopkeepers, elders and plant traders. PRA technique was used in five villages out of 14 for documentation of different practices regarding deforestation and agriculture of the area. Track visits in mountain were exercised for the documentation of medicinal plants. Lastly the collected data was then analyzed through mean, mode and median methods.

Results and Discussion

Flora of Miandam Valley

Depending upon variations in altitude, temperature, topography, soil type and moisture, vegetation of Miandam Valley can be classified into Olive-White Oak Forests, Blue Pine-Black Oak Forests, Fir-Spruce Forests, Tree Line Iron Oak Forests and Alpine Flora

Miandam valley consists of over 300 plant species. Out of total plant species, 179 are identified so far having medicinal uses (*Annexure 1*) followed by 33 ethno-veterinary, 29 Vegetables, 28 fodder, 15 wild fruit species, 11 fuelwood, 8 timber, 5 thatching plants, 4 mixing with tea species, 4 for gums and resin, 3 narcotic, 2 ornamental, 2 for decoration/handles making, 2 orchards support, 2 bees attractants, 1 specie avoid milk spoilage, 1 tooth cleaning, 1 as fumigant and 1 for graves sleepers. Majority of these species are either domestically consumed or marketed in the form of its produces.

Current Status of Medicinal Plants and its Ethno-Medicinal Uses

Conservation of species diversity is a matter of international concern. People of the area are using plants for medicinal uses since their abundance/frequency in their vicinities. Analysis of the opinion of the people in relation to international standards (Red Data Book of IUCN threatened species 1998) showed that 27 of the reported species are endangered (*Annexure 2*), 13 are rare and 10 are vulnerable in the area. Ethno-medicinal uses of endangered medicinal plants of Miandam valley is shown in annexure 2. Extinction of each endangered species from the area could result in eradicating knowledge regarding century's old traditional methods of curing disease from that particular specie.

Table 1 gives current status of medicinal plants analyzed through social survey. The results showed that majority of the respondents (91%) favored overall decrease in medicinal plants by almost 25% in the last 3-decades. Moreover, it was also found that in the last 30 years about 60% of the forest area has been deforested. Average rate of deforestation thus calculated in last 30 years is 2%/year. It is assumed that deforestation at this rate would take about 20 more years for complete deforestation of the Miandam valley.

Villages	Number of Respondents	*Current Forest Tree's Area (%)	Current status of medicinal plants after 30 Years			
			Decreased	Increased	Not change	Decrease by
Barampatai	20	25.8	19	-	1	36%
Sukarkata	10	24.7	7	1	2	7%
Serai	5	16.4	5	-	-	14%
Shahtoot	4	33.2	3	-	1	9%
Kotkey	6	31.1	3	-	3	30%
Jukhtai	26	29.9	24	1	1	21%
Dand	7	27.8	7	-	-	40%
Kulakareen	6	39.2	4	2	-	10%
Sanai	20	35.6	18	-	2	44%
Khairabad	25	29.1	25	-	-	35%
Shonga	15	65.0	15	-	-	15%
Gujarookaley	30	58.4	29	-	1	30%
Swatookaley	40	72.2	35	2	3	30%
Miandam	25	67.6	24	-	1	25%
Total/ Average/ Percentages	239	39.71%	218 (91%)	6 (3%)	15 (6%)	24.71%

*Comparison of current forest tree's area to that of 30 years back also implies that about 60% forest area has been deforested

Table 1: Status of Medicinal Plants and its Ethno-Medicinal Uses

Table 2 below gives a clear idea about major reasons behind medicinal plants decrease. 48% respondents were of the view that deforestation is the major reason behind NTFF decrease followed by 32 % favored over and improper collection, 12% grazing and 8% viewed that medicinal plants decreased due to conversion of forest land to agriculture land. Respondents also indicate some other adverse effects of deforestation that resulted decrease in snow and hence waters in river and springs decreased.

Deforestation

Domestic consumption of forest trees at valley's level was estimated as 28680 trees per annum used as fuel wood and houses construction. The preferred timber species are *Pinus wallichiana, Abies pindrow, Taxus wallichiana* and *Picea smithiana*. Main commercial uses associated to deforestation are timber and fuel wood selling. About 203,328 cubic feet timber wood equals 877 trees are exporting out each year from the valley. Similarly, an average of 2,828,750 kg fuel wood equals 581 trees are exporting from the whole valley.

Data from management plan reveals that Miandam valley consist a growing stock of 120,079 trees with an annual yield or supply of 2,037 trees from all working circles and outside working circles areas. If a tree is considered to have a weight of 4866 kg, height of 25 meter and DBH of 0.6 m then the current domestic and commercial demand of valley are about 8,053 trees per annum. Supply and demand difference is thus calculated as 6,016 trees (75% more than actual supply). It is presumed that in coming 20 years Miandam valley would be completely deforested due to which a lot of ground flora having majority of medicinal plants would be affected badly. This would ultimately leads towards lowering the preferences of local people towards indigenous ethno-medicinal uses.

Over and Improper Collection, Grazing, and Conversion of Forest Land into Agriculture Land

Another factor putting medicinal plants resources on stake is inappropriate and over collection. The people are unaware about proper collection and harvesting technique. Instead of collecting the desired part of the plant they uproot the entire plant thus making it vulnerable for extinction. About 45% losses have been observed in collection, carrying, cleaning, drying, domestic usage, marketing and grading of medicinal plants.

Free grazing of livestock is another worth mentioning problems contributes to the overall declining population of medicinal plants. 70% of the village livestock graze freely in summer seasons at upland pastures. Moreover, about 100 nomads each year carry 40,000 goats to pastures for which they pay to the owners of the pastures. They remain there for the summer season starting from March/April to Oct/Nov. This also poses a potential threat to the floral regeneration.

Conserving of forest area into agriculture land is one of the most serious problems leading to the loss floral diversity. Data of Swat forest range management plan shows a total of 406 ha of forestland converted into agriculture land.

Village	No of Respondents	Major Reasons of medicinal plants Decrease			
		Deforestation	Over and Improper Collection	Grazing	Conversion of Forest Area into Agriculture area
Barampatai	20	7	6	3	4
Sukarkata	10	3	5	1	1
Serai	5	3	2	-	-
Shahtoot	4	1	1	-	2
Kotkey	6	4	2	-	-
Jukhtai	26	13	9	3	1
Dand	7	1	4	2	-
Kulakareen	6	3	3	-	-
Sanai	20	15	3	1	1
Khairabad	25	10	7	3	5
Shonga	15	4	9	-	2
Gujarookaley	30	22	4	4	-
Swatookaley	40	17	10	11	2
Miandam	25	11	12	1	1
Total/Average	239	114	77	29	19
Percentages	100%	48%	32%	12%	8%

Table 2: Reasons of medicinal plant decrease

Conclusions

Miandam valley lies in the moist temperate region is stretched over an area of 6,949 ha (1,719 ha agricultural land, 4,388 ha forest area and 842 ha is wasteland). The valley is blessed with a floral diversity of over 300 plant species of which 190 plant species are known for a variety of uses. 179 plant species are being used locally for medicinal purposes as well add significant contribution to local economy in terms of trade. Certain threats are confronting to the existence of medicinal plants that are deforestation, over collection, grazing and conversion of forest land into agriculture area. Medicinal plants have been decreased by 25% in last 30 years for which deforestation has been identified as the major reason. About 8,053 forest trees are deforested each year both for domestic and commercial consumption. Wood consumption statistics of the valley showed that each year almost 75% more trees are cutting than the actual provision from all working circles and out side working circles area. Species decreasing quickly are *Pinus wallichiana, Abies pindrow, Taxus wallichiana*. With this deforestation rate the stocking could hardly be sustained for the next coming 20 years thus would make happen further substantial decrease in medicinal plant's wild production. Moreover, medicinal plants are free to access everywhere in the wild. The policy is not much effective to conserve them in the wild. It is concluded that ethno-medicinal uses of some important medicinal plant species are under severe threat of extinction that needs proper attention through addressing the above threats and problems.

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Annexure 1

Medicinal Plants of Miandam Valley

Acacia modesta Wall.	*Colchicum luteum* Baker.	*Melia azedarach* L.	*Rubus fruticosus* Linn.

Acacia nilotica Delile,	*Corydalis govaniana* Wall.	*Mentha longifolia* Z.K. Shinwari & M.N. Chaudhri	*Rumex dentatus* L.
Achillea millefolium L.	*Corydalis stewartii* Fedde,	*Mentha spicata* L.	*Rumex hastatus* D. Don,
Achyranthes aspera L.	*Corylus jacquemontii* Decne.	*Micromeria biflora* Benth.	*Salvia lanata* Roxb.
Aconitum violaceum Jacquem. ex Stapf,	*Cuscuta reflexa* Roxb.	*Morchella conica* Pers.	*Salvia moorcroftiana* Wall. ex. Benth.
Acorus calamus L.	*Cynodon dactylon* Steud.	*Morchella elata* Fr.	*Sambucus wightiana* Wall.
Adhatoda vasica Nees	*Cynoglossum lanceolatum* Heyne, ex Wall.	*Morchella esculenta* L.	*Sapindus detergens* Roxb.
Adiantum capillus-veneris L.	*Cyperus brevifolius* Hassk.	*Morchella ultima*	*Sarcococa saligna* Muell. Arg.
Adiantum incisum Forsk.	*Daphne mucronata* Royle,	*Morus alba* L.	*Saussurea lappa* C. B. Clrake,
Adiantum venustum	*Daphne oleoides* Schreb.	*Myrsine africana* L	*Sesamum indicum* L.
Aesculus indica Coleb. ex Wall.	*Datura inoxia* Mill.	*Myrtus communis* L.	*Silene vulgaris* Garcke,
Ajuga bracteosa Benth.	*Datura stramonium* L.	*Nasturtium officinale* R.. Br.	*Sisymbrium irio* Linn.
Allium cepa Linn.	*Dioscorea deltoidea* Wall.	*Neolitsea chinensis* Chun	*Skimmia laureola* Sieb. & Zucc. ex Walp.
Allium sativum Linn.	*Diospyros lotus* Linn.	*Nepeta govaniana* Benth.	*Solanum nigrum* L.
Amaranthus viridis Linn.	*Dryopteris jaxtaposta* christ.	*Olea ferruginea* Royle,	*Solanum surattense* Burm. f.
Arenaria griffithii Boiss.	*Echinops echinatus* Roxb.	*Onosma hispidum* Wall.	*Solanum xanthocarpum* Schrad. & Wendl.
Arisaema flavum (Forssk.) Schott	*Elaeagnus umbellata* Thunb.	*Otostegia limbata* Benth. ex Hook. f.	*Sonchus asper* Wolf. ex DC.
Arisaema jacquemontii Blume,	*Equisetum arvense* L.	*Paeonia emodi* Wall.	*Spiraea chinensis* Maxim.
Artemisia scoparia Waldst. & Kit.	*Eruca sativa* Mill.	*Papaver dubium* L.	*Stachys parviflora* Benth.
Artimisia brevifolia Wall.	*Euphorbia helioscopia* Linn.	*Periploca aphylla* Decne.	*Stellaria media* Cyrill.

Artimisia vulgaris L.	*Euphorbia wallichii* Hook.F.	*Picea smithiana* Boiss.	*Swartia alata* Royl. ex D. Don,
Asparagus adscendens Roxb.	*Fagonia arabica* Linn.	*Pimpinella diversifolia* DC.	*Taraxacum officinale* Weber,
Atropa acuminata Royle.	*Ficus palmata* Roxb.	*Pinus wallichiana* H. Ohba & M. Suzuki	*Taxus wallichiana* Zucc.
Avena sativa Linn.	*Foeniculum vulgare* Mill.	*Pistacia integerrima* Stew. ex Brand.	*Thymus linearis* Benth.
Berberis lycium Royle.	*Fragaria vesca* Linn.	*Plantago lanceolata* L.	*Thymus serpyllum* L.
Bergenia ciliata (Haw.) Sternb.	*Fumaria indica* Pugsley	*Plantago major* L.	*Trachyspermum ammi* Sprague
Berginia stracheyi Stein,	*Geranium wallichianum* D. Don,	*Platanus orientalis* L.	*Tribulus terrestris* L.
Bistorta amplexicaulis (D. Don) Greene	*Gynandriris sisyrinchium* Parl.	*Podophyllum emodi* Wall.	*Trigonella foenum-graecum* Linn.
Bunium persicum B. Fedstch.	*Hedera nepalensis* K. Koch,	*Podophyllum hexandrum* Royle,	*Urtica dioica* L.
Bupleurum longicaule Wall.	*Heracleum candicans* Wall.	*Polygonatum aviculare L.*	*Valeriana jatamansi* Jones.
Butea frondosa Roxb.	*Hyoscyamus niger* L.	*Polygonatum multiflorum* All.	*Valeriana wallichii* DC.
Calotropis procera Dryand.	*Hypericum perforatum* Linn.	*Polygonatum verticillatum* All.	*Verbascum thapsus* L.
Caltha alba Jacquem.	*Hyssopus officinalis* Linn.	*Polygonum aviculare* L	*Verbena offcinalis* L.
Cannabis sativa L.	*Indigofera heterantha* Wall.	*Portulaca oleracea* L.	*Viburnum grandiflorum* Wall.
Capsella bursa-pastoris (L.) Medik.	*Isodon rugosus* Codd	*Primula denticulata* Sm.	*Viola biflora* L.
Caralluma edulis Benth. ex Hook. f.	*Jasminum officinale* Linn.	*Pteridium aquilinum* (L) Kuhn.	*Viola serpens* Wall.
Carum carvi Linn.	*Juglans rejia* Linn.	*Punica granatum* L.	*Vitex negundo* L.
Cedrus deodara (Roxb. ex Lambert)	*Juniperus communis* Linn.	*Pyrus pashia* Buch.-Ham. ex D. Don,	*Withania coagulans* Dun.
Celtis australis Linn.	*Lathyrus aphaca* Linn.	*Quercus dilatata* Lindl.	*Withania somnifera* (L.) Dun.

Chamomilla recutita Rauschert.	*Launaea procumbens* Amin	*Quercus incana* Roxb.	*Zanthoxylum alatum* Roxb.
Chenopodium album L.	*Lepidium sativum* L.	*Rheum australe* D.Don,	*Zanthoxylum armatum* DC.
Chenopodium botrys L.	*Lotus corniculatus* L.	*Rhus semialata* Murr.	*Ziziphus sativa* Gaertn.
Cichorum intybus L.	*Male fern*	*Ricinus communis* L.	*Zizyphus mauritiana* Lam.
Citrullus colocynthis Schrad.	*Mallotus philippensis* Karst.	*Rosa moschata* Benth.	*Zizyphus vulgaris* Lam.
Colchicum autumnale L.	*Melia azedarach* L.	*Rubia cordifolia* Hochst. ex A. Rich.	

Annexure 2
Ethno-medicinal Uses of Endangered Medicinal Plants of Miandam Valley

S#	Botanical Name	Family Name	Local Name	Ethno-medicinal Uses
1	*Aesculus indica* Coleb. ex Wall.	Sapindaceae	Jawaz	Bark and seeds contain glucosid aesculin, faxin used as tonic and astingent, relieves haemorroea
2	*Arisaema flavum* (Forssk.) Schott	Araceae	Marjarey	Small amount of ground rhizome is given orally in bolus form to cows and buffaloes for acute respiratory tract infection with cough
3	*Artimisia brevifolia* Wall.	Compositae	Tarkha	Dried young shoot and leaves internally in bolus form is applied for promoting digestion and killing worms
4	*Bistorta amplexicaulis* (D. Don) Greene	Polygonaceae	Tarwa Pana, Anjabar	The powdered rhizome is taken with a glass of water for the treatment of rheumatism and gout
5	*Caralluma edulis* Benth. ex Hook. f.	Asclepiadaceae	Pamankai	Juicy stem is bitter tonic, febrifuge, stomachic and carminative useful in rheumatism. As a vegetable cooked with minced meat
6	*Colchicum autumnale* L.	Liliaceae	Sarba Zeala	The bulb contains viscid milky juice, infaming the mouth, tounge; in small doses it acts as diuretic; in large doses it is strong sedative and cathartic; given in gout and rheumatism
7	*Colchicum luteum* Baker.	Liliaceae	Qaimat guallay	Its fried corms are used for arthritis and rheumatism. Both its bark and seed are sold for its precious rates in the drug markets

8	*Corylus jacquemontii* Decne.	Cupuliferae	Zangali Badam	Generally used as brain tonic
9	*Dioscorea deltoidea* Wall.	Dioscoreaceae	Kaneez	Employed in the treatment of bilous colic; as diuretic, expectorant
10	*Geranium wallichianum* D. Don,	Geraniaceae	Srazel	Root decoction is used with pods of pesticia chinensis integrima used for curing of kidney disease, cough and fever
11	*Hyssopus officinalis* L.	Labiatae	Goli Zofa	Considered as general body and brain tonic
12	*Juniperus communis* L.	Confirae	Awbeer	Used as stimulant, diuretic and carminative
13	*Neolitsea chinensis* Chun	Lauraceae	Pewand zeala	Bark is demulcent, astringent and used in diarrhea, and dysentery. Also considered as Tonic
14	*Paeonia emodi* Wall.	Ranunculaceae	Mamekh	Used for Backache weakness
15	*Podophyllum emodi* Wall.	Berberidaceae	Kakora	The powdered rhizome with some other plants is used to control jaundice and other liver disease.
16	*Podophyllum hexandrum* Royle,	Berberidaceae	Kakora	The powdered rhizome with some other plants is used to control jaundice and other liver disease.
17	*Polygonatum multiflorum* All.	Liliaceae	Nooreallam	Infusion of its Rhizome is used for inflamation of bowels and stomach used in chronic dysentery. It is reffered as aphrodisiac
18	*Polygonatum verticillatum* All.	Liliaceae	Nooreallam	The decoction of fresh rhizome is mixed with sugar and used for treatment of joint pain
18	*Primula denticulata* Sm.	Primulaceae	Mamera	Locally the infusion form young stem base is used in eye for opthalmia
20	*Pteridium aquilinum* (L) Kuhn.	Pteridaceae	Kwanjai	Used in stomach disorder
21	*Rubia cordifolia* Hochst. ex A. Rich.	Rubiaceae	Srajarai	Root is astringent and tonic also used for Back Pain
22	*Saussurea lappa* C. B. Clrake,	Compositae	Sharshamay	Root is tonic, stomachic, stimulant, carminative and used as spasmodic in asthma, cough and cholera

23	*Skimmia laureola* Sieb. & Zucc. ex Walp.	Rutaceae	Nazar Panra	Its leaves are burnt as incense and to expel evils and evil eyes. Tea made from the leaves used for dyspepsia, smoke used as antiseptic.
24	*Solanum nigrum* L.	Solanaceae	Kamacho	Leaves in past form is applied to skin for treatment of eczema, fruits edible and are used in fever
25	*Taxus wallichiana* Zucc.	Coniferae	Banrya	Powdered bark is used as emmenagogue and antispasmodic. Dried leaves are sold for its use in shampoo
26	*Valeriana jatamansi* Jones.	Valerianaceae	Mushk-e-Bala	Unknown local uses, it is sold in the drug market for preparation of some anti spasmodic and carminative drugs.
27	*Viburnum grandiflorum* Wall.	Caprifoliaceae	Amoch	Locally the fresh fruit of *Viburnum grandiflorum* is eaten for the curing of stomachache

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Folk medicinal knowledge and conservation status of some economically valued medicinal plants of District Swat, Pakistan

English

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Abstract

This paper is based on an ethnobotanical project, carried out in the remote Hindu Kush mountain region of District Swat, Pakistan. The prime objectives of the project were to explore the conservation status, folk medicinal knowledge and traditional pre and post harvesting techniques of some economically important medicinal plants of the area. It was observed that 49 medicinal plants belonging to 32 families were collected and traded in the herb markets of Swat. Most of these plants are used by local population for curing different ailments, while some are exported to other parts of Pakistan. The traditional plant collection techniques have resulted in huge losses of these valuable plant resources. The conservation assessment of these plants revealed that due to increased exploitation and un-sustainable harvesting, 49% of these economically valued medicinal plant species are threatened.

Key Words: Folk medicinal uses; Conservation; District Swat; HinduKush-Himalayas

Introduction

Plant containing active chemical constituents in any of its part or parts like root, stem, leaves, bark, fruit and seed which produces a definite curing physiological response in the treatment of various ailments in humans and other animals is termed as medicinal plant. The various chemicals work together to reach equilibrium in the body as they do in the plant, and so produce gentle progressive healing within the body tissues.

From the earliest times mankind has used medicinal plants in an attempt to cure diseases and relieve physical suffering. Medicinal plant knowledge has usually resulted from trial and error, and was based on speculation and superstition. Medicinal plants remain the prime source of primary health care throughout the world for thousands of years. However, in the middle of 20th century, the contribution of medicinal plants was reduced by approximately one fourth as researchers favored the use of synthetic chemicals for curing diseases. Now this trend is reversing in favor of medicinal plants as they contain natural products that are chemically balanced, effective and least injurious with none or much reduced side effects as compared to synthetic chemicals. Herbal medicine is thus experiencing a revival in Western society, along with other complementary therapies such as Traditional Chinese Medicine, Osteopathy, and Homeopathy. In general, people are becoming more aware of the harmful side effects of artificial commodities and are realizing the benefits of a more natural way of life.

It has been estimated that about 20,000 plant species are used for medicinal purposes throughout the world. According to World Health Organization report (2002), 70% of the world population use medicinal plants for curing diseases through their traditional practitioners. In sub-continent, plant oriented drugs are used extensively and from a very long time. According to a survey conducted by W.H.O., traditional healers treat 65% patients in Srilanka, 60% in Indonesia, 75% in Nepal, 85% in Mayanmar, 80% in India and 90% in Bangladesh. In Pakistan, 60% of the population, especially in villages is getting health care by traditional practitioners (Hakims), who prescribe herbal preparations (Haq, 1983).

Developed countries, are turning to the use of traditional medicinal systems that involve the use of herbal drugs and remedies. About 1400 herbal preparations are used widely, according to a recent survey in Member States of the European Union. Herbal preparations are popular and are of significance in primary healthcare in Belgium, France, Germany and the Netherlands. Such popularity of healthcare plant-derived products has been traced to their increasing acceptance and use in the cosmetic industry as well as to increasing public costs in the daily maintenance of personal health and well being. Examples of such beauty-oriented therapeuticals are skin tissue regenerators, anti-wrinkling agents and anti-age creams. Most dermaceuticals are derived from algal extracts that are rich in minerals and the vitamin B group. Skincare products such as skin creams, skin tonics, etc. derived from medicinal plants are grouped together as dermaceuticals. Also, amongst the poor, cures and drugs, derived from plants, constitute the main source of healthcare products (Hoareau and Da Silva, 1999).

The practice of traditional medicine is widespread in China, India, Japan, Pakistan, Sri Lanka and Thailand. In China about 40% of the total medicinal consumption is attributed to traditional tribal

medicines. In Thailand, herbal medicines make use of legumes encountered in the Caesalpiniaceae, the Fabaceae, and the Mimosaceae. In the mid 90s, it is estimated that receipts of more than US$ 2.5 billion have resulted from the sales of herbal medicines. In Japan, herbal medicinal preparations are more in demand than mainstream pharmaceutical products.

The development and commercialization of medicinal plant based bio-industries in the developing countries is dependent upon the availability of facilities and information concerning upstream and downstream bio-processing, extraction, purification, and marketing of the industrial potential of medicinal plants. Absence of such infrastructure compounded by lack of governmental interest and financial support restricts the evolution of traditional herbal extracts into authenticated market products. Furthermore the absence of modernized socio-economic and public healthcare systems reinforces reliance of rural and low income urban populations on the use of traditional medicinal herbs and plants as complementary aids to routine pharmaceutical market products.

Materials and Methods

Study Area: SWAT

The valley of Swat is located in the remote Hindu-Kush mountains of Pakistan. The valley of Swat is one of the most scenic places of sub-continent and is called Switzerland of the sub-continent. Swat has large number of beautiful valleys and also innumerable monuments of ancient Ghandhara civilization.

Swat is situated at the northwest corner of Pakistan. It lies from 34° 34’ to 35° 55’ north latitudes and 72° 08’ to 72° 50’ east longitudes. It is bounded by Chitral and Ghizer on the north, Indus Kohistan and Shangla on the east, Buner and Malakand protected area on the south and Dir on the west (Anonymous, 1998). The total area of the Swat is 5337 Km-2 and population of about 1.3 million. Swat is part of the Malakand Division.

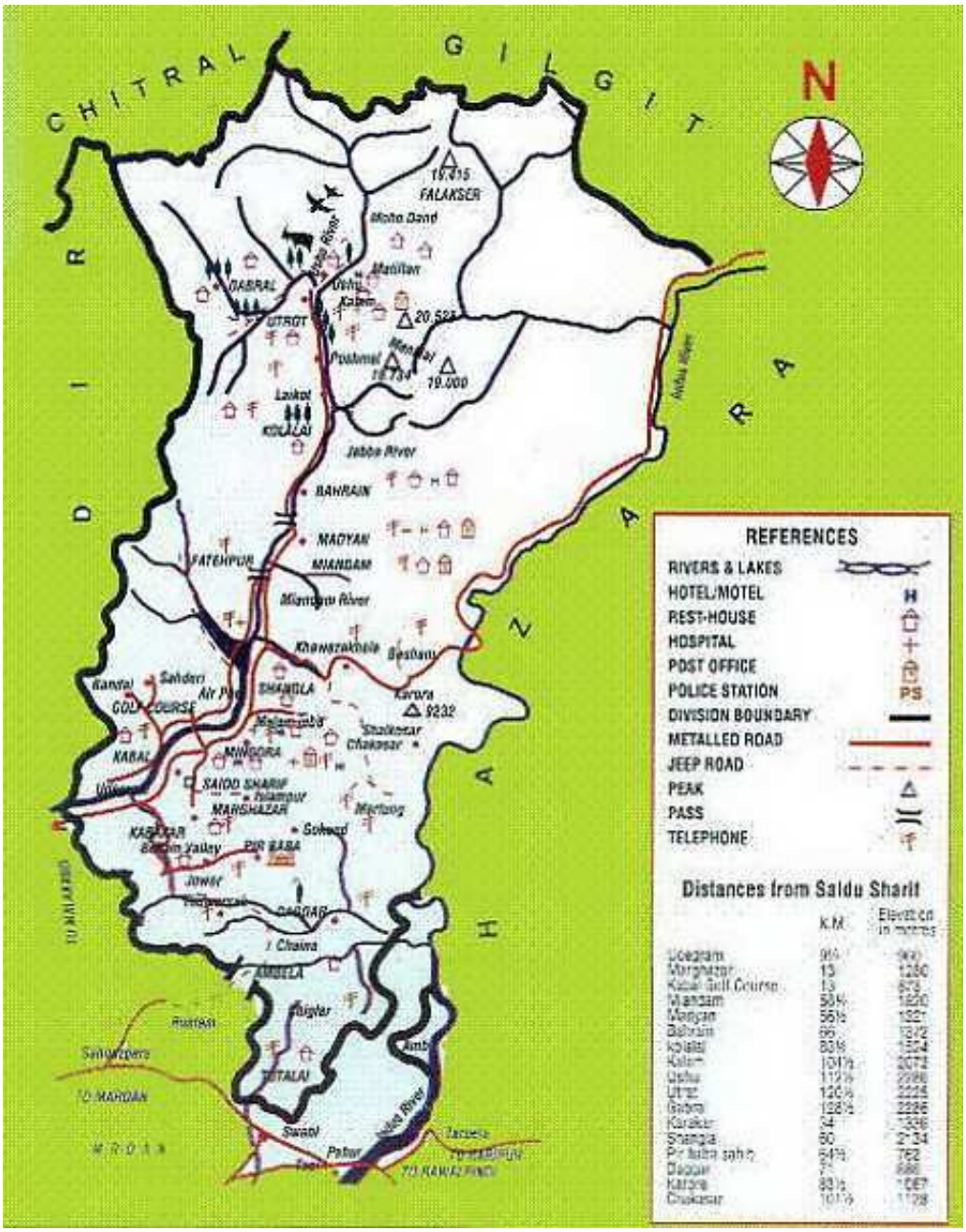

Figure 1: Map of District Swat

Swat can be divided into two regions i.e., Swat-Kohistan and Swat Proper. Swat-Kohistan is the mountainous country on the upper reaches of the Swat river up to Ain in the south. The whole area south of Ain is Swat proper, which can be further divided into:

Ethnicity and Tribes

Swat has predominantly rural population. It is inhabited by Yousafzai Pathans, Mians, Kohistanis, Gujars and Pirachas. The Pashto speaking Yousafzai Pathans are the direct descendants of Afghan of Ghazni. The Gujars and Kohistanis, who speak their own dialects of Gujri, Garwi, Torwali and Kohistanis inhabit the mountainous areas up north. The Kohistanis are settled in and around Kalam, Ushu, Utror and Gabral valleys. The nomadic Gujars also form a substantial part of the population in the northern parts of Swat valley.

Ghandhara Civilization

Swat, has been home to Buddhism from about 6th century BC to 7th century AD. Buddhism flourished in Swat and spread to other parts of Asia from here. This great progress became possible due to personal dedication of King Ashoka to Buddhism. During his reign, Buddhism spread to Tibet, China, Bhutan, Korea and Japan. Many monasteries have been found, where monks were used to

live. Some historians consider Swat as the center of Ghandhara civilization.

Figure 2: Buddha carved on a mountain rock near TindoDog, Swat

Figure 3: Statue of Buddha (Swat Museum)

Flora of Swat

District Swat contains about 1550 taxa of flowering plants and 55 Pteridophytes. There are seven types of forests from tropical dry deciduous to alpine. There are various reports about ethnobotanically important medicinal plants; the number varies from 55 to 345 species in Swat (Ahmad & Sirajuddin, 1996). The flora of swat is very diverse and unique as the area is a nexus of three big mountain ranges namely Karakorum, Hindu-kush and Himalayas.

Methods

The field work includes interviews, observations and guided field walks/ transects walks. Two methods i.e. observations and interviews were frequently used during the field work. Observations were made while visiting different villages. During this process, local methods of medicinal plants collection, storage, drying, harvesting time, processing and utilization were observed. During field work, interviews were conducted with the local inhabitants, selected informants, the herbalists 'hakims' (local physicians of eastern system of medicine), pansaries (medicinal plants sellers in the local markets). Questionnaire method was adopted during the surveys in order to get qualitative and participatory approach about the plant resources and their utilization by the local people. Questions concerning the utility of different plants, quantity of plants used, rate of consumption, availability, economics/market value was asked.

Conservation status of medicinal plants

Local people especially plant collectors got valuable information about plants abundance, distribution and localities of their maximum availability. These information's were confirmed through field visits. Personal observations were made in the field keeping several parameters in consideration. These observations include, Range extent and area of occupancy; Exploitation level; Plants availability; Habitat alternation; Conservation efforts; Plant collection techniques; Part collected; Invasive plants; Threats (Pollution, Urbanization, Lack of awareness, Deforestation etc.).The species were then categorized into Critically Endangered, Endangered, Vulnerable, Rare, Near Threatened and Secure.

[[Results and Discussion]]

During the present study, it was observed that 49 medicinal plants species belonging to 32 different families were sold in local markets and thus these play a role in uplifting the socioeconomic conditions of the area. Some of these medicinal plants are traded to national herb markets of Lahore, Karachi and Peshawar. It was observed that out of these 49 medicinal plants 24 plant species are threatened (9 Endangered, 7 Vulnerable and 8 Rare) due to excessive collection from the wild. These plants are also used locally for curing different ailments. In most cases, the market availability status of these medicinal plants have increased, showing an increased inclination of local people towards medicinal plants collection and increased dependency of local population on medicinal plants trade. A brief set of information about these plants is given below.

Table 1: Folk medicinal uses, market availability status, conservation status of some important medicinal plants of Swat, Pakistan

Plant Material	Part Used	Market Status	Conserv. Status	Folk Medicinal Uses
Araceae				
Acorus calamus L. [Skha waja]	Whole plant	Persistent	Endangered	Cough, dyspepsia, flatulence, colic and diarrhea
Amaranthaceae				
Achyranthus aspera L. [Gishkay]	Rhizome/ fruit	Increased	Secure	Diuretic, laxative, stomachic and for removing kidney stones
Adiantaceae				

Adiantum capillus-veneris L. [Sumbal]	Fronds	Increased	Vulnerable	Skin diseases, fever, cough and diabetes Expectorant, emetic and diuretic
Adiantum incisum Forssk [Sumbal]	Fronds	Increased	Secure	Skin diseases, fever, cough and diabetes Expectorant, emetic and diuretic
Alliaceae				
Allium sativum L. [Ooga]	Bulbs/ leaves	Increased	Secure	Heart diseases, diaphoretic, diuretic, expectorant, antiseptic, flatulence, asthma, whooping cough and epilepsy
Anacardiaceae				
Pistacia integerrima Stew.ex Brand [Shanai]	Leaves	Increased	Vulnerable	Jaundice and chronic wounds
Apiaceae				
Bunium persicum B. Fedtsch [Tora Zeera]	Fruit	Increased	Rare	Carminative, stomachic and stimulant
Coriandrum sativum L. [Dhanyal]	Leaves/ seeds	Increase	Secure	Piles, gastric juice secretion and colic
Foeniculum vulgare Mill [Kaga]	Leaves/ seeds	Increased	Secure	Diuretic, digestive, laxative, aphrodisiac and improve eyesight
Araliaceae				
Hedera nepalensis K.Koch [Da Wano Kalay]	Leaves	Increased	Secure	Anticancer
Artemisia brevifolia Wall [Jaukay]	Flower head	Increased	Secure	Respiratory stimulant, intestinal worms, purgative and ear ache
Artemisia vulgaris L [Tarkha]]	Leaves/ shoot	Increased	Secure	Intestinal worms and skin diseases
Calendula arvensis L. [Zair Gulae]	Leaves/ flowers	Increased	Secure	Scrofula, diaphoretic, antihelminthic and tonic
Berberidaceae				
Berberis lycium Royle [Speen Kwaray]	Whole plant	Increased	Vulnerable	Stomachic, intestinal colic, expectorant, diuretic, diarrhea, piles, jaundice and internal wounds

Berberis vulgaris Linn [Tor Kwaray]	Whole plant	Persistent	Endangered	Stomachic, intestinal colic, expectorant, diuretic, diarrhea, piles, jaundice and internal wounds
Dioscoreaceae				
Dioscorea deltoidea Wall. [Kanees]	Tubers	Decreased	Endangered	Uterine sedative, haemostatic, diuretic, expectorant, antihelminthic
Ebenaceae				
Diospyos lotus L. [Tor Amlook]	Fruits/ leaves	Increased	Secure	Carminative, purgative and flatulence
Ephedraceae				
Ephedra gerardiana Wall. ex Stapf [Asmani Bootai]	Fruit/ leaves	Increased	Vulnerable	Asthmatic bronchitis, rheumatism and cardiac circulatory stimulant
Fumariaceae				
Fumaria indica Pugsley [Papra]	Shoot	Increased	Secure	Blood purifier, diaphoretic and antipyretic
Helveliaceae				
Morchella conica Fries [Gujai]	Whole plant	Persistent	Rare	General body tonic, joins aches or potency, insomnia, enterogastritis, indigestion and poor appetite
Morchella esculenta (L.) Pers. [Gujai]	Whole plant	Persistent	Rare	General body tonic, joins aches or potency, insomnia, enterogastritis, indigestion and poor appetite
Juglandaceae				
Juglans regia L. [Ghuz]	Bark/ leaves	Increased	Secure	Bark (Dandasa) is used for cleaning and sparkling teeth. Decoction of leaves is given in eczema and intestinal worms.
Lamiaceae				
Ajuga bracteosa Wall. ex. Benth [Khwaga Bootei]	Whole plant	Increased	Secure	Internal colic, pimples, jaundice, hypertension and sore throat
Mentha longifolia (L.) Huds. [Villanay]	Whole plant	Increased	Rare	Anti-rheumatic, stomachic, carminative, tonsillitis, diarrhea and dysentery

Mentha spicata L. [Podian]	Leaves	Increased	Secure	Dyspepsia and carminative
Salvia moorcroftiana Wall.ex Benth [Khur Dug]	Leaves/ seeds	Increased	Secure	Wound healing
Thymus linearis Benth. [Kaneesh]	Fruits	Increased	Rare	Cold, cough and digestive trouble
Liliaceae				
Colchicum luteum Baker. [Suranjan-e-talkh]	Rhizome/ seeds	Increased	Vulnerable	Blood purifier, laxative and aphrodisiac
Polygonatum verticillatum All. [Peramole]	Rhizome	Persistent	Endangered	Rheumatism and aphrodisiac
Myrsinaceae				
Myrsine africana L. [Maru Rang]	Leaves	Increased	Secure	Carminative, appetizer, flavoring agent
Paeoniaceae				
Paeoniaceae *Paeonia emodi* Wall. ex Hk.f. [Mamaikh]	Rhizome/ seeds	Persistent	Endangered	Backbone ache, dropsy, epilepsy, emetic, cathartic, blood purifier, colic, purgative and tonic
Plantaginaceae				
Plantaginaceae *Plantago lanceolatum* L. [Jabai]	Leaves/ seeds	Increased	Rare	Sores, wounds and inflammation healing, laxative, mouth diseases and dysentery
Podophyllaceae				
Podophyllum hexandrum Royle [Kakorra]	Rhizome	Persistent	Endangered	Hepatic stimulant, purgative and emetic
Polygonaceae				
Bistorta amplexicaulis (D. Don) Greene [Tarva Panra]	Rhizome	Persistent	Endangered	Ulcer

Rheum australe D. Don [Chotial]	Rhizome/ Leaves	Increased	Secure	Purgative, astringent tonic, alexiterix, emmenagogue, diuretic, biliousness, lumbago, sore eyes, piles, chronic bronchitis, fever, asthma, pain, bruises, blood purifier, stomachic, dyspepsia and laxative
Portulacaceae				
Portulaca olearacea L. [Warkharay]	Seeds/leaves	Increased	Secure	Kidney, liver, urinary bladder and lungs diseases
Punicaceae				
Punica granatum L. [Anar]	Fruit/ bark/ leaves	Increased	Secure	Skin diseases, dysentery, blood purifier, whooping cough, laxative, antihelminthic, antipyretic and expectorant
Rhamnaceae				
Rhamnaceae *Zizyphus sativa* Gaert [Markhanaey]	Fruits	Increased	Secure	Astringent, cooling effect
Ranunculaceae				
Aconitum violaceum Jacq. ex Stapf [Zahar mora]	Rhizome	Persistent	Vulnerable	Gout and Rheumatism
Saxifragaceae				
Bergenia ciliata (Haw) Sternb. [Qamar Panra]	Leaves; Rhizome	Increased	Endangered	Muscular pain, pus discharge and tonic
Solanaceae				
Capsicum annuum L. [Marchakay]	Fruits	Increased	Secure	Common cold, dyspepsia and diarrhea Nervous disorders, asthma, whooping cough, antispasmodics, sedative and astringent to bowels
Hyoscyamus niger L. [Dewana Bhang]	Fruits	Increased	Secure	Common cold, dyspepsia and diarrhea Nervous disorders, asthma, whooping cough, antispasmodics, sedative and astringent to bowels
Solanum surratense Burm. f. [Manraghonay]	Fruits	Increased	Secure	Expectorant, stomachic, diuretic, anti-asthmatic, anti-gonorrhea, cough and fever pain in chest

Withania somnifera (L.) Dunal [Kutilal]	Leaves/ fruits/ roots	Increased	Secure	Poultice to swellings, ulcers and carbuncles, diuretic, rheumatism and aphrodisiac tonic
Thymeleaceae				
Daphne mucronata Royle [Laighonai]	Fruits	Increased	Vulnerable	Rheumatism
Valerianaceae				
Valeriana jatamansi Jones [Mushk-e-Bala]	Rhizome	Decreased	Endangered	Cholera, dysentery, hysteria and antispasmodic
Violaceae				
Viola biflora L. [Banafsha]	Flower	Increased	Rare	Diaphoretic, antipyretic, febrifuge, cancer, epilepsy and nervous disorders
Viola canescens Wall. ex Roxb [Banafsha]	Whole plant	Increased	Rare	Astringent, demulcent, purgative, diaphoretic, antipyretic, febrifuge and anti cancerous
Verbenaceae				
Vitex negundo L. [Marvandaey]	Leaves / roots / seeds	Increased	Secure	Febrifuge, diuretic, antihelminthic, headache and tonic

Medicinal Plants Collectors and Collection

Medicinal plant collectors are usually poor villagers. Plant collection is there part time activity besides farming and live stock rearing. They collect medicinal plants during spring and summer season which starts from April to September and sell it in the local market to earn some money. One can see a person coming from a hilltop with a bundle of fuel wood of his head and a bag of medicinal plants in his hands. He handover his bag of medicinal plants to local Pansaris and put in his pocket whatever money he gets. According to Choudhary *et al.* (2000) about 500 families are involved in medicinal plant collection in Swat and they collect 5000 tons of medicinal plants annually. However, no economic analysis exists to date for the marketing chain from collection to consumption systems. It is also necessary to know that how much plant material is collected and passing through the whole process of refinements how much quantity reaches to the market. It will give us the rough picture of the whole system from collection to consumption. It may also be the one reason of overexploitation of highly valuable and endangered medicinal plants. All available data is related to quantities traded in markets at a specific time and their approximate values.

Bulk of medicinal plants collected in the area is rhizomatous. The collectors carry with them digging tools and dig medicinal plant wherever found. Major proportions of plants collected are sold in fresh while some plants are stored in bags and sacks from one week to one year. Before storing, these plants are washed and kept under the sun for drying. During storage considerable amounts of medicinal plants are wasted due to humidity, insect attacks, inappropriate storage facilities and lack of awareness on the part of collectors.

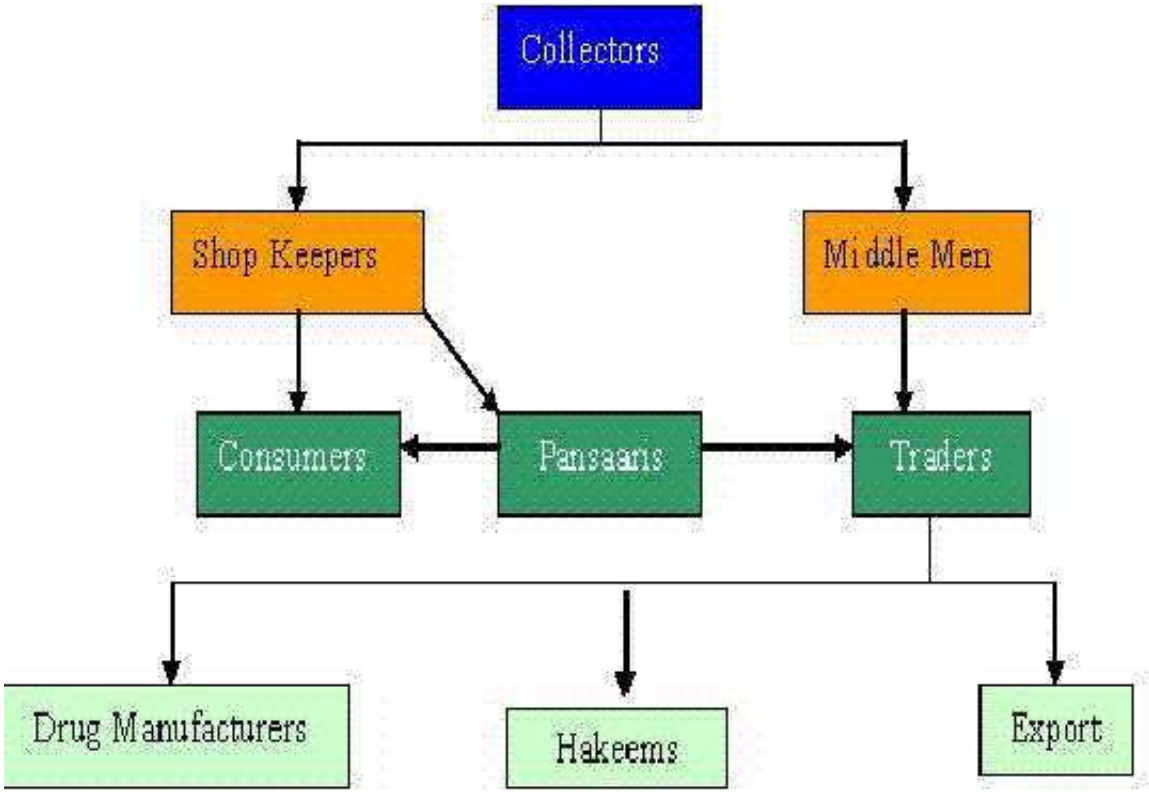

Figure 4: Chain of people involved in the medicinal plant trade in Swat

Medicinal plants are collected extensively during the summer season starting from March when the snow has almost melted to September. The collectors include men, women and children. The women and children collect plants while on their way to work in the fields and surrounding areas of their work place. The women and children of nomads (Ajar) families collect medicinal plants while grazing their livestock. This type of collection of medicinal plants is carried out on daily basis.

Drawbacks of Traditional Collections and Post Collection Processing

1. The collectors are mostly ignorant about the proper time of collection of medicinal plants. An early or late collection of medicinal plants result in an inferior quality of drug. The ideal time of a plant collection is that when plant contain maximum amounts of therapeutically active principles. Majority of medicinal plants collected are rhizomatous. These plants are primarily collected in summer and during this period the plant utilize the root chemistry and nutrition for the development of aerial parts and fruit yield. As a result the rhizomes collected are depleted of active chemical constituents. The ideal time for the collection of these plants is winter or early spring (November to February) when the plants are dormant. During this period the plant converts the nutritional chemistry of aerial parts in to alkaloidal contents and stores it in the underground parts. Thus the plant at this stage contains maximum percentage of active ingredients in its rhizome/roots. Beside this the rhizome collection has resulted in a drastic decrease of these medicinal plants in the area.
2. Medicinal plants degraded in terms of their active constituents if they are not properly dried. The local collectors are also unaware of the bleaching effect of sun rays on colored or other light sensitive drugs. The night dew and humidity also deteriorates the quality of these drugs.
3. The plants after collection are packed in bags, sacks and cotton cloths. The collectors use same packing material again and again until fully rotten. The plants are stored in mud huts and some times in the rooms used for dinning and sleeping as well. Large amounts of medicinal plants are thus wasted during packing and storage process.
4. The collectors do not afford to buy vasculums, canisters and other appropriate packing material. Medicinal plants deteriorate if the material is not properly packed and stored. The nature of the packing material has its bearing on the conditions and quality of the stored material. Similarly, the nature of storing place also has a significant effect on the stored material. Factors like temperature, humidity, light can have both direct and indirect adverse effects on the stored material. Improper storage also results in the attacks of moths, insects, beetles and ants. All these factors greatly

damage the quality and quantity of the drug.

Recommendations for sustainable use of medicinal plants in Swat

Coordinated efforts are needed for conservation, documentation and sustainable use of medicinal plants. The following recommendations may help towards this goal.

1. Conservation education including advance collection techniques, post collection processing techniques may be extended to the local communities especially to the plant collectors
2. Sustainable use of MP and accessibility of the community towards national markets would help to uplift socio-economic conditions of this backward area
3. Nurseries of some important MP should be established. Herbal Industries should be brought in contact with the local communities and it will provide the collectors better economic returns and thus better conservation environment to the flora
4. Community mobilization and involvement may be ensured in conservation. Community based organizations should be encouraged to play their due role
5. Cultivation of the profitable medicinal plants like *Colchicum luteum*, *Bergenia ciliata, Dioscoria deltoidea, Bistorta amplexicaulis, Caltha alba, Valeriana jatamansi, Viola species, Berberis lycium, Polygonatum verticilatum, Acorus calamus, Aconitum heterophyllum*, *Podophyllum hexandrum, Paeonia emodi* and *Geranium wallichianum* can be introduced as minor crops on marginal fields

Conclusions

Swat is a mountainous area with diverse and unique flora. However, over the last two decades the plant resources has been largely degraded due to indiscriminate deforestation for acquiring cultivation lands, over exploitation of plant resources for economic purposes, urbanization and industrialization trends, population explosion and increased tourism. Different measures are needed on the part of Government of Pakistan and NGO's working in the area, to check practices which have resulted in the degradation of the biodiversity. The involvement of local community in any conservation effort is highly valued as without local community participation and mobilization, conservation efforts can not be effectively materialized. Community awareness projects should be initiated in Swat, to educate the inhabitants of the area about the importance of natural resources for them and their future generations and how to utilize medicinal plants for their better livelihood on sustainable basis.

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Ecological and vegetative characteristics of a potent invader, *Hyptis suaveolens* Poit. from India.

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Ecological and vegetative characteristics of a potent invader, *Hyptis suaveolens* Poit. from India.

Abstract

Hyptis suaveolens Poit a member from Lamiaceae family has naturalized in India and is considered as a potent invader. Although it has several medicinal properties and used in folklore remedies but its spread is so fast that in due course of its establishment it disrupts the recruitment pattern in the nearby occupied. Not only it restricts the area for other species but it increases livestock pressure on the native species because of its unpalatable nature due to presence of essential oils. It has spread at an alarming stretch in the Vindhyan highland and adjoining areas along with other parts of the India. Its population expansion is so fast that it may prove to be an established invader in near future. Present paper deals with different morphological and reproductive characteristics of *Hyptis* which confer greater advantage to *Hyptis* in comparison to other species growing in its vicinity along with control methods prescribed for *Hyptis* to check its growth.

Key words: essential oils, *Hyptis*, invader, Lamiaceae, Vindhyan forests.

Introduction

Hyptis is a genus of Lamiaceae with about 400 species (Willis 1973). Most of the species are native to the tropical America (Hickey & King 1988, Hutchinson & Dalziel 1963) and extends from Southern United States through the Caribbean region and Central America, south to Argentina (Srivastava 1976, Aluri & Reddi, 1989). But few of these species has naturalized in the warmer parts of the old world (Harley 1988; Aluri & Reddi, 1989, Holm *et al.* 1979).

One of the species from genus, *Hyptis suaveolens* Poit (referred as *Hyptis* hereafter) is naturalized in India. It has now established in Deccan Peninsula, North East India, Vindhyan Highland and Andaman and Nicobar Islands (Wealth of India 1959; Yoganarasimhan 2000). *Hyptis* is of common occurrence along the rail tracks, roadsides (Verma & Mishra 1992), foothills of open forests, forest clearings (Mudgal *et al*. 1997) and can heavily infest wastelands particularly arid and rocky substrates. It is a ruderal weed (Walter 1963 Keller & Armbuster 1989, Aluri 1990) and is capable of heavy infestations displacing native flora and is said to be a potent invader of Vindhyan Highlands (Sharma *et al.* 2007). Present paper investigates ecological and vegetative features of Hyptis which favour its growth and invasiveness.

Ecology and Phenology:

Hyptis is a rigid annual herb of aggressive nature (Mudgal *et al* 1997). It starts its vegetative phase either from perrenating rootstock or viable seeds either from persistent seed bank or from fresh stock with the onset of monsoon rains (Figure 1). It can attain height of approximately 2.5 meters within a growing season. Its stem is quadrate and bears hair. Leaves are either ovate or obovate. Leaves are generally 3-5 cm long and 2-4 cm wide with serrulate margins and a long petiole. Lower surface of the leaves bears hairs; petioles up to 3 cm long. Flowering starts in it at an early age of two to three months. It produces copious blue flowers in small cymes along branch that ends with reduced leaves. Calyx is hairy in nature and is nearly 5 mm long in flower while it enlarges to 10 mm long in fruit and become ribbed. Corolla is blue, strongly zygomorphic and bilabiate, declinate, and about 8 mm long, with a limb 5 mm in diameter. The flower has 4 stamens. Hyptis flowers are pollinated by a large number of pollinators leading to enormous seed production (Plate 1).

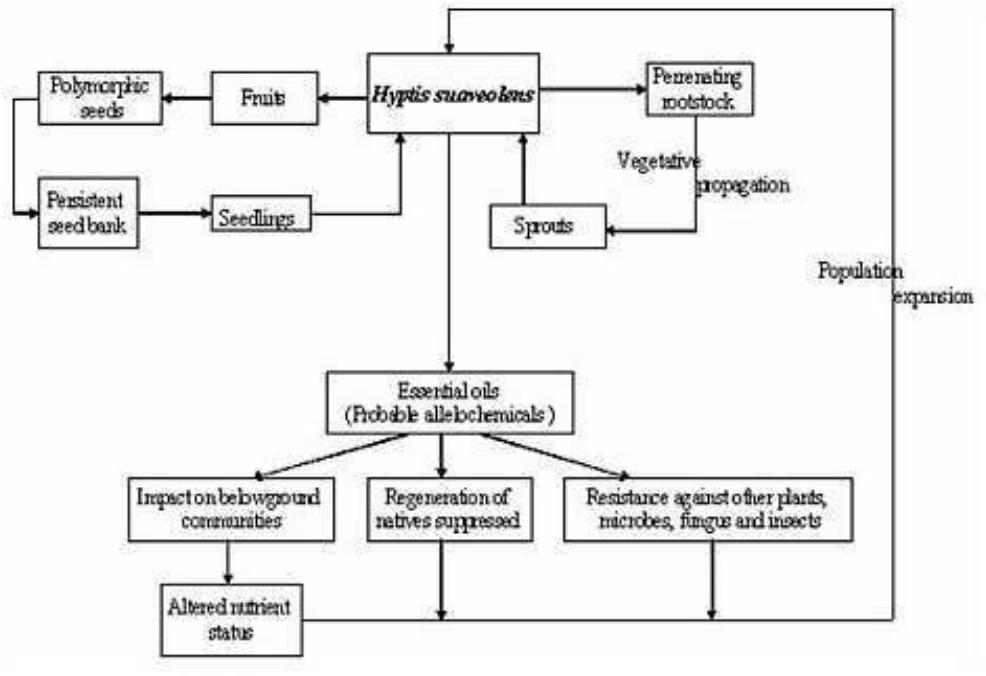

Figure 1

Cyclic representation of *Hyptis* life cycle and factors conferring invasive potential

[IMAGE]

Morphological description of *Hyptis*. a.-*Hyptis* in full bloom, b.-Mature twigs, c.- Twig bearing fruits, d.-Flowers, e.-Seeds in spined burr, f.-Dimorphic seeds, g.-Vegetative propagation

Hyptis fruits (nutlets) are about 1.2-1.5 mm long and seeds are protected in spined burr which help in its dispersal and are slightly notched at the end (Stone 1970). Seeds of *Hyptis* are characteristically dimorphic. This dimorphism is reflected in the seed size (Wulff 1973) and a inverse relationship of seed size with light requirement has been observed which confers a good spectrum for the seed germination across a range of germination temperature, so seeds are capable of germinating across a range of temperature within 10ºC to 40ºC but 25-30ºC seems to be optimum for its growth (Felippe *et al*. 1983). Seeds produce mucilage after getting in contact of water. Population expansion takes place by heavy sprouting after rains and through autogamic and allogamic reproduction (Aluri & Reddi 1989).

No evidence of substantial reproductive failure in native habitat indicates production of a good quantity of viable seed. Due to successful reproduction, *Hyptis* covers a large area after the rains and not allows the adjoining native species not to flourish. So it has potential for a successful invader. Probable factors which can make *Hyptis* a successful invader of grasslands are discussed in detail as follows,

Factors conferring invasive potential to *Hyptis*

As each plant species displays its own reproductive strategy, i.e. a set of characteristics, which maximizes the chances of its offspring to overcome the hazards posed by environmental stress, competition, predation and disease (Fenner 1985) *Hyptis* also shows strategy for better survival and establishment. It exhibit vigorous growth on the agricultural fields and wastelands. A number of vegetative characters are helpful in the heavy proliferation of *Hyptis* such as small seed size, prolific seed production (>2000 m-2) forming persistent propagule bank within short period, seed dimorphism, autogamic and allogamic mode of reproduction, good proliferation from the perrenating rootstock, probable allelochemicals and presence of essential oil conferring resistance to it against variety of pathogens. Description of life cycle of *Hyptis* along with factors favoring its growth is

presented in figure 1.

The small seed size facilitates burial of seeds because of the ease with which such seeds would penetrate into cracks or small openings in the soil. Reduction in size along with large number of seeds has also been associated with predator avoidance as reported by Fenner (1985).

Seed dimorphism in *Hyptis* is helpful in its germination across a range of temperature conferring year round seed germination. In addition to it small seeds have greater surface to volume ratio showing greater germination rates than in the large seeds (Cideciyan *et al*. 1982). Seed polymorphism is also helpful in exploration of different microsites (Sagar 1960) or safe sites as described by Harper *et al*. (1961. Polymorphic seeds as produced by some other species often differ in their germination response to temperature and light as demonstrated by Caves *et al*. (1966). Different soil qualities *viz.* soil temperature and irradiance in addition to spectral quality of light reaching to the floor may vary widely over short distances within range of dispersion of seeds of a single individual (Thompson & Grime 1979) so *Hyptis* could potentially be favoured in different microsites owing to the differential seed size.

Further dispersal of seeds across a range of area and different places is attributed to difference in seed size because as compared to larger, smaller seeds may be more easily dispersed; less predated and maintains more favourable water balance on soil surfaces (Harper & Benton 1966). Seeds of *Hyptis* have spined burr which catches in wool, fur, clothing and other fibrous materials and also floats on water and some movement is also with animal hooves in mud, machineries and other vehicles (Parsons & Cuthburston 2000). .

Although allelopathic effect of *Hyptis* is not well documented but essential oils present in it may confer competitive advantage to it as some members of Lamiaceae family *viz. Trichostema lanceolatum* (Heisey & Delwiche 1985), *Oscimum sanctum*, *Nepata cataria* and *Salvia* species possesses allelopathic properties owing to presence of essential oils, volatile oils, exudates, leachates and inhibitory zones (Qasem & Foy 2001). Essential oils of *Hyptis* has nearly 2.3 % terpinene 4-ol (Peerzada 1997) which is reported as main allelopathic inhibitory compound of *Trichostema lanceolatum*(Heisey & Delwiche 1985). So we can predict that pathogen resistance and decreased recruitment of natives by *Hyptis* is due to presence of allelopathicals. In addition to all these factors another factor which plays an important role in the species loss in the area occupied by *Hyptis* is its unpalatability to livestocks due to presence of essential oils so because of avoidance as a fodder other species are heavily used as fodder by livestocks resulting in the loss of other species.

Biological attributes *viz.* superior reproduction, dispersal benefit and probable allelopathic chemicals than the native flora are the factors which may be attributed for its spread at a fast pace on the open areas interferes with the recruitment of nearby herb and shrub causing threat to the pre-existing flora and ultimate decrease in the diversity of the area as in the case of Vindhyan highlands where it has covered a large by creating monospecific thickets and displacing native species. Its reproductive capacity is so good that it has been referred as high fertility weed (Sturtz *et al.* 1975, Tothilll *et al*. 1982.)

Hyptis also has good medicinal value owing to the presence of essential oil, a characteristic feature to the family Lamiaceae. After hydro distillation of its leaves, an average yield of 0.1 % is obtained. Main constituents of the distillate are 1, 8-cineole (32%) and o-caryophyllene (29%) (Peerzada 1997). Hyptis is known to be used for traditional medicine for the treatment of various illnesses and has been found to possess significant pharmacological (Kuhnt *et al*. 1995), anti-cancerous properties (Mudgal *et al.* 1997) and tumorigenic (Peerzada 1997) properties. In addition to above, it also has mycotoxic activity against fungus *Candida albicans*, antimicrobial activity against both gram positive *Staphyloccus aureus* and *Basillus cereus* and negative strains of *E. coli, Pseudomonas* (Olayinka *et al*. 1999). Besides all these properties it also has insecticidal properties and said to be mosquito repellant (Mudgal *et al.* 1997).

Although *Hyptis* possess medicinal properties but it is not efficiently utilized in this context. Further damage to the biodiversity of adjoining areas is much greater than its utilization as medicinal plants. To avoid its spread, small plants or small infestation should be pulled out by grubbing. Removal of larger colonies depends on planned use of the area. Use of tall growing crops *viz.* pearl or bulrush millet (*Pennisetum glaucum*) is effectively used to shade out *Hyptis*. It can also be controlled chemically with atrazine. Exploration of suitable host against the plant may prove to be a beneficial in its removal. Rust disease from *Pucinia* may seem to be promising but it further needs to be investigated (Cullen & Delfosse 1990). So efforts should be done to check it's spread so that it may not become a successful invader in near future like other invaders in the Indian forests.

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