Article

Digitizing information for wider reach through 'him-Padap-Sanklan', an e-inventory of Himalayan flora

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Abstract
'him-Padap-Sankalan' is a digital directory of floral resources of Himachal Pradesh H.P., a biologically rich state of the Himalayan Biodiversity hotspot. It provides information on nomenclature, taxonomic classification, local name(s), trade name(s) and uses of 3348 plant species along with maps showing their distribution in H.P. The information housed in 'Him-Padap-Sankalan' has been compiled from published sources, primarily the Flora of Himachal Pradesh: Analysis. The Graphic User Interface of the 'him-Padap-Sankalan' has been prepared using ASP.Net having MS-Access database in the back end. The 'scientific names', 'trade names', 'local names', 'synonyms', 'genus' and 'species' are the various search modules of 'him-Padap-Sankalan', which can be accessed using an internet browser connected through local area network. Analysis of information reveals that of the 201 families, Poaceae, Asteraceae, Papilionaceae, Scrophulariaceae, Rosaceae, Cyperaceae, Lamiaceae, Ranunculaceae, Brassicaceae and Apiaceae are the ten dominat families in the state. 24 families and 18 genera are common to all the 12 districts of H.P. The maximum number of families, genera and species are in Shimla district and the least in Bilaspur district of H.P.

Keywords database; Western Himalaya; flora; species richness; cluster analysis; map.

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1 Introduction

The information technology has benefitted every sphere of life and the plant science communities in India is no exception to it. In India, it has been utilized for preparing many databases on plants viz., the Foundation for Revitalisation of Local Health Traditions (FRLHT) has prepared a database (http://envis.frlht.org/indian-medicinal-plants-database.php) on the distribution and taxonomic details of medicinal plants of India. Sasya Sahyadri (http://www.atree.org), a database on flora of Western Ghat, has been developed by Ashoka Trust for Research in Ecology and the Environment (ATREE). The *himFlorIS* (Kumar et al., 2010) is an information system based on floristic survey in Himachal Pradesh prepared by CSIR-Institute of Himalayan Bioresource

Technology, Palampur. ECAT (Chavan et al., 2003) is the web interface developed by National Chemical Laboratory, Pune that provides information on microbes, plants, animals etc. These databases are compilation of information from various sources to a common platform and help in retrieving desired information in a single click. Therefore it makes the analyses faster, effortless and time efficient.

The necessity for development of electronic database has also been felt in the western Himalayan region (Uniyal and Jaryan, 2012). The Himachal Pradesh (H.P.) in India is one of the biologically rich states of the Himalayan Biodiversity Hotspot (Myers et al., 2000) owing to its varied topography, altitudinal range and climatic conditions. Administratively it has 12 districts, of which maximum forest cover is in Sirmaur (49.03 %) and lowest in Lahaul-Spiti district (1.40 %). The Lahaul-Spiti and parts of Kinnaur and Chamba districts represent the trans-Himalayan characteristics. Overall, 26.37 % geographical area of the state is covered by forest (FSI, 2011). Altogether it harbors *ca* 3500 higher plants, of which nearly 500 are of medicinal importance and 150 are aromatic plants (Chauhan, 1999). These plants support the livelihood of the inhabitants. Habitat degradation, excessive grazing, and over exploitation of these resources coupled with recent environmental changes are threatening the unique biodiversity of the state (Uniyal and Singh, 2012).

Fig. 1 User interface of 'him-Padap-Sanklan'.

In order to monitor and conserve the plant resources, baseline information on plants of the region in the form of electronic database thus becomes imperative as it would be collation of various scattered information in different formats (Jayakumar et al., 2001; Zhang and Wei, 2009; Ahmad et al., 2013; Baig et al., 2013; Fournier and Sanou, 2013; Podong and Poolsiri, 2013). Keeping this in mind 'him-Padap-Sanklan' has been developed using information gathered from published sources (Aswal, 1994; Chauhan, 1999; Chowdhery and Wadhwa, 1984; Collett, 1984; Daliwal and Sharma, 1999; Gammie, 1979; Kaur and Sharma, 2004; Nair, 1977; Rau, 1975; Sabnis, 1986; Sinha, 1992; Singh, 1999; Singh and Rawat, 2000; Singh and Sharma, 2006).

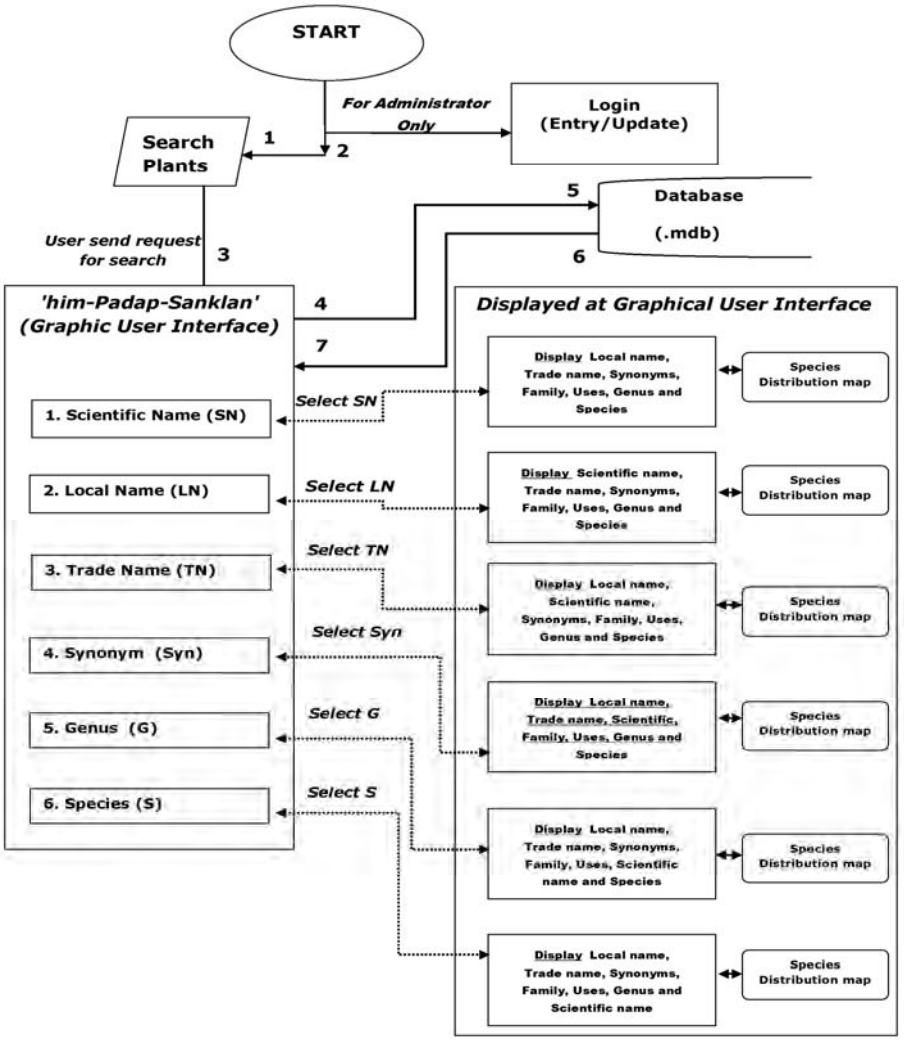

Fig. 2 Data flow diagram of 'him-Padap-Sanklan'.

2 'him-Padap-Sanklan' Framework

The 'him-Padap-Sanklan' is a web application, which is presently accessible through local area network through an internet browser and is planned to be put on web server for general users. The graphic user interface of the 'him-Padap-Sanklan' (Fig. 1) has been designed using Active Server Pages (ASP 2.0). The Microsoft Front Page and Notepad were used as editor for scripting purpose using html, vb script and J script. The backend database is in Microsoft Access format. The database can be best viewed using 2.2 GHz or higher

CPU with 1024 MB or more RAM, 1280x1024 display, 7200 RPM with a web browser (Internet Explorer 6.0 or higher) installed on it.

It consists of 6 cross search modules such as 'scientific names', 'trade names', 'local names', 'synonyms', 'genus' and 'species'. Since these modules are interlinked, the search query using one module returns the output from the other modules (Fig. 2). In other words, a query based on scientific name of a plant, provides information on its trade name, local name, synonyms, genus and species.

The 'him-Padap-Sanklan' also provides information on uses of plants and their distribution on the map of H.P. The dynamic feature to enter a new record or to edit the existing record based on appropriate user right has also been provided in 'him-Padap-Sanklan'. This can be done using 'enter plant detail' or 'update record' windows evoked by 'login' option provided in the 'him-Padap-Sanklan'.

3 Results and Discussion

'him-Padap-Sanklan' is an electronic directory of 3348 plant species distributed across H.P. that belong to 201 families representing 1150 genera. Of the total species, trade names of 148 species, synonyms of 949 species, local names of 1138 species and uses of 386 species have been provided in 'him-Padap-Sanklan'. Shimla district reported the highest species (1948), families (159) and genera (819) richness (Fig. 3). It was followed by Chamba, Kinnaur and Kullu districts. Bilaspur, on the other hand, reported least values for species (113), families (45) and genera (95).

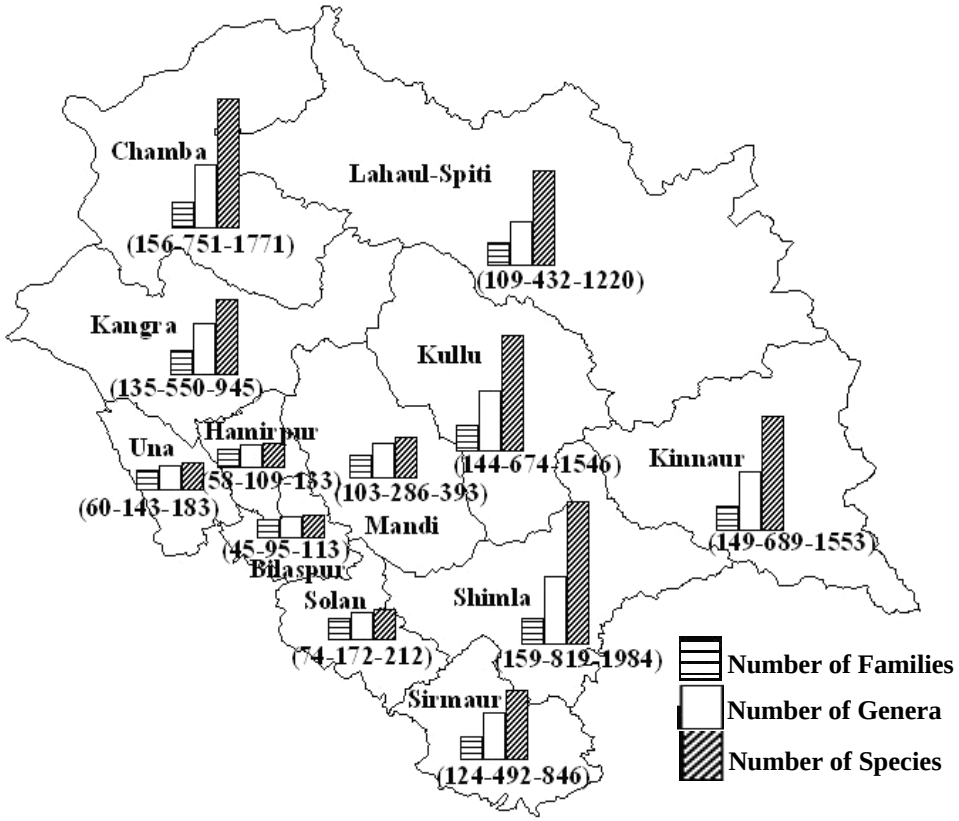

Fig. 3 District-wise floral statistics of H. P.

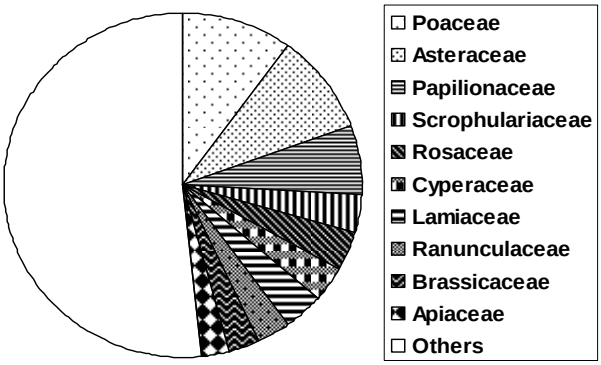

Fig. 4 Family-wise status of plant species in H.P.

The Poaceae, Asteraceae, Papilionaceae, Scrophulararіaceae, Rosaceae, Cyperaceae, Lamiaceae, Ranunculaceae, Brassicaceae, Apiaceae were observed to be the most 10 dominant families of H.P., which comprised of almost 50% of the total species recorded in the state (Fig. 4). Amongst the genera *Carex*, *Polygonum*, *Astragalus*, *Poa*, *Eucalyptus*, *Gentiana* and *Pedicularis* are the dominant genera in the state.

Table 1 District-wise dominant families with their number of species in H.P.

District	Families (no. of species)
Bilaspur	Asteraceae (19), Poaceae (19), Lamiaceae (08), Mimosaceae (06), Euphorbiaceae (05), Papilionaceae (03), Polygalaceae (03)
Chamba	Asteraceae (173), Poaceae (150), Papilionaceae (104), Lamiaceae (77), Ranunculaceae (75)
Hamirpur	Asteraceae (21), Poaceae (21), Lamiaceae (10), Euphorbiaceae (08), Mimosaceae (06)
Kangra	Asteraceae (100), Poaceae (72), Lamiaceae (54), Papilionaceae (46), Rosaceae (31)
Kinnaur	Asteraceae (164), Poaceae (141), Papilionaceae (80), Lamiaceae (69), Rosaceae (63)
Kullu	Asteraceae (172), Poaceae (136), Papilionaceae (74), Lamiaceae (70), Ranunculaceae (64)
Lahaul-Spiti	Asteraceae (165), Poaceae (113), Papilionaceae (63), Brassicaceae (60), Ranunculaceae (59)
Mandi	Asteraceae (42), Poaceae (41), Lamiaceae (32), Rosaceae (12), Cyperaceae (11)
Shimla	Asteraceae (194), Poaceae (172), Papilionaceae (145), Lamiaceae (81), Rosaceae (67)
Sirmaur	Asteraceae (79), Poaceae (78), Papilionaceae (54), Lamiaceae (45), Rosaceae (28)
Solan	Poaceae (50), Asteraceae (17), Lamiaceae (12), Papilionaceae (06), Solanaceae (05)
Una	Poaceae (29), Asteraceae (22), Lamiaceae (11), Euphorbiaceae (09), Papilionaceae (08)

Asteraceae and Poaceae are the dominant families in all the districts of H.P. (Table 1). The genera *Cyperus* has maximum representation in Chamba, Kangra, Mandi and Sirmaur district while Bilaspur and Hamirpur has maximum representation of *Acacia*. *Carex* in Kinnaur, Kullu and Lahaul-Spiti, *Eucalyptus* in Shimla, *Digitaria* in Una, and *Bothriochloa*, *Cymbopogon*, *Datura*, *Eragrostis*, *Panicum* and *Rabdosia* in Solan dominate the flora in the respective districts (Table 2).

Table 2 District-wise dominant genera with their number of species in H.P.

District	Genera (no. of species)
Bilaspur	*Acacia* (3), *Euphorbia* (3), *Polygala* (3), *Senecio* (3), *Setaria* (3), *Albizia* (2), *Blumea* (2), *Corydalis* (2), *Inula* (2), *Ixeris* (2), *Nepeta* (2), *Rabdosia* (2), *Sida* (2)
Chamba	*Cyperus* (16), *Pedicularis* (16), *Polygonum* (15), *Impatiens* (14), *Berberis* (13), *Geranium* (13), *Nepeta* (13), *Salix* (13), *Saxifraga* (13), *Senecio* (13), *Thalictrum* (13), *Astragalus* (12), *Carex* (12), *Corydalis* (12), *Euphorbia* (12), *Gentiana* (12), *Ranunculus* (12), *Saussurea* (12), *Sedum* (12), *Silene* (12), *Veronica* (12)
Hamirpur	*Acacia* (3), *Euphorbia* (3), *Senecio* (3), *Albizia* (2), *Bauhinia* (2), *Blumea* (2), *Bothriochloa* (2), *Cassia* (2), *Corydalis* (2), *Cyperus* (2), *Digitaria* (2), *Diospyros* (2), *Inula* (2), *Ixeris* (2), *Nepeta* (2), *Paspalum* (2), *Phyllanthus* (2), *Polygala* (2), *Rabdosia* (2), *Setaria* (2)
Kangra	*Cyperus* (13), *Ficus* (11), *Euphorbia* (10), *Swertia* (10), *Polygonum* (09), *Senecio* (09), *Ranunculus* (09)
Kinnaur	*Carex* (16), *Saussurea* (16), *Polygonum* (15), *Cotoneaster* (14), *Artemisia* (13), *Berberis* (13), *Bupleurum* (13), *Lactuca* (13), *Nepeta* (13), *Pedicularis* (13), *Euphorbia* (12), *Gentiana* (12), *Senecio* (12), *Thalictrum* (12)
Kullu	*Carex* (19), *Euphorbia* (16), *Polygonum* (16), *Impatiens* (15), *Gentiana* (14), *Saussurea* (14), *Saxifraga* (14), *Cyperus* (13), *Nepeta* (13), *Pedicularis* (13), *Poa* (13), *Sedum* (13), *Senecio* (13)
Lahaul-Spiti	*Carex* (26), *Astragalus* (23), *Poa* (22), *Polygonum* (20), *Artemisia* (19), *Pedicularis* (19)
Mandi	*Cyperus* (6), *Ficus* (5), *Acacia* (4), *Euphorbia* (4), *Inula* (4), *Nepeta* (4), *Quercus* (4), *Rabdosia* (4), *Ranunculus* (4), *Salvia* (4), *Solanum* (4), *Terminalia* (4), *Aristida* (3), *Cassia* (3), *Clematis* (3), *Eucalyptus* (3), *Galium* (3), *Jasminum* (3), *Phragmites* (3), *Polygala* (3), *Potentilla* (3), *Rosa* (3), *Scrophularia* (3), *Senecio* (3), *Setaria* (3)
Shimla	*Eucalyptus* (26), *Berberis* (18), *Cyperus* (18), *Astragalus* (17), *Carex* (17), *Gentiana* (17), *Impatiens* (17), *Senecio* (17), *Euphorbia* (16), *Polygonum* (16)
Sirmaur	*Cyperus* (13), *Desmodium* (8), *Euphorbia* (8), *Impatiens* (8), *Cassia* (7), *Eragrostis* (7), *Ipomoea* (7), *Solanum* (7), *Anemone* (6), *Ficus* (6), *Galium* (6), *Inula* (6), *Nepeta* (6), *Acacia* (5), *Anaphalis* (5), *Flemingia* (5), *Gentiana* (5), *Jasminum* (5), *Phyllanthus* (5), *Plantago* (5), *Polygonum* (5), *Prunus* (5), *Quercus* (5), *Senecio* (5)
Solan	*Bothriochloa* (3), *Cymbopogo*n (3), *Datura* (3), *Eragrostis* (3), *Panicum* (3), *Rabdosia* (3), *Acer* (2), *Aristida* (2), *Arthraxon* (2), *Aster* (2), *Blumea* (2), *Bromus* (2), *Campanula* (2), *Capillipedium* (2), *Cassia* (2), *Digitaria* (2), *Eucalyptus* (2), *Eulalia* (2), Ficus (2), Geranium (2), *Grewia* (2), *Inula* (2), *Jasminum* (2), *Oplismenus* (2), *Pistacia* (2), *Polygala* (2), *Salix* (2), *Salvia* (2), *Scutellaria* (2), *Sida* (2), *Sorghum* (2)
Una	*Digitaria* (4), *Acacia* (3), *Blumea* (3), *Cyperus* (3), *Diospyros* (3), *Euphorbia* (3), *Nepeta* (3), *Panicum* (3), *Senecio* (3), *Albizia* (2), *Argemone* (2), *Aristida* (2), *Bauhinia* (2), *Brachiaria* (2), *Cassia* (2), *Corydalis* (2), *Datura* (2), *Fimbristylis* (2), *Grewia* (2), *Inula* (2), *Ipomoea* (2), *Ixeris* (2), *Jasminum* (2), *Oplismenus* (2), *Phyllanthus* (2), *Polygonum* (2), *Rabdosia* (2), *Scirpus* (2), *Setaria* (2), *Sida* (2), *Terminalia* (2), *Trichodesma* (2)

The Family to Genus and Family to Species ratio are highest in case of Shimla district but the Genus to Species ratio is highest for Lahaul-Spiti district (Fig. 5). This supports the view that smaller the area, smaller will be the Genus to Species ratio and bigger the area, higher will be the Genus to Species ratio (Chawla et al.,

2012). Bilaspur is amongst the smaller district of H.P., while Lahaul-Spiti is the largest.

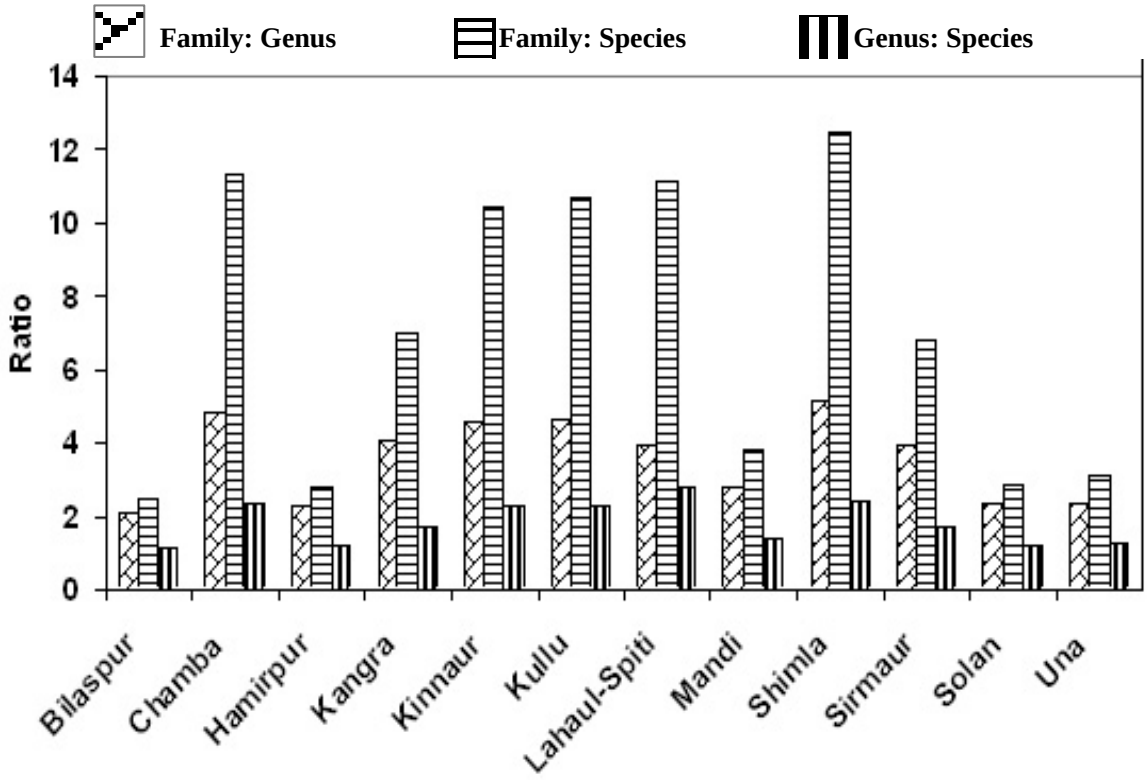

Fig. 5 Family to Genus; Family to Species and Genus to Species ratio in the 12 districts of H.P.

Table 3 District-wise species richness in H.P.

District	Species (No.)	Area (km^2)	Species Richness (No./km^2)
Bilaspur	113	1167	0.0968
Chamba	1771	6528	0.2713
Hamirpur	133	1118	0.1190
Kangra	945	5739	0.1647
Kinnaur	1553	6401	0.2426
Kullu	1546	5503	0.2809
Lahaul- Spiti	1220	13833	0.0882
Mandi	393	3951	0.0995
Shimla	1984	5131	0.3867
Sirmaur	846	2825	0.2995
Solan	212	1936	0.1095
Una	186	1549	0.1201

We also worked out the species richness per unit area for each of the district. This was obtained by dividing the total species in a district by the area of that particular district (Table 3). The species richness in H. P. ranged from 0.08 to 0.38 species/km^2. The species richness is highest in Shimla district and lowest in

Lahaul-Spiti, which is a cold desert region. Sirmaur reported 0.29 species/km^2 followed by Kullu (0.28 species/km^2), Chamba (0.27 species/km^2), Kinnaur (0.24 species/km^2), Kangra (0.16 species/km^2), Una (0.12 species/km^2), Hamirpur (0.119 species/km^2), Solan (0.110 species/km^2), Mandi (0.099 species/km^2), Bilaspur (0.097 species/km^2).

The district wise cluster analysis (Statistica, 2004) of species richness resulted in two distinct clusters (Fig. 6). The first cluster is represented by Mandi, Hamirpur, Bilaspur, Solan and Una districts which primarily have sub-tropical climate. The districts in the second cluster are comperatively at higher altitude and are governed by temperate climate.

The 24 families namely Acanthaceae, Asclepiadaceae, Asteraceae, Brassicaceae, Caesalpiniaceae, Convolvulaceae, Cuscutaceae, Cyperaceae, Dioscoreaceae, Ebenaceae, Euphorbiaceae, Fumariaceae, Lamiaceae, Liliaceae, Malvaceae, Mimosaceae, Orchidaceae, Papilionaceae, Poaceae, Polygalaceae, Ranunculaceae, Rutacceae, Solanaceae and Verbenaceae, and 18 genera namely *Aristida*, *Blumea*, *Cardamine*, *Cuscuta*, *Cyperus*, *Dioscorea*, *Diospyros*, *Eragrostis*, *Erigeron*, *Euphorbia*, *Habenaria*, *Inula*, *Leucaena*, *Polygala*, *Rabdosia*, *Setaria*, *Solanum* and *Tricholepis* are found in all the 12 districts of H.P. There are 21 families, 190 genera and 920 species which are recorded from only one district of the state.

A comparision between number of families, genera and species compiled in 'him-Padap-Sanklan' and the same information reported in recently published district flora for Chamba, Kullu, Lahaul-Spiti and Sirmaur districts of H.P. has been provided in Table 4.

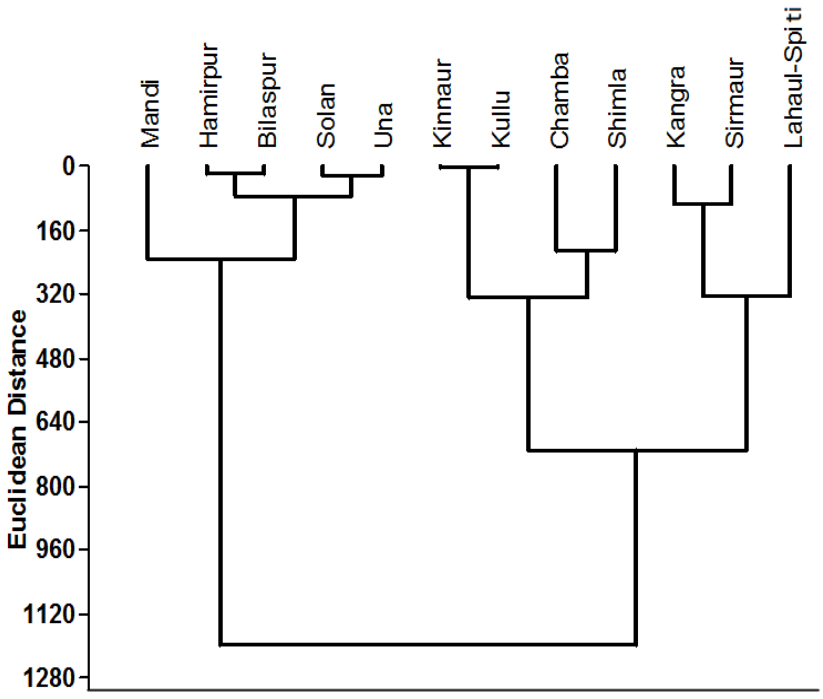

Fig. 6 Dendogram of district-wise species richness.

Interestingly, a deficit of taxa is observed for two out of four districts. The recently published flora of Chamba and flora of Kullu report lesser species as compared to earlier estimates. This points to either loss of species over the time period or limited surveys not encompassing the diverse resources (Vats and Singh, 2002). These species thus require our focus for their relocation. This is one of the many advantages that digitized

informations offer to the users.

Table 4 Comparision between 'published flora' and 'him-Padap-Sanklan'.

	Families (No.)	Genera (No.)	Species (No.)		Families (No.)	Genera (No.)	Species (No.)
Flora of Chamba	113	545	1005	'him-Padap-Sanklan'	156	751	1771
Flora of Kullu	126	504	930	'him-Padap-Sanklan'	144	674	1546
Flora of Lahaul-Spiti	79	353	985	'him-Padap-Sanklan'	109	432	985
Flora of Sirmaur	139	544	898	'him-Padap-Sanklan'	124	492	846

4 Conclusion

The 'him-Padap-Sanklan' provides online information on floral resources of H.P., which is presently available in published flora and literature. Accessing and analysing these resources is sometime tedious and difficult. The present digitized database in the form of 'him-Padap-Sanklan' is expected to rule out these constraints. These digitized information can be conveniently retrieved by interactive user-friendly queries option in the 'him-Padap-Sanklan'. In addition, it also helped in generating various baseline information through analyses of e-inventory. The database may also be analised by researchers, planners, administrators or a common user of any discipline in their own way to retrieve desired result. Maps showing distribution of species across the H.P. is a unique feature of this application.

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