

**Original Article**

**ETHNOMEDICINAL NOTES AND CHROMOSOMAL STATUS OF SOME SELECTED HERBS FROM PARVATI VALLEY, KULLU DISTRICT, HIMACHAL PRADESH**

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**ABSTRACT**

**Objective:** The objective of the present study was to enlist the ethnobotanical uses and chromosomal status of wild plants of Parvati Valley, Himachal Pradesh. Plants are locally used in curing ulcers, sores, insect bites, muscular and joint pains, pneumonia, jaundice, diarrhoea, piles, swellings, allergies and skin diseases.

**Methods:** For documentation of ethnomedicinal information, a questionnaire containing the vernacular name, plant part/s used, medicinal uses, mode of preparation and amount of dose taken was prepared. Personnel interviews/interactions were conducted with medicine men (vaid and hakims), local healers, village elders, tribals and shepherds. The interviews were cross-validated to ascertain the facts about the local use of each plant species. Chromosomal status was determined through male meiosis by using standard acetocarmine technique.

**Results:** Present paper contains information on ethnomedicinal uses, chromosome counts, male meiosis and pollen fertility on 62 medicinal herbs from Parvati Valley. Plants are used as a decoction, paste or powder in cooked form or as raw. Preparations are taken orally in pure form or as a mixture or with a little amount of salt, milk, honey or butter.

**Conclusion:** Due to indiscriminate forest clearing, grazing and collection by traders, most of the species became rare and restricted to specific pockets or are now almost extinct. To preserve herbal diversity, grazing should be restricted in alpine and sub-alpine zones. Database on ethnic knowledge, chromosomal diversity, natural regeneration and distribution pattern should be prepared for designing future plans for sustainable development.

**Keywords:** Ethnobotany, Chromosomal status, Medicinal herbs, Parvati valley, Himachal Pradesh

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**INTRODUCTION**

Parvati Valley situated along the river Parvati in Kullu district (Himachal Pradesh is approx. 130 km long and 1.5 km wide. The altitude ranges between 1100m at Bhuntar town to 4100 m at Mantalai Lake. Upper parts of the valley represent the Rocky Mountains and high peaks with glaciers while the lower regions are greener. Climate varies from hot and sub-tropical in the southern lower tracts (600-900 m) to warm temperate (900-1800 m), cool temperate (1900-2400 m) and cold alpine to glacial (2400-4800 m) in the northern and eastern mountain ranges. Valley which experiences high rainfall (800-900 mm) and heavy snowfall (8-9 m) supports dense forest of 'pines', 'deodar', 'oaks', 'spruce', 'fir', 'alder' and 'rhododendron'. The vegetation comprises a number of annual and perennial herbs of *Anemone*, *Aquilegia*, *Astragalus*, *Gentiana*, *Geranium*, *Lactuca*, *Leucas*, *Polygonum*, *Potentilla*, *Rumex*, *Saussurea*, *Taraxacum* and *Thymus*. Shrubby elements comprise species of *Artemisia*, *Berberis*, *Desmodium*, *Hippophae*, *Juniperus*, *Lonicera*, *Prinsepia*, *Rosa* and *Rubus*. Plants of immense medicinal value include *Aconitum heterophyllum*, *Ajuga bracteosa*, *Arcticum lappa*, *Berberis* sp., *Cannabis sativa*, *Centella asiatica*, *Datura stramonium*, *Gentiana* sp., *Geranium* sp., *Plantago* sp., *Viola canescens*, *Withania somnifera* and *Zanthoxylum armatum*. History of herbal medicines in India is the oldest and richest and most of the cultural conditions are associated with the use of medicinal plants in traditional systems of medicine. Even today most of the tribal communities are dependent upon local traditional healing system for their primary health care. And during the last 100 y or so, the science of ethnobotany has progressed at a much faster rate and the trend is shifting from mere documentation to a more practical one emphasizing on conservation and sustainable use of herbal resources [1-3]. Though studies have been made by some researchers to collect data on ethnobotany from Parvati Valley [4-6], no attempt has been made to analyze the cytomorphological variation in the medicinal herbs. Same kind of ethnobotanical studies was conducted from other parts of the India

[7-10]. Present studies were carried out with an aim to document the traditional knowledge about herbal drugs, a method of preparation and amount and use of drug against diseases. The purpose was also to know the chromosomal status, male meiotic course and pollen fertility and natural regeneration of locally used wild herbs.

**MATERIALS AND METHODS**

**Field surveys**

The valley has been visited consecutively for five years between 2009-2013 during the months of April-October to survey all the possible habitats and inhabitants.

**Ethnomedicinal information**

For documentation of ethnomedicinal information, a questionnaire containing the vernacular name, plant part/s used, medicinal uses, mode of preparation and amount of dose taken was prepared. Personnel interviews/interactions were conducted with medicine men (vaid and hakims), local healers, village elders, tribals and shepherds. The interviews were cross-validated to ascertain the facts about the local use of each plant species.

**Plant identification**

Plants were identified in the field by their vernacular names and by consulting the flora [11]. Besides, the ample accessions were also compared to the specimens lying in the herbaria, Department of Botany, Punjabi University, Patiala, Botanical Survey of India, Northern circle, Dehra Dun and Forest Research Institute, Dehra Dun. Well identified accessions were submitted as vouchers in the herbarium, Department of Botany, Punjabi University Patiala (PUN).

**Chromosome counts, male meiosis and pollen viability**

Chromosomal status was determined through male meiosis for which young and unopened floral buds/inflorescences were fixed in

a freshly prepared Carnoy's fixative (A mixture of ethanol, chloroform and glacial acetic acid (in the volume ratio of 6:3:1) for 24 h and preserved in 70% ethanol. Anthers were squashed in 1% acetocarmine and meiocytes were observed at different stages of meiosis. Pollen viability was estimated through stainability tests using glycerol-acetocarmine (1:1) mixture. Well-filled pollen grains with fully stained nuclei/cytoplasm were taken as apparently fertile while those with partially stained cytoplasm or unstained and shrivelled nature were counted as sterile.

### Microphotographs

Best plates of chromosome counts, meiotic abnormalities, spores and pollen grains (fertile and sterile) were photographed from the temporary mounts with Digital Imaging System of Nikon Eclipse 80i microscope and Leica Qwin Imaging system.

### Natural regeneration

Natural regeneration of species was ascertained from the new plants emerging out from the seeds in the vicinity of the adult population. Vegetative propagation, if any, was confirmed from the new shoots coming out from the underground parts. To confirm the mode of origin, the area around the root of an individual plant was also dug out.

## RESULTS AND DISCUSSION

### A. Ethnobotany

Paper encompasses ethnobotanical information, chromosome counts, male meiosis, pollen viability and natural regeneration of locally used 62 medicinal herbs. Data provided in table 1 include the species with voucher number, vernacular name, chromosome number, plant part/s used and ethnobotanical uses. Data revealed that locals used herbs in the treatment of various ailments/disorders such as ulcers, sores, insect bites, muscular and joint pains, pneumonia, jaundice, diarrhoea, tuberculosis, piles, swellings, allergies and skin diseases. For treating various ailments, the locals use different plant parts. Among the aerial parts used for curing health disorders, leaves (30.61%) were the most commonly used (fig. 1a). Other plant parts used as a herbal drug are a whole plant (24.49%), roots (18.37%), seeds (9.18%), flowers (8.17%), fruits (6.13%) and rhizome, stem and bark (1.02%).

(8.17%), fruits (6.13%) and rhizome, stem and bark (1.02%). Among different categories of plants used, the maximum numbers of species yielding drugs are herbs (59%), followed by shrubs (28%) and trees (13%; fig. 1b).

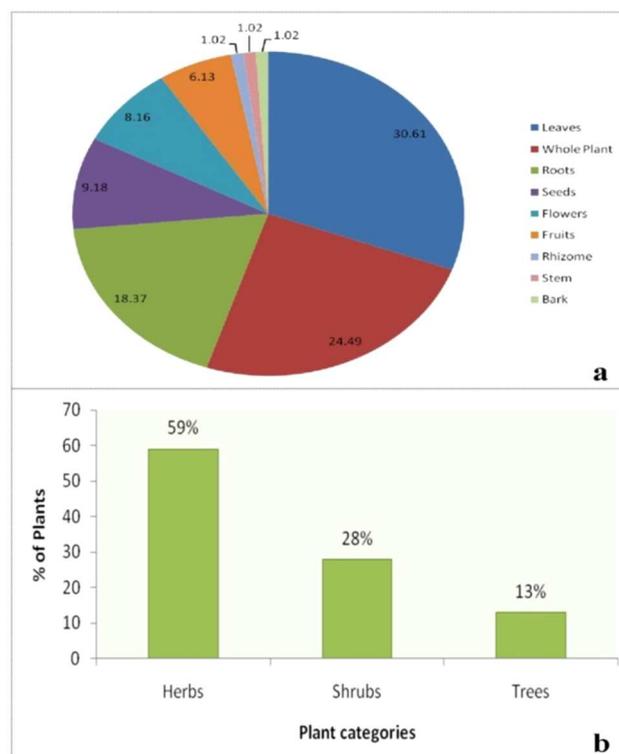


Fig. 1: a) Pie chart showing percentage of different plant parts used, b) Histogram showing categories of plants used

Table 1: Ethnobotanical information gathered for plant species from the parvati valley in kullu district (Himachal Pradesh)

S. No.	Species with voucher (PUN) & chromosome number (n)	Vernacular name/s	Plant part/s used	Medicinal uses and mode of preparation
1.	<i>Achillea millefolium</i> L./57159/2n=18	Birangesif	Leaves Flowers	Leaves are highly tonic. They are crushed and cure dysentery, urinary problems, toothache and swellings. Flowers are antiseptic, aromatic, carminative, laxative, stimulant and diuretic, used to cure gastric problems, measles, fever, piles and diabetes.
2.	<i>Aconitum heterophyllum</i> Wall./57323/2n=16	Ateesh-Pateesh	Root	Dry root is powdered, taken orally with lukewarm water twice a day to cure a toothache, fever, cough, stomachache, rheumatism, diarrhoea.
3.	<i>Agrimonia eupatoria</i> L./57945/2n=56 58037/2n=84	Agrimony	Leaves Whole plant	Leaves help in acute inflammation, cough, hysteria, giardiasis and piles. An infusion of the whole plant is used in the treatment of jaundice, diarrhoea, cold, fever and acts as a blood purifier.
4.	<i>Ajuga parviflora</i> Benth./57166/2n=32	Neelkanthi	Leaves	Decoction prepared from leaves is taken as a blood purifier and cure stomach problems. Leaf juice is used to treat earache, eye ache, throat ache, boils and gums. Also used for malarial fever, jaundice. Leaf powder is used to cure ulcers of mouth.
5.	<i>Androsace rotundifolia</i> Hardw./58668/2n=20	-	Rhizome	The extract of the rhizome mixed with salt is used as eye drops for curing cataract.
6.	<i>Anemone rivularis</i> Buch.-Ham. ex DC./58346/2n=16	Angeli	Root Whole plant	A decoction of the root is applied externally to cuts and wounds. Paste prepared from the whole plant is used to treat a cough and fever.
7.	<i>Arctium lappa</i> L./56091/2n=36	Jangli Kuth	Root	Root is diuretic, helps in reducing blood sugar.
8.	<i>Artemisia scoparia</i> Waldst. and Kit./57225/2n=18	Shaheen	Leaves	Leaves are crushed, mixed in the urine of the cow and used against piles. Crushed leaves when snuffed give relief from a headache.
9.	<i>Berberis glaucocarpa</i> Stapf./56046/2n=28	Daruhaldi, Shambhar	Flowers Fruits Roots	Flowers are boiled in water, used for acidity. Fruits are taken as laxative and anti-scorbutic. Roots boiled in water and filtered and use as an eye drop. A decoction of the root is used for treating swollen gums and toothache.
10.	<i>Bidens pilosa</i> L./56323/2n=72	Ajeran	Whole plant	Plant juice is used for cuts, sores and wounds, diarrhoea, headache and skin diseases.

11.	<i>Cannabis sativa</i> L./57928/2n=20	Bhang	Seeds Whole plant Leaves	Warm seed oil is used for massage against arthritis. Whole plant is used as a pain-killer and sleeps inducer and relieves from nausea, cold, cough and bronchitis.
12.	<i>Clematis connata</i> DC./57233/2n=16	Kuja	Leaves	Crushed leaves used to cure piles, cuts, ulcers and skin eruptions.
13.	<i>Clematis grata</i> Wall./57223/2n=16	Dhand	Leaves	Leaves are crushed and juice is extracted. The juice is then inhaled to relieve from Sinusitis, indigestion and ulcers.
14.	<i>Conyza stricta</i> Willd./57201/2n=18	Batt dawna	Whole plant	Paste of leaves is very useful on boils and heals joint fractures. Its decoction is also used for jaundice.
15.	<i>Corydalis thyrsoiflora</i> Prain/57175/2n=14	Bhootkashi	Whole plant	Used for bone fracture.
16.	<i>Cuscuta reflexa</i> Roxb./57163/2n=32	Akashbail, Niladhary	Whole plant	Plant juice is used in mental disorders.
17.	<i>Cynoglossum lanceolatum</i> Forssk./57179/2n=24	-	Root Leaves	Plant juice mixed with 'til'oil used for treatment of hair fall and rheumatic pains. Roots with milk are used as a tonic for bronchitis.
18.	<i>Datura stramonium</i> L./57168/2n=24	Dhatura	Seeds  Leaves Fruits	Decoction of leaves is used as a blood purifier. Dried seeds are roasted, powdered and mixed with hot mustard oil to make a paste. It is then applied on joints to relieve from arthritis pains. Also 8-10 seeds are taken daily against urinary complaints and asthma. Seed decoction used against fever and jaundice. Roasted leaves are used to cure pain and applied on boils and sores. Fruit juice applied on the scalp for curing dandruff and falling hairs, stomach and eye problems.
19.	<i>Desmodium elegans</i> DC./58384/2n=22	White Khathi	Leaves	Crushed leaves applied on cuts and wounds.
20.	<i>Emblica officinalis</i> Gaertn./57187/2n=104	Amla	Root Fruits  Whole plant	Root is used as a tonic, stomachic and purifies blood. Fruits are taken to cure cough, cold, anaemia, fever, piles, constipation, diabetes, stomach, liver and eye complaints. The whole plant is used in jaundice, asthma, typhoid fever and wounds.
21.	<i>Eupatorium adenophorum</i> Spreng./57324/2n=51	Thrai	Leaves	Leaves paste are applied on cuts and wounds.
22.	<i>Fagopyrum dibotrys</i> (D. Don) Hara/58662/2n=16	Kotu	Whole plant	The crushed plant is used against blood clotting.
23.	<i>Filipendula vestita</i> (Wall. ex G. Don) Maxim./57205/2n=14	-	Leaves	Crushed leaves used to stop bleeding.
24.	<i>Gentiana argentea</i> (Royle ex D. Don) DC./56067/2n=18	Karoo	Roots Leaves	Karoo prepared from roots and leaves is used as a blood purifier. Leaves are boiled in water, given as filtrate for curing fever.
25.	<i>Geranium nepalense</i> Sweet/57333/2n=28	Rattan jot	Whole plant  Leaves Root	Plant is highly astringent, used for a toothache, applied externally on the eyes. Leaf decoction used during fever, headache, and rheumatic pains. Roots used for toothache, cuts, wounds and eye problems.
26.	<i>G. wallichianum</i> D. Don ex Sweet/58677/2n=28	Gugat jot	Whole plant	Used to control stomachache, cough and throat infection.
27.	<i>Hypericum elodeoides</i> Choisy/57222/2n=18	Vasanti	Leaves Root	Leaf powder used as a febrifuge. Root decoction is given to control vomiting.
28.	<i>Impatiens laxiflora</i> Edgew./57300/2n=14	Hannu	Leaves	Leaf paste applied on cuts and wounds and gives relief from fever.
29.	<i>Lactuca dissecta</i> D. Don/57174/2n=16	Dodal	Root	A paste of roots used for skin diseases, syphilis, and rheumatism.
30.	<i>Leucas lanata</i> Benth./56097/2n=30	Dhurlughas	Leaves	Leaf infusion is given in diarrhoea and dysentery to cattle. Leaves fried in 'ghee' are used to expel the placenta after delivery.
31.	<i>Lotus corniculatus</i> L./56051/2n=12	-	Whole plant	Plant paste is used against skin inflammation.
32.	<i>Nepeta spicata</i> Benth./58664/2n=36	Billilotan	Leaves Roots	Leaves are used for cold, cough, fever, influenza and blood pressure. Roots used as a diuretic.
33.	<i>Origanum vulgare</i> L./58027/2n=30	Ban-ajwain	Tubers  Leaves	Tubers are used for epilepsy, cold, diarrhoea, uterine and kidney stones, fever and colic disorder. Leaf pastes along with pepper applied on boils, cuts, wounds, ulcers and burns.
34.	<i>Plantago depressa</i> Willd./56082/2n=12	Bartang	Seeds	Seeds used as a laxative.
35.	<i>P. lanceolata</i> L./52987/2n=12	Isabagol	Seeds	Seeds are taken with milk used to control irregular bowel syndrome and constipation.
36.	<i>P. major</i> L./58040/2n=12	Daruna, Durni	Seeds  Leaves	Powdered seeds mixed with sugar to reduce constipation and stomach problems. Leaf paste with mustard oil applied on cuts, boils, rashes, sores, scratches.
37.	<i>Plectranthus rugosus</i> Wall. ex Benth./57219/2n=24	Patharchur	Leaves	Leaves are burnt to repel fleas. Paste or juice of leaves is used against a headache.
38.	<i>Punica granatum</i> L./56120/2n=16	Daru	Root Seeds	Fresh root decoction is taken orally once at morning for 3-4 d for treating piles and to kill intestinal worms. Decoction of root acts as an astringent and is used to cure fever, cough and cholera.

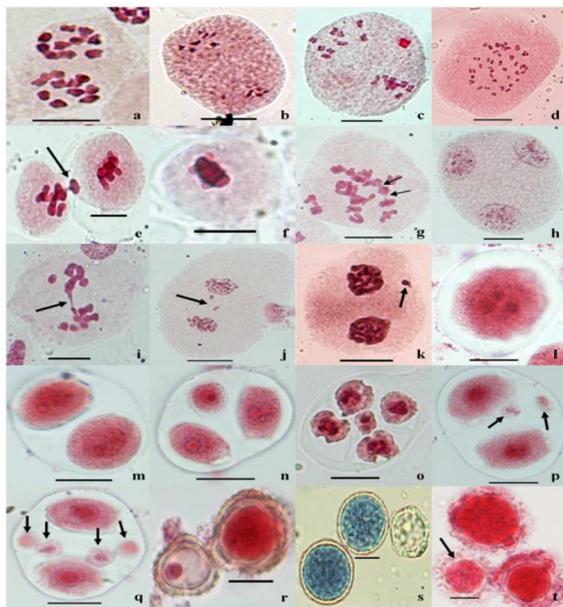
				Dried seed powder and sugar with water is taken thrice a day for 8-10 d during liver and bladder inflammation, indigestion, jaundice, diarrhoea, fever and dysentery.
39.	<i>Ranunculus laetus</i> Wall. ex Royle/56064/2n=28	Chambel booti	Leaves	Fresh leaf paste is applied on skin for treating skin infections.
40.	<i>Rumex hastatus</i> D. Don/56065/2n=18	Khatimal, Malora	Root Leaves	Decoction of root with bark of <i>Quercus leucotrichophora</i> , when cooked with wheat flour, sugar and ghee is given twice a day for 4-5 d during asthma, backache, rheumatism and weakness. Leaf juice applied on cuts and wounds.
41.	<i>R. nepalensis</i> Spreng./56056/2n=80 56057/2n=120	Kharpoo	Roots	Roots boiled in water applied externally for swellings of muscles and joint pains.
42.	<i>Senecio chrysanthemoides</i> DC./57297/2n=40	Chahl	Whole plant Whole plant	Plant juice used to stop to cut bleedings. Plant powder is used as a blood purifier, rheumatic, gastric and liver ailments.
43.	<i>Silene vulgaris</i> (Moench) Garcke/57403/2n=24 57404/2n=48	Ghadoli	Leaves	Fresh and leaves used against cough and asthma.
44.	<i>Solanum nigrum</i> L./56359/2n=24 58377/2n=48	Makoh	Leaves Flowers	Leaves are chewed to cure mouth ulcers. Leaf juice is diuretic and cathartic. Flowers used to cure boils, piles and sores and used as tonic in fever, dyspepsia, scabies, dental and liver problems.
45.	<i>S. pseudocapsicum</i> L./56109/2n=24	Kanthhari	Flowers	Crushed flowers used against asthma and tonsils.
46.	<i>S. viarum</i> Dumal/56080/2n=24	Dudhi	Whole plant	Plant paste is applied to fresh injuries, wounds and boils.
47.	<i>Sonchus asper</i> (L.) Hill/57296/2n=18	Dudhi	Whole plant	Plant paste is applied to fresh injuries, wounds and boils.
48.	<i>S. brachyotus</i> DC./57302/2n=18	Chopalu	Whole plant	Decoction used to treat stomach problems, dermatitis, inflammation and ulcers.
49.	<i>Stellaria media</i> (L.) Vill./56047/2n=26	Khukhani	Seeds	Seeds are astringent, carminative and used against asthma, bronchitis, congestion, obesity, constipation, burns, skin rashes and kidney problems.
50.	<i>Swertia ciliata</i> (G. Don) Burt/56086/2n=26 58355/2n=52	Chiretta	Whole plant	A bitter tonic used for fever, skin diseases, liver disorders, dyspepsia, intestinal worms and asthma.
51.	<i>Taraxacum officinale</i> Wigg./56102/2n=16 56058/2n=24 56132/2n=32	Hand, Dudheri, Jangli-Surajmookhi	Rhizome Flowers Whole plant	A decoction of dry rhizome along with sugar is taken orally twice a day for 6-7 d during jaundice in kidney and liver problems. Flower decoction is taken orally in equal proportion with water for two days to cure boils and blisters. Plant paste applied externally on wounds.
52.	<i>Thalictrum javanicum</i> Blume/58044/2n=14	Mamiri	Leaves	Juice of leaves is used for eye problems.
53.	<i>Thalapsi arvense</i> L./56060/2n=14	Mithri Sarson	Seeds Leaves	Seeds are used in the treatment of pus in the lungs, renal inflammation, appendicitis, swellings, wounds, cuts and pulmonary infection. Leaves used as a blood purifier.
54.	<i>Thymus linearis</i> L./57196/2n=26	Badi-banajwain	Whole plant Flowers Leaves	Decoction of the whole plant is used as an effective home remedy for curing flu, cold, cough, fever and stomach problems. The powder of flowers mixed with 'gurr' is given as a vermicide. Leaves are used as a tonic, cures fever, skin diseases and liver complaints.
55.	<i>Trifolium repens</i> L./56337/2n=32	-	Whole plant	Extract of the whole plant is made to cure a sore throat, pneumonia, cough, fever, cold and hair dandruff.
56.	<i>Verbascum thapsus</i> L./58412/2n=36	Jangli-Tambaku	Whole plant	An infusion of the whole plant is used for chest complaints, diarrhoea and bleeding of gums and lungs.
57.	<i>Viburnum mullaha</i> Buch. Ham. ex D. Don /58656/2n=18	Thalaana	Fruits	Juice of fruits is used to treat indigestion.
58.	<i>Vicia sativa</i> L./57197/2n=14	Massar	Whole plant	Extract of the plant is used as anti-poison.
59.	<i>Viola canescens</i> Wall. ex Roxb./56114/2n=18	Banaksha	Leaves Whole plant Flowers	Leaf decoction taken orally twice a day to cure cold, cough and malaria. A decoction of the fresh plant with sugar taken for 3-4 d against fever, cold, cough, asthma, jaundice and headache. Flowers are groundgrinded in milk and given in throat problems.
60.	<i>Withania somnifera</i> L./56357/2n=48	Ashwagandha	Root Whole plant	Roots and whole plant used to treat arthritis, depression, memory loss and infertility and to increase the iron content in blood.
61.	<i>Xanthium strumarium</i> L./57315/2n=36	Katula	Leaves	Decoction of leaves is used against malarial fever and as a blood purifier. Also used to treat leucorrhoea and poisonous bites of insects, boils and ulcers.
62.	<i>Zanthoxylum armatum</i> DC./56099/2n=66	Tejfal	Whole plant Fruits Twigs Seeds Leaves	Decoction of the whole plant is used in malarial fever. Powdered fruits with dried leaves of <i>Mentha longifolia</i> and <i>Trachyspermum ammi</i> seeds and black salt is taken with water thrice a day for 3-4 d during a cough, cholera, fever, stomachache and indigestion. Twigs chewed during gum problems and toothache. Seeds are used for piles, leucoderma and snake bite. Juice of leaves used for renal diseases and antifertility.

## B. Chromosomal status

Herbs were analyzed for chromosome number, male meiosis and pollen viability. Most of the species are diploid (77.42%), while 14 species (22.58%) exist at different ploidy levels (3x, 4x, 6x, 8x, 12x). *Rumex nepalensis* (2n=80, 120), *Solanum nigrum* (2n=24, 48), and *Taraxacum officinale* (2n=16, 24, 32) showed the existence of individuals with intraspecific euploid cytotypes while accessions with two chromosome counts of 2n=18 and 2n=26 were detected in *Swertia ciliata* (2n=26). *Androsace lanuginosa* (n=10) has been counted chromosomally for the first time from India (fig. 2a), confirming the chromosome count of 2n=20 from Pakistan [12]. The diploid count of n=7 for *Corydalis thyrsoiflora* (fig. 2b) adds a new dysploid cytotype to the already reported chromosome count of n=8 by investigators from Lahaul-Spiti [13] and Kangra district [14], Himachal Pradesh in India. Accession of *Gentiana argentea* showed a diploid chromosome count of n=9 (fig. 2c), compared with the previous report of 2n=20 from other regions of Himalayas [15-16]. *Rumex nepalensis*, a morphogenetically variable species depicted the existence of two cytotypes (8x, 12x) in the valley. The 12x cytotype (2n=120) has already been reported by investigators from other regions of the Himalayas in India [17] but cytotype 8x with 2n=80 is the new record for the species (fig. 2d).

## C. Meiotic course and pollen fertility

Some of the medicinal herbs depicted meiotic irregularities which included cytomixis (fig. 2e), chromatin stickiness (fig. 2f), interbivalent connections (fig. 2g), abnormal spindle (fig. 2h), chromatin bridges (fig. 2i) and laggards (fig. 2j and 2k) resulting into abnormal sporads (fig. 2l-2o) and sporads with micronuclei (fig. 2p and 2q) and pollen maformation in form of pollen sterility (fig. 2r and 2s), micro pollen and fertile pollen grains of varying sizes (fig. 2t).



**Fig. 2: (Meiotic course) *Androsace lanuginosa* a) A PMC showing equal distribution of 10:10 chromosomes at A-I. *Corydalis thyrsoiflora* b) A PMC showing equal distribution of 7:7 chromosomes at A-I. *Gentiana argentea* c) A PMC showing equal distribution of 9:9 chromosomes at A-I. *Rumex nepalensis* d) A PMC showing 40 bivalents at M-I. e) Two PMCs showing chromatin transfer. Chromatin stickiness f) A PMC showing chromatin stickiness at M-I. Inter-bivalent connections g) A PMC showing inter-bivalent connections at M-I. Abnormal spindle h) A PMC showing abnormal spindle. Chromatin bridge i) A PMC showing Chromatin Bridge at A-I (arrowed). Laggards j and k) PMCs showing laggards at Late A-I and Telophase-I (arrowed). Abnormal sporads l) Monad. m) Dyad. n) Triad. o) Polyad. p) Dyad with two micronuclei (arrowed). q) Dyad with four micronuclei (arrowed). Pollen grains r and s) Sterile and fertile pollen grains, t) Heterogeneous sized pollen grains with micro pollen (arrowed). Scale bars=10  $\mu$ m**

Such induced meiotic irregularities in the meiocytes involved in cytomixis have already been reported in a number of plants [18-21].

Triploid taxa of *Eupatorium adenophorum* (2n=51) and *Taraxacum officinale* (2n=24) showed abnormal meiotic course due to high frequency of univalents, unequal/irregular/scattered distribution of chromosomes and laggards resulting into dyads, triads and sporads with micronuclei and consequently high pollen sterility. Presence of high seed setting in both cases indicates toward their apomictic nature as suggested by some investigators [22].

## D. Chromosomal variation

Compiled chromosomal information from Indexes to Plant Chromosome Numbers, and internet site, (<http://mobot.mobot.org/W3T/Search/ipcn.html>) [23], it has been revealed that the medicinal herbs of the valley depicted considerable amount of chromosomal diversity involving aneuploidy and/or polyploidy: *Achillea millefolium* (2x,4x,5x,6x,7x,8x, 9x), *Ajuga parviflora* (2x,4x), *Agrimonia eupatoria* (2x,4x,5x,6x), *Anemone rivularis* (2x,3x,6x on x=8; 2x,4x on x=7), *Artemisia scoparia* (2x,4x), *Bidens pilosa* (2x,4x,6x,8x), *Cannabis sativa* (2x,4x,8x), *Conyza stricta* (2x,4x), *Datura stramonium* (2x,4x), *Embllica officinalis* (2x,4x,8x on x=13; 4x,14x,28x on x=14), *Fagopyrum dibotrys* (2x,3x,4x), *Geranium lucidum* (2x,4x,6x), *G. wallichianum* (2x,4x), *Hypericum elodeoides* (2x,4x), *Lotus corniculatus* (2x, 4x), *Nepeta laevigata* (2x,4x), *Plantago depressa* (2x,4x,6x), *P. lanceolata* (2x,4x,6x), *P. major* (2x,4x), *Ranunculus laetus* (4x,6x,8x on x=7; 2x,4x on x=8), *Rumex nepalensis* (4x,8x,10x,12x), *Solanum nigrum* (2x,3x,4x,6x,8x), *Sonchus asper* (2x,4x), *S. brachyotus* (2x,4x), *Taraxacum officinale* (2x,3x,4x,5x,6x), *Thalictrum javanicum* (2x,6x), *Trifolium repens* (2x,4x,6x,8x), *Vicia sativa* (2x,4x), *Viola canescens* (2x,6x), and *Withania somnifera* (2x,4x) depicted intraspecific euploid cytotypes. Aneuploidy causing chromosomal variation in these plants is equally common as is apparent from the existence of aneuploid cytotypes in *Achillea millefolium* (2n=44,45,48,53,74), *Anemone rivularis* (2n=14,16), *Arctium lappa* (2n=32,36), *Artemisia scoparia* (2n=16,18), *Corydalis thyrsoiflora* (2n=14,16), *Embllica officinalis* (2n=26,28,98,104), *Filipendula vestita* (2n=14,18), *Geranium nepalense* (2n=26, 28), *G. wallichianum* (2n=26, 28), *Impatiens laxiflora* (2n=12,14,16), *Hypericum elodeoides* (2n=16, 18), *Lepidium sativum* (2n=12,16), *Lotus corniculatus* (2n=28,32,36), *Origanum vulgare* (2n=28,30,32), *Plantago lanceolata* (2n=12,13,14), *P. major* (2n=12, 16, 18, 22, 23, 24), *Punica granatum* (2n=14, 15, 16,18,19), *Ranunculus laetus* (2n=28, 32), *Rumex hastatus* (2n=12,18), *Sonchus asper* (2n=32,36), *Stellaria media* (2n=18,26,28,40,42,44), *Swertia ciliata* (2n=18,20,24,26), *Thalictrum javanicum* (2n=14,16), *Trifolium repens* (2n=16,22, 28,30,32), *Verbascum thapsus* (2n=30,34, 36, 48), *Taraxacum officinale* (2n=16,18,21,23,22-24,26,27,32,34,36,37), *Thymus linearis* (2n=24,26), *Vicia sativa* (2n=12, 14) and *Viola canescens* (2n=12,18). Further analysis reveals that *Achillea millefolium* (2n=18, 35, 36, 44, 45, 48,53,54,60-74,81), *Aconitum heterophyllum* (2n=16,20,24,26,34), *Agrimonia eupatoria* (2n=28,42,56,70,84), *Bidens pilosa* (2n=24, 46, 48, 70, 72, 76, 96), *Taraxacum officinale* (2n=16, 18, 21, 22-24, 26, 27, 32, 34, 36, 37, 40, 48) and *Viola canescens* (2n=10, 12, 14, 16, 18, 22, 26, 34) seem to constitute species complexes. Existence of such a high chromosomal diversity in these species seems to have been facilitated due to their inherent capacity of reproduction through both sexual and vegetative means coupled with introgressive hybridization.

## E. Natural regeneration

Observations made on natural regeneration revealed that most of them are perennial and propagate through asexual (vegetative and apomictic) means. Vegetative propagation has been noticed to occur through underground parts.

## CONCLUSION

Present work revealed that Parvati Valley is rich in medicinal plants and traditional knowledge. Local people are still relying on traditional knowledge for their healthcare needs. The aspect which needs immediate attention is that flora here is under severe pressure due to various anthropogenic activities. It has been noticed by authors that various medicinal herbs are collected in mass by the traders viz. *Viola canescens*, *Centella asiatica*, *Ajuga parviflora*,

*Arcticum lappa*, *Berberis glaucocarpa*, *Thymus linearis*, *Zanthoxylum armatum*, *Aconitum heterophyllum*, *Angelica glauca*, *Swertia ciliata*, etc. Consequently, these medicinal herbs are now left in the form of only a few individuals and fall under the IUCN-World Conservation Union's Red list of threatened species. The problem becomes more serious in *Aconitum heterophyllum*, *Arcticum lappa*, *Centella asiatica* and *Swertia ciliata* where roots or perennating parts are directly collected from the wild sources. Interestingly, in spite of extensive and intensive surveys, the authors could not find even a single individual of *Bergenia stacheyi*, *Meconopsis aculeata*, *Pleurospermum candollei*, *Podophyllum hexandrum*, *Rheum emodii*, *Saussurea gossypiphora* and *Valeriana jatamansi* which are listed as important medicinal herbs. And till date, these species have not been included in any of the local conservation plans. The elderly persons, in particular, *adivasis*, are more aware to this treasure compared to the younger generation. It has been noticed that exposure of younger regeneration to western civilization coupled with limited employment opportunities has posed a serious threat to the gradual diminishing of ethnic knowledge. And it will not be surprising that after a span of 20-30 y there will be hardly any person left which will be able to provide information about the plants that at one time were used traditionally for various ethnobotanical and medicinal uses.

Keeping these facts in view, immediate steps must be taken on a priority basis to preserve the ethnic knowledge. And it is also suggested that we should follow this year's UNEP Theme of World Conservation Day as "Go Wild for Life". It envisages you to calibrate all those species under threat and take action of your own to help safeguard them for future generations. It has been rightly said that many local extinctions will eventually add up to global extinction. Furthermore, restrictions on grazing activity should be strictly imposed in alpine and sub-alpine pastures above 3000m. Present investigations form the basis for exploration of intraspecific morphogenetic diversity especially of the euploid type to detect elite genotypes/chemotypes in these medicinally important plants. Also, there is a need to prepare a database of medicinal plant wealth covering information on ethnomedicinal uses, chromosomal diversity, natural regeneration and distribution pattern which could be used for designing future plans and sustainable development.

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#### AUTHORS CONTRIBUTION

Himshikha carried out the work presented in this manuscript. Other authors have contributed to writing and correction of the manuscript.

#### CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest

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