National Herbarium of Cultivated Plants (NHCP): Taxa Added During 2008

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National Herbarium of Cultivated Plants (NHCP) is a major resource for taxonomic and systematic study of plant genetic resources (PGR). For taxa added as herbarium specimens, observations on area and habitat of collection, growth habit, phenology and use of the germplasm are noted on the herbarium sheets. The data checked against reported information aided in recording rarity, endemism, genetic erosion and loss, spread of species etc in 49 taxa added to the NHCP in 2008. Taxa of PGR importance that may be affected by climatic and man-made changes to habitat and morphology can be delineated through these procedures and aid in the use of herbarium resources for measuring species responses to environmental changes.

Key Words: Herbarium, Plant Genetic Resources, Authentication, Diversity, Native, Introduced

Introduction

National Herbarium of Cultivated Plants (NHCP) holds diversity in taxa of economic use/ potential use of the Indian region and is therefore a major resource for identification of PGR. This includes a wide range of taxa belonging to crop species, their wild relatives and weedy types which represent that part of plant diversity which is in a state of flux due to man's changing preferences and priorities. Priority for addition to the NHCP is based not only on floristic records but also on lists of species, both cultivated and wild that are of importance in PGR programmes (Ambasta *et al*., 1986; Arora and Nayar, 1984; Arora and Nayar, 2007; Arora and Pandey, 1996; Bhatt, 1990; Nayar *et al*., 2003; Santapau and Henry, 1983). Furthermore, any new introductions and additions to the native and naturalized flora collected from the field are significant for representation in the NHCP. The total holdings of the NHCP amount to 19,799 specimens representative of 3,758 species belonging to 1,430 genera and 262 families.

Holdings of a herbarium, besides its use for identification of species, also aids in collating ethnobotanical and folk importance of species (Cox and Balick, 1994; Jain and Dam, 1979; Schultes, 1960; Von Reis, 1962), working out area of origin/ probable origin (Zeven and de Wet, 1982), as a record of changes in distribution patterns in case of introduced and naturalized species, invasive weeds and a resource for plotting diversity in relation to habitat and climate change (Lane and Jarvis, 2007). For crop species the value of specimens especially of cultivars increases with addition of information on origin, detailed descriptions and images which also confirms the identity of the plant taxon/ cultivar (RHS, 2009). Since the holdings of NHCP are of potential value as records of PGR diversity, efforts were made to augment data and images on morphological traits, distribution and uses based on collector's data and reported information for taxa added to the NHCP. The standard set of parameters to be considered for the taxa added to the NHCP and the significance of these in interpreting the importance of the herbarium specimen collected and added during the year is brought out in the present paper.

Materials and Methods

Herbarium specimens received and processed for addition to the NHCP were assigned unique dentity numbers (HS [Herbarium specimen] numbers). Floristic literature, monographic accounts, checklists and internet resources were used for authentication of taxa represented in the herbarium for its taxonomic status *vis-à-vis* synonymy in plant names; other aspects of morphology, distributional records and uses of species that are relevant for determining their PGR significance were as follows: a) economic value noted during field collection and categorization into crop species, wild relatives of crop plants and minor/ wild economically important or potentially important species; reported uses of plants (Ambasta *et al*., 1986; Nayar *et al*., 2003; and Bhatt, 1990) were matched against collector's recorded data; b) habit, period of collection and habitat features noted on the herbarium specimen were checked against reported details in floras (Anon., 2009; Collett, 1921; Press *et al*., 2000; Wu Zheng-yi & Raven *et al*., 1994) and features of the plant were checked against descriptions for the taxa; provenance data are mandatory for herbarium specimens as this can aid in

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identification/ confirming the identity of the species using a flora and recording changes if any in flowering and fruiting period. c) areas of collection were checked out against type locality (locality of collection of type specimen), the distributional range of the species, both within the Indian region and outside India, particularly for delineating endemics as well as pinpointing rare or occasional occurrence of the taxa.

The above-mentioned procedure was adopted for taxa represented in the NHCP highlighting the salient features pertaining to the specimen/ taxon and the same was recorded on the specimen sheet for future reference; digital image of specimen/ photographs were included along with the database of information indicated above.

Observations and Results

A total of 49 species were added (97 herbarium specimens) during 2008 which were not represented earlier in the NHCP. Significantly, 44 species were either crop plants (6) or species of minor/ wild economic value including ornamentals, native or introduced (38), the remaining being wild species endemic or native to the area of collection.

Two major sources of specimens were (a) exploration trips, during which collections were made in selected areas, (b) species collected or introduced for their potential importance and raised in experimental plots/ field gene banks, gardens, arboreta, etc. (Table 1). Majority of the specimens added to the NHCP during the year were from natural habitats (Table 2) in Arunachal Pradesh (6), Delhi (3), Himachal Pradesh (10) and Meghalaya (7) usually collected during the major growing season *viz.* the monsoon and post-monsoon period (July to November). Equally significant number of species was represented from experimental fields and plots (Table 3) after raising plants from seeds/ propagules or cuttings; this is expected in PGR programmes where the priority for collection is of seeds and propagules/ cuttings and specimens are prepared from material raised in experimental plots.

Crop Plants: Six crop species, not represented earlier in the NHCP (Table 3), were added during the year to the collection of over 350 species already represented in the NHCP:

a) Species and Cultivars of Crops from Experimental Plots: Specimens of *Euryale ferox* (makhana), an aquatic species cultivated in sub-tropical eastern parts of Indo-Gangetic plains and extending to East Asia, the Far East and upto the Siberian region, were made from plants raised in Delhi garden; though this area is not a regular area of cultivation, the species flowered and fruited in these conditions similar to the area of commercial cultivation. Furthermore, all parts of the plant were represented in the herbarium specimen (young leaf, mature leaf, flowering node bearing flowers and developing fruits, seeds). Similarly, in *Solanum tuberosum*, flowering specimens were prepared from experimental fields in the hills as 'standard' specimens (RHS, 2009) of different cultivars. Specimen of *Petroselinum crispum* (parsley),

Table 1. Source locality of specimens added to NHCP during 2008

Area of collection: State (District)	Period of collection	Species added (specimens)	Collector
I) Exploration trips for collection of germplasm			
Himachal Pradesh (Kullu, Lahaul & Spiti)	Summer/ Monsoon/ post-monsoon	9 (10)	NBPGR, Shimla
Meghalaya (East Khasi, Shillong)	Summer	4 (4)	NBPGR, Shimla
Arunachal Pradesh (Tawang, West Kameng)	Summer/ Monsoon	6 (6)	NBPGR, Shimla
II) Collection of herbarium specimens			
Delhi and surrounding areas	Summer	3 (3)	NHCP, NBPGR, New Delhi
Himachal Pradesh (Shimla and Solan and adjacent areas)	Summer	8 (11)	NBPGR, Shimla
III Material raised in experimental conditions			
NBPGR Regional Station, Shimla, Himachal Pradesh	Summer and monsoon/ post-monsoon	14 (17)	NBPGR, Shimla
NBPGR Regional Station, Thrissur, Kerala	Post-monsoon	2 (2)	NBPGR, Thrissur
Experimental fields, Central Potato Research Institute, Kufri, Himachal Pradesh	Monsoon	2 (41)	NBPGR, Shimla
Delhi Garden, New Delhi	Summer/ Post-monsoon	1 (3)	NHCP, NBPGR, New Delhi

Summer (March-June) and Monsoon/ post-monsoon (August-October)

Table 2. Some important wild species added during 2008

S. No.	Species [HS number]	Locality of collection (District, State)	Habitat
1.	*Acer sterculiaceum* Wall. [19601]	Kullu, HP	Common in deep forest
2.	*Aralia cachemirica* Decne. [19637]	Kullu, HP	Deep forest; endemic
3.	*Corylopsis himalayana* Griff. [19503]	East Khasi, Megh.	Frequent along streams
4.	*Cotoneaster frigidus* Wall. ex Lindl. [19497]	West Kameng, ArP	Riverside; conspicuous when fruiting
5.	*Cotula australis* Hook.f. [19643]	Shimla, HP	Weed in fields (native of Australia); New record for Shimla
6.	*Dichroa febrifuga* Lour. [19494]	East Khasi, Megh.	Along roadsides
7.	*Ehretia aspera* Willd. [19671]	(Ridge) Delhi	Rocky areas; common
8.	*Erigeron multiradiatus* (DC.) Benth. [19652]	Lahaul & Spiti, HP	Common and gregarious in moist slopes
9.	*Helianthus debilis* Nutt. var. *cucumerifolius* (Torr.& A. Gray) Heiser [19575]	Solan, HP	Naturalised upto 1200m; new record for HP
10.	*Hypericum choisianum* Wall.* [19516]	Kullu, HP	Wild along roadsides
11.	*Indigofera dosua* Buch.-Ham. [19660]	Shimla, HP	Moist shady places
12.	*Juniperus recurva* Buch.-Ham. ex D.Don [19646]	Lahaul & Spiti, HP	Forests and thickets, in wetter areas
13.	*Jurinea macrocephala* (Royle) C.B. Clarke [19658]	Shimla, HP	Rocky crevices
14.	*Lindelofia stylosa* (Kar. & Kir.) Brand. [19554]	Lahaul & Spiti, HP	Frequent on alpine slopes
15.	*Maerua arenaria* Hook.f.& Thoms. [19670]	Ridge, Delhi	Rocky areas/ roadside
16.	*Olea glandulifera* Wall. ex G.Don [19626]	Shimla, HP	Moist ravines
17.	*Bistorta affinis* (D.Don) Green [19563]	Lahaul & Spiti, HP	Open slopes
18.	*Prunus carmesina* H. Hara [19514]	East Khasi, Megh.	Deep forest; rare
19.	*Prunus phaeosticta* (Hance) Maxim. [19486]	East Khasi, Megh.	Along streams; rare
20.	*Plectranthus rugosus* Wall. ex Benth. [19663]	Shimla, HP	Roadsides
21.	*Rubus acuminatus* Bl. [19505]	West Kameng, ArP	Dense forest slopes
22.	*Rubus alpestris* Bl. [19507]	West Kameng, ArP	Deep forest; gigantic plants
23.	*Rubus hexagynus* Kunth. & Bouche [19501]	West Kameng, ArP	Deep forest; polymorphic
24.	*Rubus macilentus* Cambess. [19525]	Shimla, HP	Shady moist areas
25.	*Salix daphnoides* Vill. [19661]	Shimla, HP	Frequent on slopes
26.	*Scabiosa speciosa* Royle [19544]	Lahaul & Spiti, HP	Along grassy slopes
27.	*Tragopogon gracilis* D.Don [19592]	Lahaul & Spiti, HP	Rocky dry slopes/ weed in fields
28.	*Vaccinium donianum* Wight [19491]	Tawang, ArP	Rocky slopes
29.	*Zanthoxylum nepalense* Babu [19493]	West Kameng, ArP	Open glades in broad-leaved deciduous forests and along tracks; new leaves and flowers appear in spring

ArP.: Arunachal Pradesh; HP: Himachal Pradesh; Megh.: Meghalaya *may also be naturalised

native of Europe and flowering specimens of *Cucurbita maxima* (pumpkin/ winter squash) and *C. argyrosperma* (Cushaw pumpkin) native of South/ Meso-American region were prepared from maintenance plots/ field gene bank collections (Table 3).

b) Species Collected from Farmers' Fields: *Allium odorum* (Chinese chives), a predominantly East Asian taxon, cultivated as backyard cultigen for bulbs, leaves and dried seeds was represented from Arunachal Pradesh.

Wild Species Collected from Native Habitats: A total of 28 species were added from exploration trips and collection programmes undertaken in parts of Himachal Pradesh (Lahaul-Spiti, Kullu, Solan and Shimla), parts of north-eastern region of the country (Meghalaya and Arunachal Pradesh) and from the 'Ridge' area of Delhi (Table 2). Some significant additions identified among the additions were of the following: a) endemic and rare species, *Aralia cachemirica* found in deep forests of Kullu (collected from conservation plot) and comparatively rare species of *Prunus* (*P. carmesina* and *P. phaeosticta*) from the East Khasi Hills of Meghalaya; b) species of native forest areas included *Acer sterculiaceum* from Kullu, Himachal Pradesh and *Rubus* species (*R. acuminatus*, *R. alpestris* and *R. hexagynus*) from West Kameng district of Arunachal Pradesh; high altitude species, *Lindelofia stylosa* and *Erigeron multiradiatus* added from Lahaul and Spiti; c)

Table 3. Plants in field genebank/ raised in experimental conditions/ gardens/ arboreta

S. No.	Source region/ native region	Botanical name [HS number]	Period of collection (Summer/ Monsoon-post monsoon)	Characteristics
TREES AND SHRUBS				
1.	Europe/ Eurasia	[1]*Abelia* X *grandiflora* (Andr.) Rehd. (Hybrid of *A. chinensis* R. Br. and *A. uniflora* R.Br.) [19534]	Post-monsoon	Ornamental deciduous shrub with white to pink flowers produced in clusters (developed in Italy)
2.		[1]*Iris germanica* L.* [19656]	Summer	Widespread ornamentals; also naturalised
3.		*Rosa tomentosa* Sm. [19597]	Summer	Deciduous shrub; irritating hairs around seeds in fleshy hips; also ornamental
4.	North & South America	*Magnolia grandiflora* L. [19590]	Summer	Medium/ tall tree, large fragrant white flowers/ red seeds in cone-shaped fruits; introduced over wide areas/ conditions
5.		[1]*Oenothera biennis* L.* [19531]	Summer	Biennial, rosette-forming plant with pale yellow flowers borne on tall spikes; also naturalised
6.		*Parkinsonia aculeata* L.* [19675]	Summer	Low tree introduced as a source of fibre and fodder; planted along roadsides, with sharp woody spines and yellow showy flowers born in loose racemes and moniliform pods; also naturalised
7.		[1]*Passiflora caerulea* L. [19564]	Summer	Woody vine with blue to violet floral corona and orange-yellow berry. Popular tropical ornamental
8.		[1]*Salvia coccinea* Juss.* [19573]	Summer	Widespread ornamentals; also naturalised
9.		[1]*Solanum wendlandii* Hook.f. [19578]	Summer	Woody vine, fast-growing with bunches of large, deep mauve flowers
10.	South Africa	[1]*Crocosmia* X *crocosmiflora* (Lemoine) N.E.Br. [19585]	Summer	Garden hybrid (from *C. aurea* and *C. pottsii*); genus native of the grasslands of Cape region
11.	Asia/ East Asia/ China	*Maclura tricuspidata* Carr. {=*Cudrania tricuspidata* (Carr.) Bur.} [19522]	Summer	Tree occasionally grown in China for its fruits, similar to mulberry; introduced into various regions
12.	Japan	*Viburnum sieboldii* Miq. [19654]	Monsoon	Shrub or small tree with stout bristly stem; flowers showy, in clusters and white
13.		*Spiraea nipponica* Max. [19639]	Summer	Deciduous spreading ornamental shrub, profuse white flowers in corymbs
HERBACEOUS SPECIES				
14.	Asia	*Euryale ferox* Salisb. [19726]	Post-monsoon	Planted in herbal garden
15.	India, Pakistan	*Trigonella emodi* Benth. [19634]	Monsoon	Erect herb with yellow flowers and long pods (14mm approx.) raised from seeds
16.	Europe	*Petroselinum crispum* (Mill.) Airy-Shaw [19523]	Post-monsoon	Herb grown for leaves used as condiment
17.	South America	*Solanum tuberosum* L. [19734]	Summer	Flowering specimens of cultivars from hills; cultivated in hills/ plains
18.		*S. oplocense* Hawkes [19765]	Monsoon	Wild species belonging to tuber-bearing *S. brevicaule* complex
19.	Mesoamerican region South America	*Cucurbita argyrosperma* C. Huber [19691]	Summer	Widespread; ovate/ round fruits variable in surface ribbing, stripes & flesh colour (white, yellow or orange); seeds inflated
20.		*C. maxima* Duch. [19690]	Summer	Highly variable creeping cucurbit

[1]Ornamental species *Reported to be naturalized in area of cultivation

introduced and naturalized taxa representing new additions to the local flora, namely *Helianthus debilis* subsp. *cucumerifolius* (Solan district, Himachal Pradesh) and *Cotula australis* (Shimla, Himachal Pradesh).

Checking the area of collection of the wild species against the distributional range (Zeven and de Wet, 1982; GRIN, 2009) showed that species collected were to a large extent native to India. Species from the north eastern region were either localized to the area of collection or extended to the Sino-Japanese or South East Asian region; species collected from the north western region were mostly widely distributed within the Himalayan region or extending upto Iran and Afghanistan and in some cases upto North Africa.

Ornamentals and other Exotic Species: A total of 15 species of woody and herbaceous ornamentals and others of potential economic value (Table 3): a) *Maclura tricuspidata*, native of China (occasionally cultivated), closely similar to mulberry and introduced into arboreta around the world was maintained at Shimla, Himachal Pradesh; b) woody trees, shrubs and climbers representative of summer flowering ornamentals of Shimla district, Himachal Pradesh included *Spiraea nipponica* and *Viburnum sieboldii* native to Japan, *Abelia* X *grandiflora* of European region, *Solanum wendlandii* native of Costa Rica and *Crocosmia* X *crocosmiflora* (ornamental developed in the European region from South African species); c) *Magnolia grandiflora*, *Passiflora caerulea* and *Parkinsonia aculeata*, introduced from the North/ South American region and summer flowering, were widespread trees of the sub-tropical regions of India; d) species of the European region, *Scabiosa speciosa* and polymorphic *Bistorta affinis* flowered during the monsoon/ post-monsoon period in the comparatively cooler climates in Lahaul and Spiti, Himachal Pradesh. Herbaceous species of ornamentals which were added during the year (5) invariably were noted to have the tendency to be naturalized.

Conclusions

Analysing the importance of material added to the herbarium through a synoptic interpretation of field and reported information was found to aid in highlighting significant additions. These were mostly of economically useful taxa (nearly ninety percent); the remaining were native locally available species of natural habitats. Process of authentication and checking out additional information such as detailed descriptions, references to images and distributional notes, origin or parentage and any other information not only helped to check the identity of the plant specimens but was also valuable for working out endemic and rare types especially in the north western and north eastern regions of high endemism and native diversity. Taxa which need to be taken up for further study could be identified *viz*. perennials such as the wild relatives of *Prunus*, *Rubus* and *Rosa*, polymorphic taxa such as *Plectranthus rugosus* and taxonomically confusing taxa such as *Bistorta affinis*; all parts of the plant need to be represented in these species for further taxonomic and systematic studies.

Another important component was of introduced species, both cultivated and wild; *Solanum oplocense* represented one of the close relatives of potato introduced for breeding programmes of potato. Over 500 introduced species of wild relatives of crop plants and potentially important taxa by the NBPGR (Nayar *et al*., 2008) constitute a priority group for representation in the NHCP. Plant habit, period of flowering/ fruiting and area of origin showed links to potential for getting naturalized particularly in ornamental introductions, an aspect requiring detailed survey based on a wider range of taxa.

Finally, the analysis helped to highlight the focal aspects for additions to the NHCP, *viz*. details of habitat of collection (natural or man-made) for wild species and cultigens and representation of all parts/ stages of growth of the plant (flowering, fruiting and seeds) which aid in correct identification of the material and taxonomic study of crops/ potential domesticates and related wild species.

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