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WILD RELATIVES AND RELATED SPECIES OF CROP PLANTS IN INDIA — THEIR DIVERSITY AND DISTRIBUTION

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ABSTRACT

The wild relatives of crop plants and related species are of considerable importance in studies on crop improvement and in providing basic information on species relationships. The concentration of these taxa lies in the centres of diversity of crop plants. The Indian sub-continent forms part of such a centre of diversity (Vavilov, 1950, Zeven and Zhukovsky, 1975). Further, this diversity has also been enriched due to active gene exchange with the surrounding regions, particularly in the northern/north-eastern parts (Chatterjee, 1939). In this paper, a synthesis of the diversity and distribution of such flora has been attempted, pinpointing areas of concentration of these wild types so that this information can be profitably utilized particularly by the plant explorers. Collection, study and conservation of this genetic wealth is of great importance.

SYNTHESIS OF INFORMATION

The basic information on the occurrence of wild relatives and related taxa, was synthesized from different floristic accounts/floras (Bhandari, 1978; Bor, 1960; Collett, 1923; Cooke, 1903; Duthie, 1927; Gamble, 1936; Haines, 1931; Hooker, 1897; Kanjilal *et al.*, 1940; Prain, 1903). This was further supplemented through accounts dealing with the domestication, evolution and related studies on crop plants [Anon(a), 1951; Hutchinson, 1974; Ramanujam and Iyer, 1974] and other treatises on economic plants [Anon(b), 1976; Santapau and Henry, 1973; Watts, 1892]. Over 300 species were sorted out and later, classified into different economic plant categories based on their agri-horticultural importance. The number of species in each category worked out as follows: Cereals and millets-60; Legumes-33; Fruits types-97; Vegetable types-64; Oilseed types-11; Fibre types-14; Spices/Condiments-23; Others (miscellaneous)-21.

DIVERSITY AND ITS DISTRIBUTION

The wild relatives of crop plants and related species of agri-horticultural importance, by and large, occur as components of disturbed, bio-edaphic communities within the major vegetation types. Disturbed grasslands and scrub vegetation and similar open forest areas are rich in such components except for fruit trees which are largely associates of the semi-evergreen, sub-humid/humid tropical, temperate forests. Very few taxa occur in the farmer's fields as weedy components *e.g. Echinochloa, Coix, Oryza,* and *Carthamus*. The diversity of plant resources of India and its distribution in different categories of agri-horticultural plants as given above is discussed here with emphasis on taxa more related to the cultivated types.

Wild relatives of cereals and millets

The Indian diversity in the wild related taxa of rice, wheat, barley, *Coix*, finger millet and fox-tail millet, occurs more in the humid/sub-humid tropical/sub-tropical, and in the temperate areas. Maximum diversity occurs in the *Oryza* species largely in the eastern peninsular tract: *Oryza nivara* (annual),

O. rufipogon (perennial); the weedy *spontanea* type in the *Indica* cultivars and other endemic types like *O. jeyporensis* and *O. malampuzhaensis*. The wild forms of taxa domesticated in the Indo-Burmese region are found in the north-eastern and neighbouring hill regions *viz.*, *Digitaria cruciata* and *Coix lacryma-jobi*; wild related types of minor millet *Panicum miliare* occur in tarai range and of the allied taxon, *P. psilopodium* in the hills of Tamilnadu. Variability occurs in *Setaria verticillata* and *S. viridis*, related to the Fox-tail millet, both in the plains and hills. Several members of the Maydeae (the group to which maize belongs) *viz.*, *Polytoca digitata*, *P. wallichiana*, *Trilobachne cookei*, as also of *Coix* species - *C. aquatica* and *C. gigantea* are chiefly distributed in the eastern or the western peninsular humid/sub-humid tracts, extending to the north-eastern or occasionally as in *Coix gigantea*, to the southern region. Among the wild related types of finger millet (*Eleusine coracana*), annual type *Eleusine indica* is widely distributed as compared to the perennial type, *E. compressa*, of the north-western plains. The allied species of barnyard millet (*Echinochloa frumentacea*), *E. crusgallii*, is widely distributed and several variants of this occur in rice fields and elsewhere mainly in water logged conditions.

The wild Triticeae are well distributed in the Himalayan region, mainly in the western/north-eastern Himalayas; species of *Agropyron*, *Aegilops*, *Hordeum*, *Elymordeum* and *Eremopyrum*. *Avena ludoviciana* occurs in the cultivated fields. Wild forms nearest to the cultivated barley *viz.*, *Hordeum spontaneum* and others occur mainly in the western Himalayas and *Hordeum agricrithon* may also occur in the Sikkim region. Types related to wheat also occur in the Himalayan region *e.g.*, *Elymus* spp; *E. dahuricus* (in fields), *E. dasystachys* and *E. nutans*.

Wild relatives of leguminous crops

Diversity occurs in India in the wild related types of many leguminous crops *e.g.*, black gram, green gram, moth bean, rice bean, sword bean and pigeon pea, largely occupying open forests, being well represented in the Western Ghats, eastern and north-eastern region. Of relatively greater importance are the wild types in *Vigna mungo* var. *silvestris*, related to black gram, distributed particularly in Khandala Ghats and the Konkan belt in the Western Ghats and *V. radiata* var. *sublobata*, closer to the green gram, occurring in the tarai range, sub-Himalayan tracts and sporadically in the western and eastern peninsular tracts. *V. dalzelliana* of the Western Ghats is morphologically akin to the wild types of *V. umbellata*, in which besides the Western Ghats, much variation occurs in other peninsular hills in the sub-Himalayan tracts, the north-eastern region-types from the north-eastern hills expressing more variability. Another Western Ghats species *Vigna grandis* also akin to *V. radiata* /*V. mungo* complex, is confined to the hills of Khandala and the Konkan belt. Among others, the wild forms of moth bean — *Vigna aconitifolia* occur sporadically, mainly in the northern/north-western plains in the Deccan plateau while those of *V. trilobata*, besides occurring in these areas, also extend to the sub-Himalayan tract. Yet another species is *Vigna capensis*, occurring in the sub-tropical temperate Mimalayas and in the peninsular hills, extending to the north-eastern region.

A wide array of diversity in wild *Atylosia* species (about 16) occurs in India, predominantly in the Western Ghats, Eastern Ghats and the north-eastern region. Many of these are related to the cultivated *Cajanus cajan*. Of these *Atylosia cajanifolia* is endemic to the Belladilla range in Orissa. (Maesen, 1979), while *Atylosia lineata* and *A. crassa* are confined to the Western Ghats.

In the Western Ghats wild types in *Cana-*

valia, C. ensiformis var. *virosa* and *C. obtusifolia* occur in the humid tropical belt, particularly in the lowland forest zone along the coasts. Wild forms of sword bean also occur in the north-eastern region, particularly in the hills of Manipur and Mizoram. In *Mucuna,* the wild types exhibit a wider range of distribution. *M. pruriens* occurs in the western and eastern peninsular belt, extending to the north-east, where also occurs *M. bracteata.*

Among the temperate types, *Cicer microphyllum,* a semi-prostrate plant occurring in the alpine stony deserts (2700-3500 m) is the only Indian species morphologically akin to the cultivated type.

Wild relatives of fruit crops

Rich diversity occurs in the wild relatives of tropical, sub-tropical and temperate fruit types in different phyto-geographical zones of the country. This genetic diversity mainly belongs to the Rutaceae, Moraceae, Rosaceae, Musaceae, Anacardiaceae, Rhamnaceae, Myrtaceae, Guttiferae, Euphorbiaceae and Vitaceae. Among the tropical/sub-tropical types, maximum concentration of wild species in *Citrus* and *Musa* occurs in the north-eastern region. In the Shillong plateau, *Citrus assamensis, C. latipes, C. macroptera,* and *C. medica* occur. *Citrus indica* has sporadic distribution around the Tura range and Khasi hills in Meghalaya and in the hills of Nagaland, where *C. ichengensis,* a cold tolerant type, also occurs (possibly an hybrid of *C. latipes*). *Citrus jambiri* (considered a variety of *C. limon*) is found sporadically in the peninsular hills. *C. aurantifolia* has a wider distribution, occurring in the sub-Himalayan tract extending eastwards to Khasi hills, and southwards to the Nilgiris. In *Musa* also, maximum variability occurs in the north-eastern region in the wild types, *M. balbisiana* and *M. acuminata* and in related types of the latter, *M. itinerans. Musa flaviflora* (*M. thomsonii*) is confined to Manipur and Meghalaya. Among endemic taxa *M. nagensium* is confined to the Naga hills and *M. sikkimensis* is rather widely distributed in North Bengal, Sikkim, the Khasi hills and Manipur. Among others, *Musa superba* (*Ensete superbum*) occurs in the Western Ghats and in Assam. In the foot hills of Assam also occur *M. cheesmanii, M. manii* and *M. velutina.*

In the north-eastern region, diversity also occurs in other wild fruits, *Mangifera sylvatica, Elaeocarpus floribundus, Myrica esculenta, Docynia indica* and *D. hookeriana.*

The humid tropical zone of the Western Ghats is another region of concentration of wild related taxa of cultivated fruits among which maximum variability occurs in *Artocarpus heterophyllus* and *A. lakoocha.* Wild forms of *Garcinia indica, Mimusops elengii* and *Euphoria longana* too occur. Of comparatively wider distribution in the peninsular tract are species of *Diospyros, Syzygium* and *Vitis. Spondias pinnata* also exhibits much variability in this tract.

As compared to the above regions, comparatively very few taxa occur in the northern, north-western plains and the Aravalli hills *viz., Carissa congesta, Capparis aphylla, Grewia asiatica* and *Zizyphus* spp. *Zizyphus* exhibits maximum variability in the semi-arid plains but some wild species occur in the humid/sub-humid peninsular region, *viz., Z. oenoplia, Z. rugosa,* with a few like *Z. vulgaris* confined exclusively to the Western Himalayan sub-temperate zone. *Ficus palmata* — the Indian fig, also occurs here.

Among wild relatives of temperate fruits, species of *Pyrus, Prunus, Rubus, Sorbus* and *Ribes* occur in the Himalayas. Some of these like *Prunus prostrata* and *P. tomentosa* are confined to the Western Himalayas, while *P. jenkinsii* occurs in the eastern belt. However, more species are distributed in the Himalayan zone: *P. cornuta, P. napaulensis,* allied to *P. padus, P. cornuta* and *P. acuminata.* In *Pyrus* likewise, *P. communis,* occurs largely in Kashmir; *P. kumaoni* is also con-

fined to Western Himalayas but *P. pashia* and *P. baccata* of the Western Himalayas are widely distributed eastwards to the sub-tropical zone of the north-eastern hills. *Pyrus pyrifolia* is naturalized in the Khasi hills and is also found in the Nilgiris. In *Sorbus*, *S. aucuparia* occurs in the Western and the Eastern Himalayas, while *S. vestita* occurs in the eastern Himalayas, extending to the north-eastern, sub-tropical belt. The various species of *Rubus* also exhibit similar distribution; *R. fruticosus* being confined to the Western Himalayas; *R. lineatus* to the eastern Himalayas and the widely distributed groups represented by R. *lanatus*, *R. lasiocarpus*, *R. moluccanus*, *R. niveus*, and *R. reticulatus*. *Rubus ellipticus* and *R. lasiocarpus* extend to the south in the peninsular hills. Equally high variability occurs in *Ribes*; in *R. nigrum* in the Western Himalayas, and for *R. gracilis* in both the Western and the Eastern Himalayas. *Ribes acuminatum* also has a similar range of distribution.

Wild relatives of Vegetable crops

More prominent diversity is seen in the Amaranthaceae, Cucurbitaceae and Solanaceae, and among tuberous types in the Araceae and Dioscoreaceae.

Diversity occurs in India in the wild relatives of okra (*Abelmoschus esculentus*), egg plant (*Solanum melongena*) and several cucurbits: *Luffa*, *Momordica*, *Citrullus*, *Cucumis*, *Coccinia* and *Trichosanthes*, Among the tuberous types variability is seen in *Amorphophallus*, *Dioscorea* and *Colocasia*.

The wild species nearest to the cultivated okra is *Abelmoschus tuberculatus*, which occurs sporadically in the fields/field margins in the northern/north western plains. *A. pungens* and *A. tetraphyllous* occur in the sub-Himalayan range. More variability for the former occurs in the north-eastern belt and for the latter, in the north-western tarai region, and in *A. angulosus*, a polymorphic taxon, variation exists in Karnataka and the Nilgiri hills where also occur, *A. ficulneus* and *A. manihot*.

Among the cucurbitaceous types (Chakravorty, 1959; Arora *et. al.*, 1980) in *Luffa*, several wild species occur. *Luffa acutangula* var. *amara* occurs in peninsular India and is related to the cultivated smooth gourd. Most of the species occur in disturbed sites, forest openings etc. *Luffa echinata* occurs in the Western Himalayas, central India, and the upper Gangetic Plains, and *L. graveolens* (considered a wild progenitor of *L. hermaphrodita*) in Bihar, northwards to Sikkim and in the south, in Tamilnadu. *L. umbellata* is confined to the eastern coast.

In *Momordica*, *M. balsamina* occurs in the semi-dry north-western plains, and only sporadically elsewhere in the upper Gangetic region and in the northern parts of the Western and Eastern Ghats, in contrast to *M. cymbalaria*, which is found in the Western Ghats, Maharashtra southwards, with only sporadic occurrence in the eastern peninsular region. *M. subangulata* and *M. macrophylla* occur largely in the north-eastern region; *M. subangulata* shows sporadic distribution in the Deccan plateau, extending to the Eastern Ghats. *Momordica dioica* and *M. cochin-chinensis* also occur wild/semi-wild in the gangetic plains extending eastwards. As compared to these *M. denudata* has a restricted distribution and is largely confined to the eastern peninsular tract.

Several wild species in *Trichosanthes* occur; *T cucumerina* in the north-eastern region, along with the semi-wild *T dioica* and *T cordata*, related to *T anguina*. Diversity within this genus represented by over 25 species in India, occurs in the Western Ghats and the north-eastern hills, where several endemic taxa also occur *viz.*, *T khasiana* (Khasi hills) and *T tomentosa* (Nagaland).

The wild related types of *Cucumis sativus* (cucumber) exhibit diversity in the Himalayas in *C. hardwickii* and *C. trigonus*. While the former species occurs in the Western Himalayas, the latter, is distributed in the

Himalayan belt and the peninsular hills. Among others, *C. setosus* and *C. hystrix* occur in eastern India; while *C. setosus* is restricted to the eastern plains, *C. hystrix* extends its range from the eastern plains to the north-eastern hills in Assam, the Tura range in Meghalaya and in the Mishmi hills. In comparison, in the drier north-western plains, only *C. prophetarum* occurs. This drier zone is however rich in the genetic variability of *Citrullus colocynthis* which is more common in the fallow lands.

Among the wild relatives of *Solanum melongena* (brinjal), *Solanum incanum* (*S. coagulens*) and the wild form *S. melongena* var. *insanum* are important. Variability in *S. incanum* occurs in the tarai range and in *insanum* in the eastern peninsular tract, where also occurs the primitive cultivated form possessing semi-wild characters, the *potangi* type of *S. melongena,* in the Jeypore tract of Orissa.

Diversity in the tuberous types occurs in the north-eastern region. *Amorphophallus bulbifer* occurs more in the north-eastern region while *A. campanulatus* is confined to the Deccan plateau. In *Dioscorea* several species occur, diversity being concentrated in the Western and Eastern Ghats, and the north-eastern region, *viz.*, deep rooted wild types of *D. alata, D. hamiltonii* and others. Wild forms of *Colocasia* and *Alocasia* occur in the Bengal plains, the Assam valley and the neighbouring hills. In *Moghania vestita* more variation in wild types occur in the Western Himalayas (1800 m), though the area of its domestication is limited to the Khasi hills in Meghalaya (Singh and Arora, 1973).

Wild relatives of oilseed crops

Diversity in this group is seen mainly in Cruciferae, Compositae, and the Pedaliaceae. Wild related types in *Sesamum, Brassica, Carthamus* and a few more taxa occur. While the truely wild species of *Sesamum* are distributed in the southern peninsular tract, naturalized populations of *S. indicum* occur sporadically in the northern plains and the Aravalli ranges. Two wild forms of Brassiceae occur largely in northern India; 3-valved *B. trilocularis* and 4-valved *B. quadrivalvis* which are considered varieties of *B. compestris* var. *sarson*. While the former is distributed largely in the central and eastern Himalayas and in the sub-hilly tracts of Assam, often in the fields, the *quadrivalvis* types occur in the fields of *B. campestris* in the upper Gangetic plains. Another wild or spontaneous type, *B. tournefortii* occurs in northern India. Among other oilseed types, *Carthamus oxycantha* (which may be a wild form of *C. tinctoria*) occurs as a weed in the northern plains.

Wild relatives of Fibre crops

Diversity occurs in the taxa of Tiliaceae, Leguminoseae, Malvaceae and Linaceae. *Corchorus* species present more variation than other types. The wild species of *Corchorus olitorius, C. acutangulus* and *C. trilocularis* are largely distributed in the peninsular tract, while the wild forms of *C. capsularis* occur mainly in the upper Brahamaputra valley, the Assam valley and the neighbouring north-eastern hills. The wild related types, *Crotalaria retusa,* of sunnhemp (*C. juncea*), occurs mainly in the Western Ghats in the disturbed forests while another species, *C. striata,* occurs as a weed. Among others, the hairy (rusty) types in *Hibiscus cannabinus* and *H. sabdariffa* occur in the central and the eastern peninsular tract. Yet another wild fibre yielding plant is *Urena lobata* (domesticated in tropical Africa) exhibiting a much wider distribution occurring all through, except in very dry hot/cold areas.

Wild relatives of spices and condiments

Diversity in this group is seen in the humid tropical/sub-tropical zone and is represented by the taxa of Liliaceae, Zingiberaceae,

Umbelliferae, Lauraceae, Piperaceae and Myristicaceae, *Amomum, Curcuma, Piper* and *Zingiber* being prominent.

In *Amomum*, variability occurs in the Eastern Himalayas *viz., A. subulatum*, a substitute for cardamom. *Alpinia speciosa*, a substitute for ginger also occurs here. In *Curcuma*, the eastern peninsular tracts has rich diversity in *C. angustifolia, C. amada, C. latifolia* (allied to *C. zeodoaria*, and *C. aromatica*, and *C. montana*) and in the wild forms of *C. domestica*, occurring in the Chota Nagpur plateau. In *Zingiber*, however, variation is concentrated in the Western Ghats in the south where wild and primitive forms of *Z. officinalis* occur. Other species like *Zingiber cassumunar* and *Z. zerumbet* occurring here are also sporadically distributed in the sub-Himalayan tract. The humid tropical region also holds rich diversity in *Piper* for *P. nigrum* in the Western Ghats, for *P. longum* and *P. peepuloides* in the north-eastern region, while *P. schmidtii* occurs in the Western Ghats, in the Nilgiris and also sporadically in the north-eastern region. In the Western Himalayas, several wild useful species of *Allium, A. rubellum* and *A. schoenoprasum* occur. Variability also occurs here in *Carum bulbocastanum* and occasionally in *C. carvi*, at higher elevations (3000-3600 m) in cold arid tracts.

Other wild types (including the Saccharum group)

Diversity occurs in *Saccharum* and related types. This group includes *Saccharum, Erianthus, Narenga, Ripidium* and *Miscanthus*. In *Saccharum*, both *S. bengalense* and *S. ravennae* are confined more to the northern plains. Among others, *S. rufipilum* occurs in the hills of the northern and north-eastern region while *S. filifolium* is confined to the Western Himalayas (1500-2500 m). Species concentrated in the north-eastern region include *S. longisetosum* in the Eastern Himalayas, *S. procerum* occurring in Manipur and north-westwards to Sikkim, and *S. sikkimense*, confined to the Sikkim Himalayas. *S. williamsii* from Nepal, could possibly occur in Sikkim, North Bengal and the adjoining hills in areas bordering Tibet. Some of the above species are treated under *Erianthus* (Bor, 1960), such as *E. filifolium* (*S. filifolium*), *E. ravennae* (*S. ravennae*) and *E. longisetosus* (*S. longisetosum*). *Ripidium* is also treated under *Erianthus viz., E. ravennae* (*Ripidium ravennae*). Another genus related to *Saccharum* is *Narenga*, of which *N. porphyrecoma* is distributed mainly in the peninsular tract and *N. fallax* in the Khasi and Naga hills, in the north-eastern region. *Miscanthus* is also close to *Saccharum* and most of its species are confined to the north-eastern region; *M. nepalensis* (Khasi and Naga hills), *M. nudipus* and *M. taylorii* (Sikkim) and *M. wardii* (Assam valley and Lohit in Arunachal Pradesh).

BOTANICAL AREAS/CENTRES OF CONCENTRATION OF WILD TYPES

From the above account, it may be concluded that more diversity occurs in the warm humid, sub-humid tropical/sub-tropical areas irrespective of the categories to which different plant species (wild relatives) belong. Next to this, in some specific groups like the Triticeae (*Elymus, Hordeum* & others) and the Rosaceous taxa (*Prunus, Pyrus* & others) of fruit trees, the temperate zone has more diversity. In contrast, very little diversity occurs in the arid tracts. This diversity is grouped below, areawise, for different genera whose species have already been dealt with above :

(a) More confined to the Western Himalayas :

Avena, Hordeum, Agropyron, Elymus, Eremopyrum, Fagopyrum, Amaranthus, Punica, Malus, Pyrus, Prunus, Sorbus, Rubus, Ribes, Juglans, Cucumis, Carum, Allium, Ficus.

(b) More confined to the Eastern Himalayas and North-Eastern hill region :

Alocasia, Colocasia, Corchorus, Dioscorea, Amomum, Alpinia, Curcuma, Hedychium, Camellia, Eurya, Docynia, Digitaria, Prunus, Sorbus, Rubus, Canavalia, Brassica, Mucuna, Morus, Citrus, Musa, Mangifera, Vitis, Trichosanthes, Cucumis, Momordica, Hibiscus, Abelmoschus, Erianthus, Setaria.

(c) More confined to the Western Ghats :

Artocarpus, Abelmoschus, Amorphophallus, Cucumis, Coleus, Colocasia, Solanum, Dioscorea, Zingiber, Curcuma, Crotalaria, Hibiscus, Vitis, Zizyphus, Garcinia, Diospyros, Mangifera, Rubus, Syzygium, Chionachna, Coix, Vigna, Atylosia, Canavalia, Dolichos.

(d) More confined to the eastern peninsular tract :

Oryza, Atylosia, Vigna, Dolichos, Artocarpus, Luffa, Solanum, Momordica, Colocasia, Dioscorea, Amorphophallus, Sesamum, Curcuma, Saccharum, Erianthus, Miscanthus, Narenga, Coffea.

(e) More confined to the upper Gangetic Plains :

Citrullus, Momordica, Luffa, Aegle, Feronia, Grewia, Emblica, Syzygium, Morus, Panicum.

(f) More confined to the arid & semi-arid tract/Indus Plains :

Carissa, Cordia, Grewia, Momordica, Vigna, Zizyphus, Citrullus, Coccinia.

Species of several genera, represent a much wider distribution *viz.*, *Echinochloa, Setaria, Eleusine, Abelmoschus, Amaranthus, Chenopodium, Coccinia, Saccharum* and *Solanum*.

GENEPOOL CONCEPT VIS-A-VIS ANALYSIS OF DIVERSITY

The above account on the diversity and distribution of the wild types includes both the closely related and distantly related taxa which may be classified into primary, secondary and/or tertiary genepools (Harlan & de Wet, 1971). Some of the closely related taxa have been studied in the recent years and work on crossability etc. carried out, points to the build-up of more diversity. Such examples on crossability studies relate to taxa of the same genus or in some cases, involve different genera (intergeneric crosses). Naturally occurring hybrids have also been recorded.

Morphological and cytological evidences (Govindaswamy *et al.*, 1966) point out that *Oryza nivara* may have given rise to the *spontanea* types in *O. sativa* and from Jeypore tract, many intermediate types are known (Oka *et al.*, 1959). Spontaneous hybrids between *O. perennis* and *O. sativa* are available and such variability has been collected from the Godavari district, Andhra Pradesh (Morishma and Oka, 1960). In *O. rufipogon* with similar distribution as *O. sativa*, spontaneous hybrids are available in nature and are a source of red coloured rices (Sastry and Sharma, 1974). In *Eleusine, E. indica*, morphologically and cytologically, is similar to *E. coracana* (Krishnaswamy, 1951). The diploid form is of Indian origin and *E. indica* may be the immediate ancestor of it (Mehra, 1963). The closely related species of *Setaria italica* on the basis of crossibility and morphology is *S. viridis* (Anon., 1972). In *Coix lacryma-jobi*, cultivated and wild types form a euploid series and rarely aneuploids are observed (Kaul, 1974). Among others, natural hybrids between *Saccharum spontaneum* and *S. officinarum* occur (Parthasarathy, 1951).

In the legumes karyomorphologically *Atylosia sericea* and *A. lineata* are similar to *Cajanus cajan* (Deodikar and Thakur, 1956). *A. scarabaeoides* is also related to these two

species in chromosome number (De, 1974). Among *Vigna* species with a build-up of diversity in India of wild and cultivated types (Sharma, 1979), *V. radiata* var. *sublobata* and *V. mungo* var. *silvestris* are related morphologically and cytogenetically to cultivated taxa, *V. radiata* and *V. mungo* (Arora *et al.*, 1973; Jain and Mehra, 1980).

Very few examples of such relationships and/or build up of variability are on record in other groups. Among fruit types, cytogenetical studies in *Mangifera* show that there is similarity between *M. indica* and *M. sylvatica* (Mukherjee, 1951). In *Citrus*, natural hybridization has been recorded (Bhattacharya and Dutta, 1951) and several of the related forms co-occur in the north-eastern region (Bhag Singh, 1981). *Musa superba* (*Ensete superbum*) is related to *M. acuminata* karyo-morphologically (Chakravorti, 1948). In temperate types, high degree of interrelationship occurs in *Prunus*, *Pyrus* and others. *Pyrus pyrifolia* shows much morphological variation and crosses with *P. communis;* closely related forms have been separated even at generic level *viz. Sorbus* and *Malus* (Anon., 1972).

Among vegetables, *Abelmoschus tuberculatus* on the basis of chromosome number and homology is related to *A. esculentus* (Arora and Singh, 1973) and successful hybridization is possible (Gadwal *et al.*, 1968). In *Solanum*, crosses have been attempted between *S. melongena* and *S. incanum* (Bhaduri, 1951). *S. incanum*, *S. indicum* and *S. melongena* (Swaminathan, 1949; Mital, 1950) are cytogenetically less close and differences exist in cyto-morphology (Rao and Kumar, 1980). Crossibility studies in *Luffa* indicate that *L. graveolens* is closely related to *L. echinata* on one hand and to *L. cylindrica* on the other (Dutt and Roy, 1969; 1971). *Amaranthus* species have a high degree of out crossing (Khoshoo and Pal, 1971) and interspecific hybridization in nature as well as in experimental conditions is commonly recorded (Khanna *et al.*, 1960). Among the tuberous types, wild forms in *Colocasia esculenta* exhibit much variation (Sharma & Das, 1956).

In oilseed types, *Brassica tournefortii*, morphologically, in karyomorphology and in pairing relationships (Sikka, 1940) is closer to oleiferous *B. campestris* (Narain, 1974). Wild species of *Sesamum*, *S. prostratum* and *S. laciniatum* are allied (Ramanujam, 1941; Ramanujam and Joshi, 1951), the cultivated types being closer to *S. prostratum* (Anon. (b), 1972), *S. malabaricum* also shows similar relationship (Ramanujam and Joshi, 1951) and produces fertile hybrids with cultivated sesame.

Wild tea genetic resources are also important in this context. Experimental hybridization with *C. irrawadiensis* (Wight and Barua, 1957) and vigour of hybrid (Bezbaruah, 1971; 1974) is indicative of the potential importance and closeness of this species with *Camellia sinensis*.

Some examples of distantly related gene pools where crosses have been established may be given. *Saccharum* is a hybrid complex involving *Ripidium*, *Sclerostachya* and *Miscanthus* (Rao *et al.*, 1979); fertile hybrids with *Sclerostachya* and *Narenga* have been produced (Parthasarthy and Rao, 1948). *Hordeum agricrithon* is related to *Elymus* on basis of crossibility relationships (Bor, 1960; Briggs, 1978).

DISCUSSION AND CONCLUSIONS

The foregoing account on the diversity of wild related taxa of agri-horticultural importance occurring in different phyto-geographical regions of India, and the information available on these genepools amply point out that detailed investigations have not been carried out to know the precise nature of interrelationships with the cultivated taxa. This has been possibly due to our lack of knowledge on these, taxonomically, morphologically and biosystematically. This obviously presents difficulties in the utilization of this genetic wealth.

Experimental evidences on these wild types are required for establishing their closeness (as indicated in the genepool concept above) particularly for the large array of diversity which exhibits morphological similarities; wild types are conspecific with the cultivated types *viz.*, *Vigna trilobata, V. aconitifolia, Dolichos uniflorus, D. purpureus* var. *lignosus, Moghania vestita, Momordica dioica, Trichosanthes bracteata* and *T cordata*; or exhibit similarities with other species within the same genus *viz.*, *Panicum sumatrense* to *P. psilopodium, Mucuna bracteata* to *M. utilis*, and *Carthamus oxycantha* to *C. tinctorius*. These studies assume importance in the perennial fruit-tree types also : *Aegle marmelos, Carissa congesta, Emblica officinalis, Syzygium cumini, Zizyphus mauritiana* and several others; species of *Morus, Grewia, Artocarpus* and *Phoenix* among tropical/sub-tropical types and *Pyrus, Prunus, Sorbus, Malus, Ribes* and *Rubus* species among the temperate flora. Equally important in the fruit tree taxa is the study on their utility as potential root stocks and the species of *Docynia, Prunus, Pyrus, Zizyphus, Mangifera, Citrus* and even in other groups *Piper* and *Myristica*, are being used for such purposes. The utility of sub-tropical Rosaceous taxa — *Prunus jenkinsii* and others in developing low chilling types could be looked into.

The wild wealth also needs to be analysed for some of its specific attributes of use to breeders; adaptability to stress environment, characteristics of cold hardiness and drought tolerance and adaptability to specific edaphic situations. Some examples may be cited. The distributional range would help in sorting out of many of these types.

Cold hardiness is characteristic of the temperate types *e.g. Camellia* and *Eurya* spp. and a wide diversity in Rosaceous taxa could provide root stocks of great potential value; similarly, drought hardy root stocks could be available in wild occurring *Zizyphus, Grewia, Emblica, Carissa* and other species. *Musa* species adapted to the shifting cultivation system as secondary forest components on exposed sites, often subject to burning, also provide such attributes. Further, among the annuals, several useful types in *Elymus, Hordeum, Eremopyrum* and *Cicer* deserve similar treatment. As example of taxa adaptable to peculiar edaphic situations, *Sclerophyllum coarctatum* (*Oryza coarctata*) occurring in the brackish waters may be mentioned.

Unfortunately, little work has been done on the utility of these wild relatives in breeding disease resistance. More prominent examples of such use are of *Abelmoschus tuberculatus* and *Phaseolus sublobatus* (Ahuja and Singh, 1977) to develop disease resistance for yellow-vein mosaic virus. *Sesamum prostratum* has also been used likewise. More detailed studies are needed on this aspect.

Finally, it may be pointed out that the study of wild relatives of crop plants assume special significance and deserves rather different approach from the usual floristic/taxonomic studies. Specific explorations to collect population samples of such wild taxa within the range of their distribution through survey of flora and a pre-hand knowledge of such taxa through herbarium study is a prerequisite. Depending on the distributional range of such taxa, for many of the endemic types, much material (seeds/vegetative parts) may not even be available. By and large, one of the major tasks ahead would be the conservation of this genetic wealth for posterity in gene sanctuaries and biosphere reserves, and in the experimental gardens of the national institutes engaged in such task *e.g.* Botanical survey of India, National Bureau of Plant Genetic Resources, Forest Research Institute and the National Botanical Research Institute. Perhaps in this context, there would also be a need to establish a separate 'Herbarium of Cultivated Plants', holding national collections.

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