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SPREAD OF SOUTH-WEST ASIAN CULTIVATED PLANTS AND THEIR WILD AND WEEDY RELATIVES TO SOUTH ASIA AND BEYOND

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Vavilov while advancing his theory on the centres of origin of cultivated plants assigned 83 plants to his Near-Eastern centre of origin. Of these, 15 are vegetable crops and 24 fruit crops. They belong to 32 genera. An examination of their distribution and variability show certain patterns. Some genera like *Lactuca, Pyrus, Prunus* and *Allium* show much variability in both the regions, south-west Asia and south Asia, and also in the intervening area. A few genera, *Ficus* in particular, show greater variability and distribution in south (and south-east) Asia, but the only cultivated fruit of this genus, *F. carica* is thought to have been domesticated in Asia minor. Few others, and notably *Punica* do not show much interspecific variability, but considerable intraspecific variability. This paper elucidates such information which is useful in determining priorities and strategies for biological conservation of the species. It also gives insight into the mechanisms involved in speciation and evolution of different taxa.

Key words : Cultivated plants, wild relatives, origin, spread/distribution pattern, *Lactuca, Pyrus, Zizyphus, Vitis, Berberis, Ficus, Punica, Petroselinum, Eruca sativa*

The origin and spread of cultivated plants in the world has been the subject of speculation from very early times, from the time of Theophrastus. De Candolle (1886) is credited with having given a scientific and holistic approach to this subject. He used the then available information from diverse sources as archaeology, folklore, ancient travelogues, philology and botany to develop his postulates on the origins and distribution of about 400 cultivated plants. Subsequent to this, the science of genetics and biosystematics had their origin, and considerable information was obtained from these areas of study on crop plants origin. And simultaneously, more and more evidences were also getting accumulated in the areas of archaeology, prehistory and plant geography. The Russian botanist N.I. Vavilov (1926) propounded his classical theory on the origin of cultivated plants based on these aspects and the

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observations made by him in his extensive travels. Vavilov's concepts on the centres of origin and variation of cultivated plants have been largely accepted, though some variations of the main theme have been proposed by certain latter-day evolutionists. We shall not go into these details in the present paper.

The Near-Eastern centre

Vavilov (1926) had identified eight centres of origin of cultivated plants in the world. His fourth Centre was the Near-Eastern Centre, which occupies the Near East, including the interior of Asia Minor, the whole of Transcaucasia, Iran and the highlands of Turkmenistan. He assigned to this Centre 83 cultivated plants belonging to the broad categories of grain crops (18), forage plants (8), oil plants (9), alkaloid and tannin plants (7), vegetables (15), fruits (24), and spices and dye plants (2). The fruit and vegetable plants that have been proposed to have originated in the Middle East Centre (Table 1) are discussed in this paper with regards to their occurrence in South Asia. Vavilov (loc. cit.) observed that the Near-Eastern Centre "is the most notable for its wealth of varieties of cultivated wheats, rye exists here in amazing diversity of forms, the accidental orchard fruits are concentrated here including the grape, pear, cherry, pomegranate, walnut, quince, almond and fig, ... species formation has been actively occurring here in several genera such as *Medicago, Pyrus* and *Amygdalus,* and to a considerable degree also in the wheats ..., the world's wealth of melons ..., and the leading forage crops, alfalfa, persian clover, a number of species of *Trigonella* and vetch, have also originated in the near East".

Origin and distribution of cultivated plants

Vavilov's centres of origin generally concide with the ancient centres of civilization also. This is understandable because as the early man left his nomadic habits of hunting and food gathering and gradually adopted a sedentary habit, he initially chose river valley basins for his earliest settlements. He found that his needs steadily began to increase, and the food materials that he was able to gather from naturally occurring plants was inadequate to meet his full needs. He was thus compelled to take up cultivation gradually. For cultivation, he selected types having superior attributes as higher yield, better quality, better adaptability to the prevailing environment, and some resistance to the most serious diseases and pests affecting them. As the community's requirements increased steadily, he began to explore newer areas in search of more land for cultivation, and for newer species of plants to meet his increasingly varied requirements. Almost simultaneously, a process of commerce and barter trade began to develop. With this, trade and caravan routes also began to establish gradually.

The Near-Eastern centre of Vavilov is also an area of ancient civilization. So also is the south Asian region, Vavilov's Hindustani Centre. The Indian subcontinent has been known from prehistoric times for its wealth of spices, ivory, gold, precious stones, etc. Consequently, there developed active trade between the Near-East and South Asia. The ancient traders and explorers took various routes to reach south Asia from South-west Asia. The most important among these were the overland route across Mesopotamia and Khyber pass, and a land cum sea route covering the Arabian peninsula along the coast and then by sea. Even as trade and commerce began to establish, the settlers appear to have developed a process of exchange of plants in both directions. Alongwith the useful plants, weedy and ruderal plants also began to spread. This process occurred both by chance and by design.

Not all the species that are common to both the regions have moved in this manner. Some of the species complexes would have had wide distribution covering both the regions. Then, over a period of time, because of adverse climatological and other changes, their occurrence in some of the interfering areas might have disappeared to give rise to their presence in two or more discrete areas instead of continuously. The hot and humid climates prevailing in the tropical and subtropical regions or South Asia are not conducive to the preservation of biological material for long periods. Because of this, for studying the movement and occurrence of cultivated plants from south-west Asia to south Asia, it may be necessary to depend more on botanical and related evidences rather than on archaeology.

Fruits and vegetable plants

The present status on the occurrence in south-west and south Asia of 32 genera of plants to which the fruit and vegetable plants (which Vavilov had proposed) to have originated in the Middle-East are given in Table 1. Information on the size of these plant genera and their distribution are also included in the table. These have been compiled from various sources (Hooker, 1872, 1887; Hutchinson, 1964 - 1967; Rendle 1938; Simmonds, 1976; Wlth. India, 1948 - 1976; Zeven and de Wet, 1982).

Pattern of distribution

An examination of the data shows certain interesting trends. Firstly, the movement of plants might have been a two-way process, even though this was being carried out by traders, conquerors and settlers. Prehistoric evidences show that greater movement took place from south-west Asia to south Asia. Secondly, some of the plants which had their origin in the Middle East have not got established in south Asia. This may have happened for various reasons

Table 1 : Distribution of wild and weedy species of cultivated plants in south west Asia and south Asia

Sl. No.	Cultivated plants originated in south west Asian Centre	Species present in both the centres	Species present in omly south-west Asian Centre	Species present in only South Asian Centre	Remarks
1.	2.	3.	4.	5.	6.
1.	*Cucumis melo* L., *C. flexuosus* L., *C. sativus* spp. *antasiticus* Gabarev	2. spp., *C.callosus*, *C. prophetarum*	One sp., *C. chali*	2 spp., *C. hystrix*, *C. sitosus*	*ca.* 70 spp., warmer parts of the world, especially, Africa
2.	*Cucurbita pepo* L.	2 spp., *C. maxima*, *C. moschata*	nil	one sp., *C.ficifolia*	*ca.* 30 spp., tropics and subtropics
3.	*Lepidium sativum* L.	2 spp., *L. latifolium* *L. ruderale*	12 spp., *L. ancheri*, *L.caespilosum*, *L.campestre*, *L. cartilagineum*, *L. chalepense*, *L. hirtum*, *L. lyratum*, *L. nebrodense*, *L. perfoliatum*, *L. spinosum*, *L.vesicartum*, *L. graminifolium*	3 spp., *L. apetalim*, *L. capitalum*	*ca.* 150 spp.
4.	*Brassica campestris* L. *subsp. oleifera* Metz., *B. juncea* Czern. var. *sarektana* Sinsk., B. *nigra* L. var. *pseudo-campestris* Sinsk.	nil	4 spp., *B. cretica*, *B.deflexa*, *B. elongata*, *B. tournefortii*	2 spp., *B. napus*, *B. rapa*	More than 200 spp., world-wide, but more in north temperate zone, specially in Mediterranean region

(*Contd. from p. 4*)

1.	2.	3.	4.	5.	6.
5.	*Beta vulgaris* L.	nil	6 spp., *B. adanensis*, *B. corolliflora*, *B. lomatogana*, *B. macrorhiza*, *B. maritima*, *B. trigyna*	One sp., *B. palonga*	*ca.*6 spp., Europe and Mediterranean region
6.	*Daucus carota* L.	nil	6 spp., *D. aureus*, *D. broteri*, *D. conchitae*, *D. guttatus*, *D.involucratus*, *D. littoralis*	nil	*ca.*60 spp., Europe, Asia, Africa and America
7.	*Eruca sativa* Mill. var. *orientalis* Sinsk.	nil	nil	one sp., *E.vesicaria*	*ca.*6 spp., Mediterranean and north-east Asia
8.	*Allium cepa* L., *A. porrum* L.	2 spp., *A.ascalonicum*, *A. sativum*	*ca.*77 spp.	*ca.*35 spp.	*ca.*450 spp., northern hemisphere
9.	*Petroselinum crispum* (Miller) A.W. Hill, *P. hortense* Hoff.	nil	nil	nil	*ca.*5 spp., Europe and Mediterranean region.
10.	*Lactuca sativa* L.	4 spp., *L. crambifolia*, *L. orientalis*, *L. serriola*, *L.undulata*	18 spp.	21 spp.	*ca.*100 spp., temperate Eurasia with an extension to tropical south Africa
11.	*Portulaca oleracea* L.	nil	One sp., *P. sativa*	3 spp., *P. pilosa*, *P. quadrifida*, *P. wightiana*	*ca.*200 spp., tropics and subtropics

(*Contd. from p. 5*)

1.	2.	3.	4.	5.	6.
12.	*Ficus carica* L.	nil	5 spp., F. *japannis*, *F. palmata*, *F. pseudosycomorus*, *F.sycomorus*, *F. vengalensia*	18 spp., *F. amplissma*, *F.amplocarpa*, *F. angladei*, *F. andamanica*, *F. arnottiana*, *F. costata*, *F. dalhousiae*, *F. diversiformis*, *F. ferguseni*, *F. mollis*, *F. nepalensis*, *F. nervifolia*, *F. nervosa*, *F. guttata*, *F. subincisa*, *F.trimenil*, *F. tsjakela*, *F. beddomii*	*ca.* 850 spp., tropical and subtropical regions, more in south and south-west Asia
13.	*Punica granatum* L.	nil	nil	nil	2. spp., Balkan peninsula to Himalayas
14.	*Malus pumila* Mill.	one sp., *M. sylvestris*	nil	3 spp., *M.baccata*, *M.sikkimensii*, *M. transitoria*	*ca.* 35 spp., northern temperature region
15.	*Pyrus communis* L.	nil	9 spp., *P.amygdaliformis*, *P.anatolica*, *P.boissieriana*, *P.bulgarica*, *P.elaeagnifolia*, *P. hakkiarica*, *P. salicifolia*, *P. serecea* *P. valtiriki*	11 spp., *P. arachnoidea* *P. cashimiriana*, *P. expansa*, *P. foliolosa*, *P. hedlundi*, *P. pashia*, *P.rhamnoides*, *P. theifera*, *P. ursina*, *P. wightii* *P. wenzigiana*	*ca.* 40 spp., temperate Eurasia

(*Contd. from p. 6*)

1.	2.	3.	4.	5.	6.
16.	*Cydonia oblonga* Mill.	nil	nil	nil	Monospecific genus, east Asia Minor, Caucasus, north Iran and central Asia
17.	*Prunus armeniaca* L. *P cerasus* L., *P. divaricata* Led., *P. padus* L.	one sp., *P. cerasifera*	3 spp., *P. cocomila*, *P. kurdica*, *P. spinosa*	37 spp	*ca.*200 spp., most common in temperate and subtropical parts of northern hemisphere
18.	*Cerasus avium* (L.) Moench	nil	7 spp., *C. angustifolia*, *C.bractypetala*, *C. hippophacoides*, *C. incana*, *C. mahaleb*, *C.microcarpa*, *C. prostrata*	nil	*ca.* 140 spp., northern temperate region
19.	*Amygdalus bucharica* Korsh., *A. communis* L. *A. fenzliana* Korsh., *A. scoparia* Spach., *A. spinosissima* Bge	nil	13 spp. *A. arabica*, *A. balansae*, *A. carductorum*, *A. gracea*, *A. insveta*, *A. korshinskyi*, *A. lycioides*, *A. orientalis*, *A pavotii*, *A. ramonesii*, *A. trichamygdalus*, *A. webbi*, *A. wandelvoi*	nil	*ca.* 40 spp., Mediterranean region to central China
20.	*Laurocerasus officinalis* Roem. (included under *Prunus* by Kakuan, 1965)	nil	nil	nil	*ca.* 75 spp., tropical and temperate Asia, and America with distribution to tropical Africa and Medagascar

(Contd. from p. 7)

1.	2.	3.	4.	5.	6.
21.	*Mespilus germanica* L.	nil	nil	one sp., *M. microphylla*	*ca.* 20 spp., south-east Europe to central Asia.
22.	*Juglans regia* L.	nil	nil	nil	*ca.* 15 spp., temperate to subtropical to northern hemisphere also in N. and S. America.
23.	*Corylus avellane* L.	nil	nil	2 spp., *C. ferox*, *C. jacquemontii*	*ca.* 15 spp., north temperate zone
24.	*Castanea sativa* Mill.	nil	nil	One sp., *C. indica*	10 spp., temperate northern hemisphere
25.	*Zizyphus sativa* Gaertn.	nil	2 spp., *Z. jujuba*, *Z. zizyphus*	13 spp.	*ca.* 100 spp., chiefly Indo-Malayan, but spread into the Mediterranean region Africa, Australia and tropical America
26.	*Vitis vinifera* L.	nil	5 spp., *V. hissarica*, *V. hyrcanica*, *V. labrusca*, *V. orientalis*, *V. sylvestris*	4 spp., *V. jacqemontii*, *V. lanata*, *V. parvifolia*, *V. pedicellata*	*ca.* 70 spp., northern hemisphere
27.	*Pistacia vera* L.	2 spp., *P. eurycarpa*, *P. khinjuk*	3 spp., *P. atlantica*, *P. lentiscus*, *P. terebinthus*	One sp., *P. chinense*	*ca.* 10 spp., temperate Asia, Mediterranean region, South-east Asia, South USA, Mexico, and Guatemala

(*Contd. from p. 7*)

1.	2.	3.	4.	5.	6.
28.	*Berberis vulgaris*	nil	5 spp., *B. crataegina*, *B. cretica*, *B. integerrima*, *B. khorasanica*, *B. libanotica*	45 spp.	*ca.* 225 spp., north temperate zone particularly along the Andes and Himalayas
29.	*Elaeagnus angustifolia* L.	nil	one sp., *E. spinosa*	9 spp.	*ca.* 45 spp., chiefly in the north temperate and sub-tropical zone of old and New world
30.	*Diospyros lotus* L.	nil	one sp., *D. kaki*	45 spp.	*ca.* 200 spp., tropical and sub-tropical parts of the world
31.	*Cornus mas* L.	nil	one sp., *C. sanguinea*	4 spp., *C. cantroversa*, *C. capitata*, *C. macrophylla*, *C. stracheyi*	*ca.* 4 spp., central and southern Europe to Japan and Korea, and California
32.	*Crataegus azarolus* L.	nil	19 spp.	one sp., *C. oxycantha*	*ca.* 200 spp., north temperate region.

such as climatic differences, personal preferences, human habits, etc. Thirdly, several of the plants of the Middle East may have been introduced into south Asia from very ancient times as could be inferred from the prevalence of genetic differences. Few of them may have undergone considerable differentiation, and even further speciation in their new habitat in south Asia, And fourthly, some of the genera show wide distribution and variation in south Asian region. They may have differentiated into new species in south-west Asia. A few examples of each are discussed below.

The genus *Lactuca* (family Compositae), to which garden lettuce *Lactuca sativa* L. belongs, is a fairly large genus of *ca* 100 species occurring chiefly in the north temperate region of Eurasia and the Mediterranean region. Lettuce is one of the earliest known cultivated plants. It is believed to have originated in the warmer temperate regions of the Middle East from prickly lettuce, *L. serriola* L. The latter species occurs widely in central and south Europe, east Mediterranean, and west and central Europe. About 8-21 species of the genus are present in south-west Asia and south Asia, and atleast four species are common to both these regions. Further, two other species, *L. indica*, and to some extent *L. dentriculata* are cultivated in east Asia.

The genus *Pyrus* L. (Rosaceae) includes *ca.*30 species. They are distributed widely in temperate Eurasia. The most common cultivated pear *P. communis* L. belongs to this genus. This species shows much polymorphism. Speciation is believed to have occurred in the genus in several areas of its occurrence, but more in temperate Europe, Caucasus, and east Asia. The genus *Prunus* L. (Rosaceae) is large and variable, containing *ca.* 140 species. It includes several edible stone fruits and seeds such as almond (*P. amygdalus* Batsch., now *Amygdalus communis* L.), peach (*P. persica* (L) Batsch., now *Amygdalus persica* L.), plums (*P. domestica* L., *P. americana* Marsh., *P. salicina* Lindl., *P. spinosa* L., *P. cerasifera* Ehr.), apricot (*P. armeniaca* L.), and cherry (*P. avium* L., *P. fruiticosa* Pall., *P. cerasus* L., *P. tomentosa* Thunb., *P. pumila* L., *P. bessyi* Bailey). A number of other species of this genus are used as ornamentals for their showy flowers. The genus is distributed widely in the north temperate regions. It shows several centres of variation such as east Asia, central Asia, Middle East and north America. It is represented by about three species in south-west Asia and 37 species in south Asia.

The genus *Zizyphus* Mill. (Rhamnaceae) includes *ca* 100 species. They are distributed widely in the tropics of Asia ad America and the temperate regions of both the hemispheres. Vavilov (loc. cit.) listed south-west Asia as a secondary centre of *Z. sativa* Gaertn. (now, *Z. jujuba* Mill. non Lam.). Its centre of diversity has been suggested to be China. Two species have been recorded from south-west Asia and 13 species from south Asia. Thus, the genus shows greater variability in south Asia.

The genus *Vitis* L. (Vitadaceae), which has *ca* 70 species, is distributed in the temperate to subtropical areas of Northern Hemisphere, but chiefly in America and east Asia. The delimitation of species in this genus has been very difficult, if not altogether artificial. Wild forms of *V. vinifera* L. occur in the Mediterranean region, spreading eastwards to Caucasus and northwords to central Europe. *Ca* 5 species occur in south-west Asia, four in south Asia, and none is common to both the centres. The regions of maximum diversity are central, middle, south-west and south-eastern Europe.

Berberis vulgaris L. (Berberidaceae), the European barberry, was used to be planted earlier for its edible berries, and subsequently as an ornamental. It is an alternate host of the stem rust of wheat, a serious disease of the crop, and hence, it is now being removed. The genus, containing *ca.* 225 species, is widely distributed in the north temperate zone and the Andean mountains. The species are extremely variable. *Ca.* five species occur in south-west Asia and 45 species in south Asia, mostly in the Himalayas. No species is common to both the regions.

The genus *Ficus* L. (Moraceae) is a large one containing *ca.* 850 species. They are distributed widely in the tropics and subtropics, but show greater abundance and distribution in south-west and south Asia, and Polynesia. The common cultivated fig, *F. carica* L. is considered to have originated in Carica in Asia Minor. Fig is cultivated widely in the tropics and subtropics, but chiefly in the Mediterranean countries and California (USA). Two *Ficus* spp., *F bengalensis* and *F. religiosa* are held in esteem in south Asia by the Buddhists and Hindus. While *ca* 65 species have been recorded from south Asia, south-west Asia has only about five species. This genus shows great diversity in south and south-wast Asia, but having the centre of origin of the most economically important species, the fig, in south-west Asia.

The pomegranate, *Punica granatum* L. (Punicacae) is an ancient cultivated fruit of tropical and sub-tropical Asia. Presently, it is cultivated widely in the drier subtropics and temperate areas of the Mediterranean region, and south and central Asia. Wild forms of *P. granatum* occur widely from the Balkans to the sub-Himalayas of India. The only other species of the genus *Punica*, *P. protopunica* has been described from Socotra island in the Indian Ocean. The family Punicacae is monogeneric and the genus *Punica* is dispecific, and yet, wild and cultivated forms of *P. granatum* occur widely in subtropical and temperate Asia and the Mediterranean region.

Origin of parsley, (*Petroselinum crispum* (Mill.) Nym. ex A.W. Hill) (Apiaceae), has been ascribed to this centre by Vavilov, but others (Simmonds, 1976; Zeven and de Wet, 1982) think that it originated elsewhere, in southern Europe. The species *P. crispum* does not appear to have any wild relatives in south-west Asia.

Eruca sativa L. (now *E. resicaria* (L.) Cav: Cruciferae) is another species (which Vavilov proposed) to have originated in south-west Asia, but other authors assume it to have originated elsewhere in Mediterranean region and south Asia. The quince, (*Cydonia oblong* Mill.) (Rosaceae), has been cultivated for a long time, but it does not have any wild relatives in either of these centres. Zeven and de wet (1982) have proposed it to have originated in south USSR.

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