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Biogeographical aspects of selected SW Asiatic woody taxa

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Abstract

The distributions and affinities of a selection of woody taxa in South-west Asia are considered from a global viewpoint. Genera and species in c. 15 families, together with their closest allies, are discussed taxonomically and biogeographically. Relevant distribution maps are given. Although the importance of circum-north-temperate distributions of the so-called Boreal-Tertiary elements among SW Asiatic relict taxa has often been emphasised in the literature, our findings have revealed a more complex situation with links to different parts of the world and in particular a much stronger affinity with tropical floras than previously recognised.

Key words: Flora of SW-Asia, biogeography, distribution maps.

Zusammenfassung

Die Verbreitung einer Auswahl von holzigen SW-Asiatischen Taxa aus ca 15 Familien wird vergleichend untersucht. Obwohl die Bedeutung der sogenannten borealen Tertiärelemente mit gemäßigt-nordhemisphärischer Verbreitung in der Literatur immer betont wurde, zeigen die Ergebnisse eine weitaus komplexere Situation mit Verbindungen zu verschiedenen Teilen der Welt. Insbesondere zeigt sich eine weitaus stärkere Verbindung mit tropischen Floren als bisher angenommen.

Introduction

Southwest Asia is the home of numerous woody taxa of special interest not only to the plant taxonomist but to anyone interested in global biogeography and distributional data with the potential to provide insights into past history. Now that the major modern Floras of the area are either completed (e.g. DAVIS, Flora of Turkey) or nearly so (e.g. RECHINGER, Flora Iranica), it is possible to use these major information sources as a basis for a more detailed assessment of recurring patterns of distribution and geographically distant affinities. The series of maps by MEUSEL et al. (1965 - 1992) and BROWICZ (1982 - 1994) and the information in Conspectus Florae Orientalis (ZOHARY et al. 1980 - 1994) are other important starting points. The selection of taxa that we made was based on a combination of information from these works, the standard modern Floras and our own knowledge. It includes not only clearly isolated relict taxa but vicariad taxa and other species or genera, sometimes quite widespread in our area, with thought-provoking distributions or affinities. We deliberately restricted our choice to woody plants: ZOHARY (1971) quoted an Arabic saw "trees do not err" implying, in this context, that they are reliable indicators in assessing relationships between present-day and past

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vegetation. While in no way intended to be comprehensive (we deliberately excluded the Coniferae), the selection probably does cover the great majority of types of distribution patterns. TAKHTAJAN (1969) and ZOHARY (1971) have written about the Boreal Tertiary and Indo-Malesian floral elements in the Tertiary floras of the Euro-Siberian region in SW Asia (cf. also TAKHTAJAN 1986). In this short paper we have, in addition to considering the Euro-Siberian areas of SW Asia, reviewed taxa in differing phytogeographical regions throughout the whole of SW Asia, stretching from Cyprus through to Afghanistan and Pakistan. PARKS & ÖZTÜRK (1996) have recently discussed Arcto-Tertiary elements in SW Asia with an emphasis on the north American aspect (cf. also THORNE 1993).

The distribution maps presented are inevitably somewhat diagrammatic and are intended to give a general impression of ranges. They were prepared from existing distribution maps, standard Floras and relevant papers and revisions. For ease of reference the families are mainly discussed in alphabetical order. The nomenclature throughout is that of the standard Floras and relevant papers.

Selected families

Buxaceae

Buxus has four species in our area. *B. sempervirens* is the the forests of both the Black Sea and the Caspian (where it grows together with 3 other species discussed below, *Quercus castaneifolia, Parrotia persica* and *Pterocarya fraxinifolia*); it is also distributed throughout much of the Mediterraean, but not continuously. *B. balearica* has a very scattered and disjunct range and can surely be considered as a relict species; it is local in southern Turkey and Syria and disjunctly in Sardinia, the Balearic Islands, southern Spain and Morocco. Two further SW Asiatic species are in Pakistan, one endemic there. Overall, this primarily tropical genus, with about 90 species, is throughout temperate Eurasia, in tropical SE Asia, the Horn of Africa, E & S Africa, Madagascar, the Caribbean and tropical central America. From our point of view, it is an especially interesting genus in that our species show connections, with related species, eastwards to China and SE Asia, south to Africa and west to the New World. Recent palaeontological and palynological investigations (BESSEDIK 1983, BRÜCKNER 1993) emphasise the great antiquity of the genus, extinctions of its European palaeotropical elements and evidence suggesting tropical SE Asia as the centre of diversity of at least the Eurasiatic species. The patterns of distribution of the species in our area and the overall range of the genus are repeated in many of the other families discussed below.

Ericaceae

Two genera merit discussion, *Rhododendron* and *Erica*. *Rhododendron ponticum* is a well-known example of disjunction in the Mediterranean area (SALES 1996), being widely distributed in the forests along the Black Sea, disjunctly present in Lebanon, and, far distant, at the other end of the Mediterranean in southern Spain and in Portugal. There are no significant morphological differences between the east and west populations and they do not merit any formal taxonomic distinction. Its closest allies are undoubtedly with species in northern America not, as might be expected, in the Himalayan area:

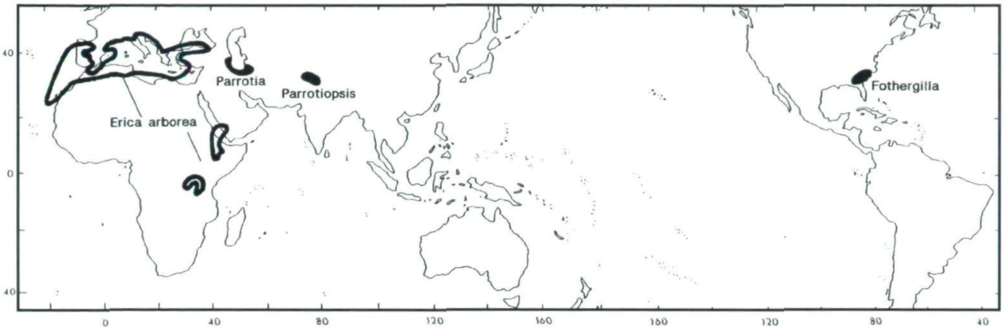

Fig. 1: Distribution of *Erica arborea*, *Parrotia*, *Parrotiopsis* and *Fothergilla*. The Chinese distribution of *Sycopsis* is not shown; a garden bi-generic hybrid exists between it and *Parrotia*.

R. catawbiense and *R. maximum* in east USA and *R. macrophyllum* in the west from California to British Columbia. This rather clear-cut species-group is certainly a good example of north temperate boreal vicariads, in this case missing out the China region.

A contrasting situation is provided by the distribution of *Erica arborea* with its links southwards to east tropical Africa. *E. arborea*, often truly arboreal (and up to 7 m tall in at least the Iberian peninsula), is a characteristic component of Mediterranean vegetation throughout the basin extending westwards to Macaronesia; southwards it stretches to east Africa as far south as Lake Victoria; it is also, maybe surprisingly, in south-west Saudi Arabia, where very large and tall specimens grow at c. 2400 m (Mrs S. Collenette in litt.). Its overall range must be the greatest of any species in the genus (Fig. 1). In the Mediterranean area, there are c.16 species of *Erica*, all relatively distinct. In contrast, in southern Africa the genus exhibits explosive speciation with over 600 species in a relatively small area. Whether or not the genus has its centre of origin in southern Africa, clearly its current area of maximum diversity, or in the Mediterranean area, *E. arborea* has today almost the same basic kind of distributional range as the genus itself, stretching from the Mediteranean towards the east African mountains, though not reaching southern Africa.

Olea europaea (Oleaceae) has some distribution similarities to *E. arborea* in that *O. europaea* ssp. *europaea* is essentially a Mediterranean species, frequently cited as a reliable marker species of Mediterranean climate, though it is not always so. To the south and east, its scarcely different African-Asian counterpart, ssp. *cuspidata*, is in western Saudi Arabia, Oman, the Himalayas, China and east tropical Africa extending to southern Africa, the Mascarenes and Madagascar. There are two further subspecies: ssp. *laperrinei* isolated in the Sudan and Hoggar mountains; and ssp. *cerasiformis*, the wild olive of the Macaronesian islands (cf. GREEN & WICKENS 1989).

In the context of links between SW Asia and southern Africa (cf BURTT 1971, WHITE & LEONARD 1991), it is also worth mentioning the herbaceous *Pelargonium* (Geraniaceae). This has a huge number of species in especially southern Africa, a diminishing number further north, one in Saudi Arabia, and, disjunctly, two species in Turkey, *P. endlicherianum* and *P. quercetorum*; it gives the impression of a southern genus extending north, not vice versa.

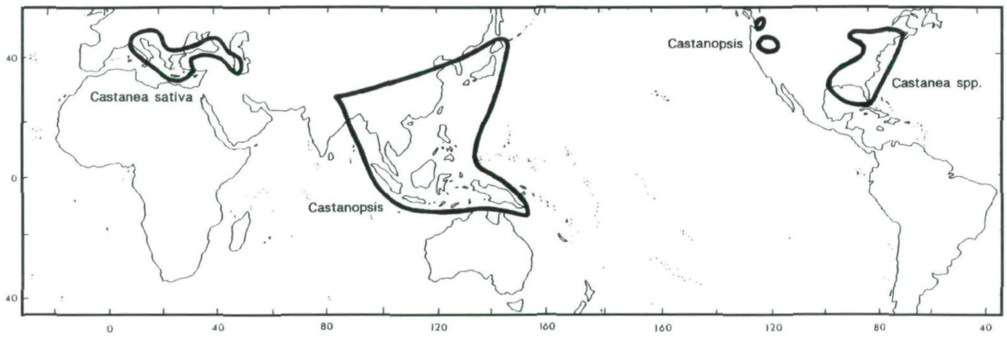

Fig. 2: Distribution of *Castanea sativa*, the other species of the genus and the closely related *Castanopsis*.

Euphorbiaceae

Flueggea, previously confused with *Securinega*, has about 14 species mostly in the tropics of the Old World, but with 3 in the Neotropics; it is also present in temperate areas of the Old World. According to WEBSTER (1984), its present-day distribution is highly relictual; two species are very widely distributed, the remainder have restricted areas. Recently, GEMECI (1993) has described a new species, *F. anatolica*, from southern Turkey; it is related to *F. virosa* a widespread palaeotropical species whose nearest stations to Turkey are far south on the banks of the river Nile in Egypt and to the west in Hazara, Pakistan. Interestingly, *F. anatolica* grows in a community of *Ceratonia siliqua* (q.v.). Another geographically isolated species of *Flueggea* is found at the other end of the Mediterranean: *F.(Securinega) tinctoria*. It grows in scrub vegetation mainly along rivers in Portugal and western Spain. WEBSTER (1984) regarded it as a relict of an early Tertiary Tethyan flora, not related as might be expected to the widespread *F. virosa*, but remarkably similar to a SW Chinese endemic species, *F. acicularis*.

Fagaceae

Castanea sativa, the Sweet Chestnut, is probably only native in the eastern part of the Mediterranean basin extending into the Caucasus but not as far as Iran. Elsewhere in western and northern Europe it is extensively naturalised. It is the only species in the Old World. The other c. 10 species are in eastern N America (Fig. 2). This pattern of distribution seems to be an example of a disjunct boreal temperate range, but the genus that is very close, and scarcely different from it, is *Castanopsis* with over 100 species concentrated in subtropical and tropical SE Asia and a two species in west N. America *Quercus*, a notoriously difficult genus to classify, includes a small number of very distinct and oligomorphic species in our area. One such, restricted to the north-eastern-most parts of the Black Sea forests, is *Q. pontica* (Fig. 3), a shrub up to 5 m very clearly different from all other Turkish, and indeed all SW Asiatic, species because of its habit and large serrate leaves with very prominent numerous parallel veins. It is difficult to suggest an ally for this undoubted relict, but the leaves and their venation are more reminiscent of tropical trees than temperate ones.

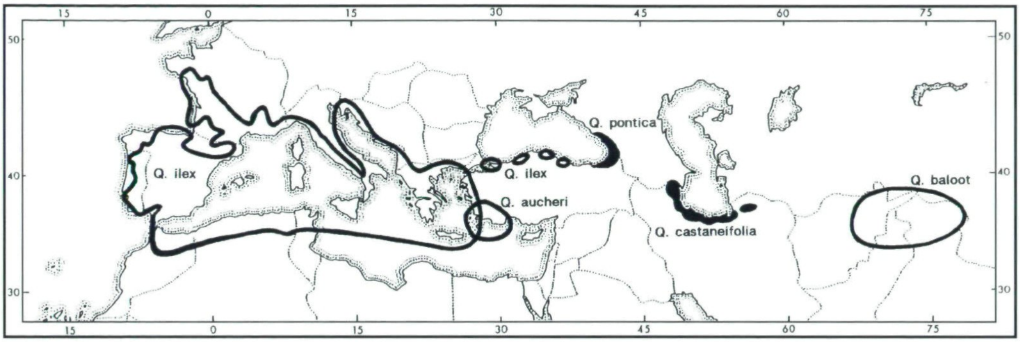

Fig. 3: Distributions of three closely related evergreen species of oak: *Quercus ilex, Q. aucheri* and *Q. baloot*. The ranges of the taxonomically isolated *Q. pontica* in the Black Sea area and *Q. castaneifolia* in the Caspian area are also shown.

The Caspian forests are the home of the endemic *Quercus castaneifolia* (with a very similar distribution in Iran to *Parrotia persica* - Fig. 3). It is another isolated species and difficult to suggest an ally for it.

In contrast to these two examples of deciduous oaks restricted to the forests of the Black and Caspian Seas, there is an interesting small species-group of evergreen stiff-leaved *Quercus* stretching disjunctly from Kashmir to the Mediterranean (Fig. 3). *Q. baloot* is in Kashmir, Pakistan and east Afghanistan; *Q. aucheri* has a very limited range in Mediterranean territory of SW Turkey and the island of Kos; *Q. ilex* is widely distributed throughout the Mediterranean. The three species are undoubtedly very closely allied and *Q. baloot* was regarded by the illustrious J.D. HOOKER (1888) as identical with *Q. ilex* (Flora British India 5: 602).

Although *Quercus* is essentially a north temperate genus with a small number of isolated morphologically distinct species and numerous readily hybridising closely allied species, its undoubted generic ally is the vast Indo-Malesian *Lithocarpus* with probably more than 250 species. This is a parallel situation to that of *Castanea* and *Castanopsis* mentioned earlier.

Hamamelididaceae

This intriguing family (ENDRESS 1989) with many fascinating examples of distribution has three genera of special interest in our area: *Parrotia, Parriotiopsis* (Fig. 1) and *Liquidambar*.

The monotypic *Parrotia persica* is an important tree species in and almost restricted to the forests of the Caspian, also known in adjacent parts of Caucasia. One of its allies the likewise monotypic *Parrotiopsis, P. jacquemontiana*, is restricted to easternmost Afghanistan, Pakistan and Kashmir. The link with the New World is provided by the similarities of these two genera with the bitypic east north American *Fothergilla* (Fig. 1). Another interesting facet of *Parrotia* is its relationship with the Chinese/Malesian/New Guinea *Sycopsis*. Although geographically separated for presumably aeons of time the inter-fertility of the two genera is evident in the hybrid x *Sycoparrotia*, formed in

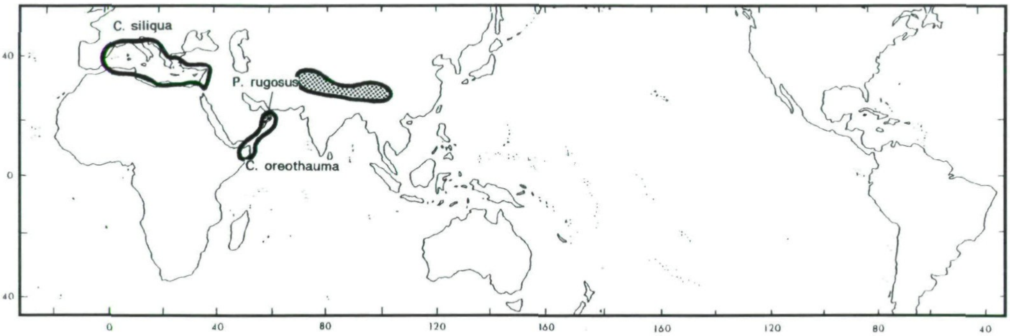

Fig. 4: Distribution of *Ceratonia* with one species in the Mediterranean, the other in Arabia and Somalia. Also shown is the distribution of *Plectranthus rugosus* extending from the Himalayan region to, far disjunctly, Oman.

cultivation by crossing the deciduous *Parrotia* with the evergreen central and western Chinese *Sycopsis sinensis*. The hybrid species, x *S. semidecidua*, is clearly intermediate in foliage and floral features between its two parents.

Fossil records of *Parrotia* are reported from Tertiary deposits in Europe as far north as Spitzbergen.

Liquidambar orientalis, the source of Levant storax, is today restricted to south western Turkey (Güner et al. 1993) where it grows in flood plains or near streams. There are many Tertiary fossil records of it and it must have been very widespread throughout the northern hemisphere (Ferguson 1989). *L. orientalis* has very definite close allies in the north American *L. styraciflua* and the two Chinese species *L. formosana* and *L. acalycina* which together make up the genus (Hoey & Parks 1994). The main development of the family today is in SE Asia, but there are also genera in tropical Africa, e.g. *Trichocladus* which reaches southern Africa, and *Dicoryphe* which is restricted to Madagascar and the Comore islands. So although the first impression of the SW Asiatic genera is that they are "northern", the family is essentially tropical.

Juglandaceae

The family, possibly related to the Anacardiaceae, has two genera in our area: the walnut, *Juglans regia*, both native (but difficult to be certain of its truly indigenous range) and cultivated; *Pterocarya fraxinifolia*, the wing-nut, widely distributed in the Caspian forests and the forests of the Black Sea and also present, rather surprisingly, in Irano-Turanian parts of SE Turkey.

Juglans is also, disjunctly, in the Himalayas, China and has about 19 species in temperate to tropical parts of the New World. The other c. 5 species of *Pterocarya* are in the Sino-Japanese area. Interestingly, both *Pterocarya* and *Juglans* are absent from Africa (Manning, 1978).

Lauraceae, Myrsinaceae, Myrtaceae

The SW Asiatic representatives of these three essentially tropical, unrelated, families can usefully be considered together; all have aromatic leaves with or without gland-dotted leaves.

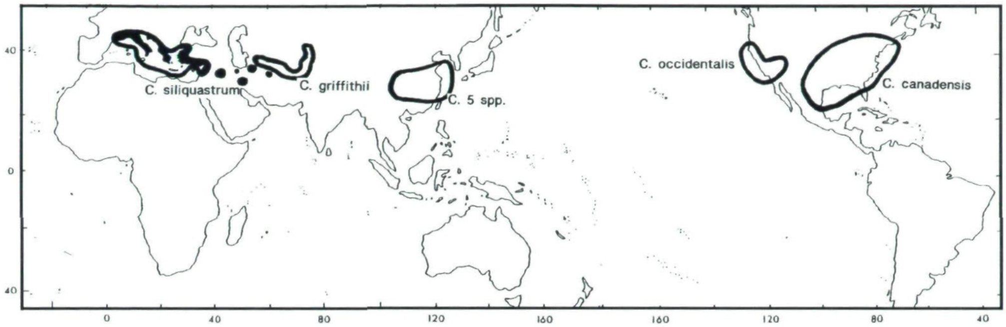

Fig. 5: Distribution of *Cercis* and its c. 6 species.

A good example of a major tropical family with only a solitary representative in our area is the well-known bay laurel, *Laurus nobilis* (Lauraceae), widespread in the Mediterranean. The only other species in the genus is *L. azorica* in the Azores, Madeira and Canary Islands. The total number of species in the Lauraceae is over 2000 almost all of which are in the tropics of Asia and America; the family is much more poorly represented in Africa.

Myrsine africana (Myrsinaceae), a small evergreen shrub, is only in the extreme east of our area in easternmost Afghanistan and in Pakistan, but the species has a vast overall distribution throughout the subtropical and tropical regions of Africa (TATON 1976) and Asia; it is also in the Atlantic Azores islands. The other 3 - 4 species of the genus have in contrast very restricted distributions; 2 in China and 1 endemic to Madagascar. The family with well over 1000 species is mainly in the tropics and subtropics of both the Old and the New World.

Myrtus communis (Myrtaceae), likewise evergreen, is a fairly widespread Mediterranean species although its native range is obscured by its age-long cultivation. The only other species in the genus, in the strict sense, *M. nivellei*, is endemic to Algeria and the Hoggar mountains. The family with upwards of 3000 species has a major development in Australia.

Leguminosae

The family has four genera of special interest in our area: *Ceratonia, Cercis, Gleditsia* (all in subfamily Caesalpiniodeae) and *Albizia* (Mimosoideae).

Ceratonia until recently was believed to be monotypic with only *C. siliqua*, the well-known carob; probably it is native only in the east Mediterranean, being widely cultivated and naturalised throughout the Mediterranean and, also, in other parts of the world. In 1980, (HILLCOAT, LEWIS & VERDCOURT) a related second species, *C. oreothauma,* was described from Somalia and Oman (Fig. 4). The genus is morphologically very isolated, gives every indication of being very ancient; it is placed in the monotypic subtribe in tribe Cassieae.

Cercis has two species in our area, the mainly east Mediterranean *C. siliquastrum* (though widely cultivated as an a ornamental throughout the Mediterranean) and the

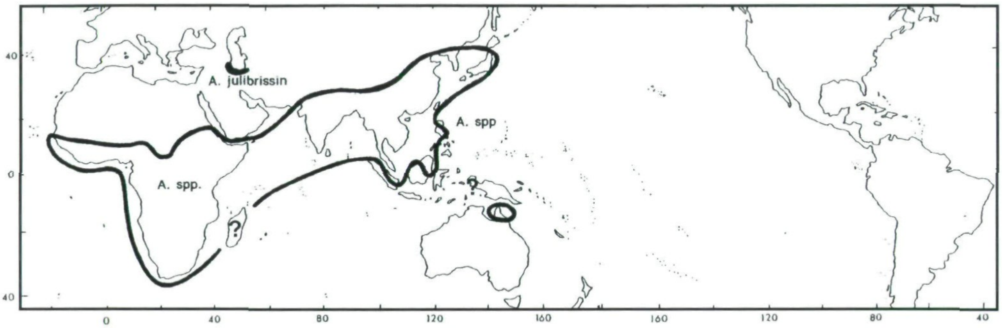

Fig. 6: Approximate distribution of *Albizia* in the Old World showing the isolation of *A. julibrissin* in the Caspian forests (but see text). Nota: the distribution of the species in central and south America is not mapped.

more Irano-Turanian *C. griffithii* from Afghanistan and Tadjikistan. Disjunctly, there are 5 species in China, one, *C. canadensis*, in eastern North America and another, *C. occidentalis,* in western America. *Cercis* seems to be another genus illustrating a fine pattern of temperate circum-boreal distribution: Europe, China, America (Fig. 5). But, although the genus is very homogeneous and taxonomically isolated, it has at least one feature that strongly suggests a tropical connection: the flowers are borne on the old wood, a character much more frequent in tropical than in temperate woody plants. The two other genera in subtribe Cercidinae are endemic to SW and tropical W Africa

The other two genera discussed here are restricted to the forests of the Caspian: *Albizia julibrissin* (possibly also native in NE Turkey) and *Gleditsia caspica*. Both genera are certainly well-developed in the tropics. *Albizia* (Fig. 6) is well-represented in Africa (c. 40 species), E Asia and Australia (c. 70 species) and in tropical S America (c. 10 species). *Gleditsia,* in addition to the isolated Caspian species, contains 6 species in China, two in SW America and one in central southern America. Although some authors have doubted *A. julibrissin* being truly native in Iran, RECHINGER (1986) was firmly of the opinion that it was indigeneous.

Magnoliaceae

The family is absent from our area today but fossils of *Liriodendron* indicate that is was once widely distributed in the northern hemisphere and apparently survived in Europe till the Pliocene and early Pleistocene. Today the genus has one species in east north America and the other in central China. Despite this huge disjunction, the two species are inter-fertile, another example of species which have been spatially separated for enormities of time, yet can still hybridize. *Hamamelis* (Hamamelidaceae) is another genus that today is restricted to China-Japan and northern America, but to our knowledge there are no certain fossil records of it from our area.

Staphyleaceae

This small family of trifoliolate or pinnate-leaved trees or shrubs is only represented in our area by *Staphylea*. In easternmost Afghanistan and the Swat-Hazara region of

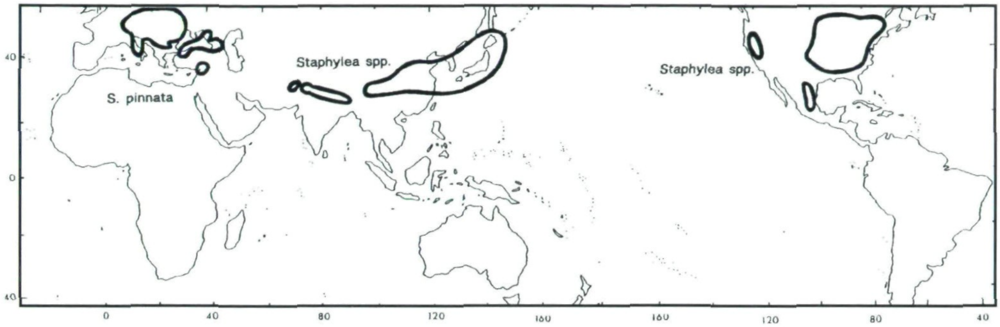

Fig. 7: The distribution of *Staphylea*.

Pakistan there is *S. emodi*, extending eastwards towards Nepal. In the forests of the Black Sea area and extending into the Caucasus, the Balkans and central Europe there is *S. pinnata*. The remaining c. 11 species are north temperate taxa in western China, Japan, Mexico, California and eastern north America (Fig. 7). The genus is certainly a northern temperate one, but its close ally *Turpinia* has about 30 species distributed throughout the Asiatic and American tropics. It provides yet another example of a situation where a taxon which appears to be, or is, north temperate but whose closest relative is in the tropics.

Styracaceae

Styrax officinalis is a characteristic and handsome small tree or shrub of the east Mediterranean; it is also native in California, where it is either named as that or else given separate varietal rank (Fig. 8). A somewhat similar pattern of distribution occurs in the species of *Arbutus* (Ericaceae): two, *A.andrachne* and *A. unedo*, in the Mediterranean with the remaining c. 12 species in N America (PARKS & ÖZTÜRK 1996).

Styrax is of special interest within the framework of this paper. It is a large well-defined genus of c.100 species. There are c. 30 species in China, 8 in the Flora Malesiana area, with the remaining species of the genus in the New World (c. 21 are in Brazil); all far disjunct from the Mediterranean *S. officinalis*

Some different types of distribution

Apart from frequently repeating distributions patterns such as those listed above, there are, in virtually every part of the world with a well-developed flora, examples of curious or seemingly anomalous ranges. South-west Asia is no exception. Although herbaceous taxa are outwith the scope of this paper it is relevant to emphasise that the endemic genera of SW Asia conform to no set pattern as far as their occurrence is concerned: they are scattered haphazardly throughout the area in differing phytogeographical areas, differing altitudes and differing habitats (HEDGE & WENDELBO 1978). And as far as their affinities are concerned, they are either quite without obvious allies or else are related to other genera within SW Asia.

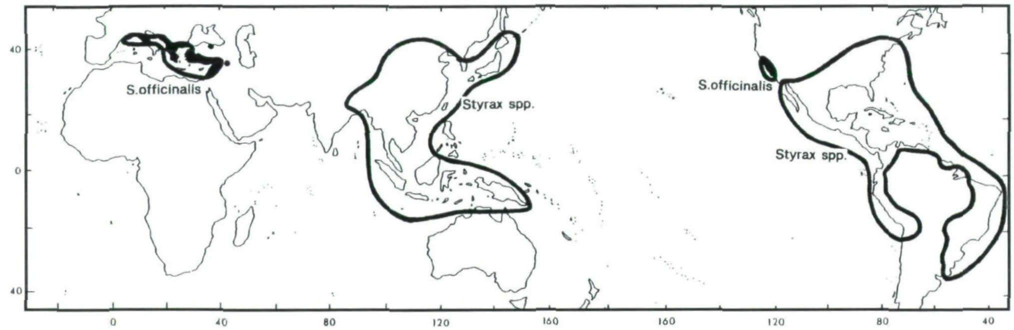

Fig. 8: Distribution of *Styrax*, including that of the Mediterranean and western American *S. officinalis*.

Three examples of seemingly anomalous distribution among our woody taxa follow: one concerns closely related vicarious species within a genus; the second, a wide-ranging species with a surprising disjunction; the third, an endemic monotypic genus.

Bosea is a tritypic genus in Amaranthaceae (Townsend 1973): one species, *B. amherstiana*, is confined to the NW Himalayan parts of Kashmir/Pakistan; the second, *B. cypria*, is a locally abundant endemic shrub in Cyprus; and the third, *B. yervamora*, is in the Canary Islands. *Bosea* seems to be a rather clear-cut genus without obvious allies, though the family is mainly a tropical one and there may be some affinities with African genera.

Another apparently curious case is that of the shrubby *Plectranthus rugosus* (Labiatae). It is a very distinct species, easily identified in this protean genus. The total range of the species is from SW China to Bhutan, Nepal, along the Himalayan mountains to eastern Afghanistan and Pakistan; thence with a major disjunction of c. 1000 km, it is in Oman on Jabal Akhdar, at an altitude of c. 2000 m (Fig. 4). Although this seems, and is, a remarkable distribution, there are other Himalayan-Oman links on Jabal Akhdar with the presence in both areas of *Olea* and *Monotheca* (Sapotaceae) species. Today the area of maximum diversity of *Plectranthus* (including *Coleus*) is Africa, mainly the east, and Madagascar; the related *Isodon* is mainly Asiatic.

The last example is the surprising distribution of the monotypic *Stocksia* (Sapindaceae): *Stocksia brahuica* is a rigid spiny shrub restricted to dry areas of Iran, south Afghanistan and Pakistan Baluchistan. It is difficult to suggest a definite ally for the genus, though the family, with well over 1000 species is mainly tropical.

Some families not discussed

There are a few other families that we could have discussed and it is worth mentioning three that fit within the patterns discussed above. Firstly, the well-known *Platanus* of Platanaceae, (monotypic and possibly with affinities to Hamamelidaceae). Secondly, Ebenaceae and *Diospyros*; and thirdly, Ulmaceae with *Celtis* and *Zelkova*.

Conclusions

In any paper dealing with biogeography, it is always easier to present facts than interpret or explain them. But we list below what we consider to be some of the more salient results of our rather cursory exploration of an intriguing subject.

1. In the past there has been a tendency to make generalisations about patterns of distribution based either on limited evidence or a relatively parochial approach. It is essential to have precise facts about the overall distribution of taxa and their correct taxonomy. The outcome can sometimes be surprising and not in line with what was previously thought. It proved to be very difficult to categorize many of the distribution patterns described above and such frequently applied terms Tethyan, Boreal-Tertiary, Indo-Malesian can be misleading. Not infrequently, it is even difficult to designate families as having a Laurasian or Gondwanaland distribution (RAVEN & AXELROD 1974). The situation is very complex, the origins and components of the SW Asian flora are very diverse and cannot be defined simplistically.

2. In several of the genera we considered there are good examples of vicariad species which disjunctly are in SW Asia, China and N America, sometimes missing out China: *Arbutus, Castanea, Cercis, Staphylea, Styrax.* Pleistocene glaciations must have played a major role in such present day disjunctions. Fossil evidence, despite its inadequacies, suggests that during the Tertiary the northern hemisphere had a widespread subtropical flora and this is supported by the clear tropical affinities of many of the taxa we reviewed and/or their present ranges. General tropical affinities were evident in many cases: *Albizia, Buxus, Gleditsia, Laurus, Myrsine, Myrtus.*

3. Our evidence indicates much stronger African connections than previously recognised among SW Asiatic woody taxa. Some examples are provided by *Erica arborea, Flueggea anatolica, Myrsine africana, Olea europaea.*

4. In many of the taxa assessed, there were clear SE Asiatic links, either through related species or related genera. Two examples of the latter are *Quercus* closely related to the SE Asian *Lithocarpus*; and *Castanea* scarcely different from *Castanopsis,* also well-developed in SE Asia.

5. Although the greatest number of taxonomically isolated taxa occur in the Euro-Siberian forests of the Black Sea area or the Caspian, both the Mediterranean and Irano-Turanian regions have substantial numbers of either relict taxa (*Liquidamber, Bosea cypria, Stocksia*) or taxa with especially interesting affinities or distributions.

6. There is no evidence of any important autochthonous development of woody taxa at generic level in SW Asia; only one genus, *Parrotia,* is truly endemic. This is in contrast to some herbaceous families such as Cruciferae where a substantial number of genera are endemic.

7. Some of the vicariad examples given above such as *Bosea, Cercis* and the evergreen *Quercus* would provide excellent, and potentially rewarding, projects for DNA and cladistic analyses.

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