Generic endemism in South-West Asia: an overview

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Abstract

A provisional list of all the endemic vascular plant genera in SW Asia is presented. The area, here defined to include Turkey, the Caucasus, N Iraq, Iran, Afghanistan and adjacent parts of Pakistan and Central Asia, has 161 genera restricted to it. By far, the greatest numbers of the endemic genera are in *Apiaceae*, *Brassicaceae* and *Asteraceae*; many are morphologically isolated and occur at random throughout the area. Non-endemic genera with relevant distributions in the area are also discussed, several having a major concentration in Central Asia/Afghanistan and radiate westwards from there reaching a limit in SE Turkey/N Iraq. Also in these and other non-endemic genera, there are many species confined to the west (Turkey) or the east (Afghanistan) but very few are distributed throughout. The paper attempts to provide a framework for future research. It draws attention to the need for a more precise terminology in discussing phytochoria and questions the validity of many currently widely used terms including Irano-Turanian.

Keywords: Central Asia, endemism, Irano-Turanian, phytogeography

Introduction

"L'Orient" of Boissier covered: (1) Greece and its islands and European Turkey; (2) Crimea, Transcaucasus and Caucasus; (3) Egypt to the first cataracts and the Arabian Peninsula till the line of the tropics; (4) Asia Minor, Armenia, Syria and Mesopotamia; (5) Persia, Afghanistan and Baluchistan and (6) S Turkestan to the line cutting the Aral Sea in two. This area comprises SE Europe, the Middle East of Zohary ("NE corner of Africa and SW edge of Asia", Zohary 1973) plus the eastern parts of Afghanistan/Baluchistan and "Turkestan" also of Zohary (1973). It is clear the care Boissier took in Flora Orientalis (1867–1884) to cover an area that, as far as he understood, constituted a floristic continuum and unit. Although Flora of Turkey (Davis 1965) covers only a political area, Flora Iranica (Rechinger 1963) deals with a more natural boundary stretching from N Iraq, to Iran, the whole of Afghanistan and highland Pakistan.

In this paper, we concentrate on the mountainous areas of SW Asia, including the Caucasus and do not investigate the Arabian Peninsula which has western floristic connections with the Sahara. The former also corresponds to the Western Asiatic Subregion of the Irano-Turanian Region of Takhtajan (1986) and to the geological province Irano-Anatolian Folded Zone (Davis *et al.* 1994). It does cover a broader area than the Irano-Turanian regional centre of endemism of Davis *et al.* (1994) and Léonard (1989). The plant distributions that we have studied for this paper extend into here.

SW Asia is an area of major plant diversity and the interest of the area is also demonstrated by the large number of its endemic taxa. The level of endemism is generally used to indicate the uniqueness of a flora and is a major criterion for conservation; it was given particular emphasis to circumscribe the Centres of Plant Diversity in Davis *et al.* (1994). Endemics have also been investigated through particular countries in the area (for references cf. Materials and Methods).

Our investigation deals with the endemic genera restricted to SW Asia as described above (see also Peterson & Watson, 1998) and, contrary to the fragmented assessments so far, we attempt an overall evaluation of the area. We were well aware of the difficulties involved in:

1. The delimitation of such a varied area. Northwards, the meeting of SW Asia and C Asia has remained unclear. Rechinger himself (1991), remarked "Of all the boundaries of Flora Iranica that of the northeast is the most artificial … much collation with the floras of Soviet C Asia and Himalayas remains to be done". Turkmenistan and Tajikistan, less so for Uzbekistan and Kyrgyzstan, are countries we investigated *vis à vis* Afghanistan.

2. Transient life of a supposedly isolated genus in a time of intensive molecular research. Of course, there are genera more distinct and isolated than others that may lose their "endemic status" in the future. That is how a number of the papers cited here became outdated. Two examples are those of Gagnidze *et al*. (2002) on the Caucasus with 17 endemic genera listed of which today only eight are accepted and the earlier Hedge & Wendelbo (1970) account of generic endemism in Afghanistan where 23 genera were listed and only 13 are recognized, some not included in the earlier list.

We hope in some way to contribute to the unfinished thought of Rechinger in 1991 "… a concluding volume of Flora Iranica would deal with the distributional areas of the endemic genera in the Flora…". Rechinger's vast contributions to taxonomy and phytogeography constitute the foundation to anyone writing on this topic.

In this paper our aims are: (1) to give an up-to-date listing of all the endemic vascular plant genera and their constituent species; (2) to discuss some those endemic genera; (3) to discuss the phytochoria in the area; (4) to provide information for conservation and (5) to provide a selection of relevant literature.

Materials and Methods

The sources for compiling the genera confined to SW Asia were the Floras of the area, e.g. Flora Iranica (Rechinger 1963), Flora Turkey (Davis 1965), Flora of Tajikistan (Ovczinnikov 1963), Field-Guide Afghanistan (Breckle & Rafiqpoor 2010, Czerepanov 2007) as well as publications on their endemics (Ekim 2009, Emami & Aghazari 2004, Gagnidze *et al.* 2002, Hedge & Wendelbo 1970, 1978; Kamelin 1965, Noroozi *et al*. 2008, Nowak *et al*. 2011, Shmida 1984) and up-to-date taxonomic information in recent publications (e.g. Al-Shehbaz 2012, Pimenov & Leonov 1993). Although the list of genera resulted from a rather detailed search, the authors are well aware that it is not exhaustive and more time would be needed to improve it, but would probably not change the basic findings.

The endemic genera in SW Asia

- List of endemic genera by family

Generic names not in bold were previously cited as endemic but now are subsumed into another genus or are no longer endemic to this area; in square brackets are short comments. In *Brassicaceae*, there are indicated the numbers of the Tribe (TR) according to Al-Shahbaz (2012).

Apiaceae

Aegokeras Raf.: *A caespitosa* (Sibth. & Sm.) Raf.—NW/SW Turkey

Agasyllis Spreng.: *A. latifolia* (M. Bieb.) Boiss.—Caucasus

Alococarpum Riedl & Kuber: *A. erianthum* (DC.) Riedl & Kuber—W/C Iran

Azilia Hedge & Lamond: *A. eryngioides* (Pau) Hedge & Lamond—W Iran

Calyptrosciadium Rech.f. & Kuber: *C. bungei* (Boiss.) Pimenov—NE Iran, Afghanistan; *C. rechingeri* Pimenov & Kljuykov—C Afghanistan

Chamaesciadium C.A. Mey. [high alpine]: *C. acaule* (M. Bieb.) Boiss.—Turkey, Caucasus, Iran

Chymsidia Albov: *C. agasylloides* (Albov) Albov—Caucasus; *C. colchica* (Albov) Woronow—Caucasus

Crematosciadium Rech.f. = *Eriocycla* Lindl.

Crenosciadium Boiss. & Heldr.: *C. siifolium* Boiss. & Heldr. ex Boiss.—W Turkey

Cymbocarpum DC.: *C. amanum* Rech.f.—S Turkey; *C. anethoides* DC.—E Turkey, Caucasus, N/NW Iran; *D. erythraeum* (DC.) Boiss.—NW Iran; *C. wiedemannii* Boiss.—N Turkey, Caucasus, Iran

Demawendia Pimenov: *D. pastinacifolia* (Boiss. & Hausskn.) Pimenov—W/C Iran, Turkmenistan

Dicyclophora Boiss.: *D. persica* Boiss.—W/S Iran

Diplotaenia Boiss. [distinct genus]: *D. cachyridifolia* Boiss.—N Iran; *D. damavandica* Mozaff., Hedge & Lamond—N Iran; *D. hayri-dumanii* Pimenov & Kljuykov—S Turkey; *D. turcica* Pimenov & Kljuykov—SE Turkey

Ekimia Duman & M.Watson: *E. bornmuelleri* (Hub.-Mor. & Reese) Duman & M. Watson—SW Turkey

Eremodaucus Bunge: *E. lehmannii* Bunge.—Caucasus, Iran, Turkmenistan, Afghanistan, Tajikistan (Pamir-Alai)

Ergocarpon C.C. Towns.: *E. cryptanthum* (Rech.f.) C.C. Towns.—Iraq, Iran

Exoacantha Labill. [distinct genus]: *E. heterophylla* Labill.—S Turkey, Syria, Lebanon, Israel

Froriepia K. Koch: *F. gracillima* Leute—SE Turkey; *F. subpinnata* (Ledeb.) Baill.—Caucasus, N Iran

Fuernrohria K. Koch: *F. setifolia* K. Koch—NE Turkey, Caucasus, NW Iran

Gongylosciadium Rech.f. [salt marsh]: *G. falcarioides* (Bornm. & H. Wolff) Rech.f.—W/N Turkey, Caucasus, Iran

Gongylotaxis Pimenov & Kljuykov [salt marshes]: *G. rechingeri* Pimenov & Kljuykov—C/E Afghanistan

Haussknechtia Boiss. [related to *Demawendia*]: *H. elymaitica* Boiss.—W Iran

Kafirnigania Kamelin & Kinzik.: *K. hissarica* (Korovin) Kamelin & Kinzik.—Tajikistan

Kalakia Alava: *K. marginata* (Boiss.) Alava—W/C Iran

Kandaharia Alava: *K. rechingerorum* Alava—SE Afghanistan

Karatavia Pimenov & Lavrova: *K. kultiassovii* (Korovin) Pimenov & Lavrova—Kyrgyzstan (Tien Shan)

Komarovia Korovin: *K. anisosperma* Korovin—Tajikistan (Pamir Alai)

Kosopoljanskia Korovin: *K. hebecarpa* Pimenov & Kamelin—Kyrgyzstan (Tien Shan); *K. turkestanica* Korovin—Kyrgyzstan (Tien Shan)

Ladyginia Lipsky: *L. bucharica* Lipsky—E Afghanistan, Tajikistan (Pamir Alai)

Lisaea Boiss.: *L. heterocarpa* (DC.) Boiss.—E Turkey; *L. papyracea* Boiss.—C Turkey; *L. strigosa* (Banks & Sol.) Eig—E Turkey, Caucasus, N Iraq, Israel

Mandenovia Alava: *M. komarovii* (Manden.) Alava—Caucasus

Mastigosciadium Rech.f. & Kuber: *M. hysteranthum* Rech.f.—C Afghanistan

Microsciadium Boiss.: *M. minutum* (d'Urv.) Briq.—Aegean, Turkey

Mogoltavia Korovin: *M. narynensis* Pimenov & Kljuykov—Kyrgyzstan (Tien Shan); *M. severtzovii* (Regel) Korovin—Kyrgyzstan (Tien Shan)

Mozaffariania Pimenov & Maassoumi: *M. insignis* Pimenov & Maasoumi—SE Iran

Neocryptodiscus Hedge & Lamond = *Prangos* Lindl.

Oliveria Vent.: *O. decumbens*Vent.—S Turkey, Iraq, Syria, W/S Iran

Olymposciadium Wolff = *Aegokeras* Raf.

Opoidia Lindl.: *O. galbanifera* Lindl.—Iran

Opsicarpium Mozaff. [doubtful status?]: *O. insignis* Mozaff.—Iran

Ormosciadium Boiss.: *O. aucheri* Boiss.—E Turkey, Syria, N Iraq, W Iran

Parasilaus Leute: *P. asiaticus* (Korovin) Pimenov—N Afghanistan, Tajikistan (Pamir Alai)

Pastinacopsis Golosk.: *P. glacialis* Golosk.—Kyrgyzstan (Tien Shan)

Paulita Soják: *P. alaica* (Piminov & Kljuykov) Piminov & Kljuykov—Tajikistan (Pamir Alai); *P. alpina* (Schischk.) Soják—Tajikistan (Pamir Alai); *P. ovczinnikovii* (Korovin) Soják—Tajikistan (Pamir Alai)

Petroedmondia Tamamsch.: *P. syriaca* Tamamsch.—E Turkey, N Iraq, Syria, Jordan, NW Iran

Pichleria Stapf & Wettst. = *Zosima* Hoffm.

Pilopleura Schischk.: *P. goloskokovii* (Korov.) Pimenov—Kyrgyzstan (Tien Shan); *P. tordyloides* (Korov.) Pimenov—Kyrgyzstan (Tien Shan)

Pinacantha Gilli [doubtful status?]: *P. porandica* Gilli.—E Afghanistan

Postiella Kljuykov: *P. capillifolia* (Post) Kljuykov—S Turkey

Pyramidoptera Boiss. [distinct genus]: *P. cabulica* Boiss.—NW/SW/C/E Afghanistan

Registaniella Rech.f.: *R. hapaxlegomena* Rech.f.—SW Afghanistan

Rhabdosciadium Boiss. [distinct genus]: *R. aucheri* Boiss.—W/S Iran; *R. microcalycinum* Hand.-Mazz.— E Turkey; *R. oligocarpum* (Post ex Boiss.) Hedge & Lamond—S Turkey; *R. petiolare* Boiss. & Hausskn. ex Boiss.—W Iran; *R. straussii* Hausk. ex Bornm.—W Iran; *R. urusakii* Akalin—E Turkey

Rhopalosciadium Rech.f. = *Torilis* Adans.

Schtschurowskia Regel & Schmalh.: *S. margaritae* Korovin—Kyrgyzstan (Tien Shan); *S. meifolia* Regel & Schmalh.—Kyrgyzstan (Tien Shan)

Sclerochorton Boiss. [doubtful status?]: *S. haussknechtii* Boiss.—W Iran

Scrithacola Alava: *S. kuramensis* (Kitam.) Alava—C/E Afghanistan, Pakistan

Sphaerosciadium Pimenov & Kljuykov: *S. denaense* (Schischk.) Pimenov & Kljuykov—Uzbekistan

Spongiosyndesmus Gilli = *Ladyginia* Lipsky

Stenotaenia Boiss. [doubtful status?; high alpine species]: *S. elbursensis* Bornm.—N Iran; *S. haussknechtii* Boiss.—W Iran; *S. nudicaulis* Boiss.— N Iran; *S. tordylioides* Boiss.—Iran

Stewartiella Nasir: *S. crucifolia* (Gilli) Hedge & Lamond—SW/NE/E Afghanistan, Pakistan

Symphyoloma C.A. Mey.: *S. graveolens* C.A. Mey.—Caucasus

Szovitsia Fisch. & C.A. Mey.: *S. callicarpa* Fisch. & C.A. Mey.—Caucasus, Iran

Thecocarpus Boiss.: *T. meifolius* Boiss.—W/S Iran; *T. carvifolius* (Boiss. & Bal.) Hedge & Lamond—S Turkey

Trigonosciadium Boiss.: *T. brachytaenium* (Boiss.) Alava—W Iran; *T. intermedium* Freyn & Sint. ex Sint.—E Turkey; *T. lasiocarpum* (Boiss.) Alava—E Turkey,? Iran; *T. tuberosum* Boiss.—E Turkey, W Iran; *T. viscidulum* Boiss. & Hausskn.—SE Turkey, N Iraq, W Iran

Vvedenskya Korovin: *V. pinnatifolia* Korovin—Tajikistan (Pamir Alai)

Zeravschania Korovin: *Z. aucheri* (Boiss.) Pimenov—W/N/C/S Iran; *Z. ferulifolia* (Gilli) Pimenov—W/ N/NE/C/E/ Afghanistan Pakistan; *Z. membranacea* (Boiss.) Pimenov—W/N/S Iran; *Z. pauciradiata* (Tamamsch.) Pimenov—Caucasus, W Iran; *Z. regeliana* Korovin—Uzbekistan; *Z. scabrifolia* Pimenov—Tajikistan

Asparagaceae

Alrawia (Wendelbo) K. Perss. & Wendelbo: *A. bellii* (Baker) K. Perss. & Wendelbo—W/C Iran; *A. nutans* (Wendelbo) K. Perss. & Wendelbo—N Iraq, W Iran

Asteraceae

Acanthocephalus Kar. & Kir.: *A. amplexifolius* Kar. & Kir.—N, NE Afghanistan, Uzbekistan, Tajikistan, Kyrgyzstan; *A. benthamianus* Regel & Schmalh.—NW, NE, E Afghanistan, Pakistan, Tajikistan, Kyrgyzstan

Acantholepis Less.: *A. orientalis* Less.—E Turkey, Caucasus, Iran, Pakistan, Turkmenistan, Uzbekistan, Tajikistan

Aegopordon Boiss.: *A. berardioides* Boiss.—Iran, E Afghanistan, Pakistan

Amblyocarpum Fisch. & C.A. Mey.: *A. inuloides* Fisch. & C.A. Mey.—Caucasus, Talish, N Iran

Chamaepus Wagenitz: *C. afghanicus* Wagenitz—NE Afghanistan

Cladochaeta DC.: *C. velutina* Anderb.—Caucasus

Cousiniopsis Nevski: *C. atractyloides* (C. Winkl.) Nevski—Iran, Turkmenistan, Uzbekistan, Kazakhstan

Cymbolaena Smoljan.: *C. griffithii* (A. Gray) Wagenitz— C Turkey, Caucasus, Syria, Israel, Iran, Pakistan Turkmenistan, Tajikistan, Kyrgyzstan

Dipterocome Fisch. & C.A. Mey.: *D. pusilla* Fisch. & C.A. Mey.—Syria, N Iraq, W/ C/S/E Iran, NW/N/SW/SE Afghanistan

Hyalochaete Dittrich & Rech.f.: *H. modesta* (Boiss.) Dittrich & Rech.f.—E Afghanistan, Pakistan

Hymenocephalus Jaub. & Spach: *H. rigidus* Jaub. & Spach—W Iran

Hypacanthium Juz.: *H. echinopifolium* (Bornm.) Juz.—Kyrgyzstan (Tien Shan); *H. evidens* Tscherneva—Kyrgyzstan (Tien Shan)

Jurinella Jaub. & Spach: *J. frigida* (Boiss.) Wagenitz—N/C Iran; *J. microcephala* (Boiss.) Wagenitz—N/C/E Iran, Turkmenistan; *J. moschus* (Habl.) Bobrov—N/S Turkey, Caucasus, N Iraq, W Iran; *J. squarrosa* (Fisch. & C.A. Mey.) Iljin—Caucasus

Karvandarina Rech.f.: *K. aphylla* Rech.f., Aellen & Esfandiari—S Iran, Pakistan

Lachnophyllum Bunge: *L. gossypium* Bunge [annual]—NW/C/NE/E Afghanistan, Pakistan, Turkmenistan, Tajikistan, Kyrgyzstan; *L. noeanum* Boiss. [annual]— E Turkey, Israel, W Iran

Lepidolopsis Poljak.: *L. turkestanica* (Regel & Schmalh.) Polj.—SW/N/NE/E/SE Afghanistan, Kyrgyzstan (Pamir Alai)

Leucocyclus Boiss. = *Aquilea* L.

Lipskyella Juz.: *L. annua* (C. Winkl.) Juz. [annual; desert]—Turkmenistan

Mausolea Bunge ex Poljak.: *M. eriocarpa* (Bunge) Poljak. ex Podlech—NE Iran, Turkmenistan

Myopordon Boiss.: *M. aucheri* Boiss.—W Iran; *M. hyrcanum* (Bornm.) Wagenitz—C Iran; *M. persicum* Boiss.—W/S Iran

Nikitinia Iljin: *N. leptoclada* (Bornm. & Sint.) Iljin—E Iran, Turkmenistan

Outreya Jaub. & Spach: *O. carduiformis* Jaub. & Spach—N Iraq, Iran, SW, SE Afghanistan, Pakistan

Perplexia Iljin = *Jurinea* Cass.

Polychrysum (Tzvel.) Koval.: *P. tadshikorum* (Kudr.) Koval.—C/NE Afghanistan, Tajikistan

Polytaxis Bunge: *P. lehmannii* Bunge [annual]—N Afghanistan, Turkmenistan, Tajikistan

Pterachaenia (Benth.) Lipsch.: *P. stewartii* (Hook. f.) R.R. Stewart—E/SE Afghanistan, Pakistan

Sclerorhachis (Rech.f.) Rech.f.: *S. caulescens* (Aitch. & Hemsl.) Rech.f.—NW/SE Afghanistan; *S. leptoclada* Rech.f.—NE Iran; *S. platyrhachis* (Boiss.) Podl. ex Rech.f.—C/E Iran, Turkmenistan; *S. polysphaera* Rech.f.—C Afghanistan

Schmalhausenia Winkl.: *S. nidulans* (Rupr.) Winkl.—Kyrgyzstan (Tien Shan)

Tiarocarpus Rech.f.: *T. hymenostephanus* Rech.f.—SW Afghanistan; *T. neubaueri* (Rech.f.) Rech.f.—C Afghanistan; *T. tragacanthoides* (Rech.f. & Gilli) Rech.f.—C Afghanistan

Turaniphytum Poljak.: *T. codringtonii* (Rech.f.) Podlech—C Afghanistan, Turkmenistan; *T. eranthemum* (Bunge) Poljak.—Turkmenistan; *T. kopetdaghense* Poljak.—Turkmenistan

Ugamia Pavlov: *U. angrenica* (H. Kraschen.) Tzevlev—Kyrgyzstan (Tien Shan)

Wendelboa van Soest = *Taraxacum* Weber ex Wigg.

Boraginaceae

Choriantha Riedl: *C. popoviana* Riedl—N Iraq

Heliocarya Bunge = *Caccinia* Savi

Tienschaniella B. Fedtsch. ex Popov: *T. umbellulifera* B. Fedtsch. ex Popov—Kyrgyzstan (Tien Shan)

Trigonocaryum Trautv.: *T. involucratum* (Steven) Husn.—Caucasus

Brassicaceae

Acanthocardamum Thell. = *Aethionema* R. Br.

Alyssopsis Boiss. [TR3]: *A. mollis* (Jacq.) O.E. Schulz—Caucasus, N/C Iran; *A. trinervis* Botsch. & Sejfulin—Turkmenistan

Anchonium DC. [TR5]: *A. billardieri* DC.—Lebanon; *A. elichrysifolia* (DC.) Boiss.—Turkey, Caucasus, Iraq, Iran

Brossardia Boiss.: *B. papyracea* Boiss.—N Iraq, Iran

Camelinopsis A.G. Mill.: *C. campylopoda* (Bornm. & Gauba) A.G. Mill.—C Iran; *C. kurdica* (A.G. Mill.) Al-Shehbaz & A.G. Mill.—N Iraq

Catenulina Soják [TR26]: *C. hedysarioides* (Botsch.) Soják.—Tajikistan

Chalcanthus Boiss. [TR28]: *C. renifolius* (Boiss. & Hohen.) Boiss.—Iran, NW Afghanistan, Turkmenistan

Chartoloma Bunge [TR33]: *C. platycarpum* (Bunge) Bunge—Turkmenistan, Uzbekistan

Chrysochamela (Fenzl) Boiss. [TR15]: *C. elliptica* (Boiss.) Boiss.—E Turkey; *C. noeana* (Boiss.) Boiss.—E Turkey; C. *velutina* (DC.) Boiss.—S Turkey, Syria

Clastopus Boiss. [TR2]: *C. erubescens* Hausskn.—N Iraq, W Iran; *C. vestitus* (Desv.) Boiss.—Iran.

Coluteocarpus Boiss. [TR19]: *C. vesicaria* (L.) Holmboe—E Turkey, Lebanon, N Iraq, W Iran

Cymatocarpus O.E. Schulz [TR26]: *C. grossheimii* N. Busch—Caucasus; *C. pilosissimus* (Trautv.) O.E. Schulz—N Iran, Afghanistan, Turkmenistan; *C. popovii* Botsch. & Vved.—Turkmenistan

Cyphocardamum Hedge [TR35] [distinct genus]: *C. aretioides* Hedge—E Afghanistan

Dichasianthus Ovcz. & Yunusov [TR26]: *D. subtilissimus* (Popov) Ovcz. & Yunusov—? Afghanistan, Uzbekistan, Tajikistan

Didymophysa Boiss. [TR47]: *D. aucheri* Boiss.—Caucasus, Iraq, Iran, Turkmenistan; *D. fedtschenkoana* Regel—Afghanistan, Pakistan, Tajikistan

Dielsiocharis O.E. Schulz: no longer endemic in this area

Elburzia Hedge [TR47]: *E. fenestrata* (Boiss. & Hohen.) Hedge— N Iran

Fortuynia Shuttlew. ex Boiss. [TR12] [rather desert habitats]: *F. aucheri* Shuttlew. ex Boiss.; *F. bungei* Boiss.—Iran, Pakistan; *F. garcinii* (Burm.) Shuttlew. ex Boiss.—Iraq, S Iran, Afghanistan, Pakistan

Glastaria Boiss. [TR33]: *G. glastifolia* (DC.) O. Kuntze—S/C Turkey, Syria, N Iraq

Gynophorea Gilli = *Erysimum* L.

Heldreichia Boiss. [alpine scree]: *H. rotundifolia* Boiss.—S/E Turkey [with four subspecies]

Iskandera N. Busch [TR5]: *I. alaica* (Korsch.) Botsch. & Vved.—Tajikistan; *I. hissarica* N. Busch—Uzbekistan, Tajikistan, Kyrgyzstan

Koieia Rech.f. = *Rhammatophyllum* O.E. Schulz

Moriera Boiss. = *Aethionema* R. Br.

Nasturtiicarpa Gilli = *Calymmatium* O.E. Schulz

Neotchihatchewia Rauschert = *Tchihatchewia* Boiss.

Pachyphragma (DC.) Rchb. [TR47] [doubtful status?]: *P. macrophylla* (Hoffm.) N. Busch—NE Turkey, Caucasus

Parlatoria Boiss. [TR47]: *P. cakiloidea* Boiss.—S Turkey, N Iraq, Syria; *P. rostrata* Boiss. & Hohen.—W/C/S Iran; *P. taurica* (Adams.) D.A. German & Al-Shehbaz—S Turkey, Caucasus, Syria, N Iraq, Iran

Peltariopsis (Boiss.) N. Busch [TR47]: *P. grossheimii* N. Busch—Caucasus; *P. planisiliqua* (Boiss.) N. Busch.—Caucasus, NW Iran, Turkmenistan

Physocardamum Hedge [TR2]: *P. davisii* Hedge—E Turkey

Physoptychis Boiss. [TR2]: *P. caspica* (Hablitzl) V.V. Botschantz.—N Iran; *P. gnaphalodes* (DC.) Boiss.—SE Turkey, Caucasus, N Iraq; *P. haussknechtii* Bornm.—C Turkey

Pyramidium Boiss. = *Veselskya* Opiz

Physorrhynchus Hook. [TR12]: *P. brahuicus* Hook.—Iran, Afghanistan, Pakistan; *P. chamaerapistrum* (Boiss.) Boiss.—W/S Iran

Pseudocamelina (Boiss.) N. Busch [TR47]: *P. aphragmodes* (Boiss.) N. Busch—S Iran; *P. campylocarpa* (Boiss.) N. Busch—W Iran; *P. glaucophylla* (DC.) N. Busch—Iran

Pseudodraba Al-Shehbaz, D. German & M.A. Koch [TR7]: *P. hystrix* Al-Shehbaz, D.A. German & M. Koch—C/E Afghanistan, Pakistan [Baluchistan]

Pseudofortuynia Hedge: *P. esfandiarii* Hedge—S Iran; *P. leucoclada* (Boiss.) Khosravi—W/E Iran

Pseudosempervivum (Boiss.) Grossh. [TR19]: *P. amanum* (Contandr. & Quézel) Al-Shehbaz, Mutlu & Dönmez—S Tukey; *P. aucheri* (Boiss.) Pobed.—C/E Turkey; *P. gurulkanii* (Yild.) Al-Shehbaz, Mutlu & Dönmez—Turkey;

P. sempervivum (Boiss. & Balansa) Pobed.—NE Turkey; *P. sintenisii* (Hausskn. ex Bornm.) Pobed.—C/E Turkey; *P. venustum* (Schischk.) Pobed.—Turkey, Caucasus

Pseudovesicaria (Boiss.) Rupr. [TR47]: *P. digitata* (C.A. Mey.) Rupr.—Caucasus

Straussiella Hausskn. [TR2]: *S. purpurea* (Bunge) Hausskn.—W Iran

Streptoloma Bunge [TR26] [desert places]: *S. desertorum* Bunge—E Iran, W Afghanistan, Turkmenistan; *S. sumbarense* (Lipsky) Botsch.—Turkmenistan [Kizyl Kum]

Strigosella Boiss. [TR26]: *S. cabulica* Boiss.—NW/E Afghanistan, Pakistan

Tchihatchewia Boiss. [TR31]: *T. isatidea* Boiss.—N/C Turkey

Veselskya Opiz: *V. griffithiana* (Boiss.) Opiz—NW/S Afghanistan

Zerdana Boiss. [TR5]: *Z. anchonioides* Boiss.—W Iran

Zuvanda (Dvořák) Askerova [TR20]: Z. *crenulata* (DC.) Askerova—Turkey, Lebanon, Syria, Iran; *Z. exacoides* (DC.) Askerova—Syria, Lebanon, Israel, Iran; *D. meyeri* (Boiss.) Askerova—Talish

Campanulaceae

Cryptocodon Fed.: *C. monocephala* (Trautv.) Fed.—Tajikistan [Pamir Alai]

Cylindrocarpa Regel: *C. sewerzowii* (Regel) Regel—Kyrgyzstan [Tien Shan]

Ostrowskia Regel: *O. magnifica* Regel—N Afghanistan, Tajikistan [Pamir Alai], Kyrgyzstan [Tien Shan]

Sergia Fed.: *S. regelii* (Trautv.) Fed.—Kyrgyzstan [Tien Shan]; *S. sewerzowii* (Regel) Fed.—Kyrgyzstan [Tien Shan]

Zeugandra P.H. Davis: *Z. iranica* P.H. Davis—W Iran; *Z. iranshahrii* Esfand.—W Iran

Caprifoliaceae

Pseudobetckea (Höck) Lincz.: *P. caucasica* (Boiss.) Lincz.—Caucasus

Caryophyllaceae

Czeikia Ikonn. = *Acanthophyllum* C.A. Mey.

Diaphanoptera Rech.f.: *D. afghanica* Podlech—C Afghanistan; *D. ekbergii* Hedge & Wendelbo—N/E Afghanistan; *D. khorasanica* Rech.f.—NE Iran; *D. lindbergii* Hedge & Wendelbo—NW Afghanistan; *D. stenocalycina* Rech.f. & Schiman-Czeika—N Iran; *D. transhyrcana* (Preobr.) Rech.f. & Schiman-Czeika—Turkmenistan

Kabulia Bor & C. Fischer = *Polygonum* L.

Kabulianthe (Rech.f.) Ikonn. [doubtful status?]: *K. honigbergeri* (Fenzl) Ikonn.—E Afghanistan

Ochotonophila Gilli: *O. allochrusoides* Gilli—N/C Afghanistan; *O. eglandulosa* Hedge & Wendelbo—C/E Afghanistan; *O. flava* Dickoré & Freitag—C Afghanistan

Pentastemonodiscus Rech.f.: *P. monochlamydeus* Rech.f.—E Afghanistan

Phrynella Pax & Hoffm.: *P. ortegioides* (Fisch. & C.A. Mey.) Pax & K. Hoffm.—C Turkey

Scleranthopsis (Rech.f.) Rech.f.: *S. aphanantha* (Rech.f.) Rech.f.—SW, C, E Afghanistan

Thurya Boiss. & Bal.: *T. capitata* Boiss. & Bal.—C/S Turkey

Chenopodiaceae

Cyathobasis Aellen: *C. fruticulosa* (Bunge) Aellen—C Turkey

Eremochion Gilli = *Horaninowia* Fisch. & C.A. Mey.

Halarchon Bunge: *H. vesiculosus* (Moq.) Bunge—W/SW Afghanistan

Fabaceae

Kerstania Rech.f. = *Podolotus* Benth.

Oreophysa (Boiss.) Bornm.: *O. microphylla* (Jaub. & Spach) Browicz—N Iran (Elburz)

Sartoria Boiss. & Heldr.: *S. hedysaroides* Boiss. & Heldr. ex Boiss.—SW Turkey

Frankeniaceae

Hypericopsis Boiss. = *Frankenia* L.

Gentianaceae

Kurramiana Omer & Qaiser: *K. micrantha* (Aitch. & Hemsl.) Omer & Qaiser—E Afghanistan, Pakistan

Hamamelidaceae

Parrotia C.A. Mey.: *P. persica* (DC.) C.A. Mey.—Talish, W/N Iran

Lamiaceae

Dorystoechas Boiss. & Heldr. ex Benth. [Mediterranean]: *D. hastata* Boiss. & Heldr. ex Benth.—SW Turkey

Zataria Boiss.: *Z. multiflora* Boiss.—S Iran, E Afghanistan, Pakistan

Zhumeria Rech.f. & Wendelbo: *Z majdae* Rech.f. & Wendelbo—S Iran

Papaveraceae

Cryptocapnos Rech.f.: *C. chasmophyticus* Rech.f.—W/C Afghanistan

Plumbaginaceae

Bamiania Lincz.: *B. pachycormum* (Rech.f.) Lincz.—C Afghanistan

Bukiniczia Lincz.: *B. cabulica* (Boiss.) Lincz.—SE/E Afghanistan

Ghazianthus = *Acantholimon* Boiss.

Gladiolimon = *Acantholimon* Boiss.

Poaceae

Nephelochloa Boiss.: *N. orientalis* Boiss.—SW Turkey

Primulaceae

Kaufmannia Regel: *K. semenovii* (Herd.) Regel—Tajikistan [Pamir Alai]

Rubiaceae

Aitchisonia Hemsl. = *Plocama* Aiton

Mericarpaea Boiss. [annual]: *M. ciliata* (Banks & Sol.) Eig—Syria, Israel, ? Iraq

Phuopsis (Griseb.) Hook. f. [distinct genus]: *P. stylosa* (Trin.) Hook. f.—Talish, W/N Iran

Sapindaceae

Stocksia Benth.: *S. brahuica* Boiss.—SE Iran, SW/SE Afghanistan, Pakistan

***Scrophulariaceae* (*Plantaginaceae*)**

Albraunia Speta: *A. foveo-pilosa* Speta—SW Iran; *A. fugax* (Boiss. & Noë) Speta—SW Iran; *A. psilosperma* Speta—Turkey, Iraq, Iran

Holzneria Speta [doubtful status?]: *H. microcentron* (Bornm.) Speta—N/S Afghanistan, Turkmenistan; *H. spicata* (Korovin) Speta—Iran, N/NW Afghanistan, Turkmenistan

Hueblia Speta = *Antirrhinum* L.

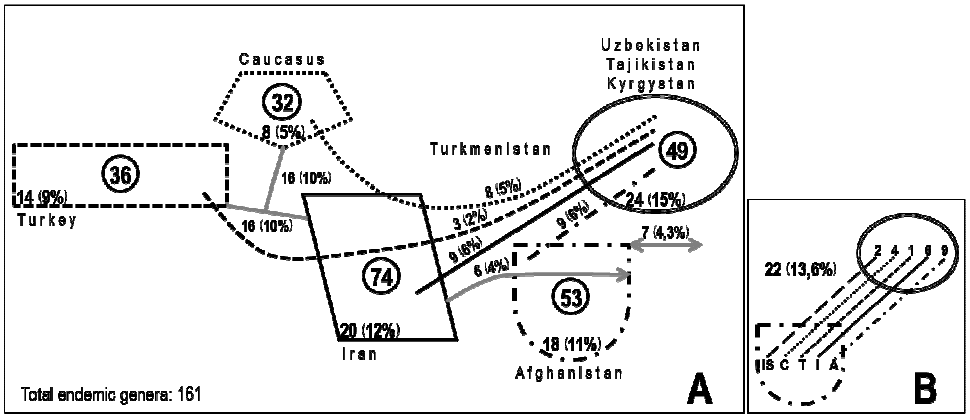

Fig. 1. Distributional analysis of the generic endemism in SW Asia.

A. In circles are the endemic genera present in each country (e.g. Iran 61 of the endemic genera here referred to are present in Iran). For each country are given the endemics restrict to that country (e.g. 20 in Iran, 12% of the 161 total endemics). Continuous lines indicate the endemics common to neighbouring countries (e.g. 16 between Iran and Turkey, representing 10% of the total 161); figures between Iran & Afghanistan refer also to four taxa that also reach Pakistan, one by-passing Afghanistan. Dotted lines indicate the genera in C Asia with different spans into the west (e.g. three are also in Iran and go as far west as Turkey), B. Detail of the genera present in both Afghanistan and C Asia; many extend to the western countries. Not all genera in the west reach C Asia via Afghanistan (or *vice-versa*) but do so via Iran and Turkmenistan (e.g. only six of the nine genera that span Iran-C Asia do so via Afghanistan). IS: Israel/Syria; C: Caucasus; T: Turkey; I: Iran; A: Afghanistan. Percentages always refer to the 161 total endemic genera involved.

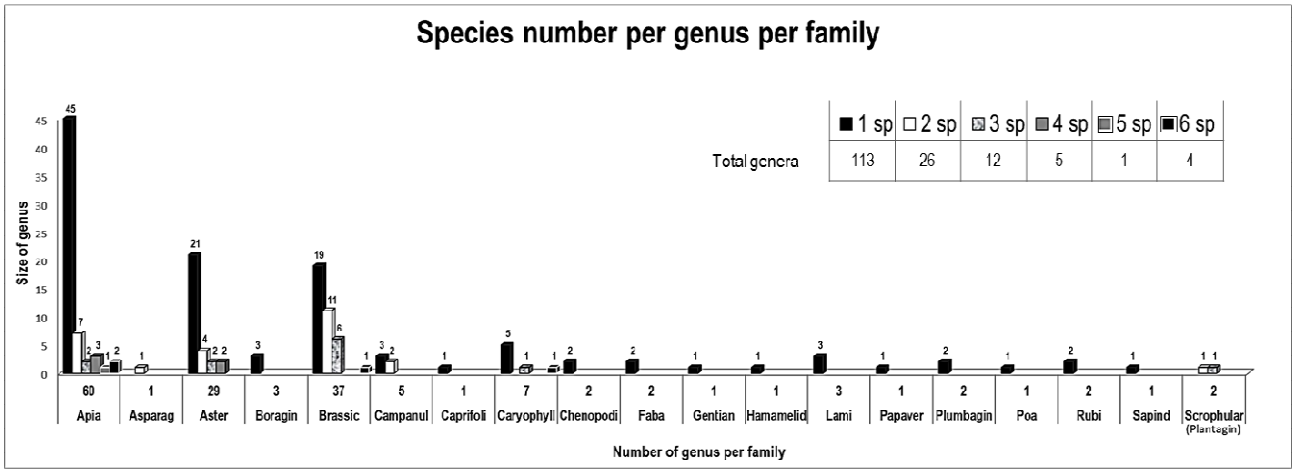

Fig. 2. Endemic genera in SW Asia per family plus number of constituent species in them. Above each family is the total number of endemic genera. Families are listed alphabetically and their names are abbreviated. Most genera are monotypic.

Table 1. Some non-endemic genera to our area, their size and species distribution in relation to Afghanistan

Genera	Species total	Species endemic to Afghanistan	Species in Afghanistan shared with Turkey	Species in Afghanistan shared elsewhere	Other data
Acantholimon	75	c. 64	0	c. 14 Pakistan & C Asia	25 other species in Turkey; 10 endemic 79 other species in Iran; 65 endemic (Assadi 2006)
Acanthophyllum	34	10	0	16 Iran & C Asia	-
Allium	74	24	2	40 Iran, Pakistan & C Asia	2 species in Turkey; cultivated
Eremurus	21	2	0	17 C Asia	2 other species in Turkey; 1 subsp. in common
Ferula	31	18	1	12 Pakistan & C Asia	30 other species; 14 endemic
Iris	31	16	2	13 Iran, Pakistan & C Asia	-
Nepeta	45	24	1	c. 20 Iran, Pakistan, Himalayas & C Asia	-

Discussion

The results show that SW Asia is rich in endemic genera, 70% are monotypic (list of genera, Figs 1 & 2). The area here assessed, from West (Turkey) to East (Tajikistan), was included in the Irano-Turanian region as recently as 1989 by Léonard and in 2012 by Djamali *et al*. (2012b). It was also within the boundaries of the "Irano-Turanian bioclimate" used to describe the climate of most of the continental Middle East and Central Asia (Djamali *et al.* 2012a). Only three endemic genera (2%) recorded in one of the countries of our area (Turkey) "escaped" this W-E/E-W distribution and extended south to the low-lands of Lebanon, Israel and

Jordan, in fact, an area also in the Irano-Turanian region of White & Léonard (subregion IT1). Rechinger's use (1986) and definition of his term Irano-Turkestanian region where he included the mountain ranges of Pamir-Alai and Tien-Shan and excluded from it the lowland Aralo-Caspian area. We have not recorded endemic genera from the low-lands in Kazakhstan (White & Léonard 1991, subregion IT3). A total of 97.5% of the genera (157) are in the higher places from Turkey, Caucasus, N Iraq, N Iran & Zagros and adjacent S Turkmenistan, Afghanistan, N Pakistan and, further north, into Pamir Alai (Tajikistan) and Tien Shan (Kyrgyzstan). Another aspect that comes to light is the fact that 84 (52.1%) of the endemic genera are actually confined to the main countries/areas involved, i.e. Caucasus, Turkey, Iran, Afghanistan and C Asia; almost as many, 73 (45.3%), cross wider areas. Much of the diversity seems to be, therefore, scattered throughout the area.

The total endemic genera occurring in the Caucasus (32) and Turkey (36) (Fig. 1), should be discussed further. At the Caucasus, three genera are shared with Turkey and three different ones with Iran; ten genera are shared simultaneously with both countries. The endemics restricted to the Caucasus itself (8) (Fig. 1B) seem to be more confined to the northern Great Caucasus (Gagnidze *et al.* 2002) which belongs to the geological province of Northern Tethyan (Adamia *et al*. 2011). The fact that the Northern and Southern Tethyan provinces differed geologically from each other till as recently as Early Tertiary (Adamia *et al*. 2011) might have had a floristic impact till today and the southern part of the Caucasus could to be floristically a part of the area we are reviewing. In Turkey, 50% (7) of the endemic genera restricted to the country are in the western part, mostly south-west, which indicates a strong Mediterranean connection. Therefore, in both areas, the Caucasus and Turkey, the number of endemic genera that can be associated to the W-E/E-W higher altitude distribution would be reduced to 24 and 29, respectively.

At the other end of the area, figures are rather higher. Altogether, 77 genera (51.5%) involve C Asia and Afghanistan; 22 genera are shared between Afghanistan and C Asia (Fig. 1B).

- Some families of special interest

***Apiaceae*:** The richness of this family in the area is now well documented (Kljuykov & Ukrainskaja 2010; Pimenov & Leonov 2004a & b). Our data confirm its morphological diversity being, by far, the family with the highest number of endemic genera, 60, of which 45 are monotypic (Fig. 2). Although there are a number of very morphologically distinct apparently isolated genera in the west of the area, more, such as the Afghan *Pyramidoptera*, seem to be concentrated in the C Asiatic/Afghan region.

***Asteraceae*:** This is the largest plant family in the area with c. 200 genera. Twenty nine endemics are listed here of which 21 are monotypic (Fig. 2). We believe our list is less complete than for the other families, especially *Apiaceae* and *Brassicaceae*, mainly so in the Central Asiatic area. As with these two families, the greatest concentration of genera and diversity is in this latter region; only four listed are in Turkey.

***Brassicaceae*:** Of the global total of 320 genera in the family, 135 are represented in Sout-West Asia. Of the 49 tribes recently recognized in the thorough global synopsis of the family by Al-Shehbaz (2012), no fewer than 30 are represented in the area, of which there are 15 among the endemic genera (cf. list of genera). We list 37 endemic genera, 20 being monotypic (Fig. 2). They are very much scattered throughout the area.

***Campanulacae*:** Although, this is not a major family in the area, the five endemic genera *Cryptocodon*, *Cylindrocarpa*, *Ostrowskia*, *Sergia* and *Zeugandra* are of particular interest. They all are in Afghanistan, Pamir-Alai or Tien Shan, with somewhat restricted distribution, very isolated in the family without clear allies and often considered as Tertiary relicts (Eddie *et al*. 2003, Eddie, pers. comm.).

***Lamiaceae*:** It is curious that, although this is a major family in the region (Afghanistan alone has over 240 species), only three endemic genera are represented, *Dorystoechas*, *Zataria* and *Zhumeria* (Hedge 1986). All

are shrubs and geographically and morphologically isolated. *Dorystoechas* is restricted to the Antalya province of SW Turkey and considered an east Mediterranean element of the flora. *Zhumeria* is from the Bandar Abbas district of southern Iran and has been regarded a Saharo-Sindian element. Both are two-staminate and have some distant affinities with *Perovskia*, also 2-staminate, a characteristic genus of central Asia/Afghanistan extending east into the Himalayas. The third genus *Zataria* has a wide range in the south of Iran, eastern Afghanistan and highland western Pakistan; with very small, usually male-sterile flowers; it has no obvious generic allies.

- Distribution patterns in some non-endemic genera

The importance of plant diversity of SW Asia is emphasized when the non-endemic genera and constituent species are brought into the discussion. Several major genera have a very characteristic pattern of distribution and species frequency in the area with a centre in Afghanistan/central Asiatic from where they radiate through Iran and the Zagros ranges to SE Turkey. *Cousinia* is, after the gargantuan *Astragalus*, the largest genus in the area, with c. 660 species. The greatest number, c. 220, are in the Pamir-Alai/west Tien Shan, c. 150 in Afghanistan, c. 60 in the Elburz and c. 40 in Turkey; only a few species occur in the Turanian lowlands (Rechinger 1986, Knapp 1987, Djamali *et al*. 2012b). *Dionysia*, a chasmophytic genus, has 49 species in our area: 5 in central Asia, 12 in Afghanistan, 33 in Iran with a concentration of endemics in the Zagros range, 3 in SE Turkey/N Iraq, the westernmost end of the genus range and surprisingly, one in the mountains of Oman. It is noteworthy that the apparently most aberrant species in the genus, *D. hissarica*, is restricted to the Pamir-Alai (Lidén 2007). Another example of a genus with a thought-provoking range is the Labiate *Perovskia*, its seven species being in Iran, Afghanistan (common), throughout central Asia and in the west Himalayas, Xinjiang and Xizang; it is absent from Turkey. These distribution patterns are very characteristic and many other genera show similar ranges with a marked reduction in species numbers from C Asia towards Turkey/N Iraq (Table 1). The case of the globally distributed *Heliotropium* is equally interesting in that the greatest number of species in our area is in Iran with 32, of which 14 are endemic (Akhani 2007). The east to west migration of *Haplophyllum* (*Rutaceae*) is another example of this distribution pattern (Manafzadeh *et al*. 2013).

- Life forms and habitats

By far, most of the endemic genera listed are herbaceous perennials or low-growing shrubs of exposed slopes. In general, annual endemic genera are rare and most, by far, in *Asteraceae*. Few genera in a variety of families are of truly deserts (e.g. *Fortuynia*, *Halarchon*) or scree plants (e.g. *Heldreichia*), chasmophytes (e.g. *Cryptocapnos*) or high alpines (e.g. *Chamaesciadium*). These latter genera occur randomly throughout our area-Afghanistan, Iran, Caucasus, Turkey. *Parrotia* and *Stocksia* are the only two major woody endemic genera in the area.

Parrotia persica, a tree up to 20 m high, is a characteristic component of the south Caspian forests. Related to the Himalayan, also monotypic *Parrotiopsis*, it is often cited as a Tertiary relict that has long-survived in these ancient Hyrcanian forests. *Stocksia* (*Sapindaceae*) is a rigid spiny shrub to 4 m high with functionally unisexual flowers. It is in Iran, Afghanistan and Pakistan and its family is essentially tropical/subtropical with very few temperate representatives. It is not clear what the allies of *Stocksia* are, but presumably they are tropical taxa. Biogeographical aspects of SW Asiatic links to tropical taxa were dealt with in an earlier paper (Sales & Hedge 1996).

- Terms used in phytogeography

In the numerous and manifold publications, both old and recent, on plant geography, there is little conformity in the terms used and their application. Most of them are, possibly inevitably, imprecise and essentially subjective. Many of the experienced authors

who have written on the fascinating and complex subject of phytogeography, such as Zohary (1973), Meusel (1971), Davis (1965), Takhtajan (1986), Rechinger (1963) and White & Léonard (1991) have differing definitions, circumscriptions and terminology of their phytochoria. Today, with our much improved knowledge of the flora, one can rightly question the reality of such widely used terms as Saharo-Arabian, Saharo-Sindian, Nubo-Sindian, Sudano-Deccanian, Hyrcano-Colchic and even Irano-Turanian. Greater confusion exists in the application of geographical terms, such as: Middle East, Near East, SW Asia, Inner Asia, Central Asia, South Asia and Middle Asia. The latter is, or has been, much used by Russian authors to cover Turkmenistan, Uzbekistan, Tajikistan, Kyrgyzstan and Kazakhstan; also, their publications are much confined to these political boundaries. But today, most western authors prefer to use "Central Asia" for this botanically most important area.

Another area of some misunderstanding is the use of the terms neo-endemic and palaeo-endemic, useful to give some indication of the apparent age-status of the taxon, but often investigated superficially in this respect; molecular research is here much needed.

Conclusions

Within SW Asia, as we have defined it, there are 161 endemic genera. They occur randomly throughout the area without any marked concentration in a particular part of it such as the Taurus range in Turkey, the Caucasian mountains, the Elburz and Zagros ranges, Hindu Kush, Pamir-Alai and Tien Shan. By far the families with most endemic genera are *Apiaceae*, *Asteraceae* and *Brassicaceae*; they account for 126 genera. There are, unexpectedly, very few in such species-rich families as *Fabaceae*, *Lamiaceae* and *Poaceae* with a total of only six. The great majority of the endemic genera are found in high-land areas on exposed steppe habitats; only a few are from lowland or desert areas. Some are in special habitats such as rock crevices or salt marshes. Herbaceous or shrubby perennials dominate. Very few are large woody plants and only a small number are annuals, these mostly in *Asteraceae*. Although to some extent it is an incomplete assessment, more of the morphologically isolated endemic genera are in the mountains of central Asia and Afghanistan than elsewhere.

We drew attention to the multiplicity of different terms used in plant geography and the need for some standardisation. Strict rules are universally used in plant nomenclature but no guide-lines exist in discussing plant geography.

Most previous phytogeographers have given emphasis to the term Irano-Turanian, but we are now less convinced about its reality. Data on relevant information on the non-endemic genera and species strongly emphasised the richness of the area as a very important region of plant diversity. The term Irano-Turkestanian, coined by Rechinger (1986), has sometimes been used for large genera, such as *Acantholimon*, *Cousinea* and *Oxytropis*, with a clear centre of distribution in the Central Asian-Afghan area radiating from there through Iran and with significantly smaller species numbers in Turkey. Our results are in agreement with this and also seem to show that the lowland Aralo-Caspian area should be excluded from this so-designated territory.

One surprising fact that emerged from our data was the great difference, in many of the larger non-endemic genera, between individual species in different parts of our area. There were very few species, for example, in *Acantholimon*, *Allium* and *Nepeta* that were common throughout the whole of our territory in, for example, Afghanistan, Tajikistan, Iran and Turkey.

Any assessment of phytochoria that is based solely on generic endemism can be misleading and, ideally, data from all taxa in an area is needed. But with probably more than 27,000 species, this will take a long time even to produce distribution and isoflor maps. Turkey, with nearly 10,000 species, is the richest area in terms of numbers (though this may be a somewhat inflated total resulting from an excessive enthusiasm to describe new species) and has the highest percentage of endemic species in our area. Future research should also bring in comprehensive cytological and molecular data of

the endemic genera that, at least morphologically, are so isolated. This might provide new insights into the floristic past history of the area.

We know that the present check-lists and data are going to be outdated as the knowledge of the area improves, but believe that we have provided a sound realistic basis for future work on plant geography and conservation in SW Asia, undoubtedly a major global hotspot.

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