

**THE TAXONOMY OF MULTISEED JUNIPERS (*JUNIPERUS*
SECT. *SABINA*)
IN SOUTHWEST ASIA AND EAST AFRICA
(Taxonomic notes on Cupressaceae I)**

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An extensive study of herbarium specimens and literature of arborescent multiseed Junipers (*Juniperus* L. sect. *Sabina* (Mill.) Spach) from SW Asia and E Africa, in preparation of a monographic volume "Drawings and Descriptions of Cupressaceae", has led to a substantially revised concept of taxa and their distribution. A total of 18 species and 7 varieties were previously recognized in this group; most turned out to be synonyms. *J. foetidissima* var. *pindicola* Formanek, *J. macropoda* Boiss., *J. procera* Hochst. ex Endl., *J. sabinooides* Griseb., *J. schugnanica* Komarov and *J. semiglobosa* Regel were lectotypified; *J. polycarpus* K. Koch has been neotypified. The following taxa answering to the above circumscription are here recognized for the area: *J. excelsa* M.-Bieb., *J. excelsa* subsp. *polycarpus* (K. Koch) Takhtajan, *J. foetidissima* Willd., *J. semiglobosa* Regel, *J. phoenicea* L. and *J. procera* Hochst. ex Endl.

INTRODUCTION

The genus *Juniperus* is one of the larger coniferous genera widely distributed in the temperate regions of the Northern Hemisphere. Its 60–70 species are commonly divided into two groups, mainly based on leaf characters, and by most contemporary taxonomists recognized as sections within the genus. The typical section (including the type of the genus: *J. communis* L.) has acicular, non-decurrent leaves in ternate phyllotaxis, the section *Sabina* (Mill.) Spach is characterized by small scale-leaves, which are decurrent and decussate. In juvenile stages of the latter section intermediate characters occur. Within the latter section a division (not formalized) can be made between monoseed and multiseed species. The latter are very often trees attaining considerable size and age. The Old World representatives of this group form the subject of this study.

Arborescent Junipers of the section *Sabina* are a conspicuous element of the xerophytic vegetation of dry mountainous regions throughout the Middle East and beyond. They occur from the southern Balkan Peninsula in the West to the Tien Shan in the East and from NE Zimbabwe in the Southwest to the Karakoram in the Southeast. From this vast territory a number of taxa have been described. Some of them are well distinguished species and their taxonomic status is undisputed. One of these, *J. phoenicea* L., is an essentially Mediterranean species occurring eastward into our area. It is distinguished from the other species by its denticulate leaf margins and its cones ripening from light ochraceous to dark red. It is only mentioned here for the sake of completeness and shall

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not be further discussed. The confusion and dispute seem to concentrate on a group of taxa characterized by the occurrence of generally 2 or more seeds per ovuliferous cone (ranging from 1–8), the colour of which ranges from light brown to blackish-purple, usually with a distinct bluish bloom. The leaf margins of these taxa are all entire.

Browicz & Zielinsky (1982), while pointing out the contradictory treatment in various local Floras and taxonomic publications, add with several rather erratic distribution maps to the confusion. I shall return to these maps later. They stress the lack of a critical analysis of this group of Junipers throughout its distribution.

For the present study, about 200 specimens, including nearly all relevant types, were studied from the following herbaria: B, BR, BRNM, E, G, GOET, L, LE, U, WAG, W, and WU. Due to the fact, that foliage characters in relatively young plants are often markedly different from those in old material, no specimens from botanic gardens (all young plants relative to the age the trees commonly have reached in their wild surroundings) were involved in this study. The ensuing taxonomic treatment has been based on an assessment of all morphological character states visible with a magnification of up to 20x. A chemical analysis of all taxa involved, such as has been carried out for several groups of American Junipers (e.g. Adams et al., 1981; Adams & Hogge, 1983), is as yet not available. Only two of its more accessible species have recently been evaluated (Adams, 1990), the results of which are promising.

HISTORICAL REVIEW

Pallas (1789) was the first post-Linnean author to describe Junipers from the area; his *J. sabina* var. *taurica* and *J. phoenicea* (non L.) from the Crimea are now considered to be synonyms of *J. excelsa* M.-Bieb. and *J. foetidissima* Willd. Marschall von Bieberstein (1800) described his species first in a little known geographical paper (with a botanical supplement) from Azerbaijan and only later (1808) also from the Crimea, citing *J. sabina* var. *taurica* Pall. as synonym.

Willdenow (1806) described *Juniperus foetidissima* as a new species from Greece and Asia Minor in Volume 4 of his *Species Plantarum*, as distinct from *J. excelsa* (which he described as new, but apparently a taxonomic synonym of *J. sabina* L.).

After these earliest descriptions of some Junipers from the northwestern periphery of the region here discussed, a monographic treatment appeared in Spach's *Revision des Juniperus* (1841), in which he divided the genus in two sections: *Oxycedrus* (= *Juniperus*) and *Sabina*. In this treatise and in Vol. 11 of his *Histoire naturelle des Végétaux* (1842) he published *J. foetida*, of which his variety *squarrulosa* is synonymous with *J. foetidissima* and his variety *excelsa* in part with *J. excelsa* M.-Bieb. This amounted to a reduction of species recognized in the region. Grisebach (1846) described a new species, *J. sabinoidea*, from Mt Athos (Greece), with *J. sabina* Sibth. & Sm. (non L.) in synonymy.

Based on an enumeration by Hochstetter in *Flora* of G.W. Schimper's second shipment of plants from Ethiopia (with *J. procera* nomen under No. 537), Endlicher

(1847) described *J. procera* as a new species from the Amhara Region. He compared it with its close allies *J. foetidissima* and *J. excelsa*, yet considered it to be distinct.

Returning to Eurasia, Koch (1849) described two new species belonging to the group of Junipers here discussed: *J. polycarpus* and *J. isophyllos*, from NE Turkey and Armenia, the first collected August 1843, the latter probably later (see below). By joining up with the region Marschall von Bieberstein had explored some four decades earlier, Koch had herewith established the occurrence of arborescent Junipers of section *Sabina* in a great arc around the Black Sea, while one very disjunct location was described from East Africa. An unpublished specimen of *J. cf. procera* was collected in Yemen on the Arabian peninsula as early as 1837 (Kerfoot & Lavranos, 1984), but not published at the time.

Antoine (1857) divided the genus *Juniperus* in three genera by raising the ranks of the three sections in Endlicher (1847) and renaming two of them. This treatment, although not generally accepted even at the time (see e.g. Parlatore, 1867), has occasionally been followed, as by Cheng & Fu (1978). Several species heretofore mentioned were thus treated by Antoine in his genus *Sabina*, in which he described no new taxa from our region.

We must now turn to the eastern limits of the region here discussed, from where a species of *Juniperus* sect. *Sabina* was identified by Brandis (1874) as *J. excelsa* (with a character state 'berries...subglobose') occurring in the Himalayas of NW India and in Afghanistan and Baluchistan. Only 5 years later Regel (1879) described a new species from the high mountains of Turkestan: *J. semiglobosa*. When Boissier published the fifth volume of his *Flora orientalis* (1884) he mentioned *J. foetidissima* and *J. excelsa* from Armenia and Nagorno Karabakh, the latter also from NE Iran. Some material from N and SW Iran which Boissier had earlier identified on herbarium labels as *J. excelsa* M.-Bieb. was described in the *Flora orientalis* as *J. macropoda* sp. nov., with an additional collection from Oman, the first report of *Juniperus* on the eastern side of the Arabian peninsula.

Two varieties of *J. foetidissima* (var. *pindicola* and var. *squarrosa*) were described, respectively by Formanek (1896) from Greece (Macedonia) and by Medwedew (1903) from 'Transcaucasia'.

From the mountains of Central Asia (Talasskij Ala-tau, Kirgizstan) Lipsky (1912) described *J. talassica* as a new species. In the same publication Lipsky referred to *J. excelsa* from the Crimea as *J. taurica*, a nomen superfluum. Komarov (1923) added a new species: *J. jarkendensis* from the Tien Shan (Kirgiz S.S.R.), but did not mention it anymore in subsequent publications. From the Kopet Mountains on the border between Turkmenia and Iran, Fedtschenko (Fedtschenko et al., 1932) described *J. turcomanica*. Komarov (1932), in his treatment of Central Asian multiseed Junipers of section *Sabina* added two more species: *J. seravschanica* and *J. schugnanica*, the first from the Zeravshanskij Khrebet, but ranging far into the mountains of Afghanistan and Pakistan (Hindu Kush), the second from the Shugnanskij Khrebet in the Pamirs. Schwarz (1934) described a prostrate form of *J. excelsa* in S Turkey (Lycia), growing at alt. 1500–1800m, as a new variety *depressa*. Sumnevicz (1948) published two more species from

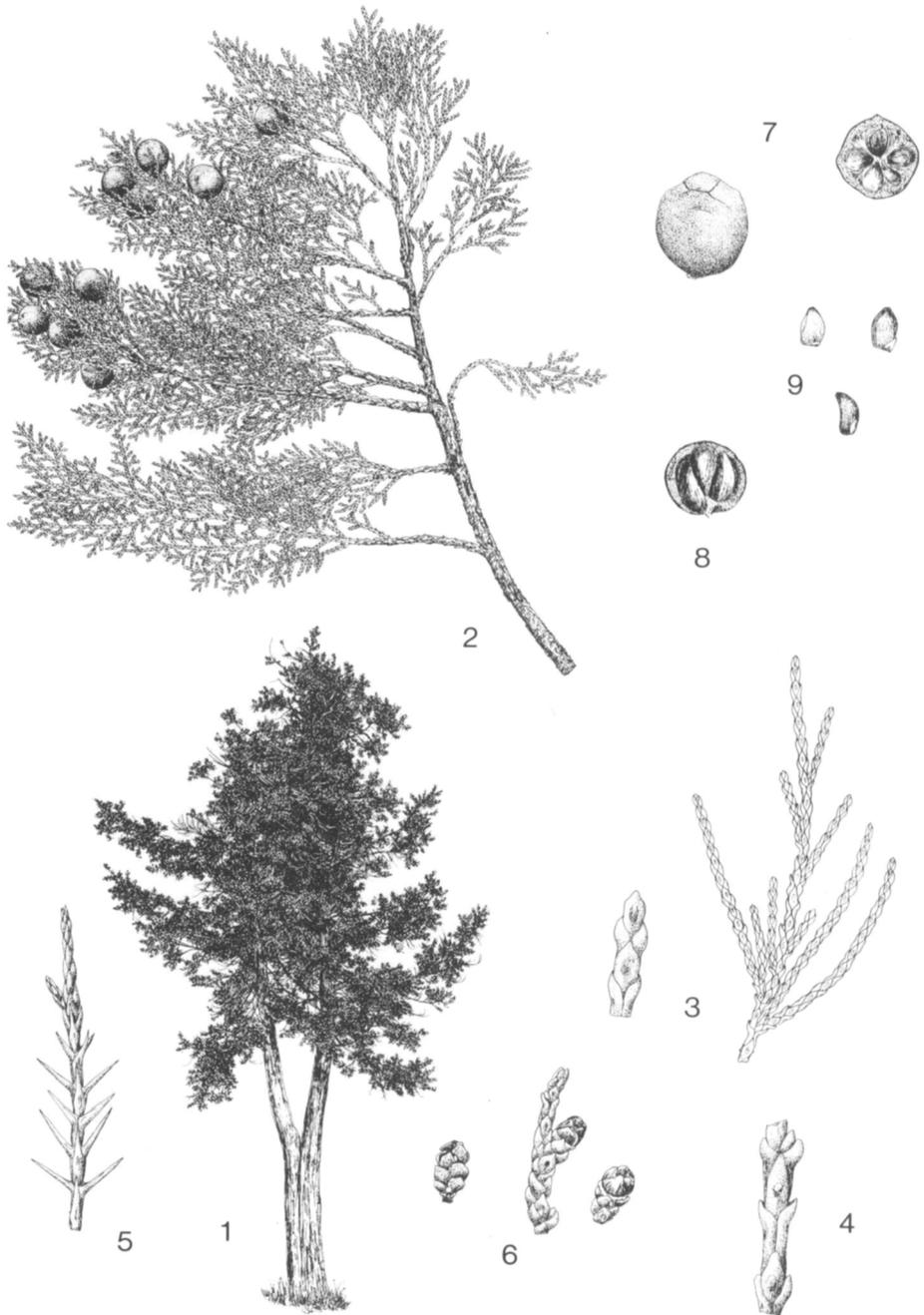


FIG. 1. *Juniperus excelsa* M.-Bieb. subsp. *excelsa*. 1, tree, Turkey; 2, shoot with cones (x 0.5); 3, ultimate branchlet (x 1.5, 3); 4, leaves (x 3); 5, juvenile leaves (x 1.5); 6, male strobili (x 2); 7, female cones, transverse section with seeds (x 1); 8, female cone, longit. sect. with seeds (x 1); 9, seeds (x 1). 1 from Karsten & Schenk, Vol. 17, t. 1; 2, 7, 9 from *Skvortsov* 7; 3 from *Davis* 33088; 4, 5 from *Sintenis* 912; 6 from *Horreüs de Haas* 1623; 8 from *Edmondson & McClintock* 2886.

the Tian Shan of Central Asia: *J. drobovii* and *J. tianschanica*. More recently Mehra (1976) proposed *J. excelsa* var. *farreana* from the western Himalayas; this name is invalid because no Latin diagnosis has been given. Finally, Imkhanitskaya (1990) reviewed *J. excelsa* s.l. from areas in the Soviet Union and proposed treatment of *J. polycarpus*, *J. seravschanica* and *J. turcomanica* as subspecies, involving two new combinations: *J. excelsa* subsp. *seravschanica* (Komarov) Imkhanitskaya and *J. excelsa* subsp. *turcomanica* (B. A. Fedtsch.) Imkhanitskaya.

Thus a total of 18 new species and 7 varieties in the multiseed Junipers of section *Sabina* have been named in the region. There has been little consideration on the relationships among these taxa resulting in a supernumerary classification. Komarov (1934), conceiving a narrow species concept in *Juniperus*, retained most of them in Vol. 1 of the *Flora SSSR*. At the other extreme are the views of Riedl (1968) and especially of Kerfoot (Kerfoot & Lavranos, 1984), who were inclined to incorporate nearly all Junipers with globose cones in a single species: *J. excelsa*. More or less intermediate treatments are commonly found in 'conifer manuals' of recent date, such as Harrison, Dallimore & Jackson (1966) and Gaussen (1968). Regional floristic publications (e.g. Kitamura, 1960; Coode & Cullen in Davis, 1965; Jain, 1976; Mehra, 1976; Polunin & Stainton, 1988; Imkhanitskaya, 1990) are typically concerned with the distinction of taxa within their respective geographic limitations. As a result, the taxa are sometimes treated in a contradictory way. We return then to Browicz & Zielinski (1982), who gave detailed maps of the distribution of Juniper species for much of our area, but who had to leave the systematic position of several of them unresolved.

DESCRIPTION OF TAXA AND DISCUSSION

Juniperus L., Sp. Pl. II: 1038 (1753). Gen. Pl. ed. 5: 461 (1754).

Juniperus sect. **Sabina** (Mill.) Spach, Ann. Sci. Nat. Bot., sér. 2, 16: 291 (1841). Basion. *Sabina* Mill., Gard. Dict., abr. ed. 4, vol. 1 (1754).

Type: *J. sabina* L.

(Prostrate) shrubs or mostly monopodial trees, attaining a considerable size and age. Bark fibrous, stripping off longitudinally. Branches numerous, spreading or ascending; ultimate branchlets of mature plants covered with imbricate scale leaves with decussate (rarely whorled) phyllotaxis. Acicular (juvenile) leaves only on seedlings or on the lowest branches of mature plants. Glands mostly conspicuous. Monoecious or dioecious. Microsporangiate strobili terminal, small, with 8–12 decussate microsporophylls each bearing 2–4 pollen sacs. Ovuliferous cones maturing in two seasons, with seed scales entirely fused, globose to subglobose–triangular, containing (1)–2–6(–8) wingless seeds. Cotyledons 2. This description only refers to specimens ascribed to the taxa here discussed, it does not pertain to all species included in section *Sabina*, which are distributed over much of the entire range of the genus.

Juniperus excelsa M.-Bieb., Besch. Länd. Terek & Kur, bot. Anhang: 204 (1800); Fl. taur.-cauc. 2: 425 (1808). Type: Crimea: *ex herb. P. S. Pallas* s.n. ('in Chersoneso taurica...', Hablizl') (lecto. LE, see Imkhanistkaya, 1990: 404). **Figs 1, 6.**

- Syn.: *Juniperus sabina* var. *taurica* Pall., Fl. Ross. 2: 15 (1789). Type: 'in Taurica', not located.
- Juniperus sabina* var. *excelsa* (M.-Bieb.) Georgi, Beschreib. Russ. Reiches 3 (5): 1358 (1800).
- Juniperus foetida* var. *excelsa* (M.-Bieb.) Spach (pro parte, sine syn. *J. occidentalis* Hook.), Ann. Sci. Nat. Bot., sér. 2, 16: 297 (1841).
- Juniperus isophyllos* K. Koch, Linnaea 22: 304 (1849). Type: not located; see note below.
- Sabina excelsa* (M.-Bieb) Ant., Cupress.-Gatt.: 45, t. 60 (1857).
- Sabina religiosa* Ant., Cupress.-Gatt.: 47, t. 61 (1857). Type: not located.
- Sabina isophyllos* (K. Koch) Ant., Cupress.-Gatt.: 48, tt. 64–66 (1857).
- Sabina olivieri* Ant., Cupress.-Gatt.: 70 (1857). Type: not located.
- Juniperus taurica* (Pall.) Lipsky (non Lindl., 1850) in O. E. Knorring & Z. A. Minkvich, Rastit. Aulie-Atinsk. u. s. Dar'inskoi obl./Travaux d'expédition pour exploration des régions de Colonisation Russe d'Asie; 2. Explor. bot. 1909, 6: 185–186, pl. (1912).
- Juniperus excelsa* var. *depressa* O. Schwarz, Repert. Spec. Nov. Regni Veg. 36: 66 (1934). Type: Lycia [S Turkey], Sipylos, O. Schwarz 1009 (B†).

Habit: tree, occasionally a shrub or a prostrate shrub, max. height 20–25m, d.b.h. 1.5–2.5m or more, usually monopodial in tree forms; branches of first order spreading or ascending, crooked in old trees; branches of higher orders more or less ascending in young trees, spreading and finally somewhat pendulous in old trees; crown (broad) pyramidal in young trees, mature trees broad, irregular, or shrub-like to prostrate in alpine locations; bark (young trees, branches) smooth, soon with papery flakes, reddish-brown, later fibrous, on old trees longitudinally furrowed, peeling in long strips, purplish- to reddish-brown. *Foliage*: branchlets numerous, in dorsiventral sprays (young trees) or more irregular and very dense esp. in dry environment; ultimate branchlets covered with leaves, quadrangular to more or less terete, very fine, diam. 0.7–1mm, persistent. *Leaves*: juvenile leaves on seedlings or on lower, shaded branches of trees, ternate, acicular, c.8–10 x 1mm, widest at base, keeled, pungent; mature leaves scale-like, decussate, imbricate, appressed or free at the mostly incurved apex, decurrent at base, ovate-rhombic on ultimate branchlets, (ob)lanceolate-acute on older shoots (–3.5mm long), 0.6–1.1 x 0.4–0.8mm, with entire margins; glands large and conspicuous, elliptic to nearly circular, often resinous; stomata on juvenile leaves epistomatic, on mature leaves amphistomatic in mostly 2 inconspicuous lines tapering from base to apex; colour light green or yellowish-green; in juvenile as well as in mature leaves a single median resin cavity occurs. *Male strobili*: numerous, solitary and terminal or subterminal on ultimate branchlets, 3–4 x 2–3mm, greenish maturing yellowish; microsporo-

phylls 8–10, peltate with rounded, thin margins, each bearing 3–4 pollen sacs. *Female cones*: numerous, mostly solitary and axillary, subterminal on ultimate branchlets, sessile; young strobili stellate-spheroid, surrounded by green leaves or bracts, 2–3mm diam., purplish–green to blue; mature cones globose, 6–11mm diam., purplish-brown to blackish-purple, often pruinose; seed scales 4(–6), decussate, entirely fused with bracts and each other, the two largest meeting at the distal pole of the cone, 4–9mm long, surface smooth, waxy, with a ridge terminating in a small umbo (0.5–0.6mm), interior resinous, becoming woody, yellowish (in sicco). *Seeds*: (2–)3–6(–8) per cone (some ovules usually abort), angular, broadest at base, ovoid but flattened or curved, 4–6 x 3–4mm, yellowish to reddish-brown.

In the Balkan countries of Albania, Yugoslavia (Macedonia), Greece (Macedonia, Thraki and Euboea) and S Bulgaria, in Turkey (Anatolia and eastward to Armenia), on Cyprus, in Syria and adjacent Lebanon, in Georgia, Armenia and Azerbaijan, eastward in Iran (Elburz Mts.) to near Ashkhabad (Kopet Mts.) in Turkmenia; also on the NE coast of the Black Sea at the foot of the Caucasus (Krasnodar) and in the Crimea.

Selected collections (39).

AZERBAIJAN. Prom Karabagh, no date, *Sjovits* 244 (L).

BULGARIA. Slivno, vii 1893, *Wagner* s.n. ('monoecious') (W); near ?Borekovo, x 1900, *V. Stribrny* s.n. (E); E. Macedonia, Struma River valley, Pirin, 15 v 1955, *N. Stojanov* 303 (E, L, W); *ibid.*, Javorov, 5 v 1961, *B. Kuzmanov* s.n. (L).

CRIMEA. 'Tauria merid.', no date, Prof. *Brunner* 1834 (E); Mt Sokoll, near Sudak, vii 1895, *A. Callier* 3237 (E, W); *ibid.*, 28 vii 1896, *A. Callier* 201 (E, W); Aj-Thodor promontory, 6 vii 1906, *J. Schirajewski* s.n. (L); distr. Yalta: Nikita, 29 v 1959, *P. H. Davis* 33088 (E); distr. Yalta, hills, 10 i 1959, *Koebex* s.n. (E); near Nikita, 25 vii 1967, *A. K. Skvortsov* 7 (E, U, W).
CYPRUS. Mt Papoutsia above Palekhori - Agross Pass, 1400m, 21 iv 1979, *J. R. Edmondson* & *M. A. S. McClintock* 2886 (E).

GREECE. Thasos, 1891, *P. Sintenis* & *J. Bornmüller* 1117 (W); Thraki, near Alexandroupolis, 29 v 1934, *K. H. & F. Reehinger* 6041 (W); *ibid.*, 14 vii 1978, *W. Greuter* 15882 (E).
KRASNODAR (Russian Rep.). near Novorossiysk, 200–300m, 31 vii 1966, *Russ. coll.* 101 (W).

SYRIA. no loc., 1855, *Th. Kotschy* 229 (W, several coll.!).

TURKEY (Anatolia). Bulgar Daglari, Cilician Taurus Mts, viii 1853, *Th. Kotschy* 414 (L, W); Phrygia, Sultan Daglari, 1500m, 25 vi 1899, *J. Bornmüller* 5560 (WU); prov. Kütahya, Murat Dag, 1000m, 5 vii 1962, *P. H. Davis* & *M. J. E. Coode* 36867 (E); Lycia, below Baba Dag, 30 vii 1947, *P. H. Davis* 13698 (E); Pozanti Dag, near Cilician Gate, 16 iii 1965, *K. H. Reehinger* 27009 (W); Antalya, Kohu Dag, 20 vi 1969, *K. Fitz* & *F. Spitzenberger* 952 (W); Torul NW of Gümüşhane, 10 x 1970, *R. H. Horreüs de Haas* 1623 (U); Irmassan Pass, road to Güzelsu, 1150m, 9 viii 1971, *F. Spitzenberger* 4 (W); Lycia, Baba Dag, 1500m, 26 v 1976, *O. Polunin* 14021 (E); Termessos, 25km WNW of Antalya, 25 ix 1989, *M. P. Frankis* 16, 17 (E, U); Sinekibeli Pass, 30km N of Kas, 27 ix 1989, *M. P. Frankis* 30 (E, U); NE slopes of Ak Dag, 5km W of Gömbe, 27 ix 1989, *M. P. Frankis* 32 (E, U).

TURKEY (Armenia). Distr. Kars, betw. Agundir and Kosor, 8 vii 1903, *E. Kenil* s.n. (as *J. isophyllos*) (WU); Aras, Arczan Dag (Boz Dag), 13 vii 1908, *A. Schelkownikow* 331 (as *J. isophyllos*) (WU).

TURKMENIA. Ashkhabad, in mountains, 22 x 1897, *D. Litwinow* 131 (WU); Ashkhabad, above Nephton, 4 v 1900, *P. Sintenis* 251 (WU); Ashkhabad, Suluklü (Saratowka), vii/viii 1900, *P. Sintenis* 912 (WU).

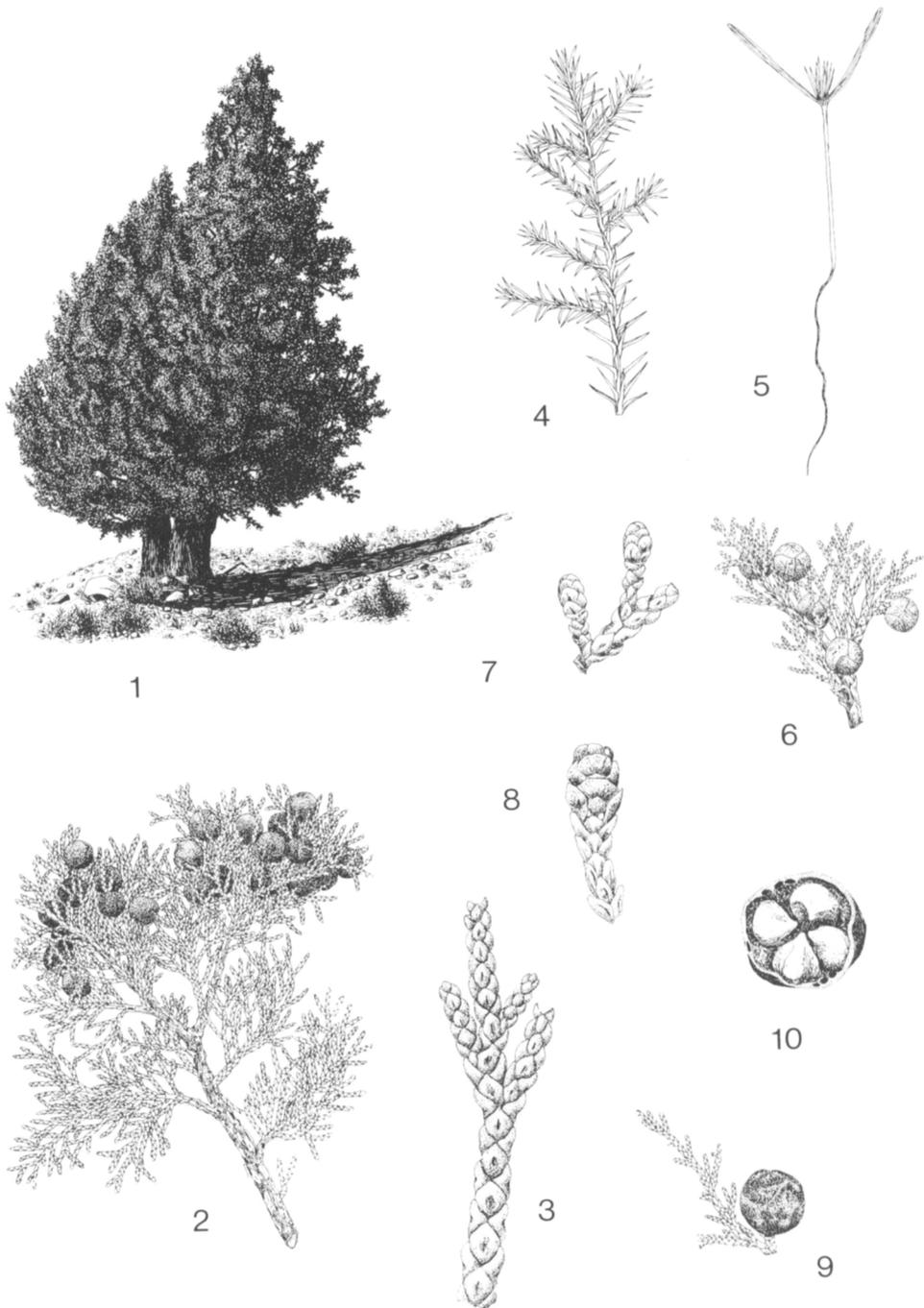


FIG. 2. *Juniperus excelsa* M.-Bieb. subsp. *polycarpus* (K. Koch) Takhtajan. 1, tree, Iran; 2, shoot with cones (x 0.5); 3, ultimate branchlet (x 2.5); 4, branchlet with juvenile leaves (x 0.5); 5, seedling with cotyledons (x 0.5); 6, branchlet with cones (x 0.5); 7, 8, male strobili (x 1.5, 2); 9 female cone (x 0.6); 10, cone with seeds (x 1.5). 1 from Karsten & Schenk, Vol. 26, t. 1; 2, 3 from Hedge, Wendelbo & Ekberg 7850; 4, 5 from Lacey s.n.; 6 from Lever s.n.; 7 from Lacey 3906; 8 from Neubauer 4484; 9, 10 from Dückelmann 46.

Juniperus excelsa M.-Bieb. subsp. *excelsa* occurs in the hills and mountains of the Eastern Mediterranean Basin, the Black Sea and a range of mountains arching around the southern end of the Caspian Sea. It becomes increasingly rare eastward along the latter chain of mountains. It does not occur in regions with an annual precipitation much below 500mm. It is especially common in Anatolia (less so in its central part) and on the Crimea, with annual precipitation between 500–1000mm. Its altitudinal range is from c. 100m (e.g. Crimea) to 2300m in the Caucasus and Turkey. It forms the tree-limit in several mountain ranges. It is resistant to summer drought and warmth, but less so than the subsp. *polycarpus* (discussed below). It grows mainly on stony, rocky calcareous or non-calcareous slopes. It may form pure, open forests, grow mixed with *J. foetidissima* or with other conifers such as *Cedrus libani*, *Cupressus sempervirens* and *Pinus* spp., or it may be part of oak-scrub communities in secondary vegetation, but not in Mediterranean maquis.

Of *J. excelsa* Marschall von Bieberstein (1800, 1808) gave two somewhat unequal descriptions. In the protologue (p.204), the leaves are described as: ‘adultae foliis minimis oppositis quadrifariam imbricatis, tenellae acerosis patulis ternis’; in the later *Flora taurico-caucasica* (p.425) as: ‘foliis adpressis oppositis, quadrifariam imbricatis obtusiusculis, tenellae ternis acerosis patulis.’ The second phrase in each refers to intermediate leaves (sensu Florin, 1931) and is similar. The first part describes the adult leaves and in the protologue they are described as very small (minimis), which they are. Many later authors (incl. the *Index Kewensis*) only referred to the second of M.’s descriptions, in which this character state is not mentioned. Yet it is one of the obvious character states to be observed in almost all specimens cited above. In this respect it is often not dissimilar to *J. procera*. Tendencies to larger leaves on ultimate branchlets (and consequently to thicker branchlets) are found mainly in specimens from eastern localities (e.g. *P. Sintenis* 912 from near Ashkhabad). Some intermediacy may therefore occur, but typical foliage is usually quite constant.

J. isophyllos K. Koch, described from NE Turkey (region of ‘Tschorukthal’ = Çoruh Valley) and collected during Koch’s second expedition (after August 1843; see Ulbrich, 1917; Edmondson & Lack, 1977; Lack, 1978) has similar foliage and small, bluish cones. Koch’s original material has not been found, it was most likely destroyed at B in the Second World War (Lack, 1978). A specimen labelled *J. isophyllos* (*Schelkownikow* 331) and collected in the same general area is typical of *J. excelsa* M.-Bieb. A type specimen being absent, circumscription of this taxon as given by Koch (1849) remains our only source of reference; it comes closer to *J. excelsa* M.-Bieb. than to *J. polycarpus* K. Koch. Therefore, including *J. isophyllos* in synonymy with *J. excelsa* subsp. *polycarpus* (K. Koch) Takhtajan, as proposed by Imkhanitskaya (1990) seems to me contrary to the available evidence. It is better treated as a synonym of *J. excelsa* subsp. *excelsa*.
***Juniperus excelsa* M.-Bieb. subsp. *polycarpus* (K. Koch) Takhtajan, Fl. Yerev.: 53 (1972). Figs 2, 6.**

Syn.: *Juniperus polycarpus* K. Koch, *Linnaea* 22: 303 (1849). Type:
Turkey, Armenia, Taltaban near Gümüşkane, 27 iv 1894,

- P. Sintenis* 5520 (neo. L!, designated here; isoneo. E!). See note below.
- Sabina polycarpus* Ant., Cupress.-Gatt.: 47, t. 63 (1857).
- Juniperus excelsa* Wall., sensu Aitch., J. Linn. Soc., Bot. 18: 97 (1880).
- Juniperus macropoda* Boiss., Fl. orient. 5: 709 (1884). *Th. Kotschy* 711 (lecto. G!, designated here; isolecto. L!). See note below.
Type: *V. L. Komarov* s.n. (lecto. LE). See note below.
- Juniperus turcomanica* B. A. Fedtsch., Fl. Turkmen. 1: 14 (1932).
Type: *D. P. Gedevanov & Dranitsya* 148 (lecto. LE). See note below.
- Juniperus seravschanica* Komarov, Bot. Zurn. SSSR 17: 481 (1932).
Type: Tadzshikistan, Zeravshan Valley, Darch, 2400m, 11 viii 1892,
- Sabina seravschanica* (Komarov) Nevski, Trudy Bot. Inst. Akad. Nauk SSSR, Ser. 1, 4: 245 (1937).
- Juniperus polycarpus* var. *seravschanica* (Komarov) Kitamura, Fl. Pl. W. Pakist. Afghan.: 7 (1964), nom. inval. sine indic. basion.;
Add. & Corr. Fl. Afghan.: 68 (1966).
- Juniperus polycarpus* var. *pendula* Mulk., Dokl. AN Armen. SSR 45 (2): 86 (1967). Type: Armenia, 1959, *Y. I. Mulkidzhanian* s.n. (ERE, n.v.).
- Juniperus excelsa* var. *farreana* P. N. Mehra, Nucleus 19 (2): 135 (1976), nom. inval., sine diagn. lat.
- Juniperus excelsa* var. *polycarpus* (K. Koch) Silba, Phytologia Memoirs 7: 34 (1984).
- Juniperus excelsa* subsp. *polycarpus* var. *pendula* (Mulk.) Imkhanitskaya, Bot. Zurn. 75 (3): 407 (1990).
- Juniperus excelsa* subsp. *seravschanica* (Komarov) Imkhanitskaya, Bot. Zurn. 75 (3): 407 (1990).
- Juniperus excelsa* subsp. *turcomanica* (B. A. Fedtsch.) Imkhanitskaya, Bot. Zurn. 75 (3): 408 (1990).

Koch (1849) did not mention any collections with his new species, but summed up the areas where he had found *J. polycarpus*: 'Tschorukthal' (= Çoruh Valley), 'Gauë Pertakrek' (= distr. Peterek) and 'Schachjol Dagh' (= Köse Dag), alt. 6000–8000'. These areas in NE Turkey were visited on the second expedition around August 1843 (Ulbrich, 1917; Lack, 1978). As mentioned above, Koch's collections at B were destroyed. No duplicates of collections from the second expedition were sent to LE (as had been done from the first, see also Lack, 1978) and no specimens of *Juniperus* collected by Koch are held a LE (D. V. Geltman, pers. comm.). At G and W, other possibilities, no relevant specimens were found. Neotypification therefore seems the only possibility left to fix Koch's name *J. polycarpus*; a specimen from NE Turkey is for this purpose chosen here.

Juniperus excelsa subsp. *polycarpus* differs from the typical subspecies in the following characters: Ultimate branchlets more quadrangular, thicker (1–1.3mm), often irregularly disposed and intricate, leaves on ultimate branchlets sometimes free at apex, larger (1.2–1.6 x 0.8–0.9mm); female cones similar to the typical subspecies but with on average less seeds (2–)3–4(–6) and sometimes larger (diam. up to 14mm in e.g. *R. Dünckelmann* 46 from Gardez, Afghanistan), more variable in size.

Unfortunately, Koch's description (1849) is not specific on the thickness of the ultimate branchlets, the best and most constant differentiating character. He failed to compare his new species with *J. excelsa*, but in referring to *J. lycia* L. (= *J. phoenicea*) as the most closely 'related' species, we might assume Koch described material with branchlets at least 1mm thick. The morphological differences observed are in part clinal. Geographically and ecologically there is some overlap with the typical subspecies, but both taxa occupy for the greater part distinct ranges and habitats. Treatment as a subspecies, proposed by Takhtajan (Takhtajan & Fedorov, 1972), seems therefore the best taxonomic judgement.

Juniperus excelsa subsp. *polycarpus* is found from the mountains around the Çoruh Valley in E Turkey eastward across the Caucasian Region to the Caspian Sea. Thence it occurs eastward around the Caspian Sea and along the Kopet Mountains into Afghanistan. Northeastward it reaches the Tian Shan and the mountains of Kirgizstan, in the south(east) of the range it is found as far as Quetta in Pakistan and Himachal Pradesh (India). In Iran it is mostly scattered along the mountain chains west of the great desert plateaus; finally there is a disjunct population on Jabal-al-Akhdar in Oman.

Selected collections (44).

- AFGHANISTAN. sine loc., pro 1863–64, *W. Griffith* 4988 (U); Prov. Jaji, above Khudi-khel, 2700m, 22 v 1937, *W. Koelz* 11552 (W); Badakhshan, Pain Shahr, 2400m, 15 vii 1937, *W. Koelz* 12432 (W); E of Gardez (near Pakistan border), 2600m, 19 xi 1948, *M. Köie* 2967 (W); *ibid.*, xii 1949, *R. Dünckelmann* 46 (W); Porandeh Valley, tributary to Panjshir River, 2950m, 25 vii 1950, *A. Gilli* 45 (W); Prov. Maimana, near Belceragh, 28 v 1962, *I. C. Hedge & P. Wendelbo* 3696 (E); upper Kurram Valley, 25 xi 1962, *E. Reiner* 804 (W); Prov. Herat, Kuh-e-Darunta, 2100–2700m, no date, *I. C. Hedge, P. Wendelbo & L. Ekberg* 7850 (E); Salang Pass, N side, 2900m, 9 x 1964, *H. F. Neubauer* 4484 (W); Mt Salang, 2700m, 30 vi 1965, *K. H. Rechinger* 31596 (B, W); Prov. Gardez, Safed Kuh, 2850m, 5 vii 1965, *K. H. Rechinger* 31869 (W); Prov. Jaji, E of Gardez, 10–11 vii 1965, *K. H. Rechinger* 32243 (B, W), 32339 (W); Prov. Urgun, Mirzakai Kotal, 9 vi 1967, *K. H. Rechinger* 35832 (B, W); Prov. Urgun, 2200–2300m, 10 vi 1967, *K. H. Rechinger* 35896 (B, W); Prov. Kataghan (Takhar), Farkhar Valley, 1550–2250m, 18–21 ix 1965, *D. Podlech* 12678, 12694 (as *J. seravschanica*) (E); Prov. Herat, 12mi. NW of Obeh, 28 iv 1971, *R. B. & E. M. Gibbons* 203 (E); 15km N of Salang Pass, 2450m, 2 vii 1976, *J. F. Veldkamp* s.n. (L).
- ARMENIA. Distr. Ararat, Gegamskiy Khrebet, 1400–1600m, 11–13 x 1974, *V. Vasák* s.n. (as *J. polycarpus*) (W); betw. vill. Dilizan and Idzevan, 920m, 12 vii 1975, *W. Greuter* 12783 (E); Distr. Ararat, NO of Ketud, 14 iv 1977, *K. Tasjanjan* et al. s.n. (det. A. Takhtajan) (W); Distr. Vardenis, near Lake Sevan, 26 vii 1984, *V. Vasák* s.n. (W).
- AZERBAIJAN. Distr. Kuba, near Gümür, 20 iv 1902, *T. Alexeenko* s.n. (as *J. polycarpus*) (WU); Distr. Kirovabad, Eljar-Oughi Mts, 13 vi 1971, *E. E. Gogina* 9 (as *J. polycarpus*) (E, W).
- IRAN. Kuh-e-Dinar, 21 vii 1842, *Th. Kotschy* 711 (type of *J. macropoda* Boiss.) (G, L); Arak (Sultanabad), no date, *T. Strauss* s.n. (WU); Prov. Kerman, Kuh-Shah and Kuh-e-Hasaran,

- 3300–3400m, 25 vii–6 viii 1982, *J. Bornmüller* 4343–4345 (as *J. macropoda*) (B, WU); Prov. Khorasan, Kopet Dag, 45km NNE of Shirvan, 2850m, 3 vii 1973, *J. R. Edmondson* 1232 (E).
 OMAN. Jabal-al-Akhdar, Saiq area, along wadi, 26 vii 1982, *J. R. Maconochie* 3655 (E).
 PAKISTAN. Baluchistan, Ziarat, 2400m, 16 ix 1889, *J. H. Lace* 3906, s.n. (as *J. macropoda*) (E); Baluchistan, Quetta to Ziarat, top of pass, 2200m, 12 v 1965, *J. Lamond* 1167 (E); *ibid.*, 12 v 1965, *K. H. Rechinger* 29299 (B, W); Hindu Kush, Chitral, Yarkhun Valley, 2700–2850m, 24–25 vii 1968, *A. Stamm & G. Wöhrl* 164, 241 (W); Baluchistan, near Ziarat, Lozalai Zhob, 12 iii 1990, *J. Lever* s.n. (U).
 TADZHIKISTAN. Gissarskiy Khrebet, Varzob River Valley, 3 viii 1985, *T. S. Elias, D. Murray & L. Newcombe* 10120 (as *J. seravschanica*) (E).
 TURKEY (Armenia). Taltaban near Gümüşkane, 27 iv 1894, *P. Sintenis* 1167 (L), *ibid.*, 27 iv 1894, *P. Sintenis* 5520 (neotype of *J. polycarpus* K. Koch, L. dupl. E).
 TURKMENIA. Kyuren-dag (NW Kopet Dag), xii 1872, *G. Sivers* 36 (paralectotype of *J. turcomanica* B. A. Fedtsch., LE); Kugitang-tau, Svintsovy Rudnik, 2000m, 14 vi 1970, *G. M. Proskuriakova* 12 (as *J. seravschanica*) (E); Kopet Dag, 27km SE of Ashkabad, 500–600m, 13 v 1975, *V. V. Nikitin & I. A. Ivanov* s.n. (as *J. turcomanica*) (E, L).
 UZBEKISTAN. Ferganskaja Oblast, Mt Tschotkal, 11 x 1910, *O. A. & B. A. Fedtschenko* 130 (paralectotype of *J. seravschanica* Komarov, LE).

Juniperus excelsa subsp. *polycarpus* is much more a continental taxon than the typical subspecies. It occurs in the Western Asiatic Subregion of the Irano-Turanian Region, and especially in the Armeno-Iranian Province (see Takhtajan, 1986: 144), characterized by mountains separated by vast steppes and deserts. The Jabal-al-Akhdar in Oman forms a disjunct enclave of this Province (Takhtajan, 1986:149), which has its western limit in the eastern parts of Turkey, roughly from Gümüşhane to Maras. West of this line *J. excelsa* subsp. *polycarpus* does not occur. It is possibly sympatric with the typical subspecies only in Armenia (including Turkish Armenia), and along the mountain chains from Azerbaijan eastward around the southern end of the Caspian Sea, where the typical subspecies becomes increasingly rare. Precipitation is still relatively high in these mountains (usually well above 500mm annually). Often identified as *J. seravschanica*, *J. excelsa* subsp. *polycarpus* occurs abundantly farther east in Afghanistan and in Tadzhikistan and Uzbekistan, with outposts in the western Tien Shan on the northern limits and in India (Himachal Pradesh) at the southeastern end of its range. Precipitation is less abundant, much of it comes as snow in winter. It is generally a higher altitude taxon and the further it reaches eastwards, the higher altitude it attains (see also Browicz & Zielinski, 1982); it occurs from 500–3800m (Kitamura, 1960), but generally between 1200–3000m. It grows exceedingly slow and in many areas groves of very old trees occur, with little or no rejuvenation. It is much more resistant to drought and radiation (heat) than the typical subspecies and strongly heliophilous, but it can tolerate winter cold equally well. Dehydration is prevented by an exceptionally thick cuticula. It occurs on stony, rocky slopes, often spaced wide apart, sometimes mixed with *J. semiglobosa*, with which it is said to have formed hybrid complexes (Browicz & Zielinski, 1982). No herbarium material seen for this study has any characters supporting that suggestion; the two taxa seem to be well separated morphologically.

Boissier (1884) described *J. macropoda* as a new species from Iran (several locations) and Oman. The first collection mentioned in the protologue is *Th. Kotschy* 711, from the mountain Kuh-e-Dinar in the southern Zagros Range. It is here designated as the lectotype of *J. macropoda* Boiss. This material, as well as a collection from one of

Boissier's other loci: Jabal-al-Akhdar, Oman (*J. Maconochie* 3655, E!), is morphologically similar to specimens labelled *J. polycarpus* K. Koch from Armenia and elsewhere. We shall discuss the misapplication of Boissier's name for a different taxon below; it should be identified with *J. excelsa* subsp. *polycarpus* as here defined only.

Juniperus turcomanica B. A. Fedtsch. was described in *Flora Turkmenii* (Fedtschenko, Popov & Shishkin, eds., 1932) and keyed out against *J. polycarpus* with 'ultimate branchlets slender, cones to 5mm diam.' versus 'ultimate branchlets thicker, cones to 10mm diam.' Other characters in the protologue are equally true for *J. excelsa* subsp. *polycarpus*. Komarov (1932, 1934) gives as cone size c. 1cm diam. Neither author specified by measurement 'slender' and 'thicker'. Also the number of seeds (3–5) per cone is similar. No morphological differences could be found in the material studied and *J. turcomanica* B. A. Fedtsch., described from the Bol'shoi Balkhan and Kopet Mountains is regarded as synonymous with *J. excelsa* subsp. *polycarpus*. The lectotype: D. P. Gedevanov & D. A. Dranitsyn 148, 3 v 1912, Turkmenia, Kopet Dag, Dschalilü (LE) was chosen by Imkhanitskaya (1990).

Juniperus seravschanica Komarov (1932) was described from Central Asia, from several of the high mountain ranges between Tashkent in the north and the Hindu Kush in the south. The lectotype at LE, chosen by Imkhanitskaya (1990) is V. L. Komarov s.n., 11 viii 1892, Tadzhikistan, Zeravshan Valley, Darch, 2400m. It was also abundantly collected in E Afghanistan, but there it has been more often identified as *J. polycarpus* or *J. excelsa*, at least by non-Russian collectors. The only difference I have been able to find with *J. excelsa* subsp. *polycarpus* is a lower number of seeds per cone (2–3, rarely 4), a character state also given in Komarov (1934) and by Imkhanitskaya (1990). Such low numbers do however occur in collections from the Caucasus identified as *J. polycarpus*, the variability simply being greater. Shape of seeds, a character elaborated by Komarov, is not at all an independent one: it is strongly correlated with the number of seeds per cone. With more seeds, there is less room for them and they become trigonate, flattened or even curved, often quite unequal in size, in short deviating from a more ovoid shape; this was pointed out by Spach (1841) long ago. Material from Pakistan (near Ziarat), referred to *J. excelsa* on herbarium labels and in the field by local foresters (J. Lever, pers. comm.) is identical in every respect to *J. seravschanica* from Tadzhikistan. Kazmi & Jenan (1975), have treated the Ziarat population, as well as others, as *J. polycarpus* K. Koch. Riedl (1968) included all these collections in *J. excelsa* M.-Bieb. Browicz & Zielinski (1982), although indicating taxonomic uncertainties, maintained *J. seravschanica* as a species and produced a map (No. 10), of which the Kashmir locations are at least in part representing a different species. *J. seravschanica* is best treated as synonymous with *J. excelsa* subsp. *polycarpus*. Some indication of genetic difference suggested by the lower number of seeds should preferably be checked in population studies.

Mehra's (1976) invalidly published *J. excelsa* var. *farreana* from NW India bears a description which would include it in subsp. *polycarpus* as well. Jain (1976) refers to the same population (Pooh forests, Himachal Pradesh), as the (only) locality of *J. excelsa*

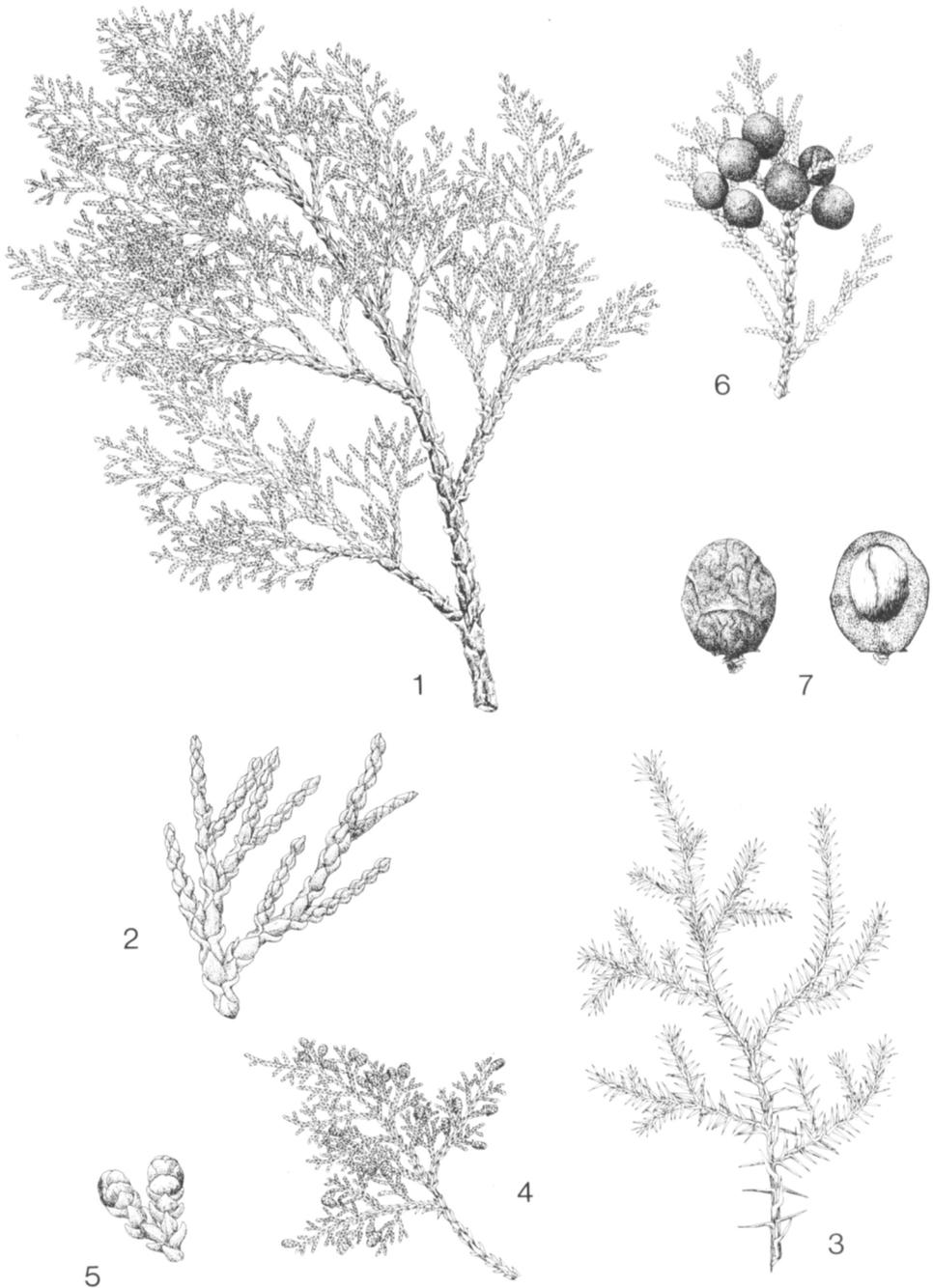


FIG. 3. *Juniperus foetidissima* Willd. 1, branch with foliage (x 0.5); 2, ultimate branchlet (x 1.7); 3, branchlet with juvenile leaves (x 0.5); 4, branchlet with male strobili (x 0.5); 5, male strobili (x 1.5); 6, branchlet with cones (x 0.5); 7, cone, longit. sect. with connate seeds (x 1). 1, 6 from *Frankis* 31; 2 from *Balls & Balfour Gourlay* 3185; 3 from *Kotateladze et al.* s.n.; 4, 5 from *Davis* 16590; 7 from *Davis* 47700.

M.-Bieb. in the Himalayas. Chemical analysis is recommended for these easternmost populations to further assess their taxonomic affinities in more detail.

Juniperus foetidissima Willd., Sp. Pl. 4 (2): 853 (1806). Type: *J. P. de Tournefort* 'in Armenia', herb. Willdenow 18547 (holo. B-W!, iso. P); see also Wagenitz (1962). Figs 3, 6.

Syn.: *Juniperus phoenicea* Pall. (non L., 1753), Fl. Ross. 1 (2): 16, t. 57 (1789).

Juniperus sabinooides Griseb., Spic. fl. rumel. 2: 352 (1846). Type: 'aff. foetidiss. diff. tuberc. baccis prominulis, ... Athos', A. H. R. Grisebach s.n., specimen with ovuliferous cones at top left of sheet (lecto. GOET!, designated here). See note below.

Juniperus foetida var. *squarrulosa* Spach, Hist. nat. vég. 11: 321 (1842). Type: as for *J. foetidissima* Willd.

Sabina foetidissima (Willd.) Ant., Cupress.-Gatt.: 49, tt. 67–71 (1857).

Juniperus foetidissima var. *pindicola* Formanek, Verh. Naturf. Vereins Brünn 34: 272 (1896). Type: sheet No. 4 (in pencil) of BRNM 00455/38 (lecto. BRNM!, designated here). See note below.

Juniperus foetidissima var. *squarrosa* Medw., Trudy Bot. Sada Imp. Jur'evsk. Univ. 3: 229 (1903); Repert. Spec. Nov. Regni Veg. 2 (14–15): 136 (1906). Type: 'Hab. in Transcaucasia', not located.

Habit: tree, occasionally a shrub or a prostrate shrub, max. height 10–15(–20)m, d.b.h. 1m, usually monopodial; branches of first order spreading or ascending, irregular, branches of higher orders spreading, short, thick and often crooked; crown more or less pyramidal in young trees, irregular and broad in old trees, often a shrub in tree line conditions on high mountains; bark on young trees or branches smooth, soon with papery flakes, on old trees fibrous, grey, peeling off longitudinally in strips. *Foliage*: branchlets usually in dense, intricate and irregular sprays; the ultimate branchlets covered with leaves, distinctly quadrangular, 1.2–2mm thick, at first green, later reddish-brown and rough with recurved scale leaves. *Leaves*: juvenile leaves on seedlings as well as on mature plants, ternate, acicular, 5–8mm long, 1.5–2mm wide at decurrent base, keeled, pungent, epistomatic; mature leaves decussate, imbricate, rhombic to ovate-rhombic, (ob)lanceolate, –5mm long on older branchlets, decurrent at base, with free, recurved apices or appressed, with entire margins, on ultimate branchlets 2–3mm long; glands usually inconspicuous and inactive, sometimes brownish; scale leaves amphistomatic, with stomata in two tapering lines from base to apex; colour shining green or yellowish-green; resin cavity single; foliage with a foetid odour when crushed. *Male strobili*: numerous, solitary, terminal or subterminal, ovoid-globose, 2–3(–3.5)mm long, pale yellowish to yellowish-brown; microsporophylls 8–12, peltate, with rounded, thin, hyaline and often erose margins, with 4 relatively large pollen sacs. *Female cones*: numerous, solitary, axillary and subterminal, sessile or with 3–4mm long peduncles with tiny scale leaves; young strobili spheroid, with 6 distinct umbo's, 2–3mm diam.,

bluish-green; mature cones globose, 5–13mm diam., dark blue or blackish, pruinose; seed scales (4–)6, in decussate pairs of unequal size, entirely fused with bracts and with each other, smooth or slightly rugose in dried specimens, with a minute umbo as an extension of the bract, 0.5mm except on the two basal scales, the interior resinous, becoming more or less woody. *Seeds*: 1–2(–3) per cone, ovoid-globose or often nearly hemispherical, more or less connate, appearing as one, large, 5–7mm diam., pale brown (seed anatomy in: Orlova & Kerimov, 1982).

Generally sympatric with *J. excelsa* subsp. *excelsa*: Albania, Macedonia, in Greece southward to the Peloponnesos, on Mt Athos and on Thásos, on Cyprus and in Lebanon, across Asiatic Turkey (but rare or absent on the interior plateau) and the SE Caucasus to the coast of the Caspian Sea in Azerbaijan; also along the coast of the Black Sea near Novorossiysk and in the Crimea.

Selected collections (26).

CYPRUS. Troodos Mts, Mt Olympus, 1800m, 5 iv 1859, *Th. Kotschy* 265 (L); Troodos Mts, 20 v 1862, *Th. Kotschy* 757 (L); Troodos Mts, Mt Olympus, summit, 18 v 1973, *K. U. Kramer* 5139 (U).

GEORGIA. Caucasus Mts, Karsaki, 1 iii 1963, *W. Koetateladze* et al. s.n. (E).

GREECE. Mt Athos, Hagion-Oros Peninsula, 1846?, *A. H. R. Grisebach* s.n. (lectotype of *J. sabinooides* Griseb., GOET); *ibid.*, no date, *Frivacoszky?* 1344 (on same sheet, GOET); Lakonia, near Canalus, 1500m, 1856, *T. G. Orphanides* 978 (E); Hellas, Mt Parnassos, 17 vii 1856, *T. von Heldreich* 542 (L); Macedonia, Pindos Mountains, 1895?, *E. Formanek* s.n. (4 sheets, BRNM No. 00455/38, type coll. of *J. foetidissima* var. *pindicola* Formanek); Oeta, above Ypati, 1500m, 9 vi 1937, *E. K. Balls & W. Balfour Gourlay* 3185 (E); Ipiros, Mt Peristéri, 1200m, 20 vii 1937, *E. K. Balls & W. Balfour Gourlay* 3675 (E); Ipiros, Tymphi Mts ('Pindus Tymphaeus'), near Baba, vii 1885, *C. Haussknecht* s.n. (E); Pindos Mts, Agrafa, 1200m, 9 viii 1937, *E. K. Balls & W. Balfour Gourlay* 3835 (E); Ipiros, E slope of Tymphi Mts, 1250m, 14 vi 1977, *E. A. Mennega & W. G. Driehuis* 198, (E, U); Samos, Mt Kerkis, 1200m, 8 x 1981, *P. H. Davis* 67793 (as *J. excelsa*) (E).

TURKEY (Anatolia). Bulgar Daglari, Selwi Ardytsch, viii 1853, *Th. Kotschy* 412, 413 (L); Cilician Mts., ix 1855, *B. Balansa* 830 (L); Bulgar Daglari, between Poranti and Meydan, 1500–1700m, 1 ix 1949, *P. H. Davis* 16590 (E); Ak Dag, 5km W of Gömbe, 1800–2000m, 27 ix 1989, *M. P. Frankis* 31, 33, 57 (E, U).

TURKEY (Armenia). 'in Armenia', *J. P. de Tournefort*, herb. Willdenow 18547 (holo. B-W); Artvin, Ardanuc, 22 vi 1961, *Kerk* 41/4 (W); *ibid.*, 15 vii 1962, *Leisler* s.n. (W); Artvin, Sarigöl to Barhal, 1100m, 1 viii 1966, *P. H. Davis* 47700 (E).

Juniperus foetidissima occupies largely the same habitats as *J. excelsa* subsp. *excelsa* and often grows mixed with it. Its altitudinal range is also similar, from near sea level on the coast of the Black Sea near Novorossiysk to c. 2000m in Anatolia. In the Caucasus it reaches 1600m, on Cyprus it is restricted to a belt of the Troodos Mountains between 1500–1950m. Lower limits may in many places be effected by grazing pressures. Like *J. excelsa* subsp. *excelsa* it grows on dry, rocky slopes, with shallow, gravelly soils. Annual precipitation varies between 400–1000mm in different localities. *J. foetidissima* seems to be slightly more tolerant to dryness and heat than *J. excelsa* subsp. *excelsa* in some areas where both taxa are found. In mixed forest it grows in open places, in Turkey with e.g. *Abies cilicica*, *Cedrus libani*, *Cupressus sempervirens*, *Pinus nigra*, *Juniperus excelsa* subsp. *excelsa*, *J. drupacea*, *J. oxycedrus* and *Quercus coccifera*.

Pallas (1789: 16, t. 57) gave a description and a coloured plate of *J. phoenicea* Pall., a later homonym of *J. phoenicea* L. (1753). I agree with Komarov (1934: 185) that the

description is too general to exclude other species of the section *Sabina* in the region, but that the quite excellent plate represents *J. foetidissima* Willd. Since Pallas refers to this plate, *J. phoenicea* Pall. non L. is a synonym of *J. foetidissima* Willd.

Juniperus foetida Spach (1842, Vol. 11, p. 314) cannot be attributed only to this species. Spach mentions *J. thurifera*, *J. sabina* and *J. virginiana* as synonyms. His description does not exclude *J. excelsa* or *J. foetidissima* either. His trinomial *J. foetida squarrulosa* refers to the type of *J. foetidissima* from Armenia (p. 321) and is described as a variety, with *J. foetidissima* in synonymy.

Juniperus sabinoidea Griseb. (1846) was described from Mt Athos on the Hagion-Oros Peninsula in Greece as a shrub of 4m height, with *J. sabina* Sibth. & Sm. (non L.) 'in Olympo Bithyniae' as a synonym. Its characters as given by Grisebach are similar to *J. foetidissima* as presently circumscribed. Grisebach examined a specimen with as yet immature cones, in which the ovuliferous scales are not fully grown to enclose the bracts completely; such cones are not globular and have 'tuberculate' scales. Vegetative characters of the type material are typical of *J. foetidissima*. The plants at the type locality have correctly been identified as *J. foetidissima* by Browicz & Zielinski (1982).

Formanek (1896) described *Juniperus foetidissima* var. *pindicola* from the Pindos Mountains in Macedonia (Greece) as follows: 'squamis inferioribus apice tuberculato-apicularis, galbulis rugoso scabridis.' The type collection (4 sheets at BRNM) contains rather poorly preserved branchlets, three of which have ovuliferous cones. These appear to be somewhat immature in that they have only 4 seed scales, while the apical edges of the upper two are not joined at the distal pole of the cone. This leaves the acutish apices of the (1-)2-4 seeds protruding, which might account for the 'prickly' nature ascribed to this taxon (Den Ouden & Boom, 1965). The minute prickle from the bract apices is similar to other material of *J. foetidissima*. Rugosity, shape of (lower) seed scales and size seem all to be more or less a function of the immature state and do not differ from such material observed in the species as a whole, while the foliage is also similar. The lectotype of *J. foetidissima* var. *pindicola* is here chosen to be sheet No. 4 (in pencil) of BRNM 00455/38 (BRNM!).

Medwedew (1903) described a new variety (var. *squarrosa*) from 'Transcaucasia', with 'longer leaves, patent or semi-appressed, acuminate, mostly ternate, rarely decussate, elliptic to ovate-lanceolate, mostly with glands, cones larger' (diagn. translated from the protologue). Such plants with predominantly juvenile leaf characters occasionally occur in several species of sect. *Sabina* and could be associated with the expression of a gene which remains commonly suppressed in the population, but is present in all individuals. Taxonomic status for individuals with juvenile leaf forms in such populations are not justified.

Juniperus procera Hochst. ex Endl., Syn. Conif.: 26 (1847). Type: Ethiopia, Simien (Amhara), 'Ad ecclesiam Adda Mariam prope Enschedcap', 6 vi 1838, G. H. W. Schimper 537, sheet with pollen cones and mature leaves (lecto. L!, designated here). See note below. **Figs 4, 6.**

Syn.: *Juniperus hochstetteri* Ant., Cupress.-Gatt. p.s.n., t. 33 (1857).

Type: not located.

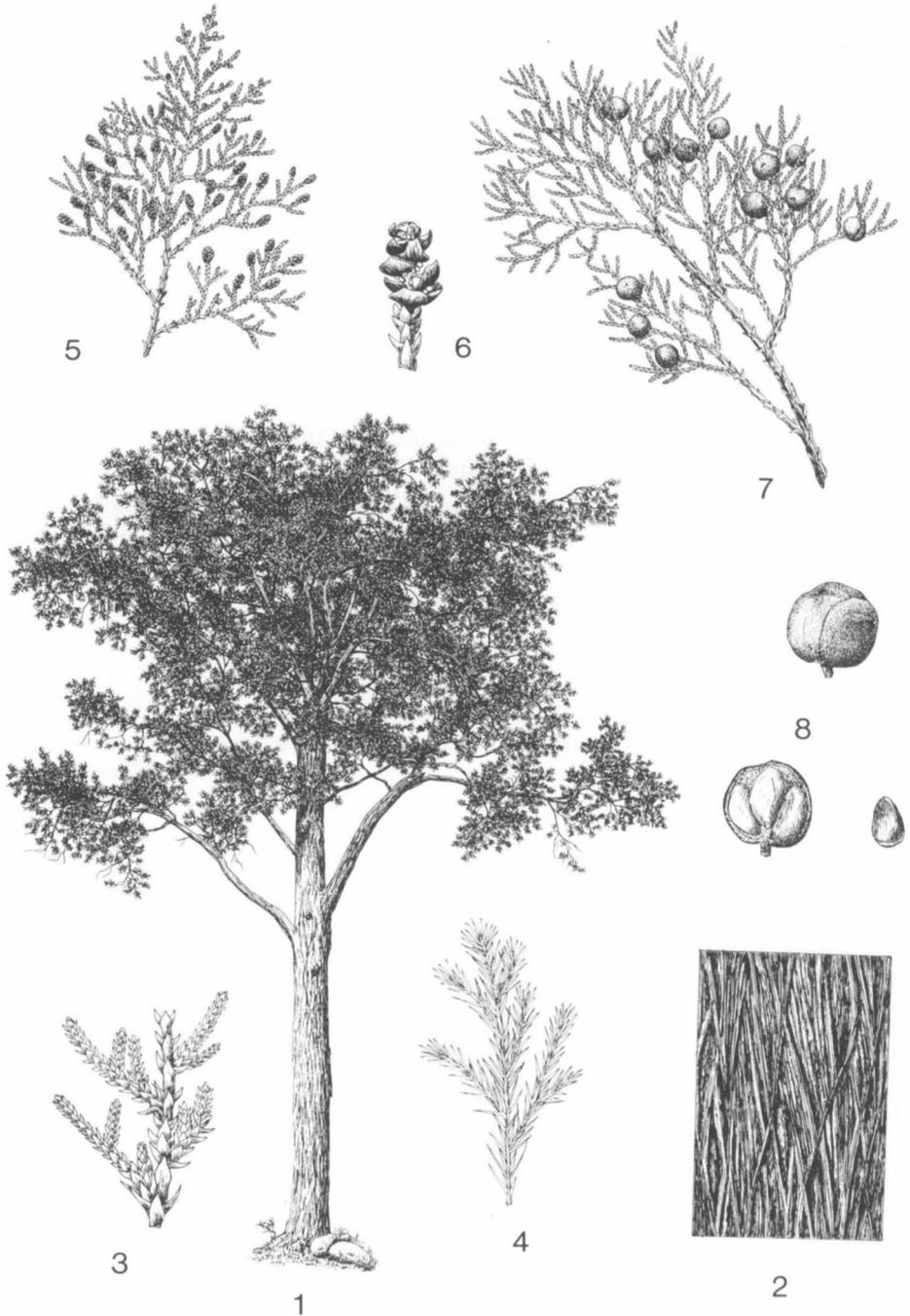


FIG. 4. *Juniperus procera* Hochst. ex Endl. 1, tree, Kenya; 2, bark (x 0.05); 3, ultimate branchlet with scale leaves (x 2.5); branchlet with juvenile leaves (x 0.5); 5, branchlet with male strobili (x 0.5); 6, male strobilus (x 2.5); 7, branchlet with cones (x 0.5); 8, cone, with seeds (x 1.5). 1, 2 from Dale & Greenway, 1961; 3, 5, 6 from de Wilde & de Wilde-Duijffes 8050; 4 from Dale 498; 7, 8 from Greenway & Kanuri 12469.

Sabina procera (Hochst. ex Endl.) Ant., Cupress.-Gatt.: 36, t. 47 (1857).

G. H. W. Schimper's collections have been distributed among several herbaria (Holmgren et al., 1990). Endlicher (1847) cites 'Schimper n. 537' from Hochstetter's second listing of plants collected by Schimper in Ethiopia and remarks that the specimen had no 'fruits'. Endlicher worked at W, where I was unable to find any Schimper collections: they were probably destroyed in a World War II bombing raid (H. Riedl, pers. comm.). There are two sheets of *Schimper 537* at L, the one with pollen cones and mature leaves is here designated as the lectotype.

Habit: tree, max. height 30–40m, d.b.h. 1.5m, usually monopodial, exposed trees sometimes multistemmed or branching very low; branches of first order thick and long, ascending and crooked in old trees; branches of higher orders assurgent in young trees, but spreading and finally pendulous in old trees; crown pyramidal in young trees, mature trees soon broad, irregular and open, domed or flat-topped in savannahs and on windswept sites; bark at first smooth, very soon with papery flakes, purplish, on older trees fibrous, deeply longitudinally furrowed, peeling in long, narrow strips, pale brown or grey-brown. **Foliage:** branchlets in dorsiventral sprays (young trees) or more irregular, ultimate branchlets sometimes pinnately arranged, slender, quadrangular, 0.6–1mm diam., orange, but covered by light green leaves. **Leaves:** juvenile leaves ternate or more or less decussate but remote, on seedlings and young trees, rarely on mature trees (but returning on coppiced trees!), acicular, widest at base, keeled, acute to pungent, 8–10 x 1mm, epistomatic; mature leaves scale-like, decussate, imbricate, appressed at base only, (ob)lanceolate on older branchlets, up to 6mm long, on ultimate branchlets triangular, 0.5–1mm long, acute, incurved but with free apices, margins entire; scale leaves amphistomatic, stomata in 2 or more inconspicuous tapering lines; glands linear-elliptic, conspicuous and active; a single resin cavity in each leaf; colour light green or yellowish-green. **Male strobili:** numerous on ultimate branchlets, solitary, terminal or subterminal, 3–5 x 2–3mm, greenish, turning orange-brown; microsporophylls 10–12, peltate, with round, denticulate margins, bearing 2–3 pollen sacs. **Female cones:** solitary, subterminal and axillary on ultimate branchlets, sessile or short pedunculate; young strobili stellate-spheroid, c.2mm diam., bluish-green; mature cones globose, 3–7mm diam., smooth, waxy, brown to purplish-black, bluish or pruinose; seed scales 4(–6), decussate, entirely fused, the two meeting at the distal pole the largest (2–5mm long), with the bract entirely fused except for a minute dorsal triangular umbo (0.3mm), interior of scales more or less woody, yellow. **Seeds:** ovules 1–2 per fertile scale; seeds (1–)2–3(–4), angular-ovoid, 4–5 x 3–3.5mm in largest cones, yellowish-brown.

In NE Sudan near the Red Sea, in the Ethiopian Highlands, in Djibouti, Somalia, Kenya, Uganda, Tanzania, in extreme eastern Zaire (Haut Katanga), Malawi and northeastern Zimbabwe; apparently also in the mountains alongside the shore of the Red Sea in Saudi Arabia and Yemen (Kerfoot, 1964, 1966; recent collections seen by Adams and Farjon).

Selected collections (27).

ETHIOPIA. Simien (Amhara), Adda Mariam, near Enschedcap, 6 vii 1838, *G. H. W. Schimper* 537 (lecto. L); Habab, viii 1872, *J. M. Hildebrandt* 327 (L); Eritrea-Amasen, Caramy, 3 xi 1902, *A. Pappi* 1617 (L, U, W); near Lake T'ana, Kebrá Uddüs Gabriel, 4 ii 1937, *R. Pichi-Sermolli* 18 (W); road to Kulubi, 23 and 40km from Alemaya, 2260m, s. dat., *E. Westphal & J. M. C. Westphal-Stevels* 829, 1033 (BR); road from Dire Dana to Harar, 1600m, 2 i 1969, *J. J. F. E. de Wilde* 4338 (BR); Mt Cilalo, near Acella, 2000m, 10 ix 1965, *W. J. J. O. de Wilde & B. E. E. de Wilde-Duyffes* 8050 (BR, U, WAG); Addis-Abeba-Harar highway, betw. Hima and Deder, 2500m, 15 viii 1974, *J. J. Bos* 8313 (WAG); Harar Prov., Alemaya, 1950m, 1 i 1975, *J. J. Bos* 9659 (WAG).

KENYA. Nyanza Prov., Londiani Distr., Tinderet Forest Res., 2260m, 14 vi 1949, *R. A. Maas Geesteranus* 4930 (L, U); Rift Valley Prov., Nakuru Distr., 2750m, 28 viii 1949, *R. A. Maas Geesteranus* 5953 (L); NE Mt Kenya, 3 ix 1949, *F. White* 1312 (W); Ku-Meru Distr., Timau-Nanyuki road, 2100m, 25 vi 1974, *R. B. & A. J. Faden* 74/862 (WAG); Mt Elgon, Kassawai Gate, 2330m, 9 ii 1979, *P. Bamps* 6511 (BR).

MALAWI. Rumphu Distr. Nyika Plateau, 2250m, 11 viii 1946, *L. J. Brass* 17159 (L); Rumphu Distr., Nyika N. P., Juniper Forest Reserve, 2200m, 11 ix 1976, *J. Pawek* 11816 (WAG); *ibid.*, 2000m, 29 vii 1982, *J. D. Chapman* 6306 (BR).

SAUDI ARABIA. Taif, Al-Shafa highland, 30 i 1988, *A. A. Fayed* 1325 (B); around Abha, 28 x 1990, *H. A. Abulfatih* 1 (= *R. P. Adams* 6190, BAYLU).

TANZANIA. Kinga Mts, 1898-1900, *W. Goetze* 981 (L, ex B); Jekukuma River, Mt Meru, E slope, 2060m, 21 ii 1966, *P. J. Greenway & Kanuri* 12469 (BR); Amani, 6 iii 1979, *J. Grabner* 176 (W).

UGANDA. Mt Elgon, E of Sabei, 20 vii 1924, *J. D. Snowden* 930 (BR); s. loc., 1939, *I. R. Dale* 498 (BR); Karamoja Distr., Mt Moroto, 800m, 11 vi 1970, *A. B. Katende* 412 (BR).

ZIMBABWE. Inyanga Distr., Nyakokwe Hill, Van Niekerk Ruins, 1525m, 23 x 1965, *H. Wils* 7462 (BR).

Juniperus procera occurs in the mountainous regions and highlands of East Africa. Its occurrence on the eastern coast of the Red Sea on the Arabian Peninsula (Kerfoot, 1964, 1966). This distribution coincides largely with the Eritreo-Arabian Subregion of Takhtajan (1986). The southernmost occurrence of the genus is in the Inyanga Mountains of Zimbabwe (Kerfoot, 1966), but it is represented by a single (protected) tree only (Coates Palgrave, 1990). Its altitudinal range in Africa is between 1050-3600m, it occurs most commonly between 1800-2700m (Wilson, 1927, Dale & Greenway, 1961, Bader, 1965, Hall, 1984). Rainfall is the predominant factor determining growth and occurrence; in East Africa it is most luxuriant where the rainfall averages 1000-1200mm annually (Wilson, 1927, Eggeling, 1952, Kerfoot, 1964, Hall, 1984). Stunted trees are still found in savannahs with annual precipitation of only 400mm. There is a dry season of at least five months duration (Hall, 1984). Conditions on the Arabian Peninsula are similar, but there is a more pronounced Mediterranean element in the pattern of moisture distribution: most rain falls in the cold season. *J. procera* is mostly a constituent of open evergreen sclerophyllous mountain forest, forming pure stands or more commonly mixtures with *Podocarpus gracilior* and with angiosperms (*Olea*, *Nuxia*, *Erythrina*, *Agauria* (tall Ericaceae), *Afrocrania volkensii*, *Cussonia spicata*, *Xymalos monospora* etc.). The broadleaf species become more dominant with increasing precipitation levels and above 1300mm annual rainfall *Juniperus* is usually absent.

The affinity with *J. excelsa*, first expressed by Endlicher (1847), was emphasized by Exell & Wild (1960) in *Flora Zambesiaca* where they suggested *J. procera* to be a

variety of that species, but retained its specific status. Kerfoot, who at first accepted it as a species (Kerfoot, 1961, 1964, 1966) has subsequently expressed the opinion that it is conspecific with *J. excelsa* s.l. (Kerfoot, 1975, Kerfoot & Lavranos, 1984), but no taxonomic treatment to that effect has yet been published. (Kerfoot at first referred to the populations on the eastern coast of the Red Sea as *J. procera*; subsequently he called them *J. excelsa*. The collections cited above from Abha and Taif in Saudi Arabia belong to *J. procera*). All local or regional flora's have treated *J. procera* as a species (e.g. Eggeling, 1952, Exell & Wild, 1960, Dale & Greenway, 1961, Coates Palgrave, 1990). Recently, Adams (1990) has shown convincingly that also on chemotaxonomic grounds *J. procera* should be regarded as a separate species. Its smaller cones with fewer seeds, as well as its more acute leaves are differential morphological characters, which are remarkably constant throughout its range. Phytogeographically it is well separated and a migration by way of the western mountains of the Arabian Peninsula into Africa during the Miocene-Pliocene (Kerfoot, 1975) is possible but not substantiated by the incomplete fossil record.

Juniperus semiglobosa Regel, Trudy Imp. S.-Peterburgsk. Bot. Sada 6 (2): 487–488 (1879). Type: Tadzhiqistan, Zeravshanskiy Khrebet, Saratag Pass, Isfara, 19 vi 1871, O. A. Fedtschenko s.n. (specimen top left on sheet with 3 Fedtschenko collections of this taxon) (lecto. LE!, designated here). **Figs 5, 6.**

Syn.: *Juniperus talassica* Lipsky, in O. E. Knorring & Z. A. Minkvich, Rastit. Aulie-Atinsk. u. s. Dar'inskoi obl./Travaux d'expedition pour exploration des regions de Colonisation Russe 2. Explor. bot. 1909, 6: 185–186, pl. (1912). Type: Kirgiztan, Karagoin Pass 1909, Z. A. von Minkwitz 1351 (iso. LE!).

Juniperus jarkendensis Komarov, Bot. Mater. Gerb. Glavn. Bot. Sada RSFSR 4: 181 (1923). Type: not located.

Juniperus schugnanica Komarov, Bot. Zurn. SSSR 17: 482 (1932). Type: Tadzhiqistan, Shugnanskiy Khrebet, 30 vii 1904, B. A. Fedtschenko s.n. (lecto. LE!, designated here). See note below.

Juniperus excelsa auct., non M.-Bieb.: Wallich, Cat. 6041 (1832); Brandis, Forest fl. NW India: 538 (1874); Nasir & Nasir, Fl. Pakistan: 20 (1987), quoad pl. himalaicae.

Juniperus macropoda auct., non Boiss.: Hooker f., Fl. Brit. India 5: 647 (1890); Rushton, J. Linn. Soc., Bot. 43 (288): 1–13, pl. 1 (1915); Gaussen, Gymn. act. fossil. 10: 166, ill. p. 171 (1968); Gamble, Man. Ind. Timbers: 412 (p. p., excl. pl. baluchistanae) (1881, repr. 1972: 698); Mehra, Nucleus 19(2): 135, f. 27A–B (1976); Jain, Indian Forester 102 (3): 109–118, table 2, f. 1.4 (1976); Polunin & Stainton, Fl. Himal.: 390, f. 2 (p. 512) (1988); Stainton, Fl. Himal. suppl.: 60, pl. 509 (p. 111) (1988); Sahni, Gymnos. India & Adj. Countries: 98, pl. 23, f. 2 (pro syn.) (1990).



FIG. 5. *Juniperus semiglobosa* Regel. 1, tree, Lahul, India; 2, branchlet with cones (x 0.5); 3, 4, leaves (x 2); 5, male strobili (x 2); 6 cone (x 2.5); 7, cones, one with partly removed scales to expose seeds (as *J. semiglobosa* from Kirgizstan) (x 1.5); 8, idem, with seed (as *J. macropoda* from Lahul, India) (x 1.5). 1 from Stainton, 1988; 2 from Visser-Hooft 36; 3, 4 from O. Polunin 6326; 5 from Anonymus F 257; 6, from Lace 1680; 7, from Vasák s.n.; 8 from Cooper 5365.

Regel (1879: 488) mentioned several collections with his new species, for this reason a lectotype is designated here.

Habit: tree, occasionally a shrub at tree line, max. height 10–20m, d.b.h. 1–2m, usually monopodial, but sometimes multistemmed; branches of first order long, spreading or ascending, in young trees nearly erect; branches of higher orders dense, spreading, from assurgent in young trees to somewhat pendulous in old trees; crown (broad) pyramidal or irregular, open or rather dense; bark of young plants and on branches at first smooth, soon with grey papery flakes, reddish-brown, on old trees fibrous, longitudinally furrowed, peeling off in long strips, reddish-brown to grey-brown. **Foliage:** branchlets in more or less compact, irregular, often intricate and pendulous sprays; ultimate branchlets numerous but more or less remote, entirely covered with leaves, terete or weakly quadrangular, quite long and thick, 1–2mm diam.; older branchlets purplish with grey flakes and leaf remnants. **Leaves:** juvenile leaves on seedlings and on lower branches of many trees, ternate, acicular, widest at base, pungent, 8–10 x 1mm, epistomatic; mature leaves predominating on old trees, ternate or decussate, scale-like, imbricate, appressed, incurved at apex, rhombic or triangular, 1–2mm long on ultimate branchlets, decurrent, (ob)lanceolate-acute and much longer (–9mm) on older shoots, with entire margins; scale leaves amphistomatic, stomata in 2 inconspicuous lines from base to apex; glands large and conspicuous, active, elliptic, often depressed; resin cavity single; colour light green to yellowish-green, lustrous from thick cuticula. **Male strobili:** numerous on ultimate branchlets, solitary, terminal or subterminal, 3–5 x 2–4mm, greenish, turning yellowish; microsporophylls 8–10, peltate, with rounded, thin margins, each bearing 3–4 pollen sacs. **Female cones:** solitary, terminal or subterminal on ultimate branchlets, axillary, sessile; young strobili stellate-spheroid, 2–3mm diam., dark green; mature cones subglobose to triangular, usually irregular and rarely globose, 4–8mm wide, 4–6mm high, fleshy, soft or rather hard (in sicco) light brown to blackish-blue, often pruinose; seed scales 4(–6), entirely fused, 3–6mm long, the two meeting at the distal pole the largest, smooth, waxy, often wrinkled when dried, with a dorsal, minute umbo being the apex of the fused bract (0.3–0.5mm); interior of scales resinous, fleshy, yellowish-green. **Seeds:** ovules 1–2 per fertile scale; seeds (1–)2–3(–4), mostly 2, with apices diverging, angular, broadest at base, more or less ovoid or conical, 3–6 x 2–4.5mm, yellowish to reddish-brown.

In the high mountains of west-central Asia: Kirgizstan, Kazakhstan near Chimkent, Uzbekistan, Tadzikistan, NE Afghanistan (Hindu Kush), in Pakistan and India along the Karakoram Range into Kashmir and along the NW Himalaya as far as Garhwal; across the border from Kashmir a single(?) location in the Kunlun Shan of China (Browicz & Zielinski, 1982).

Selected collections (36).

AFGHANISTAN. Nuristan, Shtive, 2700m, 16 vi 1948, *L. Edelberg* 1034 (as *J. excelsa* in *Fl. Iran.* 50: 6, 1968) (W); Mt Salang, 2200m, 1 vii 1965, *K. H. Rechinger* 31627 (as *J. excelsa* in *Fl. Iran.* 50: 6, 1968) (W).

INDIA. Garhwal, pro 1869, *H. Falconer* 992 (as *J. excelsa*) (L); Bashakr State, Rarang forest, 3000m, 11 viii 1890, *J. H. Lace* 505, 506 (as *J. macropoda*) (E); Chamba State, Triloknath, Pangi, 2400–3650m, 19 ix 1896, *J. H. Lace* 1680 (as *J. macropoda*) (E); Himachal Pradesh,

Lahul, Keylong, 3650m, 11 viii 1916, *R. E. Cooper* 5365 (as *J. macropoda*) (E); *ibid.*, 6–8 viii 1971, *U. C. Bhattacharyya* 45136, 45180 (as *J. polycarpus*) (L); Umlung, Thalam-buti Valley, 4200m, 28 vii 1929, *J. Visser-Hooft* 58 (as *J. macropoda*) (U); Himachal Pradesh, Lahul, Miyah Nullah, 2700m, 7 viii 1984, *R. J. D. McBeath* 1638 (as *J. macropoda*) (E).

KAZAKHSTAN. Talasskij Ala-tau, 1700m, 14 viii 1946, *B. A. Mishkin* s.n. (as *J. seravschanica*) (W); Talasskij Ala-tau, Tjulkuba Region, 27 vi 1965, *Z. Ajzjorova* s.n. (W).

KIRGIZSTAN. Sir-Darin Oblast, Talasskij Ala-tau, Karagoin Pass, 1909, *Z. A. von Minkwitz* 1351 (isotype of *J. talassica* Lipsky, LE); Tian Shan, Chatkalskij Khrebet, Mt Chimgan, 1800–2900m, 20 vii 1973, *V. Vasák* s.n. (as *J. seravschanica*) (W).

PAKISTAN. Karakoram Range, Hunza, near Sóspor Glacier, 16 vii 1856, *R. von Schlagintweit* 6003 (as *J. religiosa* hort.) (L); Karakoram Range, NW of Astor (Hasóra), 13–24 ix 1856, *R. von Schlagintweit* 6202 (as *J. excelsa*) (L), 6858 (as *J. macropoda*) (WU); Karakoram Range, Baltistan, Marfu Nullah, 3500m, 5 vii 1892, *J. F. Duthie* 11853 (as *J. macropoda*) (WU); Karakoram Range, Hunza-Nagar area, 2800m, sine dat., *H. K. Paffen* 21 (as *J. religiosa* hort.) (W); Karakoram Range, Bara Khun Valley, 3500m, 18 vi 1925, *J. Visser-Hooft* 36 (as *J. macropoda*) (U); Karakoram Range, Baltistan, Ghondakoro Glacier Basin, 3350m, 22 vii 1955, *G. L. Webster & E. Nasir* 6259 (as *J. polycarpus*) (W); Karakoram Range, Hunza-Nagar area, 2600–3000m, 1959, *F. Loblichler* 203, 241, 428 (as *J. religiosa* hort.) (W); Karakoram Range, Nagar State, near Hispar, 3950m, 20 viii 1960, *O. Polunin* 6326 (as *J. macropoda*) (E); Karakoram Range, near Kondus Glacier, 3500–4200m, vi 1961, *W. Axt* s.n. (as *J. polycarpus*) (W); Karakoram Range, Baltistan, Braldo Valley, 3800m, 20 x 1962, *E. Reiser* 1 (as *J. polycarpus*) (L); *ibid.*, E of Kande, 3600m, *Österreichische Karakorumexpedition 1970* 1041 (as *J. polycarpus*) (W); Karakoram Range, Gilgit, Yasin Valley, 3500m, 25 vii–1 viii 1975, *L. & P. Baumgartner* s.n. (as *J. polycarpus*) (W).

TADZHIKISTAN. Zeravshanskiy Khrebet, Saratag Pass, Isfara, 19 vi 1871, *O. Fedtschenko* s.n. (lectotype of *J. semiglobosa* Regel, LE); *ibid.*, Kuli-kalan, 2900m, 25 vi 1870, *O. Fedtschenko* s.n. (paralectotype of *J. semiglobosa* Regel, LE); Kokanskoje, between Karakasuk and Schagimardan, 11 vii 1871, *O. Fedtschenko* s.n. (paralectotype of *J. semiglobosa* Regel, LE); Pamirs, Shugnanskiy Khrebet, Schitcharf River, 30 vii 1904, *B. A. Fedtschenko* s.n. (lectotype of *J. schugnanica* Komarov, LE); Pamirs, Badakhshan, 3000m, 9 vii 1964, *G. Ladygina* et al. 13168 (W); Pamirs, Badakhshan, Darrah-i-Parskui, 3800m, 16 vii 1965, *Anonymus* F 257 (W).

Juniperus semiglobosa occurs in the semi-arid high valleys of the great web of mountain ranges in Central Asia, which radiate from the Pamirs in all directions. It reaches a greater altitude than the other species discussed here: from c.1600m in the north of its range to 4300m in the Karakoram Range. To the SE of the Hindu Kush it is rarely found below 2500m. It is extremely tolerant of drought and heat, but at the same time it must be resistant to frost at any time of the year at the higher altitudes. The cuticula appears to be thicker than in any of the related species and gives the leaves their glossy appearance. In the north it rarely attains a height of more than 8–10m, but in the Himalaya, e.g. in Lahul, larger trees of 15–20m are to be found. Near the tree line stunted specimens occur, but it does not attain a prostrate habit like *J. excelsa* subsp. *polycarpus*, with which it is in part sympatric. Precipitation is usually less than 400mm annually, much of it comes as snow. This species is likely to take advantage of snowmelt supplies from alpine and nival zones above it, where a much higher snowfall ensures a more or less constant availability of moisture. It grows on various rocky soils, moraines, stony slopes or even in crevices of bare rock. *J. semiglobosa* occurs across two Floristic Provinces of the Irano-Turanian Floristic Region (cf. Takhtajan, 1986). In the Turkessian Province it may form pure stands or mixtures with *J. excelsa* subsp. *polycarpus* (especially in NE Afghanistan) and *J. turkestanica* (Pamirs and Tian Shan). In more

moist conditions *Betula*, *Populus* and *Sorbus* mix with the Junipers. In the Western Himalayan Province, a monsoon influence is present and it is more often associated with other conifers, especially *Cedrus deodara*, or it forms pure groves.

Browicz & Zielinski (1982) point out that the limits of the range of *J. semiglobosa* to the north and west are well established, but that the distribution of this species to the south and east 'still require(s) further study', without indicating the reasons for this uncertainty. One of the important conclusions of the present study is, that the arborescent Junipers in the Western Himalaya and Karakoram Range have been generally misidentified, mostly as *J. macropoda* Boiss., sometimes as *J. excelsa* M.-Bieb. or *J. polycarpus* K. Koch (in sched.; Sahni, 1990) and a few times as *J. religiosa* Carrière, the latter a nom. hort. (not *J. religiosa* Royle, nom. nud. = *J. recurva*). All collections I have seen from there belong to *J. semiglobosa*. Authors like Gaussen (1968), Jain (1976), Mehra (1976), Polunin & Stainton (1988) and Sahni (1990) give illustrations which show the typical terete foliage and subglobose, sometimes almost bilobed cones of this species. Their treatments of this Juniper under *J. macropoda* Boiss. (pro syn.) make it clear that neither of them have ever seen Boissier's syntypes (from Iran and Oman), which have quadrangular ultimate branchlets and perfectly globose, multiseeded cones. The confusion with *J. excelsa* may originate with Wallich (1832), and especially with Brandis (1874), who described from the 'Arid tract of the NW Himalaya and W Tibet,...Kashmir,...on the upper Indus and its tributaries, and at the headwaters of several feeders of the Ganges.' a Juniper with 'berries...subglobose' under this name, which is none other than *J. semiglobosa* Regel. Hooker (1888) equalled *J. excelsa* sensu Brandis erroneously with *J. macropoda* Boiss., expressing doubt as to its distinctness from *J. excelsa*. Jain (1976) was right in pointing out the taxonomic distinctness of the two, but fell into a nomenclatural trap because of his failure to verify Boissier's types. His 'citation' from Boissier is an incorrect interpretation of what Boissier stated under *J. macropoda* regarding Himalayan plants: 'Planta regionis Himalaicae cujus amenta non vidi ex distrib. geographica huc potius quam ad *J. excelsam* probaliter spectat.' (Boissier, 1884: 709).

In the Russian literature a number of species were described from the mountains of Central Asia, which appear to be so close to *J. semiglobosa*, that a separate taxonomic treatment seems unwarranted.

The descriptions given of *J. talassica* Lipsky by Komarov (1932, 1934) and Fedtschenko (1924) (protologue not seen) indicate synonymy with *J. semiglobosa*. The type collection: von Minkwitz 1351 from Kirgizstan (iso. LE!) has numerous fleshy, dark blue, pruinose, (sub-)globose cones with 2-4 apically divergent (paired) seeds characteristic of *J. semiglobosa*; the foliage is likewise similar. The 'important economic character' of a higher sugar content seems to me insufficient to recognize it as a species, while other characters given to differentiate it: *cones on longer slender branchlets, globose, seeds darker*, are to be found within the range of variability of *J. semiglobosa* observed in this study.

Juniperus jarkendensis Komarov (1923) was described in a paper entitled: *De Gymnospermis nonnullis asiaticis*, but it was never mentioned again (not even in synonymy)

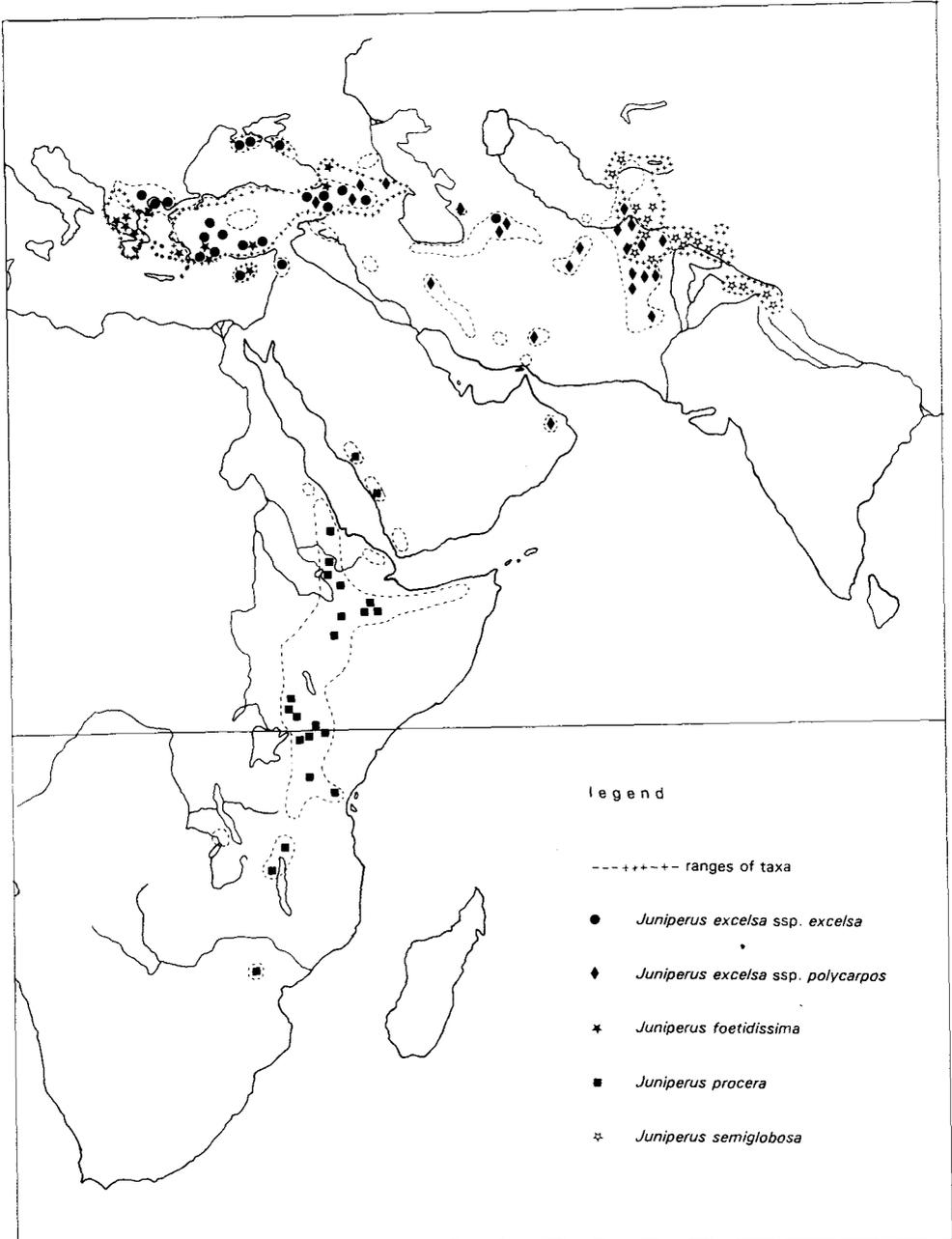


FIG. 6. Distribution of 5 taxa in *Juniperus* sect. *Sabina*: *J. excelsa* subsp. *excelsa*; *J. excelsa* subsp. *polycarpus*; *J. foetidissima*; *J. procera*; *J. semiglobosa*. Ranges are outlined, and locations verified by collections seen are indicated with symbols.

in enumerations of Asiatic Junipers by the same author (Komarov, 1932, 1934). Its description differs little from that of *J. semiglobosa* given by Komarov: it has 3 seeds per cone (instead of 4) and these are 'suborbicular and rugose'. The number of seeds falls within the range of 1–4 observed in *J. semiglobosa* when sufficient collections are studied; their shape is related to that number. At LE no specimens were found under his name.

Juniperus schugnanica Komarov, as described by its author (Komarov, 1932, 1934) from the Shugnanskiy Khrebet (Pamirs), does not differ from *J. semiglobosa*. Especially the 2–4 apically divergent seeds described in both taxa are typical for this species (see Fig. 5). Komarov's key (1934: 178–179) makes it clear that *J. talassica* shares this character as well; it is the primary cause of the semiglobose to subglobose ('hemispherical') shape of the cones. No other character than the "rather short" branchlets then remains to distinguish *J. schugnanica*, a variation observed in several specimens from the entire range of *J. semiglobosa* as given above. *B. A. Fedtschenko* s.n. (iter turketicum 1904), 30 vii 1904, from the Schitcharf River, Shugnanskiy Khrebet (Pamirs) in Tadzhikistan, is designated as the lectotype of *J. schugnanica* Komarov (LE!).

Species dubia:

Juniperus drobovii Sumnevicz, Bot. Mater. Gerb. Inst. Bot. Zool. Akad. Nauk Uzbeksk. SSR 10: 22 (1948).

Juniperus tianschanica Sumnevicz, Bot. Mater. Gerb. Inst. Bot. Zool. Akad. Nauk Uzbeksk. SSR 10: 24 (1948).

Sumnevicz (1948) described the above two new species from the mountainous areas of Uzbekistan to the east of Tashkent. *J. drobovii* is described with rather slender ultimate branchlets: 0.5–1mm; otherwise it is entirely similar to *J. semiglobosa*, especially the 'semiglobose' cones with 'truncate-emarginate apices', broader than long, containing '2–3 apically recurved' seeds giving the cone its bilobed shape. It was collected in the western Tian Shan in the Angren River valley. Sumnevicz (1948) enumerates very slight differences with *J. semiglobosa*, most of which turn out to be present in several collections of the latter species here examined, such as truncate-emarginate (versus truncate) cone apices in some material from the Karakoram. He does not mention the relative thinness of the branchlets of his species and it is doubtful if his measurement is indeed correct. *J. tianschanica* is almost similarly described (with likewise slender branchlets 0.5–1mm), but has 'subglobose, not semiglobose' ovuliferous cones. Its measurements of the seeds (5–6 × 4–5mm) are said to be larger than those of *J. semiglobosa* (and *J. talassica* Lipsky), but fall again within the variations of collections here studied. It was found at Sarytschilek in the western Tian Shan. Both taxa are probably best treated as synonyms of *J. semiglobosa* Regel; I did not succeed to obtain the type material, kept at TASH, on loan for study.

CONCLUSION

The four species and one subspecies of arborescent multiseed Junipers of section *Sabina* retained in this study occupy largely allopatric ranges. *Juniperus excelsa* subsp. *excelsa* and *J. foetidissima*, however, are sympatric for most of their ranges (Fig. 6). Ecologically, the distribution of the species can be explained in terms of adaptation to arid, continental climate. In Eurasia, an increased adaptation to continentality can be observed through the taxa *J. excelsa* subsp. *excelsa*, *J. foetidissima*, *J. excelsa* subsp. *polycarpus* and *J. semiglobosa*. The more equatorial distribution of *J. procera* ensures a less extreme range of seasonal temperatures, as well as a climate where more moisture is generally available. The distribution of at least two species is also generally connected with major orogenetic events. The East African distribution of *J. procera* concurs largely with the volcanic uplands adjacent to and associated with the Great Rift systems, along which this species has reached 18° 08' S. *J. semiglobosa*, the most distinct species taxonomically, is a true high altitude species of the mountains in Central Asia. While it crosses a relatively important floristic barrier to the SE, its limit in that direction is nevertheless climatically determined. Increased precipitation levels prevent its eastward expansion, which may be of relatively recent date connected with the rapid uplift of the Karakoram Range (1500m since the last ice age and still in progress); it is not known from Nepal. For the most part, the geographical ranges found for the taxa here recognized coincide well with the floristic (sub-)regions and provinces as defined by Takhtajan (1986). The taxa can be keyed out as follows:

1. Mature female cones fleshy, more or less soft, subglobose-triangular with (1-)2-3(-4) seeds diverging apically; ultimate branchlets 1-2mm diam., (sub-)terete; scale leaves completely appressed, with thick cuticuli, lustrous
J. semiglobosa
- + Mature female cones more or less woody, hard, globose, with 1-6(-8) seeds usually converging apically; ultimate branchlets more or less quadrangular; scale leaves appressed or with free apices _____ 2
2. Seeds (2-)3-6(-8) per cone _____ 3
- + Seeds 1-3(-4) per cone _____ 4
3. Ultimate branchlets slender to very fine, 0.7-1mm diam., often disposed in dorsiventral sprays; scale leaves very small, on ultimate branchlets 0.6-1.1mm long, appressed; female cones 6-11mm diam _____ **J. excelsa subsp. excelsa**
- + Ultimate branchlets coarser, thicker, 1-1.3mm diam., more irregularly disposed; scale leaves larger, on ultimate branchlets 1.2-1.6mm long, appressed or sometimes free at apex; female cones 6-14mm diam **J. excelsa subsp. polycarpus**
4. Ultimate branchlets slender to very fine, 0.6-1mm diam., scale leaves very small, on ultimate branchlets 0.5-1mm long, triangular, with free apices; female cones 3-7mm diam., with (1-)2-3(-4) seeds per cone _____ **J. procera**
- + Ultimate branchlets coarse, 1.2-2mm diam., scale leaves larger, on ultimate branchlets 2-3mm long, often with recurved apices; female cones 5-13mm diam., with 1-2(-3) connate seeds per cone _____ **J. foetidissima**

From this study of the arborescent, multiseed Junipers of section *Sabina* in Southwest Asia and East Africa a few final observations, some concerning earlier work on the subject, may be made. Foremost, it seems to me, is that virtually all of the previous reviews were hampered by an a priori limitation of the geographical area considered. It seems not far-fetched to conclude that political boundaries influenced taxonomy in several cases. Floristic work is geographically limited by definition, but taxonomic work should not be restricted to a certain country or region a priori. By first defining a taxonomic group, the geography follows from the assessment of its constituent OTU's. Because *J. procera* is by all accounts closely related to *J. excelsa*, East Africa became part of the region studied. Secondly, lack of reference to types and protologues has added to the nomenclatural confusion and the profusion of names. With the type method (ICBN Art. 7) being of relatively recent date, typification of older names is admittedly difficult, but a number of modern reviews and revisions here discussed have made no attempts at it. Herbarium collections of Junipers generally retain their morphological characters relatively unaltered and are easily made of all relevant parts of the tree. Yet, several relevant characters (e.g. leaf anatomy, chemistry) are difficult or impossible to evaluate from exsiccata. Study of these features may reveal differences and affinities I have failed to observe. They should, however, be compared from a range of specimens as comprehensive as possible.

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REFERENCES

- ADAMS, R. P. (1990). *Juniperus procera* of East Africa: Volatile leaf oil composition and putative relationship to *J. excelsa*. *Biochem. Syst. Ecol.* 18 (4): 207–210.
- ___ & HOGGE, L. (1983). Chemosystematic studies of the Caribbean junipers based on their volatile oils. *Biochem. Syst. Ecol.* 11 (2): 85–89.
- ___, ZANONI, T. A., RUDLOFF, E. VON & HOGGE, L. (1981). The Southwestern USA and Northern Mexico One-seeded Junipers: their volatile oils and evolution. *Biochem. Syst. Ecol.* 9 (2/3): 93–96.
- ANTOINE, F. (1857). *Die Cupressineen-Gattungen: Arceuthos, Juniperus und Sabina*. Froedr. Berck'schen Univ., Wien.

- BADER, F. J. W. (1965). Some boreal and subantarctic elements in the flora of the high mountains of tropical Africa and their relation to other intertropical continents. *Webbia* 19 (2): 531–544.
- BOISSIER, P. E. (1884). *Flora orientalis sive enumeratio plantarum in Oriente a Graecia et Aegypto ad Indiae fines hucusque observatarum*. Vol. 5, Part 2: Ordo CXLII. Coniferae, 693–713. Basel, Geneva.
- BRANDIS, D. (1874). *The Forest Flora of North-west And Central India: a handbook of the indigenous trees and shrubs of those countries*. London.
- BROWICZ, K. & ZIELINSKY, J. (1982). *Chorology of Trees and shrubs in South-west Asia and Adjacent Regions*. Vol. 1. Poznan.
- CHENG, W. C. & FU, L. K. (eds.) (1978). *Flora Reipublicae Popularis Sinicae*. Tomus 7: Gymnospermae. Academia Sinica, Beijing.
- COATES PALGRAVE, K. (1990). *Trees of Southern Africa*. Ed. 2, Cape Town.
- COODE, M. J. E. & CULLEN, J. (1965). Gymnospermae in Davis, P. H. (ed.) *Flora of Turkey and the East Aegean Islands*. Vol. 1, 67–85. Edinburgh
- DALE, I. R. & GREENWAY, P. J. (1961). *Kenya Trees and Shrubs*. Nairobi, London.
- DEN OUDEN, P. & BOOM, B. K. (1965). *Manual of Cultivated Conifers, hardy in the cold- and warm-temperate zone*. The Hague.
- EDMONDSON, J. R. & LACK, H. W. (1977). The Turkish and Caucasian collections of C. Koch I: Turkey. *Notes RBG Edinb.* 35 (3): 321–344.
- EGGELING, W. J. (1952). *The Indigenous Trees of the Uganda Protectorate*. Entebbe, London.
- ENDLICHER, S. L. (1847). *Synopsis Coniferarum*. Sankt – Gallen.
- EXELL, A. W. & WILD, H. (1960). *Flora Zambesiaca*. Vol. 1, Part 1. London.
- FEDTSCHENKO, B. A., POPOV, M. G. & SHISHKIN, B. K. (eds.) (1932). *Flora Turkmenii*. Vol. 1. Leningrad.
- FEDTSCHENKO, O. A. & FEDTSCHENKO, B. A. (1924). Conspectus florum Turkestanicae et Kirghisicae I. *Trudy Imp. S.-Peterburgsk Bot. Sada* 38 (1): 40 (*J. talassica* Lipsky).
- FLORIN, C. R. (1931). Untersuchungen zur Stammesgeschichte der Coniferales und Cordaitales. Erster Teil: Morphologie und Epidermisstruktur der Assimilationsorgane bei den rezenten Koniferen. *Kongl. Svenska Vetenskapsakad. Handl.* 10 (1): 1–588, t. 1–58.
- FORMANEK, E. (1896). Zweiter Beitrag zur Flora von Serbien, Macedonien und Thessalien. *Verh. Naturf. Vereines Brünn* 34: 255–365.
- GAMBLE, J. S. (1881). *A Manual of Indian Timbers*. Dehra Dun (repr. of 2nd ed., 1972).
- GAUSSEN, H. (1968). Les Gymnospermes actuelles et fossiles. Fasc. 10: Les Cupressacées. *Trav. Lab. Forest. Toulouse*, T. 2, sect. 1, vol. 1, chap. 13: 1–326.
- GRISEBACH, A. H. R. (1846). *Spicilegium florum rumelicae et bithynicae...* Vol. 2. Braunschweig.
- HALL, J. B. (1984). *Juniperus excelsa* in Africa: a biogeographical study of an Afro-montane tree. *J. Biogeogr.* 11 (1): 47–61.

- HARRISON, S. G. (rev.), DALLIMORE, W. & JACKSON, A. B. (1966). *A Handbook of Coniferae and Ginkgoaceae*. Ed. 4, London.
- HOLMGREN, P. K., HOLMGREN, N. H., & BARNETT, L. C. (eds.) (1990). *Index Herbariorum. Part. I: The Herbaria of the World*. Ed. 8 (Regnum Veg. Vol. 120). New York.
- HOOKER, J. D. (1888). *Flora of British India*. Vol. 4. London.
- IMKHANITSKAYA, N. N. (1990). Taksonomicheskaya zametka o *Juniperus excelsa* (Cupressaceae) – The taxonomic note on *Juniperus excelsa* (Cupressaceae). *Bot. Zurn.* 75 (3): 402–409.
- JAIN, K. K. (1976). A taxonomic revision of the Himalayan Junipers. *Indian Forester* 102 (2): 109–118.
- KARSTEN, G. H. H. & SCHENK, H. (1904–44). *Vegetationsbilder*. Vols. 1–26. Jena.
- KAZMI, S. M. A. & JENAN, A. (1975). Useful plants of Pakistan: Part 1. Gymnosperms. *Sultania* 1: 5–55.
- KERFOOT, O. (1961). *Juniperus procera* Endl. (The African Pencil Cedar) in Africa and Arabia. 1. Taxonomic affinities and geographical distribution. *E. African Agric. Forest. J.* 26 (3): 170–177.
- (1964). The distribution and ecology of *Juniperus procera* Endl. in East Central Africa, and its relationship to the genus *Widdringtonia* Endl. *Kirkia* 4: 75–86.
- (1966). Distribution of the Coniferae: the Cupressaceae in Africa. *Nature* 212 (5065): 961.
- (1975). Origin and speciation of the Cupressaceae in Sub-Saharan Africa. *Boissiera* 24a: 145–150.
- & LAVRANOS, J. J. (1984). Studies in the flora of Arabia: 10. *Juniperus phoenicea* L. and *J. excelsa* M. Bieb. *Notes RBG Edinb.* 41:483–489.
- KITAMURA, S. (1960). *Flora of Afghanistan*. (Results of the Kyoto Univ. Sci. Exped. to the Karakoram and Hindukush, 1955, Vol. 2). Kyoto.
- KOCH, K. H. E. (1849). Beiträge zu einer Flora des Orientes. (Gymnospermae, Nacktsämmler. pp. 291–307). *Linnaea* 22: 177–464.
- KOMAROV, V. L. (1923). De Gymnospermis nonnullis asiaticis. *Bot. Mater. Gerb. Glavn. Bot. Sada RSFSR* 4: 177–181.
- (1932). Mnogosemyannye vidy archi v Srednei Azii - Sabinae polyspermae Asiae Mediae. *Bot. Zurn.* 17: 474–482.
- (ed.) (1934). *Flora SSSR*. Vol. 1. (Coniferales by V. L. Komarov, pp. 130–195). Izd. Akad. Nauk S.S.S.R., Leningrad. [also consulted: Komarov, V. L. (ed.) *Flora of the U.S.S.R.*, transl. 1968.].
- LACK, H. W. (1978). Das Herbar C. Koch. *Willdenowia* 8: 431–438.
- LIPSKY, V. I. (1912). Explorations botaniques 1909 (Travaux d'expédition pour exploration des régions de Colonisation Russe d'Asie; 2.) in O. E. Knorring & Z. A. Minkvich, *Rastit. Aulie-Atinsk. u. s. Dar'inskoi obl.* 6. Leningrad.
- MARSCHALL VON BIEBERSTEIN, F. A. (1800). *Beschreibung der Länder zwischen den Flüssen Terek und Kur am Caspischen Meere. Mit einem botanischen Anhang*. Frankfurt am Main.

- ___ (1808). *Flora taurico-caucasica exhibens stirpes phaenogamas...* Vol. 2. Khar-kov.
- MEDWEDEW, Y. S. (1903). (*Juniperus foetidissima* Willd. var. *squarrosa*, var. nov.) *Trudy Bot. Sada Imp. Jur' evsk. Univ.* 3: 229. (diagn. repr. in *Repert. Spec. Nov. Regni Veg.* 2 (14/15): 136, 1906).
- MEHRA, P. N. (1976). Conifers of the Himalayas with particular reference to the *Abies* and *Juniperus* complexes. *Nucleus* 19 (2): 123–139.
- NASIR, E. & NASIR, Y. J. (1987). Gymnospermae (Fam. Nos. 178–186). *Flora of Pakistan*. Islamabad.
- ORLOVA, S. Ya. & KERIMOV, Yu. B. (1982). Morfologo- anatomicheskie issledovaniya i tyazhelopakhuchego. *Juniperus polycarpus*, *J. foetidissima*. *Izv. Akad. Nauk Azerbajdzansk. SSR, Ser. Biol. Med. Nauk* 4: 12–19.
- PALLAS, P. S. (1789). *Flora rossica seu stirpium Imperii rossici par Europam et Asiam indigenarum descriptiones et icones*. Vol. 1, No. 2. St. Petersburg. (1788 on t. p.).
- PARLATORE, F. (1867). Coniferae. (Ordo CXCIX) in Candolle, A. P. de & Candolle, Alph. de *Prodromus systematis naturalis regni vegetabilis*. Vol. XVI–2, 361–521. Paris.
- POLUNIN, O. & STANTON, A. (1988). *Flowers of the Himalaya*. Delhi, Oxford.
- REGEL, E. A. VON (1879). Descriptiones plantarum novarum in regionibus Turkestanicis a cl. viris Fedjenko, Korolkow, Kuschakewicz et Krause collectis...No. 7. *Trudy Imp. S.-Peterburgsk. Bot. Sada* 6 (2): 287–538.
- RIEDL, H. (1968). Cupressaceae. In Rechinger, K. H. (ed.), *Flora Iranica*. Lfg./Cont. No. 50: 1–10. Graz.
- RUSHTON, W. (1915). Structure of the wood of Himalayan Junipers. *J. Linn. Soc., Bot.* 43 (288): 1–13.
- SAHNI, K. C. (1990). *Gymnosperms of India and adjacent countries*. Dehra Dun.
- SCHWARZ, O. (1934). *Juniperus excelsa* M.-Bieb. var. *depressa* var. nov. *Repert. Spec. Nov. Regni Veg.* 36: 66.
- SPACH, E. (1841). Révision des *Juniperus*. *Ann. Sci. Nat. Bot.*, sér. 2, 16: 282–305.
- ___ (1842). *Histoire naturelle des Végétaux*. Vol. 11. Phanérogames. Paris.
- STANTON, J. D. A. (1988). *Flowers of the Himalaya, a supplement*. Delhi etc.
- SUMNEVICZ, G. P. (1948). Species novae generis *Juniperus* L. ex Asia media. *Bot. Mater. Gerb. Inst. Bot. Zool. Akad. Nauk Uzbeksk. SSR* 10: 22–26.
- TAKHTAJAN, A. L. (1986). *Floristic Regions of the World*. (transl. by T. Crovello). Univ. California Press, Berkeley.
- ___ & FEDOROV, A. A. (1972). *Flora Yerevana: opreditel' dikorastuscikh ratenij Araratskoj kotloviny*. Nauka, Leningrad.
- ULBRICH, O. E. (1917). II. Das Herbarium Karl Koch. *Notizbl. bot. Gard. Mus. Berlin-Dahlem* 7 ['Bd. VI'] (62): 420–434.
- WAGENITZ, G. (1962). Pflanzen von der Orientreise Tourneforts im Herbar Willdenow in Berlin. *Willdenowia* 3: 109–136.

-
- WALLICH, N. (1832). *A numerical list of dried specimens of plants, in the East India Company Museum...* ('Wallich Catalogue'). [copy seen at E].
- WILDENOW, C. L. (1806). *Species plantarum* 4 (2): 631–1157. Berlin.
- WILSON, E. H. (1927). *Juniperus procera* Hochst. *J. Arnold Arbor.* 8: 1–2.