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GYMNOSPERMS OF THE WESTERN HIMALAYA. 1. THE GENUS *JUNIPERUS* (CUPRESSACEAE)

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Abstract

A thorough study of an extensive collection of herbarium specimens and literature of *Juniperus* (Cupressaceae) from the Western Himalaya, during our work on gymnosperms of this region, has revealed that the taxonomy of West Himalayan Junipers has been confusing. A total of up to 6 taxa have been reported from this region by various earlier workers under a large number of specific and infraspecific names, most of which are synonyms. Seven taxa are recognised from the Western Himalaya in the present study: one belonging to *Juniperus* Sect. *Juniperus*, *J. communis* var. *saxatilis*, and the other six to *J.* Sect. *Sabina*. The latter section includes two acicular-leaved species, *J. squamata* and *J. recurva*, and four scale-leaved species: two multiseed, *J. semiglobosa* and *J. polycarpos*, and two monoseed, *J. wallichiana* and *J. pseudosabina*.

Introduction

The coniferous genus *Juniperus* has the largest number of species, approximately 60, within the Cupressaceae. It comprises of evergreen trees or shrubs distributed over the Northern Hemisphere extending from the Arctic regions to Mexico and the West Indies, the Azores and the Canary Islands, North Africa, Ethiopia, Sudan, and the mountains of tropical East Africa, as well as the Himalaya, China and Taiwan (Dallimore & Jackson 1948). The most conspicuous character by which it can be distinguished from the other genera of Cupressaceae is that the female cone has its seed-scale complexes completely fused and becoming fleshy to form a berry-like "fruit" enclosing the seeds. It has been customary to divide this genus into two groups, chiefly based on leaf characters: — 1. *Juniperus* Sect. *Juniperus* (Syn.: *J.* Sect. *Oxycedrus* Spach) having acicular, ternate, non-decurrent leaves, and — 2. *J.* Sect. *Sabina* (Mill.) Spach (Syn.: *Sabina* Mill.) having scale-like or acicular, decussate or ternate, but decurrent leaves. The acicular-leaved *Juniperus drupacea* Labill., occurring in Greece, Turkey and Syria differs primarily from other species of *Juniperus* in having "drupe-like" female cones with connate seeds and clustered male cones. This species is usually referred to the monotypic *J.* Sect. *Caryocedrus* Endl. Syn.: *Arceuthos* Antoine & Kotschy (Adams & Demeke, 1993; Christensen, 1997).

The taxonomy of *Juniperus* has been a hard nut for botanists, especially in the Asiatic continent. According to Brandis (1874) "the classification of Junipers in Asia seems to require critical revision". Since then more than a century has elapsed, but the situation with respect to many taxa is still ambiguous. Thus, Browicz & Zieliński (1982), while referring to species of *J.* Sect. *Sabina* in Southwest, Middle and Central Asia, remarked that their taxonomy "is often doubtful", and that "in different floristic publications or local Floras they are treated in quite contradictory ways".

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In South Asia, the Himalayan mountains provide habitat to about 10% of the *Juniperus* species in the World. A large number of botanists have, from time to time during the last two centuries, dealt with Junipers occurring in at least parts of the Himalaya (Wallich, 1832; Brandis, 1874; Gamble, 1881; 1902; Hooker, 1888; Parker, 1918; Lambert, 1933; Dallimore & Jackson, 1948; Raizada & Sahni, 1960; Gaussen, 1968; Nasir *et al.*, 1969; Stewart, 1972; Jain, 1976; Mehra, 1976, 1988; Mehra & Jain, 1976; Lewis, 1978; Browicz & Zieliński, 1982; Polunin & Stainton, 1984; Nasir & Nasir, 1987; Sahni 1990; Farjon, 1992, 1998; Adams & Turuspekov, 1998; Adams 1999, 2000, 2001).

A review of this literature reveals that the taxa of *Juniperus* in the Himalaya have been variously treated in local/regional floristic publications/floras, with no general agreement on the total number of species actually growing here, and often with misidentifications, erratic and confused synonymy and local distribution ranges, and sometimes resulting in contradictory treatments. A large number of species names and several infraspecific names have been used to designate the *Juniperus* taxa of the Himalaya. Most of these names are synonyms, and the actual number of taxa recognised by various workers from the entire Himalayan Range ranges from 4 to 9 with 4—6 taxa from the Western Himalaya and 2—5 taxa from the Eastern Himalaya.

Farjon (1992), in his study of multiseed taxa of *Juniperus* Sect. *Sabina* in Southwest Asia and East Africa, concluded that "the arborescent Junipers in the Western Himalaya and Karakoram Ranges have been generally misidentified". The present study provides a thorough floristic account of *Juniperus* taxa and their distribution in the Western Himalaya — a biogeographic zone here taken in a wide sense and coinciding with the Western Himalayan Province of Takhtajan (1986) which starts from 80° E longitude on the mountains of the Uttaranchal (= Uttar Pradesh) - Nepal border and stretches westward through the States of Himachal Pradesh and Jammu & Kashmir, northern mountain areas of Pakistan to Nuristan in Afghanistan (Fig. 1). An extensive collection of specimens of Junipers from the Western Himalaya were studied from the following herbaria: B, BM, BSD, C, CAL, DD, E, G, GB, K, KASH, LE, M, MO, RAW, S, UPS, W, WU and Z (herbarium acronyms according to Holmgren *et al.*, 1990), as well as SMPU (= Herbarium, Survey of Medicinal Plants Unit Srinagar, Central Council of Research in Unani Medicine, New Delhi). Data on morphological character states visible with a magnification of up to 20× have been assessed, along with the relevant literature, to arrive at the taxonomic treatment presented here.

Juniperus in the Western Himalaya

Field surveys in and study of extensive herbarium collections from the Western Himalaya during the course of the present study reveal that 7 taxa of *Juniperus* occur in this Himalayan Range as conceived here. One of these, *J. communis* L., has leaves basally jointed (Sect. *Juniperus*) and is a distinct species, having been recognised by all the previous workers in our area; nonetheless it is a very variable species and all our material of it belongs to *J. communis* var. *saxatilis* Pall. The other 6 taxa, which have leaves decurrent (Sect. *Sabina*), form two groups: — 1. those with acicular leaves throughout life, and — 2. those with scale-leaves in the adult stage. The latter group again includes two types, viz., one including species with multiseeded cones and the other species with monoseeded cones.

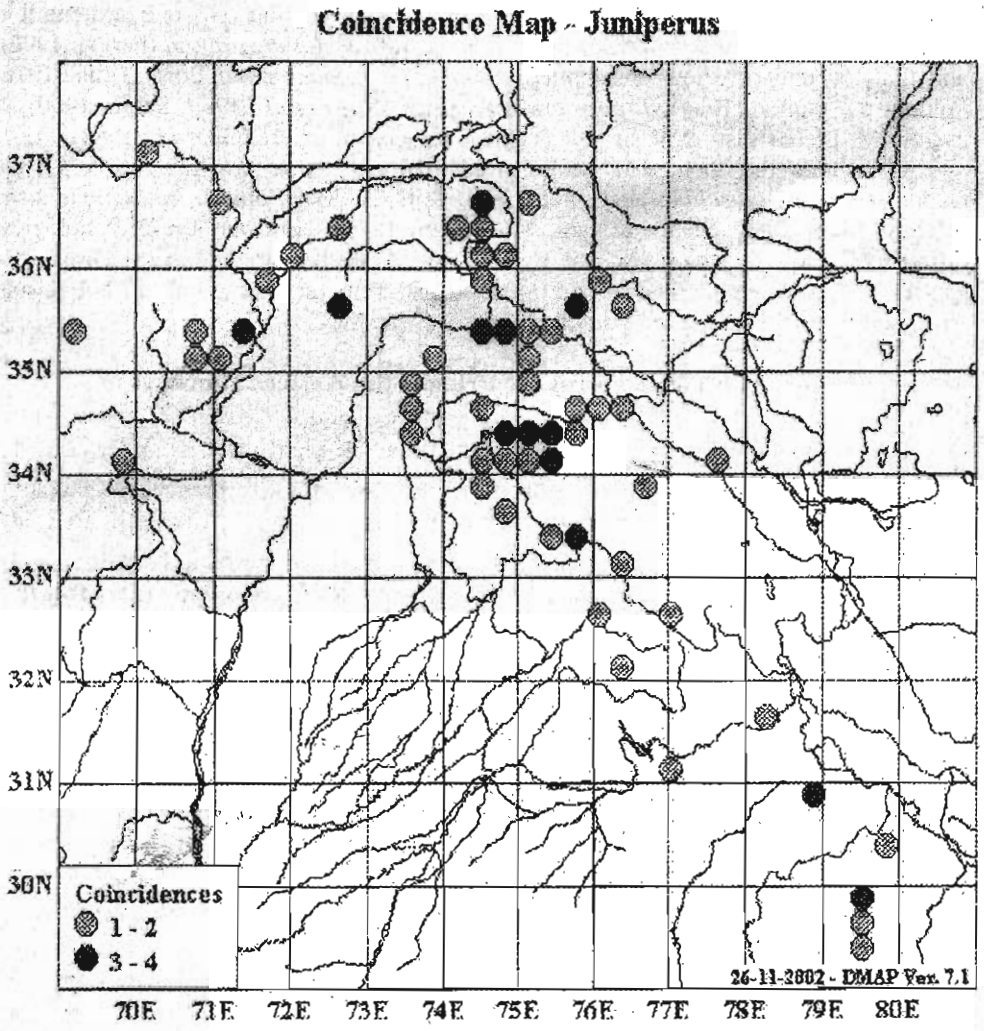

Fig. 1. *Juniperus*. Map showing the coincidences of species of *Juniperus* within the Western Himalayan Province of Takhtajan (1986). DMAP for Windows (Morton, 2001).

Among the acicular-leaved sabinaceous Junipers, *Juniperus squamata* Buch.-Ham. ex D. Don occurs all along the Western Himalaya from E Afghanistan to E Uttaranchal (India), while *J. recurva* Buch.-Ham. ex D. Don (a native of E Himalaya) does not extend westwards beyond the Nepal-Uttaranchal border. This is contrary to reports of many previous workers that this species extends throughout the Western Himalaya to Pakistan, or even Afghanistan (Raizada & Sahni, 1960; Gaussen, 1968; Lewis, 1978; Polunin & Stainton, 1984; Sahni, 1990).

Four species in the Western Himalaya represent the scale-leaved Junipers, two multiseed, *Juniperus semiglobosa* Regel and *J. polycarpos* K. Koch, and two monoseed, *J. wallichiana* Hook. fil. et Thomson ex D. Brandis and *J. pseudosabina* Fisch. & C. A. Mey. The multiseed, scale-leaved Junipers in our area have been much confused and

misidentified, even most of the previous workers could recognise only one of them, that with "fruits semiglobose" (= hemispherical) and evidently *J. semiglobosa* (Farjon, 1992), and that too under various misapplied names, like *J. macropoda* Boiss. (Jain, 1976; Polunin & Stainton, 1984), *J. polycarpos* K. Koch (Nasir *et al.*, 1969; Sahni, 1990), *J. excelsa* M. Bieb. (Nasir & Nasir, 1987) and *J. religiosa* Carrière (Gaussen, 1968).

As regards the monoseed, scale-leaved Junipers, some previous workers have recognised *J. pseudosabina* auct., non Fisch. & C. A. Mey., and *J. wallichiana* s.str. (Mehra, 1976, 1988; Mehra & Jain, 1976; Jain, 1976). However, the morphological differences given for these two are covered under one broadly conceived Himalayan species – *J. wallichiana*. The second taxon of this group, occurring only in N Pakistan within our area is true *J. pseudosabina* Fisch. & C. A. Mey.

Key to taxa of *Juniperus* occurring in the Western Himalaya

1. Leaves monomorphic, subulate throughout life of the plant **2**
— Leaves dimorphic: those on seedlings (often also on lower branches) subulate, while those on adult plants predominantly scale-like **4**
2. Leaves jointed at base; mature female cones pruinose, pericarp hard; seeds (1—)3 per cone ..... **1. *J. communis* var. *saxatilis***
— Leaves decurrent; mature female cones epruinose, pericarp soft; seeds 1(—3) per cone **3**
3. Ultimate twigs pendulous and recurved; leaves ± appressedly overlapping, glaucous-green, ± flaccid, (4—)6—9 times as long as broad, margins scarious; mature female cone ovoid-elongate ..... **2. *J. recurva***
— Ultimate twigs erect-ascending, sometimes with recurved tips; leaves incurvingly spreading or loosely overlapping, green, stiff, 3—4(—5) times as long as broad, margins herbaceous; mature female cone ellipsoid ..... **3. *J. squamata***
4. Ultimate twigs terete or tetragonal; female cones distinctly pruinose; seeds (1—) 2—4(—7) per cone **5**
— Ultimate twigs tetragonal; female cones not or slightly pruinose; seeds 1(-2) per cone **6**
5. Mature female cones globose or globose-ovoid, rounded at apex, 8—12 mm high; seeds always erect; leafy twigs ascending-spreading, the ultimate ones ± tetragonal ..... **4. *J. polycarpos***
— Mature female cones hemipsherical-triangular or depressed-globose, flatly truncate at apex, 4—6 mm high; seeds diverging at an acute angle; leafy twigs often pendulous, the ultimate ones ± terete ..... **5. *J. semiglobosa***
6. Ultimate twigs 1—1.5 mm in diameter; scale leaves to 1 mm wide, with prominently incurved apices; female cones ovoid-elliptic, 4—6 (—8) mm in diameter; seed 4—6(—9) × 3—4(—5.5) mm ..... **6. *J. wallichiana***
— Ultimate twigs 1.5—2 mm in diameter; scale leaves 1—1.2 mm wide, with slightly incurved apices; female cones oblong or elliptic-oblong, (6—)7—12 mm in diameter; seed 7—10 × 5—7 mm ..... **7. *J. pseudosabina***

Taxa of *Juniperus* in the Western Himalaya

Juniperus L., Sp. pl.: 1038 (1753). — Type: *J. communis* L.

Monoecious or dioecious, evergreen shrubs or trees. Bark thin, fibrous, peeling off longitudinally. Branches numerous, spreading or ascending; the ultimate branchlets rarely recurved or pendulous. Leaves opposite or whorled, either monomorphic and subulate throughout life, or dimorphic with subulate leaves on juvenile plants (often also on the lowest branches of mature plants) and scale leaves on adult plants; dorsal glands on leaves present or not. Male cones solitary (in ours), axillary or terminal, small, with 8—16 decussate or ternate microsporophylls each bearing 2—6 globose pollen sacs. Female cones solitary, axillary or terminal, with 3—9 decussate or ternate seed-scale complexes, some or all bearing 1—2 ovules each; seed-scales fused and fleshy at maturity, forming a berry-like cone (in ours) ripening in the second year. Seeds 1—12, free (in ours), wingless. Cotyledons 2 or 4—6.

Approximately 60 species distributed throughout the Northern Hemisphere, mostly in the temperate and alpine regions; 7 taxa occur wild in the Western Himalaya.

Juniperus* Sect. *Juniperus

= *J.* Sect. *Oxycedrus* Spach, *Ann. Sci. Nat. Ser.* 2, 16: 288 (1841).

Winter-buds ± distinct, composed of modified leaves; all leaves subulate, in whorls of 3, jointed at base; resin ducts external. Dioecious; male cones solitary, axillary; female cones berry-like with free seeds.

1. *Juniperus communis* L., Sp. pl.: 1040 (1753). — Lectotype (Farjon & Jarvis in Jarvis *et al.*, 1993: 58): Clifford Herbarium 464, *Juniperus* no. 1 (BM)

var. ***saxatilis*** Pall., Fl. Ross. 1,2: 12 (1788). — Described from [Russia, SE Siberia,] Dahuria.

= *J. sibirica* Burgsd., Anleit. Sich. Erzieh. Holzart. 2: 124 (1787) ≡ *J. nana* Willd., Sp. pl. 4: 854 (1806), nom. superfl. ≡ *J. communis* var. *nana* Baumg., Enum. Stirp. Transsilv. 2: 308 (1816) ≡ *J. communis* subsp. *nana* (Baumg.) Syme in Sowerby, Engl. Bot., ed. 3, 8: 275 (1868) — Described from Russia, Siberia.

= *J. communis* var. *montana* Aiton, Hort. Kew. 3: 413 (1789). — Described from Great Britain.

= *J. communis* var. *alpina* Suter, Fl. Helvet. 2: 292 (1802) [non Chaix in Villars, Hist. Pl. Dauphiné 1: 374. 1786] ≡ *J. alpina* S.F. Gray, Nat. Arr. Brit. Pl. 2: 226 (1821) ≡ *J. communis* subsp. *alpina* Čelak., Prodr. Fl. Böhmen: 17 (1867). — Described from Switzerland.

= *J. depressa* Steven, Bull. Soc. Imp. Naturalistes Moscou 30: 398 (1857) [non (Pursh) Raf., Amer. Monthly Mag. & Crit. Review 2: 207. 1818] ≡ *J. communis* var. *depressa* Boiss., Fl. Orient. 5: 707 (1884) [non Pursh, Fl. Amer. Sept.: 646. 1814]. — Type: [S Ukraine, the Crimea,] Steven Herbarium (H!)

Usually prostrate or decumbent-erect shrub to 1.5 m in height; dioecious. Branches dense and compact, those of higher orders pale brown, grooved. Leaves in whorls of 3, ± closely set, arising at joints in the stem, subulate, (5—)6—12 (—14) × (0.9—)1.3—1.8 (—2.5) mm, 3—8(—11) times as long as wide, upturned or upcurved, acute or acuminate, mucronate; upper surface concave, with a broad, bluish-white stomatiferous band, sometimes split into two by the midrib (at least in the proximal part of the leaf);

lower surface bluntly keeled; internodes 1—4(—5) mm. Cones solitary, borne in the leaf axils on very short (to 3 mm) peduncles. Male cones ovoid, 8—9 mm long. Female cones globose or ovoid, 6—9(—11) × 6—8(—10) mm, composed of three scales, green at first, bluish-black and pruinose when ripe in the second year; pericarp hard, rugose. Seeds usually 3, sometimes 1—2, free, 4—5 × 2.5—3 mm, ovoid–elongate, triangular with depressions between the margins, tapering into a rounded apex with a minute tip. 2n = 22 (Mehra 1988, as *J. communis*). — **Fig. 2e-g.**

Additional illustrations: Plate 512.3 in Polunin & Stainton (1984). Plate 23.1 in Sahni (1990).

Distribution: Fig. 3. Mountains of Europe, Turkey, C and N Asia, Japan, NW North America and Greenland. — In the Himalaya, it extends from Afghanistan, N Pakistan (Kaghan, Kurram, Swat, Dir, Chitral, Gilgit and Baltistan) eastwards through Kashmir, Himachal Pradesh, Garhwal and Kumaon (Uttaranchal) to Central Nepal, from 1800—4300 m.

Phenology: Flowering in March—May. Female cones ripen in August—September in the second year.

Common names: Common or Ground Juniper. — Pakistan: Bhentri. Kashmir: Yathur. Chamba (H. P.): Betar, Bithal. Kunawar (H. P.): Pama, Tailu.

Economic utility: The wood, twigs and leaves are used as incense in Punjab (Raizada & Sahni, 1960). The oil is distilled from the unripe female cones and is responsible for the characteristic flavour of gin (Sahni 1990). The twigs are used as fuel. The female cone is medicinal.

Representative collections

AFGHANISTAN: Nuristan: Shabul Gul, 3000 m, 5.8.1955, *Kitamura* (see Kitamura 1960); Vama, 5.4.1948, *Edelberg* 355 (C); Pashki Atsni-pas, 21.5.1948, *Edelberg* 704 (C); Ashpeï-pas, 11.7.1949, *Edelberg* 1773 (C). NORTHERN PAKISTAN: Chitral, S Barum glacier, 12000 ft, *Chaudhri 55* (RAW); Swat: Mountain E of Kalam, ca. 8000 ft, *Rodin 5699* (RAW); Kalam, *Stewart 24728* (RAW); Gilgit: Chhantir Gah, 2750 m, 5—6.8.1954, *Schmid 2170* (G, RAW); Upper Hunza: S-side of Batura glacier, opposite Yashbar, 3200 m, 5.9.1983, *Aldén 6033* (GB); Baltistan: Marpu nala, 11000—12000 ft, 5.7.1892, *Duthie 11854* (E); Geuse above Grenge (Biafo-Gletscher), 3900 m, 4.7.1962, *Hartmann 15* (RAW, Z); Nanga Parbat (see Troll 1967). KASHMIR: Ladakh, Sanmodangsa, 3900 m, 27.8.1976, *Wadhwa 59509* (BSD); Zanskar, 11500 ft, 13.9.1931, *Koelz 2966* (K); Sind valley, Sangam, 3600—3700 m, 2.9.1982, *Dhar et al. s.n.* (SMPU F. B. No. 1093); Baltal, 10000 ft, 15.7.1977, *Stainton 7949* (E); Sonamarg to Baltal, 16.6.1980, *unknown collector* (SMPU F. B. No. 32); Sarbal (Sonamarg), 3000 m, enroute to Zojila, 15.6.1983, *Dar 5721* (KASH); Sonamarg, 5.9.1917, *Stewart 3625* (MO); Kangan, 5500 ft, 25.7.1891, *Gammie s.n.* (K); Hills at mouth of Sind valley, 5400 ft, 22.4.1848, *Hooker fil. & Thomson s.n.* (K); Ganderbal, 1900 m, 5.7.1981, *Dar 2355* (KASH); Kishenganga valley: Sharda, 26.9.1956, *Mohd 97* (G); Lidder valley, Kolohoi valley, 11000 ft, 26.8.1956, *Polunin 56/515* (B); Srinagar, mountain behind Srinagar

Fig. 2. *Juniperus*. **a-d.** *J. recurva*. **e-g.** *J. communis* var. *saxatilis*. **h-l.** *J. squamata*. **a, e, i.** Cone-bearing branches (5 cm scale). **b, f, h, j.** Foliage of ultimate twigs (10 mm scale). **c, f, k.** Female cones (10 mm scale). **d, g, l.** Seeds (10 mm scale). — **a-d.** Collecteurs natifs no. 57. **e-g.** Hartmann 15. **h.** Dar 9869 **i-l.** Dhar & al. SMPU F.B. No. 54.

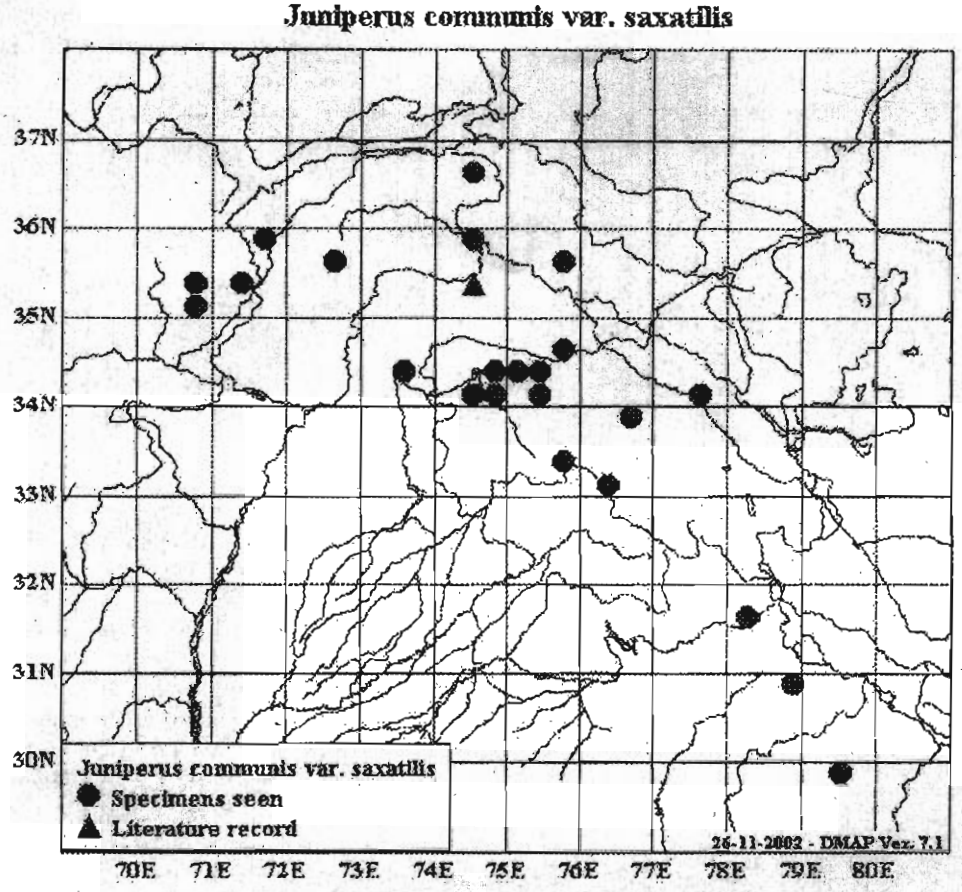

Fig. 3. Distribution of *Juniperus communis* var. *saxatilis* in the Western Himalaya based on specimens seen and information in Troll (1967) and Riedl (1968). DMAP for Windows (Morton, 2001).

(Shankaracharya), 5600 ft, 19.6.1919, *Stewart 4142½* (K); Harwan, 1800 m, 6.5.1970, *Singh 1521* (KASH); Zabarwan, 12.7.1970, *Javeid 1152* (KASH); ibid., 9000—15000 ft, 24.4.1980, *unknown collector* (SMPU F. B. No. 11); Parimchal, 4.1977, *Naqshi & Dar 5294* (KASH); Gulmarg, Gulmarg to Kilanmarg, 4.10.1980, *Dhar et al. s.n.* (SMPU F. B. Nos. 207, 1093); Kishtwar: 12000 ft, s.a., *Hooker fil. & Thomson s.n.* (UPS, 2nd specimen from the left). HIMACHAL PRADESH (Chamba State): Kunawar, above Kilar (Pangi), 10000—12000 ft, 11.9.1896, *Lace 1491* (E); Pangi (Lahoul), Shutal Forest, 8000—10000 ft, 18.9.1897, *Lace 1678* (E). UTTARANCHAL: Tehri Garhwal, Gangotri, 11000 ft, 12.6.1920, *Dudgeon & Kenoyer 203* (MO); Kumaon: Tola, 11500 ft, s.a., *Strachey & Winterbottom 4* (LE).

Juniperus communis L., is one of the most widely distributed and variable species of Junipers; Dallimore & Jackson (1948) report it to be the most widely distributed woody plant in the world, occurring in Temperate and Subarctic Eurasia and N America, as well as N Africa. It includes a number of forms, varieties and subspecies, which are variously treated without any general unanimity (Franco, 1962; Christensen, 1997; Farjon, 1998).

A perusal of the literature reveals that the Himalayan material of this taxon has mostly been identified as typical *Juniperus communis*. However, all the herbarium material studied by us from our area belongs to *J. communis* var. *saxatilis*, which is characterised by upturned or upcurved leaves usually 3—8 times as long as broad (as against patent leaves usually 9—14 times longer than broad in the other varieties (Christensen, 1997). Nonetheless, a closer examination of the specimens cited here revealed a variation in leaf setting or proximity (internode length) and size. The internodes are 1—4(—5) mm, and the leaves (5—)6—12 (—14) × (0.9—)1.3—1.8(—2.5) mm, being 3—8(—11) times longer than wide.

***Juniperus* Sect. *Sabina* (Miller) Spach**, *Ann. Sci. Nat. Ser.* 2, 16: 291 (1841). ≡ *Sabina* Miller, Gard. Dict., Abridg. Ed. 4, 3: 1235 (1754). — Type: *Juniperus sabina* L.

Conspicuous winter-buds absent; leaves all or partly scale-like, opposite or in whorls of 3, less often all subulate, but decurrent, opposite or in whorls of 3. Dioecious or monoecious; male cones terminal; female cones berry-like with free seeds.

2. *Juniperus recurva* Buch.-Ham. ex D. Don, Prodr. Fl. Nepal.: 55 (1825). ≡ *Sabina recurva* (Buch.-Ham.) Antoine, Cupress.-Gatt. 67 (1857). — Type: Nepal, Narainhetti, Buchanan-Hamilton (BM).
= *J. fargesii* sensu Mehra, Nucleus 19, 2: 136 (1976) [non (Rehder & E. H. Wilson) Kom., Bot. Mater. Gerb. Glavn. Bot. Sada RSFSR 5: 30.1924]. See also Mehra & Jain (1976), and Mehra (1988).

Conical tree to 18 m in height, or a spreading shrub, with a rather lax growth and pendulous habit; monoecious or dioecious. Branches fastigiate, decurved-ascending, the ultimate twigs pendulous and variously curving into tail-like structures. Leaves in whorls of 3, decurrent, ± appressedly overlapping, subulate, the free part 2—8 × 0.5—0.9 mm, (4—)6—9 times as long as wide, dull or glaucous-green, ± flaccid, acuminate and ending in a sharp horny tip; upper surface concave, white, sometimes divided into two stomatiferous bands by the faint or raised midrib; lower surface convex, usually furrowed near the base only, sometimes the furrow extending to the middle of leaf or even to the apex; margins membranous, undulate to minutely denticulate under a high-power lens, mostly inrolled in herbarium specimens. Male cones terminal or subterminal, c. 4 mm long, with 12—16 microsporophylls. Female cones axillary, ovoid-oblong, (6—)7—13 × (4—)7—10 mm, composed of 3—6, pointed scales, purplish-brown at first, black when ripe in the second year; pericarp soft, ± rugose. Seeds solitary, ovoid-elliptic, 5—10 × 3—7 mm, usually narrowed above into a flattish rounded apex with a minute tip, pitted, with a dark shining strip across the apex, the apex ± exserted through the pericarp at maturity. 2n = 22 (Mehra 1988, as *J. fargesii*). — **Fig. 2a-d.**

Additional illustrations: Plate 512.4 in Polunin & Stainton (1984). Fig. 72G,H in Mehra (1988).

Distribution: Fig. 4. Native of E Himalaya, occurring from Nepal eastward in Sikkim, Bhutan, Arunachal Pradesh to Upper Burma and SW China. Westerly it does not seem to extend beyond Nepal (where it is common in the alpine zone between 3000—4600 m), or at the most beyond Kumaon. This is contrary to the reports of its occurring far west through the Western Himalaya to Afghanistan by Raizada & Sahni (1960), Lewis (1978),

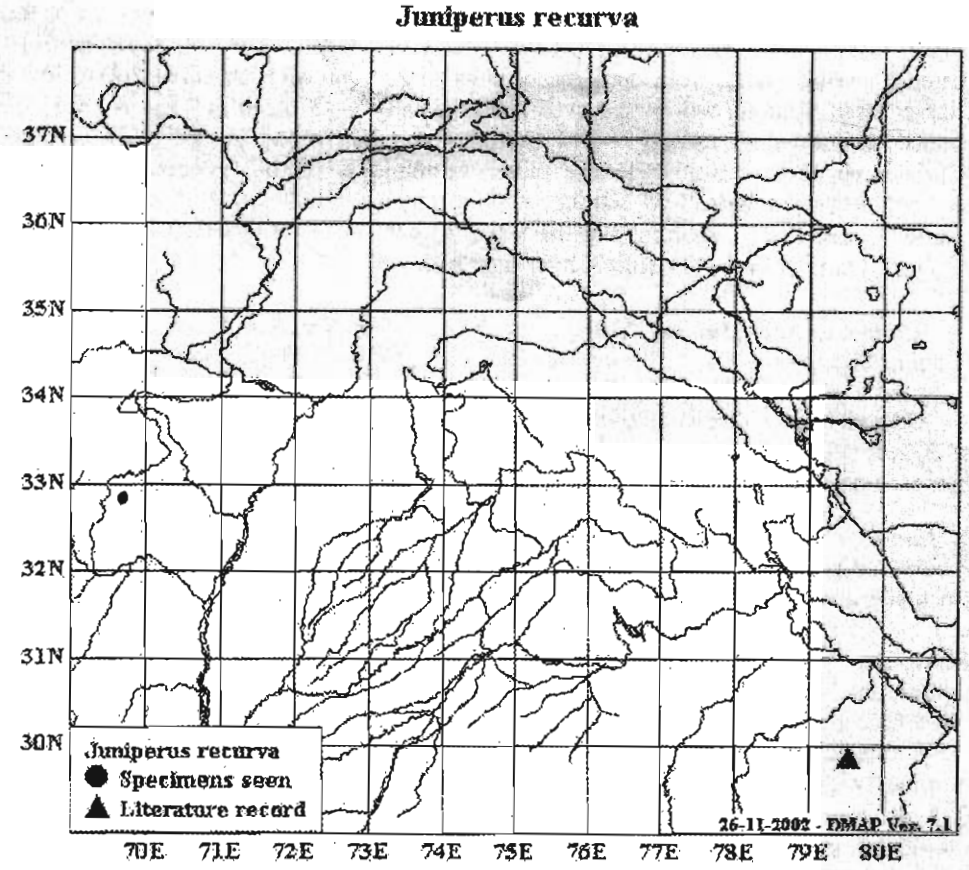

Fig. 4. Distribution of *Juniperus recurva* in the Western Himalaya based on information in Sahni (1990). DMAP for Windows (Morton 2001).

Polunin & Stainton (1984) and Sahni (1990). It should have been due to their confusing it with forms of *J. squamata* having the ultimate branchlets crowded and recurved at the tips.

Phenology: Flowering in June—July. Female cones ripen in July—October in the second year.

Common names: Drooping Juniper. — Betar, Guggal, Thelu.

Economic utility: The wood is burned for incense in Buddhist temples in the E Himalayas.

Representative collections

All the specimens of this species studied by us are from Nepal, Sikkim, etc. However, one specimen has been cited from Uttaranchal: Kumaon, Panch Chalhi glacier, 13800 ft, *Sahni* 20462 (see Sahni, 1990: 99).

Juniperus recurva has been variously treated, without any general agreement. Dallimore & Jackson (1948) suggested it to be regarded as a widely distributed and variable species including the Coffin Juniper of Upper Burma *J. coxii* A. B. Jacks. (= *J. recurva* var. *coxii* (A. B. Jacks.) Melville, see Farjon 1998) as its most vigorous variant, and *J. squamata* as its depauperate form with the arborescent *J. squamata* var. *fargesii* Rehder & E. H. Wilson as a connecting link. Parlatore in De Candolle (1868) treated *J. squamata* as *J. recurva* var. *squamata*.

Mehra & Jain (1976), and Mehra (1976), on the basis of morphoanatomical studies, recognised four taxa in the *Juniperus recurva* complex in the Himalaya: — 1. *J. recurva* s.str. – a tree having been found only in the E Nepal, — 2. *J. squamata* var. *fargesii* Rehder & E. H. Wilson (= *J. fargesii* (Rehder & E. H. Wilson) Kom.) – a tree in E. Nepal, W Sikkim and Shingalila range (Darjeeling), — 3. *J. squamata* var. *wilsonii* (Rehder) Rehder (= *J. pingii* Ferré var. *wilsonii* (Rehder) Silba, see Farjon 1998) – a shrub in W Sikkim, and — 4. *J. squamata* var. *squamata* – a shrub widely distributed in the Western Himalaya. However, the description of *J. fargesii* as given by these authors would also include it in *J. recurva*. As regards *J. squamata* s.str. and its variety *wilsonii*, they are here treated as taxa separate from *J. recurva*.

3. *Juniperus squamata* Buch.-Ham. ex D. Don in Lambert, Descr. Pinus 2: 17 (1824) ≡ *Sabina squamata* (D. Don) Antoine, Cupress.-Gatt. 66 (1857) ≡ *J. recurva* Buch.-Ham. ex D. Don var. *squamata* (Buch.-Ham. ex D. Don) Parl. in DC., Prodr. 16,2: 482 (1868). — Described from Bhutan.

= *J. recurva* Buch.-Ham. ex D. Don var. *densa* hort. ex Carrière, Traité Gén. Conif.: 27 (1855) ≡ *Sabina recurva* var. *densa* (Carrière) Antoine, Cupress.-Gatt.: 67 (1857) ≡ *J. densa* (Carrière) Gordon, Pinetum Suppl.: 32 (1862). — Described from cultivated material.

= *J. squamata* var. *meyeri* Rehder, J. Arnold Arb. 3: 207 (1922). — Type: Arnold Arboretum, 15.9.1922, *unknown collector s.n.* (not located).

= *J. squamata* var. *prostrata* Hornibr., Dwarf. Conif.: 77 (1923). — Described from cultivated material.

Dwarf spreading shrub, with a compact growth; dioecious. Main branches decumbent, the ultimate twigs erect-ascending, occasionally with recurved tips. Leaves in whorls of 3, decurrent, incurved and spreading to loosely overlapping, but not appressed, subulate, the free part 2—6 × 0.6—1.1 mm, 3—4(—5) times as long as wide, green, stiff, ending in a sharp, horny tip; upper surface concave, white, usually divided into two stomatiferous bands by the raised or faint midrib; lower surface convex, usually furrowed from the base to near the apex, sometimes the furrow extending only to the middle of leaf or even confined to the base; margin ± herbaceous, usually entire, flat or slightly incurved (but not inrolled) in herbarium specimens. Cones terminal on short, ultimate twigs. Male cones quadrangular, yellowish. Mature female cones ellipsoid, 6—8 × 4—7 mm, composed of 3—6, pointed scales, reddish-brown at first, black when ripe in the second year; pericarp soft, ± rugose. Seeds solitary, very rarely 2—3 in some cones, ovoid-ellipsoid, 5—7 × (2—)3—5 mm, usually narrowed above into a flattish rounded apex with a minute tip, faintly ridged, with 2—4 depressions above the base and a dark strip across the apex, the apex often exserted through the pericarp at maturity. 2n = 44 (Hall *et al.*, 1979). — **Fig. 2h-l.**

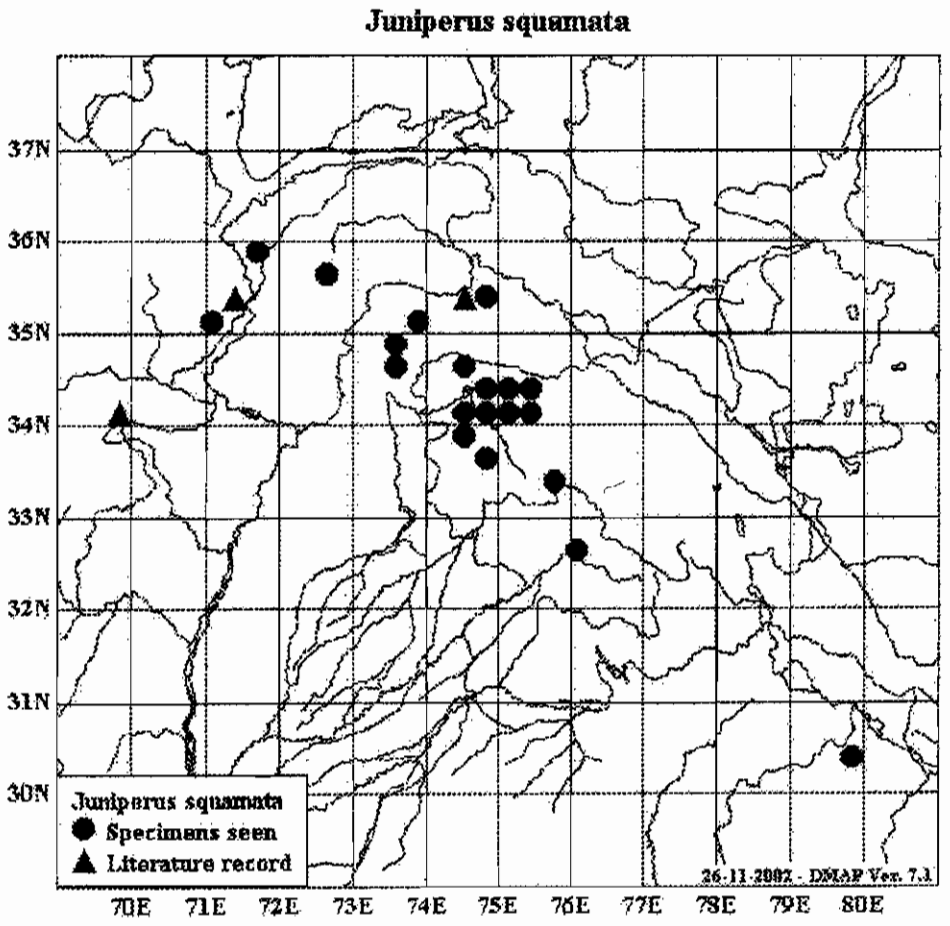

Fig. 5. Distribution of *Juniperus squamata* in the Western Himalaya based on specimens seen and information in Troll (1967) and Riedl (1968). DMAP for Windows (Morton, 2001).

Additional illustrations: Plate 512.1 in Polunin & Stainton (1984). Fig. 71C,D in Mehra (1988).

Distribution: Fig. 5. E Afghanistan, Chitral eastward to E Nepal, N Burma, C and W China, Taiwan and Japan. In the Himalaya, it occurs commonly associated with *J. communis* above 2200 m, and forms dense thickets of about waist height above the tree-line up to 4500 m.

Phenology: Flowering in June—July. Female cones ripen in July—October in the second year.

Common names: Scaly-leaved Nepal Juniper. — Hindi: Padma Chunder. Kashmiri: Yathur.

Economic utility: The wood is used for fuel, especially in alpines, where no other arboreals grow; it is also burnt for incense. The female cone is medicinal.

Representative collections

AFGHANISTAN: Nuristan: Elasoon, 7.7.1949, *Edelberg* 1729 (C). NORTHERN PAKISTAN: Chitral: *Hassandin 65* (RAW); Swat: Kalum, Ushu valley above Jaba lake, 3250—3500 m, 20.9.1983, *Aldén 6348* (GB); Hazara: upper Kaghan valley, near Lulu Sar bridge, 3450 m, 13.9.1983, *Aldén 6190* (GB); ibid., Kaghan valley, above Shogran Forest Rest House, 2900—3300 m, 15.9.1983, *Aldén 6210* (GB); ibid., Kaghan valley, Saiful Maluk, W of the Rest House, 3250—3380 m, 18.9.1983, *Aldén 6266* (GB); Baltistan: Rama above Astor, 9000—10000 ft, 29.7.1946, *Stewart 22942* (K); Nanga Parbat (see Troll 1967). KASHMIR: Ladakh: head of Masjid valley, 12000—13000 ft, 27.7.1893, *Duthie 13286* (BM, E); Sind valley: Zojila, 3500 m, 30.7.1983, *Dar 7525* (KASH); Wakalwan, 3.7.1988, *unknown collector s.n.* (KASH No. 15814); Nilnai, 3650—3900 m, 27.8.1983, *Dar 8350* (KASH); ibid., 3650 m, 27.8.1983, *Dar 8352* (KASH); Sonamarg, 4.9.1917, *Stewart 3588* (MO); ibid., 10000 ft, 23.8.1921, *Stewart 6763* (K); Sonamarg, Thajwas, 13500 ft, 26.6.1930, *Burt 256* (E); Thajwas forest, 3200 m, 20.6.1992, *Dar 9897* (C, KASH), *9899* (C, KASH), *9900* (C, KASH); Lokat Marg, 2700 m, 2.5.1993, *Dar 9979* (C, KASH); Jhelum valley: Lolab, Warnas forests, 10000—11000 ft, 29.6.1908, *Keshavanand 1010* (DD); Kishenganga valley: Rajdhani Pass, 23.7.1981, *Dhar et al.* (SMPU F. B. Nos. 548, 549); Wardwan, 10500 ft, 2.5.1976, *Stainton 7534* (E); Lidder valley: Panchtarni-Amarnath, 9.1880, *Young s.n.* (BM); Panchtarni, 3600 m, 27.7.1966, *Nair 37053* (BSD, DD); Lidderwat, 11000 ft, 25.8.1956, *Polunin 56/502* (B, BM); Pahalgam, 19.8 1920, *Stewart 5748½* (K); ibid., 7000—8000 ft, 25.8.1945, *Stewart 21784a* (K); ibid., 2275 m, sides of Lidder River, 6.7.1986, *Dar 9180* (C, KASH); Dagwan, 3500 m, 10.9.1979, *Wadhwa 66943* (BSD, DD); Mahadiv, 3500 m, 10.9.1971, *Singh 3171* (KASH); Burzawas valley, 3000 m, 7.9.1991, *Dar 9869* (C, KASH); Gulmarg, 12000 ft, 14.8.1926, *Stewart 8804a* (MO); Apharwat, 7.6.1979, *Naqshi 6984* (KASH); Yusmarg, 9900—15000 ft, 8.1977, *Gupta 1057* (KASH); Kungwatan (Kaunsarnag), 3800 m, 7.6.1959, *Rao 9329* (BSD, DD); Duksum, 2500 m, 2.9.1986, *Dar 9196* (C, KASH); Simthan Pass, 3100 m, 26.7.1971, *Singh 3013* (KASH); Kishtwar: 12000 ft, s.a., *Hooker fil. & Thomson s.n.* (C, G, M, UPS: 2 specimens on right hand side and one on left hand side of the sheet). HIMACHAL PRADESH: Chamba State, Margraon, 9.1897, *Lace 1773* (B). UTTARANCHAL: Garhwal, Jelam, 8500 ft, s.a., *Strachey & Winterbottom 3* (LE, right hand specimen); Kumaon, Pindari, 12000 ft, s.a., *Strachey & Winterbottom 2* (LE, lower 2 specimens); Pindari glacier (Almora District), 11.6.1935, *Parkinson 5967* (DD).

Some of the dwarf forms of *Juniperus squamata* with smaller and closely arranged leaves bear a resemblance to *J. wallichiana*. But these are distinguished by subulate leaves arranged ternately (against opposite in *J. wallichiana*) and having spiny, curved apices. Similarly, some forms of *J. squamata* may resemble dwarf specimens of *J. communis*, but these are distinguished by the leaves lacking basal joints and by single-seeded female cones.

Juniperus squamata is very variable in habit, stature, size, and in shape and proximity of the leaves. It is "a polymorphic shrub showing variation in the morphology of leaves" (Mehra, 1976). In the material seen from the study area by us, one is tempted

to recognise at least a few varieties (see, e.g., Bailey, 1933; Rehder, 1940). However, a closer look at them prevented us from doing so because the variation is continuous having no correlation to ecological and geographical conditions. There are intermediate specimens connecting those which are seemingly different from each other.

It seems that *Juniperus squamata* hybridises with *J. wallichiana* in the areas of their common occurrence. A putative hybrid specimen was collected by T. Thomson from Kishtwar in 1856 (LE!).

4. *Juniperus polycarpos* K. Koch, Linnaea 22: 303 (1849) ≡ *Sabina polycarpos* (K. Koch) Antoine, Cupress.-Gatt.: 47 (1857) ≡ *J. excelsa* M. Bieb., Tabl. Prov. Mer Casp.: 204 (1798) subsp. *polycarpos* (K. Koch) Takht., Fl. Yerev.: 53 (1972) ≡ *J. excelsa* var. *polycarpos* (K. Koch) Silba, Phytologia Mem. 7: 34 (1984). — Neotype (Farjon 1992: 259): Turkey, Armenia, Taltabam near Gümüskane, 27.4.1894, *P. Sintenis 5520* (L; isoneo. E).

= *J. macropoda* Boiss., Fl. Orient. 5: 709 (1884). — Lectotype (Farjon 1992: 260): [Iran, Zagros Mts.,] Kuh-e-Dinar, 21.7.1842, *T. Kotschy 711* (G; isolecto. C!, L)

= *J. turcomanica* B. Fedtsch. in Fedtsch. et al., Fl. Turkmenii 1: 14 (1932) ≡ *Sabina turcomanica* (B. Fedtsch.) Nevski, Trudy Bot. Inst. Akad. Nauk. SSSR, ser. 1, Fl. Sist. Vyss. Rast. 4: 245 (1937) ≡ *J. excelsa* M. Bieb. subsp. *turcomanica* (B. Fedtsch.) Imkhan., Bot. Žurn. 75,3: 408 (1990). — Lectotype (Imkhanitskaya 1990: 408): Turkmenia, Kopet Dag, Dcschalilu 3.5.1912, *D. P. Gedevanov & D. A. Dranitsya 148* (LE).

= *J. seravschanica* Kom., Bot. Žurn. (Moscow & Leningrad) 17: 481 (1932) ≡ *Sabina seravschanica* (Kom.) Nevski, Trudy Bot. Inst. Akad. Nauk. SSSR, ser. 1, Fl. Sist. Vyss. Rast. 4: 245 (1937) ≡ *J. polycarpos* K. Koch var. *seravschanica* (Kom.) Kitam., Add. & Corr. Fl. Afghan.: 68 (1966) ≡ *J. excelsa* M. Bieb. subsp. *seravschanica* (Kom.) Imkhan., Bot. Žurn. 75,3: 407 (1990). — Lectotype (Imkhanitskaya 1990: 407): Tadzhikistan, Zeravshan valley, Darch, 2400 m, 11.8.1892, *V. L. Komarov s.n.* (LE)

= *J. polycarpos* K. Koch var. *pendula* Mulk., Dokl. A. N. Armen. SSR 45,2: 86 (1967) ≡ *J. excelsa* M. Bieb. subsp. *polycarpos* (K. Koch) Takht. var. *pendula* (Mulk.) Imkhan., Bot. Žurn. 75,3: 407 (1990). — Type: Armenia, Vedinskij r-n, Chosrov, 1400—1700 m, 1959, *Y. I. Mulkidzhanian s.n.* (ERE).

= *J. excelsa* M. Bieb. var. *farreana* Mehra, Nucleus 19,2: 135 (1976), nom. inval.

Tree to c. 20 m in height and 2 m trunk girth, shrubby at higher elevations, with a crooked form and pyramidal crown; monoecious or dioecious. Branches spreading or ascending, often irregular, the ultimate twigs ± tetragonal, 1—1.5 mm in diameter. Scale leaves light- to yellowish-green, decurrent, opposite-decussate; those on older twigs closely imbricate or some free at the ± incurved apex, ovate or deltoid, to 4 mm long, long-pointed, those on ultimate twigs closely appressed, rhombic or ovate-rhombic, 1.2—1.5 × 0.8—0.9 mm, acute to obtusish, with an oval-oblong resinous gland, and at least some keeled at the back, margins white, entire (minutely denticulate under a strong lens), amphistomatic. Juvenile leaves ternate, subulate, 6—10 × 1 mm, long-pointed, keeled, pungent, epistomatic with two stomatiferous bands on the adaxial surface. Male cones terminal or subterminal on ultimate twigs, oval to roundish, 3—4 × 2—3 mm, yellowish. Female cones subterminal on ultimate twigs, globose or globose-ovoid, 8—12 × 8—11(—14) mm when mature, green at first, purplish-brown to blackish-purple when ripe in the second year, often pruinose with a whitish bloom; seed scales 4(—6), completely

fused, smooth, waxy, interior resinous, becoming woody. Seeds (2—)3—4(—7) per cone, free, angular, ovate-elliptic, ovate-oblong or oblong-elliptic, (3—)4—6 × (2—)3—4(—6) mm, yellowish to reddish-brown, dentiform or trigonous with longitudinal grooves and distinct margins, rugose-reticulate to densely pusticulate. — **Fig. 6a-c.**

Additional illustrations: Plate LXVIII in Brandis (1874). Fig. 2 in Farjon (1992).

Distribution: Fig. 7. E Turkey eastward through Caucasia to the Caspian Sea, Iran and then to Afghanistan; northeastward it extends to Tian Shan and the mountains of Kirgizistan, in the southeast it occurs as far as Quetta in Pakistan and Himachal Pradesh in India; also a disjunct population in Oman (Farjon, 1992).

Phenology: Flowering in May. Female cones ripen in September—October in the second year.

Common names: Eastern Juniper.

Representative collections

AFGHANISTAN: Haibagh, 9.1949, *Duckelmann 78* (DD); Sarkai Mangali Djunubie, 9.12.1949, *Duckelmann 79* (DD); Prov. Baghlan, Hindukush-Hauptkamm, Salang Pass, N side, 2900 m, 9.10.1964, *Neubauer 4484* (B); E of Gadrez (near Pakistan border), 2600 m, 19.11.1948, *Köie 2967* (W). PAKISTAN: Baluchistan: unknown locality, 10.1945, *Chief Forest Officer s.n.* (DD); Shore Tore, 30 miles from Quetta, 23.5.1969, *Sultan-ul-Abedin 3112* (MO); Chitral: Yarkhum valley, 2700—2850 m, 24.—25.7.1968, *Stamme & Wöhrl 164* (W), *241* (W); Gilgit: Ghashomeling valley, 4 km SW of Chaprot, 2700 m, 3.9.1983, *Aldén 6083* (GB); ibid., Naltar valley, above Naltar Rest House, 2800—3000 m, 8.10.1983, *Aldén 6489* (GB); Baltistan: Karakoram, Bezirk Shigar, Laskam, Braldotal, 3800 m, 20.10.1961, *Reiser 1* (Z); ibid., Goyungo, 2600 m, 5.5.1962, *Reiser 3* (Z); ibid., Biafo-Gletscher, 3100 m, 16.5.1962, *Reiser 4* (Z), *5* (Z); ibid., 2500 m, 2.5.1962, *Hartmann 23* (Z); ibid., 3100 m, 11.5.1962, *Hartmann 24* (Z). KASHMIR: Ladakh: Kharbu Koma to Shaksi (SW of Dah), 3.7.1856, *Schlagintweit 5339* (G); Kishtwar: Triloknath up to the Kali Pass, 24.—27.6.1856, *Schlagintweit 3905* (G); Chenab valley: Madagaon, 10000 ft, 1.6.1881, *Ellis 1212* (LE). HIMACHAL PRADESH: Pooh forests of Kunawar district, 3300 m (see Jain, 1976; Mehra, 1976).

Recently, Adams (2001) resurrected *Juniperus polycarpos* as a species distinct from *J. excelsa* M. Bieb., on the basis of a study of the geographic variation in RADPs and contents of leaf essential oils. This treatment of *J. polycarpos* is adopted here, although it has been customary to include *J. polycarpos* as an infraspecific taxon of *J. excelsa* (see, e.g., Coode & Cullen, 1965; Riedl, 1968; Kerfoot, 1975; Imkhanitskaya, 1990; Farjon, 1992, 1998; Christensen, 1997).

Morphologically, *J. excelsa* differs from *J. polycarpos* in having ± terete, very slender ultimate twigs, usually not more than 1 mm in diameter, with narrower scale leaves, 0.4—0.8 mm wide, and narrower female cones, 6—11 mm in diameter, with more seeds, (2—)4—6(—8) per cone (see Farjon, 1992; Christensen, 1997). Known as the Grecian or Greek Juniper, *J. excelsa* extends from the Balkans in the west to NE and SE Iran and Turkmenia in the East.

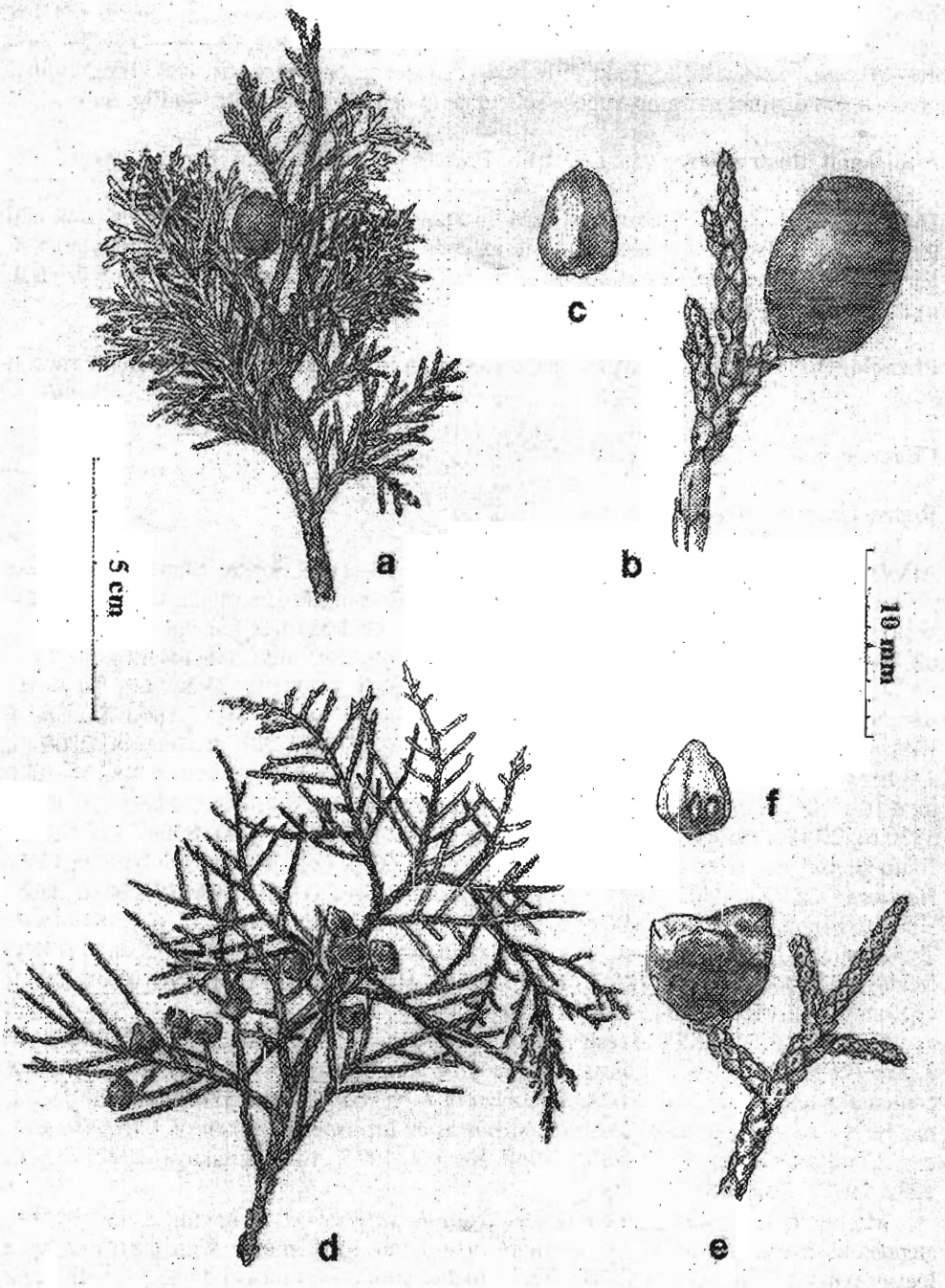

Fig. 6. *Juniperus*. **a-c.** *J. polycarpos*. **d-f.** *J. semiglobosa*. **a, d.** Cone-bearing branches (5 cm scale). **b, e.** Foliage of ultimate twigs and female cones (10 mm scale). **c, f.** Seeds (10 mm scale). — **a-c.** Aldén 6489. **d-f.** Showkat Ara 9555.

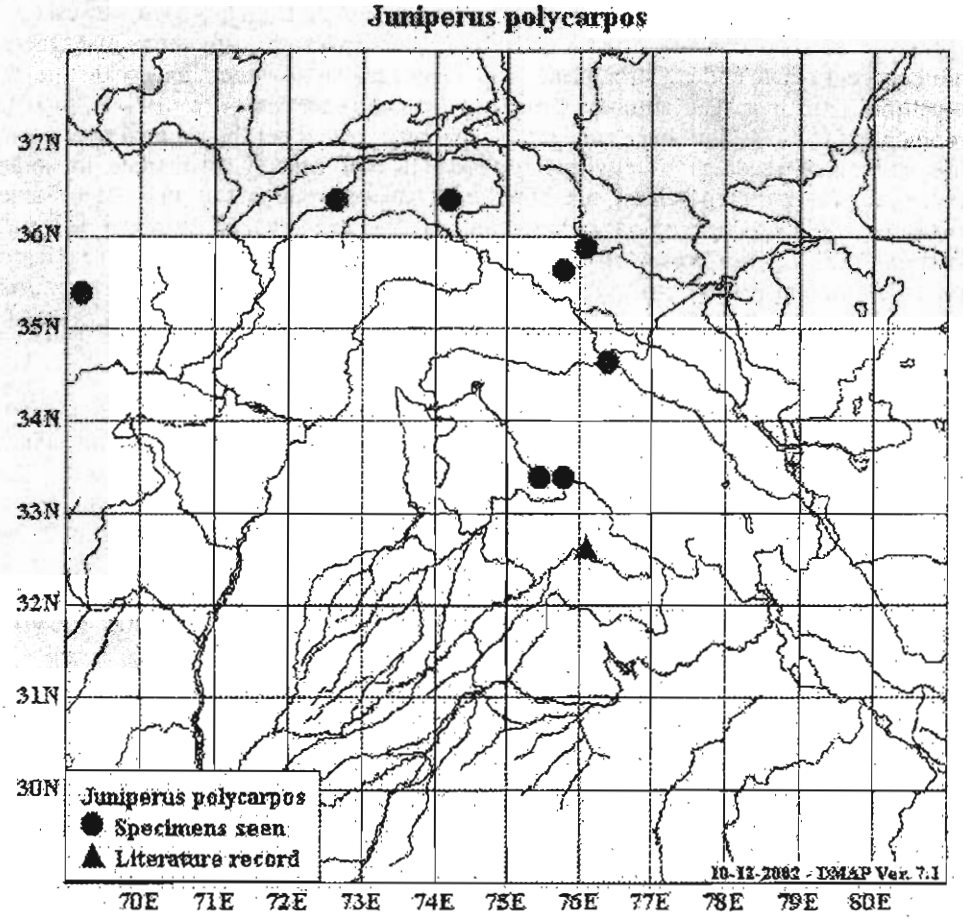

Fig. 7. Distribution of *Juniperus polycarpos* in the Western Himalaya based on specimens seen and information in Jain (1976) and Mehra (1976). DMAP for Windows (Morton, 2001).

A perusal of the literature would give a false impression of fair commonness of *Juniperus polycarpos* in the Western Himalaya because many authors have reported it from here as *J. excelsa* (Wallich, 1832; Nasir & Nasir, 1987), *J. macropoda* (Hooker, 1888; Parker, 1918; Lambert, 1933; Raizada & Sahni, 1960; Jain, 1976; Mehra, 1976, 1988; Mehra & Jain, 1976; Polunin & Stainton, 1984; Stainton, 1988), or *J. polycarpos* (Nasir *et al.*, 1969; Sahni, 1990). However, the majority of the reports of *J. polycarpos* in the above works are apparently based on misidentifications of an entirely different species: *J. semiglobosa* (see Farjon, 1992).

Our studies indicate that *Juniperus polycarpos* occurs rarely and sporadically in the Western Himalayan region from 2500—3800 m. Apart from the collections in Quetta and Chitral to Karakoram (Pakistan), only a few specimens have been seen from Ladakh, Kishtwar and Chenab valley in the Kashmir Himalaya, and a single population has been reported from Himachal Pradesh by Jain (1976, as *J. excelsa*) and Mehra (1976, as *J. excelsa* var. *farreana*).

Variability: *Juniperus polycarpos* is a tree, ranging in height from 6—20 m; however, at higher elevations it assumes shrubby form. The scale-leaves are with entire margins or minutely denticulate under a strong lens, and the dorsal glands on them may be distinct or sometimes indistinct. The number of seeds in ovulate cones varies from 2—7, though commonly it is 3—4. The shape and size of seeds also vary as per their number per cone. The surface of seeds is usually rugose-reticulate, but densely pusticulate in some specimens. The pericarp is hard, not sweet, but sometimes rather soft and sweet. Some correlation of characters has also been noticed. For example, in *Reiser 3* (Z) and *Hartmann 23* (Z), the dorsal glands are indistinct (elevated or superficial), pericarp somewhat soft and sweet, and seeds densely pusticulate; whereas in the other specimens cited here the dorsal glands are distinct (deeply impressed), pericarp hard and not sweet, and seeds rugose-reticulate.

5. *Juniperus semiglobosa* Regel, Trudy Imp. S.-Peterburgsk. Bot. Sada 6,2: 487 (1879). — Lectotype (Farjon 1992: 271): Tadzhikistan, Zeravshanskiy Khrebet, Saratag Pass, Isfara, 14.6.1871, *O. A. Fedtschenko s.n.* (LE).
= *J. talassica* Lipsky in Knorring & Minkvich, Trav. Exped. Colon. Russe 2, Bot. 1909, 6: 185 (1912) ≡ *J. semiglobosa* Regel var. *talassica* (Lipsky) Silba, Phytologia 68: 34 (1990). — Type: Kirgizistan, Karagoin Pass, 1909, *Z. A. von Minkwitz 1351* (LE).
= *J. schugnanica* Kom., Bot. Žurn. (Moscow & Leningrad) 17: 482 (1932). — Lectotype (Farjon 1992: 271): Tadzhikistan, Shugnanskiy Khrebet, Schitcharf River. 30.7.1904, *B. A. Fedtschenko s.n.* (LE).
= *J. drobovii* Sumnev., Bot. Mater. Gerb. Inst. Bot. Zool. Akad. Nauk. Uzbeksk. SSR 10: 22 (1948) ≡ *J. semiglobosa* Regel var. *drobovii* (Sumnev.) Silba, Phytologia 68: 33 (1990). — Type: Uzbekistan, Tian Shan, Angren River valley, 24.8.1939, *G. P. Sumnevicz et al. s.n.* (TASH).
= *J. tianschanica* Sumnev., Bot. Mater. Gerb. Inst. Bot. Zool. Akad. Nauk. Uzbeksk. SSR 10: 24 (1948). — Type: Kirgizistan, Tien Shan, Chatkalskij Khrebet, Sarytschilek, 13.8.1936, *V. Skorokhodov et al. 1460* (TASH).
= *J. religiosa* Carrière teste Gaussen, Gymnosp. Actuelles Fossiles 10: 123, 166, 179 (1968).
= *J. excelsa* auct., non M. Bieb. (1800).
= *J. polycarpos* auct., non K. Koch (1849).
= *J. macropoda* auct., non Boiss. (1884).

Tree to 20 m in height and 1—2 m trunk girth, frequently shrubby with several stems reaching 60—80 cm in diameter, with a rather crooked and gnarled form and a pyramidal crown; dioecious, rarely monoecious. Branches spreading or ascending, branchlets often pendulous, the ultimate twigs ± distant, terete or weakly tetragonal, 1—1.5(—2) mm in diameter. Scale leaves light- to yellowish-green, decurrent, ternate or opposite-decussate, imbricate, tightly appressed, incurved at apex; those on older twigs (ob-)lanceolate-acute, to 9 mm long; those on ultimate twigs rhombic or triangular, 1—2 mm long, obtuse to obtusish, with an oblong-elliptic and depressed dorsal gland, margins white, entire (undulate to minutely denticulate under a strong lens), amphistomatic with 2 indistinct stomatal lines. Juvenile leaves ternate, subulate, 6—10 × 1 mm, long-pointed, pungent, epistomatic with a white, median band of stomata on the upper surface. Male cones terminal or subterminal on ultimate twigs, quadrangular, 2—5 × 2—4 mm, yellowish. Female cones like males in position, hemispherical to depressed globose or triangular at

maturity, flatly truncate at apex, 4—6 × 4—9 mm, light-brown to blackish-blue, often glaucously pruinose with a mealy bloom; seed scales 4(—6), completely fused, smooth, waxy, often wrinkled (ruminate) when dried, interior resinous, fleshy, micropylar (integument) tubes sometimes projecting out and thus indicating the number of seeds within the fused scales. Seeds (1—) 2—3(—4) per cone, free, angular, ovoid or conical, broadest at base and narrowed and divergent at apices, (3—)4—6 × 2—4.5 mm, yellowish to reddish-brown, longitudinally grooved and with oval resinous pits in the grooves. 2n = 22 (Mehra 1988, as *J. macropoda*). — **Fig. 6d-f.**

Additional illustrations: Plate 512.2 in Polunin & Stainton (1984). Fig. 71A,B in Mehra (1988). Plate 23.2 in Sahni (1990). Fig. 5 in Farjon (1992).

Distribution: Fig. 8. Mountains of Central Asia, from Kirgizistan, Kazakhstan, Uzbekistan, Tadzikistan, and NE Afghanistan, through the Karakoram Range in Pakistan to India along the NW Himalaya from Ladakh, Kashmir to as far east as Kumaon and Nepal (Farjon, pers. comm.); across the border from Ladakh in western Kashgaria of China (Browicz & Zieliński, 1982).

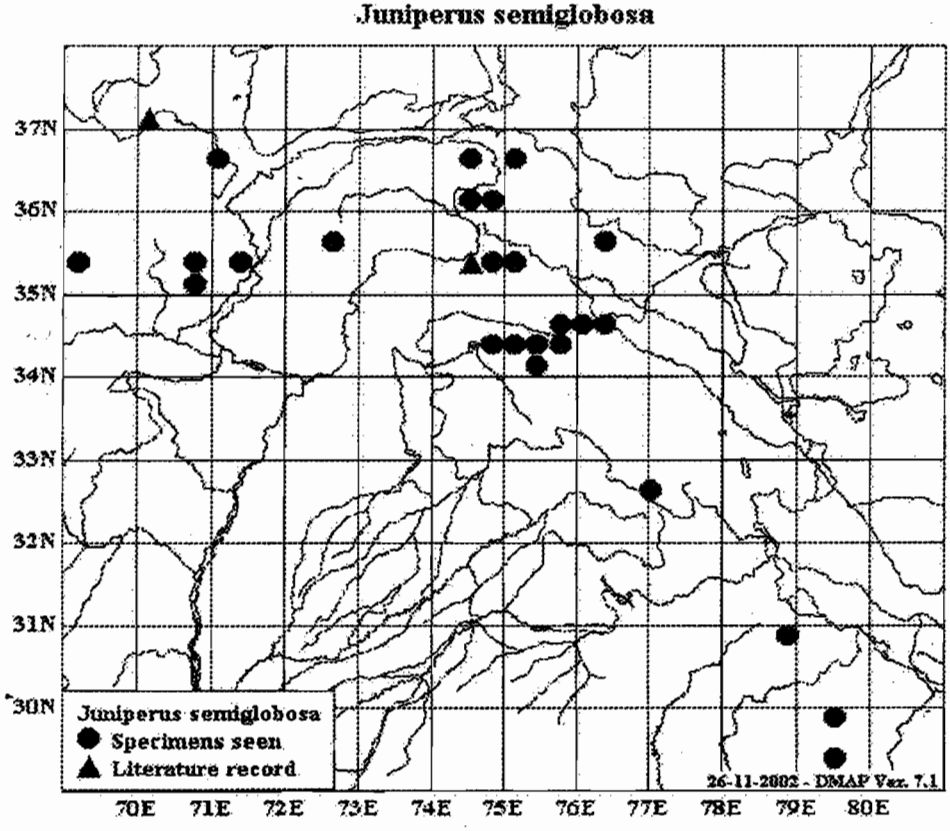

Fig. 8. Distribution of *Juniperus semiglobosa* in the Western Himalaya based on specimens seen and information in Troll (1967) and Riedl (1968). DMAP for Windows (Morton, 2001).

Phenology: Flowering in spring. Female cones ripen in September—October in the second year.

Common names: (West-)Himalayan Pencil Juniper or Cedar. — Hindi: Dhup, Padam. Himachal: Chalni, Lewar. Pushtu: Obusht. W Himalaya: Shir, Challai, Dhup.

Economic utility: The wood is hard and fragrant, used locally for furniture, fuel and charcoal. It was once used for making pencils in Punjab and is also burnt as incense in monastries as is its foliage. The female cone is medicinal.

Representative collections

AFGHANISTAN: Nuristan: Vama, 21.4.1948, *Edelberg 466* (C); Pashki Atsni-pas, 3250 m, *Edelberg 702* (C); Shtiva, 2700 m, 16.6.1948, *Edelberg 1034* (C); Minjan, Ptili-Nau, 19.7.1948, *Edelberg 1297* (C); Netshingel, 3300 m, 15.7.1949, *Edelberg 1991* (C); Parun, 10.1953, *Edelberg 2379* (C); Wakhan Sangar to SW Had, N of Hindukush, 12000 ft, Gilgit Expedition, s.a., *Giles 48* (K); Baghlan (loc. 119) c. 3 km N of Salang Tunnel, 2880 m, 12.5.1972, *Kukkonen 6035* (DD); Badakhshan prov., Jokhamtal (Hazarat-y-Sayed), 2700 m, 1.8.1974, *Frey et al. 236* (B). NORTHERN PAKISTAN: Swat: Kalam, Ushu valley, near Mahodan, E of Ushu River, 3600—4100 m, 21.9.1983, *Aldén 6314* (GB); Gilgit: near Sango Sar lake, 7 km W of Astor, 3540 m, 3.10.1983, *Aldén 6454* (GB); Nagar State, about 4 miles NW of Hispar village, 13000 ft, 20.8.1960, *Polunin 6326* (G); Upper Hunza, N-side of Batura glacier, between Camp 1 and Yashbar, 3000—3200 m, 5.9.1983, *Aldén 6031* (GB); near Minapin glacier, 3.5 km S of Minapin, 3050 m, 5.9.1983, *Aldén 6099* (GB); Baltistan: Between Suti Suree and Das Kurram, 1.7.1847, *unknown collector 562* (K); Hasora (Astor), 8.—20.9.1856, *Schlagintweit 6393* (G); Kinnibari, S of Astor, 27.9.1856, *Schlagintweit 6816* (G); Banyla, 9000 ft, 24.7.1876, *Clarke 29559* (BM: top left specimen); Nanga Parbat (see Troll 1939, 1967); Karpuchu valley, 11000—12000 ft, 9.7.1892, *Duthie s.n.* (BM: lower specimen, E); Hushe valley, Ghondakoro glacier basin at the foot of the Masherbrum, 3350 m, 22.7.1955, *Webster & Nasir 6259* (G). KASHMIR: unknown locality, 1874, *Jacquemont 1046* (G); Ladakh: Chunagund, 25.8.1940, *Stewart 21043* (DD); Kargil, 2800 m, 7.9.1970, *Bhattacharyya 41201* (BSD); Menchigam on Kargil-Saxi road, 3200 m, 5.9.1975, *Viswanathan 55658* (BSD); Drass-Kargil road, 9500 ft, 23.7.1977, *Stainton 7980* (E); Drass valley, 24.6.1870, *Yarkand expedition 1070* (K); Sind valley: above Baltal, 10000 ft, 12.6.1927, *Lambert 163* (DD); below Sonamarg, 2.7.1978, *Gadsar & Stewart 19666* (RAW); Srinagar, Sind valley, s.a., *Lancaster 52* (BM); near Sonamarg, s.a., *Lancaster s.n.* (E); Kangan, 6000 ft, 25.7.1891, *Gammie s.n.* (DD); ibid., 1820 m, 28.8.1917, *Stewart 3380* (MO); Bonzilla (Haripora), 2200 m, 17.5.1983, *Dar 5126* (KASH); Manasbal range, 2.6.1927, *Lambert 158* (DD); Gurais, 3.—4.10.1856, *Schlagintweit 7609* (M); ibid. 2420 m, *Stewart 19623* (RAW); ibid., Dawar to Chorwan, 12.8.1989, *Showkat Ara 9555* (C, KASH). HIMACHAL PRADESH: Lahul: Dartse to Tsanskar Sumdo, 17.6.1856, *Schlagintweit 4109* (M); ibid., unknown locality, 11.8.1864, *Brandis s.n.* (M); Keylang, 11000 ft, 11.8.1916, *Cooper 5365* (M); ibid., 11000 ft, 8.6.1941, *Bor 14717* (DD); ibid., 3100 m, s.a., *Bhattacharyya 40714* (BSD); ibid., 3000 m, 6.—8.8.1971, *Bhattacharyya 45180* (BSD); ibid., s.a., *Bhattacharyya* 45352 (BSD); Jispa, 3180 m, 31.5.1939, *Parker 3449* (DD); Jahlma, Pattan valley, 9500 ft, 10.6.1958, *Sethi & Negi 254* (DD); ibid., 12.6.1958, *Sethi & Negi 311* (DD), *312* (DD). UTTARANCHAL: Garhwal: Malari Dhauli valley, 9200 ft, 15.5.1914, *Osmaston 317* (DD); Tehri Garhwal, Gangotri,

10000—11000 ft, 20.8.1897, *Keshavanand* 22 (DD: lower specimen); Kumaon: Migam, 3480 m, s.a., *Strachey & Winterbottom 1* (LE); Nainital: 1938, *Champion s.n.* (DD No. 84025: seeds mostly 1 per cone).

Juniperus semiglobosa is a Central Asiatic species, occurring across the Turkestanian and the Western Himalayan Provinces of the Irano-Turanian Floristic Region (see Takhtajan, 1986). It appears to be the more frequent among the scale-leaved Junipers in our area ; extending from NE Afghanistan and N Pakistan from Swat through Gilgit, Hunza to Baltistan (see also Troll, 1939, 1967), and India from Ladakh through Kashmir, Himachal Pradesh to Kumaon in the Uttaranchal and Nepal, from an altitude of about 2000—4300 m. Despite this, it is not reported in most of the floristic works on Northwest Himalaya. This is because the (West-)Himalayan Pencil Juniper (with ± hemispherical female cones) has been misidentified mostly as *Juniperus macropoda* Boiss. (see, e.g., Hooker, 1888; Raizada & Sahni, 1960; Jain, 1976; Mehra, 1976, 1988; Polunin & Stainton, 1984; Stainton, 1988), sometimes also as *J. excelsa* M. Bieb. (see, e.g., Nasir & Nasir, 1987) or *J. polycarpos* K. Koch (Nasir *et al.*, 1969; Sahni, 1990). However, all three of the latter species have ± globose female cones and are now usually included in *J. excelsa* s.lat. In 1879, Regel described the Juniper with "semiglobose (hemispherical) berries" from Turkestan as a new species: *J. semiglobosa*. However, in the Indian subcontinent it continued to be known under one or the other of the above names, thereby leading to the confusion in its identification (Farjon, 1992). The majority of collections from this area we have seen under these names belong to *Juniperus semiglobosa*. Furthermore, the illustrations accompanying the descriptions of these misapplied names in the works of authors like Raizada & Sahni (1960), Jain (1976), Mehra (1976), Polunin & Stainton (1984), Nasir & Nasir (1987), and Sahni (1990) depict the typical terete foliage and hemispherical, sometimes almost bilobed, female cones of *J. semiglobosa*.

Juniperus semiglobosa is more common in our region as compared to *Juniperus polycarpos* whose frequency increasingly declines from Pakistan eastward along the Northwest Himalayan mountains till it stops occurring beyond Kunawar district of Himachal Pradesh. These two species may, however, occur together in some parts of our area (see Figs 7,8). *J. semiglobosa* is morphologically the most distinct species and can be distinguished from all other Juniper taxa occurring in our area by its hemispherical-triangular ovulate cones with apically diverging seeds (see Fig. 6 and Farjon, 1992).

In the North of its range it rarely exceeds 8—10 m in height, but in the Lahul Himalaya large trees of 15—20 m in height can be found. Likewise, trees with more than 2 m girth are hard to be seen at present, though specimens with over 10 m girth and estimated to be well over 1000 years old are reported from Lahul (Raizada & Sahni, 1960); this suggests a very slow growth. The species is said to be susceptible to the loranthaceous parasite *Arceuthobium oxycedri* M. Bieb., which causes considerable damage to trees making them die (Sahni, 1990).

There are still disagrements as to the synonymy of *Juniperus semiglobosa*. According to Farjon (1992, 1998) *J. talassica* Lipsky, *J. jarkendensis* Kom., *J. schugnanica* Kom., *J. drobovii* Sumnev. and *J. tianschanica* Sumnev. (see Komarov, 1934; Sumnevitz, 1948) are synonyms of *J. semiglobosa*, while Silba (1990) treated *J. talassica*, *J. jarkendensis* and *J. drobovii* as varieties of *J. semiglobosa*. Recently, Adams (1999) showed that based on terpenes and DNA *J. jarkendensis* is almost as distinct from *J. semiglobosa* as is *J. sabina* L.

Variability: In habit this species varies from a large tree, 15—20 m tall, through a medium-sized tree, 5—10 m tall, to a shrub which may be stunted, but not prostrate like *Juniperus polycarpos*, at higher altitudes. This variation is due to a variety of ecological factors, chiefly climate. Though the herbarium specimens seen by us are all dioecious (as has been reported by Mehra, 1976; Sahni, 1990), monoecious trees have also been reported (Nasir *et al.*, 1969; Nasir & Nasir, 1987). The scale leaves are usually with entire margins, but we have also noticed undulate to minutely denticulate margins in many cases under a strong lens. The number of seeds in ovulate cones varies from 1—4, though commonly it is 2—3.

This species is said to form hybrids with *Juniperus polycarpos*, *J. pseudosabina* and with *J. sabina* (Browicz & Zieliński, 1982).

6. *Juniperus wallichiana* Hook. fil. & Thomson [teste Parl. in DC., Prodr. 16, 2: 482 (1868), pro syn.] ex D. Brandis, Forest Fl. N.W. & Central India: 537 (1874). ≡ *Sabina wallichiana* (Hook. fil. & Thomson ex D. Brandis) W. C. Cheng & L. K. Fu, Fl. Reipubl. Pop. Sin. 7: 367 (1978). — Type: Hooker fil. & Thomson (K). Reported from Himalaya, 9000 – 15000 ft, from Indus to Sikkim.
= *J. pseudosabina* auct., non Fisch. & C. A. Mey. (1842).

Tree to c. 20 m in height, with a stout, dark trunk, or a gregarious shrub; dioecious. Main branches spreading-ascending, bushy, the ultimate twigs dense, smooth and cord-like, tetragonal, 1—1.5 mm in diameter. Scale leaves dark green, decurrent, opposite-decussate, arranged in 4 ranks, appressedly overlapping, incurved at apex; those on older twigs to 6 mm long, abruptly narrowing in the upper half into an acuminate tip; those on ultimate twigs narrowly elliptic to rhombic-ovate, 1.5—1.8(—2.2) × 0.7—0.9(—1) mm, subacute, with a furrow and gland for most part on the convex back, margins whitish, minutely denticulate at least towards base, epistomatic with one stomatiferous band on the concave upper surface. Juvenile leaves ternate, lanceolate-linear, forwardly spreading, 4—8 mm long, sharply pointed, pungent, upper surface concave and glaucous with a single whitish stomatiferous band, lower surface furrowed. Cones borne on short ultimate twigs. Male cones oval, 2—3 × 2 mm, yellowish. Female cones erect, very rarely recurved, but then erect and recurved ones on the same twig, ovoid-elliptic, (5—)6—10(—13) × 4—6(—8) mm, brown, maturing shining bluish-black, epruinose; pericarp somewhat succulent, ruminate, soft and thin, not resinous, often cleft or pored at apex on maturity. Seeds solitary, ovoid-elliptic, 4—6(—9) × 3—4(—5.5) mm, slightly compressed, especially above, into a flattish obtuse apex with a minute tip, longitudinally grooved, with 2—3 glandular pits above the base on either face and a shining collar-like strip across the apex, rugose-ruminate under a strong lens, the apex often exserted through the pericarp at maturity. 2n = 44 (Mehra, 1988). — **Fig. 9a-f.**

Additional illustration: Fig. 72E,F in Mehra (1988).

Distribution: Fig. 10. A native of the Himalaya from Kashmir eastwards to Bhutan. It occurs in drier areas from 2800—4600 m, sometimes forming low, open forests. In the western part of its range (Western Himalaya) it forms a clumpy shrub to 1 m in height on alpine slopes at the limit of tree vegetation, associated with *Betula utilis* D. Don and *Rhododendron campanulatum* D. Don. In the Eastern Himalaya, owing to excessive rainfall and humidity, it assumes the form of a tree up to 20 m (Sahni, 1990).

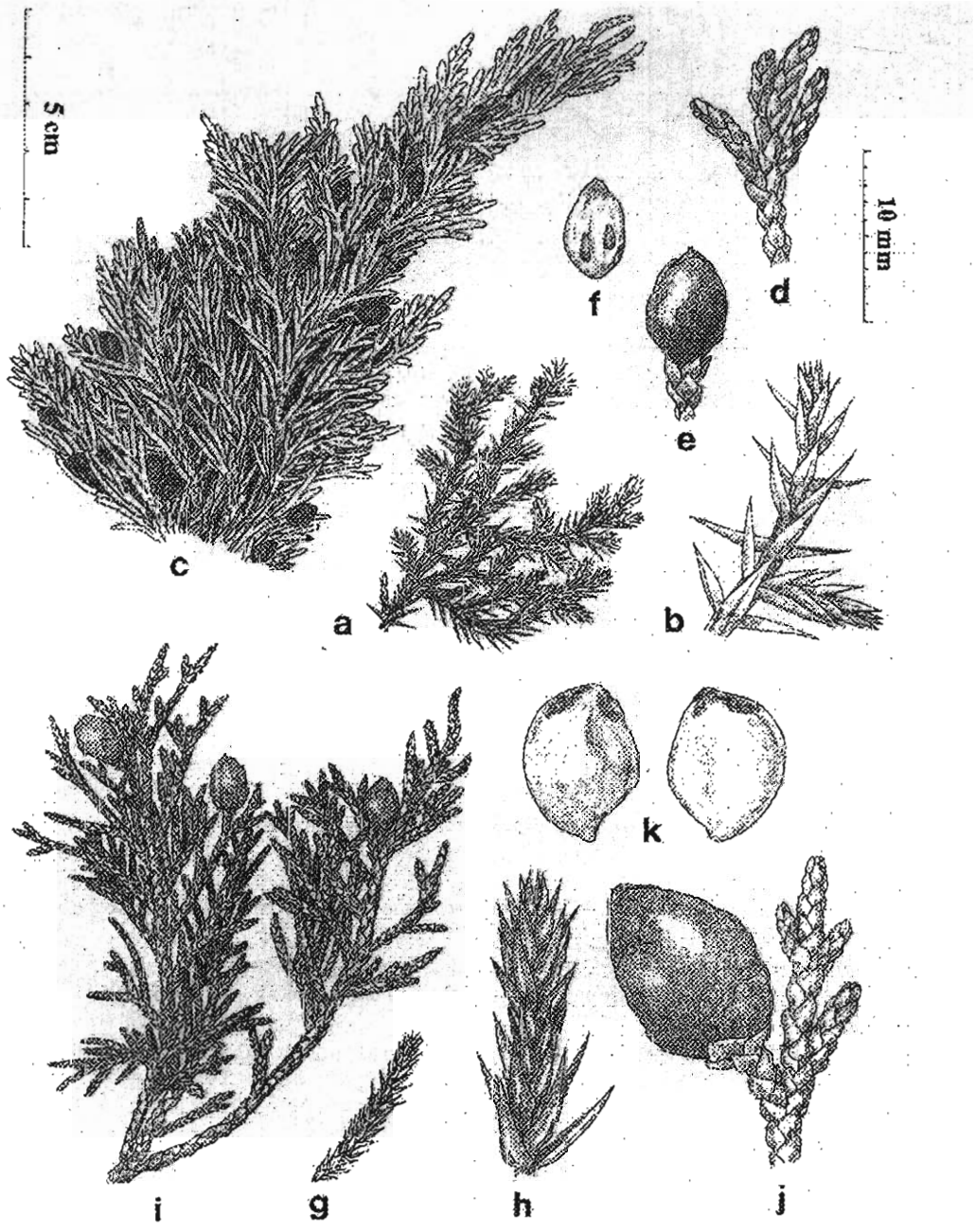

Fig. 9. *Juniperus*. **a-f.** *J. wallichiana*. **g-k.** *J. pseudosabina*. **a, g.** Juvenile foliage (5 cm scale). **b, h.** Details of juvenile foliage (10 mm scale). **c, j.** Cone-bearing branches (5 cm scale). **d, i.** Foliage of ultimate twigs (10 mm scale). **e, j.** Female cones (10 mm scale). **f, k.** Seeds (10 mm scale). — **a,b.** Dobremez 116. **c-f.** Duthie 359. **g, h.** Meebold 3268. **i-k.** Aldén 6032.

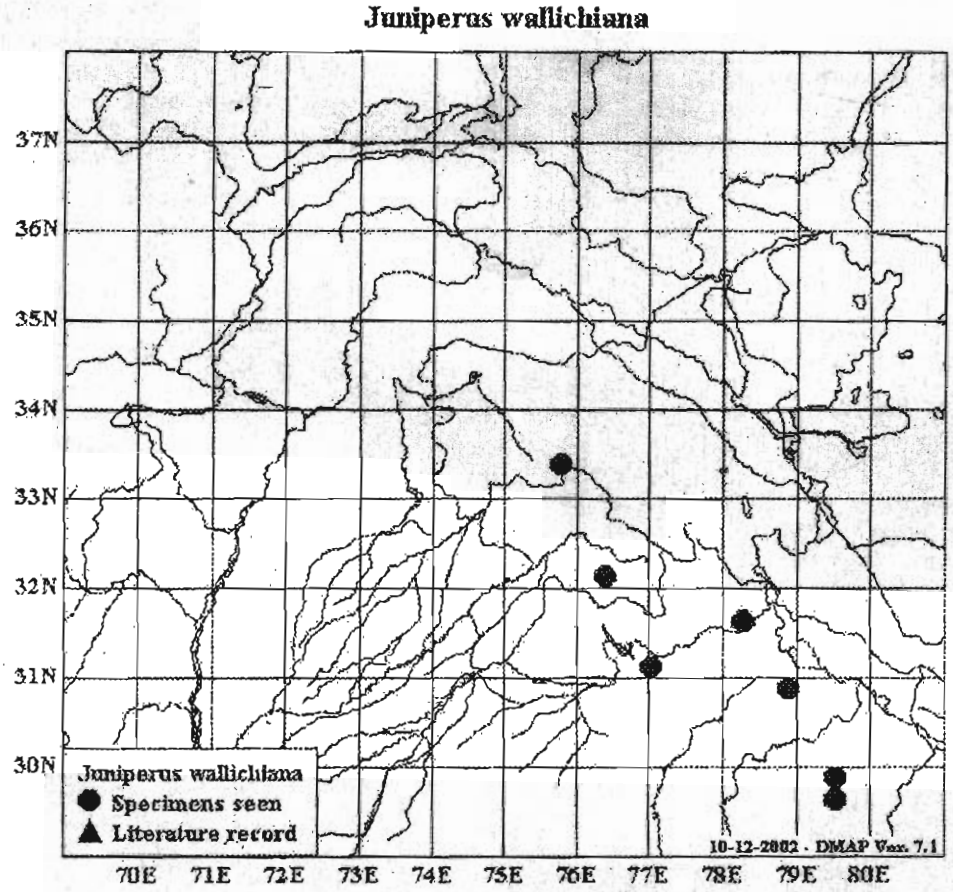

Fig. 10. Distribution of *Juniperus wallichiana* in the Western Himalaya based on specimens seen. DMAP for Windows (Morton, 2001).

Phenology: Flowering in April—May. Female cones ripen in August in the second year.

Common name: Black Juniper; J. D. Hooker collected specimens in Sikkim and called it Black Juniper as the trunks are very dark, almost black in colour. — Hindi: Bhil.

Economic utility: The wood is much used as firewood and burned as incense in Buddhist temples.

Representative collections

JAMMU & KASHMIR: Kishtwar: 10000—12000 ft, s.a., *Hooker fil. & Thomson s.n.* (C, UPS); ibid., 12000 ft, s.a., *Hooker fil. & Thomson s.n.* (M: lower specimen, upper one being *J. squamata*); Kashmir: unknown locality, 1937, *Smythe s.n.* (E). HIMACHAL PRADESH: Shimla (Bushaher State): Chhit Kul, 26.8.1934, *Parmanand 1098* (E); ibid., above Chini, 3600 m, 31.5.1928, *Parker 2925* (DD); Kulu: above Tosnal (Parbatti

valley), 11400 ft, 1.6.1934, *unknown collector 4018* (DD); Kangra: Kangra valley, Chhota Bengal, 13000 ft, 9.9.1955, *Vaid 24248* (DD); Lahul: between Chotadara and Chatru, 12000—12500 ft, 29.6.1958, *Sethi & Negi 511* (DD). UTTARANCHAL: Kumaon: Bageser to Munshari via Kathi and Namik, 5000—7800 ft, 24.—31.5.1855, *Schlagintweit 9787* (LE); Almora: Shelapani glacier (E Almora div.), 12000 ft, 13.6.1951, *Sahni 20506* (DD); Garhwal: Tehri-Garhwal, ridge above Garrglo, N side of Ganges valley, 11000—12000 ft, 27.7.1883, *Duthie 359* (G, LE); ibid, Chirbasa (Uttar-Kashi Forest Div. above Gangotri) 11700 ft, 8.6.1956, *Sahni 24977* (DD); Garhwal, Jelam, 8500 ft, s.a., *Strachey & Winterbottom 3* (LE: left hand specimen).

Juniperus wallichiana seems to have a limited distribution from SE Kashmir to Bhutan and SW China. Although reported to occur from Pakistan/Karakoram/Indus eastwards by various workers, the collections seen in the present study indicate that it is found only East of Kashmir. It is common in Sikkim and Nepal Himalaya, where it grows as a tree, and attains a bushy habit from Kumaon westwards. According to Nasir *et al.*, (1969) and Stewart (1972) this species is found chiefly east of Kashmir. Nasir & Nasir (1987), too, have excluded *J. wallichana* from their treatment of the gymnosperms of Pakistan.

Juniperus wallichiana is often misidentified as *J. pseudosabina* (see, e.g., Jain, 1976; Mehra, 1976, 1988; Mehra & Jain, 1976) but can be differentiated by the characters given in the key. It appears to form hybrids with *J. squamata* in the NW Himalaya.

Juniperus wallichiana and *J. indica* Bertol., are considered conspecific by Farjon (1998), but based on DNA evidence Adams (2000) have demonstrated that they are quite distinct.

7. *Juniperus pseudosabina* Fisch. & C. A. Mey., Index Sem. Hort. Petrop. 1842: 15, 65 (1842) ≡ *Sabina pseudosabina* (Fisch. & C. A. Mey.) W. C. Cheng & W. T. Wang, Acta Phytotax. Sin. 13,4: 75 (1975). — Type not located.

= *J. centrasiatica* Kom., Bot. Mater. Gerb. Glavn. Bot. Sada RSFSR 5,2: 27 (1924) ≡ *Sabina centrasiatica* (Kom.) W. C. Cheng & L. K. Fu, Fl. Reipl. Pop. sin. 7: 370 (1978). — Type: [Kirgizistan, Tien Shan,] 37° lat. 77° long., meridiem versus ab oppido Jarkend in loco Tochta-chon, jugi Kuenlun, 3000—4000 m, 1899, *V. I. Roborovski s.n.* (LE).

= *J. turkestanica* Kom., Bot. Mater. Gerb. Glavn. Bot. Sada RSFSR 5,2: 26 (1924) ≡ *Sabina pseudosabina* (Fisch. & C. A. Mey.) W. C. Cheng & W. T. Wang var. *turkestanica* (Kom.) C. Y. Yang, Fl. Reipubl. Pop. Sin. 7: 369 (1978) ≡ *J. pseudosabina* Fisch. & C. A. Mey. var. *turkestanica* (Kom.) Silba, Phytologia Mem. 7: 36 (1984). — Described from Uzbekistan, Samarkand Prov., Turkestansky Range.

= *J. turkestanica* Kom. var. *trisperma* Kom., Bot. Mater. Gerb. Glavn. Bot. Sada RSFSR 5,2: 27 (1924). — Type: [Uzbekistan,] Prov. Karategin, in jugo Petri Magni, vallis fluvii Sugran prope glacies aeternas, 8500 ft, s.a., *V. I. Lipsky 2709* (LE).

Tree to 16 m in height, with a dense crown, or a shrub less than 2 m and often prostrate; dioecious, rarely monoecious. Main branches suberect or horizontal; leafy twigs erect, stout and dense, mostly tetragonal, those of ultimate order 1.5—2 mm in diameter. Scale leaves decurrent, opposite-decussate, mostly arranged in 4 ranks, appressedly overlapping, slightly incurved at apex; those on older twigs to 8 mm long, abruptly narrowing in the upper half, apicular; those on ultimate twigs elliptic-rhomboid, 2—2.4 × 1—1.2 mm, subacute, with a prominent, dorsal, resinous gland, furrow indistinct, many leaves bluntly keeled on the back; margins whitish, minutely denticulate

to undulate under a strong lens. Juvenile leaves ternate, lanceolate-linear, forwardly spreading, 4—7 mm long, sharply pointed, upper surface concave and glaucous with a single whitish stomatiferous band, lower surface with a furrow. Cones borne on short ultimate twigs. Female cones erect, rarely slightly recurved, oblong to elliptic-oblong, (8—)10—15 × (6—)7—12 mm when mature, sometimes narrowing above into a beak-like apex, blackish, not or slightly pruinose, with succulent, ruminate flesh. Seeds solitary, oblong, globose-oblong to ellipsoid-globose, 7—10 × 5—7 mm, usually tapering towards base in a short point and obtusely rounded at apex, giving the look of a short-handled spoon, with a dark shining collar-like strip in the upper part and lateral grooves, rarely seeds 2 and with one side flat, very rarely the apex minutely pointed. 2n = 22 (Krogulevich, 1978). — **Fig. 9g-k.**

Additional illustrations: Fig. 4A,B in Nasir & Nasir (1987). Plate 25 in Sahni (1990).

Distribution: Fig. 11. Mongolia, China (Xinjiang), Kazakhstan, Kirgizistan, Uzbekistan, and northern parts of Pakistan. In our area it has been collected beyond Nanga Parbat, in Baltistan, Gilgit up to Chitral, in the arid, subalpine zone from 3000—4000 m.

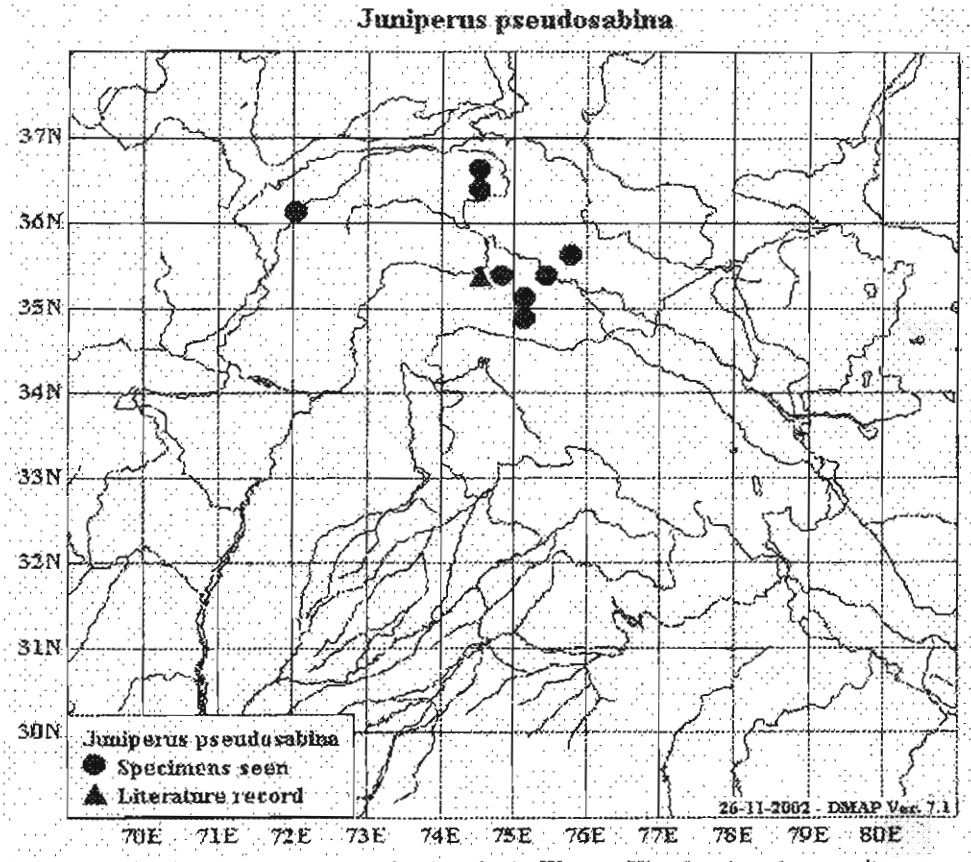

Fig. 11. Distribution of *Juniperus pseudosabina* in the Western Himalaya based on specimens seen and information in Troll (1967). DMAP for Windows (Morton, 2001).

Phenology: Flowering in April. Female cones ripen in August—September in the second year.

Common name: Turkestan Juniper.

Representative collections

NORTHERN PAKISTAN: Chitral: Barum glacier, s.a., *Chaudhri 248* (RAW); Gilgit: Balsoi valley above Chilas, 11000—12000 ft, 16.9.1893, *Duthie 14061* (BM); above Baltit, 12.8.1954, *Stewart s.n.* (RAW); upper Hunza, N-side of Batura glacier between camp 1 and Yashbar, 3000—3200 m, 5.9.1983, *Aldén 6032* (GB: the sheet has 2 specimens, one female cone (bigger one) on the upper specimen had 2 seeds with flat sides toward each other!); Naltar valley, above Naltar Rest House, 3150—3800 m, 8.10.1983, *Aldén 6500* (C, GB); near Sango Sar lake, 7 km of Astor, 3800—3950 m, 3.10.1983, *Aldén 6452* (C, GB); Baltistan: Satpura nullah, above Skardu, 13000—14000 ft, 2.8.1940, *Stewart 20231* (DD); ibid., Baltistan range, 3.8.1940, *Stewart 20323* (DD); Astor District, above Rama, 10000 ft, 27.7.1946, *Stewart 22913* (K); Burzila, 11000 ft, 8.1905, *Meebold 3268* (S); Bezirk Shigar, Curkjen Block, Skorotal, 3800 m, 20.3.1962, *Reiser 2* (Z); Lal Pir, above Sodpur, 3810 m, s.a., *Koelz 9556* (RAW); Nanga Parbat (see Troll 1939, 1967: 371).

Juniperus pseudosabina is a variable species which is sometimes divided into three species (see, e.g., Komarov, 1924, 1934): *J. pseudosabina* s.str., *J. centrasiatica* Kom., and *J. turkestanica* Kom. However, Adams & Turuspekov (1998) demonstrated on the basis of random amplification of polymorphic DNA, that the variation within the *J. pseudosabina* complex is continuous with no clustering into taxa, not even at the level of variety. *Juniperus turkestanica* and *J. centrasiatica* were also merged with *J. pseudosabina* by Farjon (1998).

Juniperus pseudosabina is said to form hybrids with *J. polycarpos* in places of their common occurrence (Browicz & Zieliński, 1982).

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