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Taxonomic Appraisal of Conifers of Kashmir Himalaya

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Abstract: The wealth of vegetation that adorns the earth shows a vast array of floristic diversity ranging from microscopic algae to gigantic *Eucalyptus*. Among these, gymnosperms, particularly conifers, constitute an important floristic component of evergreen forests by virtue of their multidimensional ecological and socio-economic values. In view of their immense importance, a thorough study has been undertaken to explore the conifers of Kashmir. During the present investigation, a total of 16 species, spread over 9 genera in 3 families, were recorded. Among these, the family Pinaceae with 7 species in 4 genera is the most dominant, while Taxodiaceae with 2 species in 2 genera is the least represented. Out of the total taxa 7 species, belonging to 5 genera, are exotic and exist in cultivation only.

Key words: Floristic diversity, gymnosperms, conifers, economic value, Kashmir

INTRODUCTION

Living gymnosperms are one of the great antiquity and include about 700-800 species in 70-75 genera. Among gymnosperms, conifers with about 550-600 species in 50 genera, form the most dominant group. Conifer forests are typical of Himalaya and provide a cool and soothing environment for recreation and health. Forests, verily the green gold of the State of Jammu and Kashmir, are dominated by conifers. These cover considerable proportion of the area of our State and contribute to its most important industries, hence the mainstay of economy. Most of the timber used in buildings is derived from conifers because of their straight-grain and ease of manipulation. Deodar is the strongest of the Himalayan coniferous woods; the blue-pine is much used in house construction and lighter furniture.

Notable as a source of pulpwood for paper manufacture are pines, firs and spruces. Conifers are effective for erosion control, protection of watersheds and wind control. Some conifers are source of foods (for wild life and birds), medicines, oils, dry fruits, ornamentals, bonsai, etc. Despite their immense ecological and socio-economic importance, taxonomy of conifers has met negligence in India, especially Kashmir Himalayan region. Even though Hooker (1888) gave the first treatment of gymnosperms in India, but he has cited very little material from this region. Since then, some local workers (for example, Lambert, 1933; Dhar, 1966, 1975, 1978; Stewart, 1972; Javeid, 1970, 1979; Singh and Kachroo, 1976; Sahni, 1990; Dar *et al*., 2002; Dar and Christensen, 2003; Dar, 2004) have also made attempts in this direction, but the overall picture is not complete. It is in this backdrop that the present study of conifers in Kashmir is attempted.

MATERIALS AND METHODS

During the present study various forests in the Kashmir Valley were explored every fortnightly from April 2002 to April 2003. For collection purposes, polythene bags, shears, tags, specimen bottles, field-note book were used. Four or five specimens of each species in a locality were collected in the form of twigs, usually cone-bearing ones. The specimens were assigned a specific field number and on spot diagnostic field characters were noted in the field-note book. The specimens were arranged in paper folds and pressed. The paper was changed after every 24 h until the specimens dried fully. In case of *Abies*, *Picea* and *Cedrus*, where all the leaves fall down the twigs a few days after direct pressing, the specimens were put in boiling water for one to two minutes prior to pressing, even then the needles fell. The method proposed by Page (1979) proved effective in these cases. The specimens were kept in 70% alcohol for 10 min and then transferred to 50% aqueous glycerol solution for 4 days. After this, the specimens were air-dried for sometime and placed in paper folds to be pressed as usual. The female cones of *Cedrus* and *Abies*, where cone scales fall while still on the tree, were collected just prior to dismembering stage and kept air-tight in small polythene bags, so as to keep them intact. The male cones

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were preserved in 70% alcohol for further study. The specimens were identified using the available literature on floristics of this region. The identifications were confirmed by matching our specimens with those deposited in the Kashmir University Herbarium at the Centre of Plant Taxonomy. For specimen description, specimens from different localities were examined minutely, using magnifying lens and dissection microscope. Numerical characters, wherever possible, were also taken into account.

Study area: The Valley of Kashmir is acknowledged as 'paradise on earth' for its diverse rationale. It lies between 33° 20' and 34° 54' N latitudes and 73° 55' and 75° 35' E longitudes. It extends roughly 107 km in length and about 116 km in breath along the latitude of Srinagar and covers an area of 15,948 sq km. It is believed that the Valley of Kashmir was once a lake called Satisar. The entire territories of Valley form two distinct topographic divisions, the mountain ranges and the Valley proper. Mountains vary in height and surround the Valley on all sides. The Valley is an oval plain with a girdle of mountains. There is sufficient organic matter and nitrogen content in the alluvium of the Valley as a result of plant residues, crop stubbles, natural vegetation and animal excretion. Himalayan ranges play the major and determinant role in determining the climate of the Valley. In general, the climate of Valley is sub-mediterranean with bixeric regimes. A unique feature of the climate is the four clear-cut seasons. Annual rainfall is about 75 cm, with sufficient rains during March and April and also July and August; precipitation in winter is in the form of snow. August is the warmest month, when temperature rises to 29.5°C; January is the coldest month. The maximum relative humidity (80%) occurs during November-December and lowest (71%) during May.

RESULTS AND DISCUSSION

Coniferales: Monoecious or dioecious trees, rarely shrubs. Photosynthetic leaves evergreen, rarely deciduous (*Larix*, *Taxodium*), spiral, distichous or whorled, solitary or in fascicles, entire, often needle-like, awl-shaped or scale-like, sometimes broad, ovate and parallel-veined (some *Podocarpus* spp.). Male cones terminal or lateral, microsporophylls with 2 (-20) pollen sacs. Female cones with a central axis having spirally arranged seed-scale complexes all around, ripening in 1-3 years.

About 50 genera with approximately 550 species; of these 30 genera are confined to the Northern hemisphere, 14 to the Southern hemisphere, whereas 6 genera are represented in both the hemispheres. Conifers are well represented in India, especially in the northern and eastern Himalayas.

Key to the families of conifers in Kashmir

1+ Photosynthetic leaves needle-like, spiral or fascicled, 2-5- angular, rarely bifacial; female cones elongated, bract- and ovuliferous- scales free, the latter with 2 inverted ovules; pollen winged ---------- --1. Pinaceae
1- Photosynthetic leaves awl-shaped or scale-like, spiral or opposite and decussate, usually bifacial or flattened; female cones short, bract- and ovuliferous-scales fused, the latter with more than two upright ovules; pollen wingless ----------2
2+ Shoots frequently with annual growth increments; female cones woody, with many (20-30) spirally arranged bract-and ovuliferous-scales; maturing in one season ----------2. Taxodiaceae
2- Shoots without annual growth increments; female cones woody or fleshy, with few, opposite and decussate bract- and ovuliferous-scales; maturing in two seasons ----------3. Cupressaceae

***Pinaceae*:** In India, the family is represented by 6 genera (Abies, Cedrus, Larix, Pinus, Picea and Tsuga), with 14 species. In Kashmir, it is represented by 4 genera with 7 species.

Key to the genera of *Pinaceae* in Kashmir

1+ Crown flat, round or dome-shaped; photosynthetic leaves in fascicles of 2, 3 or 5 (in ours), flexible; male cones clustered; female cones long-stalked ---------- 1. *Pinus*
1- Crown pyramidal or cylindrical; photosynthetic leaves in fascicles of 20 to 30 or solitary, stiff; male cones solitary; female cones short-to medium-stalked ----------2
2+ Leaves quadrangular; female cones pendulous, with medium-sized stalks; bract-scales persistent; seeds small, dark-brown ----------2. *Picea*
2- Leaves triangular or flat; female cones erect, with stout stalks; both bract-and ovuliferous-scales deciduous; seeds large, light-brown ----------3
3+ Shoots dimorphic; leaves needle-like, triangular, in fascicles on spurs and spiral on long shoots; male cones terminal, long; female cones barrel-shaped ----------3. *Cedrus*
3- Shoots monomorphic; leaves linear, bifacial, spiral; male cones axillary, short; female cones cylindrical ----------4. *Abies*

***Pinus* Linnaeus:** About 90-105 species, widely distributed in Northern hemisphere from the plains up to the limit of tree growth in Asia, North Europe and North America, to subtropical regions of North Africa, the Canary Islands, Central America, Florida, the Bahamas and British Honduras. In tropical countries, usually found at sub-tropical or warm-temperate altitudes, rarely in plains. In the Indian sub-continent, the genus is represented by 7 species, viz., *Pinus armandii*, *P. bhutanica*, *P. gerardiana*, *P. insularis*, *P. merkusii*, *P. roxburghii* and *P. wallichiana*. Of these, 3 species occur in our area.

Key to the species of *Pinus* in Kashmir

1+ Leaves in fascicles of 5; female cones cylindrical, long; bract-scales without any woody beak-like structure or transverse ridge --------1. *P. wallichiana*
1- Leaves in fascicles of 2 to 3; female cones oval or ovate, relatively short; bract-scales with a woody beak-like structure or transverse ridge ----------2
2+ Leaves in fascicles of 3, very long; female cones oval; bract-scales with a woody, beak-like structure; seeds dark-brown ----------2. *P. roxburghii*
2- Leaves in fascicles of 2, relatively short; female cones ovate; bract-scales with a central depression and a conspicuous transverse ridge on exposed portion; seeds light-brown ----------3. *P. halepensis*

***Pinus wallichiana*:** A.B Jackson in Kew Bull: 85. 1938.

Graceful tree, 35-50 m tall; trunk straight, 2-4 m in girth. Bark greyish-brown, shallowly fissured, forming oblong or avoid plates. Shoots dimorphic. Leaves needle-like, in fascicles of 5, persistent (2-4 years), 6-14 cm long, acute, spreading or drooping, bluish or greyish-brown, glaucous, triquetrous. Male cones in clusters, ovate, 1-2×0.5-1 cm, very short-stalked, consisting of numerous, spiral, stalkless, overlapping microsporophylls. Female cones terminal or sub-terminal, solitary or 2-3 together, cylindric, 10-20×4-8 cm, light-brown, 3-5 cm-stalked. Seeds winged.

Specimens examined: Fourbay (Ganderbal), hill slopes, 1800 m, 02.04.2002, A.R. Dar and G.H. Dar 01 (KASH); Gulmarg, forests, 2800 m, 15.05.2002, A.R. Dar and G.H. Dar 02 (KASH); Chitragul, forests, 1900 m, 25.05.2002, A.R. Dar and G.H. Dar 03 (KASH); Pahalgam, forests, 2134, 07.06.2002, A.R. Dar and G.H. Dar 04 (KASH); Aharbal, forests, 2850 m 06.07.2002, A.R. Dar and G.H. Dar 05 (KASH); Shankaracharya, hill slopes, 1650 m 12.07.2002, A.R. Dar and G.H. Dar 06 (KASH).

Economic utility: The timber is very useful in buildings, furniture, bridges, railway sleepers, pattern making, toys, paper pulp, etc. Blue pine is well known for useful joinery wood. By tapping, it yields an oleo-resin which by distillation furnishes turpentine and rosin. Residue of wood is used as charcoal.

***Pinus roxburghii*:** Sargent, Silva. N. Amer. 11. 1897.

Resinous, 40-50 m tall tree; trunk straight, 1-2 m in girth; crown spreading or umbrella-shaped. Bark brownish-red, thick, deeply fissured. Shoots dimorphic.

Leaves needle-like, in fascicles of 3, persistent (1-3 years), triquetrous, 8-20 cm long, acuminate. Male cones in clusters, cylindric or ovate, 1.5-4×0.4-0.7 cm, consisting of numerous, spiral, stalkless, overlapping microsporophylls. Female cones terminal or sub-terminal, solitary or in clusters of 2-5, oval, 6-9×4.5-7 cm, reddish-brown, short (0.5-1 cm)-stalked. Seeds winged.

Specimens examined: Botanical Garden, Kashmir University, 1600 m, 10-04-2003, A.R. Dar and G.H. Dar 12 (KASH); Lalpul (Uri), forests, 1200 m, 14-04-2003, A.R. Dar and G.H. Dar 13 (KASH); Shankaracharaya, hill slopes, 1650 m, 22-05-2003, A.R. Dar and G.H. Dar 52 (KASH).

Economic utility: The thick, soft bark is of value for tanning. The species is of considerable commercial importance for it is the principal resin-bearing pine of East. A sample of the charred leaves of this pine is preserved in the museum at Kew, with the information that they are used in that State as a dye.

***Pinus halepensis*:** Miller, Gard. Dict. ed. 8: 8. 1768

Less resinous, 25-30 m tall tree; trunk straight, 1-5 m in girth, gradually tapering. Bark reddish-brown, deeply and linearly fissured. Shoots dimorphic. Leaves needle-like, in fascicles of 2, persistent (2-3 years), slight and irregularly curved towards upper part, 5-11 cm long, acute, margins slightly incurving, minutely toothed, stomatal lines on both surfaces. Male cones in clusters, ovate or cylindric, 2-2.5×0.3-0.5 cm, very short-stalked, consisting of numerous, spiral, short-stalked and overlapping microsporophylls. Female cones lateral, solitary or 2-3 together, ovate-conical, 5-8×4-7 cm, dark-brown, short (1-1.5 cm)-stalked. Seeds winged.

This species exists only in cultivation in Kashmir.

Specimens examined: Shankaracharaya, hill slopes, 1650 m, 22-05-2003, A.R. Dar and G.H. Dar 51 (KASH); Gulmarg, 2800 m, Manju Kapoor (KASH).

Economic utility: Wood is of poor quality, coarse-grained and resinous. The timber is used for inferior kinds of carpentry joinery work, boxes, crates, mineprops, sleepers and telegraph poles. Wood also used as fuel and charcoal. Resin is of good quality. Bark used for tanning.

***Cedrus* Trew:** The genus comprises 4 species, viz., *Cedrus libani* (Lebnon), *C. atlantica* (Algeria and Morocco), *C. brevifolia* (Cyprus) and *C. deodara* (Western Himalaya). The morphological distinction between them is trivial and often they are regarded as geographical sub-species of *C. libani.* Only one species occurs in Kashmir.

***Cedrus deodara*:** (Roxb. ex. Lamb.) G. Don in London. Hort. Brit. 388.1830.

Pyramidal tree, 40-60 m tall; trunk massive, 3-5 m in girth. Bark brown, thick, deeply furrowed and broken into small, irregular or oblong plates. Shoots dimorphic. Leaves needle-like, in fascicles or tufts of 7-30, persistent (3-6 years), 2-6 cm long, stiff, acuminate, margins smooth, stomatal lines on all sides. Male cones solitary, cylindrical, 3-5×1-2 cm, composed of numerous, spiral, overlapping microsporophylls. Female cones solitary, barrel-shaped, 10-12×7-9 cm, reddish-brown, on 1.5-3 cm long stalks. Seeds winged.

Specimens examined: Fourbay (Ganderbal), forest slopes, 1800 m, 02.04.2002, A.R. Dar and G.H. Dar 14 (KASH); Kashmir University Campus, 1600 m, 25.06.2002, A.R. Dar and G.H. Dar 15 (KASH); Shanakaracharya, forest slopes, 1650 m, 25.06.2002, A.R. Dar and G.H. Dar 16 (KASH); Chandanwari (Uri), forest slopes, 1500 m, 13.08.2002, A.R. Dar and G.H. Dar 17 (KASH).

Economic utility: Deodar is the most important tree in the western Himalaya. It is the strongest of the Indian coniferous wood, weight for weight, about as strong as teak. It is available mostly in sleepers, through logs, scantlings and sleepers of other sizes are obtainable from timber depots. It is considered suitable for second grade pencils.

***Picea* Dietrich:** About 50 species, widely distributed in the temperate regions of the northern Hemisphere, occurring in North America, Europe, Asia Minor, the Caucasus, Siberia, the Himalaya, China and Japan.

In the Indian Sub-continent, 4 species have been reported namely *Picea smithiana* (Western Himalaya), *P. spinulosa* (Eastern Himalaya), *P. brachytyla* (Arunachal Pradesh) and *P. farreri* (N. Myanmar); of these, only the first one occurs in Kashmir.

***Picea smithiana*:** (Wall.) Boiss. Fl. Or 5: 700. 1881.

Pyramidal, 50-55 m tall tree; trunk gradually tapering, 5-8 m in girth. Bark reddish or greyish-brown, rough, superficially fissured into small plates. Shoot monomorphic. Leaves needle-like, spiral, spreading, persistent (3-6 years), 2-4 cm long, stiff, acute-acuminate. Male cones solitary, ovoid, 1.5-3×1.5 cm, very short-stalked. Female cones terminal, solitary, cylindrical, 7-13×3.5-6 cm, pendulous, dark-brown, on 3-5 cm long stalks. Seeds winged.

Specimens examined: Gulmarg, forests, 2800 m, 15.05.2002, A. R. Dar and G.H. Dar 20 (KASH); Naranag, forests, 1900 m, 15.09.2002, A. R. Dar and G.H. Dar 21 (KASH); Akhal, forests, 2250 m, 25.10.2002, A. R. Dar and G.H. Dar 22 (KASH); Ganderbal, forests, 1850 m, 18.05.1982, G.H. Dar 3635 (KASH).

Economic utility: The largest use of spruce is for pulpwood. Wood is rated as slightly or non-resistant to preservative treatment. It is used for framing material, generally millwork, boxes, crates and piano sounding boards.

***Abies* Mill:** Over 40 species, confined to temperate regions of the Northern hemisphere, but widely distributed in North America, Europe, North Africa and Asia from the Himalaya northwards. In more northern latitudes they occur even at sea level, but at a considerable elevation in the central and southern Europe, North Africa, Himalaya and Mexico.

Four species, viz., *Abies densa*, *A. delavayi*, *A. pindrow* and *A. spectabilis* occur in the Himalaya. Of these two species have been reported from Kashmir.

Key to the species of *Abies* in Kashmir

1+ Crown pyramidal or flat; young shoots pubescent; upper leaves pointed outwards and upwards forming v-shaped depression with branchlets visible from upper side; female cones oblong or ovoid-oblong ----------1. *A. spectabilis*

1- Crown narrowly cylindrical; young shoots without pubescence; upper leaves directed forwards, covering branchlets so that they are not visible from upper side; female cones cylindrical ---- 2. *A. pindrow*

***Abies spectabilis*:** (D. Don) Spach. Hist. Nat. Veg. Phan. 2: 422. 1842.

Pyramidal or flat, 50-60 m tall tree; trunk 1-3 m in girth. Bark dark-brown, fissured into long, narrow scales by deep narrow vertical grooves often running in spirals around the trunk, anastomosing at acute angles in older trees. Shoots monomorphic. Leaves linear, flattened, crowded, arranged in 3-4 rows on each side of branchlet, rigid, 2.5-6 cm×2.5-3.5 mm, rounded and emarginate, rarely entire and acute at apex. Male cones solitary, cylindrical,

shorter than or nearly as long as the leaves. Female cones solitary, oblong or ovoid-oblong, 8-12×3-6 cm, sub-sessile or short-stalked dark-purple. Seeds winged.

Specimens examined: Dachigam (Kashmir), 2700 m, 5.06.71, G. Singh, 4416 (KASH).

Economic utility: Wood is soft, easily worked, finishing with a good surface, taking paint and polish well and suitable for indoor finish of houses, the commoner kind of joinery, pit props, scaffold poles, matchwood, paper pulp. It is moderate or moderately low in shock resistance and nail withdrawal resistance.

***Abies pindrow*:** Royle III. Bot. Himal. T. 86, pp: 350-51. 1839.

Cylindrical, 45-55 m tall tree; trunk straight, 2-3 m in girth, tapering gradually upwards. Bark grayish-brown, deeply and longitudinally fissured. Shoots monomorphic. Leaves narrowly linear, flattened, spiral, spreading, acute, 1-7 cm×0.1 mm, apices bifid, margins recurved, two grayish bands of stomata on either side of shallow midrib. Male cones solitary, cylindrical, 1-2×0.3-0.6 cm, very short (0.2-0.5 cm)-stalked, consisting of numerous, spiral, short-stalked, microsporophylls. Female cones solitary, cylindrical, 8-15×4-7 cm, short (1-1.5 cm)-stalked, dark or reddish-brown.

Specimens examined: Thajwas, forest slopes, 2900 m, 8.09.2002, A.R. Dar and G.H. Dar 23 (KASH); Naranag, forests, 1900 m, 15.09.2002, A.R. Dar and G.H. Dar 24 (KASH); Akhal, forests, 2250 m, 25.10.2002, A.R. Dar and G.H. Dar 25 (KASH); Prang, forests, 1950 m, 18.06.1993, G.H. Dar 3630 (KASH).

Economic utility: Wood is exploited for lumber, plywood, framing, sheathing, sub flooring, concreate forms, decking, planking, beams, posts, sliding, paneling, millwork, prefabricated buildings and structural members, industrial crating, furniture parts, fresh fruit and vegetable containers.

***Cupressaceae*:** The family comprises about 19-20 genera with 125-130 species. About half of the genera are monotypic. It is perhaps the most widely distributed gymnosperm family, with about half of the genera confined to the Northern hemisphere and the rest to the southern hemisphere.

Juniperus and *Cupressus* are indigenous in Himalaya. *Callitris* has been introduced in the Nilgiris on plantation scale. *Thuja*, an exotic from China, is commonly planted in gardens in the sub-continent. *Calocedrus* was recorded from Myanmar, where it is rare. In all, 11 species of the family are represented in the Indian sub-continent. It is represented by 3 genera and 7 species in Kashmir.

Key to the genera of Cupressaceae in Kashmir

1+ Female cones globose or ellipsoid, bract-scale with central woody beak-like process on its outer surface; seeds winged ----------1. *Cupressus*
1- Female cones berry-like or ovoid-oblong, woody beak-like structure absent or terminal portion of bract-scale turned to hook-like structure; seeds wingless ---------- 2.
2+ Leaves awl-like or scale-like, spreading or appressed; female cones berry-like, fleshy, without or with a minute tip like structure----------2. *Juniperus*
2- Leaves scale-like, appressed; female cones ovoid-oblong, woody, with tip of bract-scale turned into a hook-like structure ----------3. *Thuja*

***Cupressus* Linnaeus:** *Cupressus* or the true cypress contains about 13 species distributed in North America, Mediterranean region, Sahara, Himalaya and China; two are native to Himalaya. In Kashmir, the genus is represented by 3 cultivated species.

Key to the species of *Cupressus* in Kashmir

1+ Bark whirled; branchlet system spreading than flat; foliage without bluish shine ----------1. *C. torulosa*
1- Bark not whirled; branchlet system flat than spreading; foliage with or without bluish shine ------2
2+ Crown pyramidal: branchlets quadrangular, with bluish shine; female cones with conspicuous bluish-white bloom, bract-scales with woody beak-like structure; seeds usually 3-sided, rarely flat. ----------2. *C. cashmeriana*
2- Crown columnar; branchlets quadrangular towards younger divisions only, without bluish shine; female cones without bluish-white bloom, bract-scales without woody beak-like structure; seeds usually flat, rarely 3-sided ----------3 *C. sempervirens*

***Cupressus torulosa*:** D.Don. Prodr. Fp. Nep. 55. 1825. Hook. f. FBI, 5: 645. 1888.

Tree, 20-30 m tall; trunk 1-2 m in girth, tapering gradually. Bark radish-brown, superficially fissured, mostly whirled/twisted in clock wise direction. Leaves, opposite and decussate, scale-like, closely appressed 2-3×1-2 mm, acute-acuminate, margins entire and slightly curved. Male cones solitary, terminal, ovoid, 2-6×2-3 mm, composed of 5-8 pairs of opposite and decussate,

imbricate microsporophylls. Female cones solitary or a few together, globose, 1.5-2×1-1.5 cm, short (4-5 cm)-stalked, composed of 6-10, opposite and decussate pairs of fused bract and ovuliferous scales, dark-brown. Seeds winged.

Specimen examined: Beehama (Ganderbal), forest slopes, 1800 m, 15.06.2002, A. R. Dar and G.H. Dar 41 (KASH); Botanical garden (Kashmir University), 1600 m, 13.03.2003, A.R. Dar and G.H. Dar 42 (KASH).

Economic utility: Wood is regarded equal to that of deodar and is used for sleepers, building purposes and often employed in the Himalaya for temples, images and poles for carrying the sacred arks. It is easy to be painted and polished, as it does not exude any oil. Next to deodar, after treatment, it is the best timber for pencil making.

***Cupressus cashmeriana*:** Royle ex Carriere Trait Gen. Conif. ed. 2: 161. 1867.

Pyramidal, 15-20 m tall tree; trunk 1-1.5 m in girth, tapering gradually. Bark light-brown, superficially fissured, peeling off in longitudinal strips. Leaves opposite and decussate, scale-like, closely appressed, 2-3×1-2 mm, acuminate, with bluish tinge on surface. Male cones solitary, terminal, ovoid, 4-6×5-2 mm, composed of 6-10 pairs of opposite and decussate microsporophylls. Female cones solitary, globose, 1.5-2×1.5-2 cm, light-brown, with conspicuous whitish bloom.

Specimens examined: Beehama (Ganderbal), forest slopes, 1800, 15.06.2002, A.R. Dar and G.H. Dar 36 (KASH); Rangil master plan, rocky slopes, 1850 m 15.06.2002, A.R. Dar and G.H. Dar 37 (KASH); Kashmir University Campus, 1600 m, 6.03.2003, A.R. Dar and G.H. Dar 38 (KASH).

Economic utility: It is a very graceful tree, worthy of introduction in parks and gardens, also as an avenue tree.

***Cupressus sempervirens*:** Linn. Sp. Pl. 1002. 1753.

Columnar or cylindrical, 5-15 m tall tree; trunk 1-1.5 m in girth. Bark greyish-brown, shallowly fissured. Leaves opposite and decussate, scale-like, closely appressed, 1-2×5-2 mm, acute, margin entire and incurving. Male cones solitary, terminal, ovate-cylindrical, 3-6×1-2 mm composed of 5-10 pairs of opposite and decussate microsporophylls. Female cones solitary or 1-2 together, ovate or globose, 2-3×1.5-2.5 cm, dark-brown, composed of 4-8 opposite and decussate pairs of fused bract and ovuliferous scales. Seeds winged.

Specimens examined: Rangil master plan, rocky slopes, 1850 m, 15.06.2002, A.R. Dar and G.H. Dar 29 (KASH); Kashmir University Campus, 1600 m, 16.03.2003, A.R. Dar and G.H. Dar 23 (KASH).

Economic utility: Wood is easily worked and very durable. It has long been used for building purposes and for furniture. The fragrant wood being obnoxious to insects, is said to keep moths away from clothes. It is sometimes, however, attacked by larvae of boring beetles.

***Juniperus* Linnaeus:** The genus *Juniperus* is one of the larger coniferous genera, comprising 60-70 species and is widely distributed in the temperate regions of the Northern hemisphere from Arctic circle to Mexico and West Indies, Azores, Canary Islands, North Africa, Ethopia, mountains of east tropical Africa, Himalaya, China and Taiwan.

In the Indian sub-continent, the genus is represented by 7 species, of which 3 species occur in Kashmir.

Key to the species of *Juniperus* in Kashmir

1+ Leaves jointed at base; female cones globose; seeds usually 3 per cone, irregularly 3-sided with at least one side flat ----------1. *J. communis*
1- Leaves not jointed at base; female cones ellipsoid, ovoid or semiglobose; seed 1 or 2(-3) per cone, 2 sided ----------2
2+ Dioecious; leaves scale-like, opposite and decussate, appressed; female cones semiglobose;seeds usually 2, rarely 3, ovoid or conical, diverging at apices ----------2. *J. semiglobosa*
2- Monoecoius; leaves subulate, spiral, spreading; female cones ellipsoid-ovoid; seeds 1, ovoid, straight at apices----------3. *J. squamata*

***Juniperus communis*:** Linn. Sp. Pl. 1040. 1753.

Shrub, 1-2 m high; stems many, spreading, decumbent or rarely upright. Bark reddish-brown, exfoliating in strips and plates. Leaves in whorls of 3, jointed at base, subulate, 0.6-1.5×0.2-0.3 cm, bifacial, acuminate. Male cones solitary, axillary, cylindrical, 0.3-0.7×0.2-0.3 cm, composed of 6-8 pairs of opposite and decussate microsporophylls. Female cones solitary, axillary, globose, 0.3-0.7×0.3-0.5 cm, composed of 3 to 4 pairs of opposite and decussate bract-and ovuliferous sacales, only few fertile.

Specimens examined: Fourbay, Ganderbal, forest slopes, 1800 m, 02.04.2002, A.R. Dar and G.H. Dar 30 (KASH); Sonamarg, open slopes, 2800 m, 10.08.2002, A.R. Dar and G.H. Dar 31 (KASH); Khilanmarg, Gulmarg, open slopes, 3000 m, 4.10.1980, U. Dhar 207 (KASH); Sangam, open slopes, 3600 m, 2.09.1982, U. Dhar 1093 (KASH); Nilnai,

rocky mountain slopes, 3650 m, 27.08.1983, G.H. Dar 8352 (KASH).

Economic utility: The twigs and leaves are used as incense in Punjab. A decoction of the branches is used as an anti-dandruff shampoo. It yields the resin "Sandarac" used in the protection of white varnish. It makes a good insect repellent.

***Juniperus semiglobosa*:** Regel. Trudy Imp. S-peterburgsk. Bot. Sada. 6(2): 487-488. 1879.

Small tree or shrub, 4-8 m tall; stem single, rarely many. Bark reddish-brown to grayish-brown, longitudinally furrowed, peeling off in longitudinal strips. Leaves opposite and decussate, scale-like, closely appressed, 0.2-0.4×0.3-0.4 cm, acuminate. Male cones solitary, terminal, cylindrical, 0.2-0.4×0.3-0.5 cm, composed of 5-8 opposite and decussate microsporophylls. Femalecones solitary, terminal, semiglobose to triangular, 0.3-0.6×0.4-0.9 cm. Seeds 2, rarely 3, per cone.

Specimens examined: Chitragul, forest slopes, 1900 m, 25.05.2002, A.R. Dar and G.H. Dar 26 (KASH); Sonamarg, forest slopes, 2800 m, 10.08.2002, A.R. Dar and G.H. Dar 27 (KASH); Gagangir, open slopes, 2200 m, 20.08.2002, A.R. Dar and G.H. Dar 28 (KASH); Kangan, orchards, 2300 m, 26.11.2002, A.R. Dar and G.H. Dar 29 (KASH).

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

***Juniperus squamata*:** Buch-Han ex. D. Don in Lambert, Genus *Pinus*, II: 17. 1824.

Shrub, stems many, prostrate, 1-2 m high. Bark reddish-brown, scaly, peeling off in longitudinal strips. Leaves subulate, 0.2-0.5×0.1-0.2 cm, bifacial, acuminate, margin entire. Male cones solitary, axillary, oval-ovoid, 0.2-0.5×0.2-0.3 cm, short (0.1-0.3 cm)-stalked. Female cones solitary, axillary, oval, 0.4-0.9×0.3-0.5 cm, composed of 2-4 pairs of opposite and decussate bract-and ovuliferous scales. Seeds one per cone.

Specimens examined: Apharwat, mountain slopes, 3700 m, 22.06.2002, A.R. Dar 32 (KASH); Sonamarg, forest slopes, 2800 m, 10.08.2002, A.R. Dar 33 (KASH); Razdani, open slopes, 22.07.1981, Dhar, Yousuf, Gupta 548 (KASH); Nilnai, rocky mountain slopes, 3650-3900 m, 27.08.1983, G.H. Dar 8350 (KASH); Zojila rocky mountains slopes, 3500 m, 30.07.1983, G.H. Dar 7525 (KASH).

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

***Thuja* Linnaeus:** A genus of 5 species, native to North America and Far eastern Asia (China, Korea and Japan). In India, as well as in Kashmir it is represented by one (cultivated) species.

***Thuja orientalis*:** Linn., Sp. Pl.: 1002.1753; ed. 2; 1422. 1763.

Pyramidal, small, 2-8 m tall tree or shrub; trunk 0.5 m in girth; bark reddish-brown, superficially fissured, peeling off in longitudinal strips. Leaves opposite and decussate, scale-like, closely appressed, imbricate, sessile, persistent, 1-3×1-2 mm, acute. Male cones solitary, terminal, ovoid, 3-7×2-5 mm, short (1-3 mm)-stalked. Female cones solitary or occasionally in groups of 2 or more, reddish-brown, short (0.6-1 cm)-stalked, composed of 3-5 pairs of opposite and decussate, fused bract-and ovuliferous scales. Seeds wingless.

Specimens examined: Kashmir University, Botanical garden, 1600 m, 16.03.1903, A.R. Dar and G.H. Dar 35 (KASH); University Campus, Kashmir University, 1600 m, 13.07.1970, G.N. Javeid 1153 (KASH).

Economic utility: Used as an ornamental.

Taxodiaceae: A family of 9 genera and about 16 species, widely distributed in north- temperate to subtropical region of both the old and New worlds, but with one genus present in the southern Hemisphere. *Taiwania cryptomeriodes Hayata* is the only species indigenous in Burma in the Indian sub-continent. *Cryptomeria* and *Taxodium* are exotics in India. In Kashmir, the family is represented by two genera with two species, both exotic.

Key to genera of Taxodiaceae in Kashmir

1+ Bark hard; leaves free; male cones axillary, clustered; female cones globular, bract-scales with no transverse ridge; seeds irregularly triangular, dark-brown ----------1. *Cryptomeria*

1- Bark spongy; leaves appressed at base; male cones terminal, solitary; female cones ovoid-oblong, bract-scales with transverse ridge on exposed portion; seeds oblong, light-brown --------2. *Sequoiadendron*

***Cryptomeria* D. Don:** Two or more species in Japan and China, geographically variable in each country and the

Chinese ones taxonomically rather poorly known. In India introduced on plantation scale in Darjeeling. The genus is represented in Kashmir by *Cryptomeria japonica*, cultivated on a very small scale.

***Cryptomeria japonica*:** D. Don in Trans. Linn. Soc. London 18.167t 13.f.I 1841.

Pyramidal, 25-30 m tall tree; trunk 1-1.5 m in girth, tapering gradually. Bark reddish-brown superficially and linearly fissured, peeling off in longitudinal strips. Leaves spirally arranged in 5 ranks, spreading, awl-shaped, 2-1×1-2 mm, spreading, acute-acuminate, margin entire. Male cones in clusters of 10-20, oval, 4-1×2-4 mm, composed of many spiral, microsporophylls. Female cones terminal, solitary, globose, 1.5-3×1.5-2.5 cm, reddish-brown, composed of 25-30 bract- and ovuliferous scales arranged in 4-5 whorls. Seeds wingless.

Specimens examined: Kashmir University Botanical Garden, 1600 m, 10.04.2002, A.R. Dar 34 (KASK); Botanical Garden, University of Kashmir, 1600 m, 1979, A.R. Naqshi and G.N. Dar 6808 (KASH).

Economic utility: Timber is used extensively in Japan for staves, tubes, casks and for building and furniture. Wood can be used for making cheap toys, light packing cases and partitions. It in not suitable for plywood. It is used for toy boxes.

***Sequoiadendron*:** (Lindley) Buchholz

A single living species of limited natural range in western North America (California, along the western slopes of the Sierra Nevada). Individuals of *Sequoiadendron* are the most massive and the tallest known living trees, reaching 105 m in height and 12 m in girth.

In the study area one tree of *Sequoiadendron giganteum* grows in the Yarikha Drug Farm, Tangmarg (2,154 m).

***Sequoiadendron giganteum*:** (Lindley) Buchholz in Am. J. Bot. 1939, xxxvi 536.

Table 1: Conifers growing as wild in Kashmir Himalaya

Name of order	Name of family	Name of genus	No. of species	Name of species
Coniferales	Pinaceae	*Pinus*	2	*P. ewallichiana*
				P. roxburghi
		Cedrus	1	*C. deodara*
		Picea	1	*P. smithiana*
		Abies	2	*A. pindrow*
				A. spectabilis
	Cupressaceae	*Juniperus*	3	*J. communis*
				J. sqamata
				J. semiglobosa

Table 2: Conifers cultivated in Kashmir Himalaya

Name of order	Name of family	Name of genus	No. of species	Name of species
Coniferales	Pinaceae	*Pinus*	1	*P. halepensis*
	Cupressaceae	*Cupressus*	3	*C. torulosa*
				C. cashmeriana
				C. sempervirens
		Thuja	1	*T. orientalis*
	Taxodiaceae	*Cryptomeria*	1	*C. japonica*
		Sequoiadendron	1	*S. giganteum*

Tree, 20-22 m tall; trunk 2-3 m in girth. Bark dark-brown, spongy, furrowed. Leaves awl-like, 4-6×1-2 cm, appressed at base, spreading towards tip, acute, margins entire. Male cones solitary, terminal. Female cones solitary, terminal, oval-ellipsoidal, 5-7×4-5 cm, composed of many spiral, bract-and ovuliferous scales.

Specimens examined: Tangmarg, Gulmarg, drug farm, 2154 m, July 1975, G.L. Dhar (KASH).

Economic utility: The timber is not durable and is used variously in Britain, it has been introduced as an ornamental and an avenue tree; the timber is produced quickly.

Wild and cultivated conifers: The conifers of Kashmir Himalaya can be categorized into wild and cultivated, as detailed in Table 1 and 2.

DISCUSSION

From the present investigation it appears that conifers of Kashmir comprising of 16 species in 9 genera and in 3 families, represent a handsome proportion of species of conifers found in India. Although conifers of Kashmir represent only a meager proportion of total species count of plants (angiosperms, gymnosperms and others) of Kashmir, still they exclusively dominate the forest vegetation of this area. Some species namely, *Pinus wallichiana*, *Cedrus deodara*, *Abies pindrow* and *Abies spectabilis* etc. form the most important sources of the timber for construction purposes and hence forming the backbone of the timber industry-the mainstay of the States economy. The other aspects of the gymnosperm species such as medicinal, ethno botanical and economical have great potential and market demand. The medicinal properties of the berries of *Juniperus communis* and other species can be of great potential, especially when our sub alpine and alpine landscapes are exclusively dominated by the shrubs of these species.

In the present study, it has been found that there is complexity in genus *Abies*, as besides the two species, i.e., *A. pindrow* and *A. spectabilis* there exists many hybrids between them in Kashmir Himalaya, and has a

great promise for further research. These hybrids show various degrees of intermediacy in characters, such as bark, leaves (arrangement, apex notching, margin recurving, groove prominence), cone characteristic (axis length, thickness, swollen or pointed tips).

In case of genus *Juniperus*, it has been found that *J. recurva* reported by previous workers from our area (Hooker, 1888; Gamble, 1902; Gaussen, 1968; Singh and Kachroo, 1976; Sahni, 1990), is actually *Juniperus squamata*. Furthermore *J. macropoda* reported from northern Himalaya under various names (e.g., *J. excelsa*, *J. polycarpos*) by various workers (Lambert, 1933; Raizada and Sahni, 1960; Sahni, 1990) has been found to be actually *J. semiglobosa*, an entirely distinct species (Dar *et al*., 2002). *J. pseudosabina* has been reported from Kashmir by many previous workers (Lambert, 1933; Gaussen, 1968; Mehra, 1988; Hooker, 1888; Gamble 1902), but we have not found it in the Valley. The present communication is an attempt to provide exact documentation of the conifer flora of Kashmir Himalaya. Out of total, 9 species in 5 genera and 2 families occur as wild (Table 1) and 7 species belonging to 5 genera in 3 families (Table 2) exist in cultivation and are cultivated in garden, parks, open rocky slopes where other trees hardly flourish. Over the years it has been found that these cultivated conifers have established themselves with ease and flourish well. Certain cultivars (*Pinus halepensis*, *Cupressus torulosa*, *C. semperverens*, *Thuja orientalis*) have grown into small forests at some places, depicting that these have got bright prospectus in this region.

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