ANATOMICAL STUDIES OF JUNIPERUS COMMUNIS L. SSP. COMMUNIS AND J. COMMUNIS L. SSP. NANA SYME

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SUMMARY

The wood descriptions of *Juniperus communis* L. ssp. *communis* are compared with those of earlier authors. The average and maximum tracheid lengths and the ray height distribution frequencies offer a means of separating the wood of the erect *J. communis* L. ssp. *communis* from that of the subspecies *nana* Syme with an entirely different habit.

1. INTRODUCTION

Except for a few species such as the American Pencil cedar *Juniperus virginiana* L. (RECORD 1934) and the African Pencil cedar *J. procera* Hochst. ex Endl. (DALE & GREENWAY 1961), the wood of *Juniperus* is not of commercial importance (PHILLIPS 1948). Its common occurrence, however, has made it worthwhile to be included in important keys (TANG 1935).

Juniperus communis L. spp. *communis* is found in the sub-arctic floristic areas, parts of Europe and in parts of Asia. The distribution is given in more detail by PILGER (1926). HULTÉN (1964) states that *J. communis* is an arctic-montane circumpolar plant with major gaps only in the Bering Sea region and around Obi Bay. The wood has been frequently described. Best known, in Europe at least, are the descriptions made by GREGUSS (1955) and JACQUIOT (1955). Specimens from such high mountain regions as the North-West Himalaya, where it occurs at 1600–4200 metres elevation, have also been described by RUSHTON (1915).

Following the Dutch botanical expeditions to East Greenland in 1968 and 1969, a number of wood specimens including *Juniperus communis* L. ssp. *nana* Syme, collected in the Angmagssalik area, became available. Later, during recent excursions, wood of the same subspecies was collected in Ireland and in the Swiss and French Alps. Bearing in mind the problems at the specific and subspecific levels, and in spite of existing controversy over the value of such anatomical features as tracheid length (DINWOODIE 1961), it was decided to investigate the anatomy of this subspecies of an entirely different, prostrate habit, and attempt a comparison with the erect *Juniperus communis* L. ssp. *communis*. Samples of the latter were obtained from Belgium, The Netherlands and the French Alps.

2. MATERIALS

Material is listed in *table 1*, which includes particulars about the diameter of specimens. The number of growth rings and a note on eccentricity are also given for easier reference.

3. DESCRIPTION OF THE WOOD

Juniperus communis L. ssp. *communis*

The growth rings are often irregular but distinct, with a relatively sudden transition from early to late wood, except where compression wood is present in which case the transition is more gradual.

The tracheids are normally angular in transverse section with frequent intercellular spaces. Where specimens are eccentric, the tracheids are rounded, intercellular spaces are more pronounced, and marked checking is present. Tracheid measurements: wall thickness in early wood (1)1.5–2(3) μm; in late wood (1.5)2–2.5(4) μm. Lumen averages 12–16 μm in the early wood; in late wood 1–6 μm radial, 10–14 μm tangential. Lengths: see *table 2*.

The bordered pits are mostly arranged in one row on the radial walls; on the tangential walls the pits are smaller and less numerous, especially in the early wood. The pit sizes in the early wood vary from 10–16 μm, the apertures are usually 4–5 μm.

The wood rays are uniseriate, only occasionally biseriate or partially biseriate, consisting of procumbent cells; square cells are rare. The end walls are often nodular and indentures are present but rare. The height of the rays is generally 1–5 cells, (20–90 μm). More information on height and distribution is given in *table 2*. Cross-field pits are cupressoid; 1–2 pits per cross-field, 3–4 pits in the marginal cells.

Parenchyma is relatively abundant, and is most frequent at the beginning of the late wood *(fig. 1)*. The strands range from 2–18 cells, see *table 2*. A type of zoning occurs where parenchyma is almost completely lacking in a large number of adjacent growth rings.

Juniperus communis L. ssp. *nana* Syme

The description is comparable to that of *Juniperus communis* L. ssp. *communis* with the following modifications. The tracheid lumen is slightly narrower, 12–14 μm in the early wood; 2–5 μm radial, 10–12 μm tangential in the late wood. Tracheid lengths are shorter, see *table 2*. Although specimens Uw 15992 and Uw 16004 are eccentric, there is no evidence of compression wood, whereas the customary checking that accompanies compression wood is present in two only slightly eccentric specimens, Uw 16003 and Uw 16009. The ray distribution frequencies are noticably different *(table 2)*. In the parenchyma, there is a slight variation in the number of cells per strand; this is made clearer in *table 2*. The zoning previously mentioned is more marked *(fig. 2)*.

Table 1. Collections, localities, diameters, number of growth rings, and eccentricity of specimens.

Wood Collection number	Collection		Locality	Diameter of stem (mm)	Number of growth rings	Eccentricity
Juniperus communis L. ssp. *communis*						
UNw 381	RIVON		Netherlands	–	64	None
UNw 469	J. Willems 1968		Belgium	21 (Branch)	17	Slight
UNw 508	E. A. Mennega 1971		Netherlands	16	33	None
Uw 20229	Student exc. 1971	No 1725	France, Savoie near Lanslevillard–Bessans: 1650 m	25	29	None
Uw 20231B	Student exc. 1971	No 1738	France, Savoie, val de l'Avérole: 1900 m	21	34	Marked
Juniperus communis L. ssp. *nana* Syme						
Uw 9207	J. van der Burgh 1962		Switzerland, Graubünden: 2100 m	9.5	16	Slight
Uw 15992	Daniëls, De Molenaar & Ferwerda 1969	No 278	Greenland	38	128	Excessive
Uw 16003	Daniëls, De Molenaar & Ferwerda 1969	No 22	Greenland	14	91	Slight
Uw 16004	Daniëls, De Molenaar & Ferwerda 1969	No 23	Greenland	15	98	Marked
Uw 16009	Daniëls, De Molenaar & Ferwerda 1969	No 279	Greenland	11.5	45	Slight
Uw 18610	Student exc. 1971		Ireland, Meenaun: 400 m	7	11	Slight
Uw 18611	Student exc. 1971		Ireland, Craoghaun: 400 m	4.5	24	None
Uw 20223	Student exc. 1971	No 1700	France, Savoie, barrage du Mt. Cenis: 2000 m	15.5	46	Marked
Uw 20225	Student exc. 1971	No 1702	France, Savoie, barrage du Mt. Cenis: 1995 m	13.5	53	None

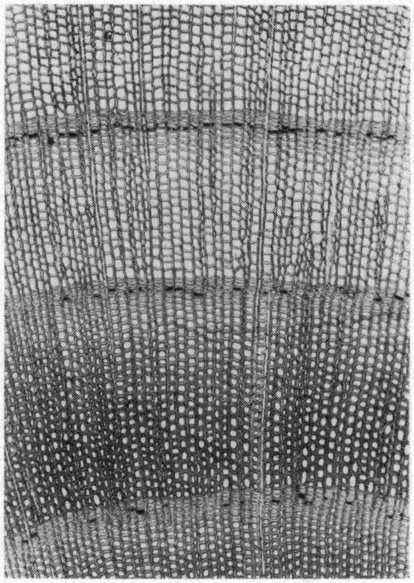


Fig. 1. *Juniperus communis* ssp. *communis*. Transverse section showing parenchyma distribution, × 80.

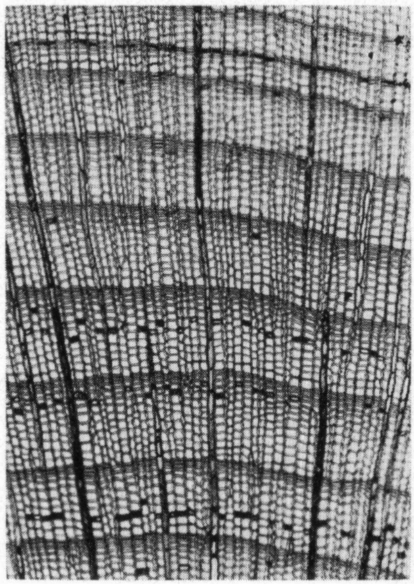
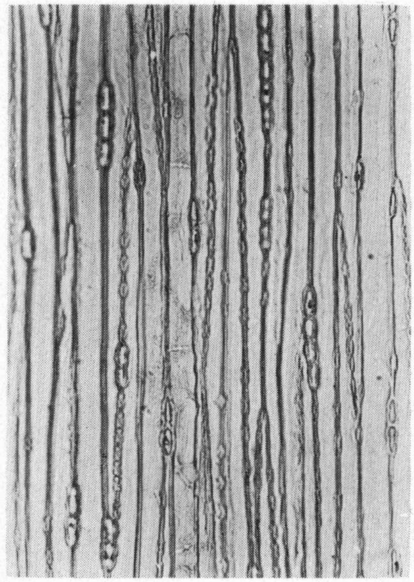


Fig. 2. *Juniperus communis* ssp. *nana*. Transverse section showing parenchyma zoning, × 80.



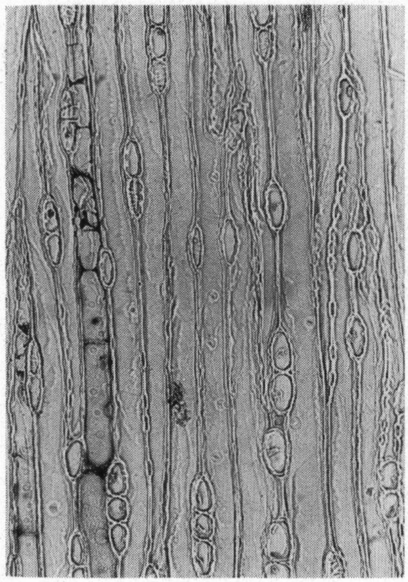


Fig. 3. *Juniperus communis* ssp. *communis*. Fig. 4. *Juniperus communis* ssp. *nana*. Tangential sections illustrating ray height distribution frequencies, × 200.

Table 2. Measurements of tracheid lengths, ray heights, ray distribution and, parenchyma strands.

Wood collection number	Tracheid length (μm)			Rays								Parenchyma cells per strand	
	Min.	Max.	Average	Height			Ave. cell breadth (μm)	Distribution frequency (%)					
				Max. no. of cells	Max. (μm)	Ave. (μm) per cell		1	2 (cells high)	3	4+	Max.	Average
UNw 381	1100	2300	1750	24	450	19.3	8.7	10	33	13	48	16	10
UNw 469	300	1450	970	14	230	17.5	9.0	10	22	20	48	10	6
UNw 508	575	2050	1380	13	210	17.8	8.7	10	50	17	33	18	14
Uw 20229	420	2050	1200	14	230	21.1	9.3	21	50	13	16	9	6
Uw 20231B	480	1950	1100	16	255	19.3	8.0	10	35	18	37	8	6
Uw 9207	325	1180	785	38	770	20.9	11.5	30	35	15	20	13	8
Uw 15992	400	1600	1100	14	260	20.0	10.5	25	40	15	20	9	7
Uw 16003	400	1600	985	9	225	21.2	11.5	45	35	–20–		9	5
Uw 16004	325	1550	1050	8	160	20.1	10.1	40	35	–25–		9	6
Uw 16009	325	1450	910	8	195	20.4	11.0	40	40	–20–		8	6
Uw 18610	240	1350	750	20	340	20.6	10.3	24	28	15	33	12	8
Uw 18611	325	1350	875	18	320	21.2	11.3	43	37	12	8	10	7
Uw 20223	250	1230	680	15	280	20.1	10.3	26	35	19	20	9	6
Uw 20225	325	1450	880	14	320	25.2	14.0	48	31	14	7	8	6

4. DISCUSSION

The descriptions made previously of *Juniperus communis* L. ssp. *communis* are found to be much in agreement. In general the measurements given by RUSHTON (1915) and BUDKEWIEZ (1934) vary little from the more recent numerical results of KAEISER (1953), GREGUSS (1955) and JACQUIOT (1955). However, on reviewing the literature, a number of points encountered should be examined.

Wide fluctuations in ray height were noted long ago by ESSNER (1883). PEIRCE (1937) concluded that only extremely low or high rays can be assigned diagnostic value. Rushton reported rays of maximum 20 cells high, Greguss 13 cells, Jacquiot 10 cells, and specimen Uw 9207 was found to have rays up to 38 cells high. It would appear, in the case of *Juniperus* at least, that the maximum number of cells should not be used as a diagnostic feature, especially in identification keys as was previously the case (BUDKEWIEZ 1934, TANG 1935). Similarly the differences in measurements obtained by various authors raise the question as to the validity of the ray cell height expressed in μm as used by Peirce. The measurements of the ray cell heights found in this investigation are supplemented by the cell breadth *(table 2)*, and both show a tendency to be greater in *Juniperus communis* L. ssp. *nana* Syme than in *J. communis* L. ssp. *communis*. However, the closeness of these results indicates the need for careful assessment of these features. Evaluation should therefore be made in conjunction with more reliable features.

The average ray height in number of cells has been used with varying degrees of success in softwood identification, although LEMOINE (1966) noted no noticeable difference in the number of cells when comparing ssp. *communis* with *J. communis* L. ssp. *hemisphaerica* Parl. In an attempt to expand the use of this feature, the ray height distribution frequency used by MILLER (1973) was applied to *J. communis* L. ssp. *communis* and to ssp. *nana*. There appears to be a significant difference between the ratio of one cell high rays to rays of two cells high in ssp. *communis* and in ssp. *nana*, irrespective of age or locality *(table 2)*. A comparison of the tangential sections is shown in *figures 3* and *4*.

Ray tracheids which are readily found in the Pinaceae, occur only sporadically throughout the Cupressaceae (RECORD 1934). BANNON (1934) found ray tracheids in *Juniperus* but the species are not listed, and as this was principally a study of the origin of ray cells rather than old wood, it cannot be considered to be of great significance as applied to this study. The present author was unable to find these cells and their presence was not reported by Greguss.

KENNEDY & WILSON (1954) found significant differences in the length of tracheids in two forms of *Abies lasiocarpa*, but DADSWELL & NICHOLLS (1959) stated that a considerable proportion of the variation in tracheid length between strains could be accounted for by variation within trees themselves. In *table 2* the maximum and average lengths of the tracheids appear to be significantly greater in ssp. *communis* than in ssp. *nana*, with the exception of specimen UNw 469. This specimen, however, was taken from a 2.5 cm thick outer branch, and differences in tracheid lengths in the branch and stem can be expected

(JACKSON & GREEN 1958). LEMOINE (1966) reported also shorter tracheids in the montane *J. communis* ssp. *hemisphaerica* than in ssp. *communis*. The measurements obtained by Lemoine from the branches between 3–5 years old, however, cannot be really compared with the results of the present study where wood of greater maturity was used.

Considering the collection localities, there is some variation within ssp. *communis*, especially in the larger specimen from The Netherlands, where the tracheids are longer. Within ssp. *nana* there is also a slight variation, but even after taking the factor of maturity into account, there appears to be a tendency for the specimens from Greenland to have slightly longer tracheids than those from more temperate zones. This last statement must be treated cautiously in the light of the small number of specimens examined and when considering SUSMEL's (1951) conclusion of his study on the Norway Spruce wood, when he stated that the mean length of the tracheids was much greater in trees of the Alpine forests than those growing in Sweden.

The wood of the Cupressaceae is characterised by relatively abundant parenchyma. These cells are normally found in long strands, but owing to the great length of the initials, the series are frequently so long that the strand character tends to be obscure. For this reason the cells have been frequently referred to as resin cells (RECORD 1934). The number of cells per strand is given in *table 2*, but as the amount of parenchyma occurring in coniferous woods never approaches the quantity as observed in many hardwoods (PHILLIPS 1948), it was not possible to obtain statistically reliable results. These figures must be considered therefore as approximations and should be cautiously interpreted.

The parenchyma in *J. communis* ssp. *communis* is frequently zonately disposed and often gives rise to fairly distinct concentric lines *(fig. 1)*. This zoning within one growth ring has been observed before by many authors and has also been described for other *Juniperus* species, such as *J. virginiana* L. (RECORD 1934). Another form of zoning was observed by the present author, namely a zoning over a number of rings *(fig. 2)*. It can be seen that a number of adjacent growth rings contain parenchyma, frequently in concentric lines, followed by a number of rings which are relatively free. This is more readily seen in J. *communis* ssp. *nana*, and sometimes these alternating zones may extend over as many as 35 growth rings.

ACKNOWLEDGEMENT

I am greatly indebted to Dr. Alberta M. W. Mennega for her help and encouragement during this investigation, and to Mr. Kuiper for his technical assistance.

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