WOOD ANATOMICAL VARIATIONS WITHIN THE GENUS *CASTANOPSIS*

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PANDE, P. K., CHAUHAN, L. & SINGH, M. 2005. Wood anatomical variations within the genus *Castanopsis*. Variations in wood anatomical characters of four species of *Castanopsis* from different localities were examined in relation to altitude and latitude. Variations were not significant due to altitude and latitude for fibre and vessel element lengths. Dimensions of different wood elements were not significantly correlated with rainfall, number of rainy days, altitude and latitude. Site-specific factors may have impact on variations in vessel arrangement, parenchyma distribution and presence/absence of broad rays, proportions of tissues and vessel element, and fibre lengths.

Key words: Vessel – fibre – dimensions – variations

PANDE, P. K., CHAUHAN, L. & SINGH, M. 2005. Variasi anatomi kayu dalam genus *Castanopsis*. Variasi ciri-ciri anatomi kayu bagi empat spesies *Castanopsis* daripada tempat berlainan dengan altitud dan latitud berlainan dikaji. Variasi disebabkan altitud dan latitud tidak bererti untuk panjang gentian dan panjang vesel. Tiada kolerasi diperhatikan antara anatomi kayu dengan jumlah hujan, bilangan hari hujan, altitud dan latitud. Faktor spesifik tapak mungkin memberi kesan kepada variasi dalam susunan vesel, taburan parenkima serta kehadiran/ketiadaan ruji lebar, perkadaran tisu, panjang elemen vesel dan panjang gentian.

Introduction

Castanopsis belongs to the family Fagaceae. It comprises about 120 species of evergreen trees, rarely shrubs, mostly distributed through tropical and subtropical Asia. In India, the genus is represented by six species occurring in Assam, West Bengal, Manipur, Nagaland and Sikkim. The species of *Castanopsis* in India are distributed between narrow latitudinal limits, i.e. 23–29° but range in altitude from 150 to 2100 m asl. Different species of *Castanopsis* are also subjected to different rainfall regimes with annual precipitation between 1845 and 4044 mm.

Presence/absence of broad rays is an important diagnostic feature of the family Fagaceae. Occurrence of broad rays in the Indian *Castanopsis* is still not clear. Gamble (1922) did not observe broad rays in Indian *Castanopsis*. Since then, no clear cut opinion was established about the presence or absence of broad rays in the genus. The absence of broad rays in *Castanopsis* is widely reported (Brandis 1921, Reyes 1938, Kanjilal *et al.* 1940, Desch 1941, Record & Hess 1943). Shimaji (1962) recorded

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the presence and absence of broad rays in the genus. Rao *et al.* (1991) also reported the presence and absence of broad rays even in different samples of the same species and tracked the loss of broad rays in some of the trees during the ontogeny of wood formation. While examining the occurrence of broad rays in *Castanopsis* species, they observed some variations in anatomical features among the species and surprisingly within the same species from different locations. This study was undertaken to examine the extent of qualitative and quantitative variations in wood elements between four commercially well-known species and also within single species of *Castanopsis.*

Materials and methods

Samples of species housed in the xylarium of the Forest Research Institute, Dehra Dun, were studied. The samples were either supported by herbarium specimens (BH) or not. In the case of samples backed up by herbarium specimen the herbarium specimen sheet number was quoted. Samples which were not supported by herbarium specimen (NBH) were checked with authentic samples. The herbarium samples were identified by the botanist of the Forest Research Institute. These samples were taken from the main bole of mature trees.

Castanopsis echinocarpa Syn. *C. tribuloides*: DDw 495 (NBH) West Bengal, DDw 3591 (NBH) West Bengal, DDw 6279 (BH/41865) Nainital, Uttaranchal, 8402 (BH/151557)Tirap, Arunahcal Pradesh.

Castanopsis indica: DDw 681 (NBH) Darjeeling, West Bengal, DDw 1254 (NBH) Assam, DDw 7336 (BH/15553), DDw 7676 Sibsagar, Assam, DDw 8261 (BH/lost) Kurseong, West Bengal.

Castanopsis lanceaefolia: DDw 1262 (NBH) Tejpur, Assam, DDw 5613 (NBH) Garo Hills, Meghalaya, F6583(NBH), Mayanmar.

Castanopsis purpurella Syn. *C. hystrix*: DDw 5844 (NBH) Darjeeling, West Bengal, DDw 7490 (NBH) Lakhimpur, Assam, DDw 7630 (BH/91360) Sibsagar, Assam, DDw 8269 (BH/lost) Kurseong, West Bengal.

Cross, radial and tangential sections were prepared and stained with haematoxylin and safranin. Variation in anatomical features was recorded for each sample. Macerations were prepared to determine the vessel element length, fibre length, tangential vessel element and fibre diameters. Their mean values were calculated from randomly collected data. Proportions of different tissues were determined using 10-point grid eyepiece micrometer. The proportion of tissue was measured in cross-sectioned rectangle area (3×1.5 cm). Data for precipitation were taken from Champion and Seth (1968). Terminology and measurements were taken according to the IAWA committee guidelines (1989). The collected data for vessel element length, fibre length, vessel element diameter, fibre diameter and wall thickness were analysed for differences between species and between samples of individual species using ANOVA. Two way ANOVA without replication was used for the determination of variance between species and their samples. Coefficients of correlation (r) were determined between altitude, latitude, precipitation, number of rainy days and different dimensions of wood elements, *viz.* fibre length, vessel element length, fibre diameter, vessel element diameter and wall thickness.

Results

General anatomical description

All anatomical details are presented in Table 1 together with values of latitude, altitude, precipitation and number of rainy days for each sample of *Castanopsis* species. The wood is light to moderately hard with straight to irregularly interlocked grain and yellowish grey to pinkish or reddish brown heartwood. The wood is diffuse porous but can also show ring-porous tendency. Growth rings are wavy, distinct to indistinct. Vessels are large to medium, almost exclusively solitary, gradually diminishing in diameter towards the latewood, arranged in a radial or oblique pattern, open or occluded with tyloses. The perforations are simple and the trachied pits are alternate, with wide border and short lenticular orifice, 7–10 µm in diameter. Pits to ray parenchyma are large, simple or with strongly reduced border, and variable in shape and size. Vasicentric tracheids present around the vessels with numerous oval bordered pits. Parenchyma is scanty paratracheal, diffuse-in-aggregates and also in concentric, fine, discontinuous wavy bands. Crystals are present in chambered axial parenchyma. Fibres are non-septate, with minute bordered pits present in radial and occasionally in tangential walls. Rays homocellular and of two types—(a) all narrow: uniseriate or occasionally 2–3 seriate and (b) of two sizes: uniseriate or occasionally 2–3 seriate plus broad, usually aggregate or compound, tall and very wide, or long and narrow with thick-walled cells.

Anatomical variations observed in different species

Castanopsis echinocarpa: Vessels are generally large, 43–300 µm in diameter, arranged in an oblique to radial pattern, sometimes medium large with a very weak pattern. The parenchyma is diffuse to diffuse-in-aggregates (sample numbers 3591, 6279 and 8402) but forming fine bands in latewood in sample number 495. The rays are mostly uniseriate and narrow compound or broad aggregate.

Vessel percentage varied from 12 to 30%. Parenchyma proportion varied from 26 to 37%. The ray percentage varied from 18 to 31% and fibre percentage varied from 23 to 26%.

Castanopsis indica: Vessels are generally arranged in oblique pattern but also show long radial arrangement (sample numbers 1254 and 7676), 43–299 µm in diameter. The parenchyma is diffuse and diffuse-in-aggregates tending to form fine uniseriate bands in latewood. The bands are more evident in sample numbers 7676 and 8261. Rays are exclusively uniseriate or 1–2 seriate in sample numbers 1254 and 7336, 1–3 seriate in sample number 7676 but uniseriate and short or long narrow aggregate rays present in sample numbers 681 and 8261.

Vessel percentage varied from 12 to 33%. Variation in parenchyma percentage was from 25 to 38%. The ray percentage varied from 19 to 25% and the fibre percentage, 22 to 36%.

Table 1 Anatomical features of *Castanopsis* species in relation to latitude, altitude and rainfall

Species	Acc No.	Locality					Vessel arrangement			Parenchyma		Ray		Proportion of tissue (%)				Mean fibre length (µm)		Mean vessel element length (µm)	Ray frequency
		Place	Latitude	Altitude (m)	Rainfall (mm)	No. rainy days	Radial	Oblique	No pattern	Diffuse-in-aggregate	Fine bands	Exclusively uniseriate	Uniseriate to aggregate	Vessel	Fibre	Parenchyma	Ray	Fibre diameter ± SD	Wall thickness ± SD	Vessel tangential diameter ± SD	
Castanopsis echinocarpa	495	Darjeeling, West Bengal	27° 3'	2100	3034	123	–	+	+	+	+	–	+ (+)	30	23	26	31	1530±69 (23±5)	4±1	662±65 (168±67)	4–8
	3591	Darjeeling, West Bengal	27° 3'	1900	3034	123	–	+	_	+	_	_	+ (+)	25	26	30	19	1470±78 (20±3)	4±1.3	595±70 (150±77)	3–6
	6279	Nainital, Uttranchal	29° 23'	1800	2516	92	+	+	_	+	_	_	+ (+)	24	24	34	18	1243±75 (25±4)	4.4±1	506±60 (174±69)	8–15
	8402	Tirap,Arunachal Pradesh	27° 33'	300	2792	135	_	+	_	+	_	_	+ (+)	12	23	37	27	1250±80 (21±4)	4±1	490±63 (163±58)	4–10
Castanopsis indica	681	Darjeeling, West Bengal	27° 30'	1500	3034	123	–	+	–	+	+	–	+ (+)	33	22	25	20	1245±70 (21±3)	5±0.4	535±50 (196±72)	3–4
	1254	Tejrpur, Assam	26° 40'	150	1845	105	+	±	–	+	+	+	R (R)	22	36	28	21	1240±70 (23±2)	4±1.3	400±49 (179±58)	7–11
	7336	Drrang, Assam	26° 45'	1200	2300	128	+	+	–	+	+	+	R (R)	15	26	38	21	1550±90 (21±2)	4±1	554±60 (170±70)	3–4
	7676	Sibsagar, Assam	26° 59'	150	2492	128	+	+	–	+	+	1–2	+ (N)	23	29	31	19	1396±60 (21±2)	5±1	403±43 (169±88)	2–4
	8261	Kureseong, West Bengal	27° 30'	1800	4044	132	–	+	–	+	+	–	+ (+)	12	31	32	25	1541±90 (21±2.5)	3.4±1	519±70 (172±54)	11–15
Castanopsis lanceaefolia	1262	Tejpur, Assam	26° 40'	150	1845	105	+	±	–	+	+	–	+ (+)	19	21	37	23	1635±80 (21±1.5)	4± 1	685±66 (198±73)	7–9
	5613	Garo Hills, Meghlaya	25° 30'	450	2600	135	±	+	–	+	+	+	– (R)	19	25	34	22	1446±85 (22±2)	5±1	598±68 (181±57)	7–10
	6583	Myanmar	–	–	–		–	+	–	+	–	1–2	– (–)	18	25	36	22	1539±76 21±1	4.5±1	610±63 (190±52)	7–9
Castanopsis purpurella	5844	Darjeeling, West Bengal	27° 30'	2200	3034	123	–	+	–	+	–	+	– (–)	18	30	32	20	1317±96 (25±5)	4±1	534±95 (165±54)	7–8
	7490	Lakhimpur, Assam	27° 14'	150	3437	130	+	±	–	+	+	–	+ (+)	24	27	25	23	1510±99 (23±3)	4±1	595±60 (179±89)	7–11
	7630	Sibsagar,Assam	26° 59'	150	2492	128	±	+	–	+	+	–	+ (+)	18	34	20	18	1350±60 (22±1)	4±1	475±55 (236±131)	7–9
	8269	Kurseong, West Bengal	27° 30'	2000	4044	132	–	+	+	+	+	+	– (–)	20	34	19	27	1420±78 (21±2)	4±1	630±59 (139±31)	3–8

R= rare, N= not studied by Rao *et al.*1991, (R)= reported by Rao *et al.* 1991
Values in the parentheses are corresponding values for rainy days.

Castanopsis lanceaefolia: Vessels large and medium large, 75–278 µm in diameter, arranged generally in an oblique pattern. The parenchyma is in fine, 2–3 seriate having wavy bands. The rays are exclusively uniseriate (5613) or uniseriate together with long and narrow aggregated rays (1262).

The relative proportions of different tissues, however, did not show much variations.

Castanopsis purpurella Syn. *C. hystrix*: Vessels are generally large to medium large showing mostly oblique arrangement, 43–363 µm in diameter, sometimes small with no particular pattern. The parenchyma is diffuse to diffuse-in-aggregates but also occurs as fine, wavy bands in sample numbers 7630 and 8269. Rays are exclusively uniseriate in sample numbers 5844 and 8269, and uniseriate with compound and aggregated rays in sample numbers 7490 and 7630.

Vessel percentage varied from 18 to 24%. The parenchyma percentage varied from 19 to 32% and the ray percentage, from 18 to 27%.

Discussion

The wood structure of *Castanopsis* is interesting in view of the presence/absence of broad rays. Broad rays were reported to be absent in *C. lanceaefolia* by Howard (1948) but Groome (1911) reported its presence. Shimaji (1954) reported the loss of broad rays in a poorly growing tree of *Quercus* during ontogeny. In this study, broad (aggregated) rays were observed in all samples of *C. echinocarpa*, all samples of *C. indica* (in two samples rarely observed), one sample of *C. lanceaefolia* and two samples of *C. purpurella*. Rao *et al.* (1991) reported presence of aggregate rays in 6 samples of *C. purpurella* out of 12 samples studied; 8 samples of *C. indica* out of 12 samples and 8 samples of *C. echinocarpa* out of 11 samples of *C. lanceaefolia*. The loss of broad rays in some of the trees of the same species of *Castanopsis* may be related to differential growth of the tree (Rao *et al.* 1991).

Statistical test showed non-significant differences due to altitude and latitude in the wood elements of different species of *Castanopsis*. In the present study, the species *Castanopsis* occurred within narrow latitudes, i.e. 26° 40' to 29° 23' and the limited sample size thus showed non-significant differences due to latitude. Van der Graaff and Baas (1974) studied wood anatomical variation within 17 eurytherm hardwood genera in relation to altitude and latitude. With increasing latitude a miniaturization of secondary xylem elements, *viz.* shorter vessel member, narrower vessels, shorter and narrower fibres, was reported together with an increase in vessel frequency. However, altitudinal variation generally follows latitudinal trends with weaker effects or none on vessel groupings. Wilkins and Papassotirion (1989) correlated latitudinal variations with a number of anatomical characteristics, *viz.* vessel element length, proportion of fibres and multiseriate rays in *Acacia melanoxylon* and found a significant positive correlation while characters such as vessel frequency, vessel element diameter but abundance of crystals were negatively correlated. They concluded that increasing latitude appears to be associated with wood anatomical features consistent with increased safety from vessel embolism, decrease vessel efficiency and low transpiration demand.

Dickinson and Phend (1985) reported that pore frequency, vessel element length, wall thickness and multiseriate ray frequency showed a significant positive correlation whereas pore diameter showed negative correlation with latitude. A decrease in pore diameter with increasing latitude was also reported by Baas (1973) in *Ilex* and by Van den Oever *et al.* (1981) in *Symplocos*. In the present study, coefficient of correlation (r) indicated that vessel, fibre length, vessel element, fibre diameter and wall thickness were weakly correlated with altitude and latitude. It may be due to the narrow latitudinal limits of *Castanopsis* studied here. Furthermore, altitudinal variations do not throw much light on intra-specific anatomical variations even though vessel element length and fibre length show a weak relationship. The anatomical features were weakly correlated with precipitation and number of rainy days. However, vessel member dimensions (r=24) showed higher degree of positive correlation with precipitation than fibre dimensions (r=14).

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