THE SECONDARY PHLOEM OF AMENTOTAXUS

R. W. DEN OUTER and E. TOES

THE SYSTEMATIC POSITION of *Amentotaxus* is uncertain (Keng, 1969). It is placed either in the Taxaceae, Cephalotaxaceae, or in a separate family, the Amentotaxaceae (Kudo & Yamamoto, 1931; Li, 1963). The genus is held to represent only one species, i.e. *A. argotaenia* (Hance) Pilger (Kudo & Yamamoto), or four species, i.e. *A. argotaenia* (Hance) Pilger, *A. cathayensis* Li, *A. formosana* Li, and *A. yunnanensis* Li (Li, 1952), or three species, i.e. *A. argotaenia* (Hance) Pilger, *A. formosana* Li, and *A. yunnanensis* Li (Hu, 1964). Finally Chuang & Hu (1963) identify *A. formosana* Li with *A. argotaenia* (Hance) Pilger.

Because of all these different opinions, further investigations seem advisable. Although hampered by the lack of suitable material, Miller (1973) made a comparative study of the secondary xylem. He concluded that a) at the specific level taxonomic evaluation is not possible, or that b) *Amentotaxus* is monotypic. A comparative study of the secondary phloem is even more difficult, because fresh material is preferable for this purpose. The present investigation deals with the comparison of *A. argotaenia* (Hance) Pilger *sensu stricto* with some other representatives of the Taxaceae and Cephalotaxaceae.

MATERIAL

Twig material of *A. argotaenia* (Hance) Pilger *sensu stricto* was obtained from Hong Kong (Lantao Peak, Lantao Island) via Dr. D. K. Ferguson of the University of Antwerp. Using an increment borer with a diameter of 5 mm., fresh samples were taken from trees of *Taxus baccata* L., *Torreya grandis* Fortune, and *Cephalotaxus harringtonia* (Forbes) K. Koch. These trees in the Arboretum "De Dreyen" at Wageningen, had a diameter of approximately 15 cm. at breast height. Two stem samples of *Austrotaxus spicata* Compt. were obtained via Dr. A. M. W. Mennega and H. J. Miller from Sweden (Stockholm nr. *233*) and Australia (D. F. P. *32.479*).

RESULTS

The results of the investigation are shown in the following table.

TABLE 1. A comparison of Amentotaxus argotaenia with some genera of the Taxaceae and Cephalotaxaceae.

	TAXUS BACCATA	TORREYA GRANDIS	CEPHALOTAXUS HARRINGTONIA	AUSTROTAXUS SPICATA	AMENTOTAXUS ARGOTAENIA
Sequence of alternating tg. layers of cells	sieve cells–crystal cells–sieve cells–parenchyma cells–etc.	sieve cells–parenchyma cells–etc.	sieve cells–1 (to 3) layers parenchyma cells–etc.	sieve cells–parenchyma cells–etc.	1 to 10 (often 5) layers of sieve cells–parenchyma cells–etc.
Growth ring boundary	inconspicuous	inconspicuous	indistinct	indistinct	indistinct
Sieve cells:					
shape	fiber; rectangular in cross section	as in *Taxus*	as in *Taxus*	as in *Taxus*	as in *Taxus*
measurements	8–15 μm rd.	as in *Taxus*	as in *Taxus*	as in *Taxus*	6–12 μm rd.
	10–25 μm tg.	as in *Taxus*	as in *Taxus*	as in *Taxus*	10–30 μm tg.
	± 1250 μm lg.	± 800 μm lg.	± 900 μm lg.	?	± 1600 μm lg.
sieve areas	in rd. walls; round to oval;	as in *Taxus*; rounded to angular;	as in *Taxus*; rounded to angular;	as in *Taxus*; rounded to angular;	as in *Taxus*; rounded to oval;
	10–15 μm	as in *Taxus*	as in *Taxus*	as in *Taxus*	as in *Taxus*
collapsed from	third period	as in *Taxus*	as in *Taxus*	second period	second period
Albuminous cells	in the layers of phloem-parenchyma cells, mostly in lg. strands	as in *Taxus*	as in *Taxus*	?	?
Phloem-parenchyma cells:					
shape in conducting phloem	fiber; rectangular in cross section	as in *Taxus*	as in *Taxus*	as in *Taxus*	as in *Taxus*
	10–20 μm rd.	as in *Taxus*	as in *Taxus*	as in *Taxus*	8–15 μm rd.
	20–25 μm tg.	as in *Taxus*	as in *Taxus*	as in *Taxus*	10–30 μm tg.
shape in nonconducting phloem	fiber; oval to round in cross section;	as in *Taxus*	as in *Taxus*	as in *Taxus*	fiber; oval in cross section;
	30–40 μm rd.				25–45 μm rd.
					15–30 μm tg.
number of cells per fiber	6–16	5–18	6–16	5–20	5–20
lg. measurements of cells	50–200 μm	70–180 μm	50–200 μm	50–200 μm	80–200 μm
pits	mainly in radial and transverse walls	as in *Taxus*	as in *Taxus*	as in *Taxus*	as in *Taxus*
transverse walls	nodular	nodular	almost smooth	smooth	nodular
Sclereids:					
shape	fiber; bone-shaped in cross section	fiber; round to rectangular in cross section	fiber; round to rectangular in cross section	fiber; round to oval in cross section	irregular; oval in cross section; almost no lumen
measurements	1250–3000 μm lg.	1000–2000 μm. lg.	1000–1750 μm lg.	up to 1 cm. lg.	1000–1750 μm lg.
crystals	in outer cell wall	in outer cell wall	absent	absent	in outer cell wall
arrangement	irregular in tg. layers; every 3 or 4 [2–∞] period	irregular in tg. layers; every 1 or 2 period	in tg. layers, sometimes 4 cells wide; every 3 or 4 period	in long tg. layers, every 2 period	scattered, single
pits	mainly in radial walls	as in *Taxus*	as in *Taxus*	as in *Taxus*	as in *Taxus*
first present from	the 4 period on	the 2 period on	the 3 period on	the 2 period on	the 4 period on
originated from	crystal cells	crystal cells	phloem-parenchyma cells	phloem-parenchyma cells	crystal cells
Crystal cells	present	present	absent	absent	present
Phloem rays:					
direction	first oblique, afterwards radial	radial	radial	almost radial	first oblique, afterwards radial
width	uniseriate	uniseriate	uniseriate, sometimes biseriate	uniseriate	uniseriate
height in cells	1–16	1–13	1–15	1–10	1–4
measurements	35–50 μm rd.	20–60 μm rd.	35–65 μm rd.	10–50 μm rd.	35–60 μm rd.
	15–30 μm tg.	15–50 μm tg.	13–30 μm tg.	13–30 μm tg.	15–30 μm tg.
	15–35 μm lg.	15–50 μm lg.	13–40 μm lg.	15–35 μm lg.	15–40 μm lg.

Abbreviations used in TABLE 1: rd. = radial, tg. = tangential, lg. = longitudinal; μm = micrometer [replaces "micron"].

CONCLUSIONS

Amentotaxus argotaenia (Hance) Pilger *sensu stricto* differs from the other investigated species in the following characteristic features: the axial system is, for the greater part, composed of sieve cells. They constitute tangential bands 1 to 10 (often 5) cells wide, alternating regularly with tangential layers of phloem-parenchyma cells 1 cell wide; sclereids, originated from either phloem-parenchyma cells or crystal cells, lie scattered in the nonconducting phloem, irregular, thus not in tangential layers; the rays are 1 to 4 cells high; the sieve cells are rather long. These differences in the characteristics of the secondary phloem are not sufficient to decide whether *Amentotaxus* should be placed in the Taxaceae or in the Cephalotaxaceae, or even in a separate family, the Amentotaxaceae.

Additional investigations are advisable, but only if and when fresh material is available.

ACKNOWLEDGMENTS

Our sincere thanks to Dr. D. K. Ferguson of the University of Antwerp and to Dr. A. M. W. Mennega and H. J. Miller of the State University of Utrecht, for providing the valuable bark samples.

REFERENCES:

CHUANG, T. I., & W. W. L. HU. 1963. Study of *Amentotaxus argotaenia* (Hance) Pilger. Bot. Bull. Acad. Sin. **4**(1): 10–14.

HU, S. Y. 1964. Notes on the flora of China IV. Gymnospermae. Taiwania, **10**(1): 13–62.

KENG, H. 1969. Aspects of morphology of *Amentotaxus formosana* with a note on the taxonomic position of the genus. Jour. Arnold Arb. **50**: 432–445.

KUDO, Y., & Y. YAMAMOTO. 1931. Amentotaxaceae. *In*: KUDO, Y., Materials for a flora of Formosa, IV. Jour. Soc. Trop. Agric. (Taihoku) **3**(2): 110, 111.

LI, H. L. 1952. The genus *Amentotaxus*. Jour. Arnold Arb. **33**: 192–198.

———. 1963. Woody flora of Taiwan. Livingstone Publ. Co., Narberth, Pennsylvania, Pp. 36, 37.

MILLER, H. J. 1973. The wood of*Amentotaxus*. Jour. Arnold Arb. **54**(1): 111–119.

DEPARTMENT OF BOTANY
AGRICULTURAL UNIVERSITY, WAGENINGEN
THE NETHERLANDS