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Characteristics of Briarwood*)

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Characteristics of Briarwood

Summary

Briarwood – a tumor-like outgrowth of *Erica arborea* – was investigated with regard to anatomical structure, properties, chemical composition, and effects of treatments (boiling in water, exposure to high temperatures). Comparisons were made with stem and root wood of *Erica*, and some other temperate and tropical wood species. Briarwood was found to have shorter and irregular fibers in comparison to stem wood; tissue arrangement is usually irregular, but some cross sections appear normal; enclosures (amorphous, crystal) are present in cell cavities. The density and hardness of briarwood are a little higher than that of stem wood, volumetric shrinkage is higher, but directional shrinkage tends to be isometric. Extractive content is very high. Ash is higher, and silica low. Boiling in water (removal of extractives) reduced the volumetric shrinkage of briarwood (the effect is normally opposite), did not affect the drying rate, but resulted in higher dimensional stability, and eliminated drying defects. Exposure to high temperatures (150–600 °C) showed a higher resistance of briarwood, which could be attributed to extractives.

Introduction

Briarwood is the wood commonly used in making the bowls of tobacco smoking pipes. It comes from tumor-like outgrowths that develop between root and stem of white heath (*Erica arborea*), an evergreen shrub. Sometimes, tumors appear in other species, such as elm, birch and olive tree (Cormio 1944) as a result of attack by fungi, insects or other exterior factors, or for unknown reasons (Tsoumis 1965). In *Erica arborea*, such formations are practically omnipresent. There is a non-convincing speculation that the reason is traumatic, induced by insects, root stress in stony ground or heavy soil (Cormio 1944), but their origin is not really known. An initial appearance can be detected in one-year-old plants, but growth to commercial size takes 40–50 years; factors affecting growth are soil characteristics (pH, texture, depth), elevation and orientation of site.

The exterior form of *Erica arborea* shrubs may be used as a diagnostic criterion of the size and shape of tumors; shrubs with many offshoots give ellipsoid tumors of low value, whereas a limited ramification (1–3 offshoots) indicates spheroid tumors of higher value (Alexandrian 1981).

Erica arborea grows mainly in the Mediterranean region (Algeria, France, Greece, Italy, etc.), but also occurs in the Canary Islands, South Tirol, and Eastern Africa (Ethiopia and the Equatorial Mountains) (Cormio 1944; Hegi 1935). Algeria is the main source of world production of briarwood.

Erica arborea shrubs are uprooted, and after removal of all offshoots and roots, the tumors are subjected to a further preliminary cleaning by cutting off useless projections. The residual briarwood pieces are then temporarily protected from drying by wetting or storing in shade. Subsequently, they are transported to the processing plant, where they are shaped to dimensions suitable for the final product. Waste is high; only about ¼ of the original growth is utilized at this stage. The pieces are next boiled in water or steamed, and exposed to mild air-drying. Classification by grade and dimensions, and final processing to pipe bowls follow.

Various woods have been used in making smoking pipes, including boxwood (*Buxus sempervirens*), wild cherry and wild pear (*Prunus mahaleb*, *Pirus communis*), ebony (*Diospyros ebenum*), rosewood (*Dalbergia latifolia*), Australian acacia (*Acacia* sp.), and others. Use of *Erica arborea* has reportedly started in the middle of the 19th century in eastern Pyrenees, France. Preference of the tumors produced by this species is attributed to fire resistance, lack of odor when heated at high temperatures, fine grain, good polish, and attractive figure especially when traces of ramifications are exposed on the surface after machining such wood to final shape.

This study was undertaken to investigate aspects of anatomical structure and chemical composition, and certain properties of briarwood in an effort to determine the characteristics that make it a preferred material for making smoking pipes, and perhaps suggest replacements. Comparisons were made with stemwood of the same species and other temperate and tropical woods.

Material and Methods

Material for this study was taken from five *Erica arborea* shrubs growing in Macedonia, northern Greece. These shrubs were 30–35 years old, and the (horizontal)diameter of the tumors was about 25 cm. The shrubs were sampled for stem, tumor and root material, and specimens were prepared to study anatomical structure and the properties previously mentioned; root material was only used for a

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study of anatomical characteristics. The number and dimensions of specimens are indicated in Tables 1, 2, 4 and 5.

In addition to *Erica arborea* tumor, stem and root wood, specimens of oak (*Quercus coccifera*), olive tree (*Olea europaea*), euramerican hybrid poplar, rosewood (*Dalbergia latifolia*), and zebrano (*Microberlinia brazzavillensis*) were studied. *Erica arborea* tumor wood was investigated in natural condition and after extraction and boiling in water.

With regard to methodology of work, the following remarks should be made:

- Material for maceration and measurement of fiber length was taken near the pith, from a middle position between pith and bark, and near the pith, separately for stem, tumor and root wood. In each case 100 fibers were measured.
- Hardness was measured with an Amsler testing machine on the end grain of specimens 2 × 2 cm in cross section and random length, after their climatization to about 12% moisture content.
- Total extractives were determined according to ASTM D 1105-84 standard procedure by use of a Soxhlet apparatus. Each extraction was performed with 2 g of air-dry flour made from stem and tumor wood. Three solvents were used consecutively as follows: alcohol 95%-benzol (4 hrs); alcohol 95% (4 hrs); water at 100°C (4 hrs).
- Inorganic elements other than silica were determined as follows: the ash obtained from 2 g of wood flour, placed in a platinum crucible, was moistened with 3 drops of distilled water, then dispersed in 5 ml of a 50% aqueous solution of HC1, and heated over a steam bath at 60°C for 30 minutes. The content was filtered and thinned with distilled water in a final volume of 50 ml. Inorganic elements were determined by atomic absorption with a spectrophotometer.
- Silica determination was made by ashing 10 g of wood flour, adding 10 ml HC1 and evaporating to dryness over a steam bath. Subsequently, a mixture of HC1 and water (1:3) was added in the crucible, and the contents were filtered, washed and filtered repeatedly. The filter (ashless filter paper) with the solid residue on it, was then placed in the crucible and ashed. Silica (SiO_2) was determined by weighing the acid insoluble ash and expressing it as a percentage of the original oven-dry weight of the wood flour (Allen *et al.* 1974).
- Temperature rise inside a bowl of smoking pipe was measured by use of an electronic digital thermometer.
- Poplar wood specimens were impregnated with total tumor wood extractives by application of vacuum and atmospheric pressure.

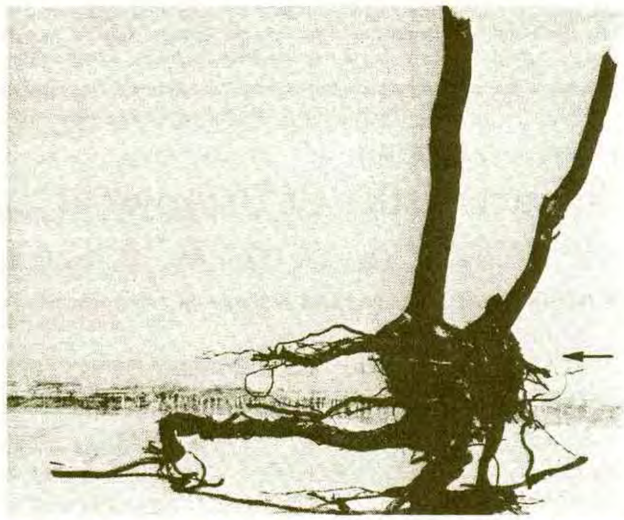

Fig. 1. An uprooted *Erica arborea* shrub. The tumor between stems and roots (arrow) is the source of briarwood.

Results

The results are presented in Figures 1–7 and Tables 1–5, and may be summarized as follows:

Fig. 1 shows an uprooted *Erica arborea* shrub with partly cut off stems. Briarwood comes from the tumor that develops between stem and root (see arrow). Fig. 2 presents scanning electron photomicrographs of (A) stem, (B) root and (C, D) tumor wood. The structure of stem wood (1, 2, 3) and root wood (4, 5) is normal; tumor wood also appears sometimes normal (6), but as a rule is irregular (7, 8). Under high magnifications, tumor wood is seen to contain amorphous or crystal inclusions (9, 10, 11, 12). Fig. 3 shows a characteristic microscopic appearance of a tangential section of tumor wood; such irregular structure results in an attractive figure of briarwood.

According to Table 1, tumor fibers are shorter than those of the stem and exhibit a greater variability of length. Fig. 4 shows that tumor fibers are also a little

Table 1. Fiber length, properties and extractives of tumor and stem wood of *Erica arborea*

Material*	Fiber length mm	Density (dry) g/cm³	Shrinkage (%)				Hardness (end, Janka) N/mm²	Extractives %
			Axial	Radial	Tangential	Volume		
Tumor	0.363 (0.082)	0.97 (0.042)	5.45 (1.69)	5.67 (1.62)	6.64 (2.20)	18.39 (2.38)	90.0 (1.7)	27.36 (0.507)
Stem	0.477 (0.013)	0.84 (0.035)	0.57 (0.16)	6.49 (0.72)	8.81 (0.57)	15.30 (0.82)	84.8 (2.9)	10.32 (0.921)

* Number of measurements or specimens (tumor-stem): fiber length 300-300, density and hardness 10–10, shrinkage 19–10, and extractives 3–3. Size of specimens: 2 × 2 × 2 cm (density, shrinkage, hardness) and wood flour (extractives). Numbers in parentheses are standard deviations. Extractives (total) are based on oven-dry weight of wood flour.

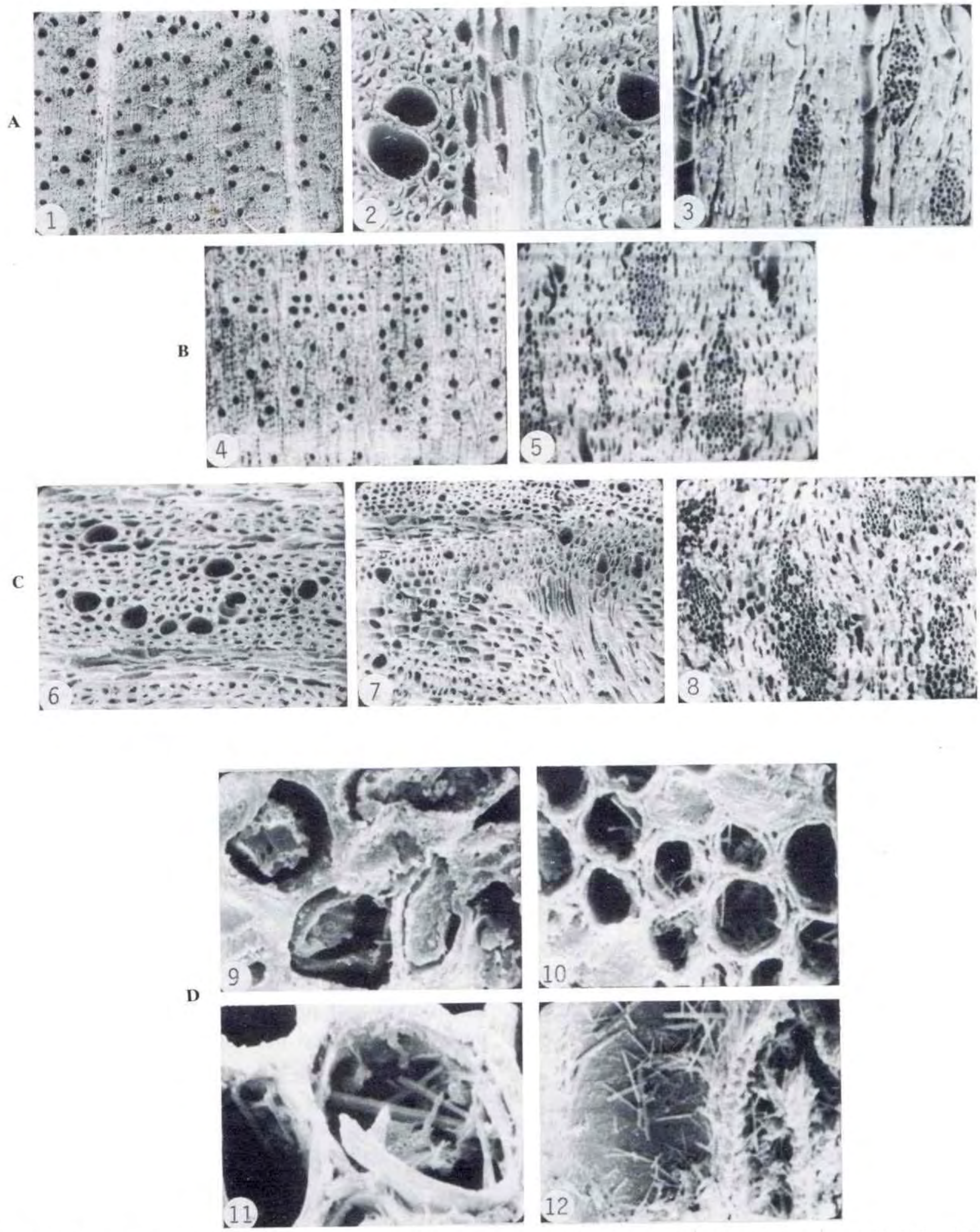

Fig. 2. SEM photomicrographs of stem (1, 2, 3), root (4, 5) and tumor wood (6–12). A. Stem wood. 1,2 transverse (1. 100×, 2. 700×), and 3. tangential (200×). B. Root wood. 4. transverse (100×), 5. tangential (200×). C. Tumor wood. 6,7. transverse (6. 400×, 7. 200×), 8. tangential (200×). D. Enclosures in tumor wood, amorphous or crystal. 9. transverse (fibers, 2000×), 10 tangential (ray parenchyma, 2000×), 11. tangential (ray parenchyma, 5000×), 12. tangential (vessel, 3000×).

shorter than root fibers, and that all fibers (stem, root, tumor) exhibit the expected trend of increase in length with increasing distance from pith. Microscopic examination of macerated material reveals that tumor fibers are usually irregular (crooked, bent, in parts dilated) along their length (Fig. 5), as is the case with other tumor wood (Tsoumis 1965); after air drying, they tend to twist.

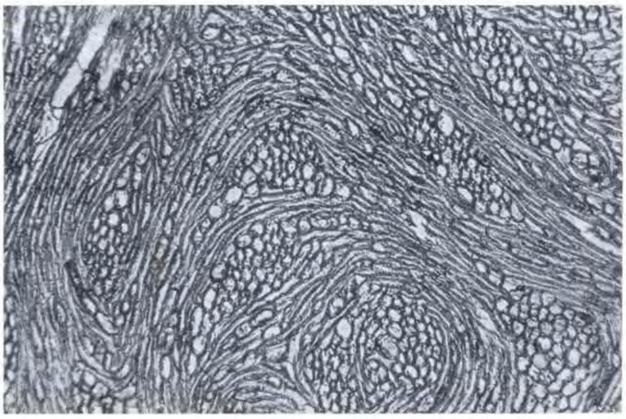

Fig. 3. Characteristic microscopic appearance of a tangential section of tumor wood (66 ×).

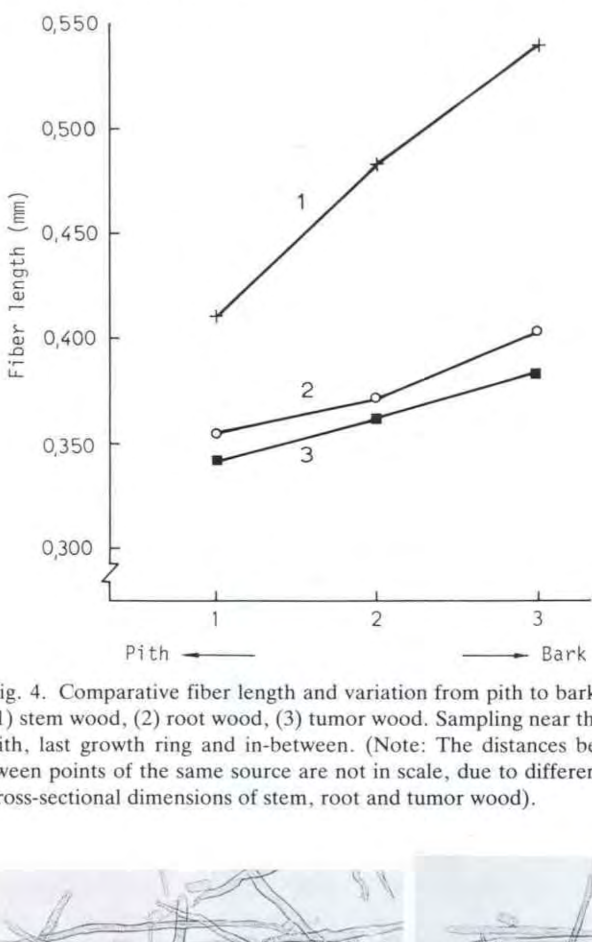

Fig. 4. Comparative fiber length and variation from pith to bark. (1) stem wood, (2) root wood, (3) tumor wood. Sampling near the pith, last growth ring and in-between. (Note: The distances between points of the same source are not in scale, due to different cross-sectional dimensions of stem, root and tumor wood).

Additional data of Table 1 show that the density of tumor wood is higher and its shrinkage tends to be isometric in comparison to stem wood; hardness is also higher and tumor wood contains about 3 times as much extractives as stem wood.

Table 2 presents the results of three separate experiments of measurement of volumetric shrinkage. In all cases, tumor wood exhibits a higher shrinkage.

Table 2. Volumetric shrinkage (%)* of tumor and stem wood of *Erica arborea*

Experiment	Tumor	Stem
1	18.39 (2.38)	15.30 (0.82)
2	19.10 (1.65)	13.10 (0.78)
3	21.88 (1.37)	14.61 (2.09)
Average	20.31 (2.62)	14.45 (1.92)

* Number and dimensions of specimens (tumor-stem): Expt. 1. 19–10 and 2 × 2 × 2 cm; Expt. 2. 32–13 and 2 × 2 × 2 cm; Expt. 3. 41–58 and 1.3 × 1.3 × 1.3 cm.

Ash content was a little higher and silica (SiO_2) lower in tumor than stem wood, but the differences were small[1)]. Among other inorganic elements, Ca and Mn showed large differences, however (Table 3).

Table 4 includes the results of boiling tumor wood in water, which is a treatment applied in making pipe bowls. The unexpected finding was that boiling reduced the volumetric shrinkage of tumor wood, whereas both in olive tree wood and oak such shrinkage increased, as expected due to partial loss of extractives.

Table 5 is made of three parts. The upper part (Expts. 1–7) includes observed reductions of weight after 15 min exposure to each step of high temperature (150–600 °C), whereas in the lower parts (Expts. 8–15) the exposure was 1 hour. At the 15-min exposure tumor wood shows a higher resistance when compared to stem wood and to oak, while the resistance

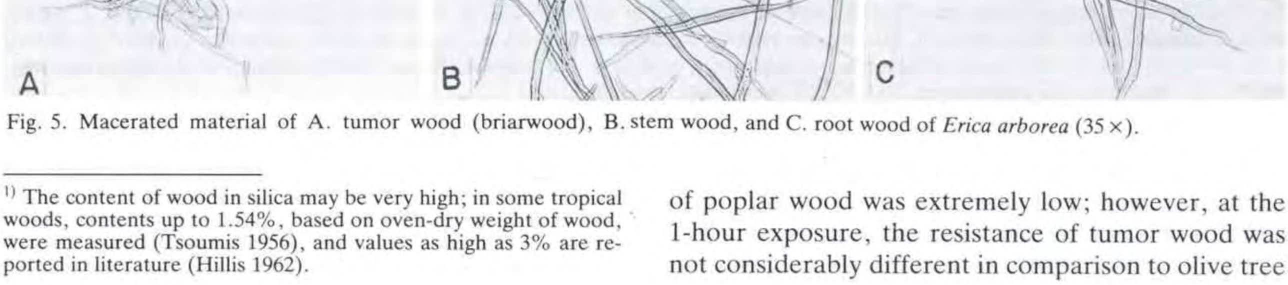

Fig. 5. Macerated material of A. tumor wood (briarwood), B. stem wood, and C. root wood of *Erica arborea* (35 ×).

of poplar wood was extremely low; however, at the 1-hour exposure, the resistance of tumor wood was not considerably different in comparison to olive tree

[1)] The content of wood in silica may be very high; in some tropical woods, contents up to 1.54%, based on oven-dry weight of wood, were measured (Tsoumis 1956), and values as high as 3% are reported in literature (Hillis 1962).

Table 3. Inorganic chemical composition of tumor and stem wood of *Erica arborea*, and some other hardwood and softwood species.

Species	Ash	Ca	K	Na	Mn	Mg	P	Fe	Zn	Cu	SiO_2[3)]
	%	ppm									%
Erica arborea(tumor wood)	0.75	630	653	262	2347	134	125	15	4	3	0.040
Erica arborea(stem wood)	0.61	1441	810	206	615	164	178	14	4	3	0.052
Poplar (*Populus* sp.)[1)]	–	1130	1230	–	29	270	100	–	–	–	–
Spruce (*Picea rubens*)[1)]	–	820	200	–	144	70	50	14	8	–	–
Pine (*Pinus strobus*)[1)]	–	210	290	–	28	70	–	10	11	–	–
Fir (*Abies* sp.) sapwood[2)]	0.33	–	241	65	30	126	29	3	–	2	–
heartwood[2)]	0.61	–	842	89	40	201	17	2	–	2	–

[1)] Date from Fengel and Wegener (1984), and [2)] Passialis and Tsoumis (1984), [3)] Silica content of other species: olive tree (*Olea europaea*) 0.041, oak (*Quercus coccifera*) 0.039, Rosewood 0.050.

Table 4. Effects of boiling in water on shrinkage, density and removal of extractives

No.	Species	Vol. shrinkage* % A	% B	Density (r_o)* g/cm³ A	g/cm³ B	Extractives** % A	% B
1.	*Erica* (tumor)	15.00	10.24	0.890	0.787	27.36	4.29
2.	Olive tree (*Olea*)	16.82	18.73	1.034	0.994	15.74	4.35
3.	Oak (*Q. coccifera*)	14.77	20.20	0.941	0.972	8.78	2.55

* A. natural condition, B. boiled in water
** *Extractives:* A. based on oven-dry weight of wood flour (tumor: total extractives, olive tree and oak: hot water extractives) and B. removed from 2 × 2 × 2 cm specimens.
Number of specimes: tumor and oak (A–B) 22–22, olive tree 13–13; dimensions: shrinkage, density and B extractives 2 × 2 × 2 cm.

wood and rosewood. It was very interesting to find that impregnation of poplar wood with tumor wood extractives resulted in considerable increase of its resistance. Tumor wood extractives alone showed a higher resistance at temperatures up to 200°C in comparison to stem extractives (Expts. 8, 9). Boiling does not appear to affect the resistance of tumor wood in temperatures up to 300°C, but at 400°C and 500°C its resistance was reduced (Expts. 10–15). Note should be made that in actual smoking a tobacco pipe, the temperature inside the bowl was measured to rise to 615°C.

Finally, it was observed that boiling did not appreciably affect the rate of air-drying of tumor wood (Fig. 6), but resulted in elimination of defects, such as checking and splitting (Fig. 7); this justifies the boiling (or steaming) applied in practice.

Discussion

The only previous work that is related to the objectives of this study is that of Cormio (1944), who compared briarwood of two origins, i.e. Italy (Calabria) and Ethiopia (Eritrea). Cormio describes macroscopic features, and namely bark (thin, rough, fissured, red-brown or blackish), sapwood (whitish, well defined in large tumors), heartwood (yellowish, reddish or grayish), growth tings (medium width, distinct in heartwood, but not well delineated), rays (wide), and pith (small, homogeneous). With regard to microscopic characteristics, Cormio writes that the wood is diffuse-porous with small, numerous, solitary and fairly uniformly distributed pores (vessels); perforations are simple and scalariform; parenchyma not

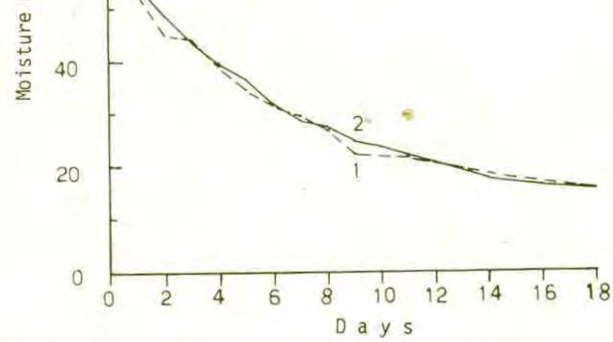

Fig. 6. Air-drying rate of tumor wood (1) boiled in water and (2) in natural condition (non-boiled).

Table 5. Resistance to high temperatures of *Erica arborea* (tumor, stem wood) and other wood species.

Heating time (for each temperature step) min	Experiment No.	Material*	Condition	Temperature, °C 150	200	250	300	350	400	450	500	550	600
				Reduction of weight (%)									
15	1.	Erica (tumor)	natural	0.08	0.58	1.25	9.44	23.54	39.96	48.18	78.66	91.91	99.50
	2.	Erica (tumor)	extracted	0.14	0.75	2.78	21.70	41.73	51.58	88.88	96.53	91.50	–
	3.	Erica (stem)	natural	0.00	0.76	3.10	31.73	54.95	93.38	99.50	–	–	–
	4.	Erica (stem)	extracted	0.22	0.53	0.93	9.59	36.27	59.54	90.25	99.50	–	–
	5.	Oak (*Qu. coccifera*)	natural	0.00	0.84	10.09	46.01	60.24	87.93	99.50	–	–	–
	6.	Poplar, hybrid	natural	0.00	2.30	84.40	99.50	–	–	–	–	–	–
	7.	Poplar, hybrid	impregnated	0.00	0.60	14.50	73.80	97.16	99.50	–	–	–	–
60	8.	Extractives (tumor)	flour	0.81	1.49		31.98		45.57		95.62		96.78
	9.	Extractives (stem)	flour	3.03	4.00		30.08		35.03		88.80		93.60
60	10.	Erica (stem)	natural		1.88	21.75	52.83		83.30		99.42		99.70
	11.	Erica (tumor)	natural		2.03	13.64	28.21		88.56		95.55		99.66
	12.	Erica (tumor)	boiled		1.48	13.98	27.75		92.37		99.51		99.62
	13.	Olive tree (*Olea europaea*)	natural		2.58	26.18	26.63		96.32		98.98		99.60
	14.	Oak (*Qu. coccifera*)	natural		6.00	44.93	49.96		96.20		99.20		99.35
	15.	Rosewood	natural		1.06	13.13	42.01		94.70		97.93		99.01

* All specimens 1 × 1 × 1 cm, except for extractives. The results are based on 5 measurements (replicates) for Expts. 1–7, and 2 measurements for Expts. 8–15.

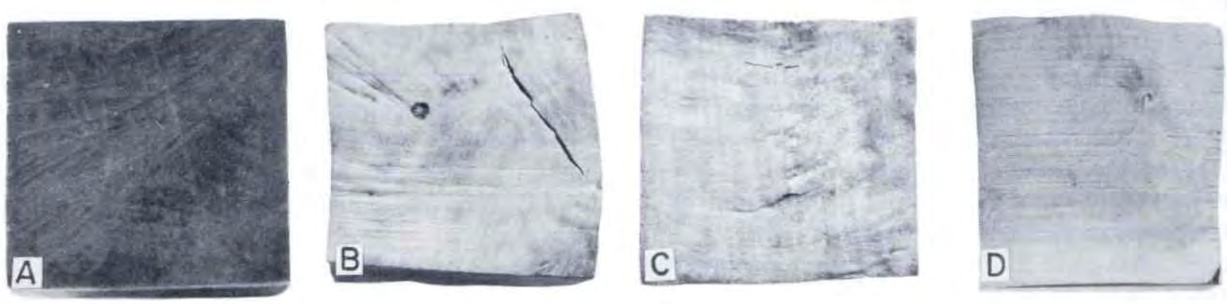

Fig. 7. Cubes of tumor wood (5 × 5 × 5 cm) after air-drying. A. boiled in water and B, C, D. non-boiled showing checks and deformation.

uniformly distributed, frequently limited to the tangential walls of vessels and sparse between fibers.

In addition, Cormio investigated certain properties including density, shrinkage, hardness, fire resistance (combustibility), machinability, ash and silica content, loss of volatile substances, moisture content, and treatment with fire retardants. All the results are presented comparatively (Calabria – Eritrea), and may be summarized as follows: density "in the air" (air-dry) 0.779–0.687 (g/cm^3) and at 110°C 0.677–0.558 g/cm^3; shrinkage at 30°C 0.94–0.61%, hardness (Janka) 1120–780 kg, fire resistance 22.7–21.7%, ash (on a wet wood basis) 0.48–0.31%, silica 34–31%; and moisture content 13.1–14.3% (air-dry wood). Some of the results are difficult to follow (e.g. shrinkage), and others are judged subjectively (machinability), or based on a specific manner of experimentation (fire resistance by exposure to gas flame).

General information about briarwood is presented in a brief monograph by Schmidt (1951) contained in a descriptive treatment of several other woods. This work includes macroscopic and microscopic characteristics, air-dry density values (mean 0.78, range 0.63–0.94), and references to preparatory boiling (to release stresses and obtain uniformity of color between sapwood and heartwood) and to high temperature resistance that makes briarwood suitable for pipes. The author rejects the opinion that the latter resistance is due to silica (Hegi 1935), because the silica content of briarwood is not "unusually high". Density values of 0.80–0.90 (without reference to base) were also supplied from another source (Istituto Legno 1976).

The present study has shown that briarwood is characterized by an irregular anatomy, as expected from a tumor-like growth, although some transverse sections appear normal in cellular arrangement. This wood has a high content of extractives, some of which are in the form of amorphous or crystal enclosures in cell cavities. Briarwood exhibits a high volumetric shrinkage, but directional shrinkage is practically isometric. Removal of extractives results in a lower shrinkage, while the normal behavior of wood is opposite.

Silica content is low, therefore this cannot be the reason for its resistance to high temperatures that develop inside a smoked pipe bowl. It appears that such resistance is rather due to extractives, because their removal results in decreased resistance, and their introduction (impregnation) to other woods (e.g. poplar) imparts an increased resistance; it is suggested that such "fire-retardant" action is due to frothing of extractives above a critical point of temperature (Hillis 1986). Another reason for such resistance could be the low content of briarwood in Ca and K in comparison to stemwood of the same species. Ca, K and Na were found to relate to burning characteristics of woods – whether they burn to charcoal or ash; species that burn to charcoal (indicating a higher resistance) had a much lower content in these elements (Kawakami *et al.* 1970). However, this viewpoint is not supported by the inorganic chemical composition of other woods (Table 3).

Boiling in water increases the dimensional stability of briarwood; the shape of wood cubes remained unchanged after air-drying, whereas non-boiled cubes changed shape and developed splits.

Other woods, temperate (including Mediterranean shrubs) and tropical, have certain properties similar to briarwood, but do not possess the totality of its characteristics. And one should admire the wisdom of common people, who selected the proper wood for the proper use (as in many other cases) and subjected it to proper treatment, such as boiling, only on practical experience and without elaborate laboratory means and tests.

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