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Distortion of Teatree Stems by Twine as a Means to Determine the Number of Years that the Stems Have Been Used to Support Cannabis Plants

REFERENCE: Horrocks M, Wallace R. Distortion of teatree stems by twine as a means to determine the number of years that the stems have been used to support cannabis plants. J Forensic Sci 2001;46(4):854–856.

ABSTRACT: In New Zealand, stems of teatree (*Kunzea/Leptospermum*) growing around illicit cannabis plots have been used to anchor lengths of twine running through the plots to hold cannabis plants upright. Forensic examinations of distortions of teatree stems caused by the twine have been carried out to determine when the twine had been first tied around the stems, in order to estimate the number of years that plots have been in operation. In this experiment, baling twine was tied around stems of a teatree (*Kunzea ericoides*) and the effect monitored for a period of three years. Varying degrees of stem distortion occurred during the first year, caused initially by expansion of callus (a wound tissue) rather than constriction of the growth (annual) rings of the xylem. Although this callus has a type of growth ring, these are not annual, therefore cannot be used to determine the number of years that stems have had twine attached. Xylem growth rings of the teatree in this experiment were not restricted until the third year. Distortion of teatree stems allows the determination of a *minimum* (not absolute) number of years that twine has been attached.

KEYWORDS: forensic science, cannabis, twine, growth rings, teatree

In illicit cannabis (*Cannabis sativa*) plots in New Zealand, lengths of baling twine are commonly run along or through groups of cannabis plants to hold them upright. Synthetic twine is preferred because it does not rot. The twine may be anchored at either end by stakes or the stems of in situ shrubs or trees. These are often either of two species of teatree (*Kunzea ericoides* and *Leptospermum scoparium*). Like cannabis, teatree is light demanding (1) and, consequently, typically inhabits areas throughout New Zealand selected by growers as ideal for cannabis—scrub, and forest gaps and margins (2).

Teatree stems with growth distortions caused by twine are often found in cannabis plots investigated by the police. Forensic examinations have been carried out on these growth distortions to determine when the twine had been first tied around the stems, in order to estimate the number of growing seasons (i.e., years) that plots have been in operation.

Lateral expansion of woody stems is normally generated by the vascular cambium, a thin layer of cells that forms a sheath surrounding the stem just under the bark (3). New cells are budded off to the inside of this layer to form xylem, the tissue that transports water from the roots to the leaves, and to the outside to form phloem, which transports food products from the leaves to the rest of the plant. In temperate climates (such as in New Zealand), trees often produce xylem in distinct, concentric layers known as growth rings or annual rings (4) with the oldest at the center of the stem. Teatree produces annual rings (John Ogden, personal communication), which are moderately distinct to distinct (5). If the lateral growth of a stem is constricted (e.g., by twine), the annual rings formed after this event may be narrower at the point of constriction than directly above or below that point.

Interference in the growth of woody stems may also result in the development of callus (a wound tissue) on the outside of the stem (3). This tissue arises from proliferation of ray cells outside the vascular cambium. It is callus that often gives damaged stems a swollen, distorted appearance.

Miller (4) has described several American cases where stem distortion has been used as forensic evidence. In one case, a human skeleton was found beneath a cucumber tree (*Magnolia acuminata*), which had a shirt sleeve tied around the stem 6 m above the ground. It was assumed that the man had hanged himself. The man was not identified and the year of death was uncertain. By examining the constricted growth rings near the area of the stem with the sleeve, the examiners concluded that the man had died "approximately five years earlier."

Little experimental information regarding this type of evidence is available. In particular, the amount of time that has elapsed between the time that the constricting material is attached and before stem distortion commences is obviously an important consideration. This paper aims to provide such information by reporting the results of an experiment monitoring the constricting effects of twine on the growth of teatree stems over several years.

Methods

A teatree (*Kunzea ericoides*) growing in the grounds of the Institute of Environmental Science and Research Ltd., Mount Albert Science Centre, Auckland was selected for the experiment. In the winter (i.e., between growing seasons) of 1996, synthetic baling twine (3 mm in diameter) was tied in a double loop and reef-knotted as tightly as possible by hand around four of the tree's stems. A year later (i.e., after one growing season) three of the stems (Samples 1*A,* 2*C,* and 3*C*) were cut from the tree and stored. The remaining stem (Sample 2*A*) was removed after a further two years. The stems were sliced crosswise and lengthwise, and the cross and longitudinal sections were polished with a disc sander and then with fine sandpaper. Transverse thin sections of wood were cut

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Received 24 May 2000; accepted 11 Sept. 2000.

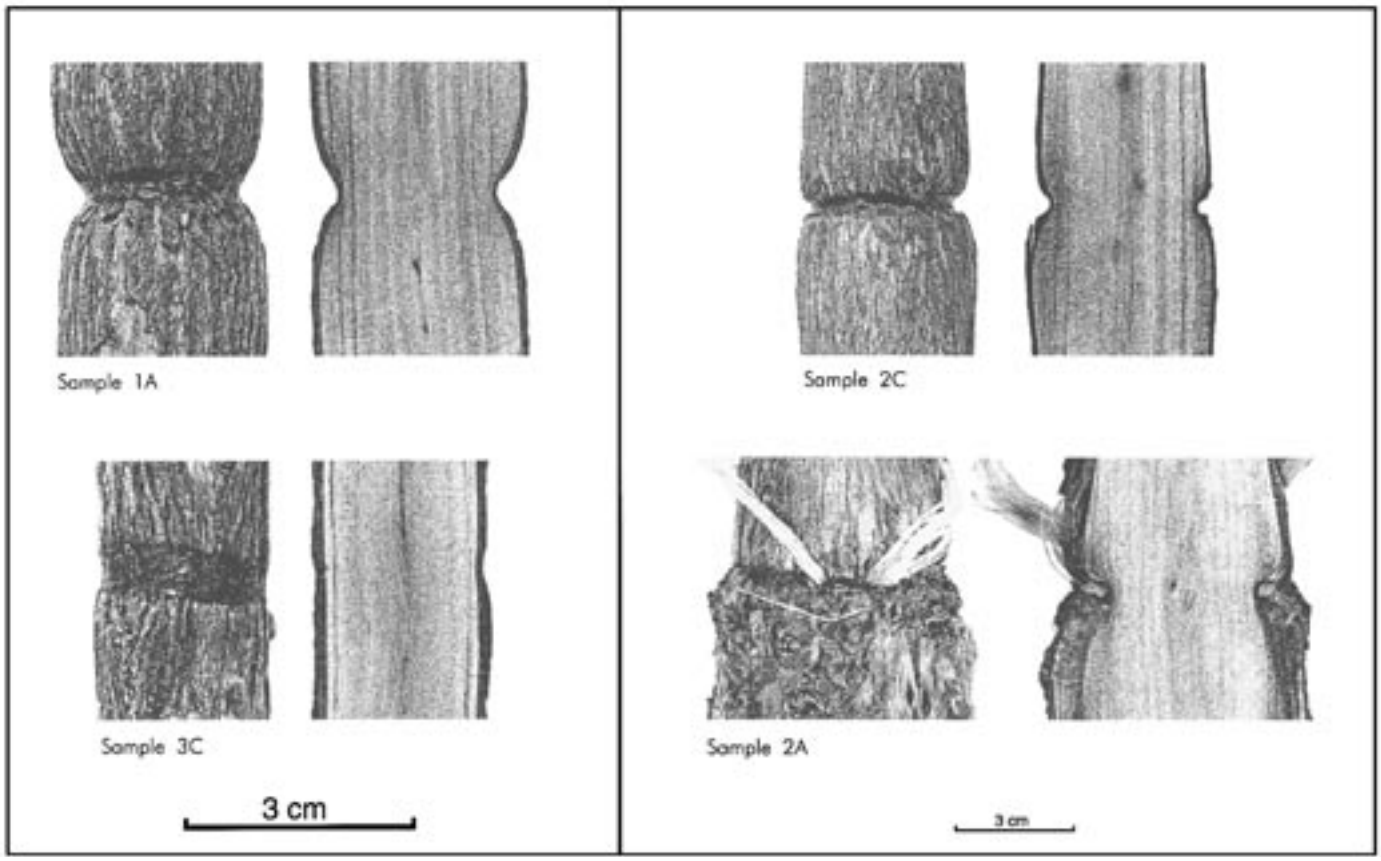

FIG. 1—*Longtitudinal sections of teatree stems showing the degree of distortion after having had twine tied around them. Samples* 1A, 2C *and* 3C *were collected after one year and Sample* 2A *after three years.*

with a rotary microtome for microscopic examination at 50x and 100x to observe cell structures in more detail.

Results

The three stems collected after one year each had seven growth rings and the stem collected after three years had ten growth rings. All four stems were thus the same age (i.e., had the same number of growth rings) at the start of the experiment.

Of the stems collected after one year, 3*C* showed the least stem distortion with the twine having caused little more than abrasion to the bark (Fig. 1). No callus development was apparent in this stem and the growth ring formed after the twine had been attached showed no constriction. Samples 1*A* and 2*C,* however, both showed "hour glass" distortion, that is, swelling of the stem immediately above and below the twine (Fig. 1). This swelling was callus tissue (Fig. 2). As with Sample 3*C,* there was no constriction of growth rings in 1*A* and 2*C*.

On the stem collected after three years (Sample 2*A*), hour glass distortion was apparent after the first year, and extreme hour glass distortion was apparent after the third year, with the stem in the process of engulfing the twine (Fig. 1). Callus formation up to 10 mm thick had occurred for at least 30 cm above the twine, and to a lesser degree to at least 10 cm below the stem. At points 10 cm above and below the twine, cross- and longtitudinal-sections revealed that this callus comprised from two to at least six incremental, tangential layers of tissue (not to be confused with xylem growth rings) (Fig. 3). Of the three growth rings in the xylem formed after the twine had been attached, only the outer one (i.e., the one most recently formed) was constricted (Fig. 2).

Discussion and Conclusions

The fact that one of the stems collected after one year showed negligible distortion clearly indicates that when twine is tied and knotted tightly around a teatree stem, distortion of the stem does not necessarily occur in the growing season immediately following attachment of twine (this would also apply to other species of woody plants). And furthermore, when distortion does occur, it is initially caused by expansion of callus above and below the twine rather than constriction of the growth rings of the xylem. Although the callus also had growth layers, the number of these (2 to 6) clearly shows that they are not annual. Growth layers in callus tissue of teatree, and presumably in an undetermined number of other woody species, thus cannot be used to determine the number of years that stems have had twine or other material tied around them.

Lack of constriction of growth rings until the third year after twine attachment clearly shows the importance of factors affecting the constricting ability of the constricting material when determining the number of years that material has been tied around stems. These factors would include tightness of the loop and of the knot of the material, and elasticity of the material (Alan Esler, personal communication). Also, growth rates (i.e., expansion) of stems vary from year to year depending on environmental conditions (6). For example, adverse conditions during growing seasons, such as cooler and drier, would be expected to result in slower growth rates

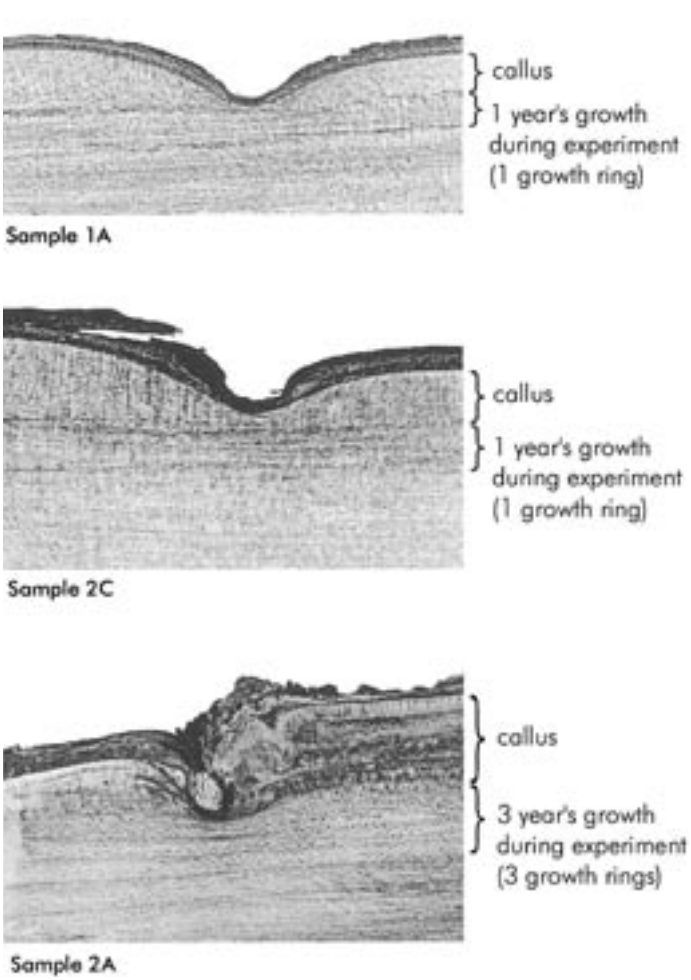

FIG. 2—*Longtitudinal sections through teatree stems showing the callus tissue and xylem growth rings formed after twine was tied around them. Samples* 1A *and* 2C *were collected after one year and Sample* 2A *after three years.*

(i.e., narrower growth rings) and vice versa. In addition, the fact that one of the three stems collected after one year showed no distortion while the other two did indicates that growth rates between stems of the same plant may differ.

The stem distortion evidence shows that the potential hiatus between time of attachment and time of commencement of distortion would prevent us from determining an absolute time period (i.e., number of years) of attachment. However, we could confidently give a *minimum* time period of attachment. For a distorted stem (of any woody species) with callus growth but no growth

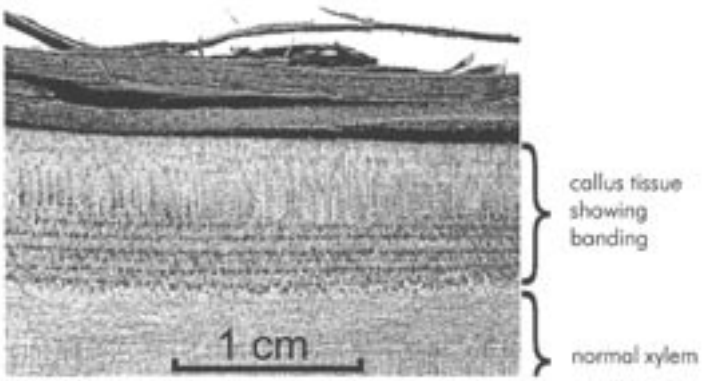

FIG. 3—*Longtitudinal section of a teatree stem collected three years after having had twine tied around it (Sample* 2A*), showing multiple growth bands in the callus tissue.*

ring distortion, we could conclusively say that the twine had been tied around the stem for *at least* one growing season. And for a distorted stem with growth ring distortion, we could conclusively say that the twine had been tied around the stem for *at least* as many growing seasons (i.e., years) as the number of distorted rings.

Acknowledgments

We thank Marnix Kelderman, Institute of Environmental & Scientific Research Ltd. Auckland, for assistance in setting up the experiment. We also thank Hamish MacDonald, Department of Anthropology, University of Auckland, for photography.

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