

GUM TAPPING IN *ANOGEISSUS LATIFOLIA* (COMBRETACEAE) USING ETHEPHON

J. R. BHATT

Department of Botany, University of Delhi, Delhi 110 007, India.

ABSTRACT

Traditional gum tapping methods in *Anogeissus latifolia* are not only unproductive but also destructive and wasteful. The present paper describes an improved tapping method based on the application of ethephon. The structure of gum-producing tissue system induced in the plant and the favourable season for tapping are described. Gummosis is enhanced by ethephon application. A 466-fold increase in gum yield has been recorded in plants treated with 1600 mg of active substance of ethephon during April–May, when the plants are leafless. This spectacular increment in yield is safe, requires no specialized instruments and the tapping technique can be easily taught to the tribals. Ethephon application leads to 'schizo-lysigenous' formation of gum cavities in the axial parenchyma of sapwood. Associated with the formation of cavities, many vessels of secondary xylem become clogged with the gummy material.

INTRODUCTION

ANOGEISSUS LATIFOLIA (Roxb. ex DC.) Wall. ex Guill. & Perr. (Family: Combretaceae) is a tree that occurs commonly in dry, deciduous forests of India. Besides providing excellent fuelwood, a hard timber and other products¹, the tree yields a valuable, light straw-coloured gum (gum ghatty of commerce) which is twice as viscous as gum-arabic². Gum ghatty has long been used in India² as an emulsifier, stabilizer and thickener in calico-printing, in confectionery, ceramics, food preparations, pharmaceuticals, drilling for petroleum and in explosives³.

Gum ghatty occurs in the form of tears or vermiform or irregular masses. The average yield per tree in a season is 60–100 g, exudation being higher in dry years³. The gum is generally collected from wild and untended trees by tribal people by crudely incising the main stem by axe. The solidified gum is handpicked. Heavy tapping injures the cambium and curtails the life-span of the tree as wound-healing becomes difficult. Thus production is unsystematic, uncontrolled and labour-intensive. The trade potential for the gum is large and promising⁴. To increase the annual yield from existing trees and to ensure their survival, the technique of tapping must be improved and standardized. In *A. latifolia* there is no natural pre-formed gum-producing tissue system either in the bark or in wood. The tree does not exude gum on its own but has potential to produce it when injured. Natural wounds (e.g. breaking of branches by wind, injuries caused by birds) also cause exudation. The anatomy

of the gum-cavities induced by injury in the bark and cambial zone has been studied by Ghosh and Purkayastha². The present author has established the favourable season for tapping, has used ethephon (an ethylene releasing synthetic chemical) for enhancing gum production and has studied the structure of gum cavities induced in the sapwood by ethephon treatment. A brief account of these aspects is given below.

MATERIALS AND METHODS

Eighteen vigorous trees of *Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guill. & Perr. (Combretaceae) free of any visible defects and growing at Shivrajpur and Dang forests of Gujarat State, India were selected for experimentation. Of these, 15 trees were treated with ethephon and the remaining three were maintained as distilled water-treated controls. Ethephon (ethrel, CEPA), a commercial preparation containing 400 g l⁻¹ of 2-chloroethylphosphonic acid was obtained from Sisco Research Laboratory, Bombay, India. The amount of 2-chloroethylphosphonic acid in the various dilutions used in this study will subsequently be referred to as 'active substance'.

A four ml solution of ethephon was used in dilutions containing 100, 200, 400, 800 and 1600 mg of the active substance. The solution was applied by a syringe into holes (5 cm × 1.5 cm) made by an increment borer in the trunk of trees at a height of 1.5–2 m from the ground level. The holes of required dimension could also be made using chisel and hammer and this is beneficial where borers are

not available. One hole was made in each tree twice annually for three successive years. The opening was made such that it slanted downwards to prevent the backflow of the introduced solution. Fresh holes were not incised upon the healed-up portions of the region of previous year's tapping but were made about 4–6 cm lateral to the healed region. The holes were covered with sealing wax after treatment. Distilled water was used as control. For each concentration of ethephon three replicates were maintained—each on a separate tree. As concentrations above 1600 mg induced 'shoot dessication' and 'die back'⁵, these were not used.

The exuded gum was harvested twice at an interval of 20 days. The data given in the histogram are means of three replicates for three years. Experiments were done in April–May and in December–January, in three successive years to study the effects of ethephon on the extent of gum production in summer and winter respectively.

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Wood blocks with bark and cambium, including the treated site, were brought to the laboratory and 10–15 μ m thick sections were cut in transverse, radial longitudinal and tangential longitudinal planes on a sliding microtome. These were stained for insoluble polysaccharides, starch, protein and lipid as per the methods suggested by Bancroft⁶.

RESULTS

The effect of ethephon treatment on the quantity of gum produced during December–January and April–May is represented in figure 1. A spectacular rise in exudation occurred in response to treatment with 1600 mg of active substance over the control in both the seasons in three successive years but gum yield is 21 times higher in April–May than in December–January using this concentration. In December–January although the yield is low, the order of increase is appreciable up to 400 mg. of active substance. Further enhancement in concentration has only an insignificant effect on gum production. In contrast, in April–May, concentrations at 800 mg and 1600 mg of active substance caused 3-fold and 9-fold increase in yield respectively, over that at 400 mg.

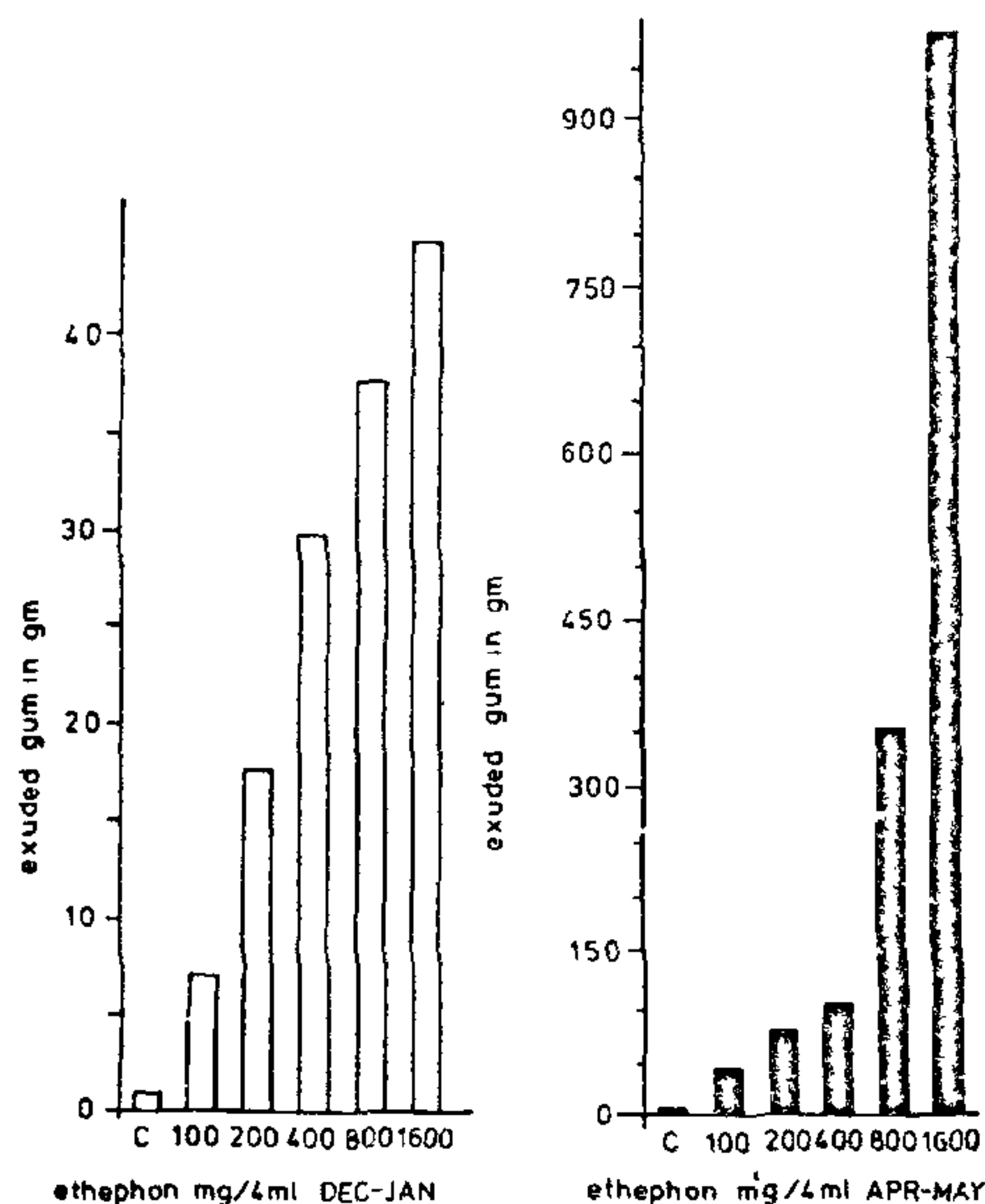
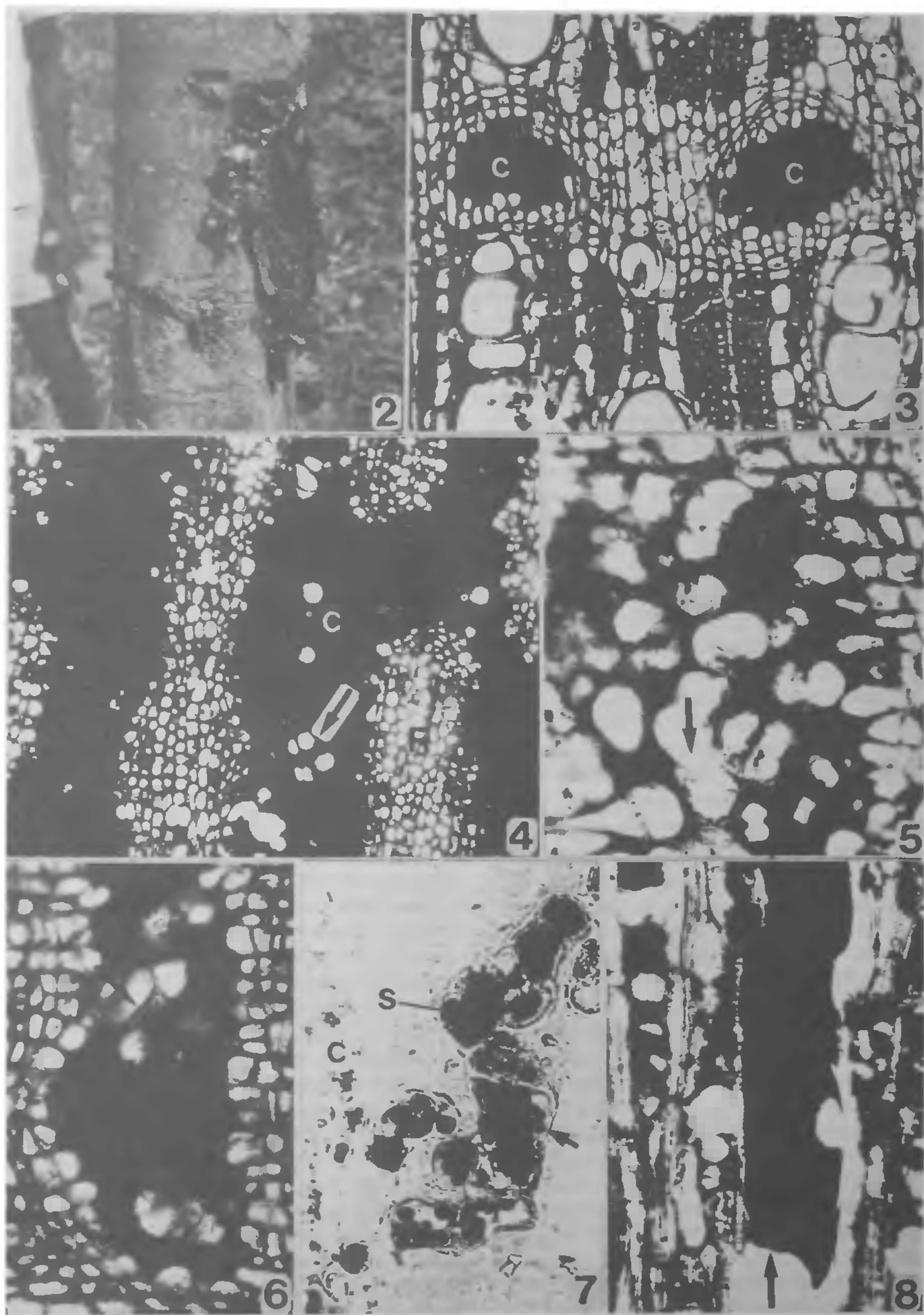


Figure 1. Mean amount of exuded gum from control and treated plants at different concentrations of ethephon in December–January and April–May. Data pooled from three successive years. C indicates control with distilled water.

A portion of the tree trunk treated with 1600 mg of active substance during April–May and showing copious gum exudation (bent arrow) is presented in figure 2. The healed-up portion of the stem at the region of previous year's tapping is indicated by the straight arrow.

In an unwounded tree there are no special tissues which are concerned with gum production. Control samples show the presence of gum cavities in the bark presumably as a response to wounding. However, the treated samples show the formation of tangential bands of gum cavities in the axial parenchyma of the sapwood (figure 3). The elongated cavities are oriented parallel to the longitudinal axis of the tree trunk and anastomose tangentially. Multiseriate rays are observed amidst the anastomosing cavity system (figure 4), although no cavities are recorded in the multiseriate rays. The cells suspended in close vicinity to the multiseriate rays indicate that some of the peripheral cells become detached and move into the lumen of the gum cavity (figure 4).

In the sapwood, a gum cavity arises schizogenously by the formation of intercellular spaces among a



group of axial parenchyma cells. However, the occurrence of isolated cells suspended within the gummy material of the cavity and their enlargement emphasize the lysigenous mode of gum cavity development (figure 5).

The contents in the gum cavity showed positive staining for proteins (figure 6) and polysaccharides (figure 4). Lipids were undetected. The large masses of sloughed-off cells suspended in the gum cavity are studded with starch grains (figure 7). Xylem vessels in the vicinity of the traumatic cavities are usually plugged by a gummy material (figure 8).

DISCUSSION

Several gums and gum-resins of international trade are exclusively indigenous⁷. Owing to lack of adequate scientific tapping techniques and collection procedures, it has become difficult to utilize these products optimally. In the present study, gum exudation has been enhanced by 466 times as a result of treatment with 1600 mg of active substance of ethephon during April–May when the plant is leafless owing to natural abscission. Ethephon application into sapwood has been reported to result in the formation of the characteristic heartwood polyphenols in *Rhus*⁸, resin enrichment in pines⁹, copious gum exudation in *Prunus* sp.⁸ and *Azadirachta indica*¹⁰, increased kino formation in *Eucalyptus* sp.⁸, stimulated gum-resinosis in *Mangifera indica*¹¹ and enhanced yields of rubber from *Hevea brasiliensis*¹².

In *A. latifolia*, there is no natural pre-formed gum-producing tissue system in the wood but the gum cavities are induced schizo-lysigenously in the axial parenchyma of sapwood upon ethephon treatment. According to Abeles¹³ ethylene may cause gum pocket or cavity or cyst formation in plants. The loss of middle-lamellar cohesiveness and the breakdown of the primary cell walls in the phloem tissue in and around gum pockets suggested an

ethylene-induced tissue deterioration in cherries¹⁴. Kawase^{15,16} also observed ethylene-induced stimulation of cellulase activity leading to aerenchyma development in water-logged sunflower plants.

The presence of starch in the epithelial cells and in sloughed-off cells suspended in the gum-cavity indicates the possible involvement of starch in gum synthesis.

Presence of gum in vessels may increase the viscosity of vessel sap and cause occlusion of the vessels preventing further sap flow. Sealing of vessels at the site of wound may help in preventing water loss and entry of pathogens⁵.

As the energy-demanding processes¹⁷ like bud-growth/shoot development and flowering/fruitletting occur during June–July and September–January respectively, the only period during which the reserve metabolites are understandably high in wood parenchyma is April–May. This seems to explain why greater exudate yields are obtained in April–May than during any other time in a year. As gum yields during April–May are about 21 times higher than in December–January in response to treatment with 1600 mg of active substance, it is suggested that *A. latifolia* should be tapped for commercial purposes in April–May and be given rest in the remaining part of the year. It is important to note that none of the treated plants in the present work showed any visible injury symptoms even after being tapped twice annually for three consecutive years. Therefore, tapping during flowering, fruiting and refoliation stages of the tree may be carried out in case the overall returns are economical.

As the technique of ethephon application is simple and requires no specialized skills, it can be easily taught to unskilled tribals dwelling in the forests. Ethephon is inexpensive, indigenously manufactured, easily available and safe. Ethephon has been tested and declared non-toxic, and is being used in agriculture as a plant growth regulator the world over^{18–21}.

Figures 2–8. 2. A portion of the main bole. Bent arrow points to copious gum exudation from the treated site (treatment with 1600 mg of active substance of ethephon). Straight arrow points to the healed-up portion of the stem bark at the region of the previous year's tapping; 3 to 8. Histology of treated wood samples; 3. Cross-section of sapwood showing tangential band of gum cavities (C). $\times 290$; 4. T.L.S. of treated wood showing anastomoses of gum cavities. Note the cells suspended in the cavity (at arrow). Contents of the cavity (C) show PAS-positive reaction. $\times 110$. R-Ray; 5. R.L.S. of treated wood showing isolated, enlarged cells suspended in the gum cavity (at arrow). $\times 680$; 6. T. S. of treated wood. Contents of the gum cavity showing positive staining with mercuric bromphenol blue. Note the irregular shape of the cavity and the protruding lining cells (at arrow). $\times 310$; 7. A group of cells (at arrow), filled with starch grains (S) (stained with I_2KI) in the gum cavity (C). $\times 300$; 8. R.L.S. of sapwood showing part of a xylem vessel occluded with gum (at arrow). $\times 410$.

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NEWS

A COMPUTER ON A CHIP

One of the first scientific applications of transputer technology is now under way. The aim is to give molecular modellers a work station with the power of a super computer—but not its price.

Chemical Design has initiated the programme and is working with Glaxo in drug design, ICI in polymers and inorganic catalysts, and British Biotechnology in protein engineering to produce a system aimed at the molecular modelling market. At the heart of the system is INMOS's transputer—'the computer on a chip'. This 9 mm square chip contains a 32-bit microprocessor capable of 10 MIPS (million instructions per second), 2 Kbytes of RAM,

a 32-bit memory interface and a memory controller.

With this system it would be possible for molecular modellers to perform calculations, which currently take days, within a few hours. Molecular modelling programs are memory intensive and therefore often require access to a supercomputer, but the MITIE workstation would be able to run such programs. According to the company the aim is to provide supercomputer performance at minicomputer prices.

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