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THE DITERPENOIDS OF *ERYTHROXYLON MONOGYNUM* - I. MONOGYNOL

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SIX new diterpenoids (Table 1) have been isolated from the wood of *Erythroxylon monogynum* Roxb. In this communication we wish to report the complete structure elucidation of the major component (compound B), now termed monogynol; the following paper discusses the constitution of compound C_1.

Monogynol, $C_{20}H_{32}O$, m.p. 119 - 119.5^o, $[\alpha]_D^{24}$ + 13.1^o ($CHCl_3$; C, 3.2%) must be identical with the solid alcohol (m.p. 118^o) isolated earlier from the essential oil derived from the same wood (1). The presence of one olefinic linkage was revealed from its quantitative hydrogenation to the saturated dihydromonogynol, $C_{20}H_{34}O$ (m.p. 127.5 - 128^o). That this olefinic linkage must be cis-disubstituted and attached to two quaternary carbon atoms was clear from IR (752, 1580, 3020 cm^{-1}) and PMR* (2H; an AB quartet:

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* The proton magnetic resonance (PMR) spectra were taken on 10-20% solutions in CCl_4 or $CDCl_3$ on a Varian A-60 spectrometer; the signals are recorded in cps from tetramethylsilane as zero.

TABLE 1. DITERPENOIDS FROM ERYTHROXYLON MONOGYNUM

No.	Trivial name	Mol. formula	m.p.	$[\alpha]_D^{28}$ (Solvent)
A	-	$C_{23}H_{38}O_2$ **	81.5 - 82°	+ 9.95° ($CHCl_3$)
B	Monogynol	$C_{20}H_{32}O$	119 - 119.5°	+13.11° ($CHCl_3$)
C_1 *	Devadarool+	$C_{20}H_{34}O_2$	124 - 125°	+11.91° ($CHCl_3$)
C_2 *	-	$C_{20}H_{34}O_2$	147 - 148°	+79.12° ($CHCl_3$)
D	-	$C_{20}H_{34}O_3$	181.5- 182°	+ 2.55° (EtOH)
E	Hydroxymono-gynol.	$C_{20}H_{32}O_2$	178 - 179°	+40.86° ($CHCl_3$)

*Form a molecular compound, which can be separated into components by partitioning the hexane solution with aq. alcoholic silver nitrate; separation first effected by R. Soman.

+Derived from the local name (Kannada: Devadaru) of the wood.

**Possibly an artefact.

319, 325, 333 and 339 cps) spectra of monogynol. The primary nature of the hydroxyl function (3340, 1020 cm^{-1}) was inferred from its chemical behaviour and its PMR absorption (2H; an AB quartet: 192, 203, 213 and 224 cps), the J-multiplicity in the latter further showed that the carbinol group must be linked to a carbon carrying no hydrogen. The PMR spectrum, moreover, revealed the presence of three methyl groups (sharp signals at 43, 55 and 59 cps, each equal to 3H), all of which must be quaternary. The mass spectrum* of monogynol showed the mol. wt.peak at m/e 288, thus confirming the mol. formula $C_{20}H_{32}O$; another prominent peak at m/e 257, ascribable to mol. wt. minus CH_2OH, is in accord with the above conclusions about the nature of the hydroxyl function.

Selenium dehydrogenation of monogynol yielded 1,7-dimethylphenanthrene; the same product was obtained after monogynol has been cleaved at the olefinic linkage and the resulting hydroxy lactone (IX, Chart 1) then subjected to Se dehydrogenation. Since monogynol, $C_{20}H_{32}O$, must be tetracyclic, the olefinic linkage must be located in the fourth ring, fused on to the perhydrophenanthrene nucleus.

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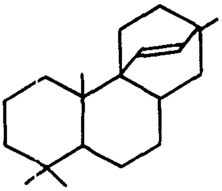
* Determined by the kind courtesy of Prof.N.S.Wulfson, Institute for Chemistry of Natural Products, Moscow, to whom we would like to record our thanks.

The above findings, taken in conjunction with the biogenetic mechanistic reasonings (2) lead to two alternatives (I) and (II) for the parent system. A decision in favour of the latter formulation could be made on the basis of the fact that the dialdehyde resulting from the cleavage of monogynol acetate at the ethylenic linkage existed solely as the methoxyhemiacetal (VIII). At this stage of the work, the parent gross system represented by II, though postulated in the biogenesis (2) of certain tetracyclic diterpenes and also constituting the artefact isosteviol (3), had not been encountered in Nature. However, since then, a few tetracyclic diterpenes of this type e.g. beyerol (4), stachenone (5) have been described. A comparison of the molecular rotation differences for the monogynol derivatives with those available for the beyerol series showed that monogynol and beyerol had the same parent skeleton. This was confirmed by a direct comparison of the deoxyperhydromonogynol, m.p. 39-40°, $[\alpha]_D^{28}$ -3.9 ($CHCl_3$) (dihydromonogynol → tosylate → parent hydro-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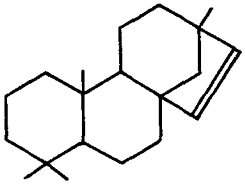
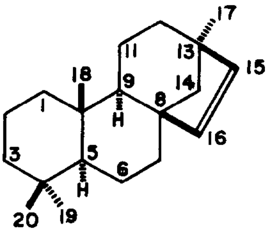
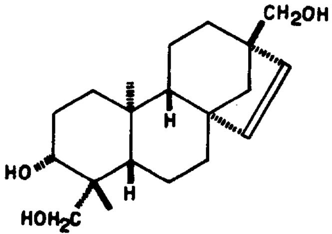

II

carbon) with beyerane*, when the two were found to have the same m.p., IR and PMR spectra, but opposite rotations . Hence, monogynol must be derived from (III), the absolute stereochemistry being based on that recently (6) secured for beyerol (IV).



III



IV

The placement of the primary hydroxyl in III could be uniquely arrived at by a study of the PMR spectrum of the methyl ester of the acid derived from monogynol**. The compound displayed sharp signals at 42, 56 and 67 cps. A comparison with the positions of the methyl signals of desoxyperhydromonogynol (beyerane) (48, 50, 54 and 56 cps)

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* We are grateful to Prof.P.R. Jefferies for kindly getting beyerane made from beyerol and supplying us with the data and samples.

**In principle the position of the -CH$_2$OH group can be deduced by a study of the apparent dissociation constant [P.F. Sommer, V.P.Arya and W.Simon, Tetrahedron Letters No.20, 18 (1960)] of the derived acid. This has been studied and will be discussed in the full paper.

showed that in the ester one methyl had suffered a diamagnetic shielding, while another had undergone a downfield shift. It is known (7,8) that a methyl attached to a carbon carrying a carboxylate ester resonates at considerably lower field than isolated methyls; thus the carboxyl function must be located on a carbon carrying a methyl, that is on C_4. The up-field shift of one of the methyls must have origin in the anisotropy of the carbon-oxygen double bond (9) when a methyl group must be coming under the influence of the diamagnetic shielding cone*; this is possible only when the methyl and the methoxycarbonyl in dihydro-III have 1,3-diaxial relationship (FIG.1). Since, as deduced above, the ester group must be located on C_4, it follows now that it must be axially oriented, when the 67 and 42 cps signals can be assigned to 19- and 18-methyl protons respectively. Based on these conclusions, monogynol must have the structure and absolute stereochemistry depicted in V.

The structure V for monogynol would require that the methyl at C_{10} should be diamagnetically shielded by the C_{15}-C_{16} olefinic linkage (6,9,12). This is borne out

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*Not many examples of diamagnetic shielding by a carbon-oxygen double bond have been recorded (10,11). This method of determining 1,3-diaxial relationship between a methyl and methoxycarbonyl has great potentialities in the terpenoid field and will be discussed in detail in the full paper.

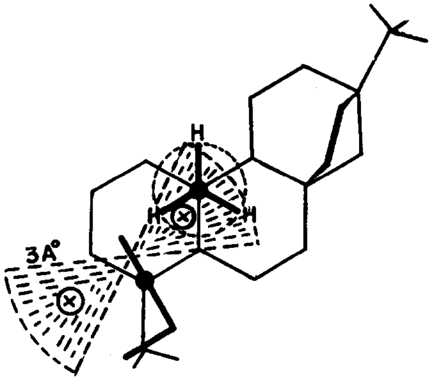
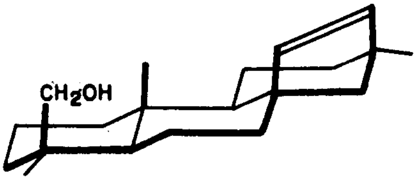
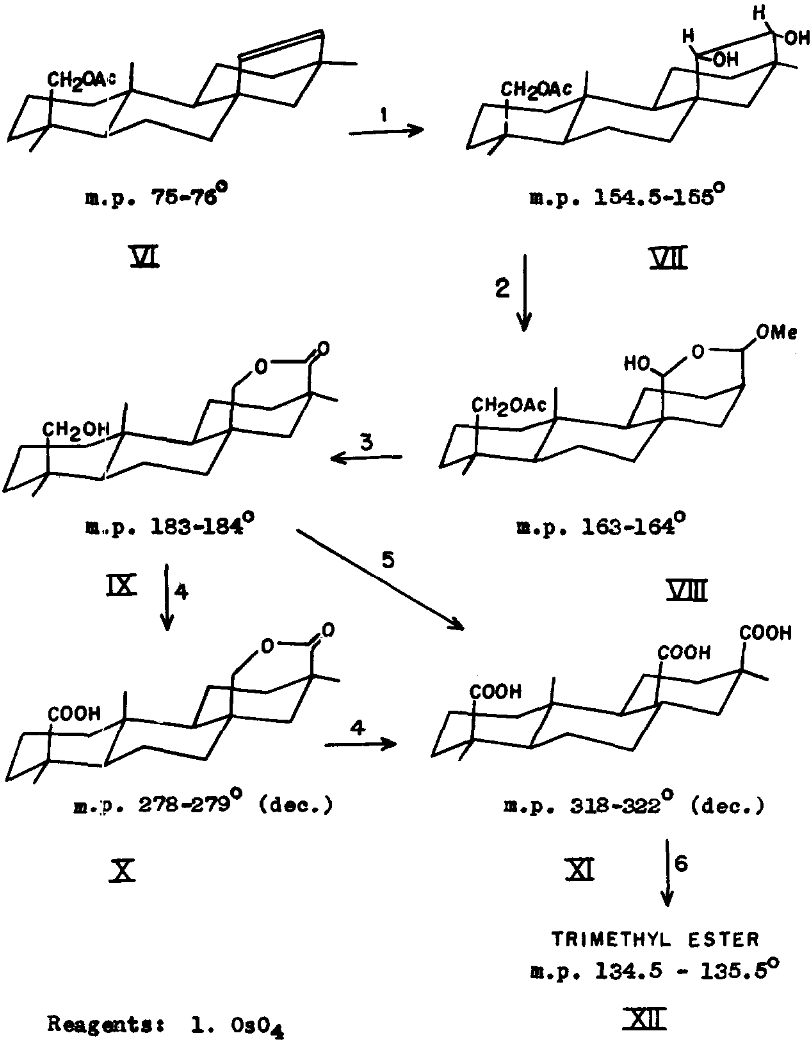


Fig.1 Top projection of Dreiding Model (to scale).



V



Reagents:
1. OsO_4
2. $NaIO_4$ in MeOH
3. MeOH-KOH
4. $Na_2Cr_2O_7$-H_2SO_4-AcOH (4 Equiv.of O)
5. $Na_2Cr_2O_7$-H_2SO_4-AcOH (8 Equiv.of O)
6. CH_2N_2

CHART 1

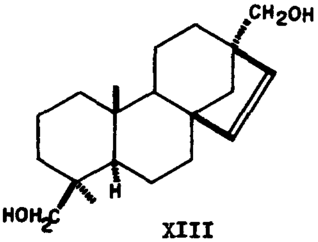
by the data collected in Table 2.

TABLE 2 : CHEMICAL SHIFTS OF METHYL GROUPS - EFFECT OF C_{15}-C_{16} OLEFINIC BOND

Compound	Chemical Shifts
Monogynol	43, 56, 59
Dihydromonogynol	56, 56, 57
Monogynyl acetate	46, 55.5, 60
Dihydromonogynyl acetate	55, 57, 57
Monogynyl acetate glycol (VII)	55, 57, 57

Chemical transformations, depicted in Chart 1, fully support the structure (V) deduced above for monogynol; the analytical and spectroscopic data are in complete agreement with the structures shown. It should be pointed out that the diamagnetic shielding of the methyl at C_{10} in (XII) should be augmented now because it comes under the shielding influence of the two methoxycarbonyl groups; in complete accord with this the compound (XII) displayed methyl signals at 27, 62 and 66 cps.

The structure of compound E (Table 1) has also been investigated and the data on hand and especially the PMR spectrum of the derived dihydro-dimethyl ester (m.p.111-12°; Me signals at 43, 68 cps) help to assign the constitution (XIII) to the compound E, which we shall now term *hydroxymonogynol*.



XIII

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