S 33. *The* Euphorbia *Resins. Part I. Euphol.*

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The equivalent-weight determinations of euphyl acetate established the formula, $C_{30}H_{50}O$, for euphol. Ozonolysis of euphyl acetate gives both acetone and formaldehyde and quantitative determinations lead to the conclusion that the *iso*propylidene group is not attached directly to a ring. Furthermore, euphyl acetate dibromide on treatment with alcoholic potash loses only one bromine to give *bromoeuphol.*

The above would indicate the inclusion of euphol in the elemi-acids group of triterpenes. Dehydrogenation of dihydroeuphol with selenium gave 1 : 2 : 8-trimethylphenanthrene as the principal product as is found for all members of this group. Chromic anhydride oxidation of dihydroeuphyl acetate yields *ketodihydroeuphyl acetate* and *diketodihydroeuphyl acetate*, which compounds are analogous to those obtained from similar oxidation of dihydro-α-elemolic acid.

Euphol obtained by Newbold and Spring (*J.*, 1944, 249) from "euphorbone" has now been extracted from *Euphorbia tirucalli* L., *E. triangularis* Desf., and *E. ingens* E. Mey. Considerable quantities of these resins were obtained in these laboratories during the war when one of us was studying the production of rubber from the *Euphorbia* species. The appearance of the paper by Jeger and Krusi (*Helv. Chim. Acta*, 1947, **30**, 2045) leads us to present our results on euphol (Williams, M.Sc. Thesis, University of South Africa, 1945) before reporting on the other constituents of these species.

Newbold and Spring prepared several derivatives of euphol to which they assigned the formula $C_{30}H_{50}O$, but did not exclude the possibility of $C_{29}H_{48}O$, and established the presence of two double bonds, one of which was easily reducible. With the larger quantities available the molecular weight has now been accurately determined by the method of Sandquist and Gorton (*Ber.*, 1930, **63**, 1935) and found to be 468 and 472 for euphyl acetate and dihydroeuphyl acetate respectively, so that the formula $C_{30}H_{50}O$ is established.

Ozonolysis of euphyl acetate has given acetone, identified as the dinitrophenylhydrazone, and formaldehyde, isolated as the dimedone compound. Since acetone has been reported to be obtained from the ozonolysis of terpenes not containing the *iso*propylidene group, the quantitative determinations were made by the method of Kuhn and Roth (*Ber.*, 1932, **65**, 1285); euphyl acetate gave 0·75 mol. of acetone whilst dihydroeuphyl acetate and dihydroeuphol under exactly the same conditions gave 0·20 and zero mol. respectively. Jeger and Krusi (*loc. cit.*) oxidised euphyl benzoate with osmic acid and lead tetra-acetate successively to obtain acetone. The formation of both acetone and formaldehyde on ozonolysis is indicative of an *iso*propylidene group being part of a carbon chain and not attached to a ring (cf. Simonsen, " The Terpenes," 1931, Vol. 1, 27; Grignard, Doeuvre, and Escorrou, *Bull. Soc. chim.*, 1924, **35**, 932).

In attempts to effect cyclisation, euphyl acetate dibromide was treated with boiling alcoholic potassium hydroxide; only one bromine atom was lost and *monobromoeuphol*, m. p. 149·5—150°, further characterised as the *acetate*, m. p. 130·5—131°, was obtained. No cyclisation had occurred because, on catalytic hydrogenation, dihydroeuphol, m. p. 121° (cf. Newbold and Spring, *loc. cit.*), was obtained. The removal of only one bromine atom also indicates that the reducible ethylenic linkage of euphol is not situated between two tertiary carbons (cf. Ipatjew, *J. Russ. Phys. Chem. Soc.*, 1895, **27**, 347) and the monobromoeuphol contains the grouping (I). This assumption receives support from the quantitative formation of acetone from monobromoeuphol on ozonolysis.

$$-CH_2-CMe=CH_2 \rightleftharpoons -CH=CMe_2 \rightarrow -CHBr-CBrMe_2 \rightarrow -CBr=CMe_2 \qquad (I.)$$

To test further the possibility of including euphol in the elemi-acids group, dihydroeuphol was dehydrogenated with selenium at 360°. No naphthalenes were obtained and the sole distillate product isolated was 1 : 2 : 8-trimethylphenanthrene, m. p. 145—146°, characterised as the trinitrobenzene derivative, m. p. 192°. This parallels the behaviour of cryptosterol (Schulze, *Z. physiol. Chem.*, 1936, **238**, 35), α-elemolic acid (Ruzicka, Rey, and Spillman, *Helv. Chim. Acta*, 1942, **25**, 1375), and lanosterol (Ruzicka, Rey, and Muhr, *ibid.*, 1944, **27**, 472). In addition, on oxidation of dihydroeuphyl acetate with chromic anhydride there was obtained *ketodihydroeuphyl acetate*, $C_{32}H_{52}O_3$, in colourless nodules, m. p. 163—164°, and *diketodihydroeuphyl acetate*, $C_{32}H_{50}O_4$, as yellow needles, m. p. 96—97° (corr.). These compounds are analogous to, but not identical with, those obtained by the oxidation of dihydrolanosteryl acetate by Ruzicka, Rey, and Muhr (*loc. cit.*).

EXPERIMENTAL.

Euphol.—The fresh latex from *E. triangularis* or *E. tirucalli* was coagulated by the addition of salt and the coagulum extracted from the rubber by alcohol. The resin so obtained was percolated through a column of alumina activated at 300°. The solid from the petroleum fraction crystallised from methanol to give euphol, m. p. 117° (corr.) (Found : C, 84·5, 84·5; H, 12·1, 12·0. Calc. for $C_{30}H_{50}O$: C, 84·4; H, 11·8%), acetate, m. p. 109° (Found : C, 81·8, 82·1; H, 11·1, 11·0. Calc. for $C_{32}H_{53}O_2$: C, 82·0; H, 11·2%). Spring and Newbold (*loc. cit.*) give m. p.s 116° and 109° respectively. The yields of pure euphol were small and for large-scale preparation the crude petroleum eluate was acetylated and the product crystallised several times from ethanol, with considerably less loss of material, to give pure euphyl acetate.

Molecular Weight Determinations.—The method used was that of Sandquist and Gorton (*Ber.*, 1930, **63**, 1935). The acetate (*ca.* 450 mg.) was hydrolysed with 0·3N-alcoholic potassium hydroxide (25 c.c.) on a steam-bath for 2 hours. After the addition of alcohol (100 c.c.) and 0·25N-acetic acid (25 c.c.) the mixture was cooled to 30° and the excess potassium hydroxide titrated against acetic acid using thymol-blue–cresol-red indicator. The blank determinations varied only within 0·2%. Euphyl acetate, m. p. 109° (Found : *M*, 468·2, 468·1. Calc. for $C_{32}H_{52}O_2$: *M*, 468·7), Dihydroeuphyl acetate, m. p. 125—126° (Found : *M*, 472·0. Calc. for $C_{32}H_{54}O_2$: *M*, 470·8).

Monobromoeuphol.—Euphyl acetate dibromide (1 g.) was refluxed with alcoholic potassium hydroxide (30 c.c.) for 3 hours and poured into water. The insoluble product was thrice crystallised from alcohol and finally from absolute ethanol to give pearly plates of *monobromoeuphol*, m. p. 149·5—150° (Found : C, 71·1; H, 9·82. $C_{30}H_{49}OBr$ requires C, 71·3; H, 9·70%). Catalytic hydrogenation of this bromo-alcohol (0·35 g.) in ethanol (10 c.c.) with Adams's catalyst gave dihydroeuphol, m. p. 121°, undepressed on admixture with authentic specimen prepared by the method of Newbold and Spring (*loc. cit.*). *Monobromoeuphyl acetate*, obtained from the alcohol (1 part) by heating on a steam-bath with acetic anhydride (5 parts) and pyridine (5 parts), crystallised from ethanol in plates, m. p. 130·5—131° (Found: C, 70·32; H, 9·25; Br, 14·69. $C_{32}H_{51}O_2Br$ requires C, 70·16; H, 9·40; Br, 14·60%).

Ozonolysis of Euphyl Acetate.—Euphyl acetate (3·4 g.) in pure carbon tetrachloride was cooled to 0°, ozone passed for 6 hours, and then air for 1 hour, whilst the issuing gases were passed through a trap containing water (10 c.c.) at 0°. The solvent was removed under reduced pressure to leave an oil which was refluxed with the water from the trap for 15 minutes and cooled to 0°. The aqueous layer, decanted from the oil, was distilled to half bulk, and the distillate divided into two halves: One half was treated with dimedone and the precipitate crystallised from methanol to give formaldehyde-dimedone, m. p. 189°, undepressed on admixture with authentic specimen. The second portion (2·5 c.c.) was treated with acetic acid (0·5 c.c.), the formaldehyde destroyed with a slight excess of potassium permanganate, and distilled. The distillate gave acetone 2 : 4-dinitrophenylhydrazone which, crystallised from alcohol, had m. p. 128°, undepressed on admixture with authentic specimen.

The solid material (2·5 g.) from the ozonide decomposition was treated with petroleum (b. p. 50—80°; 100 c.c.), filtered from the insoluble oil (0·5 g.), and percolated through activated alumina (30 × 2 cm.). Petroleum (600 c.c.) eluted a waxy solid (0·72 g.) which, twice sublimed at 200—225°/0·1 mm. and recrystallised four times from acetone, gave rectangular plates, m. p. 173—174°, unchanged by further crystallisation (Found : C, 78·10; H, 10·29. Calc. for $C_{27}H_{42}O_3$: C, 78·2; H, 10·21%).

Quantitative Determination of the iso*Propylidene Groups.*—(Method of Kuhn and Roth, *Ber.*, 1932, **65**, 1285; Pregl, "Quantitative Organic Microanalysis," 3rd English Edn., 1937, p. 210.) Euphyl acetate (Found : CMe_2, 6·83, 6·76. Calc. for $C_{32}H_{52}O_2$: CMe_2, 8·97%). Monobromoeuphol (Found: CMe_2, 8·10. Calc. for $C_{30}H_{49}OBr$: CMe_2, 8·06%). Control determinations on dihydroeuphol gave no acetone whilst dihydroeuphyl acetate gave 0·13 and 0·18% of *iso*propylidene group.

Selenium Dehydrogenation of Dihydroeuphol.—Dihydroeuphol (30 g.) and powdered selenium (60 g.) were heated in a bath at 300° for 53 hours. The ether extract failed to distil below 240°/14 mm. and was re-treated with selenium (53 g.) at 340—360° for 30 hours. The ether extract was fractionated to give (i) a yellow oil (0·36 g.), b. p. below 200°/14 mm., 145°/700 mm., yielding no picrate, and (ii) a viscous gum, b. p. 170—200°/1 mm. Fraction (ii) was redistilled to give (iia) an oil, bath temp. 140—170°/0·1 mm., from which crystals separated on cooling, and (iib) an oil, bath temp. 170—180°/0·1 mm., which set to a brown amorphous solid. Both fractions (iia) and (iib) were lixiviated with petroleum (b. p. 50—70°) and the extract gave oily crystals which, pressed on a porous plate and crystallised four times from ethanol, gave 1 : 2 : 8-trimethylphenanthrene, m. p. 145—146° (corr.) (Found : C, 92·49, 92·92; H, 7·14, 7·49. Calc. for $C_{17}H_{16}$: C, 92·68; H, 7·32%); trinitrobenzene derivative, crystallised from alcohol in long yellow needles, m. p. 192° (corr.) (Found : C, 63·61; H, 4·32. Calc. for $C_{23}H_{19}O_6N_3$: C, 63·73; H, 4·42%). Ruzicka, Rey, and Muhr (*Helv. Chim. Acta*, 1944, **27**, 482) give m. p.s 145·5—146·5° and 192·5—193·5° respectively.

Oxidation of Dihydroeuphyl Acetate by Chromium Trioxide.—Dihydroeuphyl acetate (3 g.) was dissolved in acetic acid (130 ml.), chromium trioxide in 90% acetic acid (15 ml.) added slowly during 20 minutes, and the solution kept at 40° for 4 hours. Methanol was added and the mixture was poured into water. The ether extract was washed with water, sodium carbonate, and water. The ether was completely removed, the residue dissolved in petroleum (100 ml.; b. p. 50—70°) and the resultant solution percolated through alumina (100 g.), activated at 300°, to give the following fractions : (A) (3600 ml. of petroleum), traces of amorphous yellow solid; (B) (300 ml. of benzene), gummy solid (500 mg.); (C) (300 ml. of benzene), microcrystals (400 mg.); (D) (800 ml. of benzene), coloured oil (500 mg.); (E) (100 ml. of ethanol), trace.

Fraction B, crystallised once from ethanol and twice from methanol, formed felted yellow needles of *diketodihydroeuphyl acetate* (14 mg.), m. p. 96—97°, unchanged by further crystallisation from ethanol (Found : C, 77·6; H, 10·14. $C_{32}H_{50}O_4$ requires C, 77·06; H, 10·11%).

Fraction C when crystallised from acetone, methanol, and ethanol gave fine needles (6 mg.), m. p. 160—161° (corr.) (Found : C, 78·54; H, 10·58%).

On cooling a solution of fraction D in ethanol to 0°, colourless nodules of *ketodihydroeuphyl acetate*, m. p. 163—164° (corr.) unchanged by further crystallisation, were obtained (Found : C, 79·53; H, 10·82. $C_{32}H_{52}O_3$ requires C, 79·28; H, 10·81%).

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