233. *The Resinols. Part V. β-Amyrenonol and Dehydro-β-amyrenol. The Location of the Unsaturated Centres of the α- and β-Amyrenols.*

By J. H. Beynon, K. S. Sharples, and F. S. Spring.

The presence of the grouping ·C:C·CH_2·CH· in β-amyrenol has been diagnosed by the oxidation of β-amyrenyl benzoate to the αβ-unsaturated ketone β-amyrenonyl benzoate. Reduction of β-amyrenonol, followed by treatment of the product with acetic anhydride, yields dehydro-β-amyrenyl acetate, which, like the α-isomer, contains a conjugated system of ethenoid linkages located in a single ring system. Oxidation of dehydro-α-amyrenyl acetate gives an αβ-unsaturated hydroxy-ketone, $C_{32}H_{50}O_4$. The structures of the α- and β-amyrenols are discussed in the light of these and other transformations.

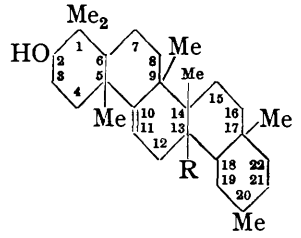
An unsuccessful attempt was made by Vesterberg (*Ber.*, 1891, **24**, 3836) to oxidise β-amyrenyl acetate with chromic anhydride with the object of preparing a derivative analogous to " oxy-α-amyrin acetate," which was later shown to be α-amyrenonyl acetate (Spring and Vickerstaff, J., 1937, 249). Repetition of this experiment gave " β-amyrenyl acetate oxide," m. p. 293°, as the only isolable product, identical with the " oxide " prepared by Rollett and Bratke (*Monatsh.*, 1922, **43**, 685), by Spring (J., 1933, 1345; Spring and Vickerstaff, J., 1934, 1859), and by Dieterle, Brass, and Schaal (*Arch. Pharm.*, 1937, **275**, 557). The oxide fails to give a coloration with tetranitromethane in chloroform and is recovered unchanged after treatment with acetic anhydride or with chromic acid. The Zerewitinoff method, however, indicates the presence of one active hydrogen atom.

In marked contrast to the behaviour of β-amyrenyl acetate, oxidation of β-amyrenyl benzoate with chromic anhydride yields β-*amyrenonyl benzoate*, m. p. 265°. Hydrolysis of the benzoate gives β-*amyrenonol*, $C_{30}H_{48}O_2$, m. p. 175°, yielding β-*amyrenonyl acetate*, m. p. 260—261°, on acetylation. This acetate exhibits the typical light absorption properties of an αβ-unsaturated ketone but fails to give a semicarbazone or oxime. It is clear that the oxidation of β-amyrenyl benzoate has proceeded in exactly the same way as that of α-amyrenyl acetate (Spring and Vickerstaff, 1937, *loc. cit.*), a methylene group in the α-position to the ethylenic linkage being converted into a carbonyl group. Furthermore, migration of the ethylenic linkage has not occurred during the oxidation, for we find that, like α-amyrenonyl acetate (Ruzicka, Leuenberger, and Schellenberg, *Helv. Chim. Acta*, 1937, **20**, 1271), the β-isomer is slowly reduced on shaking with hydrogen and platinum to give β-amyrenyl acetate, hydrogenation of the αβ-unsaturated ketone system resulting in complete reduction of the carbonyl group, the ethylenic linkage being unaffected.

Oxidation of β-amyrenonol with chromic anhydride gives the previously described " β-amyrone oxide I " (Spring and Vickerstaff, J., 1934, 650, 1859), which must now be designated β-amyrenedione, $C_{30}H_{46}O_2$; the analyses recorded by Spring and Vickerstaff clearly favour this formulation. Like β-amyrenonyl acetate, β-amyrenedione exhibits the light absorption properties of an αβ-unsaturated ketone.

Reduction of β-amyrenonyl acetate with sodium and alcohol gives a product which in spite of prolonged drying has the formula $C_{30}H_{50}O_2,C_2H_5{\cdot}OH$ and which on heating with acetic anhydride gives *dehydro-β-amyrenyl acetate*, m. p. 208—209°. Like dehydro-α-amyrenyl acetate (Spring and Vickerstaff, 1937, *loc. cit.*), the β-isomer exhibits selective absorption in the ultra-violet region of the spectrum with a maximum at 2820 A. (Fig.), indicating the presence of a system of conjugated ethylenic linkages located in a single ring system.

The conversion of the amyrenols into the corresponding dehydroamyrenols indicates the presence in the former alcohols of the system $\cdot C{:}C{\cdot}CH_2{\cdot}CH\cdot$, which must be located in a single cyclic system and not distributed between two rings. The conversion of oleanolic acid into β-amyrenol (Ruzicka and Schellenberg, *Helv. Chim. Acta*, 1937, **20**, 1553), moreover, shows that this system must be present in the triterpene acid. The structure (I, R = Me) postulated by Ruzicka and Schellenberg for β-amyrenol does not accommodate this unsaturated system, an angular methyl group being attached to C_{13}. The possibility that the conversion of the amyrenonols into the corresponding dehydroamyrenols is effected by a retropinacolinic rearrangement is considered unlikely, since the same change would have to be assumed during the sulphur dehydrogenation of α-amyrenol to dehydro-α-amyrenol (Jacobs and Fleck, *J. Biol. Chem.*, 1930, **88**, 137).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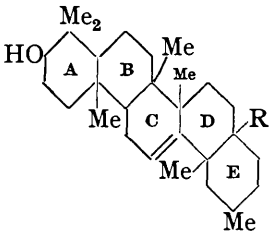
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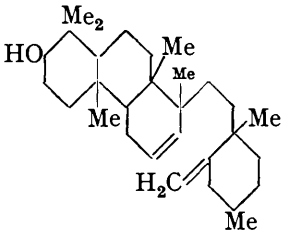
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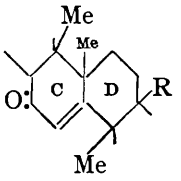
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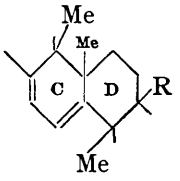
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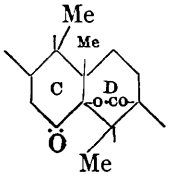
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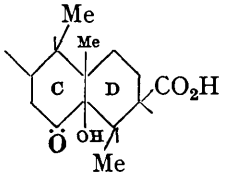
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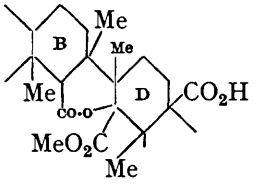
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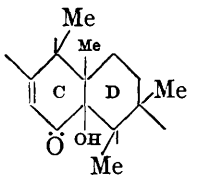
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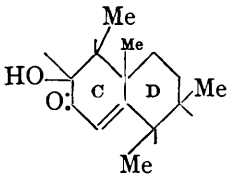
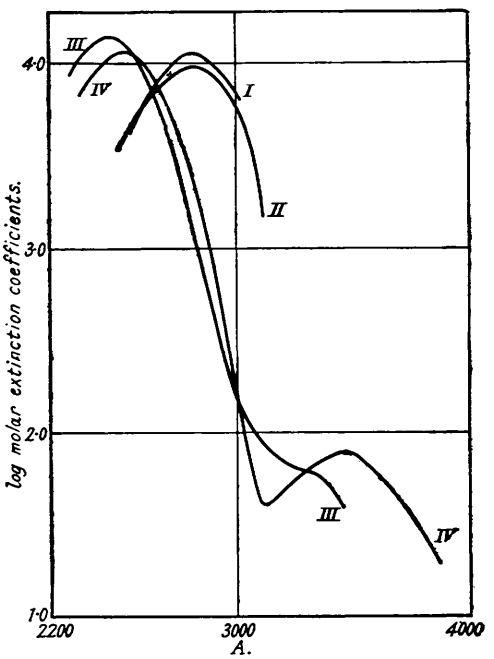

(IX*a*.)

The modified structure (II) for β-amyrenol (R = Me) and oleanolic acid (R = CO_2H) has the advantage that it accommodates the unsaturated system and at the same time interprets the data of dehydrogenation and of oxidative degradation. According to this structure the αβ-unsaturated ketones α- and β-amyrenonols (R = Me) and ketoacetyl-oleanolic acid (R = CO_2H) (Kitasato and Sone, *Acta Phytochim.*, 1933, **7**, 183; Ruzicka and Cohen, *Helv. Chim. Acta*, 1937, **20**, 804) are represented by the partial structure (III)

and the dehydroamyrenols by (IV; R = Me). Ketoacetyloleanolic acid lactone (Kitasato and Sone, *Acta Phytochim.*, 1932, **6**, 209; Ruzicka, Hösli, and Hofmann, *Helv. Chim. Acta*, 1936, **1** 109; Ruzicka and Cohen, *ibid.*, 1937, **20**, 1192), its hydrolysis product (Ruzicka, Hösli, and Hofmann, *loc. cit.*; compare Kitasato and Sone, *Acta Phytochim.*, 1932, **6**, 210; 1933, **7**, 24), and the *iso*lactonedicarboxylic acid monomethyl ester, m. p. 300—304° (Ruzicka and Hofmann, *Helv. Chim. Acta*, 1936, **19**, 114; Ruzicka and Cohen, *ibid.*, 1937, **20**, 1192) will now be represented by the partial formulæ (V), (VI), and (VII), respectively. The relative positions of the ethenoid linkage and the carboxyl group in (II) have been suggested by Haworth (*Ann. Reports*, 1937, **34**, 338), who, however, attaches the displaced methyl group at C_{20}. Such a location does not allow of a satisfactory formulation for basseol, a diethenoid tetracyclic triterpene alcohol (Beynon, Heilbron, and Spring, J., 1937, 989). Basseol contains an exocyclic methylene group and an inert ethylenic linkage, and is isomerised under extremely mild reaction conditions to β-amyrenol, with consequent saturation of the exocyclic methylene group, a behaviour which is adequately interpreted by the suggested structure (VIII) for basseol. The evidence for the existence of a methyl group attachment at C_{18} is, however, by no means conclusive.

The complete parallellism in the behaviour of the α- and β-amyrenols leads to the derivation of the same partial structure (II) for both isomers; the two alcohols may be stereoisomeric. The hypothetical structure (IV) for dehydro-α-amyrenol receives support from the behaviour of its acetate on oxidation with chromic anhydride. The main neutral product proved to be an *acetate*, $C_{32}H_{50}O_4$, m. p. 312°. That this contains an αβ-unsaturated ketone grouping was established by its absorption in the ultra-violet region, which exhibits maxima at 2500 A. and 3460 A. (Fig.). It does not react with the usual carbonyl reagents and is unchanged after treatment with acetic anhydride. The Zerewitinoff method establishes that the fourth oxygen atom is present as a tertiary hydroxyl group. The acetate, m. p. 312°, is therefore to be formulated as (IX) or (IX*a*), the oxidation of the conjugated system of dehydro-α-amyrenyl acetate (IV) having proceeded in exactly the same way as that of ergosteryl and lumisteryl acetates (Burawoy, J., 1937, 409). The oxidation of dehydro-β-amyrenyl acetate with chromic acid is being examined.



I. *Dehydro-α-amyrenyl acetate.*
II. „ -β- „ „
III. *β-Amyrenonyl acetate.*
IV. *αβ-Unsaturated hydroxy-ketone*, $C_{32}H_{50}O_4$.

Experimental.

Oxidation of β-Amyrenyl Acetate.—A solution of the acetate (3 g.) in glacial acetic acid (120 c.c.) was treated with chromic acid (2 g.), and the mixture heated under reflux for 30 minutes. The solid separating on cooling was collected, repeatedly crystallised from acetic acid and then from benzene–ethyl acetate (1 : 1), from which " β-amyrenyl acetate oxide " separated in laminæ, m. p. 292°, showing no depression in admixture with the specimen prepared by Spring (*loc. cit.*). *Active hydrogen determination* (Zerewitinoff): 9·532 Mg. evolved 0·42 c.c. of methane at 759 mm. and 16°, corresponding to 0·9 atom of active hydrogen. Hydrolysis of the " acetate oxide " gave " β-amyrenol oxide ", which after repeated crystallisation from aqueous alcohol separated in colourless needles, m. p. 215°, showing no depression on admixture with the specimen prepared by Spring (*loc. cit.*).

β-Amyrenonol.—A solution of chromic acid (5 g.) in 85% acetic acid (50 c.c.) was added

during 30 minutes to a boiling solution of β-amyrenyl benzoate (5 g.) in glacial acetic acid (300 c.c.), and the mixture heated under reflux for a further 1½ hours. The hot solution was diluted with water until turbid, and the solid separating on cooling crystallised from glacial acetic acid, from which *β-amyrenonyl benzoate* separated in needles, m. p. 265°, $[\alpha]_D^{25°}$ + 126·6° (*l* = 1, *c* = 0·3 in chloroform) (Found: C, 81·5; H, 9·4. $C_{37}H_{52}O_3$ requires C, 81·6; H, 9·6%). A solution of the benzoate (2 g.) in benzene (10 c.c.) was added to 10% alcoholic potassium hydroxide (100 c.c.), and the mixture heated under reflux for 20 hours. After dilution with water the mixture was extracted with ether, and the extract washed with water and dried. The solid obtained after removal of the solvent was crystallised from alcohol, from which *β-amyrenonol* separated in needles, m. p. 175°, $[\alpha]_D^{21°}$ + 113·2° (*l* = 1, *c* = 6·6 in chloroform) (Found: C, 81·6; H, 11·1. $C_{30}H_{48}O_2$ requires C, 81·7; H, 11·0%).

β-Amyrenonyl acetate separated from alcohol in needles, m. p. 260—261°, $[\alpha]_D^{20°}$ + 157·9° (*l* = 1, *c* = 0·38 in chloroform)(Found: C, 79·5; H, 10·3. $C_{32}H_{50}O_3$ requires C, 79·6; H, 10·4%). *Light absorption in alcohol* (Fig.): maxima, (a) 2450 A., log ε = 4·14; (b) 3300 A., log ε = 1·78.

Reduction of β-Amyrenonyl Acetate.—The acetate (81·86 mg.) in glacial acetic acid was shaken with hydrogen in the presence of Adams's platinum catalyst for 32 hours at 80°. The absorption of hydrogen was slow and uniform, the total volume absorbed (4·205 c.c. at 16° and 742 mm.) corresponding to approximately 1 mole. The catalyst was removed by filtration, and the solvent evaporated under reduced pressure. The residue after two crystallisations from alcohol separated in long needles (30 mg.), $[\alpha]_D^{19°}$ + 76·0° (*l* = 1, *c* = 0·05 in chloroform), m. p. 235°, showing no depression on admixture with authentic β-amyrenyl acetate (Found: C, 81·85; H, 10·9. Calc. for $C_{32}H_{52}O_2$: C, 81·95; H, 11·2%).

β-Amyrenedione.—A suspension of β-amyrenonol (5 g.) in glacial acetic acid (250 c.c.) was treated with a solution of chromic anhydride (1·8 g.) in 85% acetic acid (50 c.c.), added during 1 hour, the temperature being maintained at 70° throughout. The solution was maintained at 70° for a further 30 minutes and then largely diluted with water. The neutral product, isolated in the usual manner, crystallised from acetone in colourless plates, m. p. 237°, showing no depression on admixture with the specimen described in Part II (J., 1934, 650).

Dehydro-β-amyrenyl Acetate.—A solution of β-amyrenonol (2·5 g.) in boiling amyl alcohol (65 c.c.) was treated with sodium (4·3 g.) in small amounts with frequent shaking. The mixture was then boiled for a further hour, cooled, and diluted with water. The solid obtained on removal of the amyl alcohol by distillation in steam was extracted with ether, and the extract washed and dried (sodium sulphate). Removal of the solvent and crystallisation of the residue from alcohol gave prisms, m. p. 220—221° (Found: C, 78·3; H, 11·3. $C_{30}H_{50}O_2,C_2H_5{\cdot}OH$ requires C, 78·6; H, 11·5%). The reduction product (2 g.) was heated under reflux for 1 hour with acetic anhydride (25 c.c.) and anhydrous potassium acetate (2 g.). The solid separating on dilution with water was collected and crystallised from glacial acetic acid, from which *dehydro-β-amyrenyl acetate* separated in needles, m. p. 208—209°, $[\alpha]_D^{20°}$ + 331° (*l* = 1, *c* = 0·53 in chloroform)(Found: C, 82·1; H, 10·8. $C_{32}H_{50}O_2$ requires C, 82·3; H, 10·8%). *Light absorption in alcohol:* maximum 2820 A., log ε = 3·98. Dehydro-α-amyrenyl acetate (Fig.) exhibits a maximum at 2800 A., log ε = 4·057.

Oxidation of Dehydro-α-amyrenyl Acetate.—A solution of chromic acid (1·5 g.) in 85% acetic acid (5 c.c.) was added during 1 hour to a boiling solution of dehydro-α-amyrenyl acetate (1·5 g.) in glacial acetic acid (40 c.c.), and the mixture boiled for a further hour. The solid separating on dilution with water was extracted with ether, and the ethereal extract washed with sodium carbonate solution and dried (sodium sulphate). Removal of the solvent yielded an *acetate*, which separated from acetone–methyl alcohol in plates, m. p. 312°, $[\alpha]_D^{24°}$ + 61·1° (*l* = 1, *c* = 0·33 in chloroform) [Found: C, 77·0; H, 10·2; *M* (Reiche), 479. $C_{32}H_{50}O_4$ requires C, 77·0; H, 10·1%; *M*, 498]. *Light absorption in alcohol:* maxima (a) 2500 A., log ε = 4·07; (b) 3460 A., log ε = 1·89. *Active hydrogen determination* (Zerewitinoff method): 7·069 mg. evolved 0·40 c.c. of methane at 21° and 762 mm., corresponding to 1·18 atoms of active hydrogen.

Our thanks are due to Dr. A. E. Gillam for the absorption spectra data.

THE UNIVERSITY, MANCHESTER. [*Received, June 15th,* 1938.]