98. *Sapogenins. Part XI. Further Evidence on the Constitution of Quillaic and Oleanolic Acids.*

By Philip Bilham and George A. R. Kon.

From an examination of further derivatives of deoxyquillaic and echinocystic acids it is now concluded that these acids are identical.

Surface-film measurements on the oxime of the ketone (III) and on the α-form of the

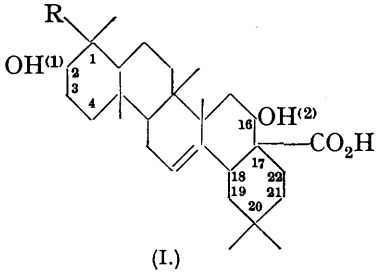
alcohol obtained by the catalytic reduction of the ketone are in agreement with previous measurements, which had led to the conclusion that one hydroxyl group of quillaic acid, $OH^{(2)}$, is situated on C_{16} and thus supported the formulation of the acid (I) in which the carboxyl was placed on C_{17}. Measurements on unimolecular films of hedraganic and the two oleananic acids and of their esters give values which are not compatible with an attachment of the carboxyl to C_{17}; the small areas found suggest that this group is attached to one of the end rings, probably to C_{20}.

The relationship of the oleananic acids with the oleanenes is discussed, and the possibility of a new formulation (VII) for sapogenins of the β-amyrin group is considered.

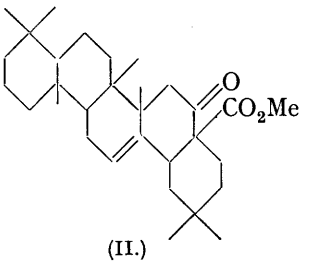
THE experiments described in Parts VI, VII, and X of this series (J., 1939, 1130; 1940, 612, 1469) have led to the inference that quillaic acid has a carbon skeleton identical with that of other sapogenins of the β-amyrin group and differs from gypsogenin in having an additional hydroxyl group, $OH^{(2)}$, which has been placed on C_{16}. On the basis of Haworth's triterpene formula, quillaic acid has the structure (I, R = CHO).

The experimental justification of this formula appeared to be satisfactory, but as it raises several points of importance for the general chemistry of the triterpenes, notably the position of the carboxyl group, which is in turn dependent of the position assigned to $OH^{(2)}$, and the mode of fusion of rings *D* and *E*, it required confirmation. The new facts now reported cannot be reconciled with formula (I) and the possibility of an alternative formulation for all triterpenes of the β-amyrin group must be considered.

In the first place, the conclusion now seems inevitable that deoxyquillaic acid, produced by replacing the aldehyde group of quillaic acid by methyl, is identical with echinocystic acid (Bergsteinsson and Noller, *J. Amer. Chem. Soc.*, 1934, **56**, 1403), both being provisionally represented by (I, R = Me). Professor Noller has kindly carried out a comparison



(I.)



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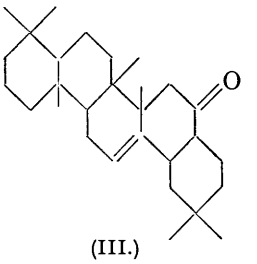


(III.)

of the acids themselves, also of the monoketo-ester (II) and the *trans*-monoketone (III) prepared by us from deoxyquillaic acid, with the appropriate derivatives of echinocystic acid; the melting points were in all cases identical or nearly so, and no depressions were observed on mixing.

We have also prepared the oxime of the ketone (III) and the *iso*dione (as III with an additional carbonyl group at C_2), the properties of which agree with the descriptions given by Noller and White (*ibid.*, 1939, **61**, 983); and we have converted deoxyquillaic acid and echinocystic acid * into the same iso*diacetyl-lactone*, m. p. and mixed m. p. 274—275°. An isomeric *diacetyl-lactone* was produced by reducing the diacetyl-lactone of quillaic acid or its *semicarbazone* by the Kishner–Wolff method and acetylating the *lactone* formed.

The position assigned to $OH^{(2)}$ of quillaic acid rests on the behaviour of unimolecular films of the secondary alcohol obtained by reduction of the ketone (III) with sodium and alcohol and provisionally termed the β-form. The epimeric α-*alcohol* has now been prepared from the ketone by catalytic reduction in acetic acid solution; it is less soluble and higher-melting than the β. The nomenclature adopted for these alcohols (α = epi, β = normal) is intended to convey the analogy with steroid alcohols, such as the 4-cholestanols. Like our compounds, these are α-decalol derivatives and have been prepared by the same methods, the compound produced by the catalytic reduction of the ketone in acetic acid

* We are indebted to Prof. Noller for the specimen of echinocystic acid used in this preparation.

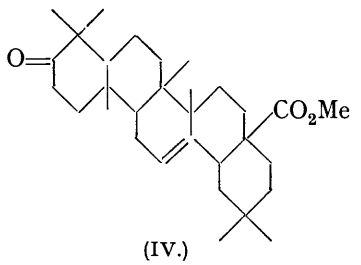
solution being termed *epi*-4-cholestanol * (Tschesche and Hagedorn, *Ber.*, 1935, **68**, 224). Quite recently, however, Marker, Jones, and Turner (*J. Amer. Chem. Soc.*, 1940, **62**, 2537) have stated that the reduction of 6-keto-steroids with sodium and alcohol gives rise to the α-form of the alcohol. For instance, cholestane-3 : 6-dione yields the diol of m. p. 216° under these conditions (Windaus, *Ber.*, 1917, **50**, 133), whereas catalytic reduction of the dione in neutral solution leads to an isomeric diol, m. p. 190°, in which both groups should have the normal (β) configuration on the basis of the Auwers–Skita rule; the two diols only differ in the configuration of the hydroxyl group on C_6. The argument is supported by the correlation of the lower-melting diol with *allo*-hyodeoxycholic acid, in which both hydroxyl groups are stated to have the β-configuration. We are unable to discover the grounds for the last statement; indeed, since the acid was originally prepared by Windaus (*Annalen*, 1926, **447**, 233) by catalytic reduction of the diketo-acid in acetic acid solution, it would be expected to have both hydroxyls of the *epi* (α) configuration.

A case for the normal configuration of the hydroxyl groups in the diol, m. p. 190°, can nevertheless be made out: this compound is doubtless identical with the diol, m. p. 195° (acetate, m. p. 140—141°), previously obtained from Δ^4-cholestene-3 : 6-diol and cholestane-3 : 5 : 6-triol by Petrov, Rosenheim, and Starling (J., 1938, 677), whilst Ellis and Petrov (J., 1939, 1078) have adduced evidence that in the latter compound the hydroxyl groups at C_3 and C_6 are *cis* to one another; *i.e.*, both have the normal configuration. The configurations provisionally assigned to our alcohols may therefore have to be reversed. It is hoped to institute a more detailed comparison of these alcohols with steroids of appropriate structure.

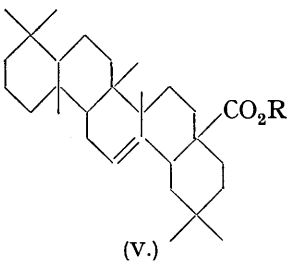
Unimolecular films of the new alcohol are liquid, like those of the β-alcohol, with a somewhat larger limiting area (83 sq. A.) (curve 1, Fig. 1); the difference of 9 sq. A. is such as might be expected in the two epimerides: the *epi*-forms of 3-hydroxysteroids exhibit slightly larger areas than the normal (Adam, Askew, and Danielli, *Biochem. J.*, 1935, **29**, 1786). The value of μ is higher than in the β-alcohol, 726 e.s.u. × 10^{-21}, and would point to the compound's having the dipole more nearly vertical at the limiting area. The value of μ is high for an alcohol and falls on compression, indicating a departure from the vertical of the dipole; the easy compressibility of the film shows that the molecule is much tilted at the limiting area.

As a check on these values films of the oxime of the ketone (III) have been examined (curve 6, Fig. 1). These were not particularly stable, but showed the expected limiting area of about 70 sq. A. with μ = 544 e.s.u. × 10^{-21}. The new results thus support our previous findings, which had led to the placing of $OH^{(2)}$ on C_{16}; † this followed because $OH^{(2)}$ is attached to a carbon atom adjacent to that carrying the carboxyl group (C_{17} in Haworth's formula) and constituted experimental evidence for the position of the latter group.

In seeking to provide independent confirmation of this important point we were led to examine unimolecular films of the two oleananic acids, hedraganic acid, and their esters.



(IV.)



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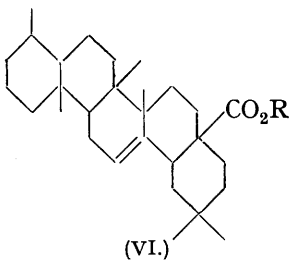


(VI.)

Jacobs and Fleck (*J. Biol. Chem.*, 1932, **96**, 341) have shown that reduction of the semicarbazone of methyl oleanonate (IV) by the Kishner–Wolff method leads to the

* The terms "normal" and "*epi*" appear to be less confusing than β and α when applied to pairs of epimeric alcohols, more especially when it is borne in mind that β-cholestanol was so termed to distinguish it from "α-cholestanol," which was eventually shown by Windaus and Uibrig (*Ber.*, 1913, **46**, 2487) to be a condensation product of β-cholestanol and amyl alcohol.

† Drake and Wolfe (*J. Amer. Chem. Soc.*, 1940, **62**, 3018) deduce an area of only 56—60 sq. A. for a hydroxyl at C_{16}; we are unable to explain this discrepancy.

dextrorotatory α-oleananic ester together with an acid termed γ-oleananic, which gives an ester isomeric with the α-ester and is also dextrorotatory. By using the modified procedure of Kon and Soper (J., 1940, 1339) it is found that the reduction product consists

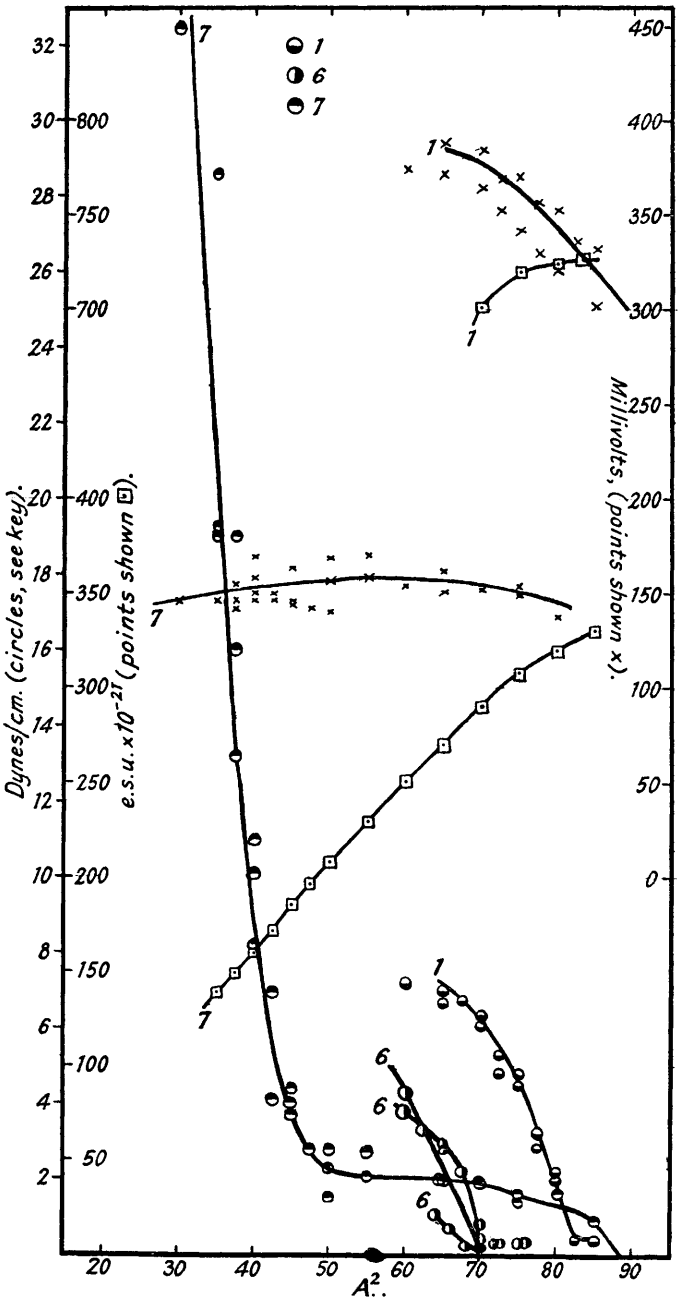


FIG. 1.

entirely of the γ-acid, which is formed in excellent yield; the α-ester was not encountered. Moreover, the rapid reduction of methyl oleanonate under the mild conditions used by Jacobs and Gustus (*J. Biol. Chem.*, 1926, **69**, 641) in the preparation of methyl hedraganate

(VI, R = Me) gives the γ-ester in a pure state and in good yield, and there is little doubt that this ester and the corresponding acid are the primary reduction products of methyl oleanonate, to which formula (V) can provisionally be assigned. In agreement with this, the acid is readily decarboxylated on heating, giving a good yield of oleanene-II, as expected.

The lævorotatory β-oleananic ester was obtained by Jacobs and Fleck (*loc. cit.*) by reduction of methyl oleanonate by Clemmensen's method under drastic conditions; we find that the yields of this compound are variable, but always low, although the lactone mentioned by Jacobs and Fleck is only obtained in small amount. Less drastic conditions lead to mixtures, and attempts to isomerise the γ-ester by prolonged treatment with amalgamated zinc and hydrochloric and acetic acids were unsuccessful, although a diminution of rotation was observed. The β-ester is hydrolysed under vigorous conditions to the *acid*; this is a monohydrate, and it can be shown that no isomerisation takes place on hydrolysis because the acid is reconverted into the original lævorotatory ester by means of diazomethane.

From the method of preparation of the β-ester it might have been supposed that it would be related to the γ-ester in the same way as oleanene-III is to oleanene-II (Winterstein and Stein, *Annalen*, 1933, **502**, 233; Bilham and Kon, J., 1940, 1469). However, although the β-acid is readily decarboxylated on heating, the hydrocarbon formed is again oleanene-II and not oleanene-III. The two acids presumably differ in the position of the double bond and this moves in the decarboxylation of one of them.

Hedraganic acid was obtained as described by Jacobs and Fleck (*loc. cit.*). It had been hoped to decarboxylate it to the lower homologue of oleanene-II and to isomerise this to *norhederabetulene*-III, which has been obtained by the isomerisation of norhederabetulene (Kon and Soper, *loc. cit.*); the acid proved to be remarkably stable and a sufficient amount of hydrocarbon has not yet been obtained.

β-Oleananic acid forms a solid stable film (curve 2, Fig. 2), but this exhibits some spontaneous contraction, as noted by Askew in other triterpene films (J., 1936, 1585). The limiting area is only 52 sq. A., and the high value of μ (282 e.s.u. × 10^{-21}) indicates that the polar group must be in line with the molecule; there is very little variation in the value of μ with compression, indicating that very little tilting or re-orientation of the molecule takes place, and this is confirmed by the comparative incompressibility of the film. The methyl ester (curve 3, Fig. 2) shows a slightly larger area (55 sq. A.) than the acid, as might be expected; the film is solid, moderately stable, and has a similar compressibility to that of the acid. The rapid rise of μ on compression is probably due to a re-orientation of the ester group, and the steady descent from a maximum of 656 e.s.u. × 10^{-21} can be attributed to a tilting of the whole molecule.

γ-Oleananic acid (curve 4, Fig. 2) occupies an even smaller area than the β-acid (45 sq. A.); the film is solid and stable but also exhibits spontaneous contraction. The value of μ (126 e.s.u. × 10^{-21}) suggests a position of the dipole less in line with the molecule, and this is confirmed by the steady fall of μ on compression, *i.e.*, on bringing the molecule more upright; the compressibility is somewhat greater than that of the β-acid, and the molecule may be more tilted. The area occupied by the γ-ester (curve 5, Fig. 2) is much greater than that of the acid (59 sq. A.). This may be due to the carbomethoxyl group's protruding at an angle or to the molecule's being tilted in order that the polar group can maintain contact with the water surface. The latter explanation receives support from the considerable compressibility of the film; the value of μ is much less than that for the β-ester, *viz.*, 382 e.s.u. × 10^{-21}, and shows an even greater diminution on compression than is observed in the acid.

It was to be expected that hedraganic acid would behave in every way like γ-oleananic acid, from which it differs solely by the replacement of a methyl group on C_1 by hydrogen, that is, in a position remote from the polar group. The limiting area observed, 47·5 sq. A., is indeed of the expected order of magnitude, but the behaviour of the films on compression is unusual (curve 7, Fig. 1), and a discussion of it is reserved for a future communication. The ester forms a poor film which collapses easily; the area appears to be about 61 sq. A.

Now the smallest area calculated from models for an acid with a carboxyl group attached to C_{17} as in formulæ (I), (V), and (VI) is 79 sq. A., and this is clearly incompatible with the

small areas observed by us; these can only be explained by assuming that the carboxyl group is attached to one of the terminal rings.

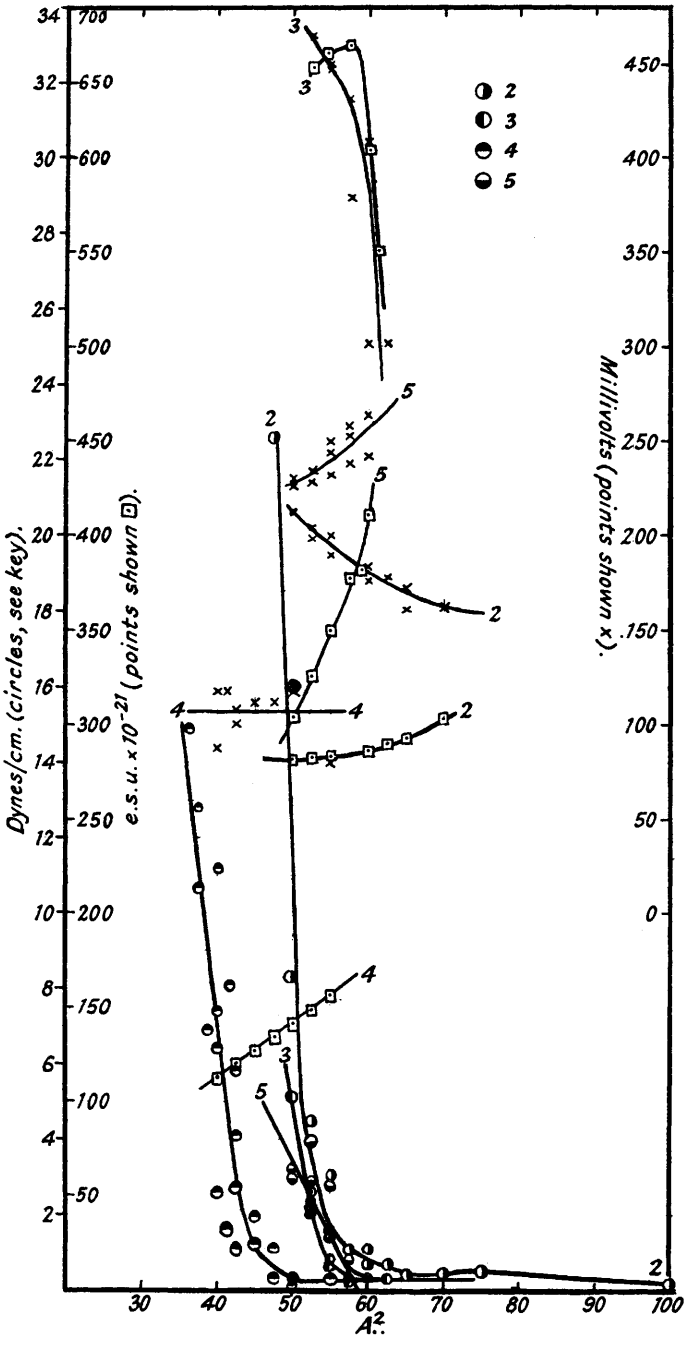
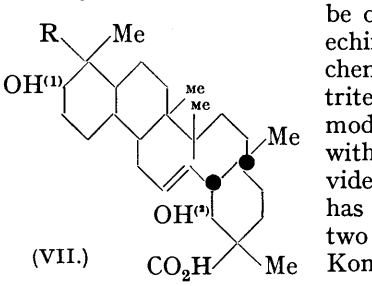


FIG. 2.

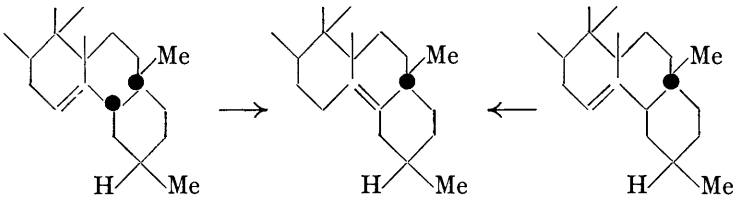
Areas of the same order of magnitude as those now found have already been observed by Noller (*J. Amer. Chem. Soc.*, 1938, **60**, 1938) for echinocystic acid, its diacetate, and its methyl ester. However, in these compounds, as in those previously examined by Askew

(*loc. cit.*), there are hydroxyl groups in addition to the carboxyl, and it is impossible to be certain which of the polar groups is responsible for the areas observed; when taken in conjunction with the values for the oleananic acids, they afford confirmation of them.

Having regard to the results of dehydrogenation and the sterically hindered nature of the carboxyl in the acids related to β-amyrin, the only likely position for this group appears to be one on C_{20}, leading to the formula (VII) for quillaic and echinocystic acid.* This is not at variance with most of the chemical evidence except that the ready lactonisation of the triterpene acids is not so easily explained. Consideration of models shows, however, that lactonisation should be possible with certain configurations of rings *D* and *E* (boat form) provided the mode of union of these rings be *cis*. Such a union has already been postulated to account for the formation of two stereoisomeric forms of the ketone (III) (Bilham and Kon, *loc. cit.*); it may be noted that the new formulation provides a natural explanation of the conversion of the *cis*- and the *trans*-form of oleanene-II into oleanene-III :



(VII.)



cis-Oleanene-II. Oleanene-III. *trans*-Oleanene-II.

The carbon atom carrying the hydroxyl group $OH^{(2)}$ of quillaic and echinocystic acid is situated next to that carrying the carboxyl, and it must also be next to the junction of rings *D* and *E* for the reasons already stated. The only position which satisfies these requirements is C_{19}. Such a position is in excellent agreement with the unreactive nature of $OH^{(2)}$ and the inability of the monoketones derived from quillaic and echinocystic acid to form stable films. Measurements carried out on models show that the area to be expected for the epimeric alcohols (norechinocystenols) greatly depends on the steric configuration of the rings constituting the molecule; with some arrangements the calculated areas agree very well with those observed. Thus, if rings *A*, *B*, and *C* have the " arm-chair " form and *D* and *E* the " boat " form with a *trans*-fusion between them, so that carbon atoms 15, 17, and 20 are uppermost and the methyl group on C_{17} is pointing upwards, the normal epimeride (OH *cis* with respect to the methyl on C_{17}) will require an area of 80 sq. A. and the *epi*-compound one of 84 sq. A., a vertical position of the bonds by which the polar group is attached being assumed.

Further discussion of the formula (VII) cannot be profitably pursued until some of the more obvious implications of it have been experimentally tested, and it is hoped to do this in the near future.

Experimental.

(Unless otherwise stated, m. p.'s are uncorrected; specimens for analysis were dried for 2 hours at 100°/1—2 mm.).

Measurements of Surface Films.—The technique of the measurements of surface area, force, and potential was similar to that of Adam and others (see Adam, " The Physics and Chemistry of Surfaces," Clarendon Press, 1938), with minor modifications suited to the apparatus available. The surface area could be measured with an accuracy of ± 0·1 sq. A. per molecule, the force with an accuracy of ± 0·1 dyne/cm., and the potential with an accuracy of ± 2 mv.; a valve electrometer made by the Cambridge Instrument Co. was used for the last measurements. The force–area curves were measured for various amounts of deposited material, and the surface potentials were checked by moving the air electrode up and down the surface of the film to see if this was homogeneous. The values of μ were calculated from the smooth curve of the surface

* See Bilham and Kon, *Nature*, 1941, **147**, 745.

potential. In those cases where spontaneous contraction (Askew, *loc. cit.*) was noted, the curves show the values obtained after contraction has ceased. The results on hedraganic acid were checked by expansion of the compressed film and re-compression, no significant hysteresis being found. The models used were of the type described by Adam, Askew, and Danielli (*Biochem. J.*, 1935, **29**, 1786; Adam, *op. cit.*).

The following comparisons have been carried out by Prof. C. R. Noller of Stanford University, Berkeley, Cal., using a Hershberg m. p. apparatus (electrically heated Thiele tube with mechanical stirrer); the m. p.'s are corrected:

Samples were placed in the bath at 200°:

Monoketone (III)	shrinks 221°;	melts 222—226°
Norechinocystenone	,, 217	,, 219—223
50/50 Mixture	,, 217	,, 219—223
Monoketo-ester from deoxyquillaic acid	,, 204	,, 205—208
,, from echinocystic acid	,, 208	,, 209—211
50/50 Mixture	,, 204	,, 207—209

Samples were placed in the bath at 280°:

Deoxyquillaic acid	darkens 294°;	shrinks 295°;	melts 300—305°
Echinocystic acid	,, ,,	,,	,,
50/50 Mixture	,, ,,	,,	,,

iso*Diacetyl-lactone of Echinocystic Acid.*—200 Mg. of echinocystic acid were left for 3 days in contact with 2 c.c. of 50% hydrobromic acid in acetic acid and 0·2 c.c. of acetic anhydride. The dark red solution was diluted with water and extracted with ether, the extract being washed with sodium carbonate, dried, and evaporated. The *lactone* solidified on rubbing with methyl alcohol and crystallised from this solvent in silky needles, m. p. 275°, but the yield of pure compound was poor. The same compound, m. p. and mixed m. p. 274°, was also prepared from deoxyquillaic acid; as it was somewhat more coloured, the crude material was dissolved in benzene–petroleum (b. p. 60—80°), and the solution percolated through a short column of activated alumina, nearly the whole of the lactone being adsorbed. The pure compound was eluted from the column with benzene and solidified at once in contact with methyl alcohol, from which it was recrystallised (Found: C, 73·6; H, 9·2. $C_{34}H_{52}O_6$ requires C, 73·4; H, 9·4%).

Reduction of the Diacetyl-lactone of Quillaic Acid.—500 Mg. of diacetyl-lactone (Elliott and Kon, J., 1939, 1130), 1·5 c.c. of 95% hydrazine hydrate, and 13 c.c. of 5% sodium ethoxide solution were heated in a sealed tube at 200° for 12 hours. The yellow, neutral gum recovered crystallised from methyl alcohol, yielding 350 mg. of the *lactone* of deoxyquillaic (echinocystic) acid, m. p. 272° (Found: C, 76·0; H, 10·4. $C_{30}H_{48}O_4$ requires C, 76·2; H, 10·2%). The same compound was also produced by the reduction of the *semicarbazone* of the diacetyl-lactone, which formed silky needles from methyl alcohol, m. p. 256—258° (Found: N, 6·6. $C_{35}H_{35}O_7N_3$ requires N, 6·7%). The lactone was converted by means of acetic anhydride and pyridine in the cold into the *diacetyl* compound, which crystallised from chloroform–methyl alcohol in prisms, m. p. 282—283°, depressed by admixture of the *iso*diacetyl-lactone described above (Found: C, 73·3; H, 9·3. $C_{34}H_{52}O_6$ requires C, 73·4; H, 9·4%).

iso*Norechinocystenedione.*—This compound was prepared by the oxidation of deoxyquillaic acid as described by Noller and White (*loc. cit.*); it crystallised from methyl alcohol in flattened needles, m. p. 220—223° (or about 230° corr.), $[\alpha]_D$ + 76·8°, + 77·3° (*c* = 1·705, 2·080 in dioxan).

α-*Form of Norechinocystenol.*—200 Mg. of the pure *trans*-ketone in 50 c.c. of "AnalaR" acetic acid and 100 mg. of Adams's catalyst were shaken in an atmosphere of hydrogen for 4 hours. The *alcohol* crystallised from acetone in thick rods, m. p. 210—211°, $[\alpha]_D$ − 26·5° (*c* = 1·65 in chloroform); needles were obtained from methyl alcohol (Found: C, 84·5, 84·5; H, 12·0, 12·2. $C_{29}H_{48}O$ requires C, 84·5; H, 11·7%). The acetate formed aggregates of silky needles, m. p. 170—171°. The β-form of the alcohol (Bilham and Kon, *loc. cit.*) can be crystallised from methyl alcohol, although it is apt to separate in a gelatinous form; when pure, it forms fine, felted needles from this solvent, $[\alpha]_D$ − 23° (*c* = 1·250 in chloroform).

trans-*Norhederabetulene.*—The hydrocarbon repeatedly crystallised from acetone melts somewhat higher than found by Kon and Soper (*loc. cit.*), *viz.*, at 157°.

Norhederabetulene-III.—The above hydrocarbon (100 mg.) was boiled for 4½ hours with 6 g. of amalgamated zinc, 20 c.c. of acetic acid, and 5 c.c. of hydrochloric acid. The new *hydrocarbon* crystallised from acetone in stout prisms, m. p. 166—167°, $[\alpha]_D$ + 31·4° (*c* = 2·165 in chloroform) (Found: C, 88·1; H, 12·1. $C_{28}H_{46}$ requires C, 87·9; H, 12·1%).

γ-*Oleananic Acid and Ester.*—Methyl oleanonate (Jacobs and Fleck, *loc. cit.*) (2 g.) was heated in a sealed tube for 15 hours with 4·5 c.c. of 95% hydrazine hydrate and 32 c.c. of 5% sodium

ethoxide solution. The contents of the tube were diluted with water and ether. The ethereal solution (extract A) was separated, and the sludgy aqueous layer acidified and extracted with ether; the extract contained a small amount of γ-oleananic acid, six-sided plates, m. p. 270—271° after crystallisation from acetone or ethyl acetate. Extract A contained the greater part of the reaction product and this also was high-melting; in spite of its apparent insolubility in alkali it was found to be γ-oleananic acid, m. p. and mixed m. p. 271—272° after crystallisation from ethyl acetate (Found: C, 81·8; H, 10·9. Calc.: C, 81·8; H, 11·0%); it effervesced with an ethereal solution of diazomethane, forming γ-oleananic ester, m. p. and mixed m. p. 169—170°, $[\alpha]_D$ + 73·4° (c = 1·865 in pyridine). The ester was also produced when methyl oleanonate (750 mg.) was boiled for ½ hour with 12·5 g. of amalgamated zinc, 32·5 c.c. of acetic acid, and 7·5 c.c. of hydrochloric acid; after two crystallisations the ester had m. p. and mixed m. p. 168—169°, $[\alpha]_D$ + 74° (c = 1·390 in pyridine). When 600 mg. of the ester were boiled for 10 hours with 12·5 g. of amalgamated zinc, 50 c.c. of acetic acid, and 21 c.c. of hydrochloric acid, it was recovered practically unchanged; after two crystallisations from methyl alcohol it formed needles, m. p. 165°, $[\alpha]_D$ + 66·5° (in pyridine), and no β-oleananic ester could be isolated from the mother-liquors.

200 Mg. of the ester were heated in a sealed tube with 20 c.c. of 20% potassium hydroxide in 85% alcohol in an oil-bath kept at 160—165° for 4½ hours, and the product isolated by adding water and ether; although the hydrolysis was apparently complete, nearly the whole of the product was found to be in the ether-soluble neutral fraction (compare above) and consisted of γ-oleananic acid.

Oleanene-II.—γ-Oleananic acid was gently heated over a free flame until completely melted, the product dissolved in petroleum (b. p. 40—60°), and the solution freed from traces of acid by shaking with alkali and decolorised by percolating through a short column of alumina; the colourless hydrocarbon had m. p. and mixed m. p. 189—190° after one crystallisation from acetone.

β-*Oleananic Acid and Ester.*—1 G. of methyl oleanonate was boiled with 250 c.c. of acetic acid, 25 c.c. of hydrochloric acid, and 25 g. of amalgamated zinc for 2 hours, 25 c.c. of hydrochloric acid being added at 15-min. intervals (Jacobs and Fleck, *loc. cit.*). The reaction product was poured into water and thoroughly extracted with ether, and the extract freed from acetic acid by means of sodium carbonate solution, dried, and evaporated. The product was dissolved in methyl alcohol and deposited a small amount of crystalline nodules (generally 200 mg.); these gave on repeated crystallisation silvery plates of β-oleananic ester, m. p. 170—172°, depressed by the γ-ester, $[\alpha]_D$ − 85·9° (c = 1·105 in pyridine) (Found: C, 82·0; H, 11·1. Calc.: C, 82·0; H, 11·2%). Equally good results were obtained by reducing the amount of acetic and hydrochloric acid in the above preparation to two-fifths, and ethyl alcohol appeared to be preferable to methyl alcohol for the crystallisation of the ester; the yields were generally about 10% but sometimes much less. The alcoholic mother-liquors contained the bulk of the material, but this generally separated as a transparent, colourless oil. When the excess of acetic acid was distilled off before the reduction product was worked up, the only solid material isolated was the lactone described by Jacobs and Fleck.

β-*Oleananic Acid.*—The above ester was hydrolysed and the product worked up exactly as described for the γ-ester. Although the hydrolysis was complete, the major part of the *acid* was found in the "neutral" portion of the reaction product. It crystallised from methyl alcohol in prisms, m. p. 234°, containing water of crystallisation (Found: C, 78·8; H, 11·0. $C_{30}H_{48}O_2,H_2O$ requires C, 78·5; H, 11·0%); it re-forms the original anhydrous ester on treatment with diazomethane; m. p. and mixed m. p. 169—170°, after one crystallisation from alcohol.

Oleanene-II.—The above acid was heated above its m. p. and the hydrocarbon purified as described above. After one crystallisation from acetone it had m. p. and mixed m. p. 190—191°, $[\alpha]_D$ + 61·7° (c = 1·845 in chloroform), in excellent agreement with the constants given by Winterstein and Stein (*loc. cit.*).

Methyl Hedraganate.—Gypsogenin methyl ester (the gypsogenin was prepared from *Saponaria Officinalis*; Kon and Soper, J., 1940, 617) was heated for 20 mins. with 5 times its weight of copper-bronze in a sausage flask at a bath temperature of 325°, and the flask was then evacuated with a mercury-vapour pump. A yellow oil distilled, and solidified on rubbing with acetone, giving a 50% yield of hedragonic ester. This was reduced exactly as described above (cf. Jacobs and Gustus, *loc. cit.*), giving a good yield of methyl hedraganate, which crystallised from acetone in stout prisms, m. p. 182—183°, $[\alpha]_D$ + 82·7° (c = 2·20 in pyridine).

Hedraganic Acid.—The above ester was hydrolysed as described above; here again the acid was found mainly in the "neutral" portion of the reaction product. It was also prepared

in good yield by the reduction of methyl hedragonate with hydrazine hydrate and sodium ethoxide as described on p. 559 (cf. Jacobs and Fleck, *loc. cit.*). The acid, crystallised twice from methyl alcohol, had m. p. 240—242° (Found: C, 81·8; H, 11·0. Calc.: C, 81·6; H, 10·9%). It effervesced with an ethereal solution of diazomethane, re-forming the ester, m. p. 182—183°. The acid was heated above its m. p., and the products were worked up as described on p. 560; only a very small amount of hydrocarbon, crystallising from acetone in leaflets melting at about 125°, was obtained, most of the acid being recovered as such, and we have not yet succeeded in preparing enough of the hydrocarbon to convert it into norhederabetulene-III.

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