PENTACYCLIC TRITERPENOID BACKBONE REARRANGEMENT: CONSTITUTION OF BREIN

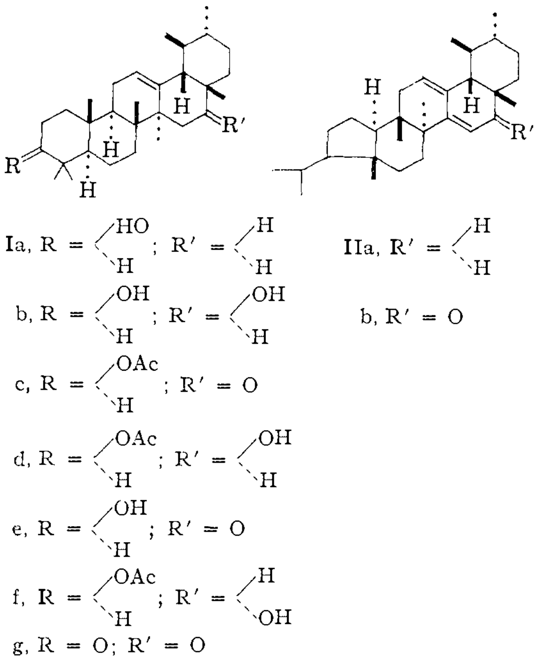
Sir:

Dehydration of α-amyrin (Ia) under various conditions gives a product, "*l*-α-amyradiene" in which the double bonds are conjugated and heteroannular, and whose structure has been shown[1] to be (IIa). We believe that this remarkable molecular rearrangement, referred to as a backbone rearrangement,[2] in addition to its intrinsic mechanistic interest, affords a useful and widely-applicable method[3] for structure elucidation in the ursane and oleanane groups of triterpenoids. As an example, we now wish to report its utilization in establishing the structure of brein, a pentacyclic triterpenoid first isolated[4] in 1851 as a constituent of *Manila elemi* resin.

Significant structural work due to Morice and Simpson[5] and Büchi, Jeger and Ruzicka[6] culminated in brein being represented as urs-12-ene-3α,21 (or 22)-diol.[7] Our re-investigation shows that brein is urs-12-ene-3β, 16β-diol (Ib).

The earlier assignment of the unusual 3α-hydroxyl configuration has been questioned[8] on the basis of molecular rotation differences. Direct chemical evidence on the 3-configuration was adduced. Partial acetylation of brein gives the diol monoacetate (Id), which on chromic acid oxidation yields breinonol-B acetate (Ic, m.p. 210–212°, $[\alpha]_D$ + 47°), alternatively obtained by catalytic hydrogenation of breindione (Ig) and acetylation. In our hands, Wolff–Kishner reduction of (Ic) gave α-amyrin (Ia) in high yield, thus establishing that brein has a 3β-hydroxyl group.

Subjection of the key intermediate, breinonol-B (Ie, m.p. 226–227°, $[\alpha]_D$ + 87°) to the backbone rearrangement by treatment with phosphorus pentoxide in benzene gave a product (IIb), which we were unable to obtain crystalline, but which was characterized by its ultraviolet absorption spectrum (λ^{EtOH} 240 mμ, ε 4900 and 293 mμ, ε 9100), characteristic of a *heteroannular conjugated dienone*,[9] and not a conjugated diene. This indicated the location of the ketone group in breinonol-B and consequently the second hydroxyl group in brein, at C-16.



Additional support for this conclusion was provided by this series of experiments which also established the configuration of the C-16 hydroxyl group. Reduction of breindione (Ig) with sodium borohydride and then acetylation gives a diol monoacetate ($C_{32}H_{52}O_3$, $[\alpha]_D$ + 47°, m.p. 202–205°) which differs from (Id) but which gives (Ic) on oxidation and must therefore be the 16-epimer (If) of brein. Since the 16-hydroxyl group of brein is acetylated under conditions in which (If) is resistant, it has the equatorial conformation. Brein consequently is represented as urs-12-ene-3β,16β-diol. Dehydration of (If) and 3β-acetoxyurs-12-en-15-ol[10] with phosphorus oxychloride in pyridine gives, in low yield in each case, the same product, ursa-12,15-dien-3β-yl acetate ($C_{32}H_{50}O_2$, m.p. 228–229°, $[\alpha]_D$ + 40°).

Satisfactory analyses have been obtained for all new crystalline compounds.

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[1] M. B. E. Fayez, J. Grigor, F. S. Spring and R. Stevenson, *J. Chem. Soc.*, 3378 (1955).

[2] G. Brownlie, F. S. Spring, R. Stevenson and W. S. Strachan, *Chem. and Ind.*, 1156 (1955).

[3] (a) G. G. Allan, F. S. Spring, R. Stevenson and W. S. Strachan, *J. Chem. Soc.*, 3371 (1955); (b) G. G. Allan, M. B. E. Fayez, F. S. Spring and R. Stevenson, *ibid.*, 456 (1956).

[4] S. Baup, *Jahresbericht für Chemie*, 528 (1851).

[5] I. M. Morice and J. C. E. Simpson, (a) *J. Chem. Soc.*, 795 (1940); (b) 198 (1942).

[6] G. Büchi, O. Jeger and L. Ruzicka, (a) *Helv. Chim. Acta*, **29**, 442 (1946); (b) **31**, 139 (1948).

[7] For a review of the evidence, see J. Simonsen and W. C. J. Ross, "The Terpenes," Vol. IV, Cambridge University Press, New York, N. Y., pp. 148–155.

[8] W. Klyne and W. M. Stokes, *J. Chem. Soc.*, 1979 (1954).

[9] For the spectrum of 3α-hydroxy-12-ketochola-7,9(11)-dienic acid, which has an identical chromophore, see H. Heusser, K. Eichenberger, P. Kurath, H. R. Dallenbach and O. Jeger, *Helv. Chim. Acta*, **34**, 2106 (1951).

[10] W. Laird, F. S. Spring and R. Stevenson, 1960, in press.

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ON THE THERMAL AND RADIATION-INDUCED CHAIN REACTION BETWEEN METHANE AND ETHYLENE

Sir:

Previous publications from this laboratory have emphasized the use of nuclear radiation as a convenient initiator, and, therefore, a powerful tool for elucidating the mechanism of ordinary hydrocarbon free radical chain reactions.[1–4] Provided it can be shown that the radiation-induced reaction is free radical in nature, one has available a new probe with which reactions can be initiated

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[1] P. J. Lucchesi, D. L. Baeder and J. P. Longwell, Proc. Fifth World Petroleum Congress, New York, N. Y., June, 1959.

[2] P. J. Lucchesi and C. E. Heath, THIS JOURNAL, **81**, 4770 (1959).

[3] W. Bartok and P. J. Lucchesi, *ibid.*, **81**, 5918 (1959).

[4] P. J. Lucchesi, B. L. Tarmy, R. B. Long, D. L. Baeder and J. P. Longwell, *Ind. Eng. Chem.*, **50**, 879 (1958).