**Tetrahedron Letters No.9, pp. 979-982, 1966. Pergamon Press Ltd.
Printed in Great Britain.**

A TRITERPENOID EPOXIDE FROM POLYPODIUM VULGARE

G.Berti, F. Bottari, A. Marsili and I. Morelli
Institutes of Organic Chemistry and Pharmaceutical Chemistry
University of Pisa, Italy

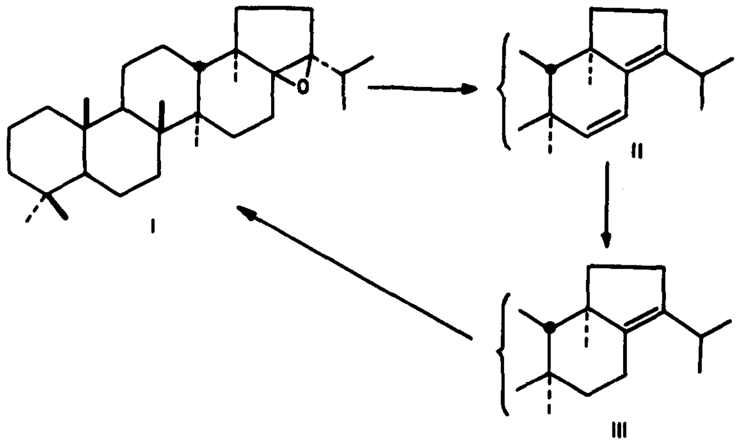
(Received 10 January 1966)

The rhizomes of the Fern Polypodium vulgare are a rich source of tetra- and pentacyclic triterpenoids. During the extensive fractionation work, which led to the isolation and characterization of cyclolaudenol and of its 4-demethyl analogue[1], a minor component was separated in about 0.02% yield, based on the dry rhizomes: in the chromatography of the nonsaponifiable fraction of the petroleum ether extract on a column of neutral alumina (act. II) petroleum ether eluted first 9(11)-fernene[2] and 22-hopene[3], then the new compound, m.p. 268-270°, $[\alpha]_D^{28}$ + 47° ($CHCl_3$), which analyzed for $C_{30}H_{50}O$. It gave a negative test with tetranitromethane and did not show carbonylic or hydroxylic bands in the IR. Reaction with hydrogen chloride in ethanol transformed it into a heteroannular conjugated diene, m.p. 155-157°, $[\alpha]_D^{20}$ + 80° ($CHCl_3$), λ_{max} 245 (infl.), 252, 261 (infl.) mμ (ε 19,700, 22,500, 15,000); its NMR spectrum showed an AB quartet, consisting of two doublets centered at 3.77 and 4.38 τ (J=10 c/s), corresponding to two adjacent protons on a double bond. The compound m.p. 268-270° was recovered unchanged after 6-hr. reflux with $LiAlH_4$ in ether. These data, and the absence of peaks that could be attributed to protons on an oxirane ring in the NMR resonance spectrum, pointed strongly to a hindered tetrasubstituted epoxide.

When the diene was hydrogenated in the presence of platinum on charcoal, GLC and UV analysis showed that it was rapidly transformed into an alkene, which changed more slowly into a second alkene; the latter, which could not be hydrogenated to the corresponding alkane, was identified as 17(21)-hopene (hopene-I)(III)[4] by its GLC retention time and IR spectrum. The identification of III and the physical data referred to above pointed strongly to the formulation of the diene as 15,17(21)-hopadiene (II); the intermediate in the hydrogenation has not yet been isolated in a pure state, but it could be 16-hopene, formed by 1,4-addition of hydrogen to II, which would isomerize slowly to the more stable 17(21)-hopene in the presence of the catalyst.

Reaction of III with p-nitroperoxybenzoic acid in chloroform produced in about 80% yield an epoxide, which was found to be identical (m.p., IR, GLC) with the new compound from <u>Polypodium</u>, a fact which demonstrated the structure of the latter as a 17,21-epoxyhopane (I). Although the stereochemistry of the epoxide ring was not proved, it can be tentatively assumed that it is the β-epoxide, as peroxyacids usually attack double bonds from the less hindered side[5], which in the case of III should be the β side, because of the presence of the α axial methyl groups in C-18 and C-21.

Transformations similar to that of I into II are known for zeorinin and iso-γ-lupene epoxides[6]; furthermore, Tsuda and Isobe[7] recently described two compounds, to which they attributed constitutions I and II, in connection with their work on the structure elucidation of the fungal metabolite dustanin: the m.ps., UV and NMR data are very near to those we found for our compounds. Only the specific rotation given for II is quite lower (+ 61° instead of + 80°). We have found that the rearrangement of I takes a different course if BF_3-etherate is used instead of hydrogen chloride: the main product is a different diene, m.p. 167-168°, $[\alpha]_D^{20}$ + 51°, λ_{max} 237, 245, 255 mμ (ε 20,300; 23,700; 15,900), NMR: only one unresolved olefinic proton peak at 4.61 τ ; a ketone, m.p. 266-272°, $[\alpha]_D^{20}$ + 53°, is also obtained in 10% yield. The study of the constitution of these two rearrangement compounds is under way.



The isolation of I from P.vulgare provides a further example of the frequent occurence of triterpenoids with hopane or rearranged hopane skeletons in Ferns. Furthermore, although 1,2-epoxides derived from pentacyclic triterpenoids had never been found in other plants, this is now the second case of such a compound isolated from a Fern[8].

This work was supported by a grant from Consiglio Nazionale delle Ricerche. We thank Dr. G.Ceccarelli for the determination of the NMR spectra.

REFERENCES

[1] G.Berti, F.Bottari, B.Macchia, A.Marsili, G.Ourisson and H.Piotrowska, Bull.Soc.Chim.France 2359(1964).

[2] H.Ageta, K.Iwata and S.Natori, Tetrahedron Letters 1447 (1963).

[3] H.Ageta, K.Iwata and K.Yonezawa, Chem.Pharm.Bull.(Tokyo) **11**,408(1963).

[4] H.Fazakerley, T.G.Halsall and E.R.H.Jones, J.Chem.Soc. 1877(1959).

[5] E.Eliel, Stereochemistry of Carbon Compounds, McGraw-Hill, New York, 1962, p.292.

[6] D.H.R.Barton, P.de Mayo and J.C.Orr, J.Chem.Soc. 2239(1958).

[7] Y.Tsuda and K.Isobe, Tetrahedron Letters 3337(1965).

[8] G.Berti, F.Bottari and A.Marsili, Tetrahedron Letters 1(1964