Tetrahedron Letters No. 18, pp 1697 - 1700, 1974. Pergamon Press. Printed in Great Britain.

4,11-EPOXY-CIS-EUDESMANE, A NOVEL OXYGENATED SESQUITERPENE IN THE FRONTAL GLAND SECRETION OF THE TERMITE, AMITERMES EVUNCIFER SILVESTRI

Lester J. Wadhams, Raymond Baker and Philip E. Howse

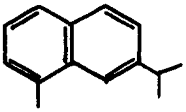
Departments of Chemistry and Biology, University, Southampton S09 5NH

(Received in UK 15 March 1974; accepted for publication 27 March 1974)

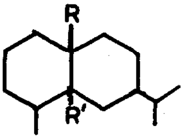
As part of a programme to develop new methods of controlling insect pests by the use of chemical repellents, we have studied the interactions between certain ants and termites. Although most termites have well developed soldier mandibles which are used in defence, many termite species have a frontal gland in the head which produces a defensive secretion. The chemical nature of the secretions in the few species studied are diverse, ranging from 1-tetradecen-3-one in Schedorhinotermes putorius[1] and toluquinone in Macrotermes carbonarius[2], to monoterpene hydrocarbons in other Termitidae[3,4,5].

We report on the major component of the defensive secretion of the soldiers of a West African species of termite, Amitermes evuncifer and an interesting rearrangement of this compound in the presence of boron trifluoride. Extracts of the frontal gland secretion of A. evuncifer soldiers were obtained by milking the alarmed soldiers with a fine glass capillary and then transferring the material to diethyl ether. Gas chromatography of this extract showed one major component accounting for over 90% of the volatile material present in the secretion. To ensure that there was no reaction of the material during the brief exposure to the air an ether extract of soldier heads was chromatographed and the trace showed the same components to be present.

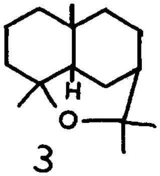
The mass spectrum of the major component showed a base peak at m/e 207 ($C_{14}H_{23}O$) together with other fragment ions at m/e 109 (83%), m/e 41 (31.5%), m/e 43 (29%), m/e 149 (25.5%), m/e



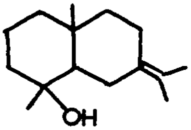
1



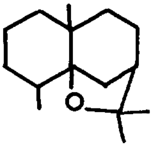
2 a R=CH$_3$ R'=H
b R=H R'=CH$_3$



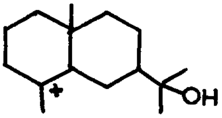
3



4



5



6

81 (20%), m/e 55 (20%), m/e 189 (19.5%), m/e 164 (16.5%) and a very weak molecular ion at m/e 222 (0.05%). The spectrum also showed a weak loss of water from the molecular ion as well as m/e 207 to m/e 189. A mono- or bicyclic sesquiterpene of molecular formula $C_{15}H_{26}O$ is indicated from the mass spectrum and the loss of 58 mass units from the molecular ion is suggestive of attachment of the oxygen atom to an isopropyl side chain.

Dehydrogenation of the crude secretion with selenium dioxide under nitrogen at 300°C for 18 hours gave eudalene (1) as the major component. If the compound is a true isoprenoid then the remaining carbon atom will be in the form of an angular methyl at either C_5 or C_{10}(2a or b)

A pure sample of the compound, obtained by preparative gas chromatography, did not absorb hydrogen in the presence of Adams catalyst and was resistant to ozonolysis even at room temperature. Reaction with sodium borohydride[6] showed no elimination of the peak on gas chromatography. The component was not abstracted by a boric acid postcolumn[7], nor was it possible to form a tetramethylsilane derivative. Thus the oxygen can be regarded as either an oxide or epoxide function and the latter can be excluded on the basis of lack of reaction with $LiAlH_4$.

The n.m.r. spectrum[8] showed a singlet (3H) at 1.00, assigned to the angular methyl at C_5 or C_{10}, and three other singlets (all 3H) at 1.22, 1.25 and 1.31. Since the molecule is saturated the downfield shift of the methyl signals must be due to the oxygen function and the singlet nature of these signals, together with the carbon skeleton obtained from the dehydrogenation reaction, is indicative of a pyranoid ring. This is in agreement with the chemical and mass spectral data which shows not only a loss of 58 mass units ($C_3H_6O^+$) from the molecular ion but also a highly favoured loss of methyl due to α cleavage to give the base peak at m/e 207.

Treatment with BF_3/etherate in methylene chloride at room temperature for 1 hour gave a mixture of compounds of molecular weight 204 with mass spectra similar to selinenes. Hydrogenation of these with Adams catalyst in ethanol gave a component of molecular weight 208 and mass spectral and gas chromatographic properties identical to that of an authentic sample of selinane (2a)[†]

Thus the structure of the major component of the defensive secretion of A. evuncifer is suggested to be 4,11-epoxy-*cis*-eudesmane (3). Molecular models indicate that the molecule will have *cis*-fused rings.

Confirmation of the structure 3 was obtained by reaction with BF_3/etherate in methylene chloride at room temperature for 6 mins. This gave a series of oxygenated products together with unreacted starting material (42%). The mass spectrum of the major product (30%) indicates that it is an alcohol of molecular weight 222 possibly of the structure (4). A second product (20%) provides evidence for the structure (3) since the mass spectrum is identical with that of dihydroagarofuran (5) and very similar to that of 3 itself. Dihydroagarofuran has been isolated from agarwood and sandalwood oils[9,10]. Formation of 5 would arise by Lewis acid catalysed ring opening to (6) followed by a 1,2 hydride shift and ring closure .

The frontal gland secretion of three Australian species of *Amitermes* contains monoterpene hydrocarbons[4]. The occurence of 4,11-epoxy-*cis*-eudesmane in *A. evuncifer* indicates an unexpected intrageneric chemical diversity of the secretion. This compound shows some selective formicidal activity and further biological studies of this are in progress.

Acknowledgements

Thanks are due to S.R.C. for financial support (LJW);to Dr. C.H. Fawcett, Wye College, London for the gift of a sample of selinane and to Dr. F.J. Ritter, TNO, Delft, Holland for the mass spectrum of dihydroagarofuran.

References

[*] All reactions were performed on microgram quantities.

1. A. Quennedey, G. Brule, J. Rigaud, P. Dubois and R. Brossut, Insect Biochem., 3, 67, (1973)
2. U. Maschwitz, R. Jander and D. Burkhardt, J. Insect Physiol., 18, 1715, (1972)
3. B.P. Moore, J. Insect Physiol., 10, 371, (1964)
4. B.P. Moore, J. Insect Physiol., 14, 33, (1968)
5. J. Vrkoč, K. Ubik, L. Dolejš and I Hrdý, Acta ent bohemoslov., 70, 74, (1973)
6. J.E. Hoff and E.D. Feit, Anal. Chem., 36, 1002, (1964)
7. B.A. Bierl, M. Beroza and W.T. Ashton, Mikrochim. Acta, 2, 637 (1969)
8. Varian HA100, $CDCl_3$ solvent

   † The mass spectral data would not distinguish between a cis and trans-ring junction.
9. M.L. Maheshwari, T.C. Jain, R.B. Bates and S.C. Bhattacharyya, Tet., 19, 1079, (1963)
10. F.J. Ritter, A.M. van Oosten and C.J. Persoons, Proc. VII Int. Congr. I.U.S.S.I., Lond., 330, (1973)