

BIOGENETIC-TYPE REACTIONS OF ACORAGERMACRONE

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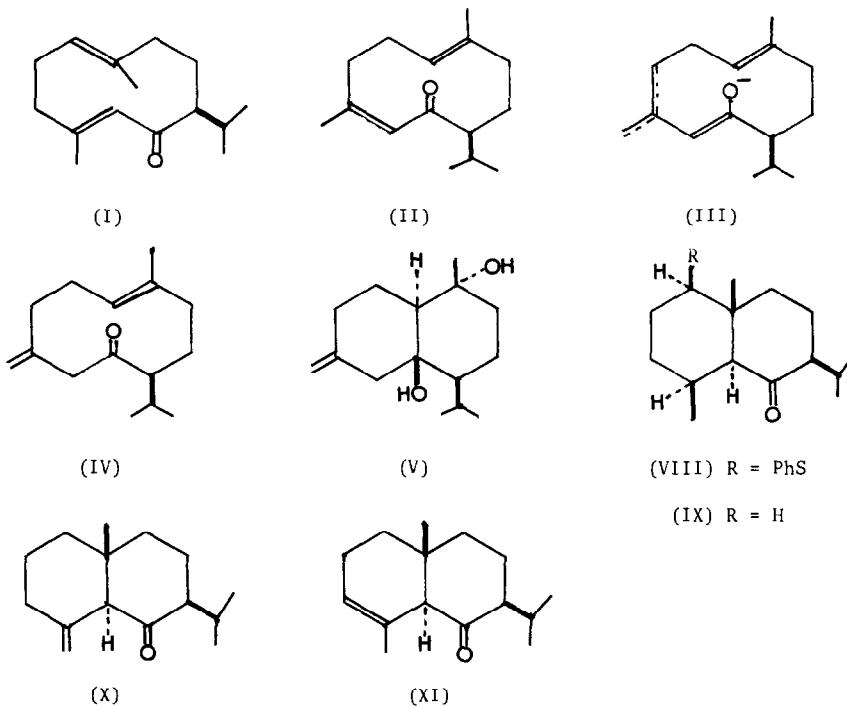
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From a biogenetic point of view, acoragermacrone (I) is regarded as the most important precursor of the sesquiterpenes of Acorus calamus L.^{1,2,3} Generally, such a ten-membered ring sesquiterpene as germacrene-B has been known to react with electrophiles to afford trans-selinane-type compounds.⁴ In the present paper, we wish to describe chemical transformation of acoragermacrone to the other sesquiterpenes, which co-occur with I, together with acid-catalysed cyclization reactions leading to the formation of trans- or cis-selinane-type or cadinane-type compounds.

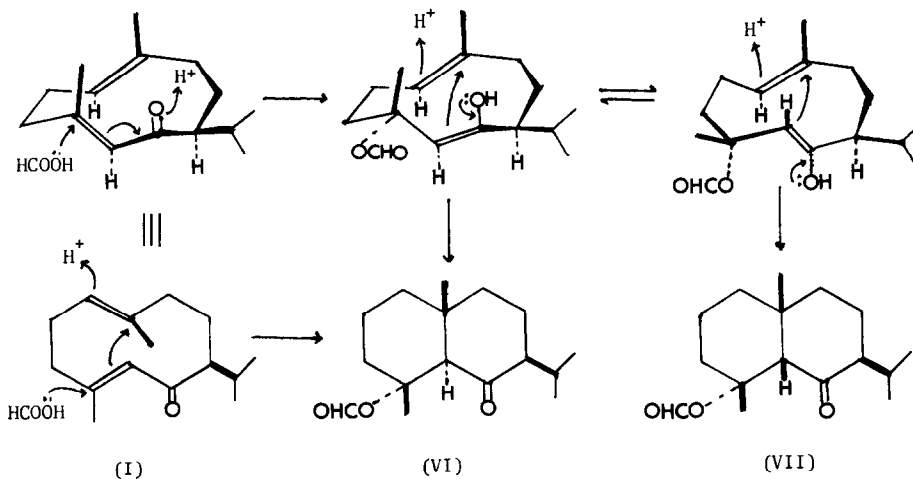
When treated with t-BuOK in t-BuOH under N₂ (room temp., 30min.), acoragermacrone (I) was converted into the known isomer (II)⁵ in 95% yield through an enolate anion (III). On the other hand, I reacted with 5% aq.KOH in t-BuOH (room temp., 24hr.) to give preisocalamendiol (IV) in 84% yield, which co-occurs with I.³ Further action of t-BuOK (room temp., 30min., under N₂) on preisocalamendiol converted it into II in 96% yield. However, any intramolecular cyclization product has not been detected under the above conditions. We further examined intramolecular cyclization reactions of I using different kinds of acid.

Acoragermacrone (I) was quite stable for 80% aq.AcOH at room temperature. However, when heated with the same reagent at 75° for 50min., I afforded a complex mixture, from which isocalamendiol (V), a cadinane-type sesquiterpene, was isolated in 28% yield (m.p. and IR spectrum). Probably, acid-catalysed double bond isomerization takes place in I, resulting the formation of IV, from which V must be directly produced under the above condition.¹ On the other hand, in the case of 80% aq.HCOOH (room temp., 10min.), three cyclization products were mainly obtained (V, 19%; VI, 17%; VII, 17%). As expected from the known conformation of I,⁶ two of them are selinane-type compounds (VI and VII). In fact, the stereostructures of these compounds are in good agreement with their physical data [VI:

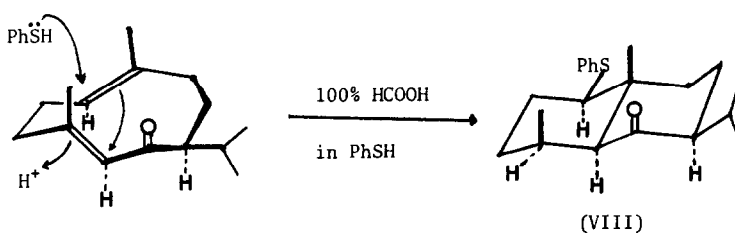


m.p. 45-48°; $C_{16}H_{26}O_3$ (m/e 220($M^+ - HCOOH$)); ν_{max} (film) 1720cm^{-1} ; δ ($CDCl_3$) 0.88(3H, d, $J=6.5\text{Hz}$), 0.92(3H, d, $J=6.5\text{Hz}$), 0.90(3H, s), 1.88(3H, s), 2.87(1H, s) and 8.04ppm(1H, s). VII: m.p. 83-85°; $C_{16}H_{26}O_3$ (m/e 220($M^+ - HCOOH$)); ν_{max} (film) 1720cm^{-1} ; δ ($CDCl_3$) 0.85(3H, d, $J=6.0\text{Hz}$), 0.98(3H, d, $J=6.0\text{Hz}$), 0.96(3H, s), 1.91(3H, s), 2.93(1H, s) and 8.03ppm(1H, s)]. In particular, the ORD curve of the former showed a positive Cotton effect ($[\phi]_{320}^F +14^\circ \times 10^2$, $[\phi]_{277}^T -28^\circ \times 10^2$, $A=+42$), whereas that of VII had a strong negative Cotton effect ($[\phi]_{324}^T -56^\circ \times 10^2$, $[\phi]_{278}^P +61^\circ \times 10^2$, $A=-117$), indicating that the latter should be a cis-selinane-type compound. In addition, the relationship between the methyl group at C_4 -position and the hydrogen atom at C_5 -position is based on measurements of intramolecular nuclear Overhauser effects: low-intensity irradiation at δ 1.91ppm caused a 13% increase in the integrated intensity of the proton signal at δ 2.93ppm. The formation of two selinanes may be considered, as shown in the next page.

We further examined acid-catalysed cyclization of I using PhSH as a solvent.⁷ When treated with 100% HCOOH in PhSH (room temp., 1hr.), acoragermacrone (I) afforded a keto-compound (VIII), in 58% yield, $C_{21}H_{20}OS$ (m/e 330(M^+)); ν_{max} (film) 3060, 1710, 1580, 735 and



690cm^{-1} ; $\delta(\text{CDCl}_3)$ 0.78-1.00(12H, complex), 3.01(1H, q, $J=6.5, 8.8\text{Hz}$) and 7.18-7.69ppm (5H, complex). The stereostructure of VIII was confirmed by its physical data coupled with chemical evidences. In particular, the appearance of the NMR quartet at $\delta 3.01\text{ppm}$ ($J=6.5, 8.8\text{Hz}$), which can be assigned to the proton attached to the carbon atom bearing the PhS-group, indicates that the PhS-group must be in an equatorial configuration. Finally, desulfurization of VIII was effected with Raney Ni in EtOH (under reflux, 3hr.) to give dihydro-acolamone (IX) (g.l.c. and IR spectrum).² In the above cyclization reaction, it should be noted that the stereochemical factors operate more preferably than electronic factor, as shown below.



The plant Acorus calamus L. has been known to contain two selinane-type sesquiterpenes, acolamone (X) and isoacolamone (XI).² As described earlier, acoragermacrone (I) is regarded as the common precursor, and chemically transformed to them, as follows.

Treatment of I with AlCl_3 in dry ether (0° , 1hr.) afforded a pale yellow liquid, from which two selinanes were successfully separated by preparative TLC [Wakogel B-5F, benzene-

n-hexane (1 : 1)] (X, 55%; XI, 23%) (g.l.c. and IR spectra).

All compounds gave satisfactory physical data, and their structures were confirmed by IR, NMR and mass spectrometric data.

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