Tetrahedron Letters No. 50, pp 5017 - 5020, 1973. Pergamon Press. Printed in Great Britain.

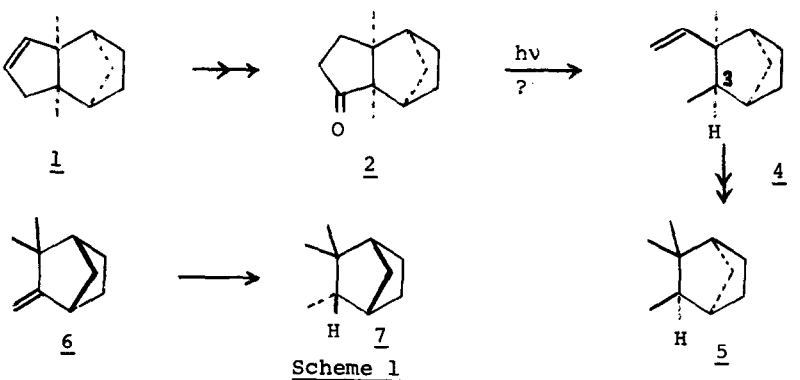
ON THE STRUCTURE OF ALBENE

By Peter T. Lansbury and Richard M. Boden

Department of Chemistry
State University of New York at Buffalo
Buffalo, New York 14214

(Received in USA 20 September 1973; received in UK for publication 5 November 1973)

Several years ago, Novotny and coworkers isolated the trisnorsesquiterpene albene (1) from plants of the genera Petasites and Adenostyles.[1] Recently the structure and absolute configuration of 1 were assigned by Herout, Sorm and their coworkers.[2] A major element in their structure proof[2] was the photochemical degradation of albanone (2) to a decarbonylated olefin, for which they proposed structure 4. In our minds, this conversion is questionable in that the C_3 epimer of 4 is at least as likely to be the actual photoproduct formed. Furthermore, 4 was allegedly transformed[2] into that stereomer of endo-



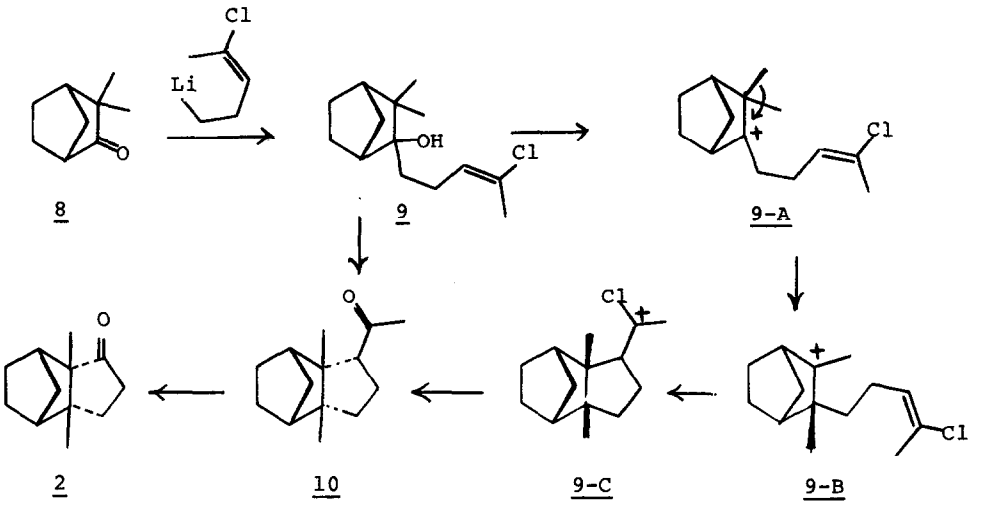
1 2 4 6 7 5

Scheme 1

camphane (5) enantiomeric (by ir and nmr) with material derived from (+)-camphene (6 → 7, Scheme 1). However, the fact that both 5 and 7 are reported[2] to be levorotatory and only 7 is a solid raises doubts about the conclusions of Sorm et al[2] and increases the suspicion that 5 is indeed an exo-camphane. Therefore, there remains some ambiguity relating to the assigned structures 1 and 2 and the chemical investigations described herein were intended to re-

solve the matter.

We have now confirmed the structure and relative configuration of 2 (and hence of albene itself) by a simple sequence of reactions (Scheme 2) beginning with camphenilone (8) and utilizing chloro olefin annelation (9 → 10), a



8 9 9-A 2 10 9-C 9-B

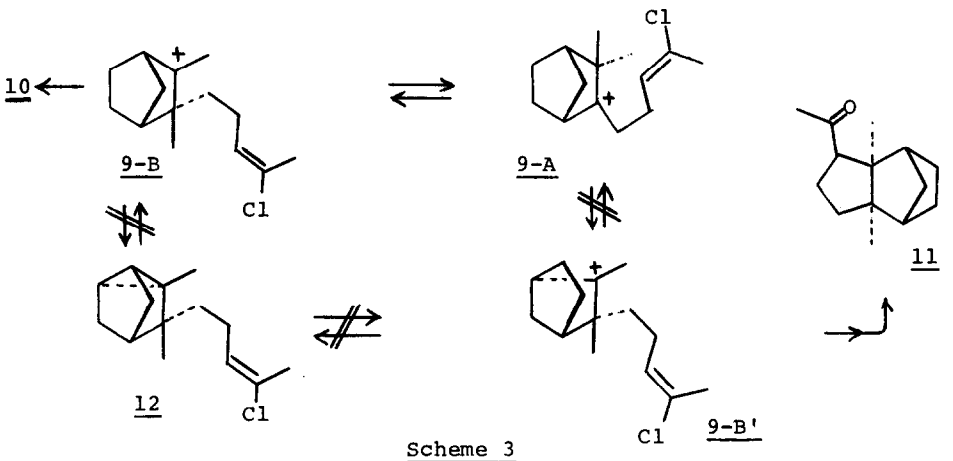
Scheme 2

powerful tool for cyclopentane synthesis.[3] As the above scheme indicates, the stereoselective formation of the endo-fused five-membered ring* was predictable with confidence in view of the well known preference of exo-2,3-methyl shifts over corresponding endo-shifts in norbornyl cations.[4] We had also shown, e.g. in the case of β-cuparenone,[5] that such alkyl shifts in t-alkyl cations do preceed cyclization onto vinyl chloride side chains enroute to cyclopentanones.

Experimentally, the alkyllithium reagent derived from 2-chloro-5-iodo-2-pentene by exchange with t-butyllithium[6] was added to 8, affording the oily carbinol 9[7] (71% yield) via bulb-to-bulb distillation in a "Kugelrohr" apparatus (oven temp. 110°/0.5mm). Refluxing 97% formic acid (2 hrs) followed by workup and "Kugelrohr" distillation (68°/0.5 mm) provided 68% of 10.[7] The

*From previous experience (ref. 3) four-membered ring formation via ion 9-A was not expected to occur, especially with the low energy route to 9-B, involving t-alkyl cation isomerization, available.

latter ketone was converted to enol acetate (acetic anhydride in carbon tetrachloride with perchloric acid catalyst) and ozonized to provide only 2 (in addition to recovered starting material); alternatively, 10 was degraded[6] via Baeyer-Villiger oxidation, acetate hydrolysis and Jones oxidation of the resultant albanol to again yield 2. The albanone acquired by either route was shown to be identical (vpc, one- and two-dimensional tlc; nmr, ir and mass spectra) with an authentic sample of 2 provided by Dr. V. Herout. Finally, it should be noted that the apparent absence of exo-fused tricyclic ketone 11 (Scheme 3), indicated by the homogeneity[8] of 2 derived from isomeric 10, not only verifies that 9-A does not isomerize by a 2,3-endo-methyl shift (↔ 9-B') but also indicates that 9-B (and hence 9-B') is not reversibly equilibrating with a tricyclene such as 12 to a significant extent under our experimental conditions.



Scheme 3

Summarizing, the stereorational synthesis of 10 and its straight-forward conversion to 2 strengthens the previously assigned structure of albene.[2] A pathway similar to 9-B → 10 may be involved in the biosynthesis of albene, wherein protonated epi-β-santalene (replace Cl by CH_3 in 9-B) cyclizes (replace Cl in 9-C by CH_3) and the resultant C_{15} tricyclic alcohol (or an equivalent) undergoes subsequent loss of a C_3-fragment.

Acknowledgement: We are grateful to the National Science Foundation and to CIBA-GEIGY Corporation for financial support.

References

1. J. Harmatha, Z. Samek, L. Novotny, V. Herout and F. Sorm, Coll. Czech. Chem. Comm. 34, 1739 (1969).

2. K. Vokac, Z. Samek, V. Herout and F. Sorm, Tetrahedron Letters, No. 17, 1665 (1972).

3. P. T. Lansbury, Accts. Chem. Res., 5, 311 (1972).

4a. D. L. Adams and W. R. Vaughan, J. Org. Chem., 37, 3906 (1972) and references cited.

4b. C. J. Collins and M. H. Lietzke, J. Am. Chem. Soc., 95, 6842 (1973).

5. P. T. Lansbury and F. R. Hilfiker, Chem. Comm., 619 (1969).

6. G. E. DuBois, Ph.D. Dissertation, State University of New York at Buffalo, 1972.

7. Characterized by an appropriate combination of infrared, nmr and mass spectroscopy.

8. Had 11 been present in significant amounts ($\gtrsim$ 5%) as would be expected if 12 intervened, the derived fused cyclopentanone isomeric with 2 would certainly have been detectable by the presence of two different methyl singlets; in our 2, as well as Herout's sample, the two exo-methyl groups were distinguishable as clean singlets (δ 0.84, 1.00) and no additional methyl signals were apparent in the nmr spectrum.