derivative VId, m.p. 166–167°; $[\alpha]^{23}D$ +107°; λ_{max}^{KBr} 5.79, 5.85, 7.97 μ; via the 21-mesylate (m.p. 109–110°), and 21-iodide (m.p. 146–149°). Hydrolysis of VId with *N* KOH in methanol at room temperature for 20 hours furnished the free alcohol VIe, m.p. 247–249°; λ_{max}^{KBr} 2.83, 5.86 μ, which on oxidation with chromium trioxide in acetone gave 4,4,14α-trimethyl-Δ^8-5α-pregnene-3,20-dione, m.p. 203–204°; $[\alpha]^{23}D$ +136°; λ_{max}^{KBr} 5.85 μ; calcd. for $C_{24}H_{36}O_2$: C, 80.85; H, 10.18. Found: C, 80.74; H, 10.28.

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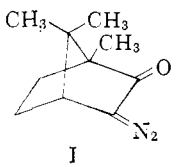
RECEIVED FEBRUARY 19, 1962

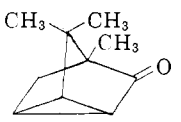
A NOVEL TYPE OF ALKYL SHIFT

Sir:

The formation of cyclocamphanone (II) by the thermal decomposition of diazocamphor (I) has long been known.[1] We have now investigated the thermal decomposition of a 3-diazobicyclo[2.2.1]-

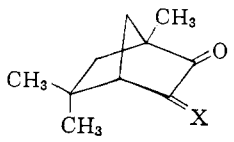


I

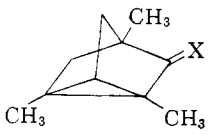


II

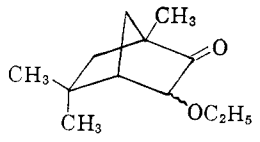
heptan-2-one in which the C_5 atom bears alkyl groups alone. *l*-Isofenchone (III)[2] was converted to its *anti*-isonitroso derivative IV, m.p. 114–114.5°,



III, X = H_2
IV, X = NOH
V = N_2
VI = O



VII, X = O
VIII, X = H_2



IX

$\lambda_{max}^{CCl_4}$ 2.85 (br), 5.76 and 6.06 μ, $[\alpha]D$ (CCl_4) −11.2° (Found: C, 66.24; H, 8.27; N, 7.73), which was converted by the Forster reaction[3] to diazoisofenchone (V), a yellow liquid, $\lambda_{max}^{CCl_4}$ 4.78, 5.89, and 7.49 μ, $[\alpha]D$ (CCl_4) −12.2° (found: C, 67.34; H, 7.95; N, 15.76).

(1) J. Bredt and W. Holz, *J. prakt. Chem.*, [2] **95**, 133 (1917), *cf.* R. Schiff, *Ber.*, **14**, 1375 (1881); A. Angeli, *Gazz. chim. ital.*, **24**, II, 317 (1894.)

(2) O. Wallach, *Ann.*, **362**, 174 (1908); **363**, 1 (1908); D. Mukherji and J. C. Bardhan, *J. Chem. Soc.*, 197 (1949).

(3) M. O. Forster, *ibid.*, **107**, 260 (1915); *cf.* M. P. Cava, R. L. Litle and D. R. Napier, *J. Am. Chem. Soc.*, **80**, 2257 (1958).

Decomposition of V in a 0.06% solution in boiling benzene under nitrogen in the presence of a large excess of copper bronze gave as the major product (average yield, 53%) an optically active, colorless crystalline ketone, $C_{10}H_{14}O$, m.p. 49–50°, $\lambda_{max}^{CCl_4}$ 5.68 μ, $\lambda_{max}^{CS_2}$ 12.05 μ, λ_{max}^{EtOH} 268 mμ (ϵ 71), ϵ_{215} 756 (*cf.* II: $\lambda_{max}^{CCl_4}$ 5.68 μ, $\lambda_{max}^{CS_2}$ 12.20 μ, λ_{max}^{EtOH} 263 mμ (ϵ 68), ϵ_{215} 850), $[\alpha]D$ ($CHCl_3$) −12.8° (Found: C, 80.11; H, 9.47: mol. wt., 171).[4] Its n.m.r. spectrum shows three signals of equal intensity with τ = 8.88, 8.91 and 8.98 p.p.m., attributable to three methyl groups in slightly different environments each attached to a carbon atom which bears no hydrogen atoms,[5] and complex absorption in the region τ = 8.2–8.7 p.p.m., but no signal with τ <8.24 p.p.m. The ketone was converted to its hydrazone, $C_{10}H_{16}N_2$, m.p. 37–41°, $\lambda_{max}^{CCl_4}$ 2.84, 2.91, 5.88 μ, $[\alpha]D$ ($CHCl_3$) −7.9° (Found: C, 73.29; H, 9.91; N, 17.11), which on reduction with sodium ethoxide in ethylene glycol in the presence of hydrazine yielded a hydrocarbon, $C_{10}H_{16}$, b.p. *ca.* 60° (40 mm.), $\lambda_{max}^{CCl_4}$ 3.26 μ (sh), $\lambda_{max}^{CS_2}$ 12.62 μ (found: C, 88.97; H, 11.07; mol. wt., 145). This product is *optically inactive:* α (*c* 4% in CCl_4) <0.05° at 1760, 400, 350, 300 and 270 mμ.[6] Its n.m.r. spectrum shows three singlets with τ = 8.86, 8.90 and 9.04 p.p.m. (intensity ratio 3:6:1); the first two of these signals are assigned to three methyl groups, two of which are now in identical environments, while the third signal can be assigned to a single cyclopropyl hydrogen atom[7]; the spectrum also shows complex absorption in the τ = 8.4–8.6 p.p.m. region, but no signal with τ <8.43 p.p.m. These data establish the structures of the ketone and hydrocarbon as VII and VIII, respectively.[8]

The rate of copper-catalyzed decomposition of V in boiling benzene is appreciably less than that of I under equivalent conditions; semi-quantitative studies indicate that the rate of each reaction is first order in diazo ketone and that the ratio of the rate constants is *ca.* 1:13. Copper-catalyzed decomposition of V in ethanol at 130° gave no VII, but gave a compound (74%), $C_{12}H_{20}O_2$, b.p. 90° (6 mm.), $\lambda_{max}^{CCl_4}$ 5.74, 9.64 μ (Found: C, 73.64; H, 10.38). This was reduced by zinc and acetic acid

(4) A second product (average yield, 15%) from this reaction, $C_{20}H_{28}O$, m.p. 57–60.5°, $\lambda_{max}^{CCl_4}$ 5.69, 5.73 μ (Found: C, 79.97; H, 9.60; mol. wt., 274), was isolated. In the presence of air, *l*-isofenchoquinone (VI) also was formed. When the concentration of the diazo ketone was $\geq$ 1%, the major product obtained was the corresponding azine, m.p. 174–175.5°, $\lambda_{max}^{CHCl_3}$ 5.76 (s), 6.04 (m) μ (found: C, 72.91; H, 8.47; N, 8.59).

(5) An alternative interpretation involving assignment of the signals with τ = 8.88 and 8.98 p.p.m. to two methyl groups in identical environments, each situated on a carbon atom bearing a single hydrogen atom, is excluded on the basis of the spectrum of the related hydrocarbon (*vide infra*).

(6) We thank Mr. G. Holzwarth for assistance in conducting these measurements.

(7) The signal due to the three cyclopropyl hydrogen atoms of tricyclene falls very close to the signals of the methyl groups. The absence of a signal at correspondingly high field in the spectrum of the ketone may be attributed to attachment of the carbonyl group to the cyclopropyl ring: *cf.* C. D. Anderson, Ph.D. Thesis, Harvard University, 1958.

(8) The absence of spin–spin coupling between the cyclopropyl hydrogen atom and the adjacent methylene group in VIII is attributed to unfavorable geometrical factors: *cf.* H. Conroy in "Advances in Organic Chemistry," Vol. II, ed. by R. A. Raphael, E. C. Taylor and H. Wynberg, Interscience Publishers, Inc., New York, N. Y., 1960, p. 265.

to III and is assigned the structure IX. Copper-catalyzed decomposition of V in cyclohexene at 130° gave VII (43%); no evidence for the formation of a norcarane derivative could be obtained. Copper-catalyzed decomposition of I in either ethanol or cyclohexene gave II (91 and 94%, respectively).

We consider that these results are best interpreted in the following manner. In the decomposition of diazoisofenchone, a carbene (or carbene-copper complex[9]) is formed which in benzene or cyclohexene rearranges to VII by concerted migration of the *endo* C_5 methyl group and C_3-C_5 bond formation; in ethanol, reaction of the carbene with the solvent takes precedence over its rearrangement, giving IX. In the decomposition of diazocamphor, loss of nitrogen may be concerted with 1,3-hydrogen migration and C_3–C_5 bond formation, giving II directly.[10]

On this view, the migration of the methyl group in the formation of VII may be classed as intermediate between a 1,2 and 1,3 alkyl shift. The formation of VII from the carbene may equivalently be viewed as an insertion reaction of the carbene at the *endo* C_5–CH_3 bond. No simple insertion reactions of carbenes at carbon–carbon single bonds have been described,[11] although certain other rearrangement reactions of carbenes may be viewed as proceeding in this fashion.[12]

(9) P. Yates, *J. Am. Chem. Soc.*, **74**, 5376 (1952).

(10) W. Reusch, M. W. DiCarlo and L. Traynor, *J. Org. Chem.*, **26**, 1711 (1961), have shown that the related transformation of camphor hydrazone to tricyclene proceeds *via* intramolecular hydrogen transfer.

(11) *Cf.*, however, W. von E. Doering and M. Jones, unpublished work referred to by W. Kirmse, *Angew. Chem.*, **73**, 161 (1961).

(12) *Cf.* L. Friedman and H. Schechter, *J. Am. Chem. Soc.*, **83**, 3159 (1961); M. S. Newman and A. Arkell, *J. Org. Chem.*, **24**, 385 (1959).

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RECEIVED JANUARY 13, 1962

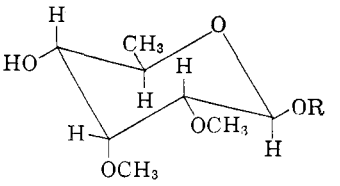
CHEMISTRY OF MYCINOSE: 6-DEOXY-2,3-DI-O-METHYL-D-ALLOSE

Sir:

Methanolysis of chalcomycin[1] yields methyl chalcoside[2] and methyl mycinoside I, m.p. 88–88.5°, $[\alpha]^{27}D$ −36° (*c* 1.6%, chloroform) [*Anal.* Calcd. for $C_9H_{18}O_5$: C, 52.41; H, 8.80; O, 38.79; OCH_3(3), 45.1; C-CH_3(1), 7.3. Found: C, 52.38; H, 8.80; O, 39.07; OCH_3, 45.2; C-CH_3, 8.13].

Aqueous hydrolysis of I gives crystalline mycinose II, m.p. 102–106° $[\alpha]^{25}D$ −46° → −42° (2 min.) → −36° (30 min.) → −29° (4 hr. and 24 hr.) (*c* 1.56%, water) [*Anal.* Calcd. for $C_8H_{16}O_5$: C, 49.99; H, 8.39; OCH_3(2), 32.29; C-CH_3(1), 7.82. Found: C, 49.94; H, 8.73; OCH_3, 31.98; C-CH_3, 7.42].

Mycinose is oxidized with bromine water to give a crystalline lactone, m.p. 134–135°, which



I, R = CH_3
II, R = H

exhibits no maximum in the ultraviolet and shows sharp bands at 2.90 and 5.68 μ in the infrared spectrum. [*Anal.* Calcd. for $C_8H_{14}O_5$: C, 50.52; H, 7.42; OCH_3(2), 32.63; C-CH_3(1), 7.90; mol. wt., 190.19. Found: C, 50.36; H, 7.69; OCH_3, 32.24; C-CH_3, 7.72; mol. wt. (by titration), 182.] Mycinose gives a positive iodoform test, reduces Fehling solution, and yields a pinkish-brown color with aniline hydrogen phthalate on papergrams; it does not reduce periodate, but the sodium borohydride reduction product takes up one mole to give acetaldehyde (0.75 mole as the 2,4-DNP) and a tetrose which was subsequently oxidized with nitric acid to give *meso*-dimethoxysuccinic acid, m.p. 162–163° [*Anal.* Calcd. for $C_6H_{10}O_6$: C, 40.45; H, 5.66; neut. equiv., 89.07. Found: C, 40.25; H, 5.83; neut. equiv., 91] which was identical with a synthetic sample (mixed m.p., R_f values, infrared spectrum). These data establish the structure of mycinose as a 6-deoxy-2,3-di-O-methylhexose.

Treatment of I with boron trichloride[3] for ten days at 4° and subsequent aqueous acid hydrolysis of the reaction product yields a crystalline sugar, m.p. 146–148°, $[\alpha]^{23}D$ −4.7° (7 min.) → 0° (40 min. and 3 hr.) (*c* 3%, water) [*Anal.* Calcd. for $C_6H_{12}O_5$: C, 43.90; H, 7.37. Found: C, 44.18; H, 7.60], which was compared with a sample of 6-deoxy-β-D-allose prepared from digitoxin[4] and found to be identical (mixed m.p., paper chromatography and paper electrophoresis,[5] infrared spectrum, X-ray powder diagram). The phenylosazones[4] (m.p. 180–183°, $[\alpha]^{23}D$ −72° [*c* 0.6%, pyridine–ethanol 2:3]) of the above two sugar samples were also identical.

Exhaustive methylation of I with methyl iodide and silver oxide, then nitric acid oxidation, esterification with methanol in the presence of hydrogen chloride, and finally treatment with methylamine, gives *ribo*-2,3,4-trimethoxy-N,N′-dimethylglutaramide,[6] m.p. 147–147.5°, $[\alpha]^{25}D$ 0° (*c* 2%, chloroform) [*Anal.* Calcd. for $C_{10}H_{20}O_5N_2$: C, 48.37; H, 8.12; N, 11.28. Found: C, 48.47; H, 8.18; N, 11.50]. Thus, from the above, methyl mycinoside must be in the pyranose form as in I. Partial methylation of mycinose with methyl iodide and silver oxide gives I. Thus, mycinose probably exists in the pyranose form[7] as in II.

(1) Parke, Davis & Company, Belgian Patent 587,213, August 2, 1960.

(2) P. W. K. Woo, H. W. Dion and Q. R. Bartz, *J. Am. Chem. Soc.*, **83**, 3352 (1961).

(3) S. Allen, T. G. Bonner, E. J. Bourne and N. M. Saville, *Chem. & Ind.*, 630 (1958).

(4) F. Micheel, *Ber.*, **63**, 347 (1930).

(5) A. P. MacLennan and H. M. Randall, *Anal. Chem.*, **31**, 2020 (1959).

(6) P. A. Levene and J. Compton, *J. Biol. Chem.*, **116**, 183 (1936).

(7) N.m.r. spectroscopy shows that mycinose does not mutarotate in chloroform until acid is added. It is therefore reasonable to assume that, under the methylation conditions in methyl iodide, it also does not mutarotate.