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CYCLIZATION OF β-PERFLUOROALKYL-IODOALKANOIC ACIDS TO PERFLUOROALKYL-SUBSTITUTED ALICYCLIC COMPOUNDS

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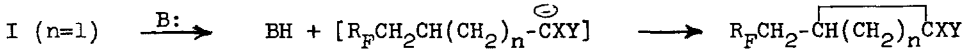
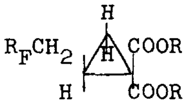
Free radical addition of perfluoroalkyl iodides (R_FI) to a variety of substrates such as unsaturated acids, esters, ketones and nitriles has given products bearing an R_F group and an iodine on adjacent carbons and at varying distance from the functional group (1,2). In appropriate cases it has now been found that ring closure to alicyclic derivatives results from reaction of an adduct $R_FCH_2CHI(CH_2)_nCHXY$ (I, where X, Y may be COOH, COOR, CN or COR, n = 1) with base (B:).



$$\text{I } (n=1) \xrightarrow{B:} BH + [R_FCH_2CH(CH_2)_n\text{-}\overset{\ominus}{C}XY] \longrightarrow R_FCH_2\text{-}CH(CH_2)_nCXY$$

II III



IV $R_F = CF_3CF_2CF_2$, R = H

V $R_F = CF_3CF_2CF_2$, R = C_2H_5

For example, reaction of I (n = 1, X, Y = $COOC_2H_5$) with aqueous KOH gave a quantitative yield of 2-(perfluoropropylmethyl)-1,1-cyclopropanedicarboxylic acid (IV). The ethyl ester (V) of this acid was obtained in 87% yield by reaction of I (n = 1) with sodium ethoxide in anhydrous ethanol. The compound III in which R_F = isoperfluoropropyl was similarly prepared, and reactions of adducts in which n > 1 are being investigated.

Although formally similar to the Perkin ring-closure reaction, (3) this cyclization process is remarkable in that structurally similar compounds undergo elimination of the acidic protons adjacent to the R_F and carbonyl groups, (4) producing an unsaturated acid.

$$R'_FCF_2CH_2CHICH_2COOH + OCH_3^- \rightarrow R'_FCF{=}CH\text{-}CH{=}CHCOOH + F^- + I^-$$

If the R_F and carboxyl functions are more widely separated, formation of a double bond adjacent to R_F is the only reaction observed (4).

$$R_FCH_2CHI(CH_2)_2COOH + OH^- \longrightarrow R_FCH{=}CH(CH_2)_2COOH$$

An expected product from reaction of I with sodium ethoxide was $R_FCH{=}CHCH_2CH(COOC_2H_5)_2$ (VI), which was shown not to be formed by an independent synthesis. Zinc reduction of the R_FI-diethyl propargylmalonate adduct VII gave authentic VI, having olefinic proton resonances at δ5.0-6.8 (2, m)

$$R_FI + HC{\equiv}C\text{-}CH_2CH(COOC_2H_5)_2 \longrightarrow R_FCH{=}CICH_2CH(COOC_2H_5)_2 \quad (VII)$$

$$VII + Zn/HCl \longrightarrow VI\ (R_F = CF_3(CF_2)_2 \text{ and } CF_3(CF_2)_3).$$

and $\nu_{C=C}$ at 1675 cm^{-1} in its infrared spectrum.

Infrared spectra of IV and V showed no unsaturation, but bands for cyclopropane at 1028 and 995 cm^{-1} in V and at 995 cm^{-1} in IV. Nmr spectra also showed that no olefinic protons were present in IV or V; in IV COOH protons appeared at δ10.75, $CF_2\underline{CH_2}$ at δ2.7 (2, t, J_{HF} = 20 Hz, 1:2:1 peak height, each peak split into a doublet by adjacent proton, J_{HH} = 5 Hz), and a complex splitting pattern of $\underline{CH}CH_2$ at δ1.6 to 2.4 with coupling constants of approximately 2-5 Hz. V was quantitatively converted to IV by alkaline hydrolysis. V reacted slowly with bromine in dilute CCl_4 solution. Gas liquid phase partition chromatography showed V to be homogeneous, providing the temperature was kept below 160°, to prevent decomposition.

This cyclization reaction has obvious synthetic utility in the area of fluorinated cyclopropane derivatives, for which very few methods are presently known.

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3. R. C. Fuson, "Reactions of Organic Compounds", John Wiley and Sons, New York, N.Y., 1962, p. 262.

4. N. O. Brace, Abstracts of Papers, American Chemical Society, New York, N. Y., Sept. 1969, Fluorine Division, paper number 42.