The Preparation of Orthoesters.—Small amounts of high boiling fractions were noted in the products of the reaction of ethyl alcohol to $CF_2{=}CCl_2$. In an effort to prepare larger quantities of these materials the following reactions were run.

Ethyl alcohol (325 ml.), sodium ethylate (1.5 moles) and $C_2H_5OCF_2CHCl_2$ (0.28 mole) were refluxed for 4 hours. The product was mixed with cold water and extracted with ether. Distillation gave 27.5 g. of 1,1,1-triethoxy-2,2-dichloroethane.

The orthoester of chlorofluoroacetic acid was never obtained during the addition of ethyl alcohol to $CF_2{=}CFCl$. At 150° a mixture of 1.7 moles of potassium hydroxide, 2.3 moles of ethyl alcohol and 0.41 mole of $C_2H_5OCF_2CHFCl$ in a stainless steel autoclave gave 22 g. of 1,1,1-triethoxy-2-chloro-2-fluoroethane. When 18 g. of this compound was treated with 10 ml. of sulfuric acid, there was obtained 6 g. of ethyl chlorofluoroacetate, b.p. 129–130°, $n^{25}D$ 1.3920, thus proving that the compound was the orthoester of chlorofluoroacetic acid.

Thermal Decomposition of 1-(1-Methylethoxy)-1,1-difluoro-2,2-dichloroethane.—Since the decomposition of alkoxypolyhaloethanes had been observed in a number of distillations, particularly those involving olefins containing only two fluorine atoms, a sample of the ether prepared by the addition of *i*-propyl alcohol to $CF_2{=}CCl_2$ was decomposed thermally.

About 0.25 mole (48 g.) of $(CH_3)_2CHOCF_2CCl_2$ was refluxed in a glass flask under a condenser cooled by water at 3–4°. Vapor passing through the reflux condenser was led through a 135-cm. tube containing a bed of sodium fluoride and condensed in a trap.

Fractionation of the volatile material gave 8 g. of a fraction boiling from −28 to −9° which was probably a mixture of propylene and *i*-propyl fluoride. In addition 18 g. of *i*-propyl fluoride, b.p. −9.0 to −7.0°, mol. wt. (calcd.) 62.1; (obsd.) 61.5, was obtained.

Distillation of the higher boiling material gave 16 g. of $CHCl_2COF$, b.p. 69.8, $n^{25}D$ 1.3946. Dichloroacetanilide made from this material had a melting point of 115–116°. A small amount of higher boiling material could not be distilled; this material was presumably dichloroacetic acid.

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GAINESVILLE, FLORIDA RECEIVED SEPTEMBER 5, 1950

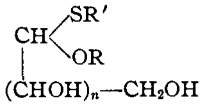
[RESEARCH LABORATORIES, AMERICAN HOME FOODS, INC.]

Mixed Acetals

BY FRANK KIPNIS,[1a] HAROLD SOLOWAY[1b] AND JOHN ORNFELT

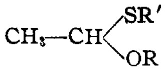
Mixed acetals containing both oxygen and sulfur loadings on the same carbon atom have been prepared by the interaction of vinyl ethers with mercaptans in the presence of acid catalysts.

Except for the acyclic carbohydrate compounds[2] (I) prepared by rather lengthy syntheses, there



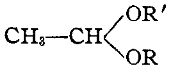
$$CH(SR')(OR)\text{—}(CHOH)_n\text{—}CH_2OH$$

I



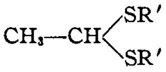
$$CH_3\text{—}CH(SR')(OR)$$

II



$$CH_3\text{—}CH(OR')(OR)$$

III



$$CH_3\text{—}CH(SR')(SR')$$

IV

does not appear in the literature any mention of mixed non-cyclic acetals (II) bearing substituted oxygen and sulfur attached to the same carbon atom.[3]

Since mixed acetals (II) were required for study during the course of certain researches, an investigation was conducted on the interaction of vinyl alkyl ethers with mercaptans. It had already been found[4a,b] that vinyl ethers will undergo reaction with alkanols in the presence of catalytic amounts of anhydrous acids to produce mixed O-acetals (III) in fair yields. When alcohols were replaced by mercaptans, the desired mixed O,S-acetals (II) were produced, together with symmetrical mercaptals (IV), generated, probably, by a redistribution mechanism.[5]

The new compounds are minty-odored liquids insoluble in water and soluble in most organic solvents, extremely unstable to dilute acid, generating acetaldehyde, an alcohol and a mercaptan on such treatment, and resistant to alkali. This instability to acid is similar to that shown by acetals and hemimercaptals. Treatment of the mixed O,S-acetals with ammoniacal sodium nitroprusside gives no coloration, indicating the absence of unreacted mercaptan, as well as stability to base. With sodium nitrite–hydrochloric acid, the acetals give a red color,[6] indicative of easy hydrolysis to the mercaptan and the alcohol, while an immediate pink color is given with the fuchsin–sulfur dioxide reagent, confirming hydrolysis to acetaldehyde.

Experimental

1-*n*-Butylthio-1-ethoxyethane.—To a 250-ml. 3-neck flask fitted with a sealed stirrer, reflux condenser and drying tube, thermometer and dropping funnel, was added 32 g. (0.45 mole) of *n*-butyl mercaptan, 0.2 ml. of thionyl chloride and 150 ml. of anhydrous ether. The stirrer was started and the solution was cooled to 10°. From the dropping funnel was added 32.4 g. (0.45 mole) of vinyl ethyl ether[7] at such a rate that the temperature did not rise

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[1] (a) Oxford Products, Inc., Cleveland, Ohio; (b) Sterling-Winthrop Research Institute, Rensselaer, New York.

[2] M. L. Wolfrom and D. I. Weisblat, THIS JOURNAL, **62**, 878 (1940); M. L. Wolfrom, D. I. Weisblat and A. R. Hanze, *ibid.*, **62**, 3246 (1940).

[3] W. E. Mochel, C. L. Agre and W. E. Hanford, *ibid.*, **70**, 2268 (1948), have reported the isolation of an impure compound, in addition to the ketal, from the interaction of 2,2-di-(ethylthio)-butane with methanol in the presence of hydrogen chloride. The crude material is suggested to be 2-methoxy-2-(ethylthio)-butane.

[4] (a) W. Reppe and K. Bauer, U. S. Patent 2,000,252 (May 7, 1935); German Patent 566,033 (December 8, 1932); (b) M. F. Shostakovskiĭ and N. A. Gershteĭn, *J. Gen. Chem.* (*U. S. S. R.*), **16**, 937 (1946); Gershteĭn and Shostakovskiĭ, *ibid.*, **18**, 451 (1948).

[5] During the preparation of this manuscript, a patent of J. W. Copenhaver (U. S. Patent 2,500,486, March 14, 1950) appeared, in which it was reported that interaction of methyl vinyl ether with ethyl thio-orthoformate in the presence of acid catalysts gave rise to 1-methoxy-1-ethylthio-3,3′-bis-(ethylthio)-propane.

[6] H. Rheinboldt, *Ber.*, **60**, 184 (1927).

[7] Purchased from General Aniline and Film Corp., N. Y. C., N. Y. The commercial product was washed with distilled water and then with sodium bicarbonate solution, dried over sodium hydroxide and fractionated through a 30 cm. Widmer column. Precautions were taken to eliminate traces of acid in all equipment in order to avoid polymerization.

TABLE I

1-ALKOXY-1-ALKYLTHIOETHANES $R—S—\overset{CH_3}{\overset{|}{C}}H—O—R'$

R	R'	B.p., °C.	B.p., Mm.	Yield, %	Formula	Analyses,[a] % Carbon Calcd.	Carbon Found	Hydrogen Calcd.	Hydrogen Found
Ethyl	*n*-Butyl	28–30	2.5	40	$C_8H_{18}OS$	59.21	59.92	11.18	11.37
n-Butyl	Ethyl	46–9	4	44	$C_8H_{18}OS$	59.21	59.24	11.18	11.30
Ethyl	Ethyl	33–5	5	40	$C_6H_{14}OS$	53.68	53.99	10.51	10.50

[a] Analyses by Oakwold Laboratories, Alexandria, Virginia.

above 15° (30 minutes). After addition was complete, the mixture was maintained at that temperature for two hours and then allowed to stand at room temperature for 14 hours. The solution was then washed with saturated potassium carbonate solution, dried with calcium sulfate, filtered, and the volatiles stripped at slightly reduced pressure. The residue was fractionated through a 35-cm. Vigreux column at 45–48° (4 mm.) to give the mixed O,S-acetal in 44% yield. The residue from the fractionation was distilled at 84–85° (4 mm.) to give 10 g. of acetaldehyde di-*n*-butyl-mercaptal.

Anal. Calcd. for $C_{10}H_{22}S_2$: S, 31.07. Found: S, 31.17.

Properties and analyses for related products are given in Table I.

MORRIS PLAINS, NEW JERSEY RECEIVED OCTOBER 10, 1950

[CONTRIBUTION FROM THE DEPARTMENT OF BIOCHEMISTRY, SOUTHWESTERN MEDICAL SCHOOL OF THE UNIVERSITY OF TEXAS]

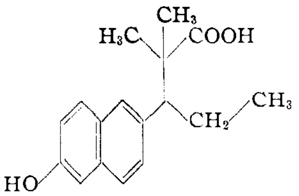
5-Hydroxy-4,4-dimethyl-3-(6-hydroxynaphthyl-2)-pentanoic Acid Lactone

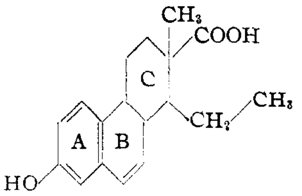
BY JAMES ASHMORE[1a] AND MAX N. HUFFMAN[1b]

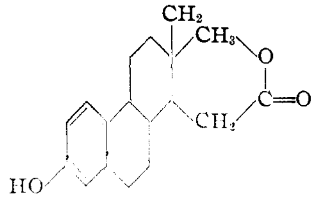
The synthesis of the lactone of 5-hydroxy-4,4-dimethyl-3-(6-hydroxynaphthyl-2)-pentanoic acid is described in detail. This compound represents a simplified 2-hydroxymethylpolyhydrophenanthryl-1-acetic acid lactone in the same manner that 2,2-dimethyl-3-(6-hydroxynaphthyl-2)-pentanoic acid represents a simplified doisynolic acid, namely, by the absence of an intact steroidal Ring C.

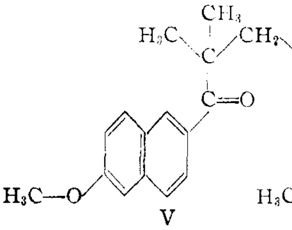
Horeau and Jacques[2] have recently shown that it is possible to prepare certain simplified doisynolic acids which possess a considerable degree of estrogenic potency. The most active compound of Horeau and Jacques—2,2-dimethyl-3-(6-hydroxy-naphthyl-2)-pentanoic acid (I)—differs from the bisdehydrodoisynolic acid (II) of Miescher[3,4] and collaborators in not possessing an intact Ring C; in fact, the compound of the French workers possesses no carbon atom comparable to that steroidal C_{11}, and furthermore contains only one asymmetric carbon atom.

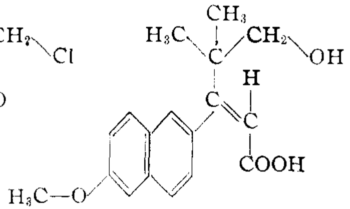
We have recently prepared from the naturally occurring steroidal hormones a series of lactones of 2-hydroxymethylpolyhydrophenanthryl-1-acetic acids.[5] Thus, from estrone was prepared the lactone III, in which it is to be observed that C_{16} of the original steroid skeleton is in the highest state of oxidation. We decided that it would be of interest to synthesize a compound of the Horeau–Jacques type which possessed the lactone configuration of our original steroidal lactones. Such a compound was realized in VIII.

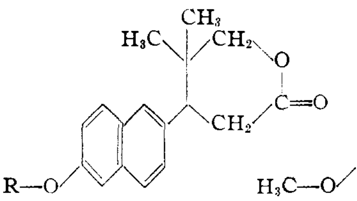

I

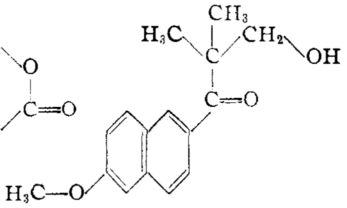

II


III


V


VI


VII (R = CH_3)
VIII (R = H)


IX

Haworth and Sheldrick[6] have shown that in the Friedel–Crafts reaction β-naphthyl methyl ether

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[1] (a) Department of Biochemistry, Saint Louis University, Saint Louis, Missouri. (b) Oklahoma Medical Research Foundation, Oklahoma City, Oklahoma.

[2] A. Horeau and J. Jacques, *Compt. rend.*, **224**, 862 (1947); R. Courrier, A. Houreau and J. Jacques, *ibid.*, **224**, 1401 (1947); A. Horeau and J. Jacques, *Bull. soc. chim. France*, 707 (1948); J. Jacques and A. Horeau, *ibid.*, 711 (1948).

[3] J. Heer, J. R. Billeter and K. Miescher, *Helv. Chim. Acta*, **28**, 991 (1945).

[4] K. Miescher, *Chem. Revs.*, **43**, 367 (1948).

[5] M. N. Huffman, M. H. Lott and J. Ashmore, THIS JOURNAL, **70**, 4268 (1948).

[6] R. D. Haworth and G. Sheldrick, *J. Chem. Soc.*, 864 (1934).