TABLE I

PARTIAL MASS SPECTRA OF REACTION PRODUCTS

No.	Gas sample	Catalyst	M./e. 27	63	64	65	66	78	79	80	81
1	n-C_3H_7Cl	None	100	21	1.0	6.2	...	4.8	..	1.2	...
2	i-C_3H_7Cl	None	100	62	3.3	19	0.5	20	0.5	5.4	...
3	n-$C_3H_7Cl + DCl$	I($AlCl_3$)	100	61	3.2	20	...	20	0.5	5.4	...
4[a]	$C_3H_6 + DCl$	I($AlCl_3$)	100	52	30	17	8.3	6.5	17	2.2	4.9
5	n-$C_3H_7Cl + HCl$	II($AlCl_3$)	100	62	3.5	20	...	21	0.6	6.0	...
6[a]	$C_3H_6 + HCl$	II($AlCl_3$)	100	55	3.0	16	...	22	0.7	4.2	...

[a] The isopropyl chloride was separated from these reaction mixtures for analysis.

used to investigate more fully these rearrangements.

CHEMISTRY DEPARTMENT
COLUMBIA UNIVERSITY
NEW YORK 27, N. Y.

LOIS M. NASH
T. I. TAYLOR
W. v. E. DOERING

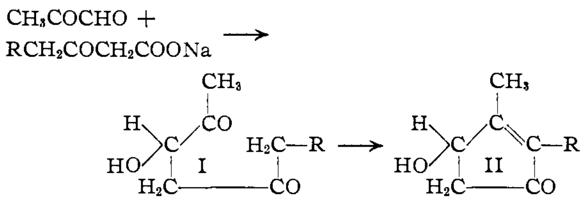
RECEIVED FEBRUARY 21, 1949

THE SYNTHESIS OF CYCLOPENTENOLONES OF THE TYPE OF CINEROLONE

Sir:

Henze[1] has studied 3-hydroxy-2,5-hexanedione and 2-hydroxy-1-phenyl-1,4-pentanedione. Hunsdiecker[2] has shown that aliphatic 1,4-diketones cyclize to cyclopentenones only if a $—CH_2—$ group is present in position 5.

We have prepared six hydroxy diketones of formula I by the reaction of pyruvaldehyde with aqueous solutions of alkali salts of beta-keto acids[3] at room temperature and about pH 8, under what may be considered "biological" conditions. On completion of the reaction, the products are extracted and distilled (60–75% yields). We have found that these hydroxydiketones could be cyclized to the cyclopentenolones of formula II by agitation with aqueous alkali (usually 2%) at room temperature, the products being then extracted and distilled (50–65% yields).



(a) R = —n-C_4H_9; (b) R = $—CH_2CH{=}CHCH_3$; (c) R = $—CH_2CH{=}CH_2$; (d) R = $—CH_2C(CH_3){=}CH_2$; (e) R = $—CH_2CH_2CH{=}CH_2$; (f) R = $—CH_2CH{=}C(CH_3)_2$.

Hydroxydiketones[4]: Ia, $C_{10}H_{18}O_3$ 1.4514, 64.48, 9.74, 64.10, 9.56; Ib, $C_{10}H_{16}O_3$, 1.4679, 65.19, 8.76, 64.75, 8.79; Ic, $C_9H_{14}O_3$, 1.4657, 63.51, 8.29, 62.82, 8.05; Id, $C_{10}H_{16}O_3$, 1.4687, 65.19, 8.76, 65.28, 8.38; Ie, $C_{10}H_{16}O_3$, 1.4675, 65.19, 8.76, 65.01, 8.52; if, $C_{11}H_{18}O_3$, 1.4715, 66.64, 9.15, 66.80 8.75.

Cyclopentenolones[4]: IIa, $C_{10}H_{16}O_2$, 1.4945, 71.39, 9.59, 71.10, 9.64; IIb, $C_{10}H_{14}O_2$, 1.5143, 72.26, 8.49, 71.75, 8.40; IIc, $C_9H_{12}O_2$, 1.5141, 71.02, 7.95, 70.23, 8.07; IId, $C_{10}H_{14}O_2$, 1.5120, 72.26, 8.49, 72.48, 8.18; IIe, $C_{10}H_{14}O_2$, 1.5089, 72.26, 8.49, 71.88, 8.35, IIf, $C_{11}H_{16}O_2$, 1.5100, 73.29, 8.95, 73.44, 8.71.

Compound IIb, although having the same structure, is not identical with natural dl-cinerolone. However, its dihydro derivative is identical with compound IIa, and with dl-dihydrocinerolone. A similar lack of identity of synthetic 2-(2-butenyl)-3-methyl-2-cyclopenten-1-one with dl-cinerone has been reported[5] and attributed to geometric isomerism in the side chain.

The cyclopentenolones of formula II have been acylated with natural d-chrysanthemum monocarboxylic acid, and IIc with the dl-cis-$trans$ synthetic acid, to furnish esters analogous to cinerin I.

All of these, except the ester of IIa, exhibit high toxicity and knockdown to flies, those of IIc and IId exceeding the "pyrethrins" in toxicity. These synthetic esters are more stable than the pyrethrins and cause no irritation when applied as sprays or aerosols.

The above synthesis of cyclopentenolones opens the way to the technical production of esters of the pyrethrin type since the synthesis of chrysanthemum monocarboxylic acid has been improved[6] and a more suitable substitute for this acid may yet be discovered.

Details of this research will be published later.

(1) Henze and co-workers, *Z. physiol. Chem.*, **189**, 121 (1930); **200**, 101 (1931); **214**, 281 (1933); and other references.

(2) Hunsdiecker, *Ber.*, **75B**, 455 (1942).

(3) Salts of beta-keto acids were prepared by cold saponification of beta-keto esters made according to the general procedure of Soloway and La Forge, THIS JOURNAL, **69**, 2677 (1947), and Green and La Forge, *ibid.*, **70**, 2287 (1948).

(4) Order of data for each compound: formula, n^{25}D, % C calcd., % H calcd., % C found, % H found.

(5) Harper, *J. Chem. Soc.*, 892 (1946).

(6) Campbell and Harper, *J. Chem. Soc.*, 283 (1945).

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
AGRICULTURAL RESEARCH ADMINISTRATION
U. S. DEPARTMENT OF AGRICULTURE
BELTSVILLE, MD.

MILTON S. SCHECHTER
NATHAN GREEN
F. B. LAFORGE

RECEIVED FEBRUARY 17, 1949

THE INHOMOGENEITY OF HEPARIN

Sir:

It has been generally conceded that even highly purified heparin is non-homogeneous.[1] By

(1) R. Jensen, O. Snellman and B. Sylvén, *J. Biol. Chem.*, **174**, 265 (1948); J. E. Jorpes and S. Gardell, *ibid.*, **176**, 267 (1948); M. L. Wolfrom and R. A. H. Rice, THIS JOURNAL, **69**, 2918 (1947).

the application of the Craig[2] counter-current distribution technique several samples of sodium heparinate were distributed between amyl alcohol and an aqueous buffer at *p*H 6.5, using 2.5% laurylamine as a "carrier."[3] After the distribution was completed, the material in the several solvent phases was recovered by shaking each with 0.5 *M* dipotassium hydrogen phosphate.

Initially, peaks representing three fractions were located by means of anthrone[4] (Curve A). Only the two larger fractions appear to have anticoagulant activity (Curve B). The approximate homogeneity of the two outer fractions is indicated by the relative constancy of the distribution coefficients as calculated[2] over several adjacent tubes. These coefficients are shown by the numbers superimposed on the graph of Fig. 1:

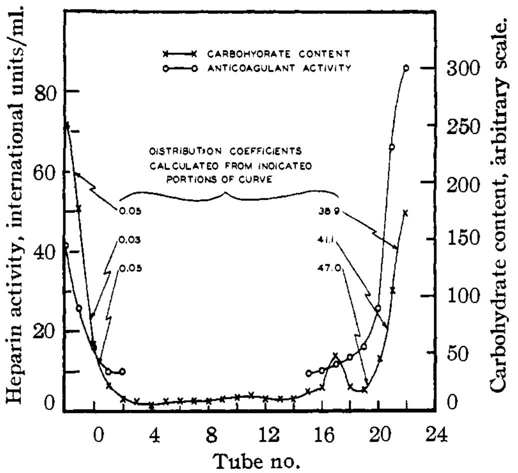


Fig. 1.

Separation of a 1-g. sample of sodium heparinate yielded, after removal of salts by dialysis, two major fractions. Preliminary data on these fractions are as follows (dry basis):

	Low coeff. fraction	High coeff. fraction
Ash, %	23.39	33.88
Potassium (calcd. from ash), %	10.46	15.19
Nitrogen, %	3.33	2.93
Sulfur, %	8.42	13.33
S/N ratio	1.10	1.98
K/S ratio	1.02	0.93
Activity (intl. u./mg.)	59 ± 6	215 ± 22

We wish to express our indebtedness to Dr. John Burke for the physiological assays and to Mr. Joseph Alicino for the microchemical analyses.

CHEMICAL DEVELOPMENT DIV. ANDREW E. O'KEEFFE
E. R. SQUIBB AND SONS FRANK M. RUSSO-ALESI
NEW BRUNSWICK MORRIS A. DOLLIVER
NEW JERSEY ERIC T. STILLER

RECEIVED MARCH 14, 1949

(2) L. C. Craig, *J. Biol. Chem.*, **155**, 519 (1944); B. Williamson and L. C. Craig, *ibid.*, **168**, 687 (1947).

(3) A. E. O'Keeffe, M. A. Dolliver and E. T. Stiller, THIS JOURNAL, in press.

(4) D. L. Morris, *Science*, **107**, 254 (1948).

SYNTHESIS OF ISOPROPYLCYCLOPROPANE

Sir:

The preparation of ethylcyclopropane and isopropylcyclopropane from methylcyclopropyl ketone has been reported recently by Van Volkenburgh, Greenlee, Derfer and Boord.[1] Because of the publication of their paper, it is desirable to report that we have been investigating the syntheses of several alkylcyclopropanes from methylcyclopropyl ketone, the results of which are being withheld until a series of hydrocarbons is completed. Our method of hydrogenation of isopropenylcyclopropane to yield essentially pure isopropylcyclopropane may be of immediate interest, however, since Van Volkenburgh, *et al.*, were able to obtain a product of only 85 mole per cent. purity by their procedure.

Dimethylcyclopropylcarbinol and isopropenylcyclopropane were prepared in essentially the same manner as previously described.[1] Hydrogenation of isopropenylcyclopropane (n^{20}D 1.4256) at 1500 to 2000 p.s.i. of hydrogen in the presence of a commercial barium-promoted copper chromite catalyst[2] at 100 to 130° was found to yield an extremely pure product with little or no ring cleavage. Fractionation of the hydrogenation product at 50-plate efficiency through a glass helix-packed column yielded distillate 80% of which had a refractive index of 1.3863–1.3864 (index range including forerun and residues was 1.3856 to 1.3864). Freezing curves were determined for consecutive cuts of this material and were found to vary from −113.30 to −113.17°. Physical constants of the purest cut, based on the freezing points, are given in the table with our constants for isopropenylcyclopropane:

TABLE I

		Isopropenyl-cyclopropane	Isopropyl-cyclopropane
F. p., °C.		−102.34 m. p.	−113.17
B. p., °C. at 760 mm.		70.33	58.37
n^{20}D		1.42550	1.38639
d^{20}, g./ml.		0.75153	0.69829
Carbon, %	Calcd.	87.7	85.6
	Found	87.6	85.6
Hydrogen, %	Calcd.	12.3	14.4
	Found	12.2	14.4

From the freezing point of our material it appears that the calculation of purity and the "100 per cent. pure" freezing point of reference 1 for isopropylcyclopropane are in error. This is not surprising since the accuracy of such calculations decreases rapidly as purity decreases. The "100 per cent. pure" freezing point, calculated from our data by the geometrical method of Taylor and Rossini,[3] is estimated to be −113.07 ± 0.05°. As-

(1) Van Volkenburgh, Greenlee, Derfer and Boord, THIS JOURNAL, **71**, 172 (1949).

(2) E. I. du Pont de Nemours, Ammonia Division, Wilmington, Delaware.

(3) Taylor and Rossini, *J. Research Natl. Bur. Standards*, **32**, 197 (1944).