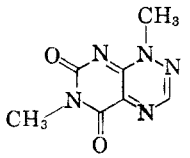
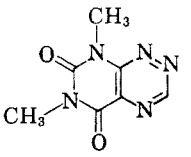
fervenulin, like toxoflavin, is readily reduced electrolytically.[2]

These facts strongly suggested that fervenulin is isomeric with toxoflavin. Consideration of the structural requirements necessary to explain the ease of hydrogenation exhibited by fervenulin resulted in the formulation of several possible structures with the basic pyrimido(5,4-e)-*as*-triazine ring system. These derivatives have been synthesized in our laboratory. Among these compounds the 6,8-dimethyl isomer II,[5] m.p. 178–179°, prepared by the method of Pfleiderer and Schündehütte,[5] by the reductive cyclization of 1,3-dimethyl-2,4 - dioxo - 5 - nitroso - 6 - formylhydrazino-1,2,3,4-tetrahydropyrimidine with sodium hydrosulfite in the presence of formic acid and formamide, was found to be identical to fervenulin[6] in every respect.



I
Toxoflavin



II
Fervenulin

The ultraviolet absorption [$\lambda_{max}^{ethanol}$ 238 mμ (ε 18,500), 275 mμ (ε 1600), and 340 mμ (ε 4200)] and the infrared absorption [λ_{max}^{Nujol} (μ) 3.0 (w), 3.4 (s), 3.8 (w), 5.8 (s), 6.0 (s), 6.4 (s), 6.55 (s), 6.8 (s), 7.0 (s), 7.1 (m), 7.2 (w), 7.4 (s), 7.8 (s), 8.0 (w), 8.25 (s), 8.75 (w), 9.0 (w), 9.2 (s), 9.6 (s), 10.05 (m), 10.4 (w), 10.7 (m), 11.3 (m), 12.2 (m), 12.45 (w), 13.4 (s), 13.55 (m), and 13.9 (s)] of the synthetic compound and those of the authentic sample of fervenulin[6] proved to be identical. There was no depression in the mixed melting point determination. The R_f values (at 25°, descending) of the synthetic and the natural product in 96% water–4% 1-butanol are 0.82 and 0.81, respectively; and in 25% acetic acid–50% 1-butanol–25% water are 0.81 and 0.81, respectively.

Thus the structure of the new antibiotic, fervenulin, is established as 6,8-dimethyl-5,7-dioxo-5,6,7,8-tetrahydropyrimido(5,4-e)-*as*-triazine (II). The structure of fervenulin and that of toxoflavin have provided a new class of antibiotics with pyrimido(5,4-e)-*as*-triazine as their basic ring system. Further studies in this interesting area are in progress.

MIDWEST RESEARCH INSTITUTE
KANSAS CITY 10, MO.
G. DOYLE DAVES, JR.
ROLAND K. ROBINS
C. C. CHENG

Received October 12, 1961

(2) T. E. Eble, E. C. Olson, C. M. Lange, and J. W. Shell, "Fervenulin: Isolation and Characterization" in *Antiobiotics Annual 1959–1960*, Antibiotica, Inc., New York, 1960, p. 227.

(3) C. DeBoer, A. Dietz, J. S. Evans and R. M. Michaels, "Fervenulin: Discovery and Biological Activities" in *Antibiotics Annual 1959–1960*, Antibiotica, Inc., New York. 1960, p. 220.

(4) G. D. Daves, Jr., R. K. Robins, and C. C. Cheng, "The Total Synthesis of Toxoflavin", *J. Am. Chem. Soc.*, **83**, 3904 (1961).

(5) W. Pfleiderer and K. H. Schündehütte, *Ann.*, **615**, 42 (1958).

(6) This comparison was made possible by a generous gift of fervenulin (Lot No. 4234-DMW-74-7) kindly provided by Dr. T. E. Eble of the Upjohn Co., Kalamazoo, Mich., to whom sincere thanks are due.

Acylation of a Carbonium Ion by the Action of a Reissert Compound

Sir:

Although many base-catalyzed condensation reactions of Reissert compounds are known,[1] the only reports of acid-catalyzed condensation reactions have been those describing the formation in relatively low yield of benzoin and some related compounds in the acid-catalyzed hydrolysis reactions of 1-benzoyl-1,2-dihydroquinaldonitrile and 2-benzoyl-1,2-dihydroisoquinaldonitrile (I).[2,3] However, on the basis of a mechanism for the acid-catalyzed hydrolysis of Reissert compounds proposed several years ago,[3] we reasoned that such compounds might function as acylating agents towards carbonium ions. We now wish to report the results of two remarkably different types of acid-catalyzed condensation reactions, the first between I and benzhydrol which illustrates the anticipated acylation reaction, and the other between I and 1,1-diphenylethylene (or 1,1-diphenylethanol) which is best described as a complex rearrangement-condensation reaction.

Treatment of 2-benzoyl-1,2-dihydroisoquinaldonitrile (I) with benzhydrol and concentrated sulfuric acid in dioxane solution gave isoquinaldamide bisulfate (VII) and α,α-diphenylacetophenone (VI),[4] the latter compound being obtained in 76% yield. In accord with the mechanism of acid-catalyzed hydrolysis of I proposed previously,[3] it is visualized that the reaction of I with sulfuric acid first gives the cyclic intermediate II. Condensation of II with the benzhydryl cation, which is formed by the action of concentrated sulfuric acid on benzhydrol,[5] gives IV. Perhaps the mesoionic compound III is also formed as an intermediate

(1) L. R. Walters, E. G. Podrebarac, and W. E. McEwen, *J. Org. Chem.*, **26**, 1161 (1961). All of the major references to base-catalyzed condensation reactions of Reissert compounds are cited in this article.

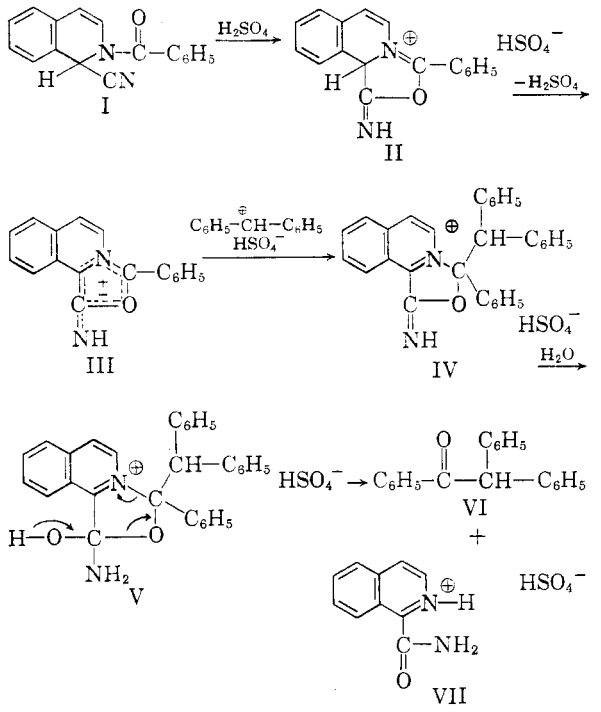
(2) W. E. McEwen and R. N. Hazlett, *J. Am. Chem. Soc.*, **71**, 1949 (1949).

(3) R. L. Cobb and W. E. McEwen, *J. Am. Chem. Soc.*, **77**, 5042 (1955).

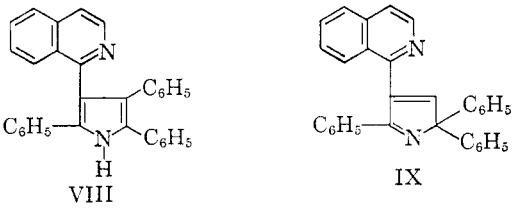
(4) A. Werner, *Ber.*, **39**, 1278 (1906).

(5) C. M. Welch and H. A. Smith, *J. Am. Chem. Soc.*, **72**, 4748 (1950).

but this has not been demonstrated to be the case. Addition of water to IV affords V, which then collapses to give VI and VII.



The sulfuric acid-catalyzed condensation of I with 1,1-diphenylethylene (or 1,1-diphenylethanol) in dioxane solution gave two isomeric compounds of molecular formula $C_{31}H_{22}N_2$. The first, a colorless substance, m.p. 194.0–194.5°, was obtained in 19–26% yield; it showed no infrared absorption peak in the NH stretching region and did not form an acetyl derivative. The second, a yellow solid, m.p. 262.5–263.5°, obtained in 6–17% yield, had a sharp infrared absorption peak at about 2.9 μ and gave an *N*-acetyl derivative, m.p. 230.0–231.5°, on treatment with hot acetic anhydride in the presence of sodium acetate. Prolonged hydrolysis of either of the isomeric compounds, $C_{31}H_{22}N_2$, in 3.6*N* sulfuric acid solution gave equimolar amounts of 1-hydroxyisoquinoline[6] and 2,3,5-triphenylpyrrole.[7] The compound of m.p. 194.0–194.5° was readily converted to its isomer by the action of hot 12*N* sulfuric acid or by potassium hydroxide fusion. Thus, it can be inferred that the compound of m.p. 262.5–263.5° is 2,3,5-triphenyl-4-(1-isoquinolyl)-pyrrole (VIII). On the basis of mechanistic concepts which will be explained more fully in a forthcoming paper, the compound of m.p. 194.0–194.5° is tentatively assigned the structure of 2,2,5-triphenyl-4-(1-isoquinolyl)-pyrrolenine (IX).[8]



Acknowledgment. This investigation was supported by a research grant, E-1961, from the National Institute of Allergy and Infectious Diseases of the National Institutes of Health, Public Health Service.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF KANSAS
LAWRENCE, KAN.

TSUNG-KAI LIAO
WILLIAM E. MCEWEN

Received October 31, 1961

(6) A. E. Tschitschibabin and A. I. Kurasanova, *J. Russ. Phys. Chem Soc.*, **62**, 1211 (1930); *Chem. Abstr.*, **25**, 2727 (1931).

(7) A. Smith, *J. Chem. Soc.*, **57**, 643 (1890).

(8) Complete and satisfactory analyses were obtained for all of the compounds reported in this communication. The known compounds were identified by mixed melting point tests and infrared spectral comparisons with samples synthesized according to the methods given in the literature.