mixture was extracted with methylene chloride to yield 2.25 g of an homogeneous product. Recrystallization from methylene chloride–hexane gave the pure sample of (**3d**): mp 262–264°; $[\alpha]_D$ +71°; ν_{max} 1705, 1520, 1450 cm^{-1}; nmr 1.06 (19 H), 1.39 ppm (18 H).

Anal. Calcd for $C_{19}H_{28}ON_4$: C, 69.47; H, 8.59; N, 17.06. Found: C, 69.58; H, 8.75; N, 16.90.

17a-Aza-D-homoandrost-4-en-3-one-17,17a-e-tetrazole (4).—A solution of 2 g of the 3 ketone (**3d**) in 75 ml of acetic acid was treated dropwise with 1.92 g of bromine in 6.2 ml of acetic acid. Three drops of a saturated solution of hydrogen bromide in acetic acid was added, and the mixture was stirred for 18 hr. The reaction mixture was then poured into water, and the precipitated solid was extracted with methylene chloride. The extract was washed to neutrality, dried, and evaporated *in vacuo* to yield 2.6 g of the corresponding 2,4-dibromo compound **3e** which, without further purification, was treated with chromous acetate as follows.[7]

Zinc dust (10 g) was amalgamated by shaking with a solution of 0.8 g of mercuric chloride, 10 ml of water, and 0.5 ml of hydrochloric acid for 5 min and decanting the supernatant. Addition of a solution of 5 g of chromic chloride in 20 ml of water and 2 ml of hydrochloric acid under an atmosphere of carbon dioxide gave a dark blue solution of chromous chloride which was immediately transferred to a three-necked flask (under a rapid stream of carbon dioxide) provided with gas inlet and outlet tubes, a dropping funnel, and a sintered-glass filtering stick tube which could be lowered or raised through a rubber stopper. This filter tube was connected to the vacuum line.[7]

A solution of 9.2 g of sodium acetate in 18 ml of deoxygenated water was added through the dropping funnel without stirring. The blue solution turned to crystals of deep red chromous acetate. The suspension was stirred; the filter was lowered and the liquid phase was withdrawn; and the precipitate was washed with two portions of ethanol, and finally with ether. To the dry powder was added with stirring 2.6 g of the dibromo compound **3e** dissolved in 75 ml of acetic acid and 18 ml of chloroform. After 8 min, air was blown through the flask to oxidize the excess of chromous acetate. The mixture was then poured into cold water, extracted with methylene chloride, washed several times with water, dried and evaporated *in vacuo*. There was obtained 1.9 g of an oily product which was dissolved in 6 ml of dimethylacetamide and added to a boiling suspension of 0.8 g of calcium carbonate in 18 ml of dimethylacetamide under a stream of nitrogen. After 30 min the mixture was cooled, poured into water, and extracted with methylene chloride, then washed with a 2% solution of hydrochloric acid and finally with water to neutrality.

The residue was purified by preparative thin layer chromatography to yield 630 mg of **4**. Recrystallization from methylene chloride–ether yielded 450 mg of the analytical sample: mp 236–238°; $[\alpha]_D$ +120°; λ_{max} 240 mμ (log ε 4.15); ν_{max} 3350, 1665, 1615, 1520, 1455 cm^{-1}; nmr 1.25 (19 H), 1.43 (18 H), 5.73 ppm (4 H).

Anal. Calcd for $C_{19}H_{26}ON_4$: C, 69.90; H, 8.03; N, 17.17. Found: C, 69.95; H, 8.07; N, 17.41.

17a-Aza-3-hydroxy-D-homoestra-1,3,5(10)-triene-17,17a-e-tetrazole,3-Methyl Ether (7).—Chlorosulfonic acid (13 ml) was added dropwise with stirring to a suspension of 6 g of sodium azide in 100 ml of ethylene chloride. After 1 hr, more sodium azide (6 g) was added, and, 15 min later, a solution of 10 g of estrone methyl ether 17-oxime (**5**)[8] was added slowly. The mixture was stirred for 2 hr and then poured into water, and the product extracted with methylene chloride. The residue was dissolved in methylene chloride and filtered through a column on Florisil. Elution with hexane–ethyl acetate (95:5) afforded 1 g of the cyano derivative **8**, which after two crystallizations from methanol–water showed mp 68–69°; $[\alpha]_D$ −84°; λ_{max} 278, 287 mμ (log ε 3.31, 3.27); ν_{max} 2230, 1605, 1580 cm^{-1}; nmr 1.73 (18 H, vinylic methyl), 3.75 (3 OCH_3), 6.67 (4 H), 6.67, 6.80 (2 H), 7.16, 7.31 ppm (1 H); MS 281 (M^+).

Anal. Calcd for $C_{19}H_{23}ON$: C, 81.10; H, 8.24; N, 4.98. Found: C, 80.83; H, 8.19; N, 5.35.

Further elution with 30% ethyl acetate in hexane, gave 200 mg of **7**. Crystallization from methylene chloride–ether gave the analytical sample: mp 245–247°; $[\alpha]_D$ +107°; λ_{max} 278, 287 mμ (log ε 3.21, 3.17); ν_{max} 1610, 1580, 1500 cm^{-1}; nmr 1.4 (18 H), 3.75 (3 OCH_3), 6.6 (4 H), 6.8 (2 H), 7.1–7.3 ppm (1 H, doublet, J_H = 8 cps).

Anal. Calcd for $C_{19}H_{24}ON_4$: C, 70.34; H, 7.46; N, 17.27. Found: C, 70.12; H, 7.68; N, 17.10.

Elution with ethyl acetate–hexane (1:1) provided 3.8 g of 3-methoxy-13α-amino-13,17-seco-1,3,5(10)-estratrien-17-oic acid 13,17-lactam (**6a**): mp 222–224°; $[\alpha]_D$ +93°; λ_{max} 278, 287 mμ (log ε 3.25, 3.25). Regan and Hayes[8] report mp 222–224°; $[\alpha]_D$ +95°; λ_{max} 279, 286 mμ (log ε 3.30, 3.26).

2-Chlorosulfonyl-3-methoxy-13α-amino-13,17-secoestra-1,3,5(10)-trien-17-oic Acid 13,17-Lactam (6b).—The above reaction was carried out with 2 g of estrone methyl ether oxime (**5**),[8] with larger amounts of chlorosulfonic acid, first heating at 35° for 1 hr and then at 50° for a second hour. After cooling, the reaction mixture was poured into water and extracted with methylene chloride. The organic layer was washed, dried over anhydrous sodium sulfate, filtered and concentrated *in vacuo*. The slightly soluble compound **6b** was recrystallized from methylene chloride–ether. There was obtained 400 mg of pure sulfonated lactam **6b**: mp 258–260°; $[\alpha]_D$ +76°; λ_{max} 306 mμ (log ε 3.47); nmr 1.2 (18 H) 4.01 (3 OCH_3), 6.87 (4 H), 7.85 ppm (1 H).

Anal. Calcd for $C_{19}H_{24}O_4NSCl$: C, 57.34; H, 6.08; N, 3.52; S, 8.06. Found: C, 57.26; H, 6.17; N, 3.95; S, 7.83.

Registry No.—**1a**, 1035-62-7; **2a**, 17556-10-4; **2b**, 2232-15-7; **3a**, 17556-03-5; **3b**, 17556-04-6; **3d**, 17556-05-7; **4**, 17556-06-8; **6b**, 17556-11-5; **7**, 17556-07-9; **8**, 17556-08-0.

Acknowledgment.—We wish to thank Dr. J. Fried for helpful discussions.

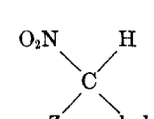
Fluoronitroaliphatics. III. Preparation of Some Negatively Substituted Halonitromethanes[1]

HORST G. ADOLPH, ROBERT E. OESTERLING,[2] AND MICHAEL E. SITZMANN

Advanced Chemistry Division, U. S. Naval Ordnance Laboratory, Silver Spring, Maryland 20910

Received May 22, 1968

For a recent study of the effect of α-fluorine on C–H acidities,[3] the negatively substituted monofluoronitromethanes, Ia–IIIa, and the corresponding monochloro derivatives, Ib–IIIb, were required. We wish now to record the syntheses and some properties of these materials.



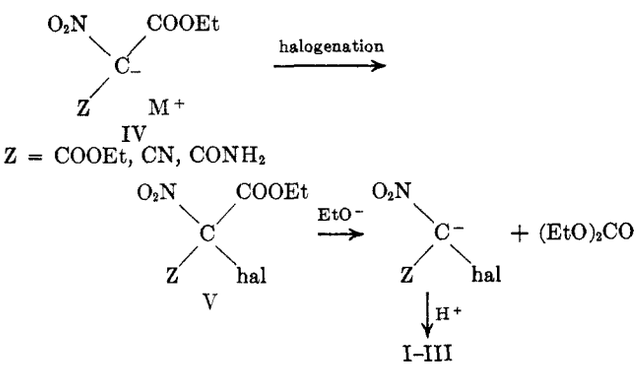
Ia, Z = COOEt; hal = F Ib, hal = Cl
IIa, Z = $CONH_2$; hal = F IIb, hal = Cl
IIIa, Z = Cl; hal = F IIIb, hal = Cl

Direct halogenation of the parent compounds, Z–CH_2NO_2, did not appear to be a promising route to I–III in view of the fact that dihalogenation, in particular difluorination, had frequently been observed with such systems. Thus, Inman and coworkers had reported the difluoro derivatives as the only products of the fluorination of the sodium salts of diethyl malonate, ethyl acetoacetate, and 2,4-pentanedione with

(1) Part II: M. J. Kamlet and H. G. Adolph, *J. Org. Chem.*, **33**, 3073 (1968).
(2) Deceased.
(3) H. G. Adolph and M. J. Kamlet, *J. Amer. Chem. Soc.*, **88**, 4761 (1966).

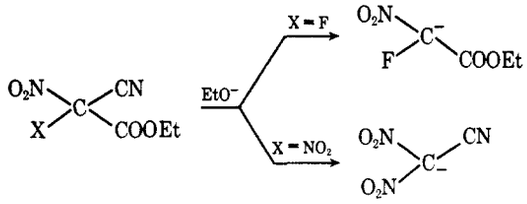
perchloryl fluoride.[4] Shechter and Roberson recorded a similar observation with primary nitroalkane salts; perchloryl fluoride fluorination gave mixtures of mono- and difluoro derivatives in low yields.[5]

Since we were interested only in the monofluorination products and wished to avoid the problems encountered by the earlier workers, the use of an easily removable blocking group was considered. Carbethoxy was chosen since it was known that, when attached to carbon carrying several electron-withdrawing substituents, it could be easily removed by alkaline hydrolysis.[6] Accordingly, the halogenation of some negatively substituted ethyl nitroacetates, generally *via* their sodium or potassium salts, and the hydrolytic cleavage of the halogenation products were investigated. For fluorination, both the perchloryl fluoride and aqueous fluorination methods were used.[1]



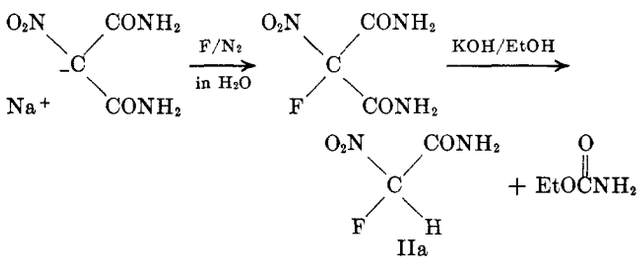
Freeman[7] reported that the reaction of sodium diethyl nitromalonate with perchloryl fluoride in N,N-dimethylformamide gave diethyl fluoronitromalonate. We have found that this reaction is more conveniently carried out in acetonitrile, where a product of excellent purity is obtained in 96% yield. Aqueous fluorination of IV, Z = COOEt, also proceeded smoothly giving V, Z = COOEt, hal = F, in 94% yield. As was expected, the latter compound was very susceptible to attack by base and with potassium hydroxide in ethanol yielded diethyl carbonate and potassium ethyl fluoronitroacetate. On treatment of the salt with cold sulfuric acid, ethyl fluoronitroacetate (Ia) was obtained in 97% yield (based on V). Ethyl chloronitroacetate (Ib) was prepared analogously, by chlorinating IV, Z = COOEt, and treating the product with base.

The fluorination of potassium ethyl nitrocyanoacetate (IV, Z = CN)[8] with perchloryl fluoride gave ethyl fluoronitrocyanoacetate (V, Z = CN, hal = F) in 25% yield. When the latter compound was treated with base, however, the nitrile group was attacked preferentially and the only product isolated was Ia, in complete contrast to the reported conversion of ethyl dinitrocyanoacetate into dinitroacetonitrile on treatment with ethoxide in ethanol.[9]



Treatment of ethyl fluoronitrocyanoacetate with concentrated sulfuric acid furnished V, Z = $CONH_2$, hal = F, as the only product. In the reaction of the latter ester amide with potassium hydroxide in ethanol the carbethoxy and carbamyl groups were attacked at about the same rate and, after acidification of the reaction mixture, Ia and fluoronitroacetamide (IIa) were obtained in about equal amounts.

A second, much shorter, route to IIa was found in the direct fluorination of sodium nitromalonamide in aqueous solution (perchloryl fluoride in acetonitrile did not react). The fluoronitromalonamide obtained thereby was converted into fluoronitroacetamide by treatment with potassium hydroxide in ethanol.



This reaction sequence was also readily adapted to the synthesis of chloronitroacetamide (IIb); see Experimental Section.

Preparation of chlorofluoronitromethane from Ia was relatively straightforward. Chlorination of the latter in aqueous solution in the presence of sodium bicarbonate gave ethyl chlorofluoronitroacetate which, upon hydrolysis with water, produced IIIa in good yield.

An attempt to remove the amide group in chlorofluoronitroacetamide (prepared by chlorination of the potassium salt of IIa in cold carbon tetrachloride suspension) was less successful; on treatment with potassium hydroxide in ethanol a complex mixture resulted which contained only traces of IIIa. Also unsuccessful were attempts, with sodium nitrite in sulfuric acid or nitrosyl tetrafluoroborate in acetonitrile,[10] to convert chlorofluoronitroacetamide into the carboxylic acid which would be expected to decarboxylate readily. In both cases the amide was recovered unchanged.

Experimental Section[11]

Diethyl Fluoronitromalonate. A. By Perchloryl Fluoride Fluorination.—Sodium diethyl nitromalonate (190 g) was placed

(4) C. E. Inman, R. E. Oesterling, and E. A. Tyczkowski, *J. Amer. Chem. Soc.*, **80**, 6533 (1958)] and H. Gershon, J. A. A. Renrick, W. K. Wynn, and R. D'Ascoli [*J. Org. Chem.*, **31**, 916 (1966)] showed, however, that in the case of diethyl malonate the monofluorination product can be obtained under certain reaction conditions.

(5) H. Shechter and A. B. Roberson, Jr., *ibid.*, **25**, 175 (1960).

(6) See, for example, E. Bergman, *ibid.*, **23**, 476 (1958).

(7) J. P. Freeman, *J. Amer. Chem. Soc.*, **82**, 3869 (1960).

(8) M. Conrad and A. Schulze, *Ber.*, **42**, 737 (1909).

(9) C. O. Parker, *Tetrahedron*, **17**, 109 (1962).

(10) L. Tsai, T. Miwa, and M. S. Newman, *J. Amer. Chem. Soc.*, **79**, 2530 (1957); G. A. Olah and J. A. Olah, *J. Org. Chem.*, **30**, 2386 (1965).

(11) CAUTION—Alkali salts of nitromethanes are sensitive to impact when dry and should be handled with care. All operations connected with perchloryl fluoride and aqueous fluorinations should be carried out in a well shielded and vented area; see also ref 1, Experimental Section. In view of the high toxicity of fluoro- and difluoronitroacetic acid and many of their derivatives and in the absence of toxicologic studies the compounds reported here must be regarded as similarly dangerous poisons. Melting and boiling points are uncorrected. Elemental analyses were by Professor Mary Aldridge, Chemistry Department, American University, Washington, D. C.

in a 2-l. three-necked flask fitted with a gas inlet tube, stirrer, and a coldfinger type condenser which was cooled with Dry Ice–acetone. Acetonitrile (1500 ml) was added, and the suspension was cooled to 5°. Perchloryl fluoride diluted with nitrogen (1:1) was introduced subsurface for 6 hr while the temperature was maintained at 5–10°. The original bright yellow solution had then become very light yellow. Sodium chlorate was filtered off (CAUTION), and the filtrate was concentrated at reduced pressure below 50°. The remaining oil was washed with dilute sodium bicarbonate solution and water and dried ($MgSO_4$) to give 179 g (96%) of diethyl fluoronitromalonate of excellent purity (glpc).

B. By Aqueous Fluorination.—A solution of 269 g of diethyl nitromalonate in 2.5 l. of water containing 121 g of sodium bicarbonate was made in the above apparatus. At 0–5° fluorine diluted with nitrogen (1:1) was introduced subsurface until the solution became colorless. The organic phase was separated and combined with the methylene chloride extract of the aqueous phase. Drying ($MgSO_4$) and removal of the solvent gave 275 g (94%) of essentially pure diethyl fluoronitromalonate.

Ethyl Fluoronitroacetate.—A solution of 61.5 g of potassium hydroxide (85%) in 575 ml of ethanol was added dropwise at −10° to a solution of 200 g of diethyl fluoronitromalonate in 575 ml of ethanol. After complete addition, the mixture was stirred 30 min at the same temperature, then poured into ice-cold dilute sulfuric acid. Immediate extraction with methylene chloride prevents the product from hydrolyzing. The extract was dried ($MgSO_4$) and distilled to give 120.6 g (96.7%) of product, bp 38–41° (0.5 mm).

Anal. Calcd for $C_4H_6FNO_4$: F, 12.57; N, 9.28. Found: F, 12.3, 11.7; N, 9.5, 9.3.

Ethylfluoronitrocyanoacetate.—Potassium ethyl nitrocyanoacetate[8] (26 g) was suspended in 250 ml of acetonitrile in the fluorination apparatus described above. Perchloryl fluoride was introduced for 2–3 hr at 5–10°. Potassium chlorate was filtered off (CAUTION), and the filtrate concentrated at 40–50° under reduced pressure. When much of the solvent had been removed, the residue was poured into cold dilute sulfuric acid; this was extracted with methylene chloride; and the extract was dried ($MgSO_4$) and distilled. The yield was 5.8 g (25%), bp 53–54° (4 mm).

Anal. Calcd for $C_5H_5FN_2O_4$: F, 10.78; N, 15.90. Found: F, 10.6, 10.3; N, 15.7, 15.5.

Carbethoxyfluoronitroacetamide.—Ethyl fluoronitrocyanoacetate (6.15 g) was added to 30 ml of 5% oleum cooled in an ice bath. The mixture was stirred 8 hr below 5°, then drowned on crushed ice. The methylene chloride extract upon removal of the solvent left 5.8 g (86%) of an oil whose ir spectrum indicated the absence of starting material. The amide was distilled at 90° (0.1 mm) in a molecular still and did not crystallize.

Anal. Calcd for $C_5H_7FN_2O_5$: F, 9.79; N, 14.44. Found: F, 9.5, 9.4; N, 14.1, 14.2.

Fluoronitroacetamide from Carbethoxyfluoronitroacetamide.—A solution of 9 g of the above ester amide in 10 ml of ethanol was added at −10° to 3.5 g of potassium hydroxide in 50 ml of ethanol. The precipitate was filtered off through a jacketed sintered-glass funnel cooled to 0° with ice or ice–water (CAUTION),[12] washed with ice-cold ether, and dissolved in ice-cold dilute sulfuric acid. The aqueous phase was extracted with ether. The extract was dried ($MgSO_4$) and evaporated to leave 5 g of a mixture of ethyl fluoronitroacetate and fluoronitroacetamide. Crystallization from chloroform gave 1 g of fluoronitroacetamide, mp 74–75°.

Anal. Calcd for $C_2H_3FN_2O_3$: F, 15.57; N, 22.95; neut equiv, 122.06. Found: F, 15.2, 15.2; N, 22.6, 22.6; neut equiv, 122.

Improved Preparation of Nitromalonamide.—Nitromalonamide is obtained in better yield, and the nitration may be carried out on a considerably larger scale than reported in the literature[13] if 90% instead of "fuming" nitric acid is used as the nitrating agent. Malonamide (225 g) was added over a 30-min period to 1290 ml of 90% nitric acid. During the addition, the temperature was kept at 10–15° by cooling with an ice bath. The mixture was stirred an additional 45 min with continued cooling and filtered through a sintered-glass funnel; the product was washed by placing into and digesting with a mixture of ice and water and isolated by filtration. The air-dried malonamide weighed 267.5 g (82.8%).

Fluoronitromalonamide.—Nitromalonamide (41 g) was dissolved in 500 ml of water containing 25 g of sodium bicarbonate, and the solution was fluorinated with a fluorine–nitrogen mixture (1:1) as described above. The solution was then saturated with sodium chloride and extracted exhaustively with ether. The ether was dried ($MgSO_4$) and evaporated to give 18 g (39%) of crude fluoronitromalonamide. Recrystallized from chloroform–acetonitrile or ethanol, it melted at 143–144°.

Anal. Calcd for $C_3H_4FN_3O_4$: F, 11.52; N, 25.46. Found: F, 11.4, 11.4; N, 25.0, 24.9.

Fluoronitroacetamide from Fluoronitromalonamide.—Fluoronitromalonamide (22.5 g) was dissolved in 100 ml of ethanol. After cooling to 0° (reprecipitation), a solution of 12 g of potassium hydroxide (85%) in 75 ml of ethanol was added while the temperature was kept below 5°. The mixture was stirred 2.5 hr at the same temperature and filtered through an ice-cooled sintered-glass funnel;[12] the precipitate was washed with cold ether and dissolved in cold dilute sulfuric acid. After saturation with sodium chloride, the solution was exhaustively extracted with ether; the ether solution was dried ($MgSO_4$) and freed from solvent to give 9.2 g (55%) of crude fluoronitroacetamide, identical with the material obtained from carbethoxy fluoronitroacetamide.

Chloronitromalonamide.—Nitromalonamide (14.7 g) was converted into the sodium salt by stirring for 1 hr (ice cooling) with a solution of 6 g of sodium hydroxide in ethanol. The air-dried salt was suspended in carbon tetrachloride, and chlorine was bubbled through until the solution contained excess chlorine. The mixture was then stirred 2 hr in an ice bath and filtered. Extraction of the solid with ether gave crude chloronitromalonamide. After one recrystallization from 2:1 carbon tetrachloride–acetonitrile the yield was 10 g (55%), mp 125–130°. One additional recrystallization raised the melting point to 129–130°.

Chloronitroacetamide.—To 4 g of chloronitromalonamide in 30 ml of ethanol was added with cooling 1.8 g of potassium hydroxide in 15 ml of ethanol. The salt was filtered off, washed with ether, and dissolved in cold dilute sulfuric acid. The solution was saturated with sodium chloride and extracted with ether to give 2 g (65%) of crude chloronitroacetamide, 1.4 g after recrystallization from chloroform–acetonitrile, mp 64–67°.

Anal. Calcd for $C_2H_3ClN_2O_3$: C, 17.35; H, 2.18; Cl, 25.58; N, 20.24. Found: C, 17.6, 17.5; H, 1.9, 1.8; Cl, 25.2, 25.2; N, 19.7, 20.3.

Chlorofluoronitroacetamide.—Potassium fluoronitroacetamide, prepared freshly from 22.5 g of fluoronitromalonamide as described above, was suspended in ice-cold carbon tetrachloride and treated with chlorine at ice-bath temperature until the solvent became slightly yellow (small excess of chlorine). The solvent was removed *in vacuo*, and the residue was triturated with a small amount of water. The aqueous phase was extracted with methylene chloride; the extract was dried ($MgSO_4$) and evaporated to give 12.3 g (58%) of crude chlorofluoronitroacetamide. Recrystallized from methylene chloride–petroleum ether, it melted at 54–55°.

Anal. Calcd for $C_2H_2ClFN_2O_3$: Cl, 22.63; F, 12.13; N, 17.90. Found: Cl, 22.9, 22.6; F, 12.3, 12.6; N, 17.7, 17.9.

Ethyl Chlorofluoronitroacetate.—Ethyl fluoronitroacetate (80 g) was suspended in 900 ml of ice water; 30.5 g of sodium bicarbonate was added; and chlorine gas was introduced with continued cooling. The solution was kept neutral with sodium bicarbonate, and chlorination continued for 2 hr. The product was extracted into methylene chloride; the solution was dried; the solvent was removed; and the residue was distilled under reduced pressure to yield 77 g (78.4%), bp 54° (15 mm).

Anal. Calcd for $C_4H_5ClFNO_4$: F, 10.24; N, 7.56. Found: F, 9.8, 9.9; N, 7.8, 7.6.

Chlorofluoronitromethane.—Ethyl chlorofluoronitroacetate (65 g) was stirred vigorously with 550 ml of water for 24 hr at room temperature. The mixture was chilled, and the organic layer was separated. The aqueous phase was saturated with sodium chloride, and the organic layer was again separated and combined with the material obtained before. The aqueous phase was then extracted twice with a small amount of methylene chloride. The extract was dried and fractionated to give an additional 3.7 g of product. The total yield was 27.8 g (69.8%), bp 78–79°.

Anal. Calcd for $CHClFNO_2$: Cl, 31.25; F, 16.76; N, 12.35. Found: Cl, 30.4, 30.7; F, 15.6, 16.1; N, 11.7, 11.8.

(12) Cooling of the funnel is essential, as the precipitate may decompose violently at room temperature.

(13) T. B. Johnson and B. H. Nicolet, *J. Amer. Chem. Soc.*, **36**, 360 (1914).

The consistently low analytical values are attributed to difficulties in handling the material due to its high volatility. No impurities could be detected by glpc, ir, and nmr analysis.

Registry No.—Ia, 3620-16-4; IIa, 14011-22-4; IIb, 14011-20-2; IIIa, 2375-33-9; V, Z = CN, hal = F, 17659-21-1; V, Z = $CONH_2$, hal = F, 17659-22-2; fluoronitromalonamide, 17659-24-4; chloronitromalonamide, 5514-96-5; chlorofluoronitroacetamide, 17659-23-3; ethyl chlorofluoronitroacetate, 1683-93-8.

Isolation and Structure of Norjavanicin

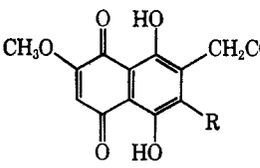
W. S. CHILTON

Department of Chemistry, The University of Washington, Seattle, Washington 98105

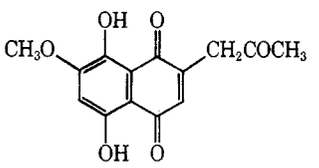
Received July 8, 1968

Substituted naphthazarins have been found in sea urchins,[1] microorganisms,[2] higher plants,[3] and frequently in species of *Fusaria*.[4,5] Structures **1a** and **4** proposed for javanicin[6] and fusarubin[7,8] have been verified by syntheses.[9,10] We have isolated fusarubin and a new quinone, norjavanicin, from a mold obtained as an aerial contaminant and identified as a *Fusarium* species.

An examination of the culture filtrate of the *Fusarium* species grown on a defined medium showed the presence of a colorless, optically active, aliphatic ketone, the triglyceride of oleic acid, and at least 11 pigments. A minor component was obtained from the pigment complex by preparative thin layer chromatography (tlc) followed by crystallization. It had the electronic spectrum of a 2-methoxynapthazarin,[6,7] and since its elemental analysis, $C_{14}H_{12}O_6$, differed from that of javanicin by a methyl group, it was named norjavanicin. The lack of infrared (ir) absorption in the normal hydroxyl region, 3300–3600 cm^{-1}, and the presence of a single type of quinone carbonyl (1610 cm^{-1}), strongly shifted by chelation,[11] supplied confirmatory evidence of the presence of the naphthazarin nucleus. In addition to the chelated quinone carbonyls, the presence of an aliphatic ketone or aliphatic ester was indicated by a 1725-cm^{-1} absorption band. The nmr spectrum of norjavanicin is composed of six singlet signals: a methoxyl resonance at δ 3.91, a quinone ring hydrogen at 6.15, a C-methyl resonance at 2.28, and a methylene resonance at 3.78. Since there is one phenolic and one quinone hydrogen,[12] each ring must bear one substituent. Structure **1b**, 6-desmethyljavanicin, is shown to be the correct structure by conversion of norjavanicin into its anhydromonoacetate and by comparison of the mass spectra of javanicin[10] (*m/e* 43, 205, 219, 230, 248, and 290) and norjavanicin (*m/e* 43, 191, 206, 216, 234, and 276). As required by the desmethyl structure, all of the principal mass spectral peaks of norjavanicin are also present in the mass spectrum of javanicin shifted +14 mass units with the exception of a common peak at *m/e* 43. Cracking of the acetonyl side chain appears to be the major reaction in the mass spectral decomposition of both of these compounds. One mode of cleavage is loss of the acetylium ion to produce a very strong *m/e* 43 peak in both spectra and another is the loss of ketene from the molecular ion radical to produce an intense M − 42 peak in the spectra of both compounds.



1a, R = CH_3
b, R = H



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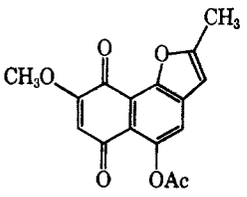
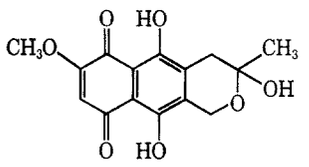


3



4

Acetylation of norjavanicin with acetic anhydride and sulfuric acid converts it into monoacetylanhydronorjavanicin (**3**). Javanicin itself undergoes similar dehydration on acetylation.[13] The anhydromonoacetate structure is confirmed by the loss of the 1725-cm^{-1} carbonyl band of norjavanicin following acetylation, appearance of an aryl acetate band at 1765 cm^{-1}, and shift of the quinone carbonyl band from the chelated (1610 cm^{-1}) to unchelated position (1685 cm^{-1}). In the nmr spectrum of **3** a doublet furano methyl signal (δ 2.44, J = 1 cps) has replaced the acetonyl methyl signal of norjavanicin.

Ample evidence supports assignment of structure **1b** to norjavanicin rather than tautomer **2**. Introduction of an alkyl substituent into the 2 position of naphthoquinone has been found to decrease the reduction potential by about 76 mV.[14] The tautomerism of methylnaphthazarin (**5**, **6**) can be viewed as an internal redox system. The alkyl substituent effect can be used to predict that tautomer **5**, with a substituted quinone ring, will be more stable than **6**, possessing an unsubstituted quinone ring. In the nuclear magnetic resonance spectrum of methylnaphthazarin

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