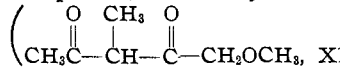
The structure of V was proved by treatment with 50% sulfuric acid as described previously[5] for the 2-methyl derivative. The formation of this lactone VI definitely allocated the methoxymethyl group to the 4-position in the pyridine ring.

Tracy and Elderfield[6] reported that ethyl formate condensed with the methylene group of ethyl methyl ketone, while ethyl oxalate condensed with the methyl group. It is evident from the above reactions (III + IV → V → VII) that methyl methoxyacetate reacted with the methyl group of ethyl methyl ketone to give 1-methoxy-3-methyl-2,4-hexadione (III). If the reaction had taken place on the methylene group, the resulting compound, 1-methoxy-3-methyl-2,4-pentadione



would have reacted with cyanacetamide to give 2,3-dimethyl-4-methoxymethyl-5-cyano-6-hydroxypyridine. This compound would have been incapable of undergoing the reactions V → VII → XII.

The biological activity of 2-ethyl-3-hydroxy-4,5-bis-(hydroxy-methyl)-pyridine hydrochloride (XII) was determined in the Merck Institute for Therapeutic Research by Dr. Klaus Unna using a single dose curative assay[7] on vitamin B_6 depleted rats. Some vitamin B_6 activity was found for this sample in dosages of 1000 and 2500 micrograms, but even the larger dose was not sufficient to produce cures which are effected by 50 micrograms of vitamin B_6. Thus, the ethyl homolog possesses less than 2% of the activity of vitamin B_6 hydrochloride.

Experimental

Since the reactions are so similar to the published synthesis of vitamin B_6,[4] only the physical constants and analyses of the products are given here.

1-Methoxy-2,4-hexadione (III).—B. p. 69.5–70° at 7.5 mm. *Anal.* Calcd. for $C_7H_{12}O_3$: C, 58.31; H, 8.39. Found: C, 58.37, 58.28; H, 8.34, 8.33.

2-Ethyl-4-methoxymethyl-5-cyano-6-hydroxypyridine (V).—M. p. 190–191°. *Anal.* Calcd. for $C_{10}H_{12}N_2O_2$: C, 62.48; H, 6.30; N, 14.57. Found: C, 62.69, 62.52; H, 6.20, 6.26; N, 14.73.

The Lactone of 2-Ethyl-3-hydroxymethyl-4-carboxy-6-hydroxypyridine (VI).—M. p. 285°. *Anal.* Calcd. for $C_9H_9O_3N$: C, 60.33; H, 5.06; N, 7.82. Found: C, 60.56; H, 4.98; N, 7.76.

2-Ethyl-3-nitro-4-methoxymethyl-5-cyano-6-hydroxypyridine (VII).—M. p. 171–172°. *Anal.* Calcd. for $C_{10}H_{11}O_4N_3$: C, 50.64; H, 4.64; N, 17.72. Found: C, 50.63, 50.81; H, 4.65, 4.54; N, 18.05.

2-Ethyl-3-nitro-4-methoxymethyl-5-cyano-6-chloropyridine (VIII).—M. p. 56–57°. *Anal.* Calcd. for $C_{10}H_{10}O_3N_3Cl$: C, 46.96; H, 3.91; N, 16.46. Found: C, 47.12, 46.86; H, 3.89, 3.68; N, 16.34.

The Dihydrochloride of 2-Ethyl-3-amino-4-methoxymethyl-5-aminomethylpyridine (IX).—M. p. 214°. *Anal.* Calcd. for $C_{10}H_{19}ON_3Cl_2$: C, 44.78; H, 7.09; N, 15.67. Found: C, 44.81; H, 7.37; N, 15.89, 15.89.

2-Ethyl-3-hydroxy-4-methoxymethyl-5-hydroxymethylpyridine Hydrochloride (X).—This compound was not obtained crystalline, but was converted to the dibromide by treatment with constant boiling hydrobromic acid.

2-Ethyl-3-hydroxy-4,5-bis-(bromomethyl)-pyridine Hydrobromide (XI).—M. p. 196°. *Anal.* Calcd. for $C_9H_{12}ONBr_3$: C, 27.72; H, 3.10; N, 3.59. Found: C, 27.95; H, 3.19; N, 3.50.

2-Ethyl-3-hydroxy-4,5-bis-(hydroxymethyl)-pyridine Hydrochloride (XII).—M. p. 192°. *Anal.* Calcd. for $C_9H_{14}NO_3Cl$: C, 49.12; H, 6.42; N, 6.37. Found: C, 49.11, 49.39; H, 6.44, 6.39; N, 6.36.

The authors wish to express their appreciation to Messrs. D. F. Hayman, W. R. Reiss, R. B. Boos and H. S. Clark for the microanalyses reported in this paper.

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(5) Harris, Stiller and Folkers, THIS JOURNAL, **61**, 1242 (1939).

(6) Tracy and Elderfield, *J. Org. Chem.*, **6**, 63, 70 (1941).

(7) Reedman, Sampson and Unna, *Proc. Soc. Exptl. Biol. Med.*, **43**, 112 (1940). By this method it has been shown that a single dose of 100 micrograms of vitamin B_6 hydrochloride cures 100% of the deficient animals within 14 days, and that a dose of 50 micrograms produces complete cures in 75% of the animals. Lower doses fail to produce complete cures, but signs of partial healing were obtained regularly with 25 micrograms.

Investigations in the 1-Methylphenanthrene Series. II. Some Substitution Products of 1-Methylphenanthrene

BY TORSTEN HASSELSTROM

The direct nitration of retene yields no crystalline derivatives.[1] On the other hand, it was found in this investigation that 1-methylphenanthrene like phenanthrene gives a crystalline mononitro derivative on nitration in glacial acetic acid. The corresponding amine was produced on reduction with sodium hyposulfite and acetylated. Through the diazo reaction 1-methylphenanthrol was obtained together with minute quantities of a dyestuff of unknown composition. The 1-methylphenanthrol was identified by its acetoxy derivative, which had the same melting point as a 1-

(1) (a) Fehling, *Ann.*, **106**, 390 (1858); (b) Fritzche, *ibid.*, **109**, 251 (1859); (c) Ekstrand, *ibid.*, **185**, 79 (1877); (d) Bamberger and Hooker, *ibid.*, **229**, 116, 144 (1885); (e) Arnot, German Patent 315,623 (1919); *Chem. Zentr.*, **91**, II, 188 (1920); (f) Arnot, British Patent 149,354 (1920); *Chem. Zentr.*, **92**, II, 37 (1921); (g) Wahlforss, Thesis, Helsingfors, 1924, p. 24; (h) Komppa and Wahlforss, THIS JOURNAL, **52**, 5009 (1930).

methylphenanthrol reported by Fieser and Young[2] and did not lower the melting point of this compound in the mixed melting point test. Since these authors conclude their 1-methylphenanthrol to be the 9-derivative, it is assumed that 1-methylphenanthrene on direct nitration produces the 1-methyl-9-nitrophenanthrene.

It is of interest to note that phenanthrene when nitrated under similar conditions yields the 9-derivative.[3] All these facts represent a further support to the suggestion recently made by Campbell and Todd[4] in their work on the constitution of acetylretene of Bogert and Hasselstrom[5] that the phenanthrene nucleus apparently has some inherent orienting influence which overcomes any directing influence of alkyl groups.

Acknowledgment.—Thanks are due to Dr. Louis F. Fieser, Department of Chemistry, Harvard University, Cambridge, Massachusetts, for an authentic sample of 1-methyl-9-phenanthrol.

Experimental

1-Methyl-9-nitrophenanthrene[6].—Fifteen grams of 1-methylphenanthrene[7] was dissolved in 200 cc. of glacial acetic acid. The solution was chilled to 18°, whereby some hydrocarbon separated and with good stirring 30 cc. of nitric acid, of sp. gr. 1.42, was added in the course of twenty minutes. After the first drops were added the mixture was cooled to 5° and kept at 5 to 10° until a clear yellow-colored solution was obtained, which usually required thirty to forty-five minutes. The clear solution was then poured into one liter of water and the sticky brownish resin removed by decanting. This was washed with sodium bicarbonate solution, then with water and stirred with a small quantity of acetone until a thick paste of crystalline material was obtained. Filtration removed some brownish tarry material; yield of solid nitro product 6 g. It was recrystallized from acetone; m. p. 146.5–146.8° (cor.), yellowish needles.

Anal.[8] Calcd. for $C_{15}H_{11}NO_2$: N, 5.90. Found: N, 5.72.

1-Methyl-9-aminophenanthrene.—One and one-half grams of 1-methyl-9-nitrophenanthrene was suspended in 50 cc. of methanol and 20 cc. of water to which was added 2 g. of commercial sodium hyposulfite. The solution was refluxed for one-half hour until all color of the nitro derivative had disappeared and when the amino product started to separate, the solution was poured into 500 cc. of water containing ammonia. The fluffy white precipitate was filtered off, yield about quantitative; m. p. 138–138.5° (cor.), pale yellow needles from methanol.

Anal. Calcd. for $C_{15}H_{13}N$: N, 6.76. Found: N, 7.05.

1-Methyl-9-diacetaminophenanthrene.—Acetylation with a boiling mixture of acetic anhydride and fused sodium acetate gave the diacetate, m. p. 193.7–194.3° (cor.) as prismatic white needles from methanol.

Anal. Calcd. for $C_{19}H_{17}NO_2$: C, 78.33; H, 5.88. Found: C, 78.82; H, 5.90.

1-Methyl-9-hydroxyphenanthrene.—A suspension of 2.5 g. of crude 1-methyl-9-aminophenanthrene in 750 cc. of water containing 10 cc. of concentrated hydrochloric acid was cooled to 0–5°. A concentrated aqueous solution of 1 g. of sodium nitrite was added in two portions and the mixture, which turned bright yellow, was allowed to stand for one and one-half hours, when still some yellowish material remained undissolved. After addition of 2.5 g. of urea the mixture was slowly brought to boiling whereby a reddish resin precipitated; yield, 1.7 g. This was suspended in a dilute potassium hydroxide solution and the mixture refluxed for half an hour. The solution was filtered yielding a colorless filtrate and 0.2 g. of a crimson insoluble dye which, recrystallized once from benzene, melted at 283° (cor.), decomp. After cooling, the alkaline filtrate was acidified with dilute hydrochloric acid and the flocculent precipitate of the phenol recrystallized from benzene; yield 1.2 g. of white fluffy crystals, m. p. 199.5–200.5° (cor.). The 1-methyl-9-phenanthrol turned brownish on storage.

Anal. Calcd. for $C_{15}H_{12}O$: C, 86.51; H, 5.81. Found: C, 86.72; H, 6.03.

1-Methyl-9-acetoxyphenanthrene.—Acetylation with acetic anhydride and fused sodium acetate gave the acetoxy derivative, m. p. 99.5–100.3° (cor.), white needles from alcohol.

Anal. Calcd. for $C_{17}H_{14}O_2$: C, 81.58; H, 5.64. Found: C, 81.65; H, 5.92.

In the mixed melting point test with an authentic sample of 1-methyl-9-acetoxyphenanthrene which had darkened somewhat in ten years of standing and melted at 98–99° (cor.) no depression was observed inasmuch as the mixture melted at 98.5–99.5° (cor.).

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(2) Fieser and Young, THIS JOURNAL, **53**, 4120 (1931).
(3) Schmidt and Strobel, *Ber.*, **36**, 2511 (1903).
(4) Campbell and Todd, THIS JOURNAL, **62**, 1288 (1940).
(5) Bogert and Hasselstrom, *ibid.*, **53**, 3462 (1931).
(6) When crude retene, m. p. 96–97° (cor.), is subjected to nitration carried out in a similar manner, about 1% of a crystalline nitro product is obtained melting in a crude state at 259–260° (cor.). Investigation of this product will be the subject matter for a separate publication.
(7) Prepared from retene in accordance with procedure described by Hasselstrom, THIS JOURNAL, **63**, 1164 (1941).
(8) All analyses by Mr. S. Gottlieb, Columbia University, New York City, New York.

The Absorption Spectra of Thiocyano Derivatives of 1,2-Benzanthracene

BY R. NORMAN JONES

The investigation of the influence of substituents on the ultraviolet absorption spectrum of 1,2-benzanthracene[1,2] has been extended to thiocyano derivatives, several of which have been prepared recently in this Laboratory by Wood and Fieser.[3]

(1) Jones, THIS JOURNAL, **62**, 148 (1940).
(2) Jones, *ibid.*, **63**, 151 (1941).
(3) Wood and Fieser, *ibid.*, **63**, 2323 (1941).