and converted to the dibenzoyl-*d*-tartrate. Systematic fractional crystallization from methanol, involving thirty-two steps, then gave a total of 233 mg. (11% over-all from XLIX) of pure **d-quinotoxine dibenzoyl-*d*-tartrate**, m. p. 185.5–186.0°, mixed with a sample of the salt prepared from the natural alkaloid, mixed m. p. 185.5–186.0°. The pure synthetic ***d*-quinotoxine** regenerated from the salt was a very pale yellow viscous oil, $[\alpha]_D$ +44° (EtOH).

A sample of synthetic *d*-quinotoxine (29.4 mg.) was converted to the *anhydrous* acid *d*-tartrate by treatment with 13.6 mg. of *d*-tartaric acid in a minimum quantity of absolute ethanol; 31.7 mg. of anhydrous **d-quinotoxine acid *d*-tartrate**, m. p. 150–153°, was obtained. Mixed with the corresponding salt (m. p. 152–155°) from the natural alkaloid, the mixed m. p. was 151–154°.

Anal. Calcd. for $C_{24}H_{30}O_8N_2$: C, 60.75; H, 6.37; N, 5.90. Found: C, 60.75; H, 6.03; N, 5.93.

On recrystallization from 80 mg. of water, the synthetic anhydrous tartrate was converted into the characteristic **d-quinotoxine *d*-tartrate hexahydrate**, beautiful long stout canary-yellow needles (26.4 mg.), m. p. 55–63°, mixed with a sample of the corresponding pure salt (m. p. 55–63°) from the natural alkaloid, mixed m. p. 55–63°.

When 290 mg. of *l*-enriched quinotoxine regenerated from the mother liquors from the above resolution was treated with 168 mg. of dibenzoyl-*l*-tartaric acid in a minimum quantity of methanol, and the salt which separated was recrystallized directly five times from methanol, 34.6 mg. of pure *l*-quinotoxine dibenzoyl-*l*-tartrate, m. p. 185–186°, was obtained.

Resolution of *dl*-Tartaric Acid by *d*-Quinotoxine.—The resolution of *dl*-tartaric acid was readily effected through the *d*-quinotoxine *d*-tartrate hexahydrate described above; it is highly probable that this was the salt with which Pasteur worked in 1853.[48]

The pure (natural) *d*-quinotoxine regenerated from 2.00 g. of the pure anhydrous *d*-tartrate, m. p. 152–155°, was dissolved in a small quantity of benzene and treated with 0.708 g. of *dl*-tartaric acid (monohydrate) and 1.00 cc. of water. The solution was then heated to drive off the benzene, cooled, and seeded with the hexahydrate, m. p. 55–63° (seeding was not necessary to induce crystallization). The yellow needles of the salt which separated were filtered by centrifuging, and twice recrystallized from 1.2 cc. of water. The pure *d*-quinotoxine *d*-tartrate hexahydrate (0.71 g., 58%) was obtained in characteristic stout yellow needles, m. p. 55–63°, which did not depress the melting point of an authentic sample. The salt was soluble in water at room temperature to the extent of *ca.* 0.05 g./cc. The sample from the resolution was converted on crystallization from absolute ethanol into the anhydrous salt, m. p. 151–154°, identical with an authentic sample.

We wish to express our appreciation of the aid given us by our preparative assistants, Mr. Richard S. Corley throughout, and Mr. Donald B. Sparrow through the latter half of the program. The persistence, zeal, and efficiency with which these men carried out their duties made their participation an important factor in the successful completion of the work.

Summary

7-Hydroxyisoquinoline (XV) has been converted, in succession, through 7-hydroxy-8-piperidinomethylisoquinoline (XVIII), 7-hydroxy-8-methylisoquinoline (XX), 7-hydroxy-8-methyl-1,2,3,4-tetrahydroisoquinoline (XXVI), N-acetyl-7-hydroxy-8-methyl-1,2,3,4-tetrahydroisoquinoline (XXVII), N-acetyl-7-hydroxy-8-methyldecahydroisoquinoline (XXXVI), N-acetyl-7-keto-8-methyldecahydroisoquinoline (XXXVII), N-acetyl-10-oximinodihydrohomomeroquinene ethyl ester (XLI), N-acetyl-10-aminodihydrohomomeroquinene ethyl ester (XLII), N-acetyl-10-trimethylammoniumdihydrohomomeroquinene ethyl ester iodide (XLIV), homomeroquinene (XLVI), N-benzoylhomomeroquinene ethyl ester (XLIX), and N-benzoyl-8-carbethoxyquinotoxine (L), to *dl*-quinotoxine (IV, R = OCH_3). Resolution of the latter through its salts with dibenzoyl-*d*-tartaric acid gave *d*-quinotoxine, identical in all respects with the natural substance. This work, taken with Rabe's earlier conversion of *d*-quinotoxine to quinine, constitutes a total synthesis of the latter alkaloid.

CAMBRIDGE, MASS. RECEIVED NOVEMBER 8, 1944

NOTES

The Action of Lead Tetraacetate on Acenaphthene and Acenaphthenyl Acetate[1]

BY RONALD F. BROWN AND LIM SING YEE[2]

Since we were in need of quantities of acenaphthoquinone for various purposes, it seemed worth while to investigate the action of lead tetraacetate on acenaphthene, even though the method of Graebe and Gfeller[3] has been used satisfactorily. Monti[4] has reported that lead tetraacetate in glacial acetic acid with acenaphthene yields acenaphthylene as the principal product either at room temperature or at 110°, although, at the latter temperature, some polyacenaphthylene and dinaphthylenecyclobutane were obtained. In no case was any acenaphthenediol diacetate formed, and no mention is made of acenaphthenyl acetate as a product. Fieser and Cason[5] have shown that acenaphthenyl acetate can be prepared in

(1) Abstracted from a thesis presented to the Graduate School of the University of Southern California in partial fulfillment of the requirements for the degree of Master of Science, May, 1943. Original manuscript received November 14, 1944.

(2) Present address: Firestone Tire and Rubber Company, Los Angeles, California.

(3) Graebe and Gfeller, *Ber.*, **25**, 652 (1892).

(4) Monti, *Gass. chim. ital.*, **68**, 608 (1938); *Chem. Abs.*, **33**, 1716 (1939); Monti, *Atti X° congr. intern. chim.*, **3**, 256 (1939); *Chem. Abs.*, **33**, 9316 (1939).

(5) Fieser and Cason, THIS JOURNAL, **62**, 432 (1940); Cason "Organic Syntheses," John Wiley and Sons, Inc., New York, N. Y., Vol. 21, p. 1, 1941.

80% yield by this method. In addition, Fieser and workers[6] have shown that lead tetraacetate can act as an alkylating agent under certain conditions, but this reaction would not be expected to be of importance in this study.

Recrystallized acenaphthene, m. p. 93.6–94.1° and redistilled acenaphthenyl acetate, b. p. 167–174° at 5 mm., were used. The other reagents and solvents were of ordinary purity. The general procedure was that described by Fieser and Cason.[5] Enough benzene was used in each run to lower the boiling point of the mixture to 85 to 90°, and the reaction was carried out under reflux. If the benzene was not present in sufficient amount the temperature tended to increase quite rapidly after each addition of red lead. It was found that the reaction would not proceed in acetic anhydride as the solvent. In glacial acetic acid, the reaction became very slow after enough red lead had been consumed to convert the acenaphthene to acenaphthenol acetate. A mixture of 2 moles of acetic acid with 1 mole of acetic anhydride was adopted as giving the maximum rate of consumption of red lead throughout the reaction.

Since we were interested in either acenaphthenediol diacetate or acenaphthoquinone as products, 2 or 4 moles of red lead was used to 1 mole of acenaphthene. Two trials were made with acenaphthenyl acetate as a reactant using an equimolar amount of red lead. Most of the runs were made in 0.1 mole quantities.

When the oxidation was complete, the reaction mixture was poured into water, the benzene layer separated, and the aqueous layer extracted with a fresh portion of benzene. At times, the benzene layer was emulsified by the presence of a finely divided solid, presumably lead dioxide. The addition of glycerol eliminated this difficulty but only after a prolonged period.[7] A much more rapid scheme was the addition of small portions of a dilute solution of sodium nitrite which reacted instantly. After washing with sodium bicarbonate solution to remove acetic acid, the benzene layer was dried over sodium sulfate and the solvent removed by distillation, beginning at atmospheric pressure and finishing under vacuum.

In five out of seven runs the oily residue was distilled under vacuum, acenaphthenyl acetate being the principal product, 30–80%. In most cases, a small high boiling fraction, 180–190° at 5 mm., was also obtained. In a typical instance, a 0.1 mole run with acenaphthenyl acetate from which 0.07 mole of the reactant was recovered, 3.4 g. of this viscous yellow oily fraction yielded, when extracted with hot sodium bisulfite solution, 0.2 g. of acenaphthoquinone, identified by melting point and melting point of a mixture, 246–248°. The oil remaining, 3.2 g., yielded no alkali insoluble material upon saponification. Acidification of the solution caused the separation of only 1.5 g. of a brown solid, m. p. 292° dec. The small residues from the vacuum distillations likewise were easily saponified to give more water soluble material than acid insoluble material.

In two runs, 0.1 mole of the hydrocarbon with 0.4 mole of red lead, the oily product remaining after the removal of the benzene, was saponified with alcoholic potassium hydroxide to give a 20% yield in both cases of crude acenaphthenol. The alkaline filtrates each gave 8.7 g. of acid insoluble material of which 4.7 g. was soluble in hot sodium carbonate solution. This led to the isolation of 3.8 g. (0.018 mole) of crude naphthalic acid. The sodium carbonate insoluble residue was slightly acidic as shown by solubility in hot sodium hydroxide solution.

These results indicated that acenaphthenyl acetate was relatively stable to the action of lead tetraacetate. When forced, the reaction yielded highly acetoxylated material from which naphthalic acid could be obtained. No acenaphthenediol diacetate was obtained in any case. Small amounts of acenaphthoquinone were formed, but this substance was difficult to separate from acenaphthenyl acetate and accounted for the yellow color of the ester.

(6) Fieser and Chang, THIS JOURNAL, 64, 2043 (1942); Fieser, Clapp and Daudt, *ibid.*, 64, 2052 (1942).

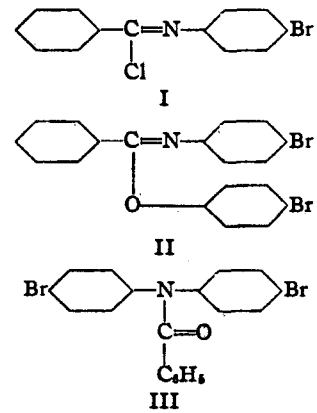
(7) Fieser, "Experiments in Organic Chemistry," D. C. Heath and Co., New York, N. Y., 2nd ed., p. 438, 1941.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF SOUTHERN CALIFORNIA
LOS ANGELES 7, CALIF. RECEIVED MARCH 3, 1945

Structure of 4,4′-Dibromodiphenylamine

BY NATHAN N. CROUNSE[1] AND L. CHARLES RAIFORD[2]

4,4′-Dibromodiphenylamine has been prepared previously by bromination of a 5% solution of diphenylamine in 20% ethanol[3] and in 5% yield by the action of hydrogen bromide on N-nitrosodiphenylamine,[4] but convincing proof of its structure was lacking. We have proved its structure by preparing the compound by a method which leaves no doubt as to the position of the bromine atoms. N-4-Bromophenylbenzimino 4-bromophenyl ether (II), prepared from N-4-bromophenylbenzimino chloride (I) and 4-bromophenol, was rearranged to the benzoyl derivative of 4,4′-dibromodiphenylamine (III), and the latter was hydrolyzed to 4,4′-dibromodiphenylamine. The rearrangement of the ether was based on similar reactions of known compounds as studied by Chapman.[5]



I

II

III

4,4′-Dibromodiphenylamine.—The supposed compound, m. p. 105.5–106°, was prepared by the method of Galatis and Megaloikonomos.[3]

Anal. Calcd. for $C_{12}H_9NBr_2$: N, 4.28. Found: N, 4.04.

N-4-Bromophenylbenzimino 4-Bromophenyl Ether (II).—A mixture of 21 g. of phosphorus pentachloride and 25 g. of 4-bromobenzanilide was heated on a water-bath, contrary to Wallach's[6] general directions, until the evolution of hydrogen chloride ceased. The phosphorus oxychloride was distilled. The intermediate imino chloride (I) was not isolated. The residue was dissolved in ether and added to a solution of 52.9 g. of 4-bromophenol as its sodium salt

(1) A portion of the thesis submitted by N. N. Crounse in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the State University of Iowa. Present address: The Hilton-Davis Chemical Co., Cincinnati, Ohio.

(2) Deceased January 8, 1944.

(3) Galatis and Megaloikonomos, *Prakt. Akad. Athenón*, 9, 20 (1934) [*Chem. Zentr.* 105, II, 2974 (1934)].

(4) Fischer, *Ber.*, 45, 1103 (1912).

(5) Chapman, *J. Chem. Soc.*, 121, 1676 (1922); 127, 1992 (1925); 569 (1929); 2462 (1930).

(6) Wallach, *Ann.*, 184, 77 (1877).