

trisiloxane,⁵ simultaneously appeared in the water-cooled condenser. However, no other cyclopolysiloxanes were noted in the course of these distillations.

Acknowledgment.—The author is greatly indebted to Dr. Earl W. Balis of this Laboratory for the carbon, hydrogen and silicon analyses reported here.

(5) Hyde and DeLong, *THIS JOURNAL*, **63**, 1194 (1941).

Summary

The following *n*-butoxy silicon compounds have been prepared: dimethyl-*n*-butoxychlorosilane, dimethyldi-*n*-butoxysilane, methyltri-*n*-butoxysilane, tetramethyl-1,3-di-*n*-butoxydisiloxane and hexamethyl-1,5-di-*n*-butoxytrisiloxane.

SCHENECTADY, N. Y.

RECEIVED SEPTEMBER 8, 1945

NOTES

Preparation of Salts of 2-Phenylethene-1-sulfonic Acid¹

BY F. G. BORDWELL, C. M. SUTER,² J. M. HOLBERT AND C. S. RONDESTVEDT

In connection with some other work it became necessary to prepare salts of 2-phenylethene-1-sulfonic acid in appreciable quantity. Salts of this acid have previously been obtained by the reaction of ammonium sulfamate with styrene³ and by the reaction of sodium bisulfite with styrene in the presence of oxygen.⁴ The yields are not good by either of these procedures. It has now been found that the reaction of dioxane sulfotrioxide⁵ with styrene can be used to obtain good yields of 2-phenylethene-1-sulfonic acid.

The sodium, calcium and barium salts of the acid were isolated on addition of water and the appropriate metallic carbonate or hydroxide to the original sulfonation mixture. The salts were identified by conversion to 2-phenylethene-1-sulfonyl chloride,^{3,4} 2-phenylethene-1-sulfonamide^{3,4} and to the *p*-chlorobenzylthiuronium salt.⁶ In addition the anilide, *S*-benzylthiuronium salt and *p*-toluidine salt were prepared.

A water-insoluble compound, C₁₆H₁₆O₃S, was obtained as a by-product in this sulfonation. Preliminary observations indicate that this material is a sultone.

Experimental

Sodium 2-Phenylethene-1-sulfonate.—To a stirred suspension of dioxane sulfotrioxide⁵ prepared by distillation of 160 g. (2 moles) of sulfur trioxide into a cooled mixture of 175 ml. of dry dioxane and 175 ml. of dry ethylene chloride, was added dropwise 257 ml. (2.2 moles) of styrene. The addition required two hours, the flask being cooled by an ice-bath during that time. The mixture was

allowed to stand overnight, heated on the steam-bath for thirty minutes, and then poured into 700 ml. of water. After standing, the layers were separated. Evaporation of the ethylene chloride layer yielded 52 g. of colorless water-insoluble material, m. p. 142–145°. After several crystallizations from acetone-water and from alcohol the substance melted at 152–153°. The yield of crude material was 9% based on sulfur trioxide. A qualitative analysis for the elements showed the presence of sulfur.

Anal. Calcd. for C₁₆H₁₆O₃S: C, 66.66; H, 5.55; mol. wt., 288. Found: C, 66.52, 66.47; H, 5.70, 5.70; mol. wt., 278 (Rast method⁷).

The aqueous layer was neutralized with sodium hydroxide, and the following crops of crystals collected: (1) from 1350 ml., 40 g.; (2) from 500 ml., 153 g.; (3) from 350 ml., 46 g.; (4) residue, 125 g. The calcium and barium salts are much less soluble. Crops 1, 2 and 3 were practically pure sodium 2-phenylethene-1-sulfonate since they gave *S*-benzylthiuronium 2-phenylethene-1-sulfonate in yields and purity comparable to that from an authentic sample of this compound. The yield from these crops was 244 g. (60% based on sulfur trioxide). The residue contained sodium 2-phenylethene-1-sulfonate, sodium sulfate and probably sodium 2-hydroxy-2-phenylethane-1-sulfonate.

The *p*-chlorobenzylthiuronium salt of 2-phenylethene-1-sulfonic acid after several crystallizations from dilute alcohol melted at 203–204° (Suter and Milne⁶ report 199°).

Anal. Calcd. for C₁₆H₁₇O₃N₂ClS₂: N, 7.28. Found: N, 6.94.

The *S*-benzylthiuronium salt was crystallized from dilute alcohol to a constant m. p., 166–167°.

Anal. Calcd. for C₁₆H₁₇O₃N₂S₂: N, 8.00. Found: N, 7.50.

The *p*-toluidine salt was crystallized from water containing a drop of acetic acid to a constant m. p., 208–209°.

Anal. Calcd. for C₁₆H₁₇O₃NS: neut. equiv., 291. Found: neut. equiv., 289.

2-Phenylethene-1-sulfonanilide was prepared and crystallized to a constant m. p., 114–114.5°.

Anal. Calcd. for C₁₄H₁₃O₂SN: N, 5.40. Found: N, 5.22.

2-Phenylethene-1-sulfonyl chloride⁴ was readily prepared from crops 1, 2 and 3 (but not from the residue) by heating the dried salt on the steam-bath with an equimolar quantity of phosphorus pentachloride for six hours, and after removal of the phosphorus oxychloride under vacuum, pulverizing the resultant mass under ice-water. The yield of crude material, m. p. 86–89°, was practically

(7) Fuson and Shriner, "Identification of Organic Compounds," John Wiley and Sons, Inc., New York, N. Y., 1940, pp. 122.

(1) This investigation was supported by a grant from the Abbott Fund of Northwestern University.

(2) Present address: Winthrop Chemical Company, Rensselaer, N. Y.

(3) Qillico and Fleischer, *Atti accad. Lincei*, **1**, 1050 (1938).

(4) Kharasch, May and Mayo, *J. Org. Chem.*, **3**, 175 (1938); Kharasch, Schenk and Mayo, *THIS JOURNAL*, **61**, 3092 (1939).

(5) Bordwell, Suter and Webber, *ibid.*, **67**, 827 (1945), and ref. cited therein.

(6) Suter and Milne, *ibid.*, **65**, 582 (1943).

quantitative. Crystallization of the material from carbon disulfide or hexane gave a purer product, m. p. 89–89.5°, but considerable loss was entailed.

CHEMICAL LABORATORY
NORTHWESTERN UNIVERSITY
EVANSTON, ILL.

RECEIVED OCTOBER 31, 1945

The Preparation of *t*-Butylamine by the Low-Pressure Hydrogenation of 2,2-Dimethylethylenimine¹

BY KENNETH N. CAMPBELL, ARMIGER H. SOMMERS AND
BARBARA K. CAMPBELL

We recently needed large amounts of *t*-butylamine, and developed a method for preparing it by the hydrogenation of 2,2-dimethylethylenimine. While our paper was being cleared by O. S. R. D., a Note by Karabinos and Serijan² appeared, in which the high-pressure hydrogenation of the imine to *t*-butylamine is described. We should like to point out that the hydrogenation can be carried out satisfactorily at low pressures, by the following procedure:

A citrate of magnesia bottle, wound for electrical heating, was charged with 100 ml. of pure dioxane, 35.5 g. of freshly-distilled 2,2-dimethylethylenimine and 9 g. of Raney nickel. The bottle was attached to a Parr low-pressure hydrogenation apparatus and flushed several times with hydrogen to remove air. Hydrogenation was carried out at 60° and an initial pressure of 60 lb./sq. in.; absorption was quantitative and complete in two hours. The solutions from two such runs were combined and distilled through a 10–15 plate Fenske-Whitmore column to give 58 g. of *t*-butylamine, b. p. 44.0–44.5°, n_D^{20} 1.3770. The amine yielded an α -naphthylthiourea, m. p. 153–154°, and a benzoyl derivative, m. p. 134–135°.

(1) The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the University of Notre Dame.

(2) Karabinos and Serijan, *THIS JOURNAL*, **67**, 1856 (1945).

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF NOTRE DAME
NOTRE DAME, INDIANA

RECEIVED OCTOBER 24, 1945

Bromine Analogs of DDT¹

BY STANLEY J. CRISTOL AND H. L. HALLER

In connection with entomological and pharmacological work on the insecticide DDT [1-trichloro-2,2-bis-(*p*-chlorophenyl)-ethane], it was necessary to prepare certain bromine-containing analogs of DDT. Of the three relatively simple analogs, that from chloral and bromobenzene and those from bromal with chlorobenzene or bromobenzene, the first, 1-trichloro-2,2-bis-(*p*-bromophenyl)-ethane, has already been described.² The preparation of the other two, 1-tribromo-2,2-bis-(*p*-chlorophenyl)-ethane (I) and 1-tribromo-2,2-bis-(*p*-bromophenyl)-ethane (II), has now been effected, although in poor yield, by the sul-

(1) The work described in this paper was carried out under a transfer of funds, recommended by the Committee on Medical Research, from the Office of Scientific Research and Development to the Bureau of Entomology and Plant Quarantine.

(2) Zeidler, *Ber.*, **7**, 1180 (1874).

furic acid-catalyzed condensation of bromal with the appropriate halobenzene.

Compound I is fairly stable, can be recrystallized from 95% ethanol, and when pure melts at 146–147°. On the other hand, II is very unstable. Recrystallization of the pure compound, m. p. 173–174°, from ethanol or from benzene-ligroin gave a mixture which melted at about 140° with decomposition. Purification of II was effected by tedious recrystallization from Skellysolve B (petroleum ether, b. p. 60–70°). I and II both eliminate the elements of hydrogen bromide in ethanolic alkali to produce the corresponding olefins. The position of the ring halogen atoms was shown by oxidation of the olefins to the *p,p'*-dihalobenzophenones. Dinitro derivatives of I and II were also prepared.

1-Tribromo-2,2-bis-(*p*-chlorophenyl)-ethane (I).—To a well-stirred mixture of 100 g. (0.36 mole) of bromal and 320 g. (5.7 moles) of chlorobenzene cooled in an ice-bath, 560 g. of 100% sulfuric acid was added dropwise over a period of one hour. The temperature of the mixture was kept below 6° during the addition, and the resulting mixture was stirred in an ice-bath for twenty-four hours. The product mixture was poured onto ice and water, and the organic fraction was extracted with ether. The ethereal solution was washed with water and dilute sodium bicarbonate solution, and then dried over anhydrous sodium sulfate. The ether and excess chlorobenzene (about 60% was recovered) were removed under reduced pressure. The residual oil was crystallized from Skellysolve B, giving 42 g. (24%) of crude I. The product was recrystallized from 95% ethanol, and when pure melted at 146–147° (cor.). About 70% recovery was obtained in the recrystallization.

Anal. Calcd. for $C_{14}H_9Cl_2Br_3$: C, 34.46; H, 1.86. Found: C, 34.68; H, 1.85.

Use of stronger or weaker acid, increase in temperature and modifications in reaction time for the condensation resulted either in poorer or unaffected yields of product. Use of acetic acid as solvent for the condensation resulted in the formation of an almost quantitative yield of the diacetate of bromal hydrate,³ m. p. 77–77.8°, rather than the desired product I.

Anal. Calcd. for $C_6H_7O_4Br_2$: Br, 62.6; mol. wt., 383. Found: Br, 61.8; mol. wt. (in benzene), 360.

1,1-Dibromo-2,2-bis-(*p*-chlorophenyl)-ethylene was obtained by heating at reflux for one hour a solution of 1.0 g. of I and 0.6 g. of potassium hydroxide in 40 ml. of 95% ethanol. The reaction mixture was poured into ice water; the product oiled out, but rapidly crystallized. The solid was separated by filtration and was recrystallized from 95% ethanol. It melted at 104–105° (cor.). The yield was not determined as a portion of the preparation was lost.

Anal. Calcd. for $C_{14}H_8Cl_2Br_2$: C, 41.32; H, 1.98. Found: C, 41.23; H, 1.90.

A solution of 125 mg. of the olefin in 5 ml. of glacial acetic acid was heated to reflux and 125 mg. of chromic anhydride was added through the condenser. Refluxing was continued for one hour. Bromine vapors were evolved during the first fifteen minutes. The product mixture was cooled and then poured into water; the oil which precipitated solidified rapidly and was filtered and dried. The yield of almost pure *p,p'*-dichlorobenzophenone was 68 mg. (88%), and the product, after recrystallization, melted at 146–147° (cor.). The melting point was not depressed upon admixture with known *p,p'*-dichlorobenzophenone.

Dinitro Derivative of I.—A mixture of 500 mg. of I and 5 ml. of fuming nitric acid was warmed in a water-bath at

(3) Gabutti, *Gazz. chim. ital.*, **30**, II, 191 (1900).

50° for one hour. The reaction mixture was cooled and poured onto ice; the resulting solid was filtered, washed, and dried. The product was recrystallized from acetone-ethanol and melted at 181.5–183.5° (cor.).

Anal. Calcd. for $C_{14}H_7Cl_2Br_2N_2O_4$: C, 29.09; H, 1.22. Found: C, 29.32; H, 1.23.

1-Tribromo-2,2-bis-(*p*-bromophenyl)-ethane (II).—This compound was prepared in the same manner as I, with substitution of 330 g. of bromobenzene for the chlorobenzene. Three layers were formed in the ether extraction, the center layer containing about 110 g. of crude bromobenzenesulfonic acid. The ether and excess bromobenzene (210 g.) were removed under reduced pressure and the residual oil was crystallized from Skellysolve B. The yield of crude solid, m. p. 136–160°, was 34.5 g. (16.5%). Several recrystallizations from Skellysolve B gave about half of this material as pure compound melting at 173–174° (cor.) and crystallizing as rhombs or needles.

Anal. Calcd. for $C_{14}H_9Br_3$: C, 29.15; H, 1.57. Found: C, 29.19; H, 1.76.

The compound was quite unstable; ethanolic solutions became acidic rapidly, and crystallization from ethanol or from benzene-ligroin resulted in products decomposing at 140–150°.

1,1-Dibromo-2,2-bis-(*p*-bromophenyl)-ethylene was prepared by the treatment of II with ethanolic potassium hydroxide (as given above for I) in 76% yield. The product recrystallized from 95% ethanol was obtained as pale yellow, prismatic needles melting at 121.8–122.7° (cor.).

Anal. Calcd. for $C_{14}H_8Br_2$: C, 33.91; H, 1.63. Found: C, 33.49; H, 1.36.

A hundred and ten mg. of the olefin was oxidized in 80% yield with chromic anhydride, as described above, to *p,p'*-dibromobenzophenone, m. p. 174–175° (cor.) after recrystallization from 95% ethanol, and the melting point was not depressed when the sample was mixed with an authentic sample prepared by the oxidation of bis-(*p*-bromophenyl)-methane according to Goldthwaite.⁴

Dinitro Derivative of II.—To 5 ml. of fuming nitric acid cooled in an ice-bath 500 mg. of II was gradually added. After one hour in the ice-bath and one hour at room temperature, the reaction mixture was poured onto ice. The precipitate was filtered, washed and dried. After recrystallization from acetone-ethanol, the product melted at 203–205° (cor.).

Anal. Calcd. for $C_{14}H_7Br_2N_2O_4$: C, 25.22; H, 1.06. Found: C, 25.53; H, 1.09.

(4) Goldthwaite, *Am. Chem. J.*, **30**, 445 (1903).

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
AGRICULTURAL RESEARCH ADMINISTRATION
U. S. DEPARTMENT OF AGRICULTURE
BELTSVILLE, MD. RECEIVED SEPTEMBER 19, 1945

Observations on the Equilibrium between *cis*- and *trans*-Stilbene

BY D. C. DOWNING AND GEORGE F. WRIGHT

The thermal equilibrium between *cis*- and *trans*-stilbene has been reported as 92–94% *trans* at 340°,¹ as 96% *trans* at 214°,² and 93% *trans* at 25°.³ In order to test this apparent independence with respect to temperature we applied the method of methoxymercuration⁴ to a sample of *trans*-stilbene isomerized at 330–340° and found

(1) G. B. Kistiakowsky and W. Smith, *THIS JOURNAL*, **56**, 638 (1934).

(2) T. W. Taylor and A. R. Murray, *J. Chem. Soc.*, 2078 (1938).

(3) C. C. Price and M. Meister, *THIS JOURNAL*, **61**, 1595 (1939).

(4) (a) G. F. Wright, *ibid.*, **57**, 1993 (1935). (b) W. H. Brown and G. F. Wright, *ibid.*, **62**, 1991 (1940). (c) A. M. Birks and G. F. Wright, *ibid.*, **62**, 2412 (1940).

(Fig. 1) that the rate of mercury consumption *versus* time was identical (curve A) with that shown by pure stilbene (curve B), whereas a 92:8 *trans-cis* mixture and an 8:92 *trans-cis* mixture consumed mercury according to curves C and D, respectively. These data indicate that the melting point lowering observed by Kistiakowsky and Smith was not owing to the presence of 8% *cis*-stilbene.

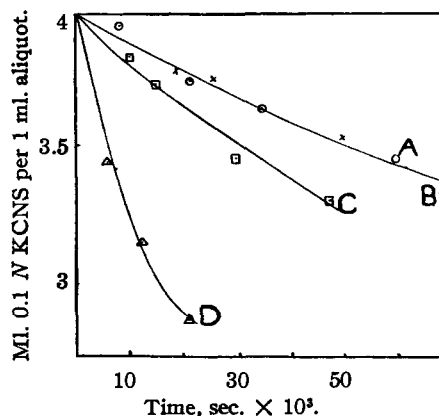


Fig. 1.—Mercury consumption by *cis-trans* mixtures *vs.* time.

The methoxymercuration was carried out without a catalyst⁴ in order to accentuate the difference in reaction rate between *cis* and *trans* isomers. The slight solubility of *trans*-stilbene in the reaction medium also exaggerated this difference.

We were unable to test the 93:7 equilibrium reported at 25° because we could not repeat the catalytic isomerization of Price and Meister with boron trifluoride in carbon tetrachloride or as its etherate. In our hands no isomerization occurred with either *cis*- or *trans*-stilbene, nor did benzoyl peroxide or peracetic acid act as a co-catalyst.

It would appear that the isomerizing action of boron trifluoride is not so simple as Price and Meister supposed it to be. We are continuing to search either for a co-catalyst in their system or for an inhibitor in our own.

Experimental

Thermal Isomerization of *trans*-Stilbene.—A bomb tube, 10 × 150 mm., containing 1.80 g. (0.01 mole) of *trans*-stilbene was heated for eight hours at 330–340°. The gas was turned off and the tube was dropped from the furnace directly into ice and water. The organic material was taken up in chloroform, washed with ferrous sulfate, dried with magnesium sulfate, and the solvent evaporated under 15 mm. The residue softened at 95° and melted completely at 109°.

Analysis for Mercury.—The procedure reported previously^(4c) was adapted to a semimicro procedure employing one-tenth of the former quantities. Methoxymercuration was carried out at 35° in a fresh 0.2 M mercuric acetate solution freed from mercurous salt by centrifugation. The 1-ml. aliquots, diluted into aqueous potassium nitrate, were extracted five times with chloroform before titration with thiocyanate using ferric sulfate indicator.

Methoxymercuration.—When a 0.2 M solution of *trans*-stilbene is stirred or shaken in catalyst-free methanol suspension, also 0.2 M in mercuric acetate, the mercury is

consumed according to curve B (Fig. 1), and a 6% yield of 1-methoxy-2-chloromercuri-1,2-diphenylethane (*trans* isomer modification) is obtained upon dilution into aqueous sodium chloride after two days. Hydrobenzoin dimethyl ether and mercurous acetate also are produced.

cis-Stilbene under the same conditions reacts rapidly to give more than a 70% yield of the diastereoisomeric methoxymercurial in less than one day. Since neither *trans*-stilbene nor the impurities arising from its thermal isomerization are very soluble in methanol, the ready solubility of *cis*-stilbene in this medium indicates that its presence ought easily be detected in mixtures after, say, two thousand seconds' reaction time.

Preparation of *cis*-Stilbene.—Most of our *cis*-stilbene was prepared directly by Bourguel's method⁵ and was purified readily by distillation. Occasionally a mixture of diphenylethane with *cis*- and *trans*-stilbene was obtained because of over-active catalyst or prolonged hydrogenation time. We have been successful in separation of these disagreeable mixtures by treating them with an excess of methanolic mercuric acetate in absence of peroxide. Crystallization of the product from ethanol yields the pure 1-chloromercuri-2-methoxy-1,2-diphenylethane corresponding to *cis*-stilbene. Regeneration of this geometric isomer from the mercurial is tricky. Reduction with hydrazine hydrate, sodium stannite or formic acid precipitates some mercury, but the remainder is evidently present as the non-isolable R₂Hg compound. Reduction with sodium thiosulfate is better but does not reliably decompose the intermediate halogen-free mercurial to the ethylene. Reaction of the diastereoisomer from *cis*-stilbene with ethyl Grignard reagent causes complete isomerization to *trans*-stilbene. A *cis*-stilbene which is over 90% pure (*n*_D²⁰ 1.6234) can, however, be obtained by shaking the diastereoisomer from *cis*-stilbene with concentrated hydrochloric acid and ether at 25° until no more mercury is freed. Distillation under 10 mm. yields the pure isomer. This demonstrates for the first time that the geometric isomer from which a diastereoisomeric methoxychloromercurial is prepared can be regenerated without conversion to an equilibrium mixture of geometric isomers.

Isomerization of *cis* and *trans*-Stilbenes with Boron Trifluoride.—When 1.80 g. (0.01 mole) of *cis*-stilbene in 8 cc. of purified⁶ carbon tetrachloride was treated with 450 cc. of boron trifluoride over fifty min., no precipitate was formed. The solution was washed with aqueous solutions of sodium carbonate and ferrous sulfate, and, after drying with potassium carbonate, was evaporated under 25 mm. to leave unchanged *cis*-stilbene, (*n*_D²⁰ 1.6225). Identical results were obtained when 1 × 10⁻⁴ mole of either benzoyl peroxide or peracetic acid was added to the original mixture.

A solution of 1.80 g. *trans*-stilbene in 15 ml. of boron trifluoride etherate plus 25 ml. peroxide-free anhydrous ether was aged for five days, then washed with aqueous sodium carbonate, ferrous sulfate and water, dried with magnesium sulfate and evaporated under 30 mm. pressure. The residue was shaken with 0.01 mole of 0.2 M methanolic mercuric acetate over a three day period during which aliquots were withdrawn. Finally 1.6 g. of mercurous acetate was filtered off and the filtrate added to 2% aqueous sodium chloride. The 1.25 g. portion which precipitated was crystallized from ethanol to melt at 134–136°. This was identified as almost pure hydrobenzoin dimethyl ether. No mercurial could be isolated, although previous experience (ref. 4 c, page 2418) has shown that it is easily separable from the ether by crystallization from ethanol and petroleum ether (b. p. 60–70°). This experiment was repeated except that the diluent ether was replaced by an equal volume of absolute ethanol. The recovered stilbene in this case contained peroxide and therefore reacted fairly rapidly when shaken with methanolic mercuric acetate. The rate was not followed analytically since undissolved *trans*-stilbene was present. After three days, 0.05 g. of mercurous acetate was filtered off and the

filtrate drowned in 2% sodium chloride. The product, 1.05 g., melted at 129° after crystallization from a quantity of ethanol just sufficient to remove the *trans*-stilbene. A second crystallization raised this melting point to 130°.

Identity with the 1-chloromercuri-2-methoxy-1,2-diphenylethane (m. p. 130–131°), obtainable from *trans*-stilbene was established by mixed melting point.

UNIVERSITY OF TORONTO
TORONTO, ONTARIO

RECEIVED JULY 13, 1945

Hexachlorobenzene from Phthalic Anhydride

BY M. N. DVORNIKOFF, D. G. SHEETS AND F. B. ZIENTY

On prolonged chlorination of phthalic anhydride at 170–265° in the presence of ferric chloride¹ a weight increase greater than that corresponding to the formation of the tetrachloro derivative is observed, and finally the weight decreases again, while carbon dioxide and phosgene (identified as diphenylurea) are being evolved. The final product, obtained in 95% yield, is hexachlorobenzene.

The formation of hexachlorobenzene from *unsym*-tetrachlorophthaloyl chloride by chlorination at 300° has been recorded in the literature.² The conversion of tetrachlorophthalic anhydride into hexachlorobenzene by exhaustive chlorination is analogous also to the production of decachlorobiphenyl by chlorination of *o*-nitrobiphenyl at high temperature in the presence of ferric chloride.³ Each of the reactions mentioned involves replacement of functional groups by chlorine.

Experimental

An agitated mixture of 148 g. (1 mole) of phthalic anhydride and 2.2 g. of anhydrous ferric chloride was chlorinated starting at 170°, gradually increasing the temperature to 265° during ninety hours, and maintaining that maximum temperature for an additional fifty hours. Then 3 g. of calcium oxide was added and the product was distilled, yielding 272 g. (95%) of slightly yellow solid, b. p. 248–255° (160 mm.) and m. p. 214–224°. On crystallization from chloroform, 79% of hexachlorobenzene, m. p. 226–227.5°, was obtained; mixed m. p. with an authentic sample of hexachlorobenzene, 226–227°. All melting points are corrected.

(1) Dvornikoff, U. S. Patent 2,028,383 (January 21, 1936).

(2) Kirpal and Kunze, *Ber.*, **62**, 2103 (1929).

(3) Jenkins, U. S. Patent 2,354,813 (August 1, 1944).

RESEARCH LABORATORIES
MONSANTO CHEMICAL CO.

ST. LOUIS 4, MISSOURI

RECEIVED OCTOBER 8, 1945

Stability of DDT and Related Compounds

BY ELMER E. FLECK AND H. L. HALLER

The action of catalysts such as iron, chromium, anhydrous ferric and aluminum chlorides in eliminating hydrogen chloride from DDT (1-trichloro-2,2-bis-(*p*-chlorophenyl)-ethane has been demonstrated.¹ Likewise the role of certain solvents in inhibiting this catalytic decomposition has been shown.² Nevertheless, the idea is widely held that pure DDT is less stable toward heat than is the technical grade.

(1) Fleck and Haller, *THIS JOURNAL*, **66**, 2095 (1944).

(2) Fleck and Haller, *Ind. Eng. Chem.*, **37**, 403 (1945).

(5) M. Bourguel, *Bull. soc. chim.*, [4] **45**, 1067 (1929).

(6) Fieser and Fieser, "Experiments in Organic Chemistry," D. C. Heath and Company, Boston, 1935, p. 308.

To test this point we have heated DDT at 115–120° in the apparatus previously described.¹ A technical grade of DDT (setting point 91.4°²) evolved but 0.02 mole of hydrogen chloride during a four-hour heating period in a U-tube carefully cleaned with nitric and hydrochloric acids followed by water, acetone, and alcohol and then dried in an oven at 110°.

The same lot of technical DDT was then recrystallized twice from alcohol. The alcoholic solution was filtered hot during the first recrystallization. The product was air-dried and was handled with stainless steel spatulas. Although the melting point of this material was 108–109°, it lost 0.45 mole of hydrogen chloride when heated as above.

A sample of this twice-recrystallized DDT was then dissolved in ether and shaken repeatedly with saturated sodium bicarbonate solution and then with water. The ether was distilled and the residue was dissolved in hot alcohol, the solution filtered hot and the crystals which separated on cooling were collected on a Buchner funnel with the aid of a nickel spatula and then dried in vacuum at room temperature. This material melted at 108–109° and lost no hydrogen chloride when heated as above at 115–120° for four hours.

These experiments are viewed as indicating how readily small traces of catalytic material may be picked up by air-drying and by handling with iron or stainless-steel equipment, and how this may lead to the assumption that DDT is not so stable in the pure form as in the crude state. While it is probable that catalytic materials may exist in the technical grade, other impurities such as polymers of chloral and 2-trichloro-1-*p*-chlorophenylethanol (I) inhibit their action to a certain extent. When these inhibitors are removed without taking safeguards against removal of catalytic substances, an apparent instability of DDT is produced.

Thus when 1 part of pure DDT and 2 parts of I were heated together as above for one hour, no hydrogen chloride was evolved. The addition of 0.01% of anhydrous ferric chloride caused the evolution of 0.8 mole of hydrogen chloride during a one-hour heating period, while the heating of I alone with anhydrous ferric chloride produced 0.6 mole. This amount of catalyst completely eliminated 1 mole of hydrogen chloride from pure DDT alone during the course of fifteen minutes heating.

In connection with the study of the catalytic elimination of hydrogen chloride from DDT, several of the isomers and related compounds were tested by the procedure described above. Thus 1,1-dichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)-ethylene, m. p. 77–78°, and 1,1-dichloro-2,2-bis-(*p*-bromophenyl)-ethylene, m. p. 123–124°, were prepared by heating the corresponding trichloroethane derivative with 0.01% of anhydrous ferric chloride as outlined above. The melting points of these compounds were not lowered when mixed with authentic material prepared by hydrolysis of the corresponding trichloroethanes with alcoholic caustic.^{4,5}

Under similar conditions, anhydrous ferric chloride eliminated 0.95 mole of hydrogen chloride from 1-trichloro-2-(*p*-chlorophenyl)-2-(*m*-chlorophenyl)-ethane. The residue remained an oil, which did not crystallize.⁴

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
BELTSVILLE, MD. RECEIVED NOVEMBER 9, 1945

(3) Fleck and Preston, *Soap and Sanit. Chemicals*, [5] 21, 111 (1945).

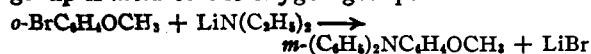
(4) Haller, Bartlett, Drake, Newman, Cristol, Baker, Hayes, Kilmer, Magerlein, Müller, Schneider and Wheatley, *THIS JOURNAL*, 67, 1591 (1945).

(5) Zeidler, *Ber.*, 7, 1181 (1874).

Rearrangement in the Condensation of *o*-Bromodimethylaniline with Lithium Diethylamide

BY HENRY GILMAN, ROBERT H. KYLE AND ROBERT A. BENKESER

It was reported recently¹ that lithium dialkylamides underwent reaction, in ether solution, with halogen *ortho* to an ether linkage to give a rearrangement product in which the dialkylamino group is *meta* to the oxygen group.



This type of rearrangement appears to be rather broad in scope, for we have observed that it takes place with *o*-bromodimethylaniline.



An authentic specimen of the *m*-*N,N*-dimethyl-*N',N'*-diethylphenylenediamine was prepared in very satisfactory yield by the following reactions which appear to be of general applicability for the complete alkylation of amines under relatively mild conditions.



In view of the marked similarity in rearrangement reactions of lithium dialkylamides in ether and alkali amides in liquid ammonia,^{1,2} it appears reasonable to expect some rearrangement of *o*-halodialkylamines to *m*-aminodialkylamines by reaction with alkali amides in liquid ammonia.

Experimental

***o*-Bromodimethylaniline and Lithium Diethylamide.**—The lithium diethylamide was prepared by the slow addition in a nitrogen atmosphere of 0.17 mole of methyl-lithium in 64 cc. ether to 0.2 mole of diethylamine in 150 cc. of ether. To the pale, creamy colored mixture which gave a negative color test I,³ was added 0.17 mole of *o*-bromodimethylaniline and the mixture soon assumed a reddish color. After stirring and refluxing for twenty-four hours, the deep red colored mixture was hydrolyzed by water. Fractional distillation of the dried ether extracts gave 7.3 g. (22%) of recovered *o*-bromodimethylaniline and 2.5 g. distilling at 95–100° (0.5 mm.) and 6.8 g. distilling at 100–102° (0.5 mm.). The last two cuts correspond to a crude yield of 28.5% or, allowing for the recovered *o*-bromodimethylaniline, 37%.

A monopicate prepared from the third fraction and less than one equivalent of picric acid, was orange-red in color and melted at 124.5–125.5° after crystallization from 95% ethanol.

Anal. Calcd. for C₁₂H₂₂O₇N₂: N, 16.66. Found: N, 16.0, 15.7, 16.0.

The dipicrate prepared from the third fraction and slightly more than two equivalents of picric acid crystallized from 95% ethanol as yellow prisms melting at 146–147°.

Anal. Calcd. for C₂₄H₂₆N₆O₁₄: N, 17.2. Found: N, 17.1 and 16.95.

(1) Gilman, Crounse, Massie, Benkeser and Spatz, *THIS JOURNAL*, 67, 2106 (1945). See also Bergstrom and Fernelius, *Chem. Rev.*, 20, 437 (1937), and Horning and Bergstrom, *THIS JOURNAL*, 67, 2110 (1945).

(2) Gilman and Avakian, *ibid.*, 67, 249 (1945). Gilman and Nobis *ibid.*, 67, 1479 (1945).

(3) Gilman and Schulze, *ibid.*, 47, 2002 (1945).

The dipicrate (m. p., 146–147°) showed no depression of m. p. in a mixed m. p. determination with the dipicrate of *m*-N,N-dimethyl-N',N'-diethylphenylenediamine prepared by the ethylation of *m*-N,N-dimethylaminoaniline.

The orange-red plates of the mono-picric acid when treated in 95% ethanol with additional picric acid gave the yellow prisms of the dipicrate (m. p., 145–146°).

In a check experiment the crude initial yield of *m*-N,N-dimethyl-N',N'-diethylphenylenediamine was 24%; b. p., 102–104° (0.3 mm.), n_D^{20} 1.5632; d_4^{20} 0.982; *MR* calcd., 63.55; found, 63.7. The picrates of this compound melted at the same points as the picrates prepared from the other experiment.

Ethylation of *m*-N,N-Dimethylaminoaniline.—To a solution of 5 g. (0.037 mole) of *m*-dimethylaminoaniline in 15 cc. of ether was added in an atmosphere of dry nitrogen, 0.04 mole of methyl lithium in 25 cc. of ether. After stirring and refluxing for sixteen hours, 6.25 g. (0.04 mole) of ethyl iodide in 10 cc. of ether was added over a fifteen-minute period, and the mixture was then refluxed for one hour. Then 0.05 mole of methyl lithium in 30 cc. of ether was added over a period of twenty minutes. The mixture was refluxed for twenty minutes and a heavy tan precipitate formed. Then in succession, by related procedures, there was added 7.8 g. (0.05 mole) of ethyl iodide in 15 cc. of ether; 0.02 mole of methyl lithium in 12 cc. of ether; and 3.1 g. (0.02 mole) of ethyl iodide in 15 cc. of ether. Subsequent to hydrolysis by water, and drying of the ether extracts, there was obtained 5 g. (71%) of *m*-N,N-dimethyl-N',N'-diethylphenylenediamine.

The authors are grateful to Dr. J. B. Dickey for some *m*-nitrodimethylaniline, and they wish to acknowledge the help of Dr. L. A. Woods for the dialkylation procedure using methyl lithium and an organic halide.

DEPARTMENT OF CHEMISTRY
IOWA STATE COLLEGE
AMES, IOWA

RECEIVED SEPTEMBER 29, 1945

The Synthesis of *dl*-Methionine

BY DALE GOLDSMITH AND MAX TISHLER

Recently, Albertson and Tullar reported a synthesis of *dl*-methionine from acetamidocyanooacetic ester and 2-methylmercaptoethyl chloride.¹ We should like to record a similar synthesis of *dl*-methionine consisting of alkylating diethyl acetamidomalonate with the 2-methylmercaptoethyl chloride and of subjecting the resulting compound to hydrolysis and decarboxylation. Our synthesis is an extension of the newly developed route to the α -amino acids from diethyl acetamidomalonate ester.² The direct yield of pure *dl*-methionine from the above mentioned reagents is 60% using *t*-butyl alcohol as the solvent for the alkylation step and omitting the isolation of the intermediate diethyl acetamido-(2-methylmercaptoethyl)-malonate. Alkylation in absolute ethanol is almost as satisfactory so far as the yield (56% over-all) is concerned, but the purification of the crude methionine is more difficult. Alkylation in isopropyl alcohol is definitely less satisfactory, and alkylation in either dioxane or xylene leads to poor yields and tarry by-products.

(1) Albertson and Tullar, *THIS JOURNAL*, **67**, 502 (1945).

(2) Albertson and Archer, *ibid.*, **67**, 308 (1945); Snyder, Shekleton and Lewis, *ibid.*, **67**, 310 (1945).

Experimental

Diethyl Acetamido-(2-methylmercaptoethyl)-malonate.—To 1200 cc. of freshly distilled *t*-butyl alcohol was added 14.8 g. of sodium strips and the mixture, protected from air, was refluxed and stirred until the sodium was entirely dissolved. Diethyl acetamidomalonate, 130 g., was added to the warm stirred solution in a few minutes time followed by 82 g. of 2-methylmercaptoethyl chloride. The mixture was stirred and boiled under reflux for six hours, at which time it was neutral to litmus. The completed reaction mixture was concentrated to dryness under reduced pressure and the residue was extracted well with absolute ethanol. The combined extracts and washings were distilled to dryness under reduced pressure and the crude residue (171 g.) was ready for hydrolysis and decarboxylation to *dl*-methionine.

The condensation product can be isolated in a pure form by recrystallizing the residue from a mixture of ether and petroleum ether. After recrystallization, the product melts at 50–52°.

Anal. Calcd. for $C_{12}H_{21}O_6NS$: C, 49.47; H, 7.27; N, 4.81. Found: C, 49.51; H, 7.31; N, 4.66.

***dl*-Methionine.**—A mixture of the crude diethyl acetamido-(2-methylmercaptoethyl)-malonate (above residue), 478 cc. of water and 122 cc. of concentrated hydrochloric acid was boiled under reflux for six hours during which time the ester dissolved. At this time an additional quantity of dilute hydrochloric acid (478 cc. of water and 122 cc. of conc. hydrochloric acid) was added and the mixture was boiled three hours longer. The mixture was concentrated to dryness under reduced pressure; about 150 cc. water was added to the residue and the concentration was repeated. The residue was dissolved in about 800 cc. of absolute ethanol and clarified with a small amount of charcoal. To the resulting solution was added 125 cc. of pyridine and after twenty-four hours storage at 5° the product was collected; wt. 59.3 g. (66.4% yield).

The crude product was purified by dissolving in 450 cc. of water, clarifying the solution with charcoal, concentrating the filtrate to 350 cc. and allowing the resulting solution to crystallize. After four hours an equal volume of ethanol was added and the mixture was stored at 0–5° for twelve hours. The weight of pure *dl*-methionine was 54.1 g.; yield 60.5%.

Anal. Calcd. for $C_6H_{11}NO_2S$: N, 9.39. Found: N, 9.46.

When the *t*-butyl alcohol in the alkylation step was replaced by 280 cc. of absolute ethanol, the yield of crude *dl*-methionine was 63% and of pure product 56%.

RESEARCH LABORATORIES
MERCCK AND Co., INC.
RAHWAY, N. J.

RECEIVED OCTOBER 23, 1945

The Quantum Yield in the Photo-reaction between Methyl Iodide and Nitric Oxide

BY T. IREDALE AND E. R. MCCARTNEY

Because of its continuous absorption spectrum, and because the products of its photodecomposition are mainly iodine, methane, with small amounts of other hydrocarbons, methyl iodide is presumed to dissociate by light absorption in the near ultraviolet into $CH_3 + I$. The quantum yield is very low because of the high probabilities of the reverse reactions $CH_3 + I = CH_3I$ and $CH_3 + I_2 = CH_3I + I$. These matters are fully discussed in recent textbooks and papers.^{1,2,3,4}

(1) Noyes and Leighton, "Photochemistry of Gases," p. 334.

(2) Spence and Wild, *Proc. Leeds Phil. Lit. Soc. Sci.*, **3**, 141 (1936).

(3) Iredale and Stephan, *Trans. Faraday Soc.*, **33**, 800 (1937).

(4) Iredale, *ibid.*, **35**, 458 (1939).

In the last communication⁴ was described how the quantum yield may be increased by the addition of NO to the photodecomposing CH₃I, the NO reacting with the CH₃ radical and so preventing the reverse reactions. The quantum yield (1.6) was obtained by comparing the velocity of photodecomposition with that of the photo-oxidation of CH₃I studied by Bates and Spence,⁵ where they obtained a quantum yield of about two. With nitric oxide a kinetic equation was obtained which seemed to account for the results pretty well, except that the quantum yield, 1.6, was too large, and should actually have been about unity. This discrepancy was too great to be accounted for by experimental errors. Blaedel, Ogg and Leighton⁶ have recently considered these discrepancies, and have indicated that the quantum yield of Bates and Spence should be 1.0 instead of 2.3, when account is taken of the temperature coefficient of the chloroacetic acid actinometer which Bates and Spence used.

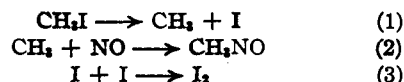
The present writers have now carried out a more direct measurement of the quantum yield of the process CH₃I + NO + hν = I + CH₃NO.

Apparatus and Procedure.—The photochemical set-up was similar to that previously described.⁴ The reaction cell was of clear quartz, about 4 cm. in diameter, and 7 cm. long, and connected to the rest of the glass apparatus by a quartz-glass seal. The nearest greased tap was 80 cm. from the cell. The source of radiation was a Hanovia mercury arc (medium pressure). Great difficulty was experienced in getting sufficient intensity of the 2537 Å. resonance radiation, even with the cooled arc. Filters were used to isolate the whole region 2500–2700 Å.,⁷ which gave more readable results. This, however, involved the use of an *average* or *weighted mean* quantum, which we obtained by using the radiation in the uranyl oxalate actinometer described by Leighton and Forbes⁸; the quantum yield of the decomposition being 0.6 in this region. The Moll large surface thermopile which was used in conjunction with a Moll galvanometer, was calibrated with the aid of a Hefner lamp as previously

described.⁹ One centimeter deflection on the galvanometer scale corresponded to 1.014 × 10⁻⁶ cal./sec. The diameter of the light beam was adjusted so that the whole area of it (π sq. cm.) fell on the thermopile elements. Corrections were applied for the non-uniformity of the beam, and for reflection at the rear window of the photo-cell.

Results and Discussion.—The results are shown in Table I.

When the pressure of the NO is > 50 mm., the quantum yield reaches a value ~ 1. The variations (0.9 → 1.2) are some indication of the order of accuracy of the experimental results.¹⁰ They permit, however, of the earlier interpretation of the photo-reaction being adopted, namely



Only when the NO pressure is low, do the back reactions CH₃ + I₂ = CH₃I + I and CH₃ + I = CH₃I begin to lower the quantum yield. Blaedel, Ogg and Leighton⁶ consider that the second of these reactions (recombination) is negligible compared with the first. The present measurements, of course, give no indication of this, but West¹¹ has shown that addition of carbon dioxide raises the quantum yield of the photodecomposition of methyl iodide presumably because of the more ready recombination of iodine atoms by three body collisions with the carbon dioxide and also, perhaps, the more ready recombination of methyl radicals to give ethane. This matter has, as yet, not been explored very fully. The iodine formed was frozen out, and titrated with approx. 0.005 N sodium thiosulfate. The other product of the reaction CH₃NO, or its decomposition product, was not identifiable.

No reaction occurred between methyl iodide and nitric oxide at room temperature in the dark.

(9) Gibson and Iredale, *Trans. Farad. Soc.*, **32**, 571 (1936).

(10) The re-adjusted value (0.8) of the previous quantum yield (1.6) obtained⁴ by comparison with Bates and Spence's results,⁵ points to a rather inaccurate extrapolation.

(11) West and Schlessinger, *THIS JOURNAL*, **60**, 961 (1938).

PHYSICAL CHEMISTRY LABORATORIES

UNIVERSITY OF SYDNEY

SYDNEY, AUSTRALIA

RECEIVED FEBRUARY 27, 1945

TABLE I

Temperature, 15–20° C. Mean galvanometer deflections corresponding to absorbed light: ~ 0.2–0.6 cm. Thiosulfate titrations: ~ 0.2–2 cc.

CH ₃ I	Pressure, mm.		Time of irradiation, min.	Quantum yield
	CH ₃ I	NO		
78.5	20.5		1158	0.5
105.0	52.0		1367	0.84
109	85.0		931	1.2
119	87		3324	0.91
122	90		1101	1.1
102	95		4184	1.14
122	100		948	1.2
101	154		917	0.9

(5) Bates and Spence, *Trans. Faraday Soc.*, **27**, 468 (1931).

(6) Blaedel, Ogg and Leighton, *THIS JOURNAL*, **64**, 2500 (1942).

(7) Bowen, *J. Chem. Soc.*, 76 (1935).

(8) Leighton and Forbes, *THIS JOURNAL*, **52**, 3139 (1930).

A Dimorphic Form of *d*-Catechin

BY O. KELLER AND L. BERGER

Extraction of *water washed* gum gambir with acetone (one part) and ether (nine parts) according to Freudenberg,¹ or with acetone (ten parts), yields *d*-catechin, m. p. 174.5–175.5° cor.; [α]_D²⁵ +16.3°; [α]_D²⁶ +15.3°; C = 5% in 50% acetone in agreement with Freudenberg and Purmann² who report m. p. 174–175°; [α]_D²⁷ +17.1°; C = 9% in 50% acetone for *d*-catechin.

We now find that extraction of *unwashed* gum

(1) Freudenberg, *Ber.*, **84**, 1204 (1921).

(2) Freudenberg and Purmann, *Ann.*, **437**, 277 (1924).

gambir by either of the above methods or by the original method of Perkin and Yoshitake³ using hot ethyl acetate gives a catechin of m. p. 210–213° cor.; $[\alpha]_D^{25} +14.7^\circ$; $C = 5\%$ in 50% acetone. The tetramethyl ether and the pentaacetyl ester of this high-melting catechin, however, correspond exactly with those reported by Freudenberg and Purmann prepared from *d*-catechin, m. p. 174–175°.² The rotation and the properties of the derivatives indicate that the catechin thus obtained is chiefly *d*-catechin. Its high melting point indicates that it is either a dimorphic form of *d*-catechin or a mixture of *d*-catechin with small amounts of *dl*-catechin (m. p. 212–214°) or *dl*-epicatechin (m. p. 224–226°). Perkin and Yoshitake³ obtained a so-called "acacatechin" from acacia or Bengal catechin which melted at 204–205°, and which on careful fractional crystallization by Freudenberg and Purmann proved to consist chiefly of *l* and *dl*-catechin with small amounts of *l* and *dl*-epicatechin. However, recrystallization of the high melting catechin from *ten* to *twelve* volumes of hot water gives, in almost quantitative yield, the low melting *d*-catechin, m. p. 174–175°, indicating that it is a dimorphic form.

Freudenberg notes that *d*-catechin crystallizes with four molecules of water and melts at 93–95°. The anhydrous product melts at 174–175°. We have found that many samples of *d*-catechin melting at 174–175° and also 210–213° contain water of crystallization (0.1 to 1 mole) depending upon the method of crystallization and the duration and type of drying.

(3) Perkin and Yoshitake, *J. Chem. Soc.*, **81**, 1162 (1902).

RESEARCH LABORATORIES
HOFFMANN-LA ROCHE INC.
NUTLEY, N. J.

RECEIVED OCTOBER 23, 1945

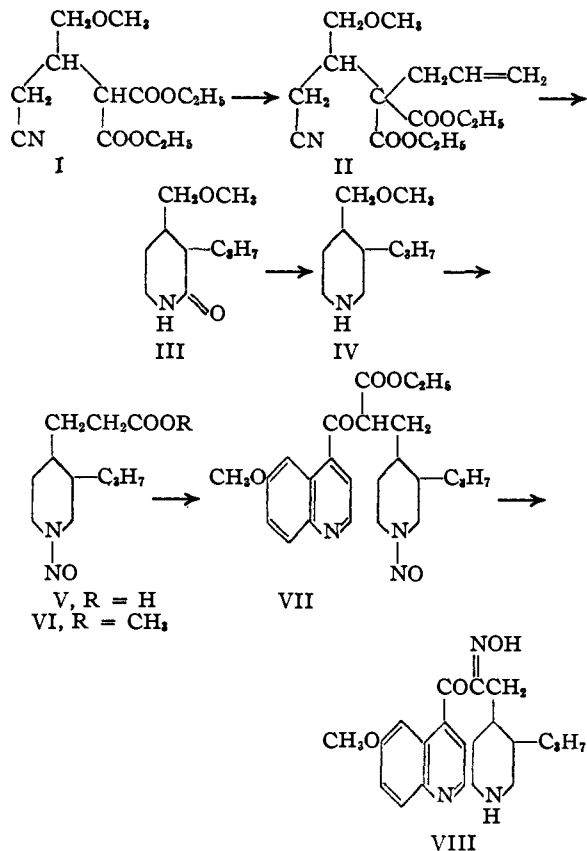
6'-Methoxy-8-oximino-3-propylrubatoxanone

By C. F. KOELSCH

The experiments described in the present paper were carried out as models for part of a projected synthesis of quinine. Key substances in the series of reactions used¹ are formulated in the accompanying chart. It is indicated that condensation of VI with ethyl quinate yielded VII, but this compound could not be purified. When the condensation product was boiled with hydrochloric acid, it was converted into a crystalline substance which appears to be the dihydrochloride of VIII, a compound whose reduction should yield interesting results. The research, however, was interrupted in 1942, before the reduction could be studied, and in view of the recent synthesis of quinine in another laboratory,² no further work on the subject is contemplated.

(1) Cf., Koelsch, *THIS JOURNAL*, **65**, 2458, 2460 (1943); **66**, 1611 (1944).

(2) Woodward and Doering, *ibid.*, **66**, 849 (1944); **67**, 860 (1945).



Experimental

4,4-Dicarbethoxy-3-methoxymethyl- Δ^4 -heptenonitrile (II).—To a solution of 46 g. of sodium in 550 ml. of dry alcohol were added 320 g. of ethyl malonate and 190 g. of γ -methoxycrotononitrile. The mixture was heated under reflux for ninety minutes, then treated with 25 g. of sodium iodide (dried at 300°) and 160 g. of allyl chloride. Heating was continued for an additional ninety minutes,³ then most of the alcohol was removed, and water and ether were added. Fractional distillation gave 407 g. (70%), b. p. 192–195° at 19 mm.

Anal. Calcd. for C₁₄H₂₃NO₅: C, 60.6; H, 7.7. Found: C, 60.7; H, 7.8.

4-Methoxymethyl-3-propylpiperidone-2 (III).—When a solution of 420 g. of II in 100 ml. of alcohol was reduced with hydrogen at 2200 lb. and 150° using Raney nickel, the calculated amount of hydrogen was absorbed in three and one-half hours. The sirupy product, freed of alcohol, was boiled and stirred for twenty hours with 180 g. of potassium hydroxide in 3500 ml. of water, and the unsaponified part (65 g.) was then removed with ether. The aqueous solution was distilled to about 750 ml., acidified strongly with sulfuric acid, filtered from potassium sulfate, and extracted with five 100-ml. portions of ether. The product, a thick sirup (188 g.) was heated at 185°, giving 158 g. of crude lactam; an additional 22 g. was obtained by distilling the extracted aqueous solution to dryness, combining the residue with the potassium sulfate, and extracting the whole with alcohol. Several fractionations of the crude lactam gave 95 g., b. p. 175–180° at 6 mm.

(3) Orienting experiments indicated that the alkylation was nearly complete after seventy minutes of boiling. When allyl chloride was used without sodium iodide, the alkylation required eight hours. When allyl bromide was used, the reaction mixture required external cooling, and the reaction was complete after less than fifteen minutes. Approximately the same yield of alkylation product was obtained in each of these experiments.

This contained III, as shown by its behavior on reduction, but it gave poor analytical figures for this substance.

Anal. Calcd. for $C_{10}H_{19}NO_2$: C, 64.8; H, 10.3. Found: C, 60.6; H, 9.3.

4-Methoxymethyl-3-propylpiperidine (IV).—The reduction of 100 g. of III with 100 g. of sodium in one liter of dry butyl alcohol gave 43 g. of basic material and 37 g. of neutral material. The latter, a viscous oil with a lard-like odor, represented the impurities in the III used, and gave no definite fraction on distillation, b. p. 140–220° at 8 mm. Distillation of the basic material gave 23 g. of crude piperidine, b. p. 120–135° at 27 mm. This was further purified and possibly separated from a stereoisomer by crystallization of its picrate, yellow needles, m. p. 112–116°, from benzene. After it had been regenerated from the picrate, IV formed a colorless hygroscopic oil (12.6 g.) b. p. 118–122° at 26 mm. It was analyzed as its picrolonate, yellow needles from benzene, m. p. 184–185°.

Anal. Calcd. for $C_{16}H_{21}NO + C_{10}H_8N_4O_6$: C, 55.2; H, 6.7. Found: C, 55.2; H, 6.4.

A solution of 12.5 g. of IV in 125 g. of 51% hydrobromic acid was boiled for six hours. The excess hydrobromic acid was then removed at 100° under reduced pressure, leaving 22 g. of 4-bromomethyl-3-propylpiperidine hydrobromide, a pale brown sirup.

Anal. Calcd. for $C_9H_{19}Br_2N$: Br, 53.2. Found: Br, 53.2.

When a portion of the hydrobromide was steam distilled from excess dilute sodium hydroxide, it yielded 3-propyl-1-azabicyclo[2,2,1]heptane, an oil with a sweet fishy odor; the picrate formed bright yellow prisms from dilute alcohol, m. p. 129–130°.

Anal. Calcd. for $C_{10}H_{17}N + C_9H_8N_2O_7$: C, 49.0; H, 5.5. Found: C, 49.2; H, 5.6.

The picrolonate formed pale yellow-brown prisms from alcohol, m. p. 204–205°.

Anal. Calcd. for $C_9H_{17}N + C_{10}H_8N_4O_6$: C, 56.6; H, 6.2. Found: C, 57.4; H, 6.6.

1-Nitroso-3-propylpiperidine-4-propionic Acid (V).—A solution of 21.5 g. of 4-bromomethyl-3-propylpiperidine hydrobromide in 25 ml. of water containing a few drops of hydrobromic acid was treated with 6 g. of sodium nitrite, warmed to 70°, and then cooled. The oily nitroso compound was taken up in ether, washed with dilute sodium carbonate, and dried by heating at 100° and 20 mm.; yield 16.6 g. This crude product was added to a solution of 1.6 g. of sodium and 12 g. of ethyl malonate in 20 ml. of alcohol, and the mixture was boiled for one hour. The product (22.2 g.) was boiled for one hour with 7.5 g. of sodium hydroxide in 50 ml. of water, unsaponified material (6.5 g.) was removed with ether, and the solution was acidified and extracted with ether. The resulting 1-nitroso-3-propyl-4-piperidylmethylmalonic acid was a yellow glass (11.8 g.) that could not be obtained crystalline even after it had been purified through its calcium salt, difficultly soluble colorless crystals from water.

Anal. Calcd. for $C_{12}H_{18}N_2O_6Ca + 1.5 H_2O$: Ca, 11.9; H_2O , 8.0. Found: Ca, 11.6; H_2O , 8.0.

When 9.7 g. of the malonic acid was heated at 150° until frothing stopped, and then cooled, there was obtained 7.9 g. of crystalline V. The product separated from dilute acetic acid in the form of colorless plates, m. p. 106°.

Anal. Calcd. for $C_{11}H_{20}N_2O_5$: C, 57.9; H, 8.8. Found: C, 58.2; H, 9.0.

A solution of 1 g. of V in 3 ml. of concentrated hydrochloric acid was treated with 0.75 g. of cuprous chloride, and after no more nitric oxide was evolved, the mixture was distilled to dryness under reduced pressure and then dissolved in water. Copper was removed with hydrogen sulfide, hydrochloric acid with excess silver oxide, and the resulting easily soluble silver salt was freed of silver with hydrogen sulfide. This gave 3-propylpiperidine-4-propionic acid, colorless crystals from a mixture of alcohol and ether that were easily soluble in water; it became brown

and sintered at 244° and melted with effervescence at 247°.

Anal. Calcd. for $C_{11}H_{20}NO_2$: C, 66.3; H, 10.5. Found: C, 66.5; H, 10.1.

Methyl 1-nitroso-3-propylpiperidine-4-propionate (VI), b. p. 195–197° at 7 mm., was a yellow oil with a furfural-like odor. It was obtained in quantitative yield by the action of diazomethane on the acid, and when a portion of the distilled ester was saponified, it gave back the parent acid.

Anal. Calcd. for $C_{12}H_{22}N_2O_5$: C, 59.9; H, 9.3. Found: C, 59.5; H, 9.1.

Condensation with Ethyl Quininate.—To a suspension of sodium ethoxide from 1 g. of powdered sodium in 25 ml. of ether was added 5.6 g. of ethyl quininate⁴ and 5.5 g. of VI. The mixture was heated at 40° in a closed vessel for twenty-four hours, and then allowed to stand at room temperature for two days. It was extracted with dilute sodium hydroxide and then with dilute hydrochloric acid. The material left in the ether was VI (1.9 g.); that removed by hydrochloric acid was ethyl quininate (0.8 g.). The sodium hydroxide extract was acidified with hydrochloric acid, then made slightly basic with sodium carbonate, quininic acid (3.5 g.) dissolving. The pale brown oil (VII, 3.6 g.) remaining gave a deep red color with alcoholic ferric chloride, but no crystalline salt could be obtained from it. It was boiled for one hour with 5 ml. of hydrochloric acid in 10 ml. of water (carbon dioxide evolution), the solution was cooled, and the crystalline product was removed and washed with dilute hydrochloric acid. Precipitated from 95% alcohol with ether, the resulting dihydrochloride of VIII formed bulky fine white needles that changed on standing under the mother liquor for one hour into dense pale yellow micro needles (1.25 g.). The salt decomposed above 245°; it gave neither a ferric chloride reaction nor a Liebermann test.⁴

Anal. Calcd. for $C_{21}H_{27}N_3O_3 + 2HCl$: C, 57.0; H, 6.5; N, 9.5. Found: C, 57.3; H, 6.3; N, 10.1.

A solution of 0.75 g. of the dihydrochloride in water was brought to pH 8.5 with sodium carbonate. The resulting white precipitate, apparently a carbonate, was nearly insoluble in water but easily soluble in dilute sodium hydroxide. It was removed and dissolved in 8 ml. of hot 3% acetic acid. Cooling this solution gave the monoacetate of VIII, which after recrystallization from water formed white needles (0.6 g.) that darkened slightly at 185°, sintered at 195° and melted with blackening and gas evolution at 198°.

Anal. Calcd. for $C_{21}H_{27}N_3O_3 + C_2H_4O_2$: C, 64.4; H, 7.2. Found: C, 64.5; H, 7.2.

The author thanks Dr. S. T. Rolfson for several of the analyses reported in this paper.

SCHOOL OF CHEMISTRY
UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MINNESOTA

RECEIVED SEPTEMBER 17, 1945

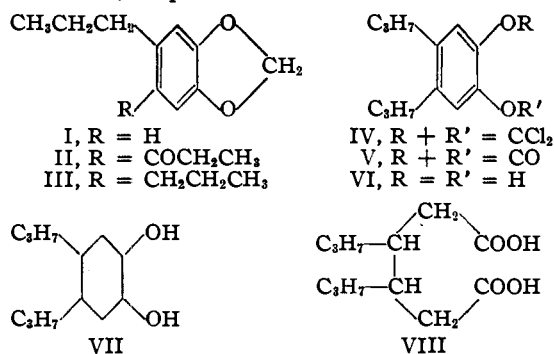
(4) 2-Chloroquininic acid, prepared by the method of Thielepage and Fulde [*Ber.*, **72**, 1432 (1939)], was converted into quininic acid nearly quantitatively when its solution in aqueous sodium hydroxide was shaken with Raney nickel and hydrogen at 35 lb. and 25° for twenty-four hours. The ester was obtained in 86% yield using alcohol and sulfuric acid [*cf.* Cohen and King, *Proc. Roy. Soc. (London)*, **B128**, 49 (1938)].

(5) The general properties of VIII were very similar to those described for 6-methoxy-8-oximino-3-vinylrubatoxonone [v. Miller, Rohde and Fussenegger, *Ber.*, **33**, 3234 (1900); Rohde and Schwab, *ibid.*, **38**, 315 (1905)] except that the latter substance was reported to give a Liebermann test. Several other α -diketone monoximes investigated by the present author have been found to give no Liebermann test, and a negative test has been reported in a similar instance by Harries and Groschuff [*Ann.*, **417**, 185 (1918)]. It therefore appears that the positive test obtained by Rohde and co-workers may have been caused by the presence of a small amount of N-nitroso compound in the substance they were investigating.

A Synthesis of β,β' -Dipropyladipic Acid

By C. F. KOELSCH

Part of the program referred to in the preceding note¹ was to establish the configuration of a synthetic homolog of hydroquinine by relating the substance to a 3,4-dipropylpiperidine. The synthesis of the latter compound and the determination of its configuration were to follow a route similar to the one used for 3,4-diethylpiperidine.² The program has been abandoned short of completion, but some of the reactions studied are of general interest and are being published. Those described in the present paper, indicated in the sequence of formulas (I–VIII), outline a synthesis of β,β' -dipropyladipic acid by a method which may prove of value for preparing other, similarly substituted, adipic acids.



Experimental

Dihydrosafrole (I), b. p. 114° at 19 mm., was obtained in quantitative yield of shaking *iso*-safrole (400 g.) with Raney nickel and hydrogen at 100 atm. for five minutes. The hydrogenation was slightly exothermic, but it stopped when one equivalent of hydrogen had been taken up.

1,2-Methylenedioxy-4-propionyl-5-propylbenzene (II).—The action of propionic acid, propionic anhydride or propionyl chloride on dihydrosafrole alone or in the presence of sulfuric acid, zinc chloride, aluminum chloride or stannic chloride under varied conditions gave none or only traces of the desired compound. The procedure finally used was developed through many experiments, and its details must be rather carefully adhered to.

A mixture of 164 g. of dihydrosafrole, 100 g. of propionyl chloride, 50 ml. of phosphorus oxychloride and 100 ml. of toluene was boiled for fifty to fifty-five minutes, then poured into water and stirred until all of the acid chlorides were decomposed. The organic layer was washed with dilute sodium hydroxide and distilled at 26 mm., giving 92 g., b. p. 80–155°; 79 g., b. p. 155–205°; and 14 g. of residue. The lower fraction was mainly dihydrosafrole and could be used as such in a later propylation. Three hundred and six grams of the fraction b. p. 155–205°, from several acylations, was dissolved in 300 ml. of ligroin (30–60°) and cooled to –10°. The resulting crystals were pressed well and washed with cold ligroin, giving 160 g. of nearly pure II. A portion redistilled (b. p. 184–186° at 24 mm.) and recrystallized from ligroin, formed thick colorless plates, m. p. 51–52°.

Anal. Calcd. for C₁₃H₁₆O₃: C, 70.9; H, 7.3. Found: C, 71.2; H, 7.3.

The oily chlorinated material remaining in the mother liquor, 124 g., b. p. 140–200° at 24 mm., was not investigated.

A mixture of 2.2 g. of II, 5 ml. of alcohol, 1.4 g. of butyl nitrite and 0.5 ml. of hydrochloric acid was allowed to stand for twenty-four hours, and then poured into ether and water. Dilute sodium hydroxide removed 1,2-methylenedioxy-4-(α -oximinopropionyl)-5-propylbenzene (1.9 g.), pale yellow needles from ether–ligroin, m. p. 99–101°.

Anal. Calcd. for C₁₃H₁₆NO₄: C, 63.7; H, 6.1. Found: C, 63.2; H, 6.5.

When 0.7 g. of the oximino compound was stirred for fifteen minutes with a mixture of 5 ml. of hydrochloric acid, 5 ml. of acetic acid and 0.4 ml. of formalin, it yielded the corresponding diketone, a bright yellow oil. With excess hydrogen peroxide and alcoholic sodium hydroxide this gave *o*-propylpiperonylic acid, colorless flat needles (0.1 g.) from 30% acetic acid, m. p. 139–141°. The same acid was obtained directly from the oximino compound in poor yield with alkaline permanganate, and in 30% yield with hot acetic anhydride.

Anal. Calcd. for C₁₁H₁₂O₄: C, 63.5; H, 5.8. Found: C, 63.7; H, 5.8.

***o*-Propylpiperonylamide**, from the acid with thionyl chloride and then ammonia, formed fine white needles from benzene, m. p. 179°.

Anal. Calcd. for C₁₁H₁₃NO₃: C, 63.8; H, 6.3. Found: C, 63.7; H, 6.1.

1,2-Methylenedioxy-4,5-dipropylbenzene (III), a colorless almost odorless oil, b. p. 158–160° at 23 mm., m. p. 25°, was obtained in 75–80% yield by boiling 100 g. of II and 10 g. of resorcinol for eight hours with 240 g. of amalgamated zinc and 250 ml. of water, 750 ml. of hydrochloric acid being added in portions.

Anal. Calcd. for C₁₃H₁₈O₂: C, 75.7; H, 8.7. Found: C, 75.9; H, 8.8.

The methylenedioxy group in III was opened by the method of Fittig and Remsen.³

1,2-Dichloromethylenedioxy-4,5-dipropylbenzene (IV), colorless crystals that fume in moist air, b. p. 184–187° at 23 mm., m. p. 34–35°, was obtained in 79–84% yield by heating 88 g. of III with 190 g. of phosphorus pentachloride for one-half hour at 110–120°, and then for one hour at 150–160°. The reaction was carried out in a 500-ml. Claisen flask, phosphorus trichloride distilling as it was formed.

Anal. Calcd. for C₁₃H₁₆Cl₂O₂: Cl, 25.8. Found: Cl, 25.7.

4,5-Dipropylpyrocatechol carbonate (V), colorless plates from alcohol, m. p. 70–73°, was obtained in 99% yield when 93 g. of IV was stirred with 200 ml. of water for one hour while the mixture was cooled so that its temperature remained at 55–60°.

Anal. Calcd. for C₁₃H₁₆O₃: C, 70.9; H, 7.3. Found: C, 71.3; H, 7.3.

4,5-Dipropylpyrocatechol (VI).—A suspension of 73 g. of V in 75 ml. of alcohol was treated with 30 g. of sodium hydroxide in 200 ml. of oxygen-free water, boiled for thirty minutes under nitrogen, and then acidified with acetic acid. The product was separated using ether, washed with dilute sodium carbonate, and then distilled, giving 49 g. (76%), b. p. 184–187° at 15 mm. The substance crystallized when it was cooled, but it was too soluble to be recrystallized; m. p. ca. 43°. Its alkaline solution rapidly became green-blue, then brown when it was exposed to air. With ferric chloride, the phenol gave a deep green color, changing to purple with sodium hydroxide. It caused only slight erythema when applied to the skin.

Anal. Calcd. for C₁₂H₁₆O₂: C, 74.2; H, 9.3. Found: C, 74.0; H, 9.0.

The lead salt formed as a white gelatinous precipitate that dried to a horny mass, when a solution of VI in methanol was treated with lead acetate. Two different preparations were analyzed.

(3) Fittig and Remsen, *Ann.*, **159**, 148 (1871); cf. Pauly, *Ber.*, **40**, 3096, 3488 (1907); Barger, *J. Chem. Soc.*, **93**, 563, 2085 (1908); Delange, *Bull. soc. chim.*, [4] **3**, 509 (1908).

(1) Koelsch, *THIS JOURNAL*, **68**, 146 (1946).

(2) Koelsch and Stratton, *ibid.*, **66**, 1881 (1944).

Anal. Calcd. for $C_{12}H_{16}O_2Pb$: Pb, 51.8. Found: Pb, 50.8, 53.2.

When 3.4 g. of VI in 5 ml. of acetic acid was treated with 9 g. of bromine in 10 ml. of acetic acid, it was converted into 3,6-dibromo-4,5-dipropyl-*o*-quinone, deep red prisms (4.2 g.) from acetic acid, m. p. 144–146°.

Anal. Calcd. for $C_{12}H_{14}Br_2O_2$: C, 41.1; H, 4.0. Found: C, 41.0; H, 4.2.

The quinone gave no pure product when it was treated with aqueous sodium hydroxide or with alkaline hydrogen peroxide. When it was warmed with zinc dust in acetic acid, it was rapidly and quantitatively reduced to 3,6-dibromo-4,5-dipropylpyrocatechol, fine white needles from acetic acid, m. p. 83–84°.

Anal. Calcd. for $C_{12}H_{16}Br_2O_2$: C, 40.9; H, 4.6. Found: C, 41.0; H, 4.9.

4,5-Dipropylcyclohexanediol-1,2 (VII).—Experiments on the hydrogenation of VI with Raney nickel and hydrogen at 200 atm. and 175° were carried out before the promoting effect of alkali on similar reactions had been discovered,⁴ and the results were erratic. Even in the best experiment, involving 43 g. of VI with freshly prepared catalyst, hydrogen absorption stopped after five hours, and there was obtained a mixture (43 g.) of VI and VII, b. p. 170–183° at 14 mm. Nothing was extracted from this mixture by aqueous alkali, and it was completely extracted from ligroin by Claisen alkali. Separation of 25 g. of the mixture was effected by treatment with alcoholic lead acetate, which precipitated the VI as its lead salt, removed by centrifuging. There was obtained 13 g. of VII, a colorless viscous oil, b. p. 170–173° at 13 mm.

Anal. Calcd. for $C_{12}H_{24}O_2$: C, 72.0; H, 12.0. Found: C, 71.9; H, 11.7.

β,β' -Dipropyladipic Acid (VIII).—A solution of 6.2 g. of VII in 20 ml. of acetic acid was kept at 25–30° by cooling while 6.4 g. of chromic anhydride in 5 ml. of water and 15 ml. of acetic acid was added in small portions. The mixture was allowed to stand at room temperature for eight hours, and then distilled to a sirup under reduced pressure. This was taken up in ether, washed with dilute sulfuric acid and then with sodium carbonate, giving 1.35 g. of neutral material and 3.45 g. of crude acidic product. Crystallization of the latter from ligroin gave 3.3 g., m. p. 86–91°, and distillation of this at 15 mm. followed by crystallization from dilute acetic acid gave 2.65 g. of VIII, colorless needles, m. p. 94–95°.

Anal. Calcd. for $C_{12}H_{22}O_4$: C, 62.6; H, 9.5. Found: C, 62.3; H, 9.7.

No attempt to resolve VIII was made, but it may be noted that the formation of a *cis*-form of VII (and therefore a *meso*-form of VIII) is not certain because of the drastic conditions used for hydrogenating VI.

The author thanks Dr. S. T. Rolfson for most of the analyses reported in this paper.

(4) Ungnade and McLaren, *THIS JOURNAL*, **66**, 118 (1944); Ungnade and Nightingale, *ibid.*, **66**, 1218 (1944).

SCHOOL OF CHEMISTRY
UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MINNESOTA

RECEIVED SEPTEMBER 17, 1945

A New Synthesis of 7,8-Diaminoquinoline

BY FRED LINSKER AND RALPH L. EVANS

Although 7,8-diaminoquinoline has been prepared previously¹ by coupling diazotized aniline with 7-aminoquinoline and reduction of the resulting azo-dye, we found it advisable to look for another procedure when large amounts of the

diamine were needed. The following process was developed and it has been found to give satisfactory results.

When 7-nitroquinoline, obtained in a Skraup reaction from *m*-nitroaniline, was reduced by iron and 50% acetic acid, it gave an almost quantitative yield of 7-aminoquinoline. The latter was treated with toluenesulfonyl chloride in pyridine solution and the tosyl compound was nitrated below 70°. A nearly theoretical yield of the crude 7-tosylamino-8-nitroquinoline was obtained, and this was hydrolyzed by means of warm sulfuric acid. The resulting nitroamine was then reduced in the usual way with stannous chloride and hydrochloric acid. The yield of diaminoquinoline was 64% of the theoretical.

Experimental

7-Nitroquinoline.—Knueppel's procedure² was used. The compound melted without recrystallization at 128–130° (lit.² 130°); yield 14% (lit.² 6%).

7-Aminoquinoline.—One hundred and twenty-nine grams of 7-nitroquinoline was dissolved in 645 cc. of glacial acetic acid and 645 cc. of water was added while the solution was warmed to 60°. Maintaining the temperature at 60–70°, 103 g. of powdered iron was added in small portions to the well-stirred reaction mixture. When the reduction was complete, the mixture was cooled to room temperature and made alkaline by adding solid sodium carbonate in small portions with external cooling and stirring. After some standing, the precipitate was filtered, washed with water, and dried over calcium chloride in a desiccator. The dried powdered precipitate was extracted by refluxing with two liters of ether for two hours and repeating this process three times with fresh portions of solvent. The combined ether extracts were then dried with sodium sulfate and evaporated to dryness. Eighty-eight grams of fairly pure 7-aminoquinoline was obtained; m. p. 91–93° (lit.⁴ 93.5–94°).

7-Tosylaminoquinoline.—Thirty-five grams of 7-aminoquinoline was dissolved in 250 cc. of dry pyridine and to the cold solution 45 g. of *p*-toluene-sulfonyl chloride was slowly added. The reaction mixture was heated for thirty minutes in a boiling water-bath under a reflux condenser, then cooled and poured into two liters of water. The precipitate was allowed to settle at 0°, filtered, washed with water and dried over calcium chloride; yield 47.5 g. The compound crystallized from ethyl alcohol in colorless prisms; m. p. 184–185°.

Anal. Calcd. for $C_{14}H_{14}N_2O_2S$: C, 64.43; H, 4.70. Found: C, 64.57; H, 4.72.

7-Tosylamino-8-nitroquinoline.—Seventeen grams of 7-tosylaminoquinoline was stirred slowly into 51 g. of concentrated nitric acid and the solution was maintained at 60–70° for two hours. After cooling, the solution was poured over 340 g. of ice. The mixture was kept in the refrigerator overnight, and the precipitated nitro compound was then filtered, washed with water, and dried in a desiccator; yield 24 g. The product was recrystallized, first from ethanol and then from 65% methyl alcohol. It formed colorless needles, m. p. 180°.

Anal. Calcd. for $C_{14}H_{13}N_3O_4S$: C, 55.98; H, 3.79. Found: C, 55.93; H, 3.95.

7-Amino-8-nitroquinoline.—Twenty-four grams of crude 7-tosylamino-8-nitroquinoline was stirred in small portions into 120 cc. of concentrated sulfuric acid. The solution was heated for one hour in a boiling water-bath, cooled to room temperature, and poured onto 700 g. of ice. An excess of ammonium hydroxide was added with stirring and

(2) Knueppel, *Ber.*, **29**, 706 (1896).

(3) Kochanska and Bobranski, *ibid.*, **69**, 1807 (1936).

(4) Hamer, *J. Chem. Soc.*, 1436 (1921).

(1) Renshaw, Friedman and Gajewski, *THIS JOURNAL*, **61**, 3322 (1939).

external cooling and, after standing at 0° overnight, the precipitated base was filtered and washed with a little dilute ammonia, yield 8.3 g. Recrystallized from absolute ethyl alcohol, the compound melted at 194°.¹

7,8-Diaminoquinoline.—A solution of 45 g. of stannous chloride dihydrate in 65 cc. of concentrated hydrochloric acid was added slowly to a suspension of 7 g. of 7-amino-8-nitroquinoline in 150 cc. of 4 N hydrochloric acid. The mixture was heated on a steam-bath until all dissolved and for one hour thereafter. The solution was cooled in the refrigerator overnight, the tin double salt was then removed by filtration and washed with a little concentrated hydrochloric acid. It was dissolved in 350 cc. of N hydrochloric acid with gentle warming, and hydrogen sulfide was passed through the solution until the precipitation of the tin sulfides was complete. The precipitate was filtered and the tin-free solution was evaporated on a water bath to dryness. Five and five-tenths grams of fairly pure dihydrochloride was thus obtained. Addition of alkali to the aqueous solution of the salt precipitated the free base, which was then recrystallized from boiling water, yielding the monohydrate as light yellow needles, m. p. 94–97° (lit.¹ 95–97°).

(5) Fournau, *et al.*, *Ann. Inst. Pasteur*, **44**, 719 (1930). These authors prepared the same compound by heating 7-chloro-8-nitroquinoline with ammonia in a sealed tube to 160° and found the base to melt at 194°.

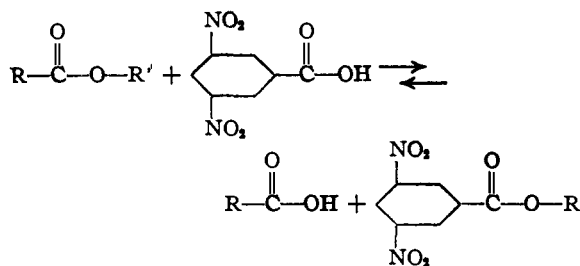
RESEARCH LABORATORY
RALPH L. EVANS ASSOCIATES
250 E. 43RD STREET
NEW YORK 17, N. Y.

RECEIVED OCTOBER 19, 1945

Identification of the Alcohol Components of Simple Esters

BY W. B. RENFROW AND ALAN CHANEY

In an attempt to devise a more satisfactory method for preparation of solid derivatives of the alcohol components of simple esters,¹ we have investigated the interchange reaction between 3,5-dinitrobenzoic acid and a number of esters.



Preliminary experiments with *n*-butyl acetate² demonstrated that a catalyst was necessary. Sulfuric acid was a good catalyst for the interchange and *p*-toluenesulfonic acid monohydrate was fairly good. The following compounds were found to have little or no catalytic action: sulfamic acid, aluminum chloride, anhydrous hydrogen chloride, acetic anhydride, 85% phosphoric acid, phosphorus pentoxide and pyridine.

With sulfuric acid as a catalyst, the 3,5-dinitrobenzoates of the alcohol components of the

(1) The usual method of identification involves saponification and isolation of the alcohol. For example, see: Shriner and Fuson, "Identification of Organic Compounds," John Wiley and Sons, New York, N. Y., 1940, p. 152.

(2) The course of the reaction was followed in preliminary experiments by isolation of unreacted 3,5-dinitrobenzoic acid.

following esters were prepared: ethyl formate, methyl acetate, ethyl acetate, *n*-propyl acetate, isopropyl acetate, *n*-butyl acetate, isobutyl acetate, *s*-butyl acetate, isoamyl acetate, ethylene glycol diacetate, β -phenylethyl acetate, ethyl monochloroacetate, ethyl trichloroacetate, methyl propionate, *n*-propyl propionate, *n*-octyl propionate, *n*-dodecyl propionate, ethyl butyrate, ethyl trimethylacetate, *n*-butyl valerate, *n*-amyl valerate, ethyl α,α -dibutylacetate, ethyl laurate, ethyl lactate, ethyl acetoacetate, diethyl carbonate, dimethyl oxalate, diethyl oxalate, diethyl malonate, diethyl adipate, dibutyl tartrate, methyl benzoate, ethyl benzoate, methyl salicylate, ethyl salicylate, ethyl benzoylacetate, diethyl phthalate and dibutyl phthalate.

Derivatives could not be obtained from the following esters: vinyl acetate, *t*-butyl acetate, cholesteryl acetate, *n*-octadecyl propionate, diglycol laurate, ethyl stearate, *n*-butyl stearate, phenyl acetate, benzyl acetate, guaiacol acetate, methyl cinnamate, ethyl cinnamate, ethyl anisate, diethyl sulfate and ethyl *p*-aminobenzoate.

The method is apparently not applicable to esters that will react readily with concentrated sulfuric acid or that have molecular weights in excess of about two-hundred-fifty.

Experimental

Sulfuric acid (2 drops) was completely dissolved in the ester (2 ml.) and 3,5-dinitrobenzoic acid (1.5 g.) added. If the boiling point of the ester was below 150°, the mixture was refluxed gently, but if the ester boiled above 150° the mixture was heated in an oil-bath (frequent stirring at first) at approximately 150°. The reaction time was usually thirty minutes, but if the 3,5-dinitrobenzoic acid failed to dissolve within fifteen minutes the mixture was heated for one hour.

The reaction product was cooled, dissolved in ether (25 ml.) and thoroughly extracted with 5% sodium carbonate solution (25 ml.). The ether solution was washed with water and the ether removed by evaporation or distillation. The product remaining (usually an oil) was dissolved in about 5 ml. of hot ethanol. Crystallization of the 3,5-dinitrobenzoates was induced by cautious addition of water, cooling and stirring. Yields of purified 3,5-dinitrobenzoates ranged from 0.2 g. in the favorable cases to 0.1 g. in the less favorable cases.

DEPARTMENT OF CHEMISTRY
OBERLIN COLLEGE
OBERLIN, OHIO

RECEIVED OCTOBER 29, 1945

p-Bromobenzyl Bromide

BY M. WEIZMANN AND S. PATAI

For experiments in the stilbene series, we needed considerable quantities of *p*-bromobenzyl bromide. Schramm's¹ claim that bromination of *p*-bromotoluene in sunlight at ordinary temperature gives the desired product in almost quantitative yield, could not be substantiated. The yield we obtained under these conditions was 14–15%, in accordance with Hantzsch and Schultze.² The other method to which reference

(1) Schramm, *Ber.*, **17**, 2922 (1884).

(2) Hantzsch and Schultze, *ibid.*, **20**, 2252 (1896).

is made in the literature³ is the bromo-methylation of bromobenzene.

A yield of 66% of a pure product is obtained when the photo-bromination is carried out under similar conditions (but with less bromine) as described for the preparation of *p*-bromobenzal bromide.⁴ One hundred and two grams (0.60 mole) *p*-bromotoluene, in a three-necked Pyrex flask, mounted with a mercury-sealed stirrer, a dropping funnel and a reflux condenser with gas-trap, is heated in an oil-bath at 120° (bath temperature) and exposed to the light of a 100-watt lamp. With constant agitation, 102 g. of bromine (0.64 mole) is added during three hours, and the stirring is continued for another thirty minutes. By this time, the evolution of hydrogen bromide has come to a standstill. The product solidifies, upon standing, to a brownish crystalline mass and is filtered by suction from the adhering oil and washed three times with 30 cc. of ethyl alcohol. The yield is 80 g. From the mother liquor, upon cooling with an ice-salt mixture, a second crystallizate (18–20 g.) is obtained. The yield is 66%; m. p. of both crops 61° sharp without further recrystallization. The product was identical with one prepared according to Schramm,¹ and gave the correct analysis. Calcd. for C₇H₆Br₂: Br, 64.0. Found: Br, 63.7.

(3) Stephen, Short and Gladding, *J. Chem. Soc.*, 117, 524 (1920).

(4) "Organic Syntheses," Vol. XVII, p. 20.

DEPARTMENT OF ORGANIC CHEMISTRY
HEBREW UNIVERSITY
JERUSALEM, PALESTINE

RECEIVED AUGUST 11, 1945

Adduct of Anthracene with *cis*-Aconitic Anhydride

BY JESSE WERNER AND PAUL NAWIASKY

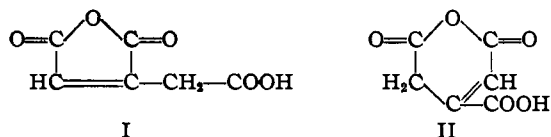
In connection with a research program being carried out in this Laboratory, it was found necessary to prepare the Diels-Alder adduct of anthracene with *cis*-aconitic anhydride. Malachowski, *et al.*,¹ have investigated the chemistry of the so-called *cis* and *trans* forms of aconitic anhydride and found decided differences in chemical behavior. The *cis* anhydride has quinonoidal properties since it adds to dimethylaniline and hydroquinone, whereas the *trans* does not.² From this and other evidence, they deduced that the two anhydrides are structural rather than geometrical isomers. The structure which they arrived at for the *cis* form is (I). That for the *trans* form is (II), with a probable equilibrium existing between the keto and enol forms. Schönberg and Ismail³ have found that the *cis* anhydride gives a red color with triphenyl phosphine, whereas the *trans* form gives no color at all, thus providing further evidence that the *cis* isomer possesses quinonoidal properties, whereas the *trans* does not. The *cis*

(1) Malachowski, Giedroyt and Jerzmanowska, *Ber.*, 61, 2525 (1928).

(2) Cf. Norton, *Chem. Rev.*, 31, 468 (1942).

(3) Schönberg and Ismail, *J. Chem. Soc.*, 1374 (1940).

structure is that of a substituted maleic anhydride. Pfeiffer and Böttler⁴ regard maleic anhydride as the quinone of furan, and as such it shows many of the reactions attributed to the quinone structure.



On refluxing with anthracene in xylene, the *cis* form was found to react very rapidly and in good yield in the Diels-Alder condensation. However, the *cis* form is rather difficult to obtain in a pure state, in contrast to the *trans* form. Since the *trans* form is slowly converted to the *cis* on melting or keeping in solution above its melting point, it was of interest to determine the relative dienophilic reactivities of the non-quinonoidal *trans* form and the quinonoidal *cis* form by refluxing the *trans* form with anthracene in xylene. The reaction in this case was quite slow, but the product obtained was identical with that from the *cis* isomer. This indicates that the mechanism involved a slow conversion of the *trans* to the *cis* form and a subsequent condensation of the *cis* isomer with anthracene.

It is of interest to note that both forms of aconitic anhydride contain the dienophilic C=C—C=O grouping. However, the dienophilic reactivities of the two are quite different, the quinonoidal nature of the *cis* form evidently enhancing its dienophilic properties.

Procedure.—Six grams of anthracene (Eastman Kodak Company) and 5.2 g. of either *cis* or *trans* aconitic anhydride (prepared according to Malachowski, *et al.*,¹ and melting at 72–73° and 135–136°, respectively) were mixed with 50 cc. of xylene. With the *cis* isomer the mixture was heated rapidly to reflux for one-half hour; with the *trans* isomer the mixture was heated to reflux during one hour and refluxed for four hours. In both cases the mixture was allowed to crystallize at room temperature overnight, after which the crystals were filtered off, washed with 100 cc. of xylene and dried on the steam-bath. The yield of pale yellow plates was 7.0 g. (63%) with the *cis* and 6.7 g. (60%) with the *trans*. Two recrystallizations from ethyl acetate gave pure white crystals, m. p. 262–263° (dec.) in each case.

Anal. Calcd. for C₂₀H₁₄O₃: C, 71.85; H, 4.22. Found: (for *cis*), C, 71.72; H, 4.28; for *trans*, C, 71.60; H, 4.37.

Mixtures of the two adducts showed no change in melting point.

(4) Pfeiffer and Böttler, *Ber.*, 51, 1819 (1918).

PROCESS DEVELOPMENT DEPARTMENT
GENERAL ANILINE WORKS DIVISION
GENERAL ANILINE & FILM CORPORATION
GRASSELLI, NEW JERSEY RECEIVED SEPTEMBER 11, 1945

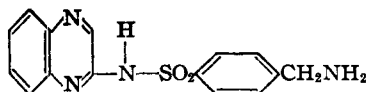
2-(4-Homosulfanilamido)-quinoxaline

BY FRANK J. WOLF, RUSSELL M. WILSON, JR., AND MAX TISHLER

Owing to the recent interest in marfanil,¹ the preparation of the corresponding homosulfanila-

(1) J. Klarer, *Klin. Wochschr.*, 20, 1250 (1941).

mido derivative of sulfaquininoxaline,² [2-(4-homosulfanilamido)-quininoxaline], was carried out.



This compound was synthesized by condensing N⁴-phthaloyl-4-homosulfanilyl chloride³ with 2-aminoquininoxaline² and hydrolyzing the resulting product.

The pharmacological activity of the product was kindly tested by D. Smith and O. Graessle of the Merck Institute. It was found to possess no bacteriostatic activity against *E. coli*, *S. aureus*, *Cl. Welchii* and *D. pneumoniae* Types I and II *in vitro* at concentrations in which marfanil was effective and did not prevent deaths due to *D. pneumoniae* Type I in the mouse when administered subcutaneously or intravenously in doses at which marfanil was slightly active.

Acknowledgment.—The authors are indebted to Dr. R. T. Major for his kind encouragement and advice.

Experimental

2-(N⁴-Phthaloyl-4-homosulfanilamido)-quininoxaline.—A solution of 43.0 g. of N⁴-phthaloyl-4-homosulfanilyl chloride and 16.8 g. of 2-aminoquininoxaline in 100 ml. of dry

(2) Weijlard, Tishler and Erickson, *THIS JOURNAL*, **66**, 1957 (1944).

(3) Bergeim and Braker, *ibid.*, **66**, 1459 (1944).

pyridine was heated on the steam-bath for two hours and then poured into water. The separated gummy material was taken up in 2.5 N sodium hydroxide, treated with Norite and filtered. The product was precipitated by acidification with glacial acetic acid, filtered and dried. The crude product weighed 24.7 g., m. p. 235–239° (48% yield).

A sample for analysis was recrystallized from glacial acetic acid, m. p. 246–247°. Calcd. for C₂₃H₁₆N₄O₄:⁴ N, 12.61. Found: N, 12.90.

2-(4-Homosulfanilamido)-quininoxaline.—The hydrolysis of 26.7 g. of crude 2-(N⁴-phthaloyl-4-homosulfanilamido)-quininoxaline to 2-(4-homosulfanilamido)-quininoxaline was carried out by heating with 8 ml. of hydrazine hydrate (85% in water) in 400 ml. of absolute ethanol for four hours. The solution was then cooled and the resulting precipitate filtered. This precipitate was taken up in 400 ml. of H₂O and 100 ml. of 2.5 N hydrochloric acid and heated on the steam-bath for one and a half hours. At the end of this time the solution was filtered. The filtrate was made alkaline with 30% sodium hydroxide, treated with Norite, filtered and acidified with glacial acetic acid. After concentrating the solution to dryness *in vacuo*, the residue (8 g.) was dissolved in 6 N ammonium hydroxide, treated with Norite and filtered. The filtrate was boiled until turbid. On cooling, light brown crystals separated; weight 4.8 g., m. p. 228° (25% yield).

A sample for analysis was recrystallized from glacial acetic acid, m. p. 230°. Calcd. for C₁₅H₁₄N₄O₂S: C, 57.31; H, 4.49; N, 17.83. Found: C, 57.55; H, 4.32; N, 17.85.

(4) Microanalyses were kindly performed by R. H. Boos, J. H. McGregor and E. J. Thornton.

RESEARCH LABORATORIES
MERCK AND CO., INC.
RAHWAY, N. J.

RECEIVED OCTOBER 5, 1945

COMMUNICATIONS TO THE EDITOR

PENICILLIN YIELDS FROM NEW MOLD STRAINS Sir:

Following ultraviolet irradiation of spores from a monoconidial isolate of the well-known strain X-1612 of *Penicillium chrysogenum*, a promising new strain, Wis. Q176, was obtained in June, 1945. This has consistently surpassed its parent in penicillin production, usually by a considerable margin.

In shake flask tests, 77% of the single spore lines from Q176 likewise exceeded X-1612 in yield. The best of these lines was Q176A8; 76% of the single spore lines from this culture also outperformed X-1612, two of them giving yields somewhat greater than any flask yields reported in this communication. Strains Q176 and Q176A8 have also been tested in shake flasks by the Department of Agricultural Bacteriology and a similar increase in yield over X-1612 was obtained.

Table I summarizes results obtained on strains Q176 and Q176A8 in both shake flasks and tanks. The shake flasks were 500-ml. Erlenmeyer flasks with 100 ml. of a medium containing per liter

40 g. of lactose, 20 g. of corn steep liquor solids, 3 g. of NaNO₃, 0.5 g. of KH₂PO₄, and 0.25 g. of MgSO₄·7H₂O. They were incubated in a shaker at 23°. The tank fermentations were made at 23° with 55 gallons of medium in 80-gallon tanks,

TABLE I
PENICILLIN YIELDS ON VARIOUS CULTURES

Expt.	X-1612 units/ml. ^a	Q176 units/ml.	Q176A8 units/ml.
Shake Flask Fermentations			
1	67	212	...
2	78	115	215
3	94	125	178
4	107	...	129
5	120	155	205
Tank Fermentations			
1 ^b	367 ^c	...	337
2	427	728	...
3	501	920	...

^a *S. aureus* cup assay. ^b A different lot of corn steep liquor was used for each of the tank experiments. ^c Each tank yield figure is the mean yield of duplicate tanks which differed in yield by from 4 to 18%.