reaction conditions and unless hydrogenation proceeds rapidly and smoothly, by-products are formed. In one explanation of the imidazole formation observed in their reductive condensations of (I) and (II), Elderfield and Kreysa[8] suggest that on reduction of the Schiff base (III), saturation of the pyridine ring occurs before substantial reduction of the azomethine linkage. This clearly requires qualification since under conditions now reported the reverse is the case. However, the more drastic hydrogenation conditions and the different catalyst used by Elderfield, *et al.*, might have caused the reaction to follow the alternative course. That these latter conditions led to extensive nuclear reduction is in accord with our experience since we used similar conditions except for the solvent employed, for making tetrahydro-Plasmochin and (IV), the published yield and analysis[6] of which have been overlooked by Elderfield, *et al.*[8]

It is of interest to note that Andersag also reports a failure to achieve more than a few per cent. yield of Plasmochin by the aminoketone route.[9]

A considerable part of this experimental work was carried out by H. G. Thompson and A. C. Benzie.

(8) Elderfield and Kreysa, THIS JOURNAL, **70**, 44 (1948).

(9) I. G. Elberfeld, *Jahresberichte*, 1940 (B. I. O. S. 116), Appendix 2).

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The Preparation of 1-(*p*-Nitrophenyl)-1,3-butadiene

BY E. C. COYNER AND G. A. ROPP[1]

In the continuation of a study[2] on Diels–Alder reactions with 1-aryl-1,3-dienes, 1-(*p*-nitrophenyl)-1,3-butadiene and its adduct with maleic anhydride have been prepared and characterized.

The diene was synthesized in two steps by a modification of the procedure described in a review[3] of German war-time investigations on extensions of the Meerwein[4] reaction.

$$CH_2{=}CH{-}CH{=}CH_2 + ClN_2C_6H_4NO_2\text{-}p \longrightarrow ClCH_2{-}CH{=}CH{-}CH_2C_6H_4NO_2\text{-}p + N_2$$

$$ClCH_2{-}CH{=}CHCH_2C_6H_4NO_2\text{-}p + KOH \longrightarrow CH_2{=}CH{-}CH{=}CHC_6H_4NO_2\text{-}p + KCl + H_2O$$

The chlorobutene, obtained in the first step, may be distilled successfully in small quantities under high vacuum, but it was found that this operation could be omitted as well as the removal of impurities, chiefly *p*-nitrophenol, from the chlorobutene by steam distillation. Actually, inclusion of these operations, as described in the Germany report, give only very low yields of diene, whereas the abbreviated procedure given in detail below resulted in a yield of 61% of purified product based on *p*-nitroaniline. Furthermore, the product is described in the German report as an oil, but in this work 1-(*p*-nitrophenyl)-1,3-butadiene was found to crystallize in yellow needles, m. p. 78.0–78.8°. It reacts readily with maleic anhydride and has been kept at room temperature in dark bottles for several months with no apparent decomposition.

Studies are now underway on the reactions of 1-(*p*-nitrophenyl)-1,3-butadiene with unsymmetrical dienophiles.

(1) Research Corporation Fellow.

(2) For a previous publication see Coyner and Ropp, THIS JOURNAL, **69**, 2231 (1947).

(3) Müller, "The Action of Aromatic Diazo Compounds on Aliphatic Unsaturated Compounds," PB 737, Office of Technical Services, Department of Commerce, Washington, D. C.

(4) Meerwein, Buchner and van Emster, *J. prakt. Chem.*, **152**, 237–266 (1939).

Experimental

1-(*p*-Nitrophenyl)-4-chloro-2-butene.—Technical *p*-nitroaniline was recrystallized once from ethanol and 140 g. (one mole) was dissolved in a hot solution of 240 cc. concentrated hydrochloric acid and 100 cc. of water. The solution was stirred rapidly and cooled in an ice–salt-bath. After 100 g. of ice was added, a solution of 70 g. of sodium nitrite in 120 cc. of water was run in during one hour while the temperature was kept between −4 and +4.5°. Stirring was continued for an additional twenty minutes and the reaction mixture was filtered. The filtrate was kept at 0° while it was added over a period of ninety minutes to a well-stirred mixture of 1 liter of acetone, 80 g. of sodium acetate dissolved in 100 cc. of water, 30 g. of cupric chloride dissolved in 50 cc. of water, and 130 cc. of liquid butadiene. The reaction mixture was maintained at −3 to +5° by means of an ice–salt-bath during the addition and was then allowed to warm to room temperature. Stirring was continued for an additional sixteen hours. One liter of ether was then added to extract the oily product, and the ethereal solution was separated, washed four times with 1-liter portions of water and dried over anhydrous magnesium sulfate. Removal of the solvent on the steam-bath gave 187.5 g. (88.6%) of crude 1-(*p*-nitrophenyl)-4-chloro-2-butene as a dark brown oil.

1-(*p*-Nitrophenyl)-1,3-butadiene.—The crude chlorobutene was dissolved in a solution of 500 cc. of ligroin and 500 cc. of benzene and treated with 5 g. of activated charcoal under reflux for two hours. The charcoal was removed by filtration, the solvents were evaporated on the steam-bath and the residual oil was dissolved in 400 cc. of methanol. This solution was then stirred at 15–33° while a solution of 112 g. of potassium hydroxide in 600 cc. of methanol was added over thirty minutes. Stirring was continued for an additional five minutes and the precipitated light yellow crystalline diene was removed by filtration; it was washed thoroughly with water and dried in a vacuum desiccator to give 76.5 g. of product, m. p. 75.0–76.8. The methanolic filtrate was added to 1200 cc. of water to precipitate 41.5 g. of less pure, dark brown product, which upon recrystallization from 400 cc. of ligroin gave 30 g. of light yellow crystalline diene, m. p. 75.5–76.8°. The total yield of product, m. p. 75.0–76.8° is therefore 106.5 g. (61% based on *p*-nitroaniline). A highly purified sample, m.p. 78.0–78.8°, was prepared by repeated recrystallizations from ligroin and from methanol.

Anal. Calcd. for $C_{10}H_9O_2N$: C, 68.56; H, 5.18. Found: C, 68.44, 68.44; H, 5.07, 4.96.

Adduct with Maleic Anhydride, 3-(*p*-Nitrophenyl)-1,2,3,6-Tetrahydrophthalic Anhydride.—A mixture of one-hundredth mole quantities of 1-(*p*-nitrophenyl)-1,3-butadiene (1.75 g.) and maleic anhydride (0.98 g.) was heated at 70° for fifteen minutes, during which time the melt solidified. The solidified cake was then heated under reflux with 3 cc. of xylene for ten minutes and cooled to room temperature. The solid product was re-

moved by filtration and recrystallized once from glacial acetic acid and three times from ethyl acetate to give pale yellow crystals, m. p. 170.9–172.0°.

Anal. Calcd. for $C_{14}H_{11}O_6N$: C, 61.54; H, 4.06. Found: C, 61.33, 61.60; H, 4.04, 3.99.

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Hydroxyethylmorphine

BY WARNER W. CARLSON AND L. H. CRETCHER

The typical result of alkylating the phenolic hydroxyl of morphine has been found to be the production of codeine-like effects, almost regardless of the chemical nature of the alkylating group.[1] However, since no reference could be found to the preparation of a hydroxyalkyl ether derivative of morphine, the alkaloid was hydroxyethylated by the procedure previously developed for use with nitrogenous phenols.[2]

Toxicity of the derivative was determined by the subcutaneous (abdominal) injection of graded doses of the compound in white mice (17 to 19 g. weight range). The results are given in Table I, along with the values listed by Small and Eddy[1] for the parent alkaloid and its methyl and ethyl ethers. Introduction of the hydroxyethyl group was found to produce a marked decrease both in acute toxicity and convulsant action. Hydroxyethylmorphine also failed to elicit the Straub reaction or circus movements in the animals. In its actions the hydroxyethyl derivative resembles γ-isomorphine, which has an LD 50 of 2000 mg./kg. and does not produce the Straub reaction or circus movements in mice.[1]

TABLE I

ACUTE TOXICITY OF HYDROXYETHYLMORPHINE TO WHITE MICE

Substituent at position 3	LD 50 mg./kg., as free base	Convulsant action, mg./kg.	Straub reaction
HO—	531	531	Present
CH_3O—	241	161	Present
C_2H_5O—	136	122	Present
HOC_2H_4O—	2500	2500	Absent

A preliminary estimate of analgesic potency in white mice was made by the method of Woolfe and MacDonald,[3] morphine and codeine being used as reference compounds. The results are given in Table II, from which it is estimated that codeine is approximately 1/10, and hydroxyethylmorphine 1/15, as analgesic as the parent alkaloid.

Experimental

Hydroxyethylmorphine.—A mixture of 5.7 g. of morphine, 8.3 g. of potassium carbonate, and 100 g. of ethylene carbonate[2] (in excess as solvent) was heated with stirring for seventy-five minutes at 98°, cooled, and poured into an excess of cold aqueous alkali. The solution was extracted three times with 50-cc. portions of chloroform, the extracts united and the product extracted by 20 cc. of 0.1 *N* hydrochloric acid. The solution was made alkaline and the product again extracted into chloroform; because of the marked water solubility of the derivative, it was not feasible to wash the extract. The chloroform solution was evaporated to a sirup under reduced pressure, the residue dissolved in boiling absolute alcohol, and the solution cooled, hydroxyethylmorphine crystallizing. Recrystallized from the same solvent (30 cc. of alcohol per g. of compound) the derivative was obtained as colorless crystals; m. p. 190°; yield, 4.6 g.; $[\alpha]_D$ −124.8° (methanol).

Anal. Calcd. for $C_{19}H_{23}NO_4$: C, 69.26; H, 7.04; N, 4.26. Found: C, 69.02; H, 7.08; N, 4.36.

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TABLE II

ANALGESIC POTENCY OF HYDROXYETHYLMORPHINE

Drug	Dose, mg./kg., as free base	Animals showing analgesia, %	Av. time to develop analgesia minutes	Average duration of analgesia minutes
Morphine	10	100	14	29
	20	100	12	80
Codeine	50	60	14	31
	100	100	14	41
Hydroxy-	50	66	12	32
ethylmorphine	100	66	12	34
	150	100	10	38
	200	100	10	58

The Ultraviolet Absorption Spectra of 1,1′- and 2,2′-Binaphthyl

BY VERNON L. FRAMPTON, JOSEPH D. EDWARDS, JR., AND HENRY R. HENZE

In a very recent article concerning the ultraviolet absorption spectra of some naphthalene derivatives, Friedel, Orchin and Reggel[1] call attention in a footnote to differences between the spectra as determined by them for 1,1′- and 2,2′-binaphthyl and those noted previously by Adams and Kirkpatrick.[2] The significance of these data is such as to warrant this communication to confirm the location of the absorption maxima reported by Friedel, Orchin and Reggel, since, as they appear to us, the ultraviolet absorption spectra of 1,1′-binaphthyl and, especially, of 2,2′-binaphthyl were of fundamental importance in the selection by Adams, *et al.*, of a binaphthyl as the basic nucleus of gossypol.

1,1′-Binaphthyl has been resynthesized[3] by three different procedures, namely: (a) by the Wurtz–Fittig reaction[4] starting with 1-chloronaphthalene; (b) according to the method of Ull-

(1) Small and Eddy, U. S. Public Health Reports, Supplement No. 138, U. S. Government Printing Office, Washington, D. C., 1938.

(2) Carlson and Cretcher, THIS JOURNAL, **69**, 1952 (1947).

(3) Woolfe and MacDonald, *J. Pharm. Exp. Therap.*, **80**, 300 (1944).

(1) Friedel, Orchin and Reggel, THIS JOURNAL, **70**, 199 (1948); see footnote (10).

(2) Adams and Kirkpatrick, *ibid.*, **60**, 2181 (1938).

(3) These experimental data are drawn from a thesis presented by Joseph Daniel Edwards, Jr., to the Faculty of the Graduate School of the University of Texas in partial fulfillment of the requirements for the Master of Arts degree, January, 1948.

(4) Rodd and Linch, *J. Chem. Soc.*, 2178 (1927).