Nitrosation of 1-Naphthyl N-Methylcarbamate and Related Compounds as It Was Followed by Oscillopolarography

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When microquantities of 1-naphthyl N-methylcarbamate (I) were nitrosated for 5 min with $NaNO_2$ in aqueous acetic acid and hydrolyzed, at a molar ratio of 1:10,000 of I:$NaNO_2$, the main product found in the resulting yellow basic solution was 1,4-naphthoquinone monoxime (V). Compound V was formed in direct proportion to the amount of I present. A colorless intermediate is postulated for the transformation. When macroquantities of I and $NaNO_2$ (in molar ratios of 1:5) were used, almost no reaction of I occurred after 5 min. However, after 3 hr or more, 1-naphthyl N-methyl-N-nitrosocarbamate (III) was formed in high yields. Although III was unstable at room temperatures in the solid state and gradually was transformed into 1,1-dinaphthyl carbonate, in microquantities III reacted under the same conditions as I to give V. When 1-naphthol was nitrosated in macroquantities (in a 1:1 ratio with $NaNO_2$), mainly a mixture of 2-nitroso-1-naphthol (IV) and V was formed. However, when a large excess of $NaNO_2$ was treated with microquantities of 1-naphthol, little or no IV or V was observed with a polarograph. A number of model compounds were examined similarly and the results were found useful in formulating a partial explanation of the chemical behavior of I.

A recently developed method for determining 1-naphthyl N-methylcarbamate (carbaryl) (I) in some foods[1] is based on the nitrosation of I, followed by hydrolysis, to form an unknown yellow material (II). This material is believed to be responsible for the quantitative polarographic wave measured at -0.45 ± 0.05 v *vs.* a mercury pool reference electrode. This polarographic response constitutes the determinative step of the method of analysis. Although the identity of II need not be known in order for the method to be applied successfully, its formation was investigated further in the hope of finding a general chemical reaction of intact carbamates. At the same time, the nitrosation of carbamates was studied in general.

Very little has been reported on the polarography of carbamates. A somewhat similar method reported for the polarographic determination of I involved the formation of a mixture of possibly eight nitrated products[2] which gave a single polarographic wave. Although these authors attempted no exact identification of the main nitrated products, they assumed[2] that I was hydrolyzed under the conditions of nitration (1.5 hr in 65% HNO_3).

In our investigations, carbaryl I gave a proportional polarographic response when a solution containing 5×10^{-10} to 2.5×10^{-7} mole of I in 4.0 ml of 50% acetic acid containing 2×10^{-3} mole of $NaNO_2$ was allowed to react for 5 min and then brought to about pH 13 with 6.0 ml of 50% KOH. Nitrosation alone does not produce II; the further step of hydrolysis apparently is required, since the colorless solution changed to a permanent yellow only after the base had been added.

In an effort to prepare a large amount of II for investigation, the concentrations of starting materials and time of nitrosation were increased; since above 1×10^{-7} mole of I in 4 ml, polarography indicated very little increase in the formation of II, the nitrosation period was increased to 3 hr or overnight at a higher (1:5) molar ratio of I:$NaNO_2$. A crystalline, yellow solid (III) formed. Although the nmr spectra of I and III indicated that both compounds contained the same ratio of aromatic to aliphatic hydrogens, the CH_3 in I appeared as a doublet due to coupling with the NH proton, while the CH_3 in III gave a singlet. Thus it appeared that the H on the nitrogen had been replaced. Hydrolysis of III by base yielded a colorless gas and a colorless solution. This solution gave no polarographic wave, and its ultraviolet spectrum was identical with that of 1-naphthol in base (λ_{max} 336 mμ). When the mother liquor from the formation of III was made basic and polarographed, a small amount of II was detected. Thus prolonged nitrosation of I did not increase the quantity of II formed. The main product (III) was assigned the structure of 1-naphthyl N-methyl-N-nitrosocarbamate.[3]

Since the carbamate groups of I and III were very labile with base, it seemed probable that II is formed through a nitrosation on the naphthalene ring and is either 2-nitroso-1-naphthol (IV) or 4-nitroso-1-naphthol (V). To test this assumption both of these ring-substitution products were prepared. Compound IV was prepared by a new procedure, described in the Experimental Section,[4] which is faster than the method previously reported.[5] Polarography, thin layer chromatography (tlc), and column chromatography showed that this product is essentially a mixture of 60% IV and 40% V. Compound IV was prepared in the oxime form from 1,2-naphthoquinone. Compound V was prepared as the oxime (1,4-naphthoquinone monoxime) by adding alcoholic $NH_2OH \cdot HCl$ to 1,4-naphthoquinone and then adding 1 drop of concentrated HCl.[6] Other methods using base proved unsatisfactory for V.

The polarograms of purified 2-nitroso-1-naphthol (IV) and of V were similar to that of II; all showed a strong wave at -0.48 v. However, when further nitrosated, IV gave a variety of new polarographic waves, which II did not. The main waves in the polarograms of II, IV, and V were identical in peak

(1) R. J. Gajan, W. R. Benson, and J. M. Finocchiaro, *J. Assoc. Offic. Agr. Chemists*, **48**, 958 (1965).

(2) R. Engst, W. Schnaak, and H. Woggon, *Z. Anal. Chem.*, **207**, 30 (1965).

(3) In the solid state III decomposed gradually at room temperature. This process was retarded when the solid was kept cold. 1,1-Dinaphthyl carbonate was isolated in high yield from a mixture of products resulting from this slow, solid state reaction. Other products of this reaction await further investigation.

(4) This procedure can also be used to prepare 1-nitroso-2-naphthol in 5 min, starting with 0.1 mole of 2-naphthol.

(5) (a) N. N. Woroshtzow and S. W. Bogdanow, *Ber.*, **62**, 68 (1929); (b) E. Beckmann and O. Liesche, *ibid.*, **56**, 4 (1923).

(6) H. Goldschmidt and W. Schmid, *ibid.*, **17**, 2064 (1883).

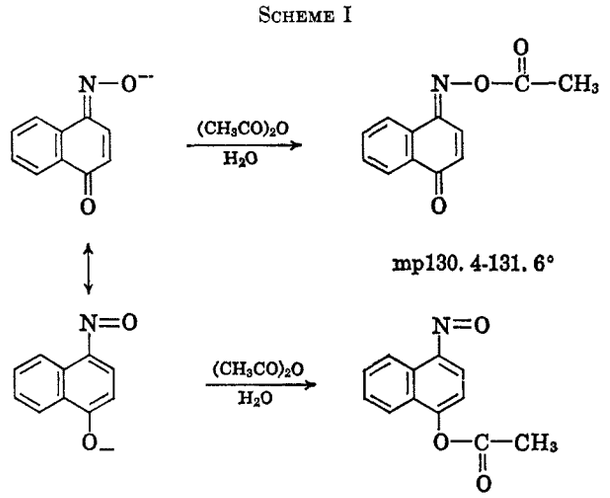
potential (−0.48 v), and their peak shapes were similar except that the peak of II had a small shoulder.

When 1-naphthol was nitrosated at microlevels, no strong polarographic waves were obtained in the −0.48-v region. Thus at microlevels IV was probably not the intermediate formed in the nitrosation of 1-naphthol.

Since oximes and nitroso compounds may be changed by nitrous acid,[7] an attempt was made to nitrosate V with $NaNO_2$ in the same manner in which I is nitrosated to produce II. Under these conditions V survived unchanged. In fact, V gave a quantitative polarographic response with no apparent upper limit both before and after treatment.

Compound V can exist as either the nitroso or the oxime tautomer. To determine which form of V was dominant, V was acetylated first in a basic medium, then under acid conditions. In both cases, it was apparently the oxime oxygen of the ambident ion and molecule which was acetylated. This is contrary to the assignment of Beckmann and Liesche, who placed the acetyl group on the ring oxygen (Scheme I).[5b]

SCHEME I



To provide more direct evidence as to the nature of II, the yellow solution of II formed from I by nitrosation and hydrolysis was extracted with ether. No product could be obtained from the basic solution, but when the pH was adjusted to 6, the yellow material could be extracted. The extract was concentrated and chromatographed (tlc). One portion was spotted alone and another portion was overspotted with V. The tlc results indicated that, except for a very minor component, II was identical with V in color and in R_f values for both adsorbents. No spot was found which had the same R_f value as IV. It is therefore concluded that II is 1,4-naphthoquinone monoxime (V).

Partially neutralized solutions of I in the nitrosation medium were polarographed with the results given in Table I. Certain peak potentials were noted which were not found with V or the electrolyte alone. It is concluded that a colorless compound(s), other than V, is present in the acidic medium and is the precursor of II. This precursor apparently could not be extracted with ether from the acid medium.

(7) E. H. White and R. J. Baumgarten, *J. Org. Chem.*, **29**, 2070 (1964), and references therein.

TABLE I

THE POLAROGRAPHY OF NITROSATED 1-NAPHTHYL N-METHYLCARBAMATE (I) AT VARIOUS pH STAGES IN THE FORMATION OF THE UNKNOWN YELLOW MATERIAL

	Peak potential *vs.* Hg pool electrode, v (2 μg of I/ml)		
pH[a]	Major peak	Minor peak	Major peak
3.0	...	−0.60	−0.90
4.3	−0.33	−0.60	−0.90
8.0	−0.30	−0.74	−1.00
12.2	−0.30	−0.70	−0.85
13.5	−0.50	−0.76	−0.82
14.0	−0.48	−0.75	−0.82
14 (blank)	...	...	−0.82

[a] The pH measurements were taken on a Beckman zeromatic pH meter with a no. 41263 electrode (no salt correction). After the nitrosation (see micromethod), the pH was adjusted by titrating the solution with 50% aqueous KOH to the desired pH reading and diluting to constant volume with water.

The reason for the limited nitrosation of I at the microlevel was not apparent. Therefore, to investigate electronic and steric factors which might govern the attack of I, 1-acetoxynaphthalene (VI), 1-nitronaphthalene (VII), 1-methoxynaphthalene (VIII), and 1,1′-dinaphthyl carbonate (IX) were treated with nitrous acid. At the macrolevel (molar ratios of 1:5 of compound:$NaNO_2$), only VIII appeared to yield V, confirming previous reports.[8] However, VII gave a peak potential near to (and four times the response of) the main peak given by II, with or without prior nitrosation and at all levels of concentrations attempted.

It is significant that after nitrosation at the microlevel VI gave a polarogram identical in shape and location with those derived from nitrosated I and III, but at the same low concentrations, I was 15% higher than VI in its polarographic response. When IX was nitrosated and hydrolyzed at microlevels, II was formed. Thus, the ring nitrosation of I leading to II does not appear to depend upon the carbamate group.

The nitrosation of VIII took place rapidly at the microlevel, but the resulting polarogram indicated that neither IV nor V was formed, in contrast to nitrosation at the macrolevel, as described above. This pattern for micro- and macroquantities is similar to that of 1-naphthol. Nitrosation of 1-naphthol with nitrosylsulfuric acid at the macrolevel has been reported[5,8] to yield almost exclusively IV. Thus, since 1-naphthol does not yield IV or V at microlevels, the nitrosation of I at high molar ratios of nitrite does not involve the initial hydrolysis of I.

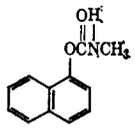
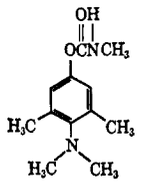
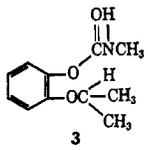
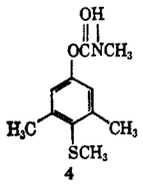
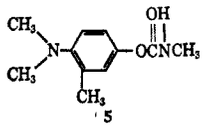
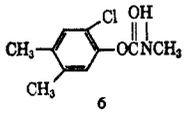
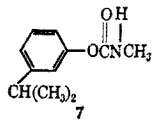
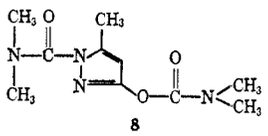
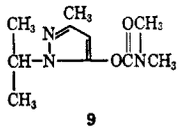
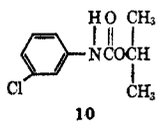
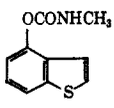
An extremely rapid reaction appeared to be taking place between I and the medium during nitrosation, as indicated by very little change in the voltage and peak height when the effect of time (0–10 min) upon the nitrosation process was studied. Based upon the mechanism that Meyer[8] has assumed for the transformation of 1-methoxynaphthalene (VIII) to V, the reaction scheme shown is proposed to account for the chemical behavior of I and related compounds in the presence of $NaNO_2$ and aqueous acetic acid (Scheme II).

To determine whether the nitrosation reaction is general for aryl N-methylcarbamates, a number of biologically active carbamates (pesticides) were nitrosated at microlevels (about 20 μg in 4 ml) and

(8) L. Blangey, *Helv. Chim. Acta*, **21**, 1579 (1938); F. Fuchs, *Ber.*, **8**, 625 (1875); K. Meyer and S. Lenhardt, *Ann.*, **398**, 79 (1913).

TABLE II

POLAROGRAPHY OF CARBAMATES (AFTER NITROSATION BY MICROMETHOD)

Structure	Peak potential vs. Ag wire electrode, v	Heights, units/μg
 1	−0.68	2.5
 2	−0.83	0.13
 3	−0.80 −0.97	0.25 0.1
 4	−0.80	0.052
 5	−0.60 −0.80	0.013 0.06
 6	−0.78 −0.9	0.032 0.032
 7	−0.80 −0.95	0.39 0.25
 8	−0.70 −0.90	0.014 0.029
 9	−0.90	0.015
 10	−0.55 −0.70	0.0029 0.0074
 11	−0.55 −0.85 −0.95	0.006 0.041 0.035

hydrolyzed, and the resulting solutions were polarographed. The structures of these carbamates and the number of peak potentials with their corresponding relative heights are given in Table II. This nitrosation process and detection system is most sensitive to I. The absence of peaks for certain compounds appears to be due to (1) the failure of the ring to nitrosate or (2) the drastic alteration of the molecule. Thus the one available *ortho* position in **6** (Table II) appears to be sterically hindered, since **6** gave no reduction wave. Compounds **2** and **5** were drastically changed to other compounds. These results were similar to those found by using large amounts of the pesticides and nitrite in acid (macrolevels). When 20 μg each of **1**, **3**, and **7** were nitrosated together in the same solution, the polarogram showed that **1** was nitrosated quantitatively; the other two showed separate and distinct peak potentials.

When these carbamates and model compounds are nitrosated, the identities of the main reaction products vary greatly according to the concentration of the starting carbamate. Thus, the nitrosation reaction cannot be considered general for aryl N-methylcarbamates. The authors are still uncertain as to why nitrosation on the ring takes place only at very low concentrations of I.

Experimental Section

1-Naphthyl N-methylcarbamate (I) was obtained from Union Carbide Corp., mp 139–141°, and was also prepared as described below. 1-Nitronaphthalene (VII), mp 61°, and 1-methoxynaphthalene (VIII), bp 265°, were obtained from Eastman Kodak Co. Melting points were taken with a Nalco Co. hot stage and are uncorrected. Infrared spectra were taken in KBr disks on a Beckman IR-5A spectrophotometer. Nmr measurements were taken on a Varian A-60 recording spectrometer. A cathode ray polarograph, Model K1000 Polarotrace (Southern Analytical Ltd., Surrey, England) and a David differential cathode ray Polarotrace Model A1660 were employed for the polarography. The elemental analyses were performed by Chemco, Inc., Washington, D. C. The physical constants and sources of the carbamate pesticides listed in Table II are given in the literature.[9]

1-Naphthyl N-Methylcarbamate (I).—This preparation is a modification of a reported procedure[10] and is used to illustrate the general preparation of aryl N-methylcarbamates (N,N-dimethylcarbamates have been prepared similarly by using N,N-dimethylcarbamyl chloride in place of methyl isocyanate). Into a 125-ml pressure bottle (A. H. Thomas Co.) were placed 14.4 g (0.1 mole) of 1-naphthol (mp 95–96°), about 7.3 g (0.128 mole) of liquid, White Label, methyl isocyanate (Eastman Kodak) (*Caution:* use a hood; avoid contact with the skin), and about 35 ml of dry pyridine. The bottle was closed and heated for 3 hr at steam-bath temperatures. During the slow cooling process, crystals were formed. The reaction mixture was poured into an ice–water mixture. The solid was filtered, washed with water, and air dried to yield 18.0 g (89.5%) of I, mp 141–142° (lit.[10,11] mp 142 and 145°). Recrystallization from hot ethanol did not change the melting point range.

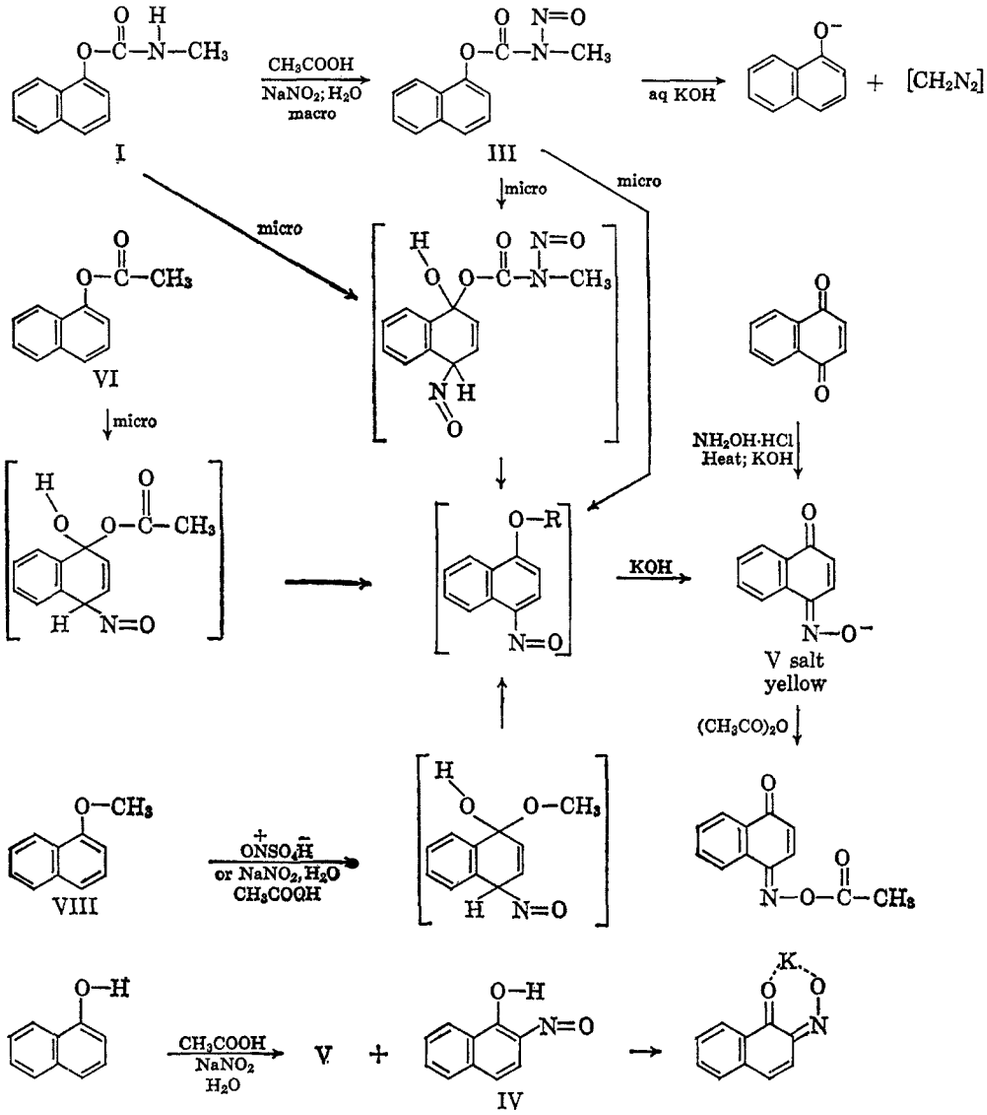
Nitrosation. A. Macromethod. Preparation of 1-Naphthyl N-Methyl-N-nitrosocarbamate (III).—To a 500-ml erlenmeyer flask containing 310 ml of glacial acetic acid was added, with stirring, 20.1 g (0.10 mole) of I. To this covered solution was added, over a 20-min period, a solution of 34.5 g (0.50 mole) of sodium nitrite in 100 ml of water. After each addition the solution was stirred briefly and the flask was covered. At first no gas escaped. Later, a colorless gas evolved which turned brown

(9) J. Damico and W. R. Benson, *J. Assoc. Offic. Agr. Chemists*, **48**, 344 (1965).

(10) W. J. Skraba and F. G. Young, *J. Agr. Food Chem.*, **7**, 612 (1959).

(11) H. L. Haynes, J. A. Lambreck, and H. H. Moorefield, *Contrib. Boyce Thompson Inst.*, **18**, 507 (1954–1957).

SCHEME II



when exposed to the air. (Interruption of the reaction after 10 min gave approximately 99% of I.) After the addition was completed, the covered vessel was set aside for 3 hr or more at room temperature. A large mass of yellow-orange crystals was filtered, thoroughly washed with water, and air dried, mp 68.5–69.0°. Material heated to 90° for 30 min showed only a slight melting point depression. Recrystallization from warm (50°) aqueous ethanol did not raise the melting point. More crystals were obtained when the filtrate was diluted with water. The crude yield was 20.0 g (87%). *Anal.* Calcd for $C_{12}H_{10}N_2O_3$: C, 62.56; H, 4.38; N, 12.16. Found: C, 63.04; H, 4.74; N, 11.83. The nmr spectrum of fresh III in $CDCl_3$ showed a singlet peak at τ 6.88 while I in $CDCl_3$ showed a split methyl peak centered at τ 7.29 (J_{HH} = 5 Hertz). Integration of the areas showed a 7:3 ratio of aromatic to aliphatic hydrogens for both III and I. The N*H* band by the nmr was broad in I and was missing in III. The infrared spectrum showed no N*H* band for III and the following assignments are made (cm^{-1}): C=O (1740), N=O (1510), N=O (1352), COC (1222), NO (950), CH (806), CH (766). The carbonyl band[12] of I (1710 cm^{-1}) was shifted 30 cm^{-1}.

Upon standing for 10 days at room temperatures, III gave the following analysis: C, 64.67; H, 4.55; N, 8.64. Over a period of several months, the melting point range was raised to 98–117°. At least two compounds appeared to be present during the melting process. Recrystallization of a weighed portion from aqueous alcohol gave a high yield of white crystals, mp 128–129°. Nmr showed no CH_3 groups, and a spectrum almost identical with IX. The nmr and infrared spectra were consistent with 1,1′-dinaphthyl carbonate (IX); a mixture melting point gave no depression. The thin layer chromatographic (tlc) behaviors of authentic IX (mp 128–129°) and the derived product were identical on alumina and silica. Alumina hydrolyzed some of the carbonate to 1-naphthol, while I was not hydrolyzed under the same developing conditions. The carbonate was hydrolyzed to a compound which coupled with a solution of *p*-nitrobenzenediazonium fluoroborate to form a blue dye which was identical with the dye formed by 1-naphthol.

Nitrosation B. Micromethod.—Solutions of I in acetic acid were prepared so that 2.0 ml contained between 0.2 and 100 μg. To 2.0 ml of this solution in a 50-ml erlenmeyer flask was added 2.0 ml of 1.0 *N* $NaNO_2$ in water. After 3 min. 6.0 ml of 50%, w/v aqueous KOH was added and the solution was swirled. The resulting hot, yellow, basic solution was allowed to cool for 15 min. The solution (5 ml) was transferred to a polarographic cell, deaerated for 5 min with prepurified nitrogen, and polarographed between −0.2 and −0.7 *vs.* a Hg pool electrode at 25 ± 1°. This polarogram showed a characteristic peak of II at −0.45 ± 0.05 v *vs.* Hg pool electrode or −0.68 ± 0.05 v *vs.* Ag wire electrode. The peak had a shoulder at a slightly lower voltage (−0.48 v) than the main peak. Extraction (twice) of this solution with ether gave no aromatic product as detected by thin layer chromatography (see below). However, when the basic solution was neutralized with acetic acid to a pH of about 6.0, a yellow material was extracted with ether and the tlc behavior was observed on alumina and silica gel with acetone–benzene (1:4) as a developing solvent and nitrobenzenediazonium fluoroborate in ethanol as the chromogenic reagent.[13] The yellow material had the same

(12) J. T. Chen and W. R. Benson, *J. Assoc. Offic. Anal. Chem.*, **49**, 412 (1966).

(13) J. M. Finocchiaro and W. R. Benson, *ibid.*, **48**, 736 (1965).

R_f and color as 1,4-naphthoquinone monoxime (V) but a small amount of a brownish material was slightly separated from II on silica gel. When V was superimposed onto a spot of II, almost all of II was identical with V in R_f and color. Alumina gave less data, since the R_f values were low. The ultraviolet spectra of II and V in base gave a λ_{max} of 413 mμ.

2-Nitroso-1-naphthol (IV).—To a 500-ml erlenmeyer flask was added 10 g (0.07 mole) of 1-naphthol and 50 ml of glacial acetic acid. Complete solution was not necessary. Solid $NaNO_2$ (7.0 g, 0.10 mole) was gradually added with swirling. The solid gradually dissolved. Heat and some gases were evolved. A dark colored, thick mixture formed. After 5 min ice and water were added until no further solid precipitated. The mixture was filtered, washed with water, and pressed dry. The solid was stirred in a beaker to remove the last traces of acetic acid. The filtered, air-dried, yellow product weighed 12.0 g (99.4% yield), mp 142–146° dec (lit.[3] 145–150, 152–156, and 162° dec). The controversy on the melting points is summarized.[3] The tlc of IV (as prepared here) showed two yellow spots on silica gel which corresponded to the major product IV (R_f 0.32) and V (R_f 0.51). There was a small amount of material near the origin as well. No unreacted 1-naphthol was found. A copper chelate was formed by IV. About 10 mg of IV was purified on an alumina column with 1:4 acetone and benzene: mp 150° dec. 1,2-Naphthoquinone and $NH_2OH \cdot HCl$ also gave pure IV, mp 150° dec. [When this nitrosation procedure was used to prepare 1-nitroso-2-naphthol,[4] a brown solid was formed: crude yield, 99%; mp 95° (lit.[14] mp 97° crude, 99% yield, and 106° recrystallized). Tlc (silica gel) yielded a major and a very minor spot. A basic aqueous solution formed a chopper chelate.]

1,4-Naphthoquinone Monoxime Acetate.—In a 125-ml erlenmeyer flask, 1,4-naphthoquinone monoxime (1.0 g) was dissolved in a slight excess of aqueous KOH (0.43 g, 30 ml) to yield a deep red solution. Excess (2 ml) acetic anhydride was added and the flask was shaken. An immediate reaction took place and a red solid precipitated. The shaking was continued for 5 min. The precipitate was filtered, washed with water, and air dried; yield was 1.0 g (crude), mp 125–126°.

Recrystallization from hot aqueous ethanol with charcoal gave yellow needles, mp 130.4–131.5°. *Anal.* Calcd for $C_{12}H_9NO_3$: C, 66.97; H, 4.22; N, 6.51. Found: C, 66.94; H, 4.29; N, 6.13. The infrared spectrum showed two carbonyl absorption bands (1783 and 1658 cm^{-1}). Bands were also visible at 1597 (aromatic and C=C), 1193 (CO), and 937 (NO) cm^{-1}. The nmr and infrared spectra are consistent with the proposed structure. These data do not conform to the structure given in the literature[5b] (mp 132.5°). Under the acidic Beckmann conditions,[5b] the same compound was formed as identified by melting point (130.5–131.5°) and by infrared spectral analysis.

1,4-Naphthoquinone Monoxime (V).—Hydroxylamine hydrochloride (7.0 g, 0.1 mole) was refluxed with 2 drops of concentrated HCl solution and 15.8 g (0.1 mole) of 1,4-naphthoquinone in 25 ml of 95% ethanol for 10 min. This solution was cooled and diluted with water. A brown solid formed (Va). Part of the solid was dissolved in aqueous KOH, filtered, and precipitated with concentrated HCl to give a gray solid (Vb). The total crude yield was 15.0 g (86.7%), mp 197° dec (lit.[5] 198–199° dec). There was no difference in the R_f values (0.52) or color of Va and Vb on silica gel. They both exhibit absorption bands at 3140–2750 (OH), 1625 (CO), 1585 (C=C), 1550 (C=N), 970 (N—O), and 846 (two adjacent H) cm^{-1}.

1-Naphthyl acetate (VI) was prepared in 5 min by shaking 10.2 g (0.1 mole) of acetic anhydride with 14.4 g (0.1 mole) of 1-naphthol dissolved in an equivalent amount of aqueous NaOH. The yield was 90%, mp 46–48° (lit.[15] mp 49°).

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Amino Derivatives of Starches. 2-Amino-3,6-anhydro-2-deoxy-D-mannose[1]

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Treatment of phenyl 2-acetamido-2-deoxy-6-*O*-(*p*-tolylsulfonyl)-α-D-mannopyranoside (**1a**) with base gives phenyl 2-acetamido-3,6-anhydro-2-deoxy-α-D-mannopyranoside (**3a**), converted by acid hydrolysis into a crystalline 2-amino-3,6-anhydro-2-deoxy-D-mannose hydrochloride (**4**), a reference compound required in structural studies on aminated starch derivatives. Chemical and physical evidence indicated that **4** possessed a furanoid ring system.

In the previous paper in this series[2] it was shown that methyl 3,6-anhydro-2-*O*-(*p*-tolylsulfonyl)-α-D-glucopyranoside is very resistant to amination by displacement of the C-2 substituent with hydrazine. It was inferred, and verified by experiment, that 3,6-anhydro-2-*O*-(*p*-tolylsulfonyl)-D-glucopyranose units in a polysaccharide show a similar lack of reactivity toward hydrazine. Consequently, units of 2-amino-3,6-anhydro-2-deoxy-D-mannose are not probable constituents of an aminated amylose prepared[3] by hydrazinolysis followed by reduction of a 2(?),6-di-*O*-(*p*-tolylsulfonyl)-amylose. Reference compounds have been synthesized for possible[4] and probable[5] reactions in the amination process. In this paper the synthesis is described of the last of these proposed[4] reference compounds, 2-amino-3,6-anhydro-2-deoxy-D-mannose.

Treatment of phenyl 2-acetamido-2-deoxy-6-*O*-(*p*-tolylsulfonyl)-α-D-mannopyranoside[4] (**1a**) with aqueous ethanolic sodium hydroxide at room temperature, or with ethanolic sodium acetate at reflux, gave the crystalline phenyl 2-acetamido-3,6-anhydro-2-deoxy-α-D-mannopyranoside (**3a**) in good yield; acetylation gave the crystalline 4-acetate (**3b**). Acid hydrolysis of the anhydro glycoside (**3a**) gave, in high yield, a crystalline, chromatographically homogeneous 2-amino-3,6-anhydro-2-deoxy-D-mannose hydrochloride (**4**). This substance reduced Fehling solution, but did not recolorize Schiff reagent, indicating that it was not an aldehyde or aldehydrol form, even though it exhibited no detectable mutarotation.

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