across a biphenyl system in those cases where the kinetic properties of the reacting group are concerned (*e.g.*, II, X = OCH_3, Y = $COOCH_3$). It would be predicted on the basis of the results reported herein, however, that resonance transmission of substituent effects should be much less important in the biphenyl system than has been found to be the case for benzene derivatives. This view finds experimental confirmation in the study of Berliner and Liu on the comparative rates of hydrolysis of esters of benzoic and *p*-phenylbenzoic acids,[1a,22] and in the comparative reactivities found by Miller for the chlorine atoms in 4-chloro-3,5-dinitrobiphenyl and 4-chloro-3,4′,5-trinitrobiphenyl.[23] The chlorine atom in the latter compound is only 2 to 3 times as reactive as that in the former, whereas the chlorine in picryl chloride is some 6×10^5 times as reactive as that of 2,6-dinitrochlorobenzene.[23]

Acknowledgment.—We wish to express our appreciation to the Monsanto Chemical Company for a fellowship held by one of us (V. P. K.) which made the early completion of this work possible.

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[22] E. Berliner and L. H. Liu, This Journal, **75**, 2417 (1953).

[23] Private communication from Dr. J. Miller, University of Western Australia.

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NOTES

The Conversion of Carboxylic Acid Hydrazides to Amides with Raney Nickel

By C. Ainsworth

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Raney nickel has been found to cleave carboxylic acid hydrazides to form amides and ammonia. The reaction consists simply of heating a solution of the acid hydrazide in alcohol for several hours with a relatively large amount of the catalyst.

$$RCONHNH_2 \xrightarrow{\text{Raney Ni}} RCONH_2 + NH_3$$

The cleavage represented above does not take place, however, when a catalytic amount of nickel and the hydrazide are heated in an atmosphere of hydrogen. Thus, benzoic acid hydrazide with about ten parts by weight of Raney nickel was changed to benzamide. On the other hand, benzoic acid hydrazide and a trace of Raney nickel heated under an atmosphere of hydrogen in the Parr shaker did not undergo reduction. Starting material was recovered. Under similar conditions employing Adams catalyst, hydrogen was taken up and cyclohexanecarboxylic acid hydrazide[1] was obtained. That is, the benzene ring was reduced without cleavage of the N–N bond. The cyclohexanecarboxylic acid hydrazide with *excess* Raney nickel was converted to cyclohexanecarboxamide.[1]

The Raney nickel reaction was found to be general for alkyl, aryl and heterocyclic carboxylic acid hydrazides. As examples, *n*-butyric and nicotinic acid hydrazides were converted in good yield to the corresponding amides.

The reaction has been applied to *dl*-isolysergic acid hydrazide which is obtainable from the ergot alkaloids by treatment with hydrazine.[2] The configuration of the resulting amide, relative to lysergic acid or isolysergic acid, is not assigned.[3] The product, however, was identical with the amide prepared from *dl*-isolysergic acid hydrazide by the general method of Stoll[4] which employs the azide as an intermediate.[5]

Experimental[6]

General Procedure.—A mixture of 1–2 g. of the carboxylic acid hydrazide, 100 ml. of 95% ethanol and about 10 g. of moist Raney nickel was heated under reflux with stirring for approximately three hours. The nickel was removed by filtration and the filtrate was evaporated to dryness. The residue was extracted with hot water or benzene from which the amide separated on cooling. All products were compared with authentic samples and shown to be identical. In this way *n*-butyric, benzoic and nicotinic acid hydrazides were converted to the corresponding amides in 60–80% yield.

Cyclohexanecarboxylic Acid Hydrazide.—A mixture of 6.8 g. (0.05 mole) of benzoyl hydrazine, 100 ml. of 95% ethanol and 0.1 g. of Adams catalyst was shaken under an atmosphere of hydrogen for six hours. A heat lamp was employed during this time and 0.15 mole of hydrogen was taken up. The catalyst was removed by filtration and the filtrate was taken to dryness. The residue was dissolved in 100 ml. of hot benzene and, on cooling, 5 g. (70% yield) of cyclohexanecarboxylic acid hydrazide separated. A sample was recrystallized from benzene and obtained as needles, m.p. 156–157° (lit.[1] m.p. 158–159°).

Anal. Calcd. for $C_7H_{14}N_2O$: C, 59.12; H, 9.92; N, 19.70. Found: C, 59.28; H, 9.73; N, 19.87.

Cyclohexanecarboxamide.—Using the general procedure outlined above, 2 g. of cyclohexanecarboxylic acid hydrazide with about 10 g. of Raney nickel gave 1 g. of cyclohexane carboxamide, m.p. 188–189° (lit.[1] m.p. 184–185°).

Anal. Calcd. for $C_7H_{13}NO$: C, 66.10; H, 10.30; N, 11.01. Found: C, 66.34; H, 10.31; N, 11.01.

***dl*-Lysergic Acid Amide or *dl*-Isolysergic Acid Amide.**—To a solution of 1 g. of *dl*-isolysergic acid hydrazide[7] dissolved in 500 ml. of ethanol was added about 10 g. of Raney nickel. The mixture was heated under reflux for two hours with

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[1] S. Olsen and E. Enkenmeyer, *Ber.*, **81**, 359 (1948), obtained cyclohexanecarboxylic acid hydrazide from the corresponding ester and hydrazine. They reported also the conversion of this compound to cyclohexanecarboxamide by treatment with nitrous acid.

[2] A. Stoll and A. Hofmann, *Helv. Chim. Acta*, **26**, 922 (1943).

[3] The interconversion under mild conditions of lysergic and isolysergic acid derivatives is well known; see reference 4.

[4] A. Stoll and A. Hofmann, *Helv. Chim. Acta*, **26**, 944 (1943).

[5] The author is grateful to Dr. E. C. Kornfeld for a sample so prepared.

[6] Melting points were taken on a Fisher–Johns block and recorded as read. The microanalyses were performed by H. L. Hunter and Gloria Beckmann.

[7] Furnished by Dr. R. P. Pioch of this Laboratory.

stirring. The nickel was removed and the filtrate was taken to dryness. The residue was treated with 10 ml. of methanol and the solid was collected by filtration. The product was dissolved in 5 ml. of warm dimethylformamide and 25 ml. of methanol was added. After standing at 5° over the week-end, 0.6 g. (about 60% yield) of the lysergic acid amide was obtained as prisms. The compound on heating melted at 130–133° with gas evolution, resolidified at 140° and began to darken at about 170°, finally remelting at 190–192°. The analytical data obtained for a sample which was dried under reduced pressure at 78° for four hours corresponded to the amide with one mole of methanol of crystallization.

Anal. Calcd. for $C_{16}H_{17}N_3O \cdot CH_3OH$: C, 68.20; H, 7.07; N, 14.04; wt. loss after heating at 140° for 1 hr., 10.70. Found: C, 68.30; H, 7.27; N, 14.15; wt. loss, 140°, 1 hr., 10.00.

The lysergic acid amide obtained above gave a positive van Urk test.[8] It was shown to be identical with the compound prepared by an independent method,[5] by comparison of infrared and ultraviolet absorption curves, and X-ray diffraction patterns.

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(8) H. W. van Urk, *Pharm. Weekblad*, **66**, 473 (1929) [*C. A.*, **23**, 4014 (1929)].

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Metalation of Dibenzoselenophene

BY WILLIAM J. BURLANT AND EDWIN S. GOULD

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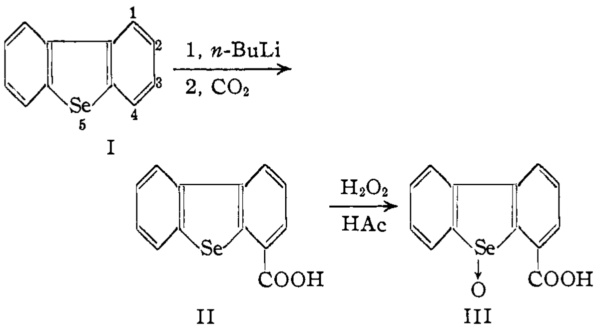
We have been interested in confirming the pyramidal configuration about the selenium atom in selenoxides by resolution of unsymmetric selenoxides; earlier attempts to resolve such compounds were unsuccessful.[1,2] Often resolution is facilitated as the asymmetric centers of the substrate and of the resolving agent approach each other closely; accordingly, the synthesis of a carboxy-substituted cyclic selenoxide III, in which the seleninyl and carboxy groups are close to each other, was undertaken.

The sulfur analog of the unoxidized acid II, has been obtained from the lithiation and subsequent carbonation of dibenzothiophene,[3] but we have been able to find no report of the metalation of dibenzoselenophene. Attempts to metalate diphenyl selenide[4] were not successful.

By using conditions slightly more vigorous than those of Gilman and Esmay,[3] we have succeeded in lithiating dibenzoselenophene; carbonation of the new organometallic compound afforded a dibenzoselenophene carboxylic acid II, in surprisingly high yield (96%). **This appears to be the first successful metalation of an arylselenium compound.** Iodo- and methyl-substituted dibenzoselenophenes have been prepared by treating the lithium compound with iodine and dimethyl sulfate. When the order of carbonation of the lithium salt was reversed, a fair yield of valeryldibenzoselenophene was obtained.

The carboxylic acid was easily oxidized to the desired selenoxide III, but resolution of this compound has not yet been accomplished.



It should be noted that if solution in aqueous media is part of the resolution procedure, manipulations probably should be rapid, for preliminary experiments in this Laboratory, using H_2O^{18}, have shown that dibenzoselenophene-5-oxide exchanges its oxygen with water at an appreciable rate (35% exchange in 90 minutes for a 0.05 *M* solution). If enantiomorphs were isolated, such exchange would possibly be tantamount to racemization.

In light of similar studies on the oxygen, nitrogen and sulfur analogs of dibenzoselenophene,[5] it might be predicted that metalation "*ortho*" to the hetero atom would be most likely. We have employed ultraviolet absorption spectra to suggest orientation of substitution (as has been done in nitration studies by Sawicki and Ray[6]). We find that the spectrum of our carboxylic acid is almost identical with that of its sulfur analog, 4-carboxydibenzothiophene, but quite different from 2-carboxydibenzothiophene.[7] These studies do not, *a priori*, rule out substitution at the 1- or 3-positions, but aside from the chemical unlikelihood of such orientation, it would be expected that the spectra of the 1- and 3-substituted acids would differ greatly from those of the 2- and 4-substituted acids (since conjugation effects between the selenium atom and the carboxyl group would be absent). We have also not precluded the possibility of the formation of small quantities of isomeric acids.

Unfortunately, the recently reported "deselenization" reaction[8] cannot be used to distinguish the 2-acid from the 4-acid, since both should yield biphenyl-3-carboxylic acid upon removal of selenium.

Experimental[9]

4-Carboxydibenzoselenophene (II).—To a solution of *n*-butyllithium in 100 ml. of ether (prepared from 0.5 mole of *n*-butyl bromide and 1.23 g. atoms of lithium[10]) was added 46.2 g. (0.2 mole) of dibenzoselenophene[11] in 400 ml. of dry ether. The mixture was refluxed in a nitrogen atmosphere for four hours. It was then added dropwise and with vigorous stirring to a slurry of powdered Dry Ice in ether. After carbonation, 1 liter of water was added, the mixture shaken and the layers separated. The ether layer was extracted once with water, and the combined aqueous phase washed several times with ether. Subsequent acidification with 6

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(1) W. Gaythwaite, J. Kenyon and H. Phillips, *J. Chem. Soc.*, 2280 (1928), failed to resolve phenyl tolyl selenoxide, *p*-carboxydiphenyl selenoxide and *p*-carboxyphenyl methyl selenoxide; F. Holliman and F. Mann, *ibid.*, 37 (1945), could not resolve selenoisochroman oxide.

(2) E. Gould and J. McCullough, unpublished work, were unable to resolve 2(?)-succinyldibenzoselenophene oxide.

(3) H. Gilman and D. Esmay, THIS JOURNAL, **74**, 266 (1952).

(4) H. Gilman and R. Bebb, *ibid.*, **61**, 109 (1939).

(5) H. Gilman, "Organic Chemistry, An Advanced Treatise," John Wiley and Sons, Inc., New York, N. Y., 1942, Vol. I, pp. 536, *et seq.*

(6) E. Sawicki and F. Ray, THIS JOURNAL, **74**, 4120 (1952).

(7) H. Gilman, *J. Org. Chem.*, **3**, 108 (1938).

(8) G. Wiseman and E. Gould, THIS JOURNAL, **76**, 1706 (1954).

(9) Melting points are corrected. Absorption spectra were determined in 95% ethanol using a Beckman model DU spectrophotometer equipped with a phototube multiplier.

(10) H. Gilman, J. Beel, C. Brannen, M. Bullock, E. Dunn and L. Miller, THIS JOURNAL, **71**, 1499 (1949).

(11) J. McCullough, T. Campbell and E. Gould, *ibid.*, **72**, 5753 (1950).