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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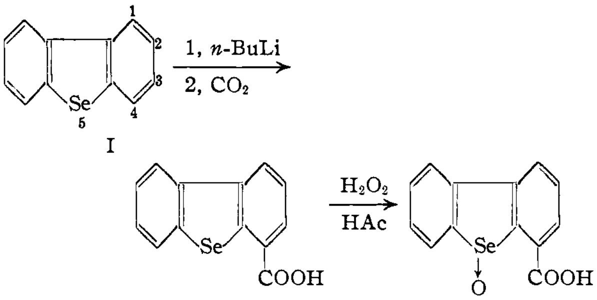
We have been interested in confirming the pyramidal configuration about the selenium atom in selenoxides by resolution of unsymmetric selenoxides; earlier attempts to resolve such compounds were unsuccessful.[1,2] Often resolution is facilitated as the asymmetric centers of the substrate and of the resolving 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.



I

II

III

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).

N hydrochloric acid afforded a tan powder which was redissolved in dilute sodium hydroxide; the basic solution was treated with charcoal, boiled, filtered and reacidified. In this way there was obtained 53.0 g. (96%) of II, melting at 251–255° dec. After two crystallizations from methanol, the melting point was constant at 262–265° dec.

Anal. Calcd. for $C_{13}H_8O_2Se$: C, 56.06; H, 2.92; neut. equiv., 275.2. Found: C, 56.49; H, 2.99; neut. equiv., 278.

Ultraviolet Absorption Spectra.—The ultraviolet spectrum of 4-carboxydibenzoselenophene displayed maxima at 288 mμ, log ϵ 3.81; 296 mμ, log ϵ 3.76; 342 mμ, log ϵ 3.46. The spectrum of the sulfur analog, 4-carboxydibenzothiophene, showed maxima in mμ at 282, log ϵ 3.85; 340, log ϵ 3.51. In the region of the spectra investigated (260–350 mμ) 2-carboxydibenzothiophene had no maxima.

4-Valeryldibenzoselenophene.—When carbonation was effected in the reverse order, by adding powdered carbon dioxide to the mixture containing the lithium salt, no acidic fraction was obtained. When the ether layer was stripped of solvent, the residue was crystallized from methanol. Yellow crystals (37.2 g., 59%), which are presumed to be 4-valeryldibenzoselenophene were thus obtained, melting at 102–108°. After one recrystallization from the same solvent, the melting point was constant at 107–108°.

Anal. Calcd. for $C_{17}H_{16}SeO$: C, 64.76; H, 5.12. Found: C, 64.96; H, 5.21.

A 2,4-dinitrophenylhydrazone, prepared in ethanol and recrystallized from ethanol–acetone, was constant melting at 245–255° dec.

Anal. Calcd. for $C_{23}H_{20}N_4O_4Se$: C, 55.75; H, 4.07. Found: C, 55.68; H, 4.11.

4-Methyldibenzoselenophene.—From 46.2 g. (0.2 mole) of dibenzoselenophene, 0.8 mole of *n*-butyllithium and 25.2 g. (0.2 mole) of dimethyl sulfate, according to a previously described procedure,[3] there was obtained 39.2 g. (80%) of 4-methyldibenzoselenophene. The crude pink crystals melted at 75–80°; after two recrystallizations from low-boiling petroleum ether, the melting point was constant at 83–84°.

Anal. Calcd. for $C_{13}H_{10}Se$: C, 63.68; H, 4.11. Found: C, 63.86; H, 4.14.

4-Iododibenzoselenophene.—Using the method of Gilman and Summers,[12] from 0.2 mole of I and 0.8 mole of *n*-butyllithium, there was obtained 36.4 g. (51%) of white crystals, melting at 96–100°. After one recrystallization from ethanol, the material was constant melting at 99–100°.

Anal. Calcd. for $C_{12}H_7ISe$: C, 40.36; H, 1.97. Found: C, 40.87; H, 2.03.

4-Carboxydibenzoselenophene-5-oxide (III).—The method of McCullough, *et al.*,[11] afforded a quantitative yield of the oxide from 5.5 g. (0.02 mole) of the acid II. The material decomposed at 192–194° (with the evolution of oxygen), and then melted at 260–265° with decomposition (the melting point of (II)).

Anal. Calcd. for $C_{13}H_8O_3Se$: C, 53.62; H, 2.76; iodometric equiv. wt., 291.2. Found: C, 53.44; H, 2.82; iodometric equiv. wt., 292.

Salts.—The strychnine salt of III was prepared by dissolving equimolar quantities of the acid and alkaloid in a small volume of 95% ethanol, boiling for 10 minutes, filtering, adding ether to incipient cloudiness and chilling for an hour. The white crystals were obtained in quantitative yield, decomposing at 170–177°. One crystallization from the same solvent changed the decomposition point to 169–171°, $[\alpha]^{23}D$ 0.00° in the concentration range of 0.2 to 2.0%, in 95% ethanol. Further purification failed to change the melting point or the specific rotation.

Anal. Calcd. for $C_{34}H_{30}N_2O_5Se$: C, 65.28; H, 4.83; N, 4.47. Found: C, 65.19; H, 4.89; N, 4.71.

In an attempt to obtain the free acid, the salt was treated with 10% sodium hydroxide solution, stirred and filtered to remove the liberated strychnine; when the filtrate was acidified with 10% aqueous sulfuric acid, the material recovered, in quantitative yield, was the reduced acid II. Its identity was established by a mixed melting point with an authentic sample.

With cinchonine, quinine and brucine there were obtained oils or non-purifiable mixtures.

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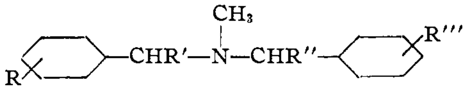
[12] H. Gilman and L. Summers, THIS JOURNAL, **72**, 2767 (1950).

Catalytic Debenzylation. IV. The Competitive Hydrogenolysis of Benzyl-like Groups Attached to Different Nitrogen Atoms

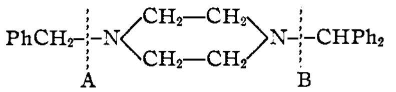
BY RICHARD BALTZLY AND PETER B. RUSSELL

RECEIVED MAY 13, 1954

In previous papers in this series[1–3] the effect of substitution, both in the aromatic nuclei and on the α-positions, on the relative ease of cleavage of the benzyl groups in a dibenzylmethylamine (I) by hydrogenolysis has been studied. The results are open to objection on the grounds that the substitution in one nucleus might have an effect on the ease of cleavage of the other.[4] Indeed that some such effect does in fact operate is quite obvious since the over-all rate of hydrogenolysis is a function of the total substitution in I rather than the substitution of the benzyl group removed.[2]



I



II

The present communication presents a brief series of experiments which show clearly that the *relative* ease of cleavage of a benzyl group from I is a function of the substitution *in that group alone* and not in I as a whole.

The first experiments were carried out with N-benzyl-N′-benzhydrylpiperazine (II). Here although both benzyl-like groups are in the same molecule they are attached to different isolated nitrogen atoms and presumably the above objections no longer apply. Hydrogenolysis of II under the usual conditions[1–3] in the absence of added acid (redn. 1) gave predominately the cleavage A (*ca.* 70%) with some cleavage B (30–40%). In acid solution (redn. 2), however, the cleavage was almost unilateral in the direction A.

Similar results were obtained when a mixture of N-benzhydryl-N′-methyl- and N-benzyl-N′-methylpiperazines was hydrogenated. Under acid conditions (redn. 4) the benzhydryl group was cleaved to a less extent than in the absence of acid (redn. 3) (19:35).

These results are in accord, qualitatively at

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(1) R. Baltzly and J. S. Buck, THIS JOURNAL, **65**, 1984 (1943).

(2) R. Baltzly and P. B. Russell, *ibid.*, **72**, 3410 (1950).

(3) *Idem, ibid.*, **75**, 5598 (1953).

(4) H. Dahn, P. Zoller and V. Solms, *Helv. Chim. Acta*, **37**, 565 (1954).