this material was identified as fluorenone-3-carboxylic acid (lit.[19] m.p. 286°). A larger quantity (18 mg.) of water-soluble acid XXIV was isolated; m.p. 195–200°. This was identified as trimellitic acid. The m.p. of an analytical sample was 206°.

Anal. Calcd. for $C_9H_6O_6$: C, 51.4; H, 2.86. Found: C, 51.6; H, 2.92; microcuries of carbon-14 per millimole of XXIV, 1.08.

Discussion of Results

The observed carbon-14 distribution in the product VII is good evidence for a steric effect owing to the *o*-methyl group during the dehydration–rearrangement of 2-phenyl-2-(*o*-tolyl)-ethanol-1-C^{14} (VI). The difference from unity of the ratio (55.0 ± 0.5/45.0 ± 0.5 = 1.22 ± 0.01) of phenyl to *o*-tolyl migration is clearly much greater than the error inherent in the radioactivity determinations so that the greater per cent. of phenyl migration is a real and significant value.

The carbon-14 distribution in the product XV indicates that the over-all influence of the methyl group on the dehydration–rearrangement of 1-methyl-9-fluorenylcarbinol (XIV) is negligible, since the phenyl and *o*-tolyl moieties in this carbinol have migrated in the ratio of 50:50. This result is quite unexpected in view of the known electrical effect of a methyl group.[20] If the steric effect of the methyl group in XIV is assumed to be negligible (*vide supra*), then the electrical effect of the methyl group must also be assumed to be negligible. A negligible electrical effect could be explained on the basis of a resonance interaction between the phenyl and *o*-tolyl moieties of XIV through the biphenyl (4a–4b) bond. The only other plausible explanation for the equal migration ratios of the phenyl and *o*-tolyl moieties of XIV would be that the electrical and steric effects of the methyl group almost exactly cancel each other. In the hope that additional data may be gathered which would allow a choice between these two explanations, the dehydration–rearrangement of 3-methyl-9-fluorenyl-(carbinol-C^{14}) is under investigation. It is assumed that the time variable (electromeric) and static (inductive) effects of the methyl groups in this latter compound and in XIV should be nearly identical.

The rearrangement of carbinols VI and XIV may be formulated as proceeding through resonance-stabilized intermediates analogous to those discussed in the preceding paper.[1c,21]

Acknowledgment.—The authors are indebted to Drs. G. B. Butler, W. M. Lauer and J. D. Roberts for many helpful suggestions during the course of this research.

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[19] A. Sieglitz and J. Schalzhes, *ibid.*, **54**, 2070 (1921).

[20] Drs. J. G. Burr and L. S. Ciereszko in this Laboratory have shown that the *p*-tolyl group in 2-phenyl-2-(*p*-tolyl)-ethanol-1-C^{14} migrates in preference to the phenyl group in the ratio of 66:34 when this carbinol is subjected to the conditions of the Wagner rearrangement.

[21] This formulation is similar to that supported by Cram to explain his results in the Wagner–Meerwein rearrangements of isomers of 3-phenyl-2-butanol and similar compounds: D. J. Cram, THIS JOURNAL, **71**, 3863 (1949); D. J. Cram and R. Davis, *ibid.*, **71**, 3871 (1949); D. J. Cram, *ibid.*, **71**, 3875 (1949).

OAK RIDGE, TENNESSEE

[CONTRIBUTION FROM THE CHEMISTRY DIVISION OF OAK RIDGE NATIONAL LABORATORY]

Studies in the Wagner Rearrangement. V. Further Evidence for a Steric Effect[1,2]

BY CLAIR J. COLLINS, LEON S. CIERESZKO[3] AND JOHN G. BURR, JR.

RECEIVED JUNE 16, 1952

The radioactivity distributions in the products of the dehydration–rearrangement of 2-phenyl-2-(α-naphthyl)-ethanol-1-C^{14} and 2-phenyl-2-(β-naphthyl)-ethanol-1-C^{14} have been determined and the per cent. migrations of the phenyl and naphthyl groups have been calculated for each system. These migration ratios are: α-naphthyl:phenyl = 52:48; β-naphthyl: phenyl = 56:44. The present results are compared with previous work, and are discussed with respect to steric considerations and the presumed carbonium ion intermediates.

Introduction

The Wagner rearrangements of 11H-benzo[b]-fluorene-11-methanol-C^{14} (I, 52% β-naphthyl migration, 48% phenyl migration)[4a] and of 11H-benzo[a]fluorene-11-methanol-C^{14} (II, 76% α-naphthyl migration and 24% phenyl migration)[4b] have been reported. For the latter reaction it was suggested that the steric influence of the carbon and hydrogen at the 1-position of II should be either very small or negligible. Next 1-methyl-9-fluorenyl-(carbinol-C^{14}) (V) and 2-phenyl-2-(*o*-tolyl)-ethanol-1-C^{14} (VI) were prepared and subjected to the conditions of the Wagner rearrangement.[2] While the results indicated a steric effect during the rearrangement of VI, the methyl group in V had no apparent over-all influence on the course of the rearrangement of this carbinol, since the ratio of phenyl to *o*-tolyl migration was 50:50. This result was unexpected since, if the methyl group of V exerts no steric effect, the electromeric and inductive effects of this methyl group should enhance the migration tendency of the *o*-tolyl fragment of carbinol V.

In the present paper we report the migration ratios during the Wagner rearrangements of

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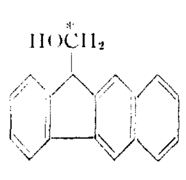
[1] This paper is based upon work performed under Contract Number W-7405-eng 26, for the Atomic Energy Commission at the Oak Ridge National Laboratory.

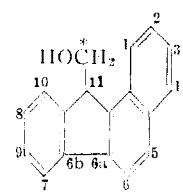
[2] Previous paper, B. M. Benjamin and C. J. Collins, THIS JOURNAL, **75**, 402 (1953).

[3] Member of the Research Participation Program jointly sponsored by the Oak Ridge Institute of Nuclear Studies and this Laboratory, September, 1951–February, 1952.

[4] (a) C. J. Collins, J. G. Burr and D. N. Hess, THIS JOURNAL, **73**, 5176 (1951); (b) C. J. Collins, D. N. Hess, R. H. Mayor, G. M. Toffel and A. R. Jones, *ibid.*, **75**, 397 (1953). The migrating groups are connected by a biphenyl-type bond, and thus are not strictly "naphthyl" and "phenyl" groups. In the interest of ease of expression, however, these fragments, as well as other migrating fragments in the 9-fluorenylcarbinol series, will be referred to by these simpler names.



I



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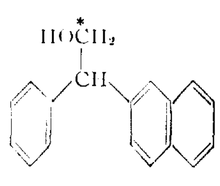

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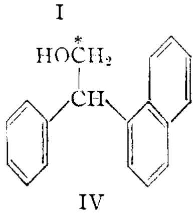

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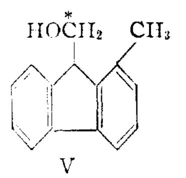

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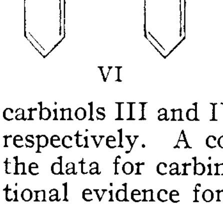

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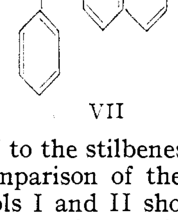
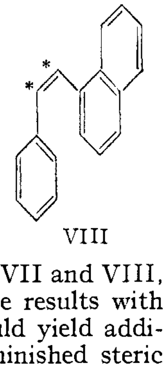


VII



VIII

carbinols III and IV to the stilbenes VII and VIII, respectively. A comparison of these results with the data for carbinols I and II should yield additional evidence for or against a diminished steric effect in the 9-fluorenylcarbinol series, since if the 6a–6b bond in II prevents the carbon and hydrogen in the 1-position from exerting a steric effect during Wagner rearrangement, then the migration ratio of the α-naphthyl group of IV should be significantly smaller than that of the α-naphthyl moiety of II. The synthetic and degradative techniques were similar to those reported elsewhere for analogous compounds.[2,4,5] These results show that β-naphthyl migration is preferred over phenyl migration for carbinol III in the ratio 56:44, while the ratio of α-naphthyl to phenyl migration for carbinol IV is 52:48.

Discussion of Results

The rearrangement reactions known as "1,2-shifts"[6] have been the subjects of chemical investigations for many years. Studies of the rearrangements of unsymmetrical pinacols[7] produced confusing results chiefly because of the difficulties encountered in isolating the principal reaction products[8] and in recognizing the existence of stereospecific reactions.[9–11] During the classical work with symmetrical pinacols[12] the difficulties arising from differences in the respective strengths of the two pinacolic carbon–oxygen bonds[7a] were circumvented, although such factors as stereospecificity[9–11] the variation in degree of migrating group participation in the rate-determining hydroxyl ion removal,[13a] and solvent effect[13b] were not considered.

Although it would be assumed from Bachmann's work[9a] on 1,2-diphenyl-1,2-di-(α-naphthyl)-1,2-ethanediol and its β-naphthyl analog that the "intrinsic migratory aptitudes" of the α- and β-naphthyl groups are much greater than phenyl, the work of Bergmann and Schuchardt[9b] showing stereospecificity in phenyl and α-naphthyl migrations would cast doubt on these conclusions. Previous attempts[14–16] to relate the α-naphthyl and phenyl migratory aptitudes were similarly inconclusive. The migratory aptitude of the o-tolyl group has not been determined since 1,2-diphenyl-1,2-di-(o-tolyl)-1,2-ethanediol has been reported not to react when submitted to the conditions of the pinacol rearrangement.[12c]

The work presented here, in the paper by Burr and Ciereszko,[5] and in three papers by Collins, *et al.*,[2,4] develops an experimental approach whereby the migration ratios of various groups may be determined with a precision of ±1%, and without the complications mentioned in a preceding paragraph.[17] The product yields are essentially quantitative during the crucial reactions, although the determination of migration ratios is *not dependent* upon a quantitative separation of two products from a reaction mixture but only upon the carbon-14 distribution in a single compound. Thus per cent. migrations of the α-naphthyl moieties during the dehydration–rearrangements of carbinols II and IV are 76 and 52, respectively. It has therefore been demonstrated that the presence of the 6a–6b (biphenylene) bond in carbinol II enhances the ability of the α-naphthyl moiety to migrate. This result is consistent with the suggestion that the carbon and hydrogen in the 1-position of carbinol II exert a very small steric effect during the rearrangement of this compound.[18] Another possible explanation for these results might be that during the dehydration–rearrangement of II, intermediate IX, which would be expected to favor α-naphthyl migration, makes a considerable contribution to the transition state. Such an intermediate should be of more importance than X, favoring phenyl-group migration. This explanation, however, is not considered too likely in view

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[5] J. G. Burr and L. S. Ciereszko, THIS JOURNAL, **74**, 5426 (1952).

[6] See G. W. Wheland, "Advanced Organic Chemistry," 2d edition, John Wiley and Sons, Inc., New York, N. Y., 1949, pp. 451–534. for an excellent discussion of 1,2-shifts.

[7] (a) M. Tiffeneau and J. Levy, *Bull. soc. chim.*, [IV] **33**, 759 (1923); (b) A. M. McKenzie, R. Roger and W. B. McKay, *J. Chem. Soc.*, 2597 (1932).

[8] A. McKenzie and R. Roger, *ibid.*, 844 (1924).

[9] (a) W. E. Bachmann and R. V. Shankland, THIS JOURNAL, **51**, 306 (1929); (b) E. Bergmann and W. Schuchardt, *Ann.*, **487**, 234 (1931).

[10] (a) P. I. Pollak and D. Y. Curtin, THIS JOURNAL, **72**, 961 (1950); (b) **73**, 992 (1951).

[11] E. Alexander and D. C. Dittmer, *ibid.*, **73**, 1665 (1951).

[12] (a) P. J. Montagne, *Rec. trav. chim.*, **26**, 253 (1907); (b) J. C. Bailar, THIS JOURNAL, **52**, 3596 (1930); (c) W. E. Bachmann and F. H. Moser, *ibid.*, **54**, 1124 (1932); (d) W. E. Bachmann and J. W. Ferguson, *ibid.*, **56**, 2081 (1934).

[13] (a) Paper XI, S. Winstein and D. Trifan, *ibid.*, **74**, 1154 (1952), and previous papers; (b) R. F. Brown, *ibid.*, **74**, 428 (1952); R. F. Brown, J. B. Nordmann and M. Madoff, *ibid.*, **74**, 432 (1952).

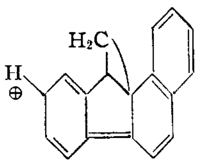
[14] A. McKenzie and A. C. Richardson, *J. Chem. Soc.*, **123**, 79 (1923).

[15] A. McKenzie and W. S. Dennler, *ibid.*, **125**, 2105 (1924).

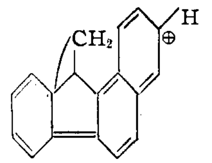
[16] E. Luce, *Compt. rend.*, **180**, 145 (1925).

[17] This technique was apparently first employed to show that hydrogen migration takes place to the complete exclusion of methyl migration during the pinacol rearrangement of 1-methyl-1,2-butanediol; J. D. Roberts, R. E. McMahon and J. S. Hine, THIS JOURNAL, **71**, 1896 (1949).

[18] R. T. Arnold, J. J. Webers and R. M. Dodson, *ibid.*, **74**, 368 (1952), have shown that the steric effect of an o-methylene group which is part of a five-membered ring is much less than the steric effect of an o-methylene group which is part of a six-membered ring, thus lending support to our suggestion.



IX



X

of the observation that β-naphthyl migration during the rearrangement of carbinol III occurs to the extent of 56% while β-naphthyl migration during rearrangement of carbinol I occurs to the extent of 52%. Here the net effect of the biphenyl bond in carbinol I is a repression of the tendency of the β-naphthyl moiety to migrate. The data for the dehydration rearrangements of carbinols I and III, in fact, seem to substantiate the case for a large ortho-steric effect in compound IV and a small or negligible ortho-steric effect in Compound II.

Experimental

Analytical Determinations.—Carbon-14 determinations were performed by wet combustion to carbon dioxide of 1–5-mg. samples of the analytically pure organic compounds followed by ion-chamber determinations of the carbon-14 content using a vibrating-reed dynamic condenser electrometer. This method has been described by Neville.[19] Standardization of ion-current values was made against carbon-C^{14} dioxide generated from Bureau of Standards sodium carbonate solutions. Melting points are uncorrected. Carbon and hydrogen assays were performed by Dr. Harry W. Galbraith, Knoxville, Tennessee.

Phenyl-(β-naphthyl)-acetonitrile-1-C^{14}.—This compound was prepared from phenyl-(β-naphthyl)-carbinol[20] and thionyl chloride. The phenyl-(β-naphthyl)-chloromethane was not isolated, but the crude product (80% purity as measured by chlorine analysis) prepared from 12 g. of the carbinol was intimately mixed with 3.0 g. of cuprous cyanide-C^{14}. The flask containing this mixture was immersed in an oil-bath which had been preheated to 200°. During the two-hour reaction time the bath was maintained at 200–210°. The cooled melt was extracted with acetone, and after removal of the acetone by evaporation the residue was distilled under high vacuum in a short-path still to give a thick yellow oil. This oil was dissolved in acetone and a white amorphous residue was removed by filtration. From the acetone solution 4 g. (32%) of an oil was obtained which crystallized over a two-day period. One crystallization from hexane yielded white prisms, m.p. 85–86°.

Anal. Calcd. for $C_{18}H_{13}N$: N, 5.76. Found: N, 5.75; microcuries of carbon-14 per millimole, 4.14, 4.18.

2-Phenyl-2-(β-naphthyl)-acetic-1-C^{14} Acid.—The nitrile (3.2 g.) was hydrolyzed in 40 cc. of 50% (by volume) sulfuric acid. The mixture was refluxed for four hours, then cooled, and the oily layer which separated was extracted with ether. The ether layer was extracted with 2 *M* sodium hydroxide. Acidification of this alkaline extract yielded a tan oil which subsequently crystallized. This solid was filtered. One crystallization from boiling alcohol after treatment with Norit followed by a second crystallization from aqueous methanol yielded needles, m.p. 128–130°, yield of purified material 1.65 g. (50%).

Anal. Calcd. for $C_{18}H_{14}O_2$: C, 82.5; H, 5.38. Found: C, 82.4; H, 5.49; microcuries of carbon-14 per millimole, 4.09, 4.10, 4.12, 4.09.

2-Phenyl-2-(β-naphthyl)-ethanol-1-C^{14} (III).—This alcohol was prepared by the action of 3 g. of lithium aluminum hydride on 1.1 g. of 2-phenyl-2-(β-naphthyl)-acetic-1-C^{14} acid in ether solution. The excess hydride was decomposed with ethyl acetate and dilute aqueous sodium hydroxide. Ether extracts of the hydrolyzed mixture yielded 1.1 g. (94%) of an oil which later crystallized. One crystallization from hexane gave needles, m.p. 63–64°.

Anal. Calcd. for $C_{18}H_{16}O$: C, 87.1; H, 6.50. Found: C, 87.3; H, 6.67.

1-Phenyl-2-(β-naphthyl)-ethylene-1,2-C_1^{14} (VII).—Rearrangement of 800 mg. of carbinol III was effected using 2 g. of phosphorus pentoxide and 25 cc. of xylene. The procedure was the same as that previously reported[4] for the preparation of benz[a]anthracene-5,6-C_1^{14}. Crystallization of the crude product from methanol yielded a first crop of 220 mg. of thick needles, m.p. 146–147° (lit.[21] 145–146°). A second crop of 150 mg. was obtained from the mother liquors; yield of purified product, 50%.

Oxidation of 2-Phenyl-2-(β-naphthyl)-ethylene-1,2-C_1^{14} (VII).—This oxidation was carried out by boiling under reflux for two hours 99 mg. of VII, 1.0 g. of potassium permanganate, 10 cc. of water and 15 cc. of acetone. This reaction mixture was cooled and passed through a filter. The filtrate was concentrated with an air-stream until the acetone had been removed, and the remaining solution was acidified, chilled and filtered. After one crystallization from methanol the solid naphthoic acid was redissolved in molar sodium hydroxide, treated with Norit and filtered. The filtrate was acidified, and the white crystals of β-naphthoic acid were filtered from the warm solution; m.p. 180–183° with sublimation (lit.[22] 184–185°), yield 22 mg.

Anal. Microcuries carbon-14 per millimole of α-naphthoic-*carboxy*-C^{14} acid, 2.30, 2.26, 2.27.

Phenyl-(α-naphthyl)-acetonitrile-1-C^{14}.—This nitrile was prepared in the same manner as the phenyl-(β-naphthyl)-acetonitrile-1-C^{14}. Thus from phenyl-(α-naphthyl)-carbinol[23] 10.7 g. of crude phenyl-(α-naphthyl)-chloromethane[24] was obtained. This was treated with 3.1 g. of cuprous cyanide-C^{14} to yield 5.85 g. (52%) of distilled nitrile. This distillate crystallized spontaneously. One crystallization from hexane yielded a material whose m.p. was 95–96° (lit.[25] 97°).

Anal. Microcuries of carbon-14 per millimole, 1.66, 1.66.

2-Phenyl-2-(α-naphthyl)-acetic-1-C^{14} Acid.—The nitrile was hydrolyzed similarly to the β-isomer. Thus 2.15 g. of nitrile yielded 2.14 g. (92%) of 2-phenyl-2-(α-naphthyl)-acetic-1-C^{14} acid, m.p. 140–141°.[26]

Anal. Microcuries of carbon-14 per millimole, 1.66.

2-Phenyl-2-(α-naphthyl)-ethanol-1-C^{14} (IV).—A lithium aluminum hydride reduction of 1.79 g. of 2-phenyl-2-(α-naphthyl)-acetic-1-C^{14} acid yielded 800 mg. of purified carbinol IV, m.p. 91–92°.

Anal. Calcd. for $C_{18}H_{16}O$: C, 87.1; H, 6.50. Found: C, 87.3; H, 6.41.

1-Phenyl-2-(α-naphthyl)-ethylene-1,2-C_1^{14} (VIII).—A procedure identical with that used for the preparation of compound VII was employed to convert 720 mg. of IV to 670 mg. (100%) of the stilbene VIII; m.p. 69–71° (lit.[21] m.p. 70.5°).

Oxidation of 1-Phenyl-2-(α-naphthyl)-ethylene-1,2-C_1^{14} (VIII).—This oxidation was carried out analogously to the oxidation of VII, using 100 mg. of VIII. The yield of purified α-naphthoic-*carboxy*-C^{14} acid was 26 mg. (35%), m.p. 159–160° (lit.[27] 159–161°).

Anal. Microcurie of carbon-14 per millimole, 0.869, 0.872, 0.865, 0.875, 0.866 (av. 0.868).

Calculation of Migration Ratios. (a) For the Rearrangement of 2-Phenyl-2-(β-naphthyl)-ethanol-1-C^{14} (III).—The average millimolar radioactivity for β-naphthoic-*carboxy*-C^{14} acid (2.28 μc.) obtained by the oxidation of VII, when divided by the millimolar radioactivity of III (4.10 μc. as determined for 2-phenyl-2-(β-naphthyl)-acetic-1-C^{14} acid) gives the factor for β-naphthyl migration. Thus, (2.28 ÷ 4.10) × 100 = 55.6% β-naphthyl migration (44.4% phenyl migration).

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[24] J. F. Norris and J. T. Blake, This Journal, **50**, 1812 (1928).

[25] H. A. Michael and J. Jeanpretre, *Ber.*, **25**, 1618 (1892).

[26] A. McKenzie and H. S. Tattersall, *J. Chem. Soc.*, **123**, 2527 (1925).

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(b) **For the Rearrangement of 2-Phenyl-2-(α-naphthyl)-ethanol-1-C^{14} (IV).**—Using 0.868 μc. as the average molar radioactivity of α-naphthoic-*carboxy*-C^{14} acid, and 1.66 μc. as the average molar radioactivity of IV (as determined for phenyl-(α-naphthyl)-acetonitrile-1-C^{11} and for 2-phenyl-2-(α-naphthyl)-acetic-1-C^{14}), (0.868 ÷ 1.66) × 100 = 52.3% α-naphthyl migration (and 47.7% phenyl migration).

Acknowledgment.—The authors are indebted to Drs. J. D. Roberts and W. M. Lauer for many helpful suggestions during the course of this research.

OAK RIDGE, TENNESSEE

[CONTRIBUTION FROM THE RESEARCH LABORATORIES, THE UPJOHN COMPANY]

Microbiological Transformations of Steroids. III.[1] Preparation of 11-Epi-corticosterone and of 6β-Hydroxy-11-desoxycorticosterone

BY S. H. EPPSTEIN, P. D. MEISTER, D. H. PETERSON, H. C. MURRAY, H. MARIAN LEIGH, D. A. LYTTLE, L. M. REINEKE AND A. WEINTRAUB

RECEIVED SEPTEMBER 29, 1952

11-Desoxycorticosterone (or its acetate) is converted to 11-epicorticosterone by the mold *Rhizopus nigricans*. 11-Desoxycorticosterone (or its acetate) is converted to 6β-hydroxy-11-desoxycorticosterone by *Rhizopus arrhizus*.

Discussion

With our discovery that molds of the genus *Rhizopus* (order of *Mucorales*) can oxygenate progesterone to hydroxylated steroids and especially to 11α-hydroxyprogesterone,[2] a systematic study was made of the ability of these organisms to introduce oxygen into various steroids. This paper reports on the biooxygenation of 11-desoxycorticosterone and its acetate by *Rhizopus nigricans* Ehrb. (A.T.C.C. 6227b) and *Rhizopus arrhizus* Fischer (A.T.C.C. 11145).

Our general procedures and techniques have been reported in the preceding publications. Medium H at a *p*H of 4.5–5.0 was employed together with a growth to conversion cycle of usually 24 hr./24 hr. A concentration of 11-desoxycorticosterone acetate (I) of 0.25 g./liter of medium was optimal under the fermentation conditions used, whereas somewhat lower concentrations of 11-desoxycorticosterone, free alcohol, (II) were employed because of its greater inhibitory effect upon the course of the bioconversion. Since the fermentations with these two steroid substrates are otherwise identical, only the experiments on I with the two species of *Rhizopus* will be reported in detail. The major product of the biooxygenation of I or II by *Rhizopus nigricans* can be isolated most conveniently from the steroid-containing solvent-free extractives in one of several ways—direct crystallization by addition of ether, crystallization from ethyl acetate after removal of extraneous oily material with *n*-hexane, or column chromatography over Florisil.[3] The major biooxygenation product of I or II by *Rhizopus arrhizus* can be obtained by column chromatography over Florisil.

Under our conditions *Rhizopus nigricans* and *Rhizopus arrhizus* convert I or II completely in a 24-hour period. With *Rhizopus nigricans* one main component (III) is formed which by paper chromatography[2b,2c] has a mobility slower than that of corticosterone. A small amount of a material (IV) more polar than III is invariably formed (about 3% by paper chromatographic estimation). Its chemistry will be discussed at a future date.

By selective acetylation of III the C-21 acetate (V) was formed. Reaction with two equivalents of acetic anhydride yielded the diacetate (VII). Oxidation of V with chromic anhydride yielded a compound (VI) identical to 11-dehydrocorticosterone-21-acetate (compound A acetate) by the following physical criteria: melting point, mixed melting point, optical rotation, infrared, paper chromatography and elementary analysis. An authentic sample of corticosterone was carried through the same reactions. A comparison of the constants of the two preparations with those found in the literature for compound A acetate is given in Table I.

TABLE I

COMPARISON OF CONSTANTS OF COMPOUND A ACETATE DERIVED FROM EPICORTICOSTERONE AND CORTICOSTERONE

	VIa (from III)	VIb (from corticosterone)	VI (literature)[4]
M.p., °C.	179–181	179–181	179–181
Mixed m.p., °C.	179–181		
[α]D (dioxane)	239°	235°	234°

Infrared spectra identical for VIa and VIb.

This sequence of reactions establishes III as 11-epicorticosterone or 11α,21-dihydroxy-4-pregnene-3,20-dione (since by paper chromatography and other physical properties as well as by its ability to form a diacetate readily, III is different from corticosterone).

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(1) Paper II by P. D. Meister, D. H. Peterson, H. C. Murray, S. H. Eppstein, L. M. Reineke, A. Weintraub and H. Marian Leigh, THIS JOURNAL, **75**, 55 (1953).

(2) (a) D. H. Peterson and H. C. Murray, *ibid.*, **74**, 1871 (1952); (b) D. H. Peterson, H. C. Murray, S. H. Eppstein, L. M. Reineke, A. Weintraub, P. D. Meister and H. Marian Leigh, *ibid.*, **74**, 5933 (1952); (c) U. S. Patent 2,602,769, filed Feb. 23, 1952, issued July 8, 1952, based on an original application filed Aug. 19, 1950. The biooxygenations described in detail in the present communication were disclosed in this patent. In THIS JOURNAL, **74**, 3962 (1952), J. Fried, *et al.*, *via* a Communication to the Editor describe the biooxygenation of desoxycorticosterone to 11-epicorticosterone by *Aspergillus niger*.

(3) A synthetic magnesia-silica gel made by the Floridin Co., Warren, Pa.

(4) T. Reichstein and C. W. Shoppee, *Vitamins and Hormones*, **I**, 363 (1945).