Experimental Part

1,7-Dimethyl-4-bromoindene-1 (II).—A Grignard reaction, using 25 g. of 7-methyl-4-bromohydrindone-1, 32 g. of methyl iodide, and 8.3 g. of magnesium, and refluxing the mixture for fifteen minutes, gave, after evaporation of the washed and dried ethereal extract, 26 g. of the crude carbinol as a viscous oil. This was heated at 190° for twenty minutes to effect dehydration, and the indene was purified by steam distillation from a mixture of the somewhat dark oil with dilute sodium hydroxide solution. The colorless, mobile oil was extracted, dried and distilled in vacuum; b. p. 110–111° at 1.8 mm.; yield, 15.6 g. (63%). The substance decomposes when distilled at atmospheric pressure and it polymerizes on long standing.

Anal. Calcd. for $C_{11}H_{11}Br$: C, 59.19; H, 4.98. Found: C, 59.30; H, 4.61.

1,7-Dimethyl-4-bromohydrindene (III) was obtained in 80% yield by hydrogenating the unsaturated compound in absolute alcohol solution using Adams catalyst. After removing the solvent by fractionation, the product was obtained as a mobile liquid, b. p. 98.5° at 1.5 mm.

Anal. Calcd. for $C_{11}H_{13}Br$: C, 58.67; H, 5.82. Found: C, 58.61; H, 5.50.

1,7-Dimethyl-4-(α-naphthoyl)-hydrindene (IV).—The Grignard reagent from 12 g. of III was prepared by the technique described in our earlier work[1] and added to a stirred solution of 23 g. of α-naphthoyl chloride in ether at −10°. After refluxing overnight and decomposing the mixture, the ether-soluble portion was subjected to steam distillation in the presence of alkali in order to remove an oily by-product (dimethylhydrindene?) and to hydrolyze unchanged acid chloride. After extracting with ether and thorough washing with alkali, the reaction product was distilled in vacuum, giving a viscous, pale yellow oil; yield, 9.4 g. (59%). Seed was obtained after standing for several weeks, and the substance then crystallized from petroleum ether as small, colorless needles melting at 112–114°.

Anal. Calcd. for $C_{22}H_{20}O$: C, 87.95; H, 6.72. Found: C, 87.87; H, 6.77.

16,20-Dimethylcholanthrene (V).—Pyrolysis of the crude ketone (9 g.) under nitrogen at 400–405° for thirty minutes gave, after distillation in vacuum and one crystallization from ether, 1.7 g. (20%) of yellow hydrocarbon, m. p. 154–155°. The material was purified through the picrate and crystallized once from ether: yellow, m. p. 161–162°. A solution in benzene (50 cc. per 0.1 g.) was passed through an adsorption tower of activated alumina, which removed further colored impurities: pale yellow plates, m. p. 166–167.5°, corr. After four repetitions of the adsorption process, the hydrocarbon was obtained as plates from ether, m. p. 169–170°, corr., having a barely visible yellow tinge. The solution in concentrated sulfuric acid is orange-red. On mixing the sample with methylcholanthrene the melting point was depressed about 14°.

Anal. Calcd. for $C_{22}H_{18}$: C, 93.58; H, 6.43. Found: C, 93.58; H, 6.35.

The *picrate* crystallizes from benzene as black prisms melting at 179–180°, corr. (depression with methylcholanthrene picrate).

Anal. Calcd. for $C_{28}H_{21}O_7N_3$: N, 8.22. Found: 8.33.

CONVERSE MEMORIAL LABORATORY
CAMBRIDGE, MASSACHUSETTS RECEIVED JUNE 18, 1935

NOTE

The Oxidizing Faculty of Nitrogen Oxide

BY JANNIK BJERRUM[1] AND LEONOR MICHAELIS

It has been recently observed by Meyerhof[2] that in certain types of biological systems which utilize molecular oxygen as oxidant in the respiration process, nitric oxide can be used in place of oxygen, being reduced to nitrous oxide during the process. This observation suggested that nitric oxide might be reduced by other easily oxidizable organic compounds. The experiment was tried with various leuco dyes, such as those of methylene blue, pyocyanine and 2,6-chloroindophenol, with substituted *p*-phenylenediamines, and with semiquinoid violet reduction products of the quaternary γ,γ′-dipyridylium compounds (viologens).

The dye was dissolved in a buffer solution, some drops of a 1% solution of colloidal palladium added, hydrogen bubbled through the system until the dye was reduced, the hydrogen washed out with nitrogen and nitric oxide generated from ferrous sulfate and sodium nitrite, according to the procedure of O. Warburg,[3] was passed through the solution. The dye was gradually oxidized. With methylene blue this was shown to occur both in acid and alkaline solution, in aqueous solution and in alcoholic solution.

(1) Fellow of the Rockefeller Foundation.

(2) Meyerhof and Schulz, *Biochem. Z.*, **275**, 147 (1934).

(3) O. Warburg, *ibid.*, **189**, 354 (1927).

Pyrogallol, dissolved in pure water, was also found to be oxidized but only after addition of a little palladium.[4]

In the second series, ascorbic acid (Vitamin C) instead of hydrogen was used as a reductant. It was added to the reaction vessel containing the dye through a stopcock funnel in amount just sufficient to reduce the dye. When thereafter nitric oxide was bubbled through the system, no oxidation of the leuco-dye took place, but on the addition of a few drops of colloidal palladium, oxidation occurred. With tetramethyl- or tetraethyl-*p*-phenylenediamine no previous reduction is necessary. These were dissolved in acetate buffer and de-aerated with nitrogen. They are oxidized by NO, but only in the presence of palladium.

A further series of experiments, using the same apparatus, was made with inorganic salts. Nitric oxide passed into an aqueous solution of ferrous sulfate, pyrophosphate and tartrate gave deeply colored solutions of the nitroso complexes. When, however, the nitric oxide was removed by passing purified nitrogen through the solution,[5] it could be shown that no oxidation had taken place either in the presence or absence of palladium. From the literature it is known that chromous and stannous salts in aqueous solution are oxidized by nitric oxide without a catalyst, ammonia and hydroxylamine being formed. We found, in addition, that when nitric oxide was passed through solutions of cuproammino or chloro complexes prepared in the reaction vessel from the corresponding cupric complex and metallic copper, slow oxidation took place either to the complex cupric salt or to the complex nitroso cupric salt.

CONTRIBUTION FROM THE
LABORATORIES OF THE
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(4) According to Oppenheimer [*Ber.*, **36**, 1744 (1903)], pyrogallol is oxidized without catalyst in alkaline solution, nitrous oxide being formed.

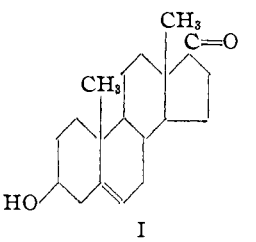
(5) *Cf.* Manchot, *Ber.*, **47**, 1601, 1614 (1914).

COMMUNICATIONS TO THE EDITOR

THE CONSTITUTION OF DEHYDRO-ANDROSTERONE AND ITS PREPARATION FROM CHOLESTEROL

Sir:

In the course of certain experiments on male urine, there has been isolated besides androsterone, $C_{19}H_{30}O_2$, an unsaturated hydroxy ketone of the formula $C_{19}H_{28}O_2$, which has been called dehydro-androsterone [Butenandt and Dannenbaum, *Z. physiol. Chem.*, **229**, 192 (1934)]. In most of these experiments this hydroxy ketone has not been isolated as such, but rather has been obtained in the form of its chloride derivative. Butenandt has transformed this hydroxy ketone into androsterone, and therefore the constitutional formula, I, has been assigned. The position of the double bond and the arrangement of the hydroxyl group in this formula are still uncertain. The name assigned to this unsaturated hydroxy ketone suggests that the hydroxyl group has the same stereochemical



I

arrangement as in androsterone. This seems doubtful to us for the following reasons. Butenandt has shown that on hydrogenation the unsaturated chloro ketone yields a saturated chloro ketone, $C_{19}H_{30}OCl$, which is different from the one which has been prepared by Ruzicka [Ruzicka, Goldberg and Brüngger, *Helv. Chim. Acta*, **17**, 1393 (1934)] by oxidation of β-cholestyl chloride. This suggests that the chlorine atom in the unsaturated chloro ketone isolated from urine does not have the same stereochemical arrangement as the chlorine atom in Ruzicka's chloro ketone but rather it indicates that it