# Alkaloid Studies. VI. (1) Lithium Aluminum Hydride Reduction of Apoyohimbine and the Synthesis of 3,4,5,6-Tetradehydroyohimbane-16-methanols

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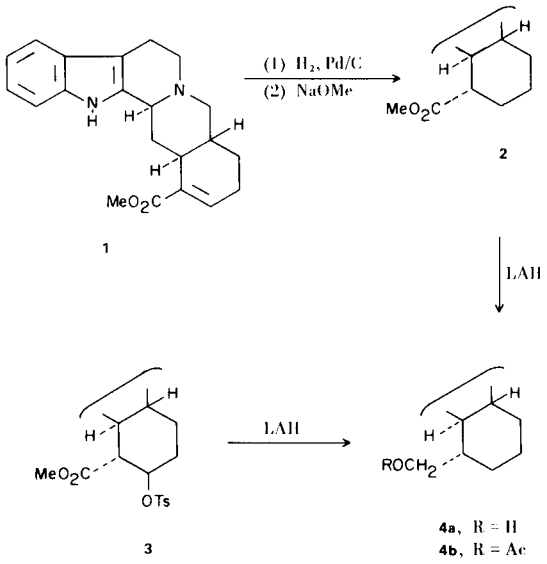
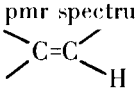
Catalytic reduction of apoyohimbine (**1**), prepared from yohimbine and thionyl chloride in pyridine, gives methyl yohimbane-16α-carboxylate (**2**) after equilibration with methoxide. LAH reduction of **2** or β-yohimbine *O*-tosylate (**3**) gives yohimbane-16α-methanol (**4a**). LAH reduction of **1** affords yohimbane-16α-carboxaldehyde (**5**), yohimb-16-ene-16-methanol (**6a**) and yohimbane-16β-methanol (**7a**). Structural assignments **6a** and **7a** are confirmed by mass spectral measurements. Pmr spectra of **4a**, **6a** and **7a** and their *O*-acetates **4b**, **6b** and **7b** are discussed. LAH reduction of apo-α-yohimbine (**8**) affords alloyohimb-16-ene-16-methanol (**9**). Dehydrogenation of **4a** with palladium black and maleic acid gives 3,4,5,6-tetradehydroyohimbane-16α-methanol (**10**) iodide, and **7a** gives 3,4,5,6-tetradehydroyohimbane-16β-methanol (**11**) iodide and picrate. Properties of **10** and **11** differ from those of melinonine E.

Reduction of apoyohimbine (**1**) (obtained by base treatment of yohimbine *O*-sulfate (3) according to Barger and Field (4) or, more satisfactorily, by treatment of yohimbine with thionyl chloride in pyridine) with hydrogen and palladium chloride/gum arabic catalyst in aqueous acetic acid has been reported (4) to produce "deoxyyohimbine" (stereochemistry undefined). In our experiments complete reduction of the double bond of apoyohimbine with 10% palladium on charcoal proceeded with difficulty. The reduction product, a methyl yohimbanecarboxylate, was equilibrated with sodium methoxide to give an ester which is formulated as methyl yohimbane-16α-carboxylate (**2**) in which the methoxycarbonyl group has the thermodynamically more stable equatorial conformation. Reduction of **2** with lithium aluminum hydride (LAH) produced yohimbane-16α-methanol (**4a**). An improved method for the preparation of alcohol **4a** was developed in which β-yohimbine *O*-tosylate **3** (5) was reduced with LAH.

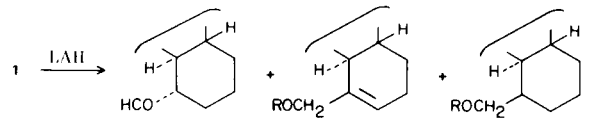



Apoyohimbine (**1**), when reduced with 3 moles of LAH, was reported to give two $C_{20}H_{24}N_2O$ compounds: apoyohimbyl alcohol (**6a**, stereochemistry undesignated) (m.p. 232° dec. (6a); m.p. 178-181° (6b)) and dihydroapoyohimbal (**5**, stereochemistry undesignated) (m.p. 192-195° (6b)). In our hands reduction of **1** with 2.7 moled of LAH gave three products, A, B, and C.

Compound A (m.p. 200-203°), which showed carbonyl absorption at 1715 $cm^{-1}$, was identified as dihydroapoyohimbal (6b) and was assigned the 16α-carboxaldehyde structure **5**. Compounds B (m.p. 200-203° dec.) and C (m.p. 278-279° dec.) were shown to be alcohols by their ready acetylation. A strong band at 790 $cm^{-1}$ (CH out-of-plane deformation) in the infrared spectrum and a

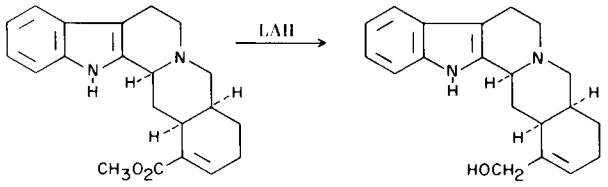
signal at δ 5.63 in the pmr spectrum indicated that compound B possessed a  moiety. Compound C showed no unsaturation as evidenced by the absence of strong absorption at 780-795 $cm^{-1}$ in the infrared spectrum and the absence of olefinic proton signals in the pmr spectrum in trifluoroacetic acid (insoluble in deuteriochloroform and $D_6$-DMSO). Mass spectral measurements (7) established their molecular weights and provided evidence for their structural assignments: alcohol B, m/e 308 ($M^+$), m/e 291 (M-17) (loss of OH); alcohol C, m/e 310 ($M^+$), m/e 293 (M-17) (loss of OH). Therefore compound B was assigned structure **6a**, apoyohimbyl alcohol, and compound C, a yohimbane-16-methanol. The latter compound clearly differed from yohimbane-16α-methanol (**4a**) (equatorial hydroxymethyl group) (*vide supra*) and was therefore assigned structure **7a**, yohimbane-16β-methanol (axial hydroxymethyl group) (8).

In order to provide further evidence for the structural assignments **4a**, **6a** and **7a**, these alcohols were converted to their *O*-acetates, **4b**, **6b** and **7b**, respectively. The pmr spectrum (in deuteriochloroform) of **6b** showed a broad one proton multiplet at δ 5.78 (half-band width 9 Hz) for the olefinic proton at C-17 and an AB quartet centered at δ 4.60 ($J_{AB}$ = 12 Hz) for the methylene protons of the acetoxymethyl group. The two-proton signal of the methylene protons of the axial acetoxymethyl group of **7b** was observed as an apparent ABX pattern centered at δ 4.18 with apparent $J_{AB}$ = 15 Hz, whereas the corresponding two proton signal of the methylene protons of the equatorial acetoxymethyl group of **4b** was observed at δ 4.13 as a broad singlet with half-band width of 6 Hz.




5 6a, R = H 6b, R = Ac 7a, R = H 7b, R = Ac

Reduction of apo-α-yohimbine (9) (**8**) with LAH afforded alloyohimb-16-ene-16-methanol (**9**), isolated as the hydrochloride salt. The mass spectrum (10) gave peaks at m/e 308 ($M^+$-HCl) and 291 ($M^+$-HCl-OH), confirming the $C_{20}H_{24}N_2O$ structure.

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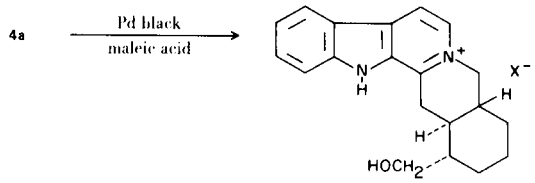
Dehydrogenation of **4a** with palladium black and maleic acid gave 3,4,5,6-tetradehydroyohimbane-16α-methanol (**10**) iodide and **7a** gave 3,4,5,6-tetradehydroyohimbane-16β-methanol (**11**) iodide and picrate. Under the same conditions **6a** and **9** failed to yield tetradehydro products. The infrared and ultraviolet spectra and melting points of **10** iodide (264-267° dec.) and **11** iodide (244-246° dec.) were found to differ from those of melinonine E iodide (11) (234-238° dec.), an alkaloid from *Strychnos melinoniana* Baillon (12,13,14) whose structure (stereochemistry undesignated) was suggested (13) to be a 3,4,5,6-tetradehydroyohimbane- or alloyohimbane-16-methanol of empirical formula $C_{20}H_{23}N_2O^+$.

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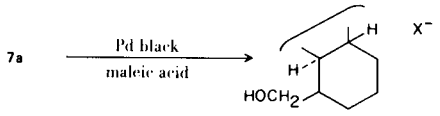


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## EXPERIMENTAL

Unless otherwise noted all melting points were taken in sealed capillaries which were inserted in a Mel-temp apparatus 10-40° below the melting point and are uncorrected. Samples for analysis were dried *in vacuo* over phosphorus pentoxide at 100° for 18-24 hours. Ultraviolet absorption spectra were measured on a Cary recording spectrophotometer. Infrared spectra were determined on a Perkin-Elmer spectrophotometer (Model 21). Pmr spectra were determined with a Varian model A-60 spectrometer with tetramethylsilane as internal standard.

Methyl Yohimb-16-ene-16-carboxylate (Apoyohimbine) (**1**).

A solution of 2.00 g. (0.00564 mole) of yohimbine in 25 ml. of dry pyridine was chilled by means of an ice bath and 4.0 ml. (0.0056 mole) of thionyl chloride was added. The resulting solution, protected from moisture with a drying tube, was kept at 3-5° for 18 hours. The dark red brown solution was poured onto ice and concentrated ammonium hydroxide was added until the *p*H was about 10. The resulting brown precipitate was removed by filtration, washed with dilute ammonium hydroxide and dried to produce 1.80 g. of brown powder. A solution in chloroform:ether (2:1) was passed through a column of 100 g. of Woelm neutral alumina (act. III). Evaporation *in vacuo* of the eluate gave a light pink solid which was crystallized from ethanol to yield 1.20 g. (63%) of **1** as colorless crystals, m.p. 249-250° dec. (lit (4) m.p.

251-252° dec.); uv max (methanol), 224, 280, 290 nm ($\epsilon$, 26,600, 4,850, 3,970); ir (potassium bromide), 3350 (s), 1696 (s), 1616 (m) $cm^{-1}$; $[\alpha]_D^{25}$ + 18° (*c* 1.06, pyridine) (lit (4) $[\alpha]_D \sim 40°$, acetic acid?).

Methyl Yohimbane-16α-carboxylate (**2**).

Apoyohimbine (**1**) (0.336 g., 0.0010 mole) was dissolved in 7 ml. of glacial acetic acid and added to a prereduced suspension of 0.100 g. of 10% palladium on charcoal catalyst in glacial acetic acid. Hydrogenation was carried out at room temperature for 2 hours at which time the uptake had essentially ceased. The catalyst was removed and the filtrate was diluted with 50 ml. of water and made alkaline with concentrated ammonium hydroxide. Filtration produced 0.286 g. of a colorless crystalline powder, m.p. 225-233° dec. Ir analysis indicated that appreciable starting material was present. The crude product was hydrogenated once more using the same conditions and the product was isolated as above to yield 0.241 g. (71%) of methyl yohimbane-16-carboxylate as colorless crystals, m.p. 196.5-198° dec. After several recrystallizations from methanol the product melted at 214-216° dec. (lit (4) m.p. 200-203° dec. for deoxyyohimbine); uv max (methanol), 226, 282, 292 nm, ($\epsilon$, 39,000, 7,450, 5,930), ir (potassium bromide), 1716 (s) $cm^{-1}$, $[\alpha]_D^{25}$ + 51° (*c* 0.53, methanol).

*Anal.* Calcd. for $C_{21}H_{26}N_2O_2 \cdot 3/4\ H_2O$: C, 71.7; H, 7.87; N, 7.96; O–$CH_3$, 4.26. Found: C, 71.8, 71.8; H, 7.45, 7.52; N, 7.87; O–$CH_3$, 4.15.

Equilibration of 0.250 g. of the above ester with sodium methoxide in refluxing methanol for 40 hours gave 0.217 g. (87%) of **2** as colorless crystals, m.p. 206-215° dec., which, when recrystallized from aqueous methanol, had m.p. 206-209° dec., $[\alpha]_D^{25}$ + 70° (*c* 0.50, methanol).

*Anal.* Calcd. for $C_{21}H_{26}N_2O_2 \cdot 1.2\ H_2O$: C, 70.3; H, 7.97; N, 7.81. Found: C, 70.2; H, 7.86; N, 8.13.

Yohimbane-16α-methanol (**4a**).

(A) LAH (0.155 g., 0.004 mole) was added in small portions to a stirred mixture of 0.155 g. (0.00038 mole) of methyl yohimbane-16α-carboxylate (**2**) in 40 ml. of dry ether which was chilled in an ice bath. After the addition was complete the solution was allowed to warm to room temperature and was refluxed gently for one hour. The excess LAH was decomposed by the careful addition of 1.0 ml. of water and then 10 ml. of a 20% solution of sodium potassium tartrate was added. The mixture was diluted with 5 ml. of water, placed in a liquid-liquid extractor and continuously extracted with 50 ml. of ether. The ether extract was dried over magnesium sulfate and the solvent was removed *in vacuo* to give 0.148 g. of a white foamy solid. Crystallization from aqueous methanol gave 0.0921 g. (64%) of **4a** as colorless crystals, m.p. 204-210° dec., with previous sintering, $[\alpha]_D^{25}$ −31 ± 5° (*c* 1.1, pyridine).

*Anal.* Calcd. for $C_{20}H_{26}N_2O \cdot 1/4\ H_2O$: C, 76.3; H, 8.48; N, 8.91; $H_2O$, 1.43. Found: C, 76.2; H, 8.29; N, 9.00; $H_2O$, (K.F.), 0.9.

(B) To a mixture of 0.350 g. of LAH in 15 ml. of dry tetrahydrofuran was added dropwise a solution of 0.509 g. (0.0010 mole) of β-yohimbine *O*-tosylate (**3**) (5) in 10 ml. of dry tetrahydrofuran. The mixture was stirred under nitrogen at room temperature for 3 hours and then was refluxed for 20 hours. The excess LAH was decomposed with ethyl acetate and ethanol and the mixture was poured onto 50 g. of ice and extracted with four 50-ml. portions of chloroform. The combined extracts were dried over magnesium sulfate and concentrated *in vacuo* to give 0.40 g. of a glass. This solid was crystallized from methanol to give 0.088 g. (28%) of **4a** as colorless irregular plates, m.p. 212-219° dec., (sinters 176-180°) (lit (6b) m.p. 202-205° for dihydroapoyohimbyl alcohol), $[\alpha]_D^{25}$ −39 ± 4° (*c* 1.3, pyridine).

*Anal.* Calcd. for $C_{20}H_{26}N_2O$: C, 77.4; H, 8.44; N, 9.03. Found: C, 77.0; H, 8.15; N, 9.17.

From the mother liquors an additional 0.094 g. (30%) of product was obtained.

Yohimbane-16α-methanol *O*-Acetate (**4b**).

A solution of 0.440 g. (0.0014 mole) of yohimbane-16α-methanol (**4a**), 6.0 ml. of pyridine and 4.0 ml. of acetic anhydride was allowed to stand at room temperature for 24 hours and the solvent was removed *in vacuo* at 40°. The residue was treated with 15 ml. of water and brought to *p*H 7.5 with concentrated ammonium hydroxide. The mixture was filtered and the precipitate was washed with water to give 0.500 g. (100%) of light tan crystals, m.p. 197-202° dec. Recrystallization from methanol gave 0.120 g. of **4b** as colorless needles, m.p. 222-224° dec., (lit (6b) m.p. 209-213° for dihydroapoyohimbyl acetate), $[\alpha]_D^{25}$ −31° (*c* 1.0, pyridine), ir (potassium bromide), 3222, 1709 $cm^{-1}$.

*Anal.* Calcd. for $C_{22}H_{28}N_2O_2$: C, 75.0; H, 8.01; N, 7.95. Found: C, 74.8, 75.2; H, 7.80, 8.15; N, 8.07, 8.23.

Yohimbane-16α-carboxaldehyde (**5**), Yohimb-16-ene-16-methanol (**6a**) and Yohimbane-16β-methanol (**7a**).

To a mixture under nitrogen of 5.50 g. (0.145 mole) of LAH and 200 ml. of dry peroxide-free tetrahydrofuran, cooled in an ice bath, was added a slurry of 18.0 g. (0.0536 mole) of apoyohimbine (**1**) in 100 ml. of tetrahydrofuran over a period of 5 minutes. The mixture was stirred at room temperature for 1.5 hours and then heated under reflux for 1.5 hours. The excess LAH was decomposed by the dropwise addition of ethanol and the solvent was removed *in vacuo*. To the gray residual solid was added 20 ml. of chloroform and the mixture was filtered. The precipitate was washed with two 100-ml. portions of chloroform and the filtrate was concentrated *in vacuo* to give a tan solid residue. This solid was dissolved in 250 ml. of chloroform, the solution was filtered through alumina and the filtrate was poured into 300 ml. of water. The mixture was filtered and the precipitate was washed with two 100-ml. portions of chloroform. The chloroform layer was separated, washed with 200 ml. of water, dried over sodium sulfate and concentrated *in vacuo* to give 13.1 g. of tan solid. Crystallization from methanol-chloroform gave 2.53 g. (15%) of yohimbane-16α-carboxaldehyde (**5**) as colorless needles, m.p. 200-203° dec., (lit (6b) m.p. 192-195° for dihydroapoyohimbal), $[\alpha]_D^{25}$ −43° (*c* 1.1, pyridine), ir (potassium bromide), 3378 (m), 1715 (s) $cm^{-1}$.

*Anal.* Calcd. for $C_{20}H_{24}N_2O$: C, 77.9; H, 7.84; N, 9.08. Found: C, 77.9; H, 7.96; N, 9.04.

The mother liquor from which **5** separated was concentrated on a steam bath and the solution was cooled and filtered to give 2.18 g. of off-white crystals (only weak carbonyl absorption at 5.83 μ). This fraction was chromatographed over 100 g. of neutral alumina (Woelm activity III) with chloroform-acetone (1:1) as the eluant and 100 ml. cuts were collected. Fractions 4-12 were combined, evaporated and the residual solid was triturated with methanol to give 1.00 g. of colorless crystals, m.p. 260-265° dec. Recrystallization from methanol gave 0.880 g. (5%) of yohimbane-16β-methanol (**7a**) as colorless crystals, m.p. 278-279° dec., $[\alpha]_D^{25}$ −111° (*c* 1.2, pyridine), ir (potassium bromide), 3448 (m), 3237 (s), 1629 (w) $cm^{-1}$.

*Anal.* Calcd. for $C_{20}H_{26}N_2O$: C, 77.4; H, 8.44; N, 9.03; M.W. 310.4. Found: C, 77.4; H, 8.52; N, 9.01; m/e (7) 310.

The mother liquors from **7a** were concentrated *in vacuo* to give

7.2 g. of a solid which was chromatographed over 300 g. of neutral alumina (Woelm activity III) with chloroform-ethyl acetate (1:1) as the eluant and 250 ml. cuts were collected. Yohimbane-16α-carboxaldehyde (**5**) (1.00 g., 6%) was eluted in fractions 2, 3, and 4. After the tenth fraction the solvent was changed to chloroform:-acetone (1:1). Fractions 8-12 were combined and crystallized from methanol to give 1.08 g. (7%) of yohimb-16-ene-16-methanol (**6a**) as colorless crystals, m.p. 200-203° dec., (lit m.p. 232° dec. (6a) and 178-181° (6b) for apoyohimbyl alcohol), $[\alpha]_D^{25}$ -71° (*c* 1.5, pyridine), ir (potassium bromide), 790 $cm^{-1}$, δ ($D_6$-DMSO-TMS) 4.00 (broad s, 2, $CH_2OH$), 5.63 (m, 1, C=$CH$—).

*Anal.* Calcd. for $C_{20}H_{24}N_2O$: C, 77.9; H, 7.84; N, 9.08; M.W. 308.4. Found: C, 77.4; H, 8.22; N, 9.26; m/e (7) 308.

Yohimb-16-ene-16-methanol *O*-Acetate (**6b**).

A mixture of 1.00 g. (0.0032 mole) of yohimb-16-ene-16-methanol (**6a**), 10 ml. of dry pyridine and 5 ml. of acetic anhydride was stirred at room temperature for 16 hours and worked up as for **4b** to give 0.89 g. of tan crystals. Recrystallization from ethanol with the aid of activated carbon gave 0.43 g. (38%) of **6b** as colorless needles, m.p. 203-205° dec., (lit (6b) m.p. 192-194° for apoyohimbyl acetate), $[\alpha]_D^{25}$ -63° (*c* 0.62, pyridine), ir (potassium bromide), 1706 (s), 1263 (s) $cm^{-1}$.

*Anal.* Calcd. for $C_{22}H_{26}N_2O_2$: C, 75.4; H, 7.48; N, 7.99. Found: C, 75.0; H, 7.56; N, 8.17.

Yohimbane-16β-methanol *O*-Acetate (**7b**).

A mixture of 0.40 g. (0.0013 mole) of yohimbane-16β-methanol (**7a**), 6.0 ml. of pyridine and 4.0 ml. of acetic anhydride was stirred at room temperature for 25 hours and worked up as for **4b** to give 0.44 g. of tan crystals. Recrystallization from methanol gave 0.26 g. (57%) of **7b** as pale yellow needles, m.p. 155-159°, $[\alpha]_D^{25}$ -125° (*c* 1.1, pyridine), ir (potassium bromide), 3401 (s), 1721 (s), 790 (w) $cm^{-1}$.

*Anal.* Calcd. for $C_{22}H_{28}N_2O_2 \cdot 1/2\ H_2O$: C, 73.1; H, 8.09; N, 7.75. Found: C, 73.3; H, 7.93; N, 7.80.

Alloyohimb-16-ene-16-methanol (**9**).

To a mixture of 0.700 g. of LAH in 30 ml. of dry ether, cooled in an ice bath, was added portionwise 2.00 g. of apo-α-yohimbine (**8**) (9). The mixture was stirred under nitrogen at room temperature for 1 hour and refluxed for 1 hour. The excess LAH was decomposed with ethanol and the mixture was filtered through Celite diatomaceous earth. The solid was washed with three 30-ml. portions of ether and the filtrate was concentrated *in vacuo*. To the residue was added 100 ml. of chloroform and 100 ml. of water and the mixture was filtered through Celite diatomaceous earth. The filter cake was washed with three 300-ml. portions of chloroform and the organic phase was separated from the filtrate. The aqueous phase was extracted with two 100-ml. portions of chloroform and the combined chloroform extracts were dried over magnesium sulfate. Evaporation of the extract *in vacuo* gave 2.0 g. of a glass which resisted attempts to crystallize it. The glass was dissolved in chloroform and chromatographed over 75 g. of neutral alumina (Woelm, activity III). The fractions constituting the main peak were combined to give 1.14 g. of a glass which resisted attempts to crystallize it. On standing the glass darkened and appeared very sensitive to air oxidation. The glass was dissolved in ethanol and treated with hydrogen chloride. The solution was concentrated *in vacuo* and filtered to give 0.640 g. of **9**·HCl as yellow crystals, m.p. 273-275° dec. A second crop (0.256 g., m.p. 264-266° dec.) was obtained from the mother liquors, giving a total yield of 44%.

A 0.500 g. sample was recrystallized from ethanol to give 0.140 g. of **9**·HCl as off white crystals, m.p. 274-277° dec., $[\alpha]_D^{25}$ -145° (*c* 0.20, pyridine).

*Anal.* Calcd. for $C_{20}H_{24}N_2O \cdot HCl$: C, 69.7; H, 7.31; N, 8.12; Cl, 10.3. Found; C, 69.3; H, 7.37; N, 8.13; Cl, 10.2.

3,4,5,6-Tetradehydroyohimbane-16α-methanol (**10**) Iodide.

A mixture of 1.24 g. (0.004 mole) of yohimbane-16α-methanol (**4a**), 2.32 g. (0.020 mole) of maleic acid, 1.50 g. of palladium black and 50 ml. of water was stirred and refluxed under nitrogen for 48 hours. The catalyst was removed by filtration and the process was repeated 3 times with a total of 2.30 g. of fresh catalyst for a total time of 200 hours. The filtered solution was cooled to 5° and a solution of 2.5 g. of sodium iodide in 10 ml. of water was added. The resulting gummy solid was crystallized from aqueous methanol to yield 1.08 g. (62%) of **10** iodide as yellow crystals, m.p. 263-265° dec. Recrystallization from methanol gave 0.63 g. of yellow crystals, m.p. 264-267° dec., $[\alpha]_D^{25}$ + 94° (*c* 1.0, methanol), ir (potassium bromide), 3383 (s), 3077 (s), 1637 (s), 1577 (m), 1550 (w), 1527 (m) $cm^{-1}$, uv max (methanol) 220, 251, 206, 360 nm (ε, 27,800, 29,800, 20,000, 6,900).

*Anal.* Calcd. for $C_{20}H_{23}IN_2O \cdot 1/4\ H_2O$: C, 54.7; H, 5.40; N, 6.38; I, 28.9. Found: C, 54.6; H, 5.69; N, 6.37; I, 28.6.

3,4,5,6-Tetradehydroyohimbane-16β-methanol (**11**).

(A) Iodide.

A mixture of 0.093 g. (0.30 millimole) of yohimbane-16β-methanol (**7a**), 0.174 g. (1.5 mmole) of maleic acid, 0.150 g. of palladium black and 8.0 ml. of water was refluxed for 17 hours. The catalyst was removed by filtration, washed with 3 ml. of hot water, and the combined filtrate and wash was cooled to room temperature and treated with a solution of 0.200 g. of sodium iodide in 3 ml. of water. Cooling and filtering gave 0.120 g. of yellow crystals. Recrystallization from methanol gave, in two crops, 0.080 g. of **11** iodide as yellow crystals, m.p. 244-246° dec., ir (potassium bromide), 3356 (s), 3058 (s), 1634 (s), 1572 (s), 1524 (m), 1499 (m), 800 (w) $cm^{-1}$; uv max (methanol), 210, 252, 305, 365 nm (ε, 28,800, 33,500, 22,200, 4,960).

*Anal.* Calcd. for $C_{20}H_{23}IN_2O$: C, 55.3; H, 5.34; N, 6.45. Found: C, 55.4; H, 5.65; N, 6.35.

(B) Picrate.

Dehydrogenation of 0.250 g. of **7a** as above gave an aqueous solution to which was added excess of a saturated aqueous solution of picric acid. Chilling and filtering gave 0.410 g. of yellow solid, m.p. 200-208° dec. Recrystallization from aqueous acetone afforded 0.220 g. of **11** picrate as yellow-orange crystals, m.p. 221-223° dec.

*Anal.* Calcd. for $C_{26}H_{25}N_5O_8$: C, 58.5; H, 4.35; N, 13.1. Found: C, 58.8; H, 4.69; N, 13.2.

Acknowledgment.

We wish to thank Mr. L. M. Brancone and staff for elemental analyses and Mr. W. Fulmor and staff for infrared, pmr and ultraviolet spectral measurements.

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(7) Measured on a CEC-21-103 spectrometer; we thank Dr. J. Karliner for this measurement.

(8) Catalytic reduction of dihydroapoyohimbal (**5**) was reported (ref. 6b) to give dihydroapoyohimbyl alcohol (**4a** ≡ **7a**; stereochemistry unspecified). Since **5** has an α-CHO group, dihydroapoyohimbyl alcohol is expected to have an α-$CH_2OH$ group as in **4a**. The reported melting points for the alcohol and its acetate are reasonably near those we have found for **4a** and its acetate **4b** and differ considerably from those found for **7a** and its acetate **7b**.

(9) C. F. Huebner, B. Korsun, M. E. Kuehne, L. H. Liu and H. B. MacPhillamy, *J. Am. Chem. Soc.*, 81, 2481 (1959); P. A. Diassi and R. M. Palmere, *J. Org. Chem.*, 26, 3577 (1961).

(10) Measured on a Hitachi Perkin-Elmer RMU-6D spectrometer by the Morgan-Schaffer Co., Montreal, Quebec.

(11) We thank Professors P. Karrer and H. Schmid, University of Zürich, for a sample of melinonine E picrate.

(12) E. Schlittler and J. Hohl, *Helv. Chim. Acta*, 35, 29 (1952).

(13) E. Bächli, C. Vamvacas, H. Schmid and P. Karrer, *ibid.*, 40, 1167 (1957).

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Received March 12, 1970 Pearl River, New York 10965