[CONTRIBUTION FROM THE LABORATORIES OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH]

The Veratrine Alkaloids. XXXIX. A Study of Certain Selenium Dehydrogenation Products of Cevine

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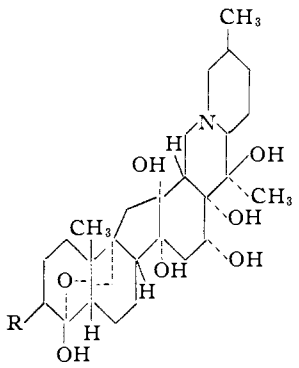
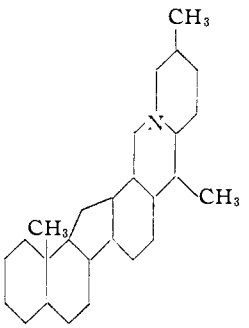
Several new bases which were isolated from a large scale selenium dehydrogenation of cevine are described. Mild chromic acid oxidation or air oxidation of both veranthridine and cevanthridine give rise to red keto bases which are shown to be fluorenones. The formation of these fluorenones confirms the assignment of fluorene structures to veranthridine and cevanthridine and therefore supports our earlier conclusion that cevine and the related tertiary polyhydroxy bases possess a C-nor/D-homosteroid type structure.

The disposition of the eight oxygen atoms of veracevine[1] (I) and cevine[2] (II) about the basic skeleton III has recently been derived by coöperative efforts of groups working in London, Zurich and Harvard.[3] This fundamental skeleton III, which

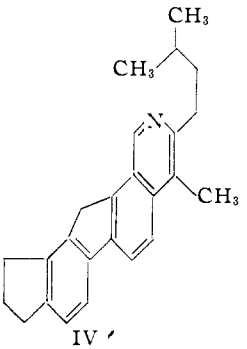


I, R = β-OH
II, R = α-OH

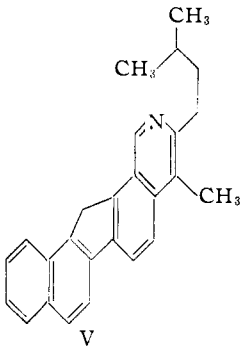


III

is common to germine[4] and unquestionably protoverine,[5] was first proposed by us on the basis of chemical and spectral studies from this Laboratory on a series of hydrocarbons and bases isolated from the pyrolysis and dehydrogenation mixtures obtained from cevine.[6] For two of these key substances, cevanthridine[7-9] ($C_{25}H_{27}N$)[10] and veranthridine[6,8] ($C_{26}H_{25}N$),[9] we proposed a 1,2-cyclopentanofluorene structure IV and a 1,2-benzofluorene structure V, respectively. These degradation products accounted for 25 and 26 carbon atoms, respectively, of the original 27 in cevine. Because of their unique character they had promised to play an important role in the final elucidation of the skeleton of the cevine alkaloids. It therefore appeared desirable to accumulate more data regarding their structures and relationship to cevine. The present paper describes further dehydrogenation experiments and in particular presents evidence which



IV



V

confirms our earlier proposal[6] that the non-nitrogenous portion of cevine and the related polyhydroxy tertiary bases possess a C-nor/D-homosteroid type of structure. A preliminary account of this work appeared in a Communication to the Editor.[11]

A large amount of cevine was dehydrogenated to increase the supply of cevanthridine and veranthridine available for study and also to supply possible new products which would aid in interpreting the structures of cevanthridine and veranthridine. Dehydrogenation of 140 g. of cevine in the usual way furnished a non-volatile basic fraction of 33 g. Chromatography of this fraction afforded substantial amounts of cevanthridine and veranthridine, together with a very small quantity of the base obtained earlier by Craig and Jacobs and for which the formulation of $C_{20}H_{19}N$ had been proposed.[9] It now appears that this formulation should be revised to $C_{20}H_{17}N$. The ultraviolet spectrum of this base is almost superimposable upon that of cevanthridine (Fig. 1).[12] Furthermore, like cevanthridine, this base absorbs two moles of hydrogen to give a crystalline tetrahydro base, $C_{20}H_{21}N$, the ultraviolet spectrum of which is almost identical with that of tetrahydrocevanthridine (Fig. 2). These observations are best accommodated by a lower homolog of cevanthridine with a formulation of $C_{20}H_{17}N$.[13] It is likely that this substance has the

(1) S. W. Pelletier and W. A. Jacobs, THIS JOURNAL, **75**, 3248 (1953); S. M. Kupchan and D. Lavie, *ibid.*, **76**, 314 (1954).

(2) V. Prelog and O. Jeger, Solanum and Veratrum Alkaloids in "The Alkaloids, Chemistry and Physiology," edited by R. H. F. Manske and H. L. Holmes, Vol. III, Academic Press, Inc., New York, N. Y., 1953, p. 270; J. McKenna, *Quart. Rev.*, **7**, 231 (1953).

(3) D. H. R. Barton, O. Jeger, V. Prelog and R. B. Woodward, *Experientia*, **10**, 81 (1954); D. H. R. Barton, C. J. W. Brooks and P. de Mayo, *J. Chem. Soc.*, 3950 (1954).

(4) L. C. Craig and W. A. Jacobs, *J. Biol. Chem.*, **148**, 57 (1943).

(5) L. C. Craig and W. A. Jacobs, *ibid.*, **143**, 427 (1942).

(6) W. A. Jacobs and S. W. Pelletier, *J. Org. Chem.*, **18**, 765 (1953).

(7) B. K. Blount, *J. Chem. Soc.*, 122 (1935); 414 (1936).

(8) L. C. Craig and W. A. Jacobs, *J. Biol. Chem.*, **129**, 79 (1939).

(9) L. C. Craig and W. A. Jacobs, *ibid.*, **139**, 263 (1941).

(10) L. C. Craig and W. A. Jacobs, *ibid.*, **139**, 293 (1941).

(11) S. W. Pelletier and W. A. Jacobs, THIS JOURNAL, **76**, 2028 (1954).

(12) The absorption spectrum previously published[6,10] for cevanthridine has been found to have too low extinction coefficients over the entire spectrum. The revised curve was obtained with freshly purified cevanthridine and shows a band at 292 mμ which was previously unnoted. A revised curve is also presented for tetrahydrocevanthridine.

(13) Unfortunately the amount of this $C_{20}H_{17}N$ base available for study was too limited to allow sufficient purification to give good analytical data. This base, like cevanthridine and veranthridine, is readily susceptible to air oxidation, particularly in solution. After standing a few minutes in benzene, partial oxidation [presumably to a fluorenone like that derived from cevanthridine (*vide infra*)] occurs as indicated by the appearance of an orange band when chromatographed on alumina.

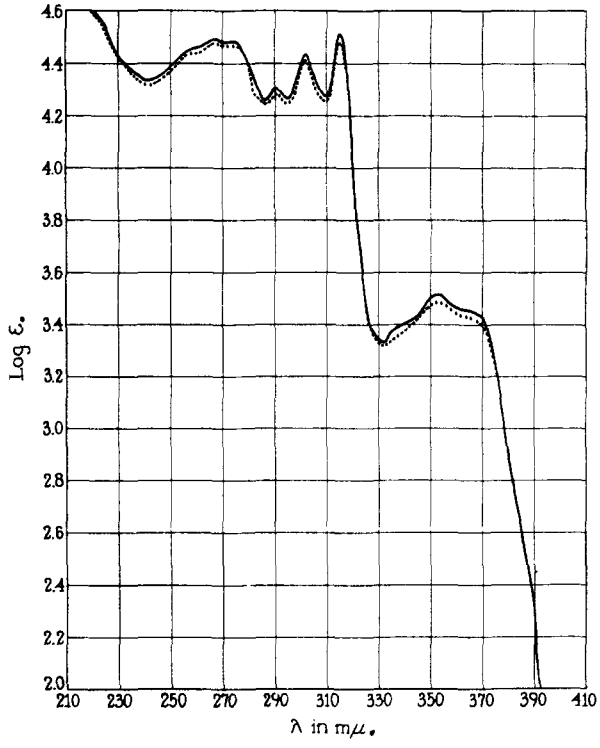


Fig. 1.—Ultraviolet absorption spectra: ——, cevanthridine (IV); ------, $C_{20}H_{17}N$ base (VI).

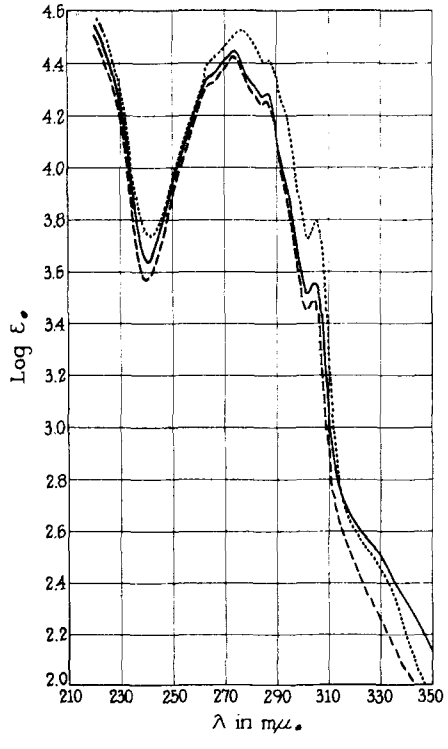
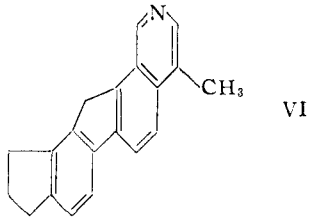


Fig. 2.—Ultraviolet absorption spectra: ——, tetrahydrocevanthridine; – – –, $C_{20}H_{21}N$ base; ------, the $C_{25}H_{25}N$ base (VI).

structure VI, differing from cevanthridine only in the loss of the five carbon side chain.



VI

Another base isolated from the mixture by chromatography and repeated crystallization from acetone melted at 186–190° and gave analytical values corresponding to $C_{24}H_{23}N$ or $C_{25}H_{25}N$. Titrations with perchloric acid in acetic acid indicated a molecular weight more satisfactory for the $C_{25}H_{25}N$ formulation. The ultraviolet spectrum of this substance (Fig. 2) is very similar to that of tetrahydrocevanthridine and the tetrahydro $C_{20}H_{21}N$ base. It must, however, possess different structural features for in the presence of Adams catalyst 4.7 moles of hydrogen appeared to be absorbed. Unfortunately a crystalline reduction product could not be isolated.

Near the end of the chromatogram, a base was eluted which crystallized from chloroform as brilliant orange needles, m.p. 266–269° and proved to have the formulation of $C_{26}H_{23}NO$. Its basic character was demonstrated by titration in acetic acid against perchloric acid. The ultraviolet spectrum (Fig. 3) showed λ_{max} 265 mμ, log ε 4.58; 292 mμ, log ε 4.73; 302 mμ, log ε 4.90; 342 mμ, log ε 4.08. The infrared spectrum showed the presence of a conjugated ketone (1697 cm.$^{-1}$). The formulation and spectra suggested that this substance is the ketone VII which could be derived from veranthridine by replacement of two hydrogen atoms with an oxygen atom. The occurrence of this substance (*oxoveranthridine*) among the dehydrogenation products suggested that it probably

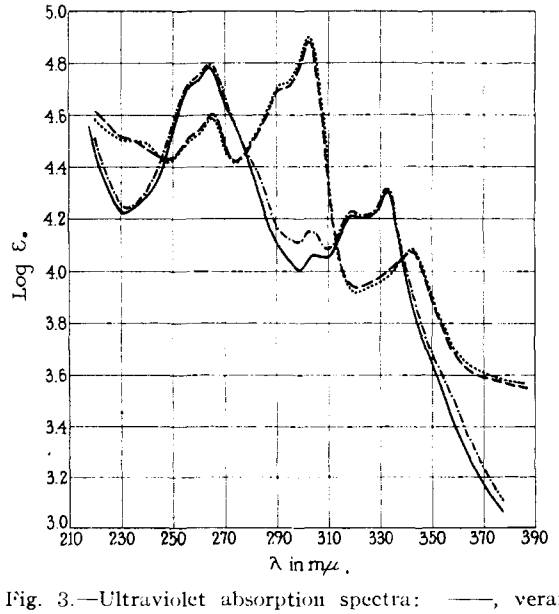
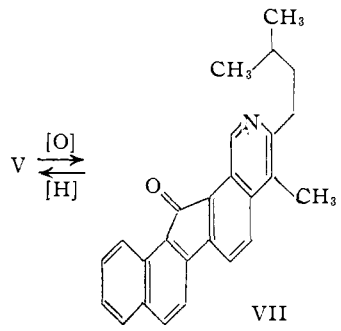
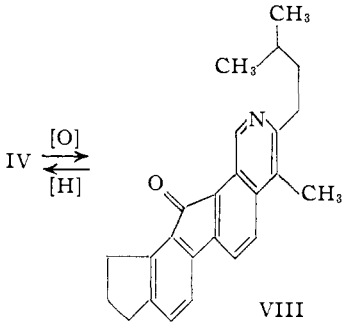


Fig. 3.—Ultraviolet absorption spectra: ——, veranthridine (V); –·–·–, Huang-Minlon reduction product of oxoveranthridine; ------, oxoveranthridine (VII) from dehydrogenation mixture; – – –, oxoveranthridine from chromic acid oxidation of veranthridine.



VII



VIII

originated from the air-oxidation of veranthridine and therefore that both veranthridine and cevanthridine might lend themselves well to oxidative study.

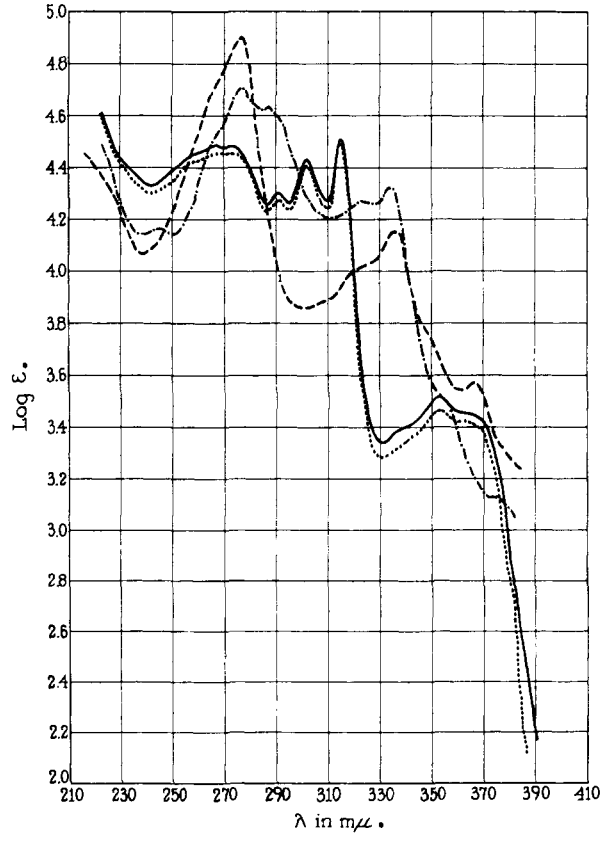


Fig. 4.—Ultraviolet absorption spectra: ——, cevanthridine (IV); ------, Huang-Minlon reduction product of oxocevanthridine; – – –, oxocevanthridine; -·-·-·, $C_{25}H_{23}NO_2$, oxidation product from cevanthridine.

Oxidation of veranthridine V with an excess of chromium trioxide in acetic acid did indeed give a red keto base, $C_{26}H_{23}NO$, which was in all respects (m.p., ultraviolet spectrum, Fig. 3) identical with that (VII) isolated from the dehydrogenation mixture. Reduction of this base under Huang-Minlon conditions regenerated veranthridine (V) (same m.p. and ultraviolet spectrum, Fig. 3). A similar oxidation of cevanthridine (IV) afforded a complex mixture which was separated into three components on alumina. The major component[14] was a keto base, *oxocevanthridine*, $C_{25}H_{25}NO$ (VIII) (titrates against perchloric acid in acetic acid) which crystallized from chloroform as reddish-orange needles, m.p. 253–255°. The infrared spectrum, ν^{CHCl_3} (C=O), 1697 cm.$^{-1}$ indicated the presence of a conjugated ketone. The ultraviolet spectrum (Fig. 4) showed λ_{max} 276.5 mμ, log ε 4.90; 336 mμ, log ε 4.15; 367 mμ, log ε 3.57. It was later found that this keto base may be obtained in an almost quantitative yield by simply shaking cevanthridine with alcoholic sodium ethoxide in the presence of air.[13] Reduction of VIII under Huang-Minlon conditions regenerated cevanthridine as shown by analysis, m.p. and ultraviolet spectra (Fig. 4).

The facile conversion of both veranthridine and cevanthridine by mild oxidation to the colored ketobases and the smooth reduction of the latter to the parent bases by the specific method employed indicates that these red ketones are fluorenones and therefore that veranthridine and cevanthridine are fluorene derivatives. These results support our earlier proposal[6] that the non-nitrogenous portion of cevine (and the related polyhydroxytertiary bases) does not possess a normal steroid skeleton but rather a C-nor/D-homosteroid type of skeleton which has been shown to be present in jervine and veratramine by Wintersteiner, Fried, *et al.*[15]

Experimental[16]

Selenium Dehydrogenation of Cevine.—Finely powdered cevine (140 g.) was dehydrogenated with three times its weight of selenium at 340–345° for three hours. The residue was ground and continuously extracted with ether for three days in a Soxhlet. After removal of the ether, the residue was dissolved in benzene and extracted several times with 10% hydrochloric acid. The precipitated hydrochloride[17] was dissolved in chloroform, the solution extracted several times with 10% sodium hydroxide, treated with Norit and then evaporated to dryness *in vacuo*. The dark-colored residue (33.4 g.) was dissolved in 200 ml. of benzene and chromatographed over 1700 g. of alumina. Fractions 1–32

(14) The other components of the mixture were a very small amount of colorless leaflets of m.p. 248–252° and a larger amount of golden-orange needles of m.p. 325–329° dec. This latter component was obtained in better yield by oxidation of cevanthridine with a large excess of chromium trioxide. *Cf.* Experimental. Since its ultraviolet spectrum (Fig. 4) was similar to that of oxocevanthridine and analysis showed the empirical formula to be $C_{25}H_{23}NO_2$, the possibility was considered that this substance is the N-oxide of oxocevanthridine. However, attempts to reduce this product to oxocevanthridine with sodium hydrosulfite or sulfurous acid were without success.

(15) For leading references see O. Wintersteiner and M. Moore, THIS JOURNAL, **75**, 4938 (1953).

(16) Melting points are corrected. They were taken on a hot-stage with a microscope equipped with a polarizer. Finely powdered samples were placed on the stage about 15° below the m.p. and the temperature raised rapidly to within 3° of the m.p. The temperature was then raised 2° per minute. M.p.'s were often 10° lower for some compounds when placed on the hot-stage at room temperature.

(17) The acidic solution which was shown previously to contain simpler pyridine bases[9] was not studied again.

of 200 ml. each were collected using benzene as the eluent. Fractions 33–46 of 400 ml. each were collected using benzene–ether (1:1). Fractions 47–50 of 800 ml. each were collected using ether. The fractions were evaporated to dryness and processed as described below.

Fractions 1–5 (2.74 g.) yielded oils which did not crystallize.

Cevanthridine, $C_{25}H_{27}N$ (IV).—Treatment of fractions 6–13 (8.23 g.) with acetone gave crystalline fractions with melting points ranging from 160–208°. These fractions were combined (3.5 g.), dissolved in 90 ml. of benzene and rechromatographed over 300 g. of alumina. Ultraviolet light revealed the presence of five distinct bands. The two lower bands which fluoresced bright blue and pale violet, respectively, were eluted quickly with 390 ml. of benzene to give 3.4 g. of material. Recrystallization from chloroform thrice gave pure cevanthridine, m.p. 215–217°, ultraviolet (Fig. 1) λ_{max}: 270 mμ, log ε 4.45; 291 mμ, log ε 4.27; 302 mμ, log ε 4.40; 315 mμ, log ε 4.49; 353 mμ, log ε 3.46.

Anal. Calcd. for $C_{25}H_{27}N$: C, 87.93; H, 7.97. Found: C, 88.00; H, 8.10.

The $C_{25}H_{25}N$ Base.—Fractions 14–18 (790 mg.) on treatment with acetone or ether gave yellow crystals melting at 145–175°. The whole mixture, however, was given a preliminary purification by passing a solution in benzene over 70 g. of alumina. Everything eluted successively with benzene and ether was combined, dissolved in 5 ml. of benzene and rechromatographed over 70 g. of alumina. The first fraction of 100 ml. was evaporated to dryness and crystallized from ether to give pale yellow leaflets, m.p. 160–175°. Treatment with Norit in ether and recrystallization from ether (3×) and acetone (3×) gave pearly white leaflets, m.p. 186–189°, ultraviolet (Fig. 2) λ_{max} 276 mμ, log ε 4.53; 287 mμ, log ε 4.41; 305 mμ, log ε 3.80.

Anal. Calcd. for $C_{25}H_{25}N$: C, 88.45; H, 7.42; N, 4.13; mol. wt., 339.5. Found: C, 88.43, 88.54; H, 7.28, 7.27; N, 4.44, 4.28; mol. wt., 340, 342.[18]

Veranthridine, $C_{26}H_{25}N$ (V).—Fractions 19–30 (927 mg.) crystallized from ether to give 131 mg. of yellow crystals of m.p. 210–225°. Two recrystallizations from benzene–ethanol gave 75 mg. of pale orange, fibrous needles, m.p. 228–230°, ultraviolet (Fig. 3) λ_{max} 265 mμ, log ε 4.79; 319 mμ, log ε 4.22; 333 mμ, log ε 4.31.

Anal. Calcd. for $C_{26}H_{25}N$: C, 88.84; H, 7.17; N, 3.99. Found: C, 88.67; H, 7.05; N, 4.15.

Fractions 31–38 (1.38 g.) gave no crystalline material from ether. The processing of these fractions is described below under the $C_{20}H_{19}N$ base.

Oxoveranthridine, $C_{26}H_{23}NO$ (VII).—Fractions 39 and 40 (1.08 g.) crystallized from ether to give 119 mg. of an orange powder, m.p. 210–235°. Crystallization from benzene and then from chloroform gave brilliant orange needles (60 mg.), m.p. 266–269°, ultraviolet (Fig. 3) λ_{max} 265 mμ, log ε 4.58; 292 mμ, log ε 4.73; 302 mμ, log ε 4.90; 342 mμ, log ε 4.08. The basic character of this substance was demonstrated by titration against perchloric acid in acetic acid.[18,19]

Anal. Calcd. for $C_{26}H_{23}NO$: C, 85.45; H, 6.34; N, 3.83. Found: C, 85.37, 85.41; H, 6.37, 6.21; N, 3.82.

The $C_{20}H_{17}N$ Base (VI).—Fractions 31–38, 41–42 (382 mg.) and the mother liquors from 39–40 were combined (2.4 g.) and rechromatographed in benzene over 125 g. of alumina. The first four 150-ml. fractions yielded 1.51 g. of material which would not crystallize from ether. The next four 150-ml. fractions gave 240 mg. of material which separated from ether as orange crystals, m.p. 230–250°, and which consisted of a mixture of oxoveranthridine and the $C_{20}H_{17}N$ base. The 240 mg. was resolved by chromatographing in benzene two more times over alumina. The $C_{20}H_{17}N$ base eluted somewhat more rapidly than oxoveranthridine and could be followed by its brilliant fluorescence under ultraviolet light. Recrystallization of this fraction from benzene gave 15 mg., m.p. 236–239° cor. This base oxidized rather rapidly in solution and even on standing at refrigerator temperatures turned brown.

Anal. Calcd. for $C_{20}H_{17}N$:[19] C, 88.52; H, 6.32. Found: C, 88.14; H, 6.80.

Fractions 43–50 (706 mg.) consisted of a black resin which did not furnish any crystalline material when treated with various solvents or when rechromatographed over alumina.

Tetrahydro Base, $C_{20}H_{21}N$.—A solution of 17.5 mg. of the $C_{20}H_{17}N$ base in acetic acid was hydrogenated over 25 mg. of Adams catalyst. Absorption of hydrogen beyond the catalyst's requirement amounted to about 2.8 ml. (S.T.P.) or 1.9 moles. The solution was filtered from the catalyst and evaporated to dryness *in vacuo*. The residue was taken up in benzene, washed with dilute sodium carbonate solution, dried over sodium sulfate and concentrated to dryness. Crystallization from hot ethanol afforded 13 mg. of micro, six-sided leaflets, m.p., 213–213.5°. The crystals turned tan on exposure to light. The ultraviolet spectrum (Fig. 2) showed λ_{max}: 274 mμ, log ε 4.42; 287 mμ, log ε 4.26; 305 mμ, log ε 3.49.

Anal. Calcd. for $C_{20}H_{21}N$: C, 87.22; H, 7.69. Found: C, 87.42, 87.15; H, 7.76, 7.82.

As a check on the amount of hydrogen absorbed, 6.0 mg. of the base in 3.0 ml. of glacial acetic acid was hydrogenated with 6.0 mg. of Adams catalyst. After one hour, hydrogen consumption amounted to 2.54 ml. (S.T.P.). A 6-mg. sample of catalyst under the same conditions gave a blank of 1.56 ml. (S.T.P.). The hydrogen absorbed by the base (0.98 ml.) represents 1.98 moles. Isolation of the tetrahydro derivative as described gave leaflets of m.p. 211–212°.

Anal. C, 87.32; H, 7.98.

Oxidation of Veranthridine (V) to Oxoveranthridine (VII).—A solution of 25 mg. of veranthridine in 1 ml. of acetic acid was treated with a solution of 10.5 mg. of chromium trioxide [theory for 2 (O) is 9.5 ml.] in 2 ml. of acetic acid. After heating at 100° for 20 minutes the mixture was allowed to stand at 25° for a half hour. The solution was evaporated to dryness *in vacuo*, the residue taken up in chloroform and washed successively with sodium bicarbonate solution and water. Evaporation of the chloroform solution gave 19 mg. of product. This was dissolved in 10 ml. of benzene and chromatographed over 1.0 g. of alumina in a 5 mm. column. Development of the chromatogram under ultraviolet light showed four distinct bands. The first band was eluted quickly with 10 ml. of benzene to give 1.5 mg. of material of m.p. 253–263°. The second band was eluted with 30 ml. of benzene to give 13.4 mg. of reddish-orange crystals. These were recrystallized three times from chloroform to give brilliant orange needles, m.p. 267–270°, undepressed when mixed with the oxoveranthridine obtained by chromatography of the basic dehydrogenation mixture. The ultraviolet spectra of the two samples were also indistinguishable (Fig. 3). Infrared: ν^{CHCl_3} (conj. >C=O), 1697 cm.$^{-1}$.

Anal. Calcd. for $C_{26}H_{23}NO$: C, 85.45; H, 6.34. Found: C, 85.66; H, 6.34.

Reduction of Oxoveranthridine (VII) to Veranthridine (V).—Oxoveranthridine (15 mg.) was suspended in a mixture of 85% hydrazine hydrate (1 ml.), diethylene glycol (6 ml.), and potassium hydroxide (50 mg.). After boiling under reflux for one hour the substance had dissolved and the solution acquired a brilliant blue-green color. The condenser was removed and the excess of water and hydrazine was boiled off until the reaction mixture attained 205°. The mixture was then boiled under reflux for two hours during which time the green color changed to orange-brown. The cooled mixture was diluted with 30 ml. of water and an orange powder was collected. This was dissolved in benzene and chromatographed over 1 g. of alumina. The material contained in a brilliant blue band (ultraviolet light) was eluted with benzene and recrystallized twice from benzene–ethanol and once from benzene to give faint orange needles, m.p., 229–231°, undepressed when mixed with authentic veranthridine. The ultraviolet spectrum (Fig. 3) was substantially the same as that for authentic veranthridine but indicated the presence of a small amount of the oxo compound as a contaminant.

Oxidation of Cevanthridine with Chromium Trioxide. A.—A solution of 217 mg. of cevanthridine in 12 ml. of acetic acid was treated with 8.9 mg. of chromium trioxide (theo. for 2 (O) is 8.5 mg.) in 8.9 ml. of acetic acid. After heating at 90° for ten minutes, the mixture was allowed to stand overnight. It was evaporated to dryness *in vacuo*, and the

(18) J. Fritz, "Acid-Base Titrations in Nonaqueous Solvents," G. Frederick Smith Chemical Co., Columbus, Ohio, 1952, pp. 13–15.

(19) The indicator used was methyl violet. Although the end-point in the case of the deep red ketones was not sharp enough to determine the molecular weight, the method sufficed to show the basic character of these substances.

residue in chloroform was washed with sodium carbonate solution and water. Evaporation to dryness gave 173 mg. of a brown powder. A preliminary purification was effected by passing a solution of the mixture in benzene–chloroform (10:1) through alumina. The total amount eluted with benzene–chloroform was 145 mg. This was dissolved in 100 ml. of the same solvent and chromatographed over 20 g. of acid washed alumina. Development of the chromatogram under ultraviolet light showed the presence of three bands: 1, a blue fluorescent band; 2, a red band; 3, an orange band. After material began to emerge from the column the following fractions were collected.

Benzene–$CHCl_3$	Fraction	Ml.	Mg.	
(20:1)	1	75	13.5	Band 1; colorless; m.p. 214–218°
(20:1)	2	100	43.3	Bands 1, 2; red; m.p. 246–258°
(10:1)	3	400	25.2	Band 2; red; m.p. 257–259°
(2:1)	4	200	51.0	Band 3; red; m.p. >315°

Fraction 2 was rechromatographed in benzene over 10 g. of basic alumina. The first fraction eluted contained 20 mg. of colorless material which was combined with fraction 1. The red component which was then eluted with benzene–chloroform (10:1) was combined with fraction 3. Rechromatography of fraction 1 over 10 g. of basic alumina removed a small amount of red material. Recrystallization of the colorless fraction from benzene–pet. ether gave leaflets of m.p. 215–217°. The analysis and ultraviolet spectra indicated this material to be cevanthridine.

Anal. Calcd. for $C_{25}H_{27}N$: C, 87.43; H, 7.97. Found: C, 87.81, 87.60; H, 7.83, 8.16.

Oxocevanthridine, $C_{25}H_{25}NO$ (VIII).—Recrystallization of fraction 3 from chloroform gave 23 mg. of fine long needles of a brilliant orange color, m.p. 252–254°. The ultraviolet spectrum of oxocevanthridine appears in Fig. 3; infrared ν^{CHCl_3} (conj. >C=O), 1697 cm.$^{-1}$. Titration against perchloric acid showed the basic character of this product.[18,19]

Anal. Calcd. for $C_{25}H_{25}NO$: C, 84.47; H, 7.09. Found: C, 84.47; H, 7.12.

Chromatographing fraction 4 three times over alumina with benzene–chloroform (5:1) gave a colorless fraction, m.p. 248–252°, from benzene and a golden or orange fraction, m.p. 320–323°[14] dec. from chloroform. The amount of the 248–252° component was too small to investigate further. The 320° component was obtained in larger yield by oxidation of cevanthridine with an excess of chromium trioxide as described below.

B.—A solution of 245 mg. of cevanthridine in 15 ml. of warm acetic acid was treated with a solution of 200 mg. of chromium trioxide in 20 ml. of acetic acid and 3 drops of water. The mixture was warmed at 90° until the precipitate dissolved to give a clear green solution. After standing overnight, an additional 96 mg. of chromium trioxide in 5 ml. of acetic acid was added. After warming, this was followed by five more 96-mg. portions of chromium trioxide in acetic acid with continued heating on the steam-bath. The mixture was evaporated to dryness *in vacuo*, the residue taken up in chloroform and then washed with sodium carbonate solution and water. Evaporation of the chloroform extract gave 82 mg. This was dissolved in 60 ml. of benzene–chloroform (3:1) and chromatographed over 20 g. of alumina. Illumination of the column with ultraviolet light revealed the presence of three bands. The second band contained the major portion of material which melted at 325–329°[14] dec. after three recrystallizations from chloroform.

Anal. $C_{25}H_{23}NO_2$: C, 81.26; H, 6.28. Found: C, 81.41, 81.01; H, 6.22, 6.32.

Oxidation of Cevanthridine in the Presence of Air.—A solution of cevanthridine (20 mg.) in warm ethanol (5 ml.) was treated with a solution of sodium ethoxide prepared from 0.5 g. of sodium and 5 ml. of ethanol. The mixture was heated for three hours at 100° with occasional shaking to introduce air. After cooling the black mixture was diluted and extracted with chloroform. Evaporation to dryness gave a brown powder which was chromatographed in benzene on alumina. A bright red band was eluted slowly. Rechromatography of this fraction gave 16.7 mg. of oxocevanthridine, m.p. 250–253°. Recrystallization from benzene afforded thin rectangular needles, melting at 253–254.5°, undepressed when mixed with an authentic sample.

Anal. Calcd. for $C_{25}H_{25}NO$: C, 84.47; H, 7.09. Found: C, 84.33; H, 7.05.

Reduction of Oxocevanthridine (VIII) to Cevanthridine (IV).—A suspension of oxocevanthridine (27 mg.) in a mixture of 85% hydrazine hydrate (1 ml.), diethylene glycol (6 ml.), and potassium hydroxide (50 mg.) was boiled under reflux for 90 minutes. The condenser was removed and the excess of water and hydrazine was boiled off (temperature, 200°). The mixture was then boiled for three hours. The cooled mixture was diluted with water and the yellow plates which separated were collected, m.p. 195–210°. The crystals in chloroform were treated with Norit, the solution filtered, concentrated to 1 ml. and then diluted with 5 ml. of acetone. White leaflets (7.5 mg.), m.p. 213–214°, separated. Recrystallization from chloroform–acetone gave pure cevanthridine, m.p. 214.5–216.5°, undepressed when mixed with an authentic sample. The ultraviolet spectrum (Fig. 4) was identical with that of authentic cevanthridine.

Anal. Calcd. for $C_{25}H_{27}N$: C, 87.93; H, 7.93. Found: C, 87.91; H, 7.83.

Ultraviolet Absorption Spectra.—Ultraviolet absorption spectra were determined in 1-cm. silica cells at 30° with a model DU Beckman spectrophotometer. The solvent was 95% ethanol. Concentrations in the range of 1×10^{-4} to 1×10^{-5} mole/liter were used.

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