

A Chemical Investigation of the Constituents of *Nicotiana glauca* R. Grah. (Solanaceae) (Wild Tobacco).

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INTRODUCTION.

Since, besides the cultivated tobacco, *Nicotiana tabacum*, two varieties of wild tobacco have been shown by Dwight Marsh (1927) to contain nicotine, it would naturally be expected that this alkaloid would be found in *Nicotiana glauca*. Juritz (1922) gives figures for the nicotine content of this plant as from 0.04 to 0.18 per cent., but in view of later work it is to be doubted whether there is more than a small trace of nicotine in the plant, if any at all. In 1934 Shmuk stated that the alkaloid of *Nicotiana glauca* was not nicotine, but no identification was made. In 1935, C. R. Smith found the roots of *Nicotiana glauca* to contain about 1 per cent. of anabasine, as well as pyridine and ammonia, and he stated that it was doubtful if any nicotine was present in the plant. The anabasine he obtained had a specific rotation of -9.1° and formed a picrate of melting point $212-213^{\circ}$ C., whereas the anabasine isolated by Oryekhov and Menshikov (1931) from *Anabasis aphylla* had a rotation of -82.2° and gave a picrate of melting point $200-205^{\circ}$ C.

At the time of publication of Smith's paper, the authors had isolated from the leaves and stems of *Nicotiana glauca* a liquid base which proved to be anabasine; this base gave a picrate of melting point 213° C., but the base was definitely shown to be optically inactive. As regards other constituents of the basic extract from the plant, no definite identifications were made; pyridine was almost certainly present, and the smell of piperidine was apparent during steam distillation of the percolates; but neither anatabine, found by Späth and Keszler (1937) to occur with anabasine in cultivated tobacco nor 2-3'-dipyridyl could be detected.

The authors have prepared and investigated certain salts and derivatives of d-l-anabasine; of these the most notable are the well-crystallised mono-hydrochloride and the tetra-bromo derivative.

The total alkaloid in the dried plant was found by extraction and estimation to be about 1.3 per cent.

DESCRIPTION AND POISONOUS PROPERTIES OF THE PLANT.

The following description is due to Walsh (1909):—

“ Wild tobacco is a well-known plant throughout the country. It is not, however, a native, having come from America.

“ Wild tobacco grows to a height of ten or twelve feet, sending up thin, brittle stems, which grow very rapidly. The leaves are heart or egg-shaped, larger on one side of the rib than the other, and have long stalks. The flowers are tubular in shape, of a bright yellow colour, and contain a sweet juice which is not poisonous. The plant is often seen growing on dam walls and in hedges, and once it has obtained a hold on a farm it is somewhat difficult to eradicate. The tree is poisonous both green and in a dried state; it appears to be specially fatal to ostriches. Several authentic cases are on record, however, of cattle having died from eating it.

“ An old inhabitant of Oudtshoorn gave the writer a graphic description of the effects of wild tobacco on a troop of ostriches driven daily to the commonage. There were some fifty birds in the troop, the majority of which staggered back one evening with most grotesque contortions of the neck. Nearly two-thirds of the affected birds died during the night or the next day.

“ As to the the actual quantity of the plant to be eaten to cause death it is difficult to state definitely. One account states: ‘ A few leaves proved fatal to an ox ’. Another: ‘ The ox ate some dried chips remaining after the trees (wild tobacco) had been cut down, and died the same night.

“ *Symptoms of Wild Tobacco Poisoning.*—Symptoms appear rapidly, and death has occurred within seven hours. Staggering gait, with spasmodic jerkings of the head, dullness and stupor. Ostriches jerk their necks about wildly, and bend their heads over on to the back. Death occurs while in a stupor.”

EXTRACTION OF THE ALKALOID.

On account of the great water-solubility of the alkaloid, extraction with organic solvents in various ways was found to be ineffective. Percolation of the ground plant with 1 per cent. hydrochloric acid extracted the alkaloid completely. The percolate, after solar evaporation to small bulk, was rendered alkaline with lime and distilled with steam superheated to 120° C., and the distillate, acidified and evaporated to dryness, was extracted with chloroform saturated with ammonia gas. This process had three disadvantages: (1) Small amounts of water unavoidably present in the hygroscopic hydrochlorides gave rise, in the final stage, to a high concentration of ammonium chloride, with a consequent suppression of pH; as a result, anabesine mono-hydrochloride (see later) crystallised from the extracted alkaloid; (2) during percolation gummy material was formed, apparently due to a large amount of pectin, and this rendered the percolation very slow; and (3) there was a possibility that optically active materials, if present, might be racemised by the distillation with superheated steam.

To overcome these difficulties, the extraction method finally adopted consisted of percolation with 0·5 per cent. caustic soda solution, acidifying of the percolate with hydrochloric acid, filtering and extracting the filtrate.

again rendered alkaline, with large quantities of ether and then with chloroform. Percolation with caustic soda, according to Branfoot (1929), should result in the formation of metapeptic acid, by hydrolysis of the pectins. Although a bulky, somewhat gelatinous precipitate (probably hemicelluloses, proteins, etc.) was obtained on acidifying the percolate, it was not successfully shown that this precipitate contained metapeptic acid.

In this final method of extraction, estimations of the residual base in the aqueous residue were carried out by precipitation with silicotungstic acid. The results were calculated as anabesine and on the assumption that anabesine silicotungstate has the formula $H_8[Si(W_2O_7)_6] \cdot 2C_{10}H_{14}N_2$ (like nicotine silicotungstate). The results of extraction and estimation, from 2 Kg. of the dried, ground plant, were:—

Extracted by ether.....	15.6 grams		
Extracted by chloroform.....	1.4 grams		
	17.0 grams	i.e.	0.85 per cent.
Total extracted by solvents.....			
Unextracted, estimated.....	8.5 grams	i.e.	0.42 per cent.
	25.5 grams	i.e.	1.27 per cent.
Total Basic Material.....			

PHYSIOLOGICAL TESTS.

Physiological tests on the basic extract gave the following results:—

Original Dry Plant.

M.L.D. for rabbits, approximately 6 grams per Kilogram of body-weight. Symptoms like those of nicotine poisoning.

Plant after Hydrochloric Acid Extraction.

Non-poisonous.

Basic Material Extracted.

M.L.D. for rabbits, 0.062 gram (=4.9 grams of plant) per Kilogram of body-weight. Symptoms like those of nicotine poisoning.

INVESTIGATION OF THE ALKALOID.

A. Alkaloid Extracted with Steam Distillation.

5.66 grams of the base was extracted by distillation with superheated steam, as described above. A light yellow crystalline solid crystallised from this material, and was removed by filtration. The purification of this solid, and its identification as anabesine mono-hydrochloride, is described later.

The filtered liquid was submitted to repeated fractionation at reduced pressure, and gave the following fractions:—

Fraction.	Temperature Range.	Pressure.	Weight.	Appearance.
f ₁	140–160° C.	10 mm.	3.30 gr.	Yellowish liquid, started to crystallise within a few hours.
f ₂	160–170° C.	10 mm.	0.57 gr.	Yellowish liquid with small amount of crystalline solid.
f ₃	Undistillable residue...	—	1.70 gr.	Dark, semi-solid.

After three days, sufficient solid had crystallised from the fractions f_1 and f_2 to filter off with suction. 9 mg. of solid was obtained, which, after sublimation at $80^\circ\text{C.}/0.035\text{ mm.}$, consisted of needle-like crystals and melted sharply at 107°C. (corrected) without decomposition. This solid contained nitrogen and chlorine, and gave a precipitate directly in aqueous solution with silver nitrate solution. A small amount of the solid was precipitated with aqueous picric solution and, although the quantity of picrate obtained was too small to recrystallise, it was definitely shown to be identical with d-l-anabasine picrate.

	<i>Corrected Melting Point.</i>
Picrate obtained.....	202-211 C.
d-l-Anabasine Picrate, recryst.....	212-213°C.
Mixture.....	207-211 C.

Although Oryekhov and Menshikov (1931), the original investigators of optically active anabasine, stated that the dihydrochloride of anabasine was too hygroscopic to isolate in solid form, it is considered likely from the above results that the compound was d-l-anabasine dihydrochloride. Unfortunately, insufficient material was obtained for fuller investigation, and attempts to prepare the dihydrochloride from anabasine fractions have up to the present been unsuccessful.

Fractions f_1 and f_2 were similar in properties, and were considered to consist mainly of the same constituent. 1.53 grams of the fraction f_1 , freed from crystalline solid, was submitted to distillation under a pressure of 0.02 mm. in the distillation apparatus according to Pregl (1923). From 93 to 95°C. (bath temperature), over a period of $1\frac{1}{2}$ hours, a light yellow fraction weighing 0.85 gram was obtained; this fraction was found to be mainly *d-l-anabasine*.

The fraction was a light yellow liquid with characteristic smell, and gradually darkened on exposure. It was very soluble in water and strongly alkaline to litmus, and showed no optical rotation in solution in aqueous alcohol. It contained nitrogen and gave precipitates with alkaloid reagents, reacted as a secondary amine, contained no methylimino group and gave a positive test for the pyridine nucleus (Vongerichten, 1899). Unsaturation was shown by immediate discolouration of acid permanganate solution, and oxidation with alkaline permanganate gave nicotinic acid (corrected melting point of acid twice sublimed under high vacuum, $222-225^\circ\text{C.}$, mixed melting point with nicotinic acid $227-228^\circ\text{C.}$; copper salt, characteristic appearance of copper nicotinate).

Elementary analysis of the fraction gave the following results--

	<i>Per Cent. Carbon.</i>	<i>Per Cent. Hydrogen.</i>
5.535 mg. gave 4.182 mg. of water and 14.673 mg. of carbon dioxide.....	72.31	8.44
1.288 mg. gave 1.211 mg. of water and 3.444 mg. of carbon dioxide.....	72.92	10.52
		<i>Per Cent. Nitrogen.</i>
2.183 mg. gave 0.396 c.c. of nitrogen at 24°C. and 621 mm. pressure.....		17.04
Calculated for $\text{C}_{10}\text{H}_{14}\text{N}_2$: C 74.0 per cent., H 8.7 per cent., N 17.3 per cent.		

Determination of the equivalent weight by means of the platinichloride gave the following results:—

	<i>Per Cent. Platinum.</i>	<i>Equiv. Wt.</i>
4.949 mg. of the platinichloride gave 1.688 mg. of platinum.....	34.11	81.1
4.392 mg. of the platinichloride gave 1.495 mg. of platinum.....	34.04	81.6
Calculated for $C_{16}H_{14}N_2 \cdot H_2PtCl_6$	34.10	81.1

d-l-Anabasine was synthesised according to Smith (1931), and a comparison of the picrate and picrolonate of the fraction with the corresponding salts of d-l-anabasine gave:—

	<i>Corrected Melting Points.</i>
Picrate of fraction, twice recrystallised.....	210–211.5° C.
d-l-Anabasine picrate, recrystallised.....	212–213° C.
Mixture.....	211–213° C.
Picrolonate of fraction.....	253° C.
Anabasine picrolonate, crude.....	245–248° C.
Mixture.....	247–250° C.

From all the above results the fraction is definitely proved to be somewhat impure d-l-anabasine. In case nicotine should be present as an impurity, the fraction was tested for this alkaloid. The ordinary tests (Rosenthaler, 1923) gave doubtful results. The micro test of Hofmann (1931) gave a positive result, but as a similar result was obtained with synthetic anabasine, containing no nicotine, no conclusion could be drawn as to the presence of nicotine in the fraction.

B. ALKALOID EXTRACTED WITHOUT STEAM DISTILLATION.

24.9 grams of base, extracted with ether and chloroform from the percolates, was submitted to repeated fractionation at reduced pressure. A list of the fractions obtained and the investigations carried out on them is given below:—

F_1 , 0.7 gram, to 99° C./28 mm.—This fraction smelt of pyridine and piperidine, and gave a picrate with a long range of melting point. A test for piperidine, using the methods employed by Späth and Zajic (1936), gave no positive result.

F_2 , 1.8 grams, 99–102° C./25 mm.—This fraction also gave a picrate with a long range of melting point. It was combined with the residue from F_1 and the mixture tested for pyridine by removal of the secondary bases with p-toluene sulphonic chloride (Späth and Zajic, 1936). The resulting 1 c.c. of solution of hydrochlorides of tertiary bases, on the addition of caustic soda, gave a distinct smell of pyridine, gave the tests according to Vongerichten (1899) and Oesterreichischen Tabakregie (1934) for the pyridine nucleus and gave the copper sulphate test for pyridine (Beilstein, 1899), but yielded a picrate too impure for identification as pyridine picrate.

F_3 , 2.1 grams 102–111° C./30 mm.—The picrate of this fraction melted at 206–222° C., and all attempts to purify it were unsuccessful. Benzoylation and oxidation of the fraction, based on the method of Späth and Keszler

(1937), produced no hippuric acid; thus it was unlikely that anatabine, which occurs with anabasine in cultivated tobacco, was present in the fraction, except perhaps in very small quantity.

F_4 , 0.9 gram, 111-159° C./25 mm.—This fraction consisted largely of anabasine: Picrate, melting point 204-211° C. (corrected), mixed melt with d-l-anabasine picrate 209-212° C. (corrected).

F_5 , 0.95 gram, 159-161° C./27 mm.—This fraction was also impure d-l-anabasine: Picrate, melting point 206-210° C. (corrected), mixed melt with d-l-anabasine picrate 208-211° C. (corrected).

F_6 , 5.3 grams, 165-169° C./30 mm.—This was the main anabasine fraction: Picrate, melting point 208-212° C. mixed melt with d-l-anabasine picrate 210.5-212.5° C. 1.34 grams of the fraction made up to 10 c.c. of solution, showed no rotation, thus proving that the anabasine obtained from the leaves and stems of the plant by methods unlikely to cause racemisation was optically inactive.

Removal of non-basic material and subsequent drying and distillation of the resultant liquid gave pure d-l-anabasine, of boiling point 280-281° C./650 mm. Nitrogen determinations on this product gave:—

	<i>Per Cent. Nitrogen.</i>
2.319 mg. gave 0.421 c.c. of nitrogen at 22.5°C. and 624.5 mm. pressure	17.2
2.242 mg. gave 0.406 c.c. of nitrogen at 23°C. and 623 mm. pressure..	17.1
Calculated for $C_{10}H_{14}N_2$	17.3

Determination of molecular weight by titration gave the following results:—

	<i>Molecular Weight.</i>
0.1328 gram neutralised 8.14 c.c. of N/10 sulphuric acid.....	163.1
0.1304 gram neutralised 8.00 c.c. of N/10 sulphuric acid.....	162.9
Calculated for $C_{10}H_{14}N_2$	162.2

The picrolonate of this purified anabasine melted sharply, with decomposition, at 252.5-253° C. (corrected), whereas the melting point of active anabasine picrolonate, as given by Oryekhov and Norkina (1932), is 237-239° C.

The picrate of fraction F_6 , recrystallised several times from water, melted at 211.5-212.5° C. (corrected); mixed melt with d-l-anabasine picrate 212-213° C. (corrected). Determination of nitrogen in the recrystallised picrate gave:—

	<i>Per Cent. Nitrogen.</i>
2.616 mg. gave 0.500 c.c. of nitrogen at 25°C. and 625 mm. pressure..	18.01
1.926 mg. gave 0.372 c.c. of nitrogen at 25.5°C. and 624 mm. pressure	18.13
Calculated for $C_{10}H_{14}N_2 \cdot 2C_6H_5(NO_2)_3OH$	18.06

F_7 , 4.1 grams, 180-220° C./30 mm.—The picrate of this fraction melted at 202-221° C. (corrected), but digestion with boiling alcohol left a comparatively insoluble part shown by melting point and mixed melt to be anabasine picrate. The alcohol-soluble part of the picrate could not be identified.

The fraction was tested for the presence of dipyriddyls by dissolving in absolute alcohol and passing in dry hydrogen chloride, but no hydrochlorides were precipitated.

*F*₈, 7.35 grams, undistillable residue.—By treatment of the picrate as described under *F*₇, this residue was shown to contain some anabasine. Tests for dipyriddyls, carried out as under *F*₇, yielded a trace of hydrochlorides too deliquescent to handle in air.

PREPARATION OF SALTS AND DERIVATIVES OF d-l-ANABASINE.

d-l-Anabasine Picrate.

The picrate was formed as a voluminous crystalline mass when an alcoholic solution of picric acid was added to an alcoholic solution of d-l-anabasine. In the presence of small amounts of basic material there was a tendency for the picrate to be precipitated in oily form which crystallised on scratching with a glass rod. Two distinct crystalline forms of the picrate were observed: plates when crystallised from 50 per cent. alcohol and needles when crystallised from water (Plate 1). Both forms melted sharply at 212-213° C. (corrected).

d-l-Anabasine Mono-hydrochloride.

This salt crystallised from the base when the latter was obtained by extraction with ammoniacal chloroform of the dried hydrochlorides from steam distillation. It could be crystallised by the addition of anhydrous acetone to a strong solution in chloroform, but was best purified by vacuum sublimation (180° C., 0.0003 mm. pressure), when white needle crystals were obtained (Plate 2). 0.30 gram of the mono-hydrochloride was obtained from 5.66 grams of base.

The salt melted at 189° C. (corrected). It was found to be hygroscopic, very soluble in water, alcohol and chloroform and slightly soluble in other organic solvents. An N/100 solution in water was found to have a pH value between 6 and 7.

Elementary analysis of the salt gave the following results:—

	<i>Per Cent.</i> <i>Carbon.</i>	<i>Per Cent.</i> <i>Hydrogen.</i>
3.488 mg. gave 7.721 mg. of carbon dioxide and 2.386 mg. of water. . .	60.37	7.66
3.989 mg. gave 8.847 mg. of carbon dioxide and 2.712 mg. of water. . .	60.47	7.61
	<i>Per Cent. Nitrogen.</i>	
3.634 mg. gave 0.518 c.c. of nitrogen at 19.5°C. and 624 mm. pressure		13.66
3.161 mg. gave 0.451 c.c. of nitrogen at 22°C. and 624 mm. pressure. . .		13.56
	<i>Per Cent. Chlorine.</i>	
5.237 mg. gave by direct precipitation 3.743 mg. of silver chloride.		17.69
3.763 mg. gave by direct precipitation 2.729 mg. of silver chloride.		17.95
6.183 mg. gave by micro-Carius (Niederl, Baum, McCoy and Kuck, 1940)		
4.475 mg. of silver chloride.		17.91
5.194 mg. gave by micro-Carius 3.734 mg. of silver chloride.		17.78
	<i>Per Cent. C.</i>	<i>Per Cent. H.</i>
Calculated for C ₁₀ H ₁₄ N ₂ ·HCl.	60.42	7.61
		<i>Per Cent. N.</i>
		14.11
		<i>Per Cent. Cl.</i>
		17.85

The platinichloride and aurichloride were prepared from the salt, and the following analytical figures were obtained:—

	<i>Per Cent.</i> <i>C.</i>	<i>Per Cent.</i> <i>H.</i>	<i>Per Cent.</i> <i>N.</i>	<i>Per Cent.</i> <i>Cl.</i>	<i>Per Cent.</i> <i>Pt.</i>	<i>Mol. Wt.</i> <i>of Base.</i>
<i>Platinichloride</i> —						
Found.....	21·23	2·86	4·82	36·56	34·15	161·5
	—	—	—	37·93	34·00	164·0
Calculated for—						
$C_{10}H_{14}N_2 \cdot H_2PtCl_6$	20·98	2·82	4·90	37·18	34·10	162·2
<i>Aurichloride</i> —						
					<i>Per Cent.</i> <i>Au.</i>	<i>Molecular</i> <i>Weight.</i>
4·162 mg. gave 1·944 mg. of gold.....					46·71	164·4
5·395 mg. gave 2·526 mg. of gold.....					46·80	162·4
Calculated for $C_{10}H_{14}N_2 \cdot (HAuCl_4)_2$					46·81	162·2

The salt formed the same picrate and picrolonate as d-l-anabesine (*Picrate*, melting point 210-211·5° C., mixed melt with d-l-anabesine picrate 210-211·5° C.; *Picrolonate*, melting point 244-245° C., mixed melt with d-l-anabesine picrolonate 252-252·5° C.).

d-l-Anabesine mono-hydrochloride was prepared by neutralising two drops of d-l-anabesine with hydrochloric acid (litmus), drying in a vacuum desiccator and subliming the product. This product melted at 189° C. (corrected), and gave no depression of melting point when mixed with the above compound. Thus the solid which crystallised from the steam-distilled base was definitely proved to be d-l-anabesine mono-hydrochloride.

d-l-Anabesine Aurichloride.

This compound was precipitated as a pale yellow crystalline solid when an aqueous solution of gold chloride was added to a solution of anabesine 1:1 hydrochloric acid. It crystallised from 1:1 hydrochloric acid in feathery leaflets with a corrected melting point of 218° C. (decomp.).

DL-(d-l) Anabesine Sulphate.

This salt was apparently more hygroscopic than the corresponding mono-hydrochloride, and neutralisation of anabesine with sulphuric acid (litmus) and long drying in a vacuum desiccator produced only a gummy product.

d-l-Anabesine Perchlorate.

Evaporation on the water bath of a strong aqueous solution of d-l-anabesine with 50 per cent. perchloric acid solution and scratching of the residue with a glass rod gave a crystalline mass of the perchlorate, which was extremely soluble in water and did not sublime in high vacuum. It was recrystallised by the addition of ether to the cold alcoholic solution, and consisted of pure white prisms of corrected melting point 164·5-166° C. without decomposition.

p-Toluene Sulphonic Acid (d-l) Anabesine.

0·3 gram of d-l-anabesine was dissolved in a small quantity of water and 0·16 gram of caustic soda added. Then an ethereal solution of 0·35 gram of p-toluene sulphonic chloride was added, and after shaking the liquid

was steam-distilled to remove any unchanged p-toluene sulphonic chloride, then cooled and extracted with ether. The ether solution was dried over anhydrous sodium sulphate. After removal of the ether a gummy material was left, which was too soluble in methyl alcohol to be crystallised from this solvent, and which could not be induced to crystallise even after drying for two weeks in a vacuum desiccator.

The dried product weighed 0.60 gram. That it was a compound of anabasine and p-toluene sulphonic acid was probable, as it had no smell, was unaffected by steam distillation and gave no sublimate or distillate when heated to 200° C. under high vacuum, but regenerated d-l-anabasine (melting point and mixed melt of picrate) when heated in a sealed tube with concentrated hydrochloric acid according to the method of Hinsberg and Kessler (1903).

Tetrabromo-(d-l-) Anabasine.

The addition of excess bromine water to d-l-anabasine produced red, oily drops which solidified, on the removal of free bromine in a gentle air stream, to an orange-coloured mass. Dried in a vacuum desiccator, the compound retained a deep yellow colour, and melted with decomposition at 135-136° C. (corrected). Attempts to recrystallise and to sublime the compound resulted in decomposition. Micro-Carius estimations, using the method of Niederl, Baum, McCoy and Kuck (1940) gave the following results: —

	<i>Per Cent. Bromine.</i>
6.452 mg. gave 10.114 mg. of silver bromide.....	66.7
7.126 mg. gave 11.117 mg. of silver bromide.....	66.4
Calculated for $C_{10}H_{11}N_2Br_4$	66.4

Tetrabromo-(d-l-) Anabasine Picrate.

The addition of a cold, saturated solution of picric acid in alcohol to a cold, saturated alcoholic solution of tetrabromo-d-l-anabasine produced a picrate consisting of short, deep yellow prisms very slightly soluble in alcohol. Washed with cold alcohol and dried by suction, this picrate melted sharply at 174.5-175° C. (corrected) without decomposition.

Tetrabromo-(d-l-) Anabasine Picrolonate.

This salt came down slowly on mixing cold, saturated alcoholic solutions of picrolonic acid and d-l-anabasine. It was light yellow and of indefinite crystalline form. After washing with a little cold alcohol, in which it was somewhat soluble, and drying with suction, it melted sharply at 172-173.5° C. (corrected) with decomposition.

SUMMARY.

1. The alkaloid contained in *Nicotiana glauca* has been extracted and found to consist largely of optically inactive anabasine. It is of interest to note that anabasine from *Anabasis aphylla* is strongly laevo-rotatory, and the anabasine isolated from *Nicotiana glauca* in the U.S.A. by C. R. Smith had a small laevo rotation.

2. The alkaloid probably contains pyridine and piperidine, but the presence of these compounds could not be definitely proved.
3. Other alkaloids which have been found to occur with anabasin in cultivated tobaccos could not be detected.
4. The total alkaloid was found to comprise 1.3 per cent. of the dried plant.
5. Anabasin was found to form a well-crystallised mono-hydrochloride, which was fully investigated.
6. Other salts and derivatives of d-l-anabasin which were prepared and investigated were the picrate, aurichloride, neutral sulphate (di-anabasin sulphate), perchlorate, compound with p-toluene sulphonic acid and the tetra-bromo derivative and its picrate and picrolonate.

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PLATE I.



FIG. 1.—d-l-Anabasine Picrate, from 50% Alcohol. $\times 90$.

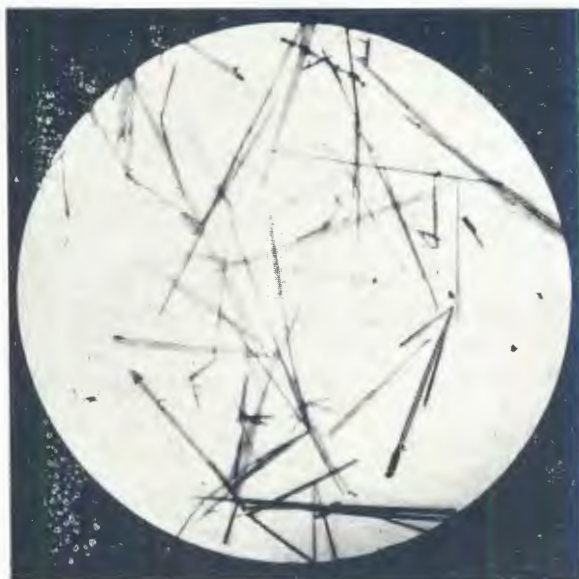


FIG. 2.—d-l-Anabasine Picrate, from water. $\times 35$.

PLATE II.

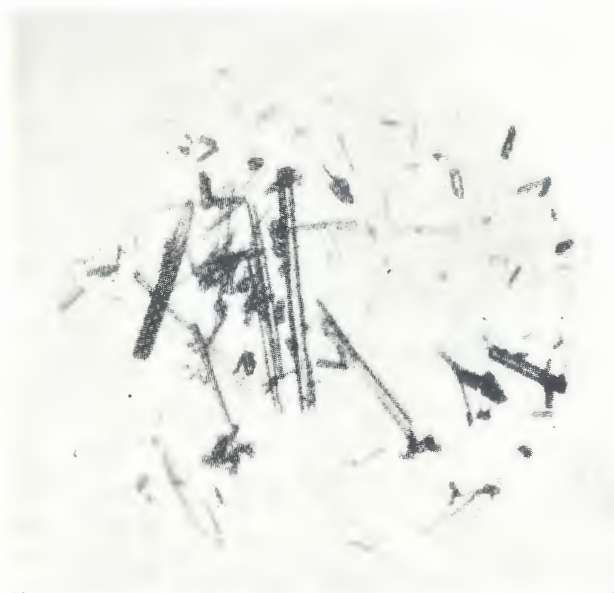


FIG. 3.—d-l-Anabasine Mono-Hydrachloride, vacuum-sublimed. $\times 90$.