of Science was directed to advertise for sale copies of the "Life and Works of Doctor Augustin Gattinger" by Henry Nathaniel Oakes, published by the academy. The grant for scientific research allotted to the academy by the American Association for the Advancement of Science was awarded to Nathan H. Woodruff, of Donelson, Tennessee, to continue at Peabody College his research on the "acidity of soils at the roots of ferns in Tennessee." Dr. Charles G. Shoup, assistant professor of biology, Vanderbilt University, was elected a member of the board of trustees of the Reelfoot Lake Biological Station for the term of three years.

Officers elected for the year 1936 are: Claude R. Fountain, *president,* Nashville; Paul J. Kruesi, *vice-president,* Chattanooga; John T. McGill, *secretary-treasurer,* Nashville; Jesse M. Shaver, *editor,* Nashville; Eleanor Eggleston, *librarian,* Nashville.

JOHN T. MCGILL,
Secretary-treasurer

THE OKLAHOMA ACADEMY OF SCIENCE

THE twenty-fourth annual meeting of the Oklahoma Academy of Science was held at the University of Oklahoma, Norman, Okla., on December 6 and 7, 1935. The academy program was divided into four sections which were as follows: Biology, Geology, Physical Sciences and Social Sciences. One hundred and twenty-eight papers were presented. A special section was arranged for high-school science teachers. The total membership in the Oklahoma Academy of Science is 387.

Dr. D. W. Ohern, geologist from Oklahoma City, Okla., gave the annual address to the academy on Friday evening in the university auditorium. The subject of this lecture was "Science in the Thought of To-day." Dr. Ohern was president of the Oklahoma Academy of Science in 1910.

Dr. Charles E. Decker gave the presidential address at the luncheon on Saturday. His subject was "The Oklahoma Academy of Science in Relation to the Advancement of Science and Research in the State."

More than 300 people were present at the meetings. The officers elected for 1936 are as follows:

President, Dr. Horace J. Harper, Oklahoma A. and M. College, Stillwater, Okla.

Vice-president, Section A (Biology), Dr. T. C. Carter, Northwestern State Teachers College, Alva, Okla.

Vice-president, Section B (Geology), Dr. Robert H. Dott, Oklahoma Geological Survey, Norman, Okla.

Vice-president, Section C (Physical Sciences), Dr. A. T. Goble, University of Tulsa, Tulsa, Okla.

Vice-president, Section D (Social Sciences), Dr. L. B. Hoisington, University of Oklahoma, Norman, Okla.

Secretary-treasurer, Dr. Duane Roller, Oklahoma University, Norman, Okla.

Assistant secretary-treasurer, Professor H. I. Featherly, Oklahoma A. and M. College, Stillwater, Okla.

DUANE ROLLER,
Secretary

SPECIAL ARTICLES

SPECTROSCOPIC SIMILARITY BETWEEN ERGOT (LYSERGIC ACID) AND THE YOHIMBINE ALKALOIDS

IN a previous communication,[1] announcing the isolation of ergotocin (the orally effective principle of ergot), the writers reported the alkaline hydrolysis products of ergotocin to be lysergic acid and a base which was at that time the object of further study. In the meantime Jacobs and Craig[2] have identified this basic hydrolysis product as propanolamine; our independent study, not previously reported, has led to the same result.

The degradation reactions commonly employed in establishing the constitutions of natural substances usually give very low yields of identifiable products; hence it seemed desirable, in view of the minute quantities of material available for the investigation of ergotocin to seek other means of attack. Comparison of the ultra-violet absorption spectra of ergotocin and its derivatives with those of other presumably related substances has proved a promising avenue of approach.

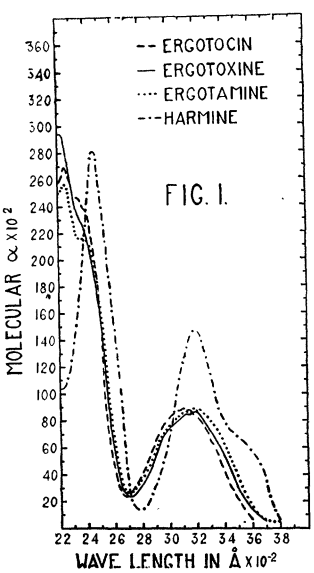
Early in this study we were impressed by the marked similarity in the molecular absorption curves for ergotoxine, ergotamine and ergotocin (Fig. 1). Probably these three substances have a common structural skeleton (lysergic acid) chiefly responsible for their respective ultra-violet absorptions.

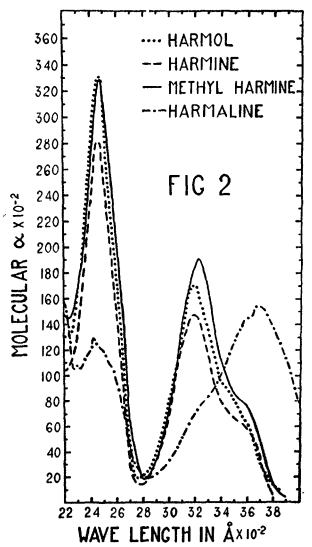
That ergotocin might be structurally related to the harmala alkaloids is suggested by the similar fluorescence of their solutions; this possibility was, however, rejected after a comparison of the absorption curve of ergotocin with those of harmol, harmine, methyl harmine, harmaline[3] and tetrahydroharmine (Figs. 1 and 2).

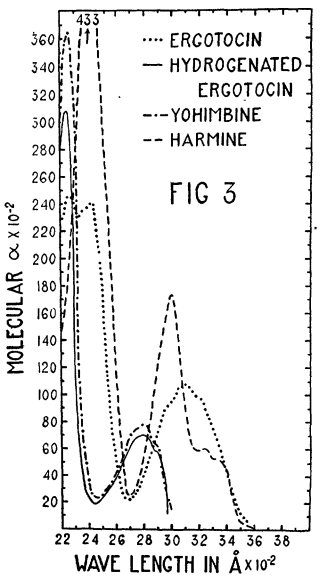
[1] M. S. Kharasch and R. R. Legault, SCIENCE, 81: 388, 1935; *Jour. Am. Chem. Soc.,* 57: 1140, 1935.

[2] W. A. Jacobs and L. C. Craig, SCIENCE, 82: 16, 1935.

[3] For purposes of record it seems desirable to report that the same possibility of relationship had occurred to H. A. Shonle and E. C. Kleiderer, of the Eli Lilly Research Laboratories, early in June, 1935. At that time they prepared for publication and submitted to us for comment a note suggesting this relationship. Upon examination of our absorption curves, however, they withheld publication. We still believe that these curves constitute more cogent arguments against the structural relationship of ergotocin



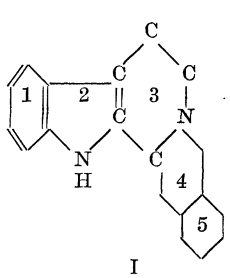




The further study of absorption spectra revealed that the curve of yohimbine is strikingly similar to that of ergotocin in shape, but somewhat displaced toward the shorter wave-lengths (see Fig. 3). We therefore undertook the platinum-catalyzed hydrogenation of ergotocin.

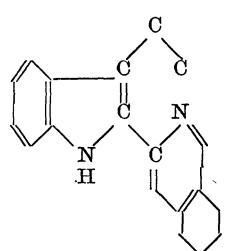
The specific rotation of hydrogenated ergotocin (m.p., 223° C. uncorr.) in methyl alcohol is about −70°, as compared with the specific rotation, +40.2° of ergotocin. The maleate and succinate salts of hydrogenated ergotocin are also laevorotatory in water solution, while those of ergotocin are dextrorotatory.[4] The ultra-violet absorption curves of hydrogenated ergotocin and yohimbine are almost identical (see Fig. 3). It is therefore probable that ergotocin and yohimbine have closely related structural skeletons; in fact, these skeletons may well be identical.

Rather drastic degradations (*e.g.,* alkali fusion or selenium dehydrogenation) have been used to derive the proposed structural formula of yohimbine. The most recent of these (that of Scholz[5]) has the following skeleton:

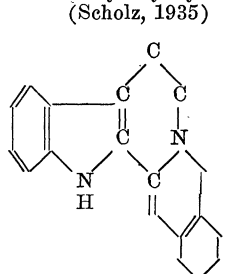


I

If Scholz's formula and the relationship above suggested are indeed correct, the ergot alkaloids, including ergotocin (and therefore lysergic acid) must have the *tetracyclic* structural nucleus represented by rings 1 to 4 inclusive. In the opinion of the writers, however, there is still reasonable uncertainty as to the exact constitution of yohimbine—note the new structure (II) assigned to tetrahydroyobyrine by Scholz.[4]



II
Tetrahydroyobyrine
(Scholz, 1935)

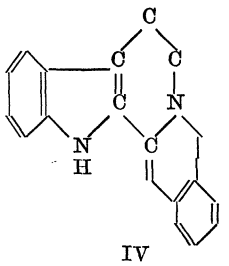


III
Tetrahydroyobrine
(Barger and Scholz, 1933)

(and therefore lysergic acid) to the harmala alkaloids than are furnished by the rather meager experimental comparisons recently cited by Jacobs and Craig (W. A. Jacobs and L. C. Craig, *Jour. Biol. Chem.*, 111: 455, 1935) in favor of such a relationship.

[4] The hydrogenated ergotocin maleate is similar to ergotocin maleate in causing powerful uterine contractions in a 0.2 mg dose when administered intraveneously.

[5] Scholz, *Helv. Chim. Acta,* 18: 923–33, 1935. See also Barger and Scholz, *ibid.*, 16: 1353, 1933.



IV

Yobyrine
(Barger and Scholz, 1933)

The writers believe that definite conclusions as to the structural relationship between the ergot and the yohimbine alkaloids, tetrahydroyobrine and yobyrine, may be drawn from further study of the ultra-violet absorption spectra of these compounds and their hydrogenation products. Syntheses of the tetracyclic nuclear structure illustrated by rings 1 to 4 in I and of the corresponding tricyclic nuclei obtained by breaking either the C—N or the C—C bond between rings 3 and 4 are now under way in this laboratory.

We hope that this announcement of the probable close skeletal relationship between yohimbine and the ergot alkaloids, together with the statement of the work now under way in this laboratory, will be regarded by other investigators as a justifiable reservation of this approach to the problem. Their courtesy and consideration will be gratefully appreciated by the writers.

The writers are indebted to Drs. T. Hogness and P. Zscheile, Rockefeller Foundation grant fellow, for the absorption spectra measurements, and to the Eli Lilly Company for a supply of ergotocin.

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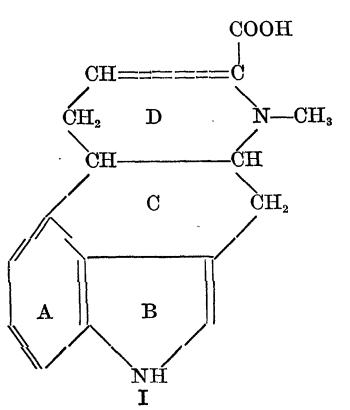
THE ERGOT ALKALOIDS. THE STRUCTURE OF LYSERGIC ACID

A PROVISIONAL structure for lysergic acid,[1] *viz.*, 3-propenyl-3, 4-dihydro-4-methylcarboline-5-carbonic acid, was suggested on the basis of the interpretation of its properties, of its degradation products and of a possible analogy to other alkaloids biogenetically related to tryptophane. More recent observations, however, have brought the conviction that this view must be revised. The nature of the previously reported product of the alkali fusion of dihydrolysergic acid, the base $C_{11}H_{11}N$, has now been determined. Although greatly handicapped by the very small yield of this base, we have convinced ourselves of its identity with 1-methyl-5-aminonaphthalene by comparison with that synthetically obtained.[2] The formation of this amine makes it probable that two fused six-membered rings enter into the make-up of lysergic acid and emerge on alkali fusion as a naphthalene derivative, and that the amino group is produced by cleavage of a fused pyrrol ring (an indol derivative).

The tribasic acid, $C_{14}H_9O_8N$, obtained in earlier work[3] by nitric acid oxidation of ergotinine and which retains the *N* methyl group of lysergic acid, has been found to yield quinoline, isolated as the picrate, on distillation with soda lime. It appears probable, therefore, that this acid is a quinoline derivative and possibly an N-methyl quinoline betaine tricarboxylic acid, as suggested by formula II. Picric acid has also been isolated from the nitric acid oxidation of lysergic acid, an observation compatible with an indol structure.

Finally, lysergic acid on catalytic hydrogenation yields at first dihydrolysergic acid which, contrary to the former, can no longer be titrated, indicating the proximity of the double bond and carboxyl group in the ring containing the $N \cdot CH_3$ group. Further hydrogenation appears to attack the indol ring system. The behavior of lysergic acid on hydrogenation leaves little doubt that it must be tetracyclic.

These observations, which together with other general considerations will be discussed more fully elsewhere, suggest a possible structure[4] for lysergic acid as presented in formula I. Oxidative cleavage with nitric acid of Rings A and B could give the tribasic



I

[6] At Bucknell University since September 15, 1935.

[1] W. A. Jacobs and L. C. Craig, *Jour. Biol. Chem.*, 111: 455, 1935.

[2] V. Veselý, F. Stursa, H. Olejnicek and E. Rein, *Coll. Czech. Chem. Commun.*, 1: 506, 1929.

[3] W. A. Jacobs, *Jour. Biol. Chem.*, 97: 739, 1932.

[4] The position assigned to the carboxyl group and double bond in Ring D in this formula, as well as the size of the betaine ring, in II is still arbitrary. There is also possibility that production of lysergic acid itself from the alkaloid may involve stereochemical rearrangements or a shift of the double bond in a precursor.