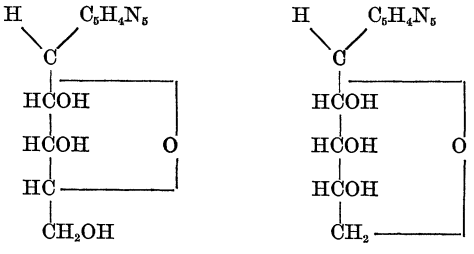
and the basal and intervertebral ganglia of the reinoculated animals are typical of experimental poliomyelitis.

SIMON FLEXNER

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK, N. Y.

THE RING STRUCTURE OF ADENOSINE

ADENOSINE is an adenine glycoside of d-ribose. As in the case of other glycosides, this particular one may exist in two forms isomeric with regard to their ring structure.



I. II.

Fig. I represents the furanoside and Fig. II the pyranoside structure. It has now been established that natural adenosine possesses the furanoside structure. This information is important in connection with the theory of the structure of nucleic acids, of which a detailed discussion will be given elsewhere.

The structure was established through the complete methylation of the nucleoside. By hydrolysis of the methylated nucleoside a trimethyl ribose differing from 2, 3, 4-trimethyl ribose has been obtained and to the new sugar is attributed the furanose structure. The points of difference are:

(1) The physical state at room temperature; the substance from the nucleoside being a liquid whereas 2, 3, 4-trimethyl ribose is crystalline.

(2) The optical rotation; that of the new substance being $[\alpha]_D^{26} = +51.6°$ and that of the corresponding pyranose $[\alpha]_D^{27} = -51.7°$.

P. A. LEVENE
R. STUART TIPSON

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK, N. Y.

ALARIA MUSTELAE SP. NOV., A TREMATODE REQUIRING FOUR HOSTS

AN undescribed trematode of the superfamily, Strigeoidea, occurring in the intestines of wild minks and weasels of Michigan, is of particular interest because it requires four hosts for the completion of its life history and its hermaphroditic adult stage is preceded by a series of three larval stages, cercaria, agamodistomum and metacercaria.

The cercaria resembles in many respects *Cercaria marcianae* Cort and Brooks, 1928, but differs from the latter in its smaller size, its simpler excretory system which consists of five flame cells in the body and two in the tail stem on each side, the spination which is restricted to the anterior portion of the body, the possession of only a single row of spines around the opening of the acetabulum, and by the position of the four penetration glands, two on either side of the ventral sucker. The further development of the cercaria is much like that of *C. marcianae* for it also penetrates frogs and tadpoles, in which it undergoes some growth and development. It also retains many of its cercarial characters after entering its first vertebrate host so that it is similar to *Agamodistomum marcianae* from which it can be distinguished, however, by the same characters which differentiate the cercariae of the two species. When these agamodistomes were fed to laboratory raised rats and mice, they underwent further growth and development becoming fully developed metacercariae of the diplostomulum type in the muscles. Similar metacercariae were found as natural infections in the muscles and lungs of the mink and raccoon, and in the muscles of the white-footed deer-mouse.

Experimentally infected laboratory mice were fed to a parasite-free ferret, and ten days later full grown Alaria were found in the intestines. Metacercariae from lungs of minks when fed to dogs, cats and ferrets also developed into Alaria. The worms raised experimentally in all these hosts agree in all characters including measurements with those found in the intestines of wild weasels and minks.

Experiments to get cercariae to penetrate directly into mice were unsuccessful, proving that the stage occurring in frogs and tadpoles is an essential step in the life cycle of this parasite. *Alaria mustelae* passes through the following stages and hosts in order to complete its life history; sporocysts in the snail, producing cercariae, which penetrate into tadpoles or frogs in which they become agamodistoma; these when eaten by a mammal, such as a mink, raccoon or mouse, become metacercariae in the muscles or lungs; metacercariae grow to adult state when eaten by another mammal such as a mink, weasel, cat, dog or ferret, in the intestines of which they deposit their eggs. From the latter, miracidia hatch, which are capable of infecting the snail.

Many metacercariae in all stages of development were secured from lungs of mink, making it possible to follow the development of the reserve excretory system and the reproductive system. The reserve

excretory system arises as an outgrowth from the primary excretory bladder, the branches of which secondarily anastomose to form the network of vessels and spaces characteristic of the adults of the superfamily Strigeoidea. All the organs of the reproductive system are completely formed in the metacercaria but in a less mature state than in the adult.

Alaria mustelae, sp. nov.: characters of the genus. Length 0.82–1.74 mm, foliaceous forebody one to two times length of the cylindrical hindbody, entirely covered with retrorse spines. Oral sucker terminal, average width and length 0.082 x 0.082 mm, slightly larger than acetabulum, but shorter than pharynx, which averages 0.106 x 0.078 mm; ovary anterior to testes, averaging 0.152 mm in width; Mehlis' gland postero-lateral to anterior testis; uterine eggs few, averaging 0.11 x 0.072 mm. Cercaria fork-tailed, pharyngeate, flame cell pattern $2[(1+1+1)+(1+1+(2))]$, developing in slender unbranched sporocysts in the snail, *Planorbula armigera.* Agamodistomum stage in frogs and tadpoles. Metacercariae of diplostomulum type, in muscles and lungs of small frog-eating mammals.

Poche, 1925, split up the family Strigeidae Railliet, separating off the family *Cyathocotylidae* with *Cyathocotyle* Mühling as the type genus. It is here proposed to restrict the family Strigeidae still further by removing all those forms not belonging within the subfamily *Strigeinae* Railliet. The genus *Brauninа* Heider becomes the type of the family *Brauninidae* fam. nov., which is characterized by the great reduction of the hindbody, by the inclusion within the holdfast organ of all reproductive organs except terminal portions of genital ducts, and the possession of cirrus and cirrus-pouch. The genus *Alaria* Schrank is the type of the family *Alariidae* Tubangui, 1922, which includes the subfamilies *Alariinae* Hall and Wigdor, and *Polycotylinae* Monticelli. The genus *Cleistogamia* Faust is removed from the superfamily *Strigeoidea* since it does not have a holdfast organ, and possesses several characters not found within the superfamily *Strigeoidea.* These characters are those structures which make the cleistogamous type of fertilization imperative and the nonoperculate egg with filamentous appendages. The genus Cleistogamia Faust is placed in a new family *Cleistogamiidae* with the single subfamily *Cleistogamiinae* Faust, 1927. No suggestion is offered regarding its relationship to other families.

A more complete description of this parasite, its life history, and a discussion of the taxonomy of the Strigeoidea will appear elsewhere.

NELLY J. BOSMA

ZOOLOGY DEPARTMENT,
UNIVERSITY OF MICHIGAN

THE RELATION BETWEEN IRON, HUMIC ACID AND ORGANIC MATTER IN THE NUTRITION AND STIMULATION OF PLANT GROWTH

THIS communication will report briefly an extensive investigation just concluded in which the chemical substance contained in natural soil humic acid, chiefly responsible for the marked stimulation of growth of various higher and lower plants, has been determined. The growth studies have been conducted with the free-living aerobic soil bacterium *Azotobacter vinelandii,* and, although the findings apply strictly to this organism only, there are numerous reasons for believing them to apply quite generally to other organisms, in qualitative respects, at least. A wide variety of experimental conditions have been employed with respect to method of growth, criteria of growth and stimulation, nature of medium, source and concentration of nitrogen, temperature, pH, duration of experiment and humic acid. The results are being described in detail elsewhere,[1] but in view of their general implications and interest are being summarized here.

Both natural soil humic acids and synthetic humic acids have been employed. The former were prepared by washing soil with N HCl and then extracting with 10 per cent. KOH, the latter by boiling 20 per cent. glucose in 35 per cent. HCl and then centrifuging and extracting with 10 per cent. KOH. Purification was accomplished in both cases by precipitating at pH 3, centrifuging, and redissolving at pH 7.5, the cycle being repeated five times in all. It was possible to prepare, by minor variations in method and soil used, natural humic acids varying in iron content from 0.06 to 1.4 per cent. By adding $Fe_2(SO_4)_3$ to the glucose-HCl mixture during boiling, it was possible to prepare synthetic humic acids varying in iron content from 0.03 to 4.4 per cent.; other metals could be introduced similarly into the synthetic humic acids.

It has been determined that natural humic acid increases growth primarily, if not entirely, by virtue of the *iron* it contains; the organic fraction is substantially inactive, and likewise other inorganic impurities. The following evidence supports this finding.

(a) Natural humic acid may be substituted more

[1] "The Chemical Nature of Humic Acid Growth Stimulation in Relation to Iron" and "The Physiological Nature of Humic Acid Stimulation of *Azotobacter* Growth," submitted for publication to *Soil Science.* These papers contain some seventy-five tables and figures of experimental data and represent several thousand experimental cultures. The relation of the present investigation to previous similar ones will not be discussed here, beyond mentioning the following recent pertinent papers: Clark, SCIENCE, 71, 269 (1930); Hopkins, *Bot. Gaz.,* 89, 209 (1930); Olsen, Compt. rend. Lab. Carlsberg, 18, 1 (1930); Iwasaki, *Bioch. Zeit.,* 226, 32 (1930); Blumenberg and Blumenberg, U. S. Patent 1,783,694, Dec. 2 (1930); Farries and Bell, *Ann. Bot.,* 44, 424 (1930); and Ashby, *Ann. Bot.,* 43, 805 (1929).