St. Lawrence County," Dr. D. H. Newland, New York State Museum; "Some Aspects of Pleistocene Geology," Professor Earl T. Apfel, Syracuse University; "Adirondack Rocks in Kodachrome," and Movies of Buffalo Meeting, Professor H. L. Alling, University of Rochester; Report of Nominating Committee, Professor G. B. Cressey, Syracuse University.

The visiting delegates left for their homes on Saturday afternoon enthusiastic about the talks which they had heard and the geological features which they had seen and with their cars laden with mineral specimens collected.

The officers for next year are Professor George H. Chadwick, *president;* Robert W. Jones, *secretary-treasurer,* who will succeed Dr. Robert Wesley Brown and Dr. John S. Brown, retiring president and secretary-treasurer, respectively. The association is eagerly looking forward to next year's meeting, which will be held in the Catskills.

FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS

THE ninth annual meeting of the Field Conference of Pennsylvania Geologists was held in West Virginia from May 27 to 30. More than fifty geologists from New York, New Jersey, Pennsylvania, Virginia and West Virginia attended.

The conference hosts were the members of the West Virginia Geological Survey. The 1939 committee consisted of Dr. Paul H. Price, state geologist of West Virginia, *chairman;* Dr. B. L. Miller, Lehigh University; Dr. R. E. Sherrill, University of Pittsburgh, and M. N. Shaffner, Pennsylvania Topographic and Geologic Survey, secretary and treasurer.

The annual dinner was held at the University of West Virginia at Morgantown on Sunday evening. A welcome was extended to the group by the president of the university, Dr. Charles E. Lawall. Other speakers were, Dr. Paul H. Price; Dr. Arthur Bevan, state geologist of Virginia; Dr. B. L. Miller; Dr. R. W. Stone, Pennsylvania Topographic and Geologic Survey; E. T. Heck, West Virginia Geological Survey; Professor Herbert Woodward, University of Newark, and M. N. Shaffner.

The committee accepted an invitation from the New Jersey Geologists to meet with them in New Jersey in 1940, and the following committee was appointed for that meeting: Dr. Meredith E. Johnson, state geologist of New Jersey, *chairman;* Professor Herbert Woodward; Dr. Bradford Willard, Pennsylvania Topographic and Geologic Survey, and M. N. Shaffner.

On Sunday the excursion covered strata from Lower Mississippian to Upper Pennsylvanian in the area between Morgantown and White Sulphur Springs. On Monday strata from Upper Ordovician to Middle Mississippian were covered between White Sulphur Springs and Petersburg, and on Tuesday strata from Upper Silurian to Lower Mississippian were covered between Petersburg and Berkley Springs. The leaders were Dr. Paul H. Price, E. T. Heck, Herbert Woodward and Professor H. M. Fridley, West Virginia Geological Survey.

M. N. SHAFFNER,
Secretary and Treasurer

SPECIAL ARTICLES

THE RELATION OF "COENZYME R" TO BIOTIN

THE value of yeast or plant extracts as stimulants to growth of the root nodule bacteria (*Rhizobium* sp.) has been long recognized. Allison, Hoover and Burk[1] explained the stimulation on the basis that the extracts provide a specific coenzyme for respiration (Coenzyme R), and concluded that the active agent "is certainly not identical with bios, since its addition to synthetic medium essentially free from bios resulted in growth of yeast negligible compared with the heavy growth obtained where bios was present." Apparently, it has been assumed by many workers that this implies that biotin, a growth factor for yeast, is not a growth stimulant for rhizobia, a conclusion which does not necessarily follow from the foregoing statement.

Evidence obtained in this laboratory strongly indicates a relationship between the growth factor requirements of yeast and rhizobia. Treatment of yeast extract with acids, alkalies, solvents, adsorbents and oxidizing agents resulted in parallel preservation or destruction of the activity for both *S. cerevisiae* and *R. trifolii.*

During preparation of biotin concentrates by the procedure of Kögl and Tonnis,[2] fractions were tested at each stage of purification, and total units and purity of the active factor assayed by growth of *S. cerevisiae* and *R. trifolii.* The concentration of biotin, as assayed by yeast growth, was accompanied by the same degree of purification of the Rhizobium factor, until the norite adsorption step was reached. Unexpectedly, the eluate (biotin fraction) was highly active with *R. trifolii,* but inactive with yeast. On addition of a small quantity of the filtrate, however, the activity for yeast was completely restored. Further investigation disclosed that the filtrate factor could be replaced by synthetic β-analine. Following this lead, a prepara-

[1] F. E. Allison, S. R. Hoover and D. Burk, SCIENCE, 78: 217, 1933.

[2] F. Kögl and B. Tonnis, *Zeits. Physiol. Chem.,* 242: 43, 1936.

tion of "Coenzyme R" obtained from *Azotobacter* by the method of Hoover and Allison[3] was tested, and it was found, in agreement with these workers, that alone it was completely inactive with yeast. When 0.1 gamma per ml of β-alanine was added, however, the preparation stimulated yeast growth in a manner identical with that of the biotin concentrate. For maximum growth response, it required 5 gammas per ml of the former, but only 0.3 gamma of the latter. With a given level of either "Coenzyme R" or biotin concentrate, a maximum in the curve of yeast stimulation was obtained in the region of 0.05 to 0.5 gamma per ml of β-alanine. With *R. trifolii* near maximum stimulation was obtained with either "Coenzyme R" or biotin alone; addition of 0.05 gamma per ml or over of β-alanine gave a small but consistent supplementary effect. It is not surprising that β-alanine is much less effective with *R. trifolii* than *S. cerevisiae* since the former is apparently capable of decarboxylating aspartic acid to form β-alanine.[4] The growth of *R. trifolii* was not decreased when the amount of β-alanine was raised to 1.0 gamma per ml. These results have been confirmed with several species of *Saccharomyces* and *Rhizobium*.

Consideration of these data leads to the following alternative conclusions:

(1) "Coenzyme R" and biotin are identical.

(2) "Coenzyme R" and biotin are distinct, but with such similar chemical and physical properties that we have not been able to separate them by any of the procedures indicated.

(3) "Coenzyme R" and biotin are distinct, but each acts as a growth stimulant for either or both yeast and rhizobia.

Final decision with regard to the relationship must necessarily rest until both factors are available in pure form. However, until a more purified "Coenzyme R" is prepared which definitely shows no activity for yeast even in the presence of β-alanine, conclusion 1 appears to be the simplest assumption. If the two factors are distinct, the present evidence favors conclusion 3, *viz.*, that biotin also is a stimulative factor for *R. trifolii*.

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SAND CULTURE[1] OF COTTON PLANTS

THE successful culture of many vegetables and flowers in water, sand, cinders, etc., suggested that this technic might be useful in research on the physiology of the cotton plant. Publications on the subject have been scattered in scientific and lay journals; in those available to us, no references to the culture of cotton plants were found.

Preliminary attempts to grow cotton seedlings by immersion of the roots in nutrient solutions were not successful. However, when the young plants were placed in sand,[2] they grew to maturity. The seeds were germinated between moistened filter papers and when the roots were from 1½ to 2 inches long, each was transplanted to a washed clay flower pot (4-inch diameter) containing wet sand. The sand was kept wet by irrigation twice daily with distilled water. Every third day, the sand was flooded with the culture solution. The solution used was that recommended by the New Jersey Agricultural Experiment Station as described by Ellis and Swaney,[3] and contained the following ingredients[4] dissolved in distilled water:

	Parts per million
$Ca(NO_3)_2$	740
KH_2PO_4	310
$MgSO_4$	280
$(NH_4)_2SO_4$	95
$FeCl_3$	8.5
H_3BO_3	0.85
$ZnSO_4$	0.48
$MnSO_4$	0.46
$CuSO_4$	0.07

The pots were kept on the window sills of a chemical laboratory with southern exposure. On clear days, they received approximately two hours of sunshine. Despite these abnormal environmental conditions, growth was steady and fairly rapid. Some plants attained a height of 100 cm in 100 days. In periods of mild weather, numerous squares[5] developed, several of which opened to form the cotton flower. Most of the bolls were shed within two weeks after the flower[6] appeared. In two instances, however, bolls set and developed normally. Although they were small, the seeds were fertile and the lint mature.

The cotton plant may thus be grown successfully under the artificial régime described. Conditions were far from optimal as indicated by the large numbers of shed squares and an abnormally long time required for maturation of the bolls. With a more favorable environment, the method might be used advantageously to study the basic and optimum requirements of the cotton plant. It would be particularly useful in deter-

[3] S. R. Hoover and F. E. Allison, *Trans. 3rd Internatl. Cong. Soil Sci.*, 1: 158, 1935.

[4] A. I. Virtanen and T. Laine, *Enzymologia*, 3: 266, 1937.

[1] The term "psammoponics" to designate sand culture has been introduced by W. A. Hamor, *Ind. Eng. Chem., News Edition*, 17: 1, 1939.

[2] 20–30 mesh standard sand.

[3] C. Ellis and M. W. Swaney, "Soilless Growth of Plants," Reinhold Publishing Co., New York, 1938.

[4] The ferric chloride is made up in a separate solution and added to the medium just before use.

[5] Cotton flower buds.

[6] The flowers last 24 hours.