ham[2] has arranged the data of the trials of peas made at Wisley in 1911[3] in a convenient form for statistical analysis.

Comparison with the wheat data already discussed is interesting. In wheat, selection has been *primarily* in the same direction—largeness of yield in bushels per acre—for all varieties. In peas, it has been in diverse directions. For the character here dealt with—time required for development—the tendency has been, consciously or unconsciously, to differentiate widely the varieties. Hence in the pea data, it is idle to lump all the materials together, for any constant thus obtained would be largely spurious and insignificant.[4] In practical tests one must decide between a series of closely similar strains—not between those which are widely and obviously differentiated; hence, we split the material up into the four classes recognized by Durham, that is, into 81–90, 91–100, 101–110, 111–120 day peas and calculate the inter-period correlation[5] for each class separately for the only economically important character[6] for which data are available—total days required for the formation of usable pods. Hence, designating by the subscripts 1, 2, 3, the three successive cultures of 1909[7] we have the following relationships:

For 91–100 day peas, $n = 30$,

$r_{12} = .16 \pm .12$, $r_{13} = .19 \pm .12$, $r_{23} = .12 \pm .12$

For 101–110 day peas, $n = 40$,

$r_{12} = .43 \pm .09$, $r_{13} = .37 \pm .09$, $r_{23} = .78 \pm .04$

For 111–120 day peas, $n = 18$,

$r_{12} = .27 \pm .15$, $r_{13} = .50 \pm .12$, $r_{23} = .45 \pm .13$

All the values are positive. Their wide fluctuation and the magnitude of the probable errors is probably largely attributable to the necessary smallness of the number of varieties in each class.

It is clear that a single test when carried out in the manner of those of the Royal Horticultural Society has little decisive value concerning the merit of a variety. This is not intended as a criticism of these tests, for they are in comparison with many others apparently of a very high order of merit. But certainly they lend their emphasis to the point[8] made in the preceding paper.

Is it not time for a concerted and systematic effort on the part of those interested in agricultural science to put this important problem on a sound basis, biologically and statistically?

J. Arthur Harris
Cold Spring Harbor, N. Y.,
December 21, 1912

[2] Durham, F. R., "An Analysis of the Pea Trials at Wisley, 1911," *Journ. Roy. Hort. Soc.*, 38: 67–72, 1912.

[3] "Pea Trial at Wisley, 1911," *Journ. Roy. Hort. Soc.*, 37: 403–424, 1911. The two original papers must be consulted for the details that are here excluded for lack of space.

[4] As a matter of fact these constants have been calculated for another purpose, but they need not be published here.

[5] To be of value in determining the relative merit of varieties the performances of a given strain in a test should be a good basis for prediction as to the results of a subsequent experiment. To what extent this is true may be determined for any two or more series of trials of a number of varieties by determining the coefficient of correlation between their performances, correction being made when symmetrical tables are involved—*i. e.*, when any determination is used both as a first and as a second member of a pair—for environmental heterogeneity from experiment to experiment. This does not apply to the pea data.

[6] The data for the individual growth periods give, on the basis of the total data, such irregular correlations that it is not worth while to consider them for the subclasses.

[7] Had the cultures been made at the same season in three succeeding years, the test would have furnished data of more value to the practical grower. Data for such tests are, as far as I am aware, not available.

[8] This has already been emphasized on general grounds by various students of agronomy. See especially C. V. Piper and W. H. Stevenson, "Standardization of Field Experimental Methods in Agronomy," *Proc. Amer. Soc. Agron.*, 2: 70–76, 1910.

ON THE METAMORPHOSIS OF AN AMŒBA, VAHLKAMPFIA SP., INTO FLAGELLATES AND VICE VERSA[1]

An amœba of the limax group isolated, in 1909, from tap-water in Oakland, California,

[1] Presented to the Cincinnati Research Society, January 9, 1913.

was studied during the past year under varying conditions of environment. The culture contained the descendants of a single amœba grown in symbiosis with a single species of bacillus.

My work was started with the idea of investigating the physical and chemical conditions necessary for the growth of this particular amœba. When, in the course of the work, it was discovered that the trophozoits had the ability to turn, apparently at will, into actively motile flagellated forms, my efforts were directed mainly towards investigating, first, the effects of varying environment upon the morphology and development of the amœba and, second, the conditions which led to the production of flagellated forms.

The trophozoits usually possess a single nucleus with the large karyosome and thick nuclear membrane characteristic of members of the limax group.

The flagellated forms vary in shape, but are most often egg-shaped or pyriform, with the nucleus situated at the pole, from which two long, delicate flagella arise.

These flagellates disappear instantly if a thin cover-glass is placed on a preparation, but may be watched for varying lengths of time in a hanging drop. The metamorphosis of one may be described briefly as follows: For a while it maintained the elongated form; then became pyriform, and whirled round and round, and in a minute or so, during its gyrations, it projected numerous waves of blunt pseudopodia; shortly it became elongated again. It progressed in this form until twenty minutes after the observation commenced, when it suddenly became motionless and spherical. In a few moments it projected a clear blunt pseudopod into which the endoplasm flowed and then it wandered off as a typical trophozoit of the limax type.

Throughout a long series of cultural experiments it was found that this metamorphosis occurred very inconstantly. Traces of various monovalent and bivalent salts seemed to exert no beneficial effect. Daily observations on one subculture were made during more than two months without revealing any flagellated forms. However, it was finally discovered that if the trophozoits were first grown in hen's ovomucoid containing a trace of the egg yolk, the development of the flagellated forms was favored. Furthermore, that they could be constantly obtained if the cultivations were carried out in hanging drops placed in contact with an abundant supply of free oxygen.

The technique is as follows: a loopful from the surface of a yolk-ovomucoid culture containing the trophozoits is mixed with two or three loopfuls of distilled water on a cover-glass and placed on a Barber moist chamber at 22°–25° C. No flagellates may be seen in an hour or so, but hundreds may be seen after three or four hours.

Two "pure lines"—each originating from a single flagellate—were obtained for me by Dr. G. L. Kite, by means of the Barber isolation pipette. Both of these showed a much greater tendency to flagellate than the original stock.

Since the ability to turn over into a flagellated stage has been established as a generic character, a technique which will enable one to determine this power is evidently of importance.

In 1912 Chatton and Lalung-Bonnaire established the new genus *Vahlkampfia* (in honor of E. Vahlkampf, who was the first to make known the characteristic mitosis of these amœbæ) to include those members of the limax group which had the ability to flagellate. These amœbæ are said to be always uninucleated. Nuclear division is by promitosis. They multiply after nuclear division by simple fission. Their cysts are always uninucleate.

My findings show that these generic characters must be greatly extended. For example, under certain cultural conditions the trophozoits form endogenous buds; under other conditions, characterized by a reduced oxygen tension, the nucleus apparently divides repeatedly by amitosis, without division of

the cytoplasm, thus giving rise to large multinucleated forms containing as many as thirty or forty nuclei. When these multinucleated forms are placed in contact with an abundant supply of free oxygen the cytoplasm immediately begins to divide. Furthermore, the free oxygen supply starts off many of the multinucleated forms and their nuclei divide simultaneously.

These findings have raised the question, in my mind, as to the validity of the multinucleated genus *Pelomyxa* and the binucleated genus *Sappina*.

It may be of interest to describe here a reaction which I believe indicates the presence of peroxides in the living cell. When these amœbæ are grown in ovomucoid containing a trace of sodium carbonate and then mounted in an aqueous solution of Grübler's methyl green, the granules within their cytoplasm exhibit a purple color in a few minutes. The nucleus does not give this reaction. Now methyl green is split by peroxides into a purple compound and this reaction occurs in the test tube only, in my experience, in the presence of traces of sodium carbonate.

If this reaction really indicates the presence of peroxides, it shows that the so-called "nutritional granules," or "plastids" in reality perform an important part in the oxidations of the cell, and would seem to add significance to the observation of Kite and Chambers, who found that the nucleus of the spermatogonia of the squash bug was composed of powerful reducing substances.

The complete details of this work will be sent to the *Archives für Protistenkunde*.

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THE ILLINOIS STATE ACADEMY OF SCIENCE

The fifth annual meeting of the Illinois State Academy of Science was held at Bradley Polytechnic Institute, Peoria, Illinois, on February 21 and 22, 1913, under the presidency of Professor Henry Crew, of Northwestern University. After the opening business was transacted, the president's address was given by Professor Crew upon the title, "An Italian Academician." This address presented Galileo as an experimenter of the highest type—one who used the method of science in discovering some of the truths of nature at a time when the common practise was to deal with assertions about nature, or if the apparent facts of nature seemed to controvert assertions "to stare nature out of countenance." It is hoped that this excellent address will receive wide publication, for Professor Crew's special studies of the work of Galileo have resulted in the presentation of Galileo as a man of very much more far-reaching significance to modern science than most scientists have thought. Another special feature of the program was a symposium upon the "Science of Sanitation." The topics and speakers in this symposium were: "The Influence of Shallow Wells on Health," by Edward Bartow, director of the Illinois Water Survey, University of Illinois; "The Control of Stream Pollution," by Paul Hansen, Illinois Water Survey, University of Illinois; "Sanitary Aspect of Milk Supply," by P. G. Heinemann, department of bacteriology, University of Chicago; "Housing in Relation to Health," by Marion Talbot, department of household administration, University of Chicago; "Birth and Death Registration," by Frederick R. Green, American Medical Association, Chicago. This symposium proved unusually interesting to all the members who were present, and it is hoped by means of the annual volume of the academy's *Transactions* to give the symposium papers wide distribution throughout the state.

After an informal reception for members and friends of the academy, an excellent dinner was served by the department of domestic science of Bradley Polytechnic Institute; and in a period when efficiency in education is being demanded everywhere, it is a pleasure for the members of the academy to attest the efficiency of the service given by Bradley's domestic science department. The dinner and the service was entirely by students in the department, and no better dinner has been served to the academy. The after-dinner program consisted of a series of short addresses outlining the nature and significance of the past year's discoveries in each of several branches of science. This apparently impossible task was performed in such a way as to give the members a good perspective regarding the chief occurrences and the dominant points of view prevailing at present. The speakers were John M. Coulter, Henry B. Ward, Stephen A. Forbes, William S.