above the other, and as soon as the supply of tabs in any color is used up another set of strips may be prepared and pasted on this card.

The strips may be arranged according to the spectrum or by the alphabetical order of topics they are to indicate. I have found the latter more convenient, especially with the subject each color indicates written opposite the strips of that color on the cardboard holder. I have two such holders in use in daily reading, one at the laboratory and one at home. The preparation of additional strips furnishes constructive amusement to children who find kindergarten entertainments to their liking.

I have still to be convinced that a functional index, with almost the completeness of a dictionary, should not be demanded by the readers of scientific journals. In the meantime it is up to the readers to convince the editors of a serious omission in their commonly gratuitous undertaking.

DONALD A. LAIRD

COLGATE UNIVERSITY

A PROPOSED BIOGRAPHICAL ENTOMOLOGICAL DICTIONARY

AMERICAN entomologists and arachnologists should be much interested in the project of Professor Embrik Strand to publish a Biographical Entomological Dictionary containing the autobiographies of all entomologists and arachnologists who have done scientific work as authors or as collectors in all parts of the world.

This project has been explained in *Entomological News,* May, 1924, page 178, also May, 1924, pages 227–9, and in *The Entomologist* for March, 1924, page 68. However, the response from American entomologists has not been very great. The project has several auspicious features that should warrant wholehearted and prompt support: (1) There is no question about the publication of data; (2) the editor appreciates the desirability of individuality in the form of the biographies; (3) it is not necessary to be saving of space, since the editor suggests that all the main points in the life of the individual, even though they may have nothing to do with the professional career, should be included; for example, work in other biological fields than entomology or arachnology.

All persons who have done work with insects or spiders are urged to send an autobiography to Professor Strand at the earliest opportunity. Professor Strand's address is: Professor Embrik Strand, Director of the Systematic Zoological Institute, Universität, Kronvalda bulvars 9, Riga, Latvia.

To facilitate the assembling of the autobiographies of Americans, it is suggested that they may be sent to Dr. H. P. K. Agersborg, Department of Biology, The James Millikin University, Decatur, Illinois, or to Professor C. L. Metcalf, 201 Natural History Building, Urbana, Illinois, who will be glad to forward them by registered mail to Professor Strand.

H. P. K. AGERSBORG
C. L. METCALF

SPECIAL ARTICLES

CAN THE HYDROGEN ION CONCENTRATION OF LIVING PROTOPLASM BE DETERMINED?

THE various determinations that have been made of H-ion concentration in organisms are applicable in the case of plants only to the cell sap, and in the case of animals usually to no more than body fluids bathing the exterior of the cells. To assume that the results correspond to the cH of the protoplasm in contact with these inanimate fluids would be unjustifiable, as the following experiments will demonstrate. The subject of study is *Pelomyxa palustris,* a multinucleate Amoeba which frequently attains the giant size of 3 mm or more in diameter. Its markedly vesicular or foam structure renders this organism peculiarly suitable for colorimetric tests of cH; for, since it is desirable that the indicator should be as uniformly distributed as possible, and since it is impossible, as far as I am aware, to impart a visible coloration to living protoplasm itself, the nearest approach to ideal conditions is afforded by such an intimate foamy admixture of protoplasm and vacuolar fluid as *Pelomyxa* presents. The average diameter of the vacuolar vesicles is one third to one half that of the nuclei, but larger and smaller ones also occur. Neutral red was the indicator used. It is absorbed readily from dilute solution and forms in the vesicles a much more concentrated solution than in the external liquid. Granules in the protoplasm also stain deeply, but their color is little affected by the cH of any medium in which they may be placed and so is of no use as an indicator.

The tint of the neutral red in the great majority of the vesicles is practically uniform and corresponds sometimes to a neutral and sometimes to a very slightly acid medium. It is more acid than the water outside—a relation which seems to hold whenever the cH of cell vacuoles is compared with that of the bathing fluid. Comparing therefore the three media, cell sap, protoplasm and external liquid, we see that the neutral red has a different concentration in all three media and the H-ions in at least two of them. Why, then, should we assume that their concentration in the protoplasm agrees with that of the internal rather than the external liquid or indeed with either?

There is, however, more convincing evidence that the protoplasm is deliminated sharply as regards acidity from at least some of its vacuoles, for certain of these may assume a cH widely differing from that of the rest. Parenthetically it may be remarked that *Pelomyxa* is a gross feeder and is usually crammed with algae, diatoms, small animals, sand and débris. These lie in the vacuoles and the living ingesta are for the most part apparently uninjured by their situation, proving the innocuous character of the contents of the ordinary vacuoles. An occasional vesicle, however, may assume digestive functions. Usually a few of these are to be seen in any large *Pelomyxa*. I have watched the acidity increase in an ordinary vacuole until the neutral red assumed a deep purple or bluish tint. The contained alga, green and apparently healthy to begin with, having its own vacuole stained orange by the dye, lost the orange hue of its sap, lost its green color and became ultimately disorganized. At a later stage one finds in such vacuoles only a collection of strongly stained granules in rapid Brownian movement. The granules diminish in number, apparently passing into the protoplasm, and the hue of the indicator returns to normal. Very occasionally an alkaline vesicle may be observed—deep yellow with neutral red—containing a few granules (still of the same deep red color as in an acid vacuole). Since the ordinary vacuoles do not contain granules this may represent a subsequent stage in the history of a digestive vacuole.

These phenomena illustrate very well how, even in a liquid circulating mass of protoplasm, chemical substances and chemical operations may be localized within narrow limits. More particularly they demonstrate that the H-ion concentration of a vacuole can be no criterion of that of the protoplasm that surrounds it—may indeed be such as applied externally would be lethal.

Similarly, the absence of any distinct local variations in cH in the vesicles of *Pelomyxa* during the cycle of physical changes that attends its amoeboid movement does not prove that no such variations of cH take place in the protoplasm.

GEO. W. SCARTH

BOTANICAL LABORATORY,
McGILL UNIVERSITY

THE TOTAL IONIZATION PRODUCED IN AIR BY ELECTRONS OF VARIOUS ENERGIES

RECENT experiments on the total ionization produced by slow electrons in air have yielded results in agreement with the Bohr[1] theory of ionization in the region of the faster, low-speed electrons for which exact ionization experiments had not previously been performed. Since the experiments with very slow electrons have indicated an increase in the ionizing efficiency of electrons with increasing speed and experiments with hard cathode-rays and β-rays have shown the same quantity to decrease with increasing velocities it appeared that a maximum value must lie somewhere in the intervening range.

Previous experiments with low-speed particles have been limited in their application due to the fact that at the pressures used the electrons with the greater energies in this range hit the sides of the ionization chamber before their energy had been exhausted. In these experiments an ionization chamber of hemispherical shape was sealed off from the tube where the electrons were emitted from a hot tungsten filament, except for a small capillary hole in the anode, one end of which was 2 mm from the filament and the other end at the geometric center of the ionization chamber. By running a diffusion pump system during the experiment, and adjusting an artificial leak into the ionization chamber the air pressure in the filament tube was kept between 0.0001–0.001 mm, while the pressure in the chamber was varied at will from 0.001 to 1.5 mm. The latter pressure was adjusted until the radius of the vessel was just greater than the range of the electrons used, and the number of electrons which passed into the chamber and the number of positive ions produced by them were measured with a quadrant electrometer. This was done at frequent voltage intervals as the accelerating voltage between the filament and the anode was raised to 1,500 volts, and a graph was made of the number of ions produced per electron plotted against the energy of the electrons expressed in volts.

Bohr's theory considers both primary and secondary ionizations and predicts that, for a gas with a single ionization potential, ionization will set in when the energy of the colliding electron expressed in volts is equal to this potential. The average ionization produced per unit path will rise rapidly to a maximum at twice the ionization potential and then decrease slowly; for gases with several ionization potentials the position of the maximum is shifted to higher voltages. R. H. Fowler[2] has shown that a numerical factor of approximately three fourths should be introduced in the Bohr equation when the distribution of the velocities of emission of the secondary electrons is taken into account. The theory also predicts sudden breaks in the ionization curves when the accelerating voltage becomes equal to large ionization potentials compared to which the other potentials are small. This should occur in air at potentials belonging to electrons on inner rings of argon, nitrogen and oxygen. Assuming that all the energy of the electron

[1] Bohr, N., *Phil. Mag.*, *25*, 101 (1923); *30*, 581 (1915).

[2] Fowler, R. H., *Proc. Camb. Phil. Soc.*, 21, 521, 531 (1923).