secured farther out, that is, near the water's edge. It is hardly possible that the specimens on the bars followed the retreating water since this would, in some instances, have required a migration of several hundred yards. It is more probable that they burrowed deeper and thus kept near to or in the subterranean water.

The collections made in March showed at least two and possibly three generations of Amphioxus to be present in the sand. The oldest specimens were sexually mature, the large females being heavy with eggs. Besides the mature males and females two groups of smaller sized individuals were found. The smallest specimens were less than an inch in length. It would seem, then, that it requires two and possibly three years for this species of Amphioxus to mature.

No observations were made to confirm the statement made by some that the animals leave their burrows and swim freely at night. Collections were made both at daylight and at dark, but no night collecting was attempted. It seems open to doubt, however, that animals which swim as weakly as do Amphioxus could trust themselves to the ebb and flow of the waves on exposed shores and still be able to congregate within the small area in which they are found on the bars between tides.

The species of Amphioxus collected has not been definitely determined. The specimens are now being identified. In general appearance they are much like the common lancelot *Branchiostoma lanceolatum*.

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SPECIAL ARTICLES

CHONDRIOSOMES AND GOLGI APPARATUS IN PLANT CELLS

IN a recent contribution to these columns I outlined the more important results of some studies on the cytoplasmic structures of plant cells as exhibited in the meristem of growing root-tips. The outcome of these studies, like that of similar investigations by plant cytologists, was quite inconclusive as regards the point of most outstanding importance just at present, *viz.*, what cytoplasmic elements in plant and animal cells are homologous. Until we can get at the functional equivalence of the various formed bodies in plant and animal cytoplasm, the enigma of morphological homology would appear to be insoluble. At the present time so little is known of the physiology of chondriosomes and Golgi apparatus that comparisons between plant and animal are in general impossible. But it has occurred to me that the problem of functional equivalence might be approached from a different angle. Thus, we now know with great certainty and elaborate detail the behavior of chondriosomes and Golgi apparatus during the differentiation of the animal sperm. So regular and constant are the essential features of this process that their equivalence can be easily traced throughout the whole range of animal forms. If plants produced sperms comparable to those of animals, it would be at least conceivable that the processes of their differentiation might be capable of direct comparison. Thence conclusions could be drawn with a very high degree of certainty as to the homologies existing between cytoplasmic structures in plant and animal cells.

It so happens that the bryophytes possess sperms remarkably similar, superficially at least, to those of some Platyhelminthes, though unfortunately the structure of the latter has not as yet been very satisfactorily described. This similarity suggests, nevertheless, the possibility that the bryophyte sperm may likewise exhibit the usual characteristics of animal sperm formation. I am now engaged in the task of examining into this possibility, with results which, while still incomplete, seem to give a decisive answer to the long-standing riddles of cytoplasmic homologies. These results are here briefly outlined pending the preparation of a detailed paper.

I have examined the antheridia of Polytrichum juniperinum and P. piliferum, employing the usual osmic acid impregnation methods for the Golgi apparatus, and Fe-hematoxylin methods as often used for study of sperm formation in animals. The early androcytes, which are morphologically equivalent to the animal spermatid, present an appearance so nearly identical to that of an insect spermatid that it is doubtful whether even an expert in animal spermatogenesis could detect any important differences. These early androcytes of Polytrichum contain a spherical nucleus, in close juxtaposition to which is a spherical cytoplasmic structure and scattered bodies which are ring-like in plane view, rods in profile. These cytoplasmic structures exactly correspond to the chondriosome body or nebenkern, and the scattered Golgi bodies, respectively, of practically all insect spermatids. In the differentiation of the moss sperm, the nebenkern presents (though indistinctly on account of its small size) appearances of the differentiation into chromophilic and chromophobic materials so characteristic of insect spermatids. The nebenkern eventually elongates and is applied, together with the blepharoplast filament, along one side of the sperm nucleus, thus vaguely recalling the situation in an animal sperm like that of Lepisma, etc. The scattered bodies gradually merge together to form a mass (first called by M. Wilson the limosphere), which in

its every appearance is strikingly like the acroblast of insect spermatids. The differentiation of an apical body or acrosome in association with this mass has been established, the details being similar to the processes which I have heretofore described in many insects. The manner of deposition of the apical body does not, however, agree with the account previously given by Allen (Ann. of Botany, vol. 31, 1917). The acrosome having been separated from the so-called limosphere, the latter is eventually cast out of the sperm in the rejected protoplasmic ball, as in the case of the acroblast (Golgi remnant) in animal sperms.

This history leaves, to my mind, no reasonable doubt that the nebenkern body in mosses represents the homologue of the similar body in insects, and hence is composed of material directly homologous to the chondriosome content of animal cells. Similarly, that the limosphere represents the Golgi complex so familar in the insect sperm. Tracing these materials back into the androgonial generations, I find that the Golgi material reappears as scattered, disc-like bodies with a heavily impregnated peripheral rim, while the chondriosome material is represented by the kinetosomes, in earlier generations the polar plates, of Allen's descriptions. Direct proof of this identification is lacking, due to the absence thus far of the essential division stage in my preparations, but the morphological details and other features which can not here be entered into leave practically no doubt of the genetic relations of the two materials involved.

Passing now into the cells which form the epidermis of each antheridium, and thence into the cells of the perigonial leaves, we find always two kinds of cytoplasmic elements demonstrated simultaneously with those of the spermogenous cells. One of these is the plastids, the other, bodies scattered through the cytoplasm and morphologically identical with the scattered "Golgi bodies" of the androgonia and early androcytes. In other words, in somatic tissues the nebenkern material of the androcytes seems to be represented by the plastidome, and the Golgi bodies by the spherome of the Dangeards' nomenclature. That considerable gaps are left in the connecting links of proof, I frankly concede, but the general picture is so unequivocal that I believe extended researches will eventually provide critical proof of the homologies here made out. It is of the greatest interest that the spherome in spermogenous tissue and in leaf tissue of mosses should be so like that in plant root-tips, as reported in my previous note. Further, the comparison of the chondriosome material to that of the chloroplastids is borne out by the known origin of plastids from bodies which react in a manner characteristic of animal chondriosomes. a fact indeed which early led to their identification as such. These considerations, together with others which can not be argued in the short space of this article, leave me no alternative but to conclude: (1) that the plastidome of plant cells is the homologue of the animal chondriome and (2) that the spherosome ensemble (spherome) is the homologue of the animal Golgi apparatus. This conclusion seems to increase the probability of the suggestion put forward in my previous note to the effect that the chondriosomes in general may represent the physical basis of carbohydrate metabolism. The homologizing of the apparently inactive spherosomes with the Golgi apparatus in animal cells perhaps introduces some theoretical difficulties which can not at present be profitably considered.

The conclusion here reached leaves the problem of the plant vacuolar system, judged by some workers to be the homologue of the Golgi material, in a state even more unsettled than before. It is possible that further research will bring out some relation between the vacuome and the Golgi apparatus (spherome), but at present this does not seem very probable. The recent findings of Lloyd and Scarth (SCIENCE, Vol. 63, 1926) relative to the origin of vacuoles from preexistent lipoid bodies, certainly agrees in a general way with my own studies in the root-tip cells of Vicia faba. But I have been unable to demonstrate any vacuome in the spermogenous tissue of mosses, and if it be represented there, it seems scarcely likely to be related to anything known in animal sperm cells. It is possible that an answer may be found in the recent work of Nassonov and of Lowther on the Protozoa. Nassonov finds that the contractile vacuole is always associated with a lipoidal substance, which he homologizes with the Golgi apparatus. But Lowther finds scattered bodies probably equivalent to the Golgi apparatus and quite without relation to the lipoidal wall of the contractile vacuole. These observations suggest that vacuoles are everywhere associated with lipoidal materials in the form, generally speaking, of an enclosing membrane, as De Vries long ago postulated in his tonoplast theory. Further, that in this respect the plant and protozoan vacuoles may be, to an unknown extent, equivalent, but in general without known representatives in the cells of higher animals. Thus it would be possible through Lowther's results to bring the Golgi material in Protozoa into line with the spherome of plant cells and the well-known Golgi apparatus of all Metazoa, while consigning the lipoidal basis of vacuoles possibly to a new, hitherto specifically unrecognized category of cellular consitituents. It will be quite apparent that our whole knowledge of normal vacuoles is as yet very unsatisfactory and that in attempting to find a solution of their morphological meaning it will be a

great mistake to jump hastily to conclusions. My only reason for these remarks on the subject is that the vacuome has been so widely homologized with the Golgi apparatus that in offering evidence for a contrary view it seemed necessary to take some account of another possible meaning of vacuoles in general.

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THE EFFECT OF HELIUM ON THE INTENSITY OF THE MERCURY SPECTRUM

RECENT researches have shown that the intensity distribution in spectra is altered by the presence of a foreign gas, the intensities of the spectral lines being, in most cases, increased.

The presence of an inert foreign gas and a radiating one might well have quite different effects on the spectrum under consideration. The author has recently studied, in the physical labroatories of Washington University, St. Louis, Missouri, the intensity of various lines in the mercury vapor spectrum as influenced by the presence of helium.

The discharge tube was an ordinary three-electrode one. Electrons from an oxide-coated filament were accelerated to full speed as they pass through a nickel grid, beyond which they travel with a constant velocity in the field free space between the grid and the plate, being finally caught by the latter. The spectrum is produced between the grid and the plate. The plate and the grid were connected to the positive terminal of a battery and the filament to the negative terminal, which was grounded. A microammeter in the plate circuit measured the electron current passing through the grid and received by the plate. This current was kept constant.

Helium, which had been stored in a reservoir, after passing slowly over activated coconut charcoal surrounded by liquid air, was admitted to the discharge tube at varying pressures. The mercury spectrum was photographed through a quartz window by means of a spectrograph and the intensities of the lines measured by the microphotometer method. The temperature of the discharge tube, and a side tube containing mercury, was kept constant, assuring a constant pressure of mercury vapor, by means of heating coils.

Five exposures, each for the same length of time, were made upon the same plate. One exposure was the spectrum from pure mercury vapor, and the others for varying pressures of helium. The accelerating potential was kept constant during each set of five exposures. There were, then, on the same plate, five spectra of mercury vapor, in which all the variables, energy of impact, mercury pressure and electron current are kept constant, and only one variable altered, *viz.*, the pressure of the helium.

In one case the plate-grid potential was nineteen volts, which is below the ionizing potential of helium; in the second case, ninety-nine volts, far above the ionizing potential. The spectrum was studied, then, as influenced by inert helium and radiating helium. Helium lines appeared strongly on the second plate but not at all on the first plate.

In both cases, the intensities of the mercury lines increase with the admission of helium, the increase continuing as the helium pressure, measured by a McLeod gauge, increases. The increase in intensity is not uniform for the various lines. Below helium pressure 0.024 mm there seem to be types of irregular changes in intensity. Because of the small number of lines studied this change can not be definitely associated with a particular series of mercury lines. Beyond this pressure the increase in the intensities of the lines is practically the same for all lines, a gradual increase being shown as the pressure of the helium increases.

Mercury lines 4,358, 4,047, 3,663, 3,341, 3,131, 3,024, 2,967, 2,652 and 2,536 were examined. With the exception of 3,663, the increase in intensity, from helium pressure 0.03 mm upward, is greater at an impact energy of nineteen volts than for ninety-nine volts. It would then seem that inert helium produced a greater increase in intensity than radiating helium. Beyond a pressure of 0.06 mm the inert and radiating helium seem to produce approximately the same intensity change.

The presence of helium would lengthen the path of the electron, keeping the electron longer in the space, and, therefore, giving them a greater chance of hitting mercury atoms, with a resulting increase in intensity. At an impact potential of nineteen volts these impacts with the helium atoms present would be elastic. At an impact potential of ninety-nine volts inelastic collisions with the helium atoms would occur and, although an increase in the path of the electron would occur, with an increase in the intensity of the mercury spectrum, yet the chance of exciting the mercury atom would be somewhat reduced compared to the chance when inert helium is present.

Since the change in intensity in different lines, however, varies, it is evident that the changes can not be entirely due to the lengthening of the path of the electron. The greatest irregularities in the changes are confined to the lower helium pressures, where the pressure of the helium is approximately that of the mercury vapor, 0.01 mm.

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