SPECIAL ARTICLES

THE PARTHENOGENETIC DEVELOPMENT OF EGGS IN THE OVARY OF THE GUINEA PIG

A relatively far-going parthenogenetic development of eggs in the ovary of the guinea pig has been observed by us so far in thirty animals. It can therefore not be considered an exceptional occurrence. We observed these ovarian structures, which owe their origin to parthenogenesis, for the first time more than twenty years ago. But owing to their shape and situation, resembling those of ovarian follicles, we believed at that time that they originated in some way in the follicles. Very soon afterwards, however, the suggestion came to us that the structures observed bore a great resemblance to certain embryonal formations, and that, therefore, these bodies might really be due to a far-going parthenogenetic development of the ovum within the mammalian ovary. Definite proof for this interpretation we obtained when, in continuing our search for these structures, we found unmistakable embryonic structures corresponding to neural tube and to other embryonic formations in at least two, and probably in three, guinea pigs. In the large majority of the animals observed, the development proceeds to the formation of embryonal placenta rather than to the development of the embryonal organs proper. We found further confirmatory evidence when we succeeded in producing experimentally extrauterine pregnancy in the guinea pig. It thus became possible to observe eggs embedding themselves and developing in the peritoneal tissue between tube and uterus. In such an embryo developing from a fertilized egg, as well as in the ovarian extrauterine pregnancy which owes its origin to parthenogenesis, a retardation in the development of the embryo and a relative preponderance of placental structures occur, owing to the abnormal conditions under which development takes place. Under both conditions the developing placental structures are of the same character, and giant cells and plasmodia are produced; giant cells migrate into the surrounding tissue and are especially attracted by the blood-vessels; they may substitute the blood-vessel-endothelium and here, in contact with the blood, agglutinate into a syncytial layer. They also may penetrate into the blood stream.

We may assume that in both cases in contact with the host tissue, which is devoid of decidua and under the stimulus of the strange tissue, the early embryonic formations differentiate into placenta rather than into embryonic organs proper. Factors present in the blood-vessels act as a formative stimulus leading to the production of syncytia. There is no structure in the ovary outside of the ovum which can give rise to such formations in the guinea pig; neither the granulosa, nor the theca interna of follicles ever undergo any changes even remotely approaching these parthenogenetic formations. A careful study makes it certain that they are identical with embryonic and placental structures such as are produced in normal and particularly in extrauterine pregnancy in the guinea pig.

These parthenogenetic structures take a cyclic course; they develop through mitotic cell multiplication. After some time the unsatisfactory condition of nourishment, the unyieldiness of the tissue in which they are enclosed prevent their further development. Mitotic growth ceases. The host connective tissue encircles them, presses on them, invades them and thus they gradually disappear.

Not uncommonly hemorrhages occur in the structures just as they occur in the normal placenta. These hemorrhages are due to the ingrowth of blood-vessels into trophoblastic tissue which shows little resistance and to the rarefying action of the wandering giant cells. Furthermore, around the growing embryonic structures hyperemia is found and it seems that the process of ovulation especially is apt to lead to hemorrhages in these fragile tissues. Not only the greater part of the embryo, but even parts of the surrounding ovarian stroma may be destroyed through these hemorrhages. Under no other conditions have we observed hemorrhages of this character in the ovary of the guinea pig.

These embryonal formations develop in young as well as in older animals and especially also in animals which have been kept separated from males. I have observed them in guinea pigs which had not yet ovulated at the time of the development of these embryonal bodies; they may also develop during the latter part of pregnancy and in all these cases we can with certainty exclude a previous fertilization of the ovarian ovum. They, therefore, owe their origin to parthenogenesis.

As many as three embryonic structures may be found in the ovaries of a guinea pig at the same time; these multiple bodies may be situated either in one ovary or in both ovaries. This multiplicity suggests the conclusion that, in addition to local stimuli, some more general condition affecting the animal as a whole favors their development. So far we have not succeeded in producing them at will through various experimental procedures of a physical or physico-chemical nature. The embryonic bodies originate in all probability in follicles during the early stages of atresia. At the time of ovulation such an atresia takes place en masse and this may therefore be a specially favorable period for their development; in some cases, however, we can exclude a preceding ovulation in the history of the animal in which they are found, and they must have originated in follicles becoming atretic at other periods of the sexual cycle.

Atresia of follicles may initiate not only processes of maturation in the egg, but also further-going changes which are not of a purely degenerative character, but consist in the formation of mitotic figures other than maturation spindles, and lead to the formation of segments with well-preserved nuclei. Such processes have been observed by ourselves as well as by various other investigators and recently new evidence of the occurrence of early segmentation in ovarian eggs has been brought forward by Newman and by Sansom. Our own findings of far-going parthenogenetic development in the ovarian egg of the guinea pig does not depend for recognition upon the interpretation of these early changes in the eggs of atretic follicles. On the contrary, the more than exceptional occurrence of the parthenogenetic embryonic structures described by us lends support to the interpretation of the changes observed in the eggs of atretic follicles as attempts at parthenogenetic development which in the large majority of cases prove abortive, but which apparently in certain cases overcome the obstacles to a further-going development.

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SUBSOIL ACIDITY

In any forest association the various plants have their rootage systems at different levels in the soil, though for the most part in the upper portion. Secondary roots may be spread over a wide superficial area with an occasional plant sending a tap-root deeper. These relations have been recently reviewed by MacDougall,[1] who also quotes Sherff as stating that plants are able to live together because the main part of their absorbing systems are placed at different levels in the soil.

Study of soil conditions at these various levels, then, is essential to an understanding of physiological behavior and ecological relations of plants growing in the open. One condition is soil acidity, and of subsoil acidity a few studies have been made. Wherry,[2] in New Jersey, dug pits and tested at twenty-five centimeter intervals to a depth of one hundred centimeters, finding a marked decrease in acidity with depth. Salisbury,[3] working at Rothamsted, England, does not tell of his method but finds a decrease in acidity to a depth of thirty inches.

The writer has made borings in areas of soil types found in southeastern Pennsylvania, in all cases in wooded areas and as typical of the whole area as possible. Surface soil conditions have been reviewed in a previous paper.[4]

All sampling was done with a soil auger; an ordinary one and a half inch wood auger fitted with 22-inch joints of gaspipe and a handle which could be uncoupled and carried in the field in a canvas case. Borings could be made to 300 centimeters, but usually bedrock or a cherty subsoil was reached at 100 centimeters or less. Care was taken to keep the auger clean; upon removing it from the boring the outer part of the "core" was scraped off and some of the remainder was pressed into a container. Shell vials were tried but found to be too fragile; seriological test tubes of size 16 × 120 mm. were adopted, being carried in a cloth-lined case in the field. They were marked at 5 cc. and 15 cc. levels, were provided with clean corks and were carefully cleaned in distilled water each time after using.

In the field a sample was tamped lightly with a glass rod to the 5 cc. level and the tube was corked. Being brought to the laboratory (the same day usually, or within twenty-four hours) distilled water was added to the 15 cc. level and the soil was thoroughly stirred. The suspension settling, the extract was tested by the colorimetric method with Clark and Lubs standards of 0.2 pH interval. A simple type of comparator was constructed, using electric light screened by blue glass. Turbid solutions were diluted one half and compared with standards which had corresponding turbid solutions placed before them.

Average pH of Sub-soil Samples

Depth	Hagerstown loam	Chester loam	Manor loam	Dekalb loam	Conowingo loam
S	7.025	6.781	6.480	5.607	5.571
— 15 cm.	6.945	5.793	5.375	5.524	5.421
— 30 cm.	6.859	5.477	5.577	5.599	5.691
— 45 cm.	6.916	6.175	5.850	5.521	6.018
— 60 cm.	7.006	6.293	5.887	5.666	6.218
— 75 cm.	7.070	6.216	5.983	5.750	6.170
— 90 cm.	7.075	6.230	5.733	6.000	6.166
— 105 cm.	7.100	6.233	....	....	....

From tests of over five hundred samples pH values are given in the accompanying table, averaged to the third decimal place. It will be seen that in all cases there is an increase in acidity with depth to 15 or 30 cm., then a gradual decrease toward neutrality. The extent of this variation seems correlated with the productiveness of the soil, being least in the fertile Hagerstown loam.

The relation of these results to plant life, the significance of the variation in pH values with increasing depth, and the relation to microbiotic forms of the soil will be treated in a later paper.

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[1] MacDougall, W. B., 1922, "Symbiosis in a deciduous forest," *Bot. Gaz.*, v. 73, pp. 200–212.

[2] Wherry, E. T., 1920, "Observations on the soil acidity of Ericaceae and associated plants in the Middle Atlantic states," *Proc. Acad. Nat. Sci.*, Philadelphia, v. 72, pp. 84–113.

[3] Salisbury, E. J., 1922, "Stratification and hydrogen-ion concentration of the soil in relation to leaching and plant succession with special reference to woodlands," *Journ. Ecology*, v. 9, pp. 220–240.

[4] Kelley, A. P., 1922, "Plant indicators of soil types," *Soil Science*, V. 13, pp. 211–223.