LETTERS TO THE EDITORS

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Is Parthenogenesis Sexual or Asexual Reproduction?

CYTOLOGISTS and others commonly refer to parthenogenesis as asexual reproduction. This usage is, for example, to be found in the books of Wilson[1], Darlington[2], and White[3], along with the facts that indicate that parthenogenesis is a derivative of normal sexual reproduction. To an elementary student of these phenomena, parthenogenesis appears to have much more in common with other types of sexual reproduction, and to refer it to asexual reproduction puts it in the same general category as budding and fission, to which parthenogenesis has little or no significant resemblance. The fact that parthenogenetic eggs develop without fertilization is no doubt responsible for this usage, a fact which, however, need not carry the entire weight of the decision as between sexual and asexual reproduction. True enough the biological significance of sexual reproduction is in part dependent upon fertilization; but most of this significance also relates to cross-fertilization, which is by no means co-extensive with sexual reproduction.

Sexual reproduction should not be diagnosed entirely upon the basis of what happens to an egg *after* it is formed. There has been a long biological history behind the development and perfection of mechanisms and processes which have made it possible to produce any kind of egg at all. In fact, an egg is a gamete, produced most commonly in a specialized female gonad. During its production complex gametogenetic processes of great significance normally take place, though some of these may be secondarily reduced in such a way as to secure the advantage of the normal efficiency of sexual reproduction without requiring the union with a sperm for activation. Whether parthenogenetic eggs are produced meiotically or ameiotically, there is usually evidence that such production is a derivative of the usual gametogenetic processes, and few, if any, cytologists now deny that parthenogenesis is a derivative of normal sexual reproduction.

If these things are true, there is no such thing as an 'asexual egg'. An egg is always a gamete, usually formed in a definite ovary, and, whether this ovary belongs to a female or a hermaphroditic organism, it is associated with femaleness and, of course, sex. Commonly, also, it is stored temporarily and then conducted from the body in accessory female reproductive organs. So far, certainly, there is nothing in common with asexual methods of reproduction other than the fact that a step which may lead to the production of a new individual has been taken.

Let us consider an informative example such as the occurrence of haploid parthenogenesis in the honey bee. All eggs are reduced and haploid, having undergone typical gametogenesis. Such eggs are produced normally only in the ovaries of the queen. Assuming the marriage flight has occurred, most of these eggs will be fertilized and produce females, mostly workers. But some of these eggs may remain unfertilized and develop into drones or males. Whether any particular egg shall be fertilized or not depends upon the physiological operation of the female machinery which allows sperm access to the eggs or denies it. Thus the sex of the offspring is determined. To recapitulate: *female* gametes, produced in *female* gonads, and stored in *female* accessory organs are either fertilized or not, depending upon the operation of the *female* reproductive machinery, which has been supplied previously with *male* gametes. If the eggs are fertilized they become *females*, if they remain unfertilized they become *males*. There is not an asexual atom in this whole procedure!

If this may be considered an extreme case, it nevertheless differs from other parthenogenetic cycles only in degree. As Wilson[1] quotes Brachet with approval, there is "a veritable bridge set up by Nature between fertilization and natural parthenogenesis". There may be transition also between normal sexual reproduction and asexual reproduction, but such transitions do not follow the route of parthenogenesis. Sexual reproduction is better characterized as reproduction which involves gamete formation, and thus is distinguished from asexual reproduction which does not involve gamete formation. To continue to describe parthenogenesis as asexual can only lead to confusion as we attempt to understand the evolution of specialized sexual reproductive processes from the more primitive asexual mechanisms which involve mainly budding and fission. Proper usage of the terms already available should make it possible for us to express ourselves clearly and effectively in discussing this general topic along the lines indicated. However, if there are good and sufficient reasons for continuing to refer to parthenogenesis as an asexual process in spite of the foregoing statements, then we should all benefit by having them clearly set forth.

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[1] Wilson, E. B., "The Cell in Development and Heredity", 3rd edit. (Macmillan, New York, 1925).
[2] Darlington, C. D., "The Evolution of Genetic Systems" (Cambridge University Press, 1939).
[3] White, M. J. D., "Animal Cytology and Evolution" (Cambridge University Press, 1945).

The Retinal Receptors

DARTNALL'S discovery, reported in *Nature* of August 5, p. 207, of two new retinal pigments, visual yellow 2 and visual red, together with the fundamental observation that the crests of the known pigments are separated by equal frequency intervals, leads to the expectation of the discovery of further pigments. Since those already known are iodopsin (visual blue) (0·57 μ), visual violet (0·533 μ), visual purple (0·502 μ), visual red (0·475 μ) and visual yellow 2 (0·407 μ), the additional ones in the visible spectrum should be visual green (0·655 μ), visual blue-green (0·609 μ), visual orange (0·450 μ) and visual yellow 1 (0·427 μ). Dartnall's discovery also raises an important issue, namely, are the results of these physico-chemical investigations in agreement with the physiological ones which have been performed by other workers, both on man and on certain animals? If agreement is found, the reliability of both types of investigation is greatly increased. In the accompanying table are shown: (*a*) the wavelengths of the crests which would be expected on a quantum theory basis; (*b*) those found by Granit in animals' eyes by means of the micro-electrode method; (*c*) those found by Granit in animals' eyes using the electric polarization method; (*d*) those