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Nature of Parthenogenesis

Genetic systems in which reproduction is entirely parthenogenetic, i.e., in which populations are all-female or effectively so (rare nonfunctional males may sometimes be present) have traditionally been divided into automictic (or meiotic) and apomictic (or ameiotic). In the former type meiosis occurs, but a compensatory doubling of the chromosome number takes place at some other stage in life cycle; in the apomictic type of system meiosis has been suppressed altogehter, and there is no compensatory doubling process since there has been no reduction.

It will be evident that in neither type of parthenogeneis is there any recombination of genes present in different individuals. But in most types of automixis there is at least the theoretical possibility of genetic segregation, provided that the parent was heterozygous.

There has been a good deal of rather uninformed speculation as to the evolutionary potentialities of parthenogenetic systems. Opinions have ranged from the view that the genotypes of such organisms are virtually "frozen" and incapable of adaptive change, to the equally extreme standpoint according to which they are capable of a great deal of essentially chaotic genetic change. These divergent opinions find their reflection in the taxonomic treatment of parthenogenetic forms, some authors assigning species status to them, while others speak of "agamic complexes" -- including a large number of biotypes differing to almost every conceivable degree and presenting a formidable and perhaps insoluble problem as far as nomenclature is concerned.

The distinction between automictic and apomictic systems, although based on a fundamental difference in the cytological mechanisms, is not particularly meaningful in genetic terms. A more significant classification of parthenogenetic systems would be based on the distinction between mechanisms that favor heterozygosity and those which enforce homozygosity. "Heterozygosity," in this sense, includes both allelic differences at single loci and structural heterozygosity due to inversions, translocations and other types of chromosomal rearrangements. Mechanisms of parthenogenesis that favor heterozygosity generally (but not always) permit polyploidy, and a significant number of animal populations that reproduce parthenogenetically consist of triploids and a few are tetraploid or pentaploid.

The only mechanism of parthenogenesis that rigidly enforces complete homozygosity is the one in which we have meiosis leading to a haploid egg nucleus, with restoration of diploidy by a fusion of embryonic cleavage nuclei in pairs. This system seems to be a very rare one, almost all the known examples being in scale insects and white flies (order Homoptera), although the parthenogenesis of the mite Cheyletus eruditus has been said to fall in this category by Peacock and Weidmann (1961). Excellent examples of this type of mechanism have been described in the scale insect Gueriniella serratulae by Hughes-Schrader and Tremblay (1965) and in the soft scale Pulvinaria hydrangeae by Nur (1963). There are a considerable number of parthenogenetic forms in the scale insects (apparently all diploid) and Brown (1965) states that in the armored scales (family Diaspididae) the usual mechanism is apomixis, while among the Pseudococcidae most parthenogenetic systems are meiotic.