Chapter 5

The Prophecies of Parthenogenesis

ALAN R. TEMPLETON*

Introduction

Parthenogenesis is the development of an unfertilized egg into a new individual. This phenomenon has long fascinated both scientists and laymen alike. Undoubtedly, the most celebrated case of a virgin birth is that given in Matthew 1, 19-25: the account of the birth of Jesus Christ. Whether or not one accepts this account literally, one can still legitimately ask the question: Why is this account of a virgin birth contained in Matthew? Most people would respond by answering there was a prophecy that the Messiah would be the result of a virgin birth, and that this account was inserted into the Gospel to show that this prophecy was met. If the person asked is a bit more knowledgeable about the Bible, he or she may quote Isaiah 7, 14, which is also quoted in Matthew 23 and reads in the King James version: "Behold, a virgin shall conceive, and bear a son, and shall call his name Immanuel." Thus, the prophecy seems to be rather clear-cut. However, if the same passage in Isaiah is read in the New English Bible, it begins: "A young woman is with child." The word in question here is the Hebrew word \textit{almah} which scholars of the Hebrew language agree simply means a young woman of marriageable age, whether married or not (Argyle 1963, p. 28). However, the quote of Isaiah 7, 14 found in Matthew gives the Greek word \textit{parthenos} meaning "virgin" as the translation of \textit{almah}. Consequently, this most famous instance of parthenogenesis does not owe its existence to any "prophecy of a virgin birth," for such a prophecy never existed. Instead, it owes its existence to the far more mundane reason of a mistranslation from Hebrew to Greek (Argyle 1963, p. 28).

In less celebrated instances of parthenogenesis, other "prophecies of parthenogenesis" have been invoked to explain this phenomenon. For example, the "prophecy of environmental uncertainty vs. environmental certainty," the "prophecy of weedy habitats," and the twin genetic-ecological "Prophecies of the cost of meiosis and the cost of sex" have been frequently invoked, just to mention a few. These prophecies are grand sounding and certainly impart a profound reason for the evolution of parthenogenesis; but are these prophecies real, or, as in the case of Jesus, are there more mun-

*Department of Biology, Washington University, St. Louis, Missouri 63130 U.S.A.
Tychoparthenogenesis and the Abandonment of Sex

The pioneering work of Stalker (1951, 1952, 1954) first established that parthenogenesis existed in the genus *Drosophila* and, moreover, that it was a widespread phenomenon. Since Stalker's initial survey, many other *Drosophila* have been shown to display tychoparthenogenesis, that is, accidental or rare parthenogenesis in an otherwise sexually reproducing species (Carson 1961, 1962, 1967a, Futch 1973, Templeton 1979a). In addition, this capacity for tychoparthenogenesis is more pronounced in natural populations than in inbred laboratory populations (Carson 1961, Templeton 1979a, Templeton et al. 1976a), thereby implying parthenogenesis is a true evolutionary potential in the genus. Only one species, *Drosophila mangabeirai* (Carson et al. 1957), has utilized this potential fully and become totally parthenogenetic.

All parthenogenetic *Drosophila* are automictic; that is, they retain normal meiosis, and most are diploid, although polyploidy frequently arises. Because most are diploid and have normal meiosis, the question immediately arises as to how diploidy is restored in the absence of fertilization. This is accomplished by one of three mechanisms in *Drosophila*. The first is central fusion (Figure 5-1) in which two haploid pronuclei that segregated at meiosis I fuse to restore diploidy. As can be seen from this figure, central fusion also restores the maternal genotypic composition for all loci that have not recombined with their centromere and even restores the maternal state half the time when there is recombination. The decay into homozygosity is slow under central fusion in organisms such as *Drosophila* with chromosomes of small recombinational length. Moreover, with inversions or other crossover suppressors yielding absolute linkage to the centromere, permanent heterozygosity can be maintained (Carson 1967b).

The second mechanism for restoring diploidy is terminal fusion (Figure 5-2) of pronuclei that divided at meiosis II which causes a rapid decay into homozygosity in the absence of selection. The final mechanism is called gamete or pronuclear duplication (Figure 5-3) in which a haploid pronucleus mitotically forms cleavage nuclei which then fuse. This mechanism enforces total homozygosity in a single generation.

At this point, some might already object to my earlier statement that parthenogenetic *Drosophila* can serve as a useful general model for the nonhybrid evolution of thelytoky in the insects. Automixis has often been dismissed from consideration of the evolution of parthenogenesis for both theoretical and factual reasons.