Comment

Virgin birth, genetic variation and inbreeding

Watts et al. (2006) and Chapman et al. (2007) recently reported facultative parthenogenesis in Komodo dragons (Varanus komodoensis) and hammerhead sharks (Sphyrna tiburo), respectively. In both cases, the parthenogenic events resulted in progeny homozygous for all loci, suggesting automatic parthenogenesis with terminal fusion and no recombination (Lenk et al. 2005). The genetic consequences of this type of parthenogenesis are analogous to intragametophytic selfing in plants (for the population genetics of this system, see Hedrick 1987a,b). For the hammerhead shark, Chapman et al. (2007) concluded that females are XX and males are XY and that both the mother and her parthenogenetic offspring were XX females. On the other hand, in Komodo dragons, females are ZZ and males are ZZ (Watts et al. 2006) and the mothers were ZW and all their parthenogenetic progeny were ZZ males. Both reports suggest that facultative parthenogenesis could potentially be adaptive when no male mates are available but that it may also have negative consequences and lower genetic variation in populations of endangered species.

To examine this situation, assume that the frequency of allele \( A \) in the unmated female mother is \( p_1 \) and that frequency of heterozygotes \( (A_1A_2) \) in the population to 0 in her progeny, and the genetic load from lethals is eliminated. To examine purging in Komodo dragons, again assume \( A_2A_2 \) is lethal so an \( A_1A_2 \) female would only have \( A_1A_1 \) sons. Therefore, the frequency of the \( A_1 \) allele is reduced from 1/2 in the mother to 1/4 in the progeny of the mother and her sons, and the genetic load from lethals is halved.

However, when the female is heterozygous for multiple, detrimental variants, automatic parthenogenesis may result in a low probability of viable offspring and greatly reduce the likelihood of a descendant population. If there are \( m \) heterozygous lethals in the female, then the probability that each offspring is viable is only 1/2\(^m\). For example, with \( m=3 \), only 12.5% of the progeny would be expected to be viable.

The recently documented parthenogenesis in hammerhead sharks and Komodo dragons may be expected to result in both a substantial loss of genetic variation and in purging of genetic load in descendant individuals. It is not clear how common this type of parthenogenesis is, because even other reptiles vary greatly in types of parthenogenesis (Schuett et al. 1997; Lenk et al. 2005). Further, in fishes, there are a number of different sex-determination mechanisms (Mank et al. 2006) and it is even possible that a ZZ system could produce viable, parthenogenetic female WW offspring when there is not a fully developed sex chromosome system. For the Komodo dragon, it appears that a single female and her male progeny could start a population, which would have both lowered genetic variation and genetic load. Unknown parthenogenesis in captive populations could result in unexpectedly high inbreeding, loss of genetic variation and changes in founder contribution.

Philip W. Hedrick*
School of Life Sciences,
Arizona State University,
Tempe, AZ 85287-4501, USA
*philip.hedrick@asu.edu


