Triploidy in Parthenogenetic Species of the Teiid Lizard, Genus Cnemidophorus

Abstract. *Mitotic figures from the bone marrow of three parthenogenetic species of* Cnemidophorus *(whiptail lizards) exhibit chromosome numbers in the triploid range. The species are* C. velox *with 68 chromosomes,* C. tesselatus *with 69, and* C. exsanguis *with 70. A fourth parthenogenetic species,* C. perplexus, *has 46 chromosomes, the same number as the bisexual subspecies* C. tigris septentrionalis.

Preliminary results of a cytogenetic study of parthenogenetic species of *Cnemidophorus* (*1*) suggest that at least three of the species are triploid, and a fourth species, diploid.

Variability in chromosome number within the more than 90 recognized bisexual species and subspecies of the genus has not been established. *Cnemidophorus gularis* (*2*) is reported to possess a diploid number in excess of 40, but an exact count has not been obtained. The diploid number of 46 which I find in *Cnemidophorus tigris septentrionalis* is the same as that reported for *Cnemidophorus sexlineatus* (*3*).

Assuming a basic diploid number of 46 for bisexual members of the genus, somatic cells of triploid individuals would be expected to contain 69 chromosomes. In the study reported here, bone marrow cells from the parthenogenetic species *Cnemidophorus velox*, *Cnemidophorus tesselatus*, and *Cnemidophorus exsanguis* showed modal chromosome numbers of 68, 69, and 70, respectively. *Cnemidophorus perplexus*, which is also parthenogenetic, showed only 46.

The marrow from which the mitotic figures were obtained was flushed from the long bones of the legs. Air-dried smears were prepared from the resulting suspension of marrow cells and were made permanent after they were stained in aceto-orcein (*4*). Before the animals were killed, they were injected with vincaleukoblastine sulfate (*5*). This substance was far superior to colchicine as an inhibitor because it permitted the collection of metaphase cells for a longer period of time without the chromosomes becoming excessively shortened.

The chromosome numbers which are reported here were observed in more than 20 cells from each species, and found to be modal in at least two animals. A much larger sample is needed to establish with certainty the chromosome numbers of these species.

The generalized karyotype in parthenogenetic as well as bisexual members of the genus consists of a few comparatively large metacentric or submetacentric chromosomes, a number of acrocentrics which can be arranged in a series exhibiting a gradual decrease in chromosome size, and an approximately equal number of microchromosomes (Fig. 1). The size distinction between microchromosomes and the smallest of the macrochromosomes is not sharp, in contrast to the condition found in iguanid lizards (*3*). In all of the parthenogenetic species so far examined, one or more of the macrochromosomes have satellites or show pronounced secondary constrictions. In cells from *Cnemidophorus tesselatus*, especially those cells in which the chromosomes are highly condensed, satellites may become detached and lose all positional relationship with the chromatids and with each other. These figures thus appear to have two extra microchromosomes.

The karyotypes of the four parthenogenetic species included in this study are distinct from each other in total number of chromosomes as well as in the morphology of several individual chromosomes. The species for which triploidy is proposed appear to have three sets of chromosomes rather than a complement resulting from fragmentation of the basic set found in bisexual species (Fig. 1). The absence of morphologically defined counterparts at several points in the presumably triploid karyotypes suggests the possibility of alloploid origins for these species. This condition might also result from an ameiotic form of oogenesis which would permit the accumulation of structural changes, duplications, and deletions. It is doubtful that heteromorphic sex chromosomes are responsible in view of their apparent absence in *C. tigris septentrionalis* (Fig. 1*B*), the infrequency with which they occur in other reptiles, and the extent of their differences

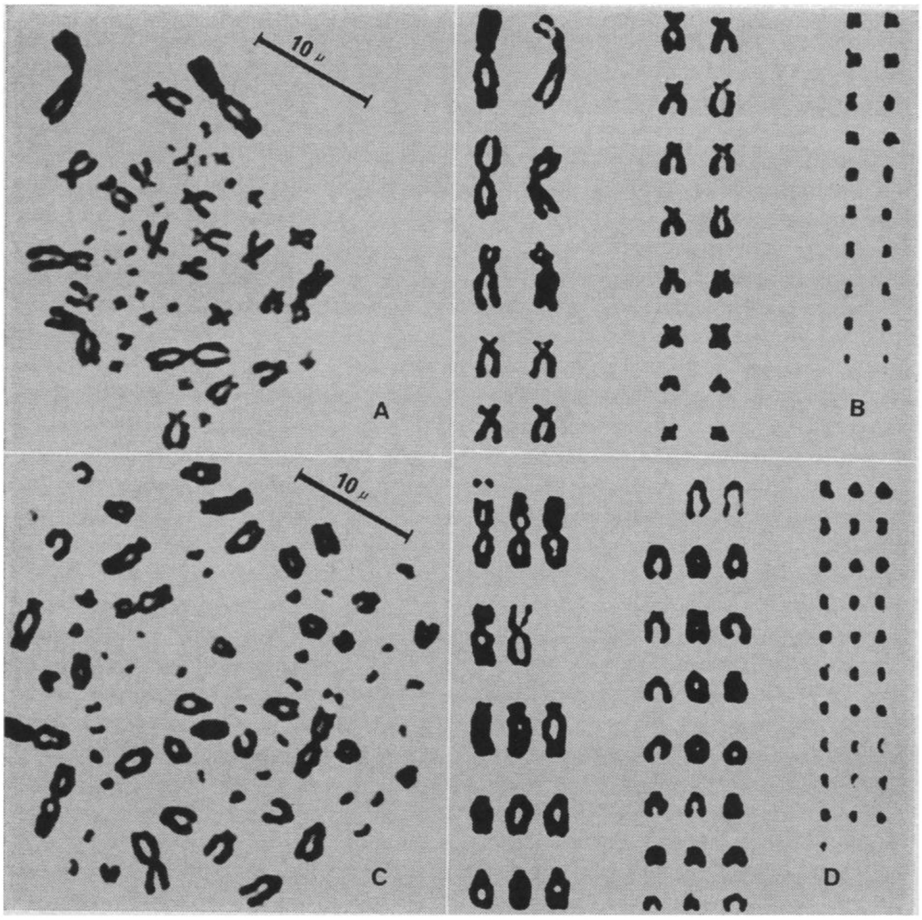

Fig. 1. (*A*) Mitotic metaphase figure from bone marrow of a female from the diploid bisexual subspecies *Cnemidophorus tigris septentrionalis*. (*B*) Karyotype prepared from (*A*) showing 46 chromosomes. (*C*) Mitotic metaphase figure from bone marrow of the pathenogenetic and presumably triploid species *Cnemidophorus velox*. (*D*) Karyotype prepared from (*C*) showing 68 chromosomes.

In those reptiles for which they have been reported (*6*). The female is generally considered to be the heterogametic sex in reptiles.

While parthenogenesis and polyploidy are frequently encountered among invertebrates, often in association with each other, they are seldom observed in higher animals, and in no previous instance have they been demonstrated to occur together throughout a natural, self-reproducing population of vertebrates.

This condition is reported to be approached in two genera: in *Lacerta*, the Old World counterpart of the American genus *Cnemidophorus*, and in salamanders of the genus *Ambystoma*. Triploid individuals are produced by natural hybridization between bisexual and diploid parthenogenetic forms of *Lacerta saxicola* (*7*), but triploid hybrid offspring resulting from this union possess rudimentary gonads and appear to be sterile. Populations of triploid females in the *Ambystoma jeffersonianum* complex are capable of producing viable eggs, but the eggs do not develop unless stimulated by sperm from diploid males (*8*). The sperm are not believed to contribute chromosomes to the triploid nucleus.

There are no reports of the hatchling *Cnemidophorus* being produced by an individual hatched and reared in complete isolation. While such conclusive evidence is lacking, the term parthenogenesis is here used without qualification because all available evidence supports the viewpoint that the all-female populations of *Cnemidophorus* are parthenogenetic rather than gynogenetic as in the case of triploid *Ambystoma*. The number of specimens thus far karyotyped, the normal appearance of their ovaries on gross examination, and the apparent absence of logical parental candidates for interspecific crosses at some of the collection sites provide a reasonable basis for the tentative assumption that these individuals are not sterile hybrid offspring such as those reported in *Lacerta*.

Vertebrate systematists have seldom been faced with the difficult problem of placing asexual populations within a taxonomic framework designed for sexually reproducing organisms. The significance of triploidy to this problem cannot be properly evaluated until it is established in each case whether triploidy arose within a single species, or resulted from hybridization between two different species. Likewise, the significance of triploidy for an understanding of the genetics of the parthenogenetic forms cannot be discussed with any degree of authority until it has been determined whether an ameiotic or meiotic form of oogenesis is involved.

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References and Notes

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5. The vincaleukoblastine sulfate used in this study was generously supplied by Dr. G. H. Svoboda, Eli Lilly and Company. The A.M.A. Council of Drugs has approved vinblastine as the generic name for vincaleukoblastine (VLB). VLB is marketed as Velban (vinblastine sulfate) by Eli Lilly and Company, Indianapolis, Indiana.
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Blepharisma intermedium: Ultraviolet Resistance of Pigmented and Albino Clones

Abstract. *An albino mutant of* Blepharisma intermedium *is much more sensitive (on the basis of time to regeneration of transected cells) to short-wavelength ultraviolet radiation than the wild type (containing a reddish pigment) from which the mutant derived. In the wild type, absorption of ultraviolet light by the pigment present in the outer surface of the cell presumably reduces the intensity of the radiation impinging on the vulnerable interior.*

Blepharisma intermedium contains a reddish pigment thought to be a hydroxy derivative of mesonaphthodianthrone (*1*). When present in high concentration in *Blepharisma* (for example, in cells grown in dim light or darkness) this pigment acts as an intracellular photosensitizer to intense visible light; when externally applied in extracts to colorless cells it induces damaging photooxidations (*2*). The function of the pigment in the outer

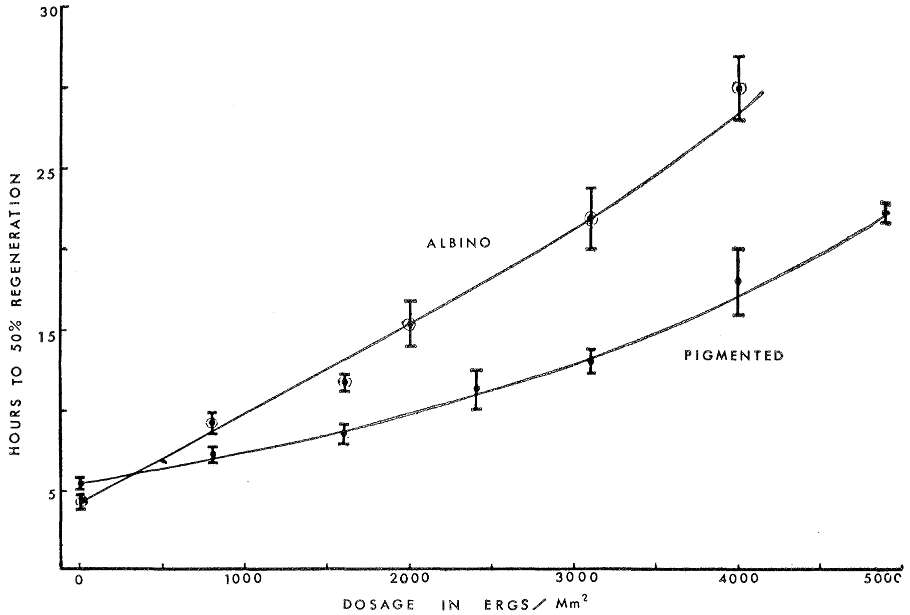

Fig. 1. Regeneration times for albino and pigmented clones of *Blepharisma intermedium*, Rao-A stock, irradiated with ultraviolet. Points are means for series, each of three to six experiments, with one standard deviation.