Unisexual reproduction occurs in quite different animalian groups. The absence of the second progenitor inevitably results in more or less steady cloning—more or less strict repetition of individual genotype in many generations. Since males are not able to breed without females, cloning brings about the appearance of all-female races or species, which are not numerous in nearly all taxa. The majority of unisexual species known to date are supposed to be (and likely are) parthenogenetic. However, some other kinds of reproduction and unisexual inheritance have been recorded in a few species.

Avoidance of the normal sexual reproduction can produce the genetic effect of different sorts. Being dependent on particular mechanisms of preservation of the parental somatic chromosomal number in offspring, it can vary from inheritance of only maternal features to complete substitution of maternal for paternal ones. Anyway, it seems obvious that any unusual rearrangement of the genetic material, while reproducing, abruptly changes the characteristic features of the “Mendelian population,” which are considered to be the base of the commonly accepted concept of speciation (Dobzhansky, 1937; Timoféeff-Ressovsky, 1939; Mayr, 1942, 1963; Simpson, 1944; Timoféeff-Ressovsky et al., 1969, 1973; Vorontsov, 1980, 2004).

PARTHENOGENESIS

During parthenogenesis, the juvenile originates from an egg without any participation of spermatozoa. Fertilization does not occur, that is why in such a case the complete (non reductional) diploid or polyploid chromosome set of somatic cells is to be preserved in the egg. In natural populations, parthenogenesis is always connected to deep disintegration of meiosis that leads to a complete stoppage of genetic recombination, so that the maternal characters are inherited by the offspring without any changes.

When discussing the origination of parthenogenetic forms and inevitable competitive interactions of them with their closest bisexual relatives, one quite often considers the “double advantage” of parthenogenesis (Maynard Smith, 1978) that gives the population an opportunity not to spend 50% of environmental resources on males. According to another, maybe more reasoned point of view, the advantages of parthenogenetic populations could be caused by their higher heterozygosity and genotypic uniformity of individuals rather than by higher rate of breeding without males (Suomalainen, 1969; Suomalainen and Saura, 1973, Suomalainen et al., 1976; Grant, 1977; Grebelnyi, 2005, 2006).

The parthenogenetic-like effect is also produced by some other secondary modifications of sexual reproduction, which include gynogenesis, hybridogenesis, and androgenesis. Gynogenetic and hybridogenetic complexes, Bacillus, Corbicula, Rana, Poecilia, Poeciliopsis, Menidia, Cobitis, Bombyx.

Unisexual reproduction is usually recognized as the most accepted mechanism of cloning, i.e., reproduction without genetic recombination. Transfer from bisexual to parthenogenetic propagation causes the appearance of all-female populations, races, and species. It was ascertained in natural populations of numerous of reptile and insect species. Clonal and hemiclonal species of fishes and amphibians propagate by means of gynogenesis and hybridogenesis. Less known are instances of androgenesis found in some insects and mollusks. In this case offspring develops only under control of male genes supplied by spermatozoa. Mother’s genes included into the egg nucleus have to be entirely lost. Androgenesis may be called mirroring of parthenogenesis.

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GYNOGENESIS

Gynogenesis is the development of unfertilized egg that proceeds only after stimulation by sperm. Spermatozoon penetrates the egg, but soon the male pronucleus is eliminated. Further development of the embryo is controlled only by the maternal genome and leads to the production of all-female offspring.

The widely known example of gynogenesis is crucian carp Carassius auratus gibelio. Its range extends from Western Europe to Japan. In the eastern part of this enormous space, bisexual populations are more common. In Europe, the species is nearly everywhere represented by a unisexual form and breeds with the participation of males of several species of cyprinids (Cyprinus carpio, Carassius carassius, Rutilus rutilus; Cyprinidae). All studied gynogenetic females of crucian carp in European and Chinese populations occurred to be triploid. In Japan, most of gynogenetic populations are triploid, tetraploid ones are not so common (Golovinskaya et al., 1947, 1965; Cherfas, 1987; Zhou et al., 2000; Vasil'eva and Vasil'ev, 2000; Murakami et al., 2001; Brykov et al., 2005).

Gynogenesis was also discovered in diploid and triploid races of small viviparous tropical fishes of the genera Poecilia (=Molliesenia) and Poeciliopsis (Poeciliidae; Hubbs and Hubbs, 1932, 1946; Miller and Schultz, 1959; Schultz, 1961, 1966, 1969); in loaches, Cobitis (Cobitidae; Sofradžja and Berberovic, 1978; Vasil’ev and Vasil’ev, 1982; Vasil’ev, 1985; Vasil’ev et al., 2007; Lebedeva, 2007); in triploid races of the caudate amphibian genus Ambystoma (Ambystomatidae; Macgregor and Uzzell, 1964; Cuellar, 1974); and in only some insects (triploid race of beetle Ptinus mobilis, Ptinidae, the reproduction of which depends on the presence of males of the diploid species Ptinus clavipes; Sanderson, 1960).

HYBRIDOGENESIS

During hybridogenesis, the offspring originates from fertilized egg, which is the principal difference between hybridogenesis and gynogenesis. The paternal genes being brought by spermatozoon reveal themselves in phenotype. As in the cases mentioned above, the offspring is also all-female, but of a hybrid constitution, because it inherits chromosomes from both parents, which was proved by crosses of individuals with marker genes. However, during the initial stage of oogenesis, the father’s chromosomes are eliminated and only the mother’s ones are to be retained in the mature egg. Therefore, each subsequent generation can be produced only after one haploid set of chromosomes is again borrowed from a male of the related species. Borkin and Darevsky (1980) suggested to call this kind of reproduction “credigenesis.”

The phenomenon of hybridogenesis was most completely investigated in small fishes Poeciliopsis which inhabit the rivers of Gulf of Mexico. All-female diploid populations that arose from interspecies hybrids of the genus live there. For reproduction, they use males of related bisexual species, and thus “parasitize” on them (Schultz, 1977; Vrijenhoek, 1972; Angus and Schultz, 1979).

Strong evidence of hybridogenesis was also obtained in the frog Rana esculenta. Actually, this well-known European species is a permanent hybrid of R. lessonae and R. ridibunda (Berger, 1967; Borkin et al., 1987; Vinogradov et al., 1990; Lada et al., 1995).

ANDROGENESIS

Similar to gynogenesis, androgenesis can serve as a natural way to clone or multiply identical genotypes. It may be called mirroring of parthenogenesis. Like during common sexual reproduction, androgenetic offspring develop from fertilized eggs, but they inherit only genes introduced by spermatozoon. Genes contained in the egg nucleus are lost.

The possibility of androgenetic development was so obvious to some experienced geneticists that they firstly managed to demonstrate this wonderful phenomenon in experiments on the silkworm Bombyx mori (Hasimoto, 1934; Astaurov, 1936a, 1936b, 1937). By means of strong, sublethal warming-up of eggs, the female pronucleus was eliminated. Then, as a result of fusion of two haploid sperm nuclei, the formation of diploid individuals was observed. Moreover, when a female was inseminated by two genetically different males, the two-father’s hybrids were sometimes obtained (Strunnikov, 1958; Astaurov, 1968).

Only quite recently, the cases of natural androgenesis were found and properly explained. The freshwater clam Corbicula sandai (Mollusca, Bivalvia, Corbiculidae) is a common diploid bisexual dioecious species from Lake Biwa, Japan. This species is supposed to breed in a usual way as it has normal haploid spermatozoa possessing half the DNA found in somatic cells. Two other species, C. leana and C. fluminea closely related to C. sandai are hermaphrodites (Miyazaki, 1936; Kraemer and Galloway, 1986). It has been shown, that being individually isolated these molluscs are able to produce progeny that was checked for two generations (Ikematsu and Yamane, 1977). Thus, reproduction by either self-fertilization or gynogenetic development was suggested (Okamoto and Arimoto, 1986).

Recently, it has been realised that one of the Japanese populations of C. leana is triploid. In Taiwan, C. fluminea individuals from the same locality occurred to be diploid or triploid (Komaru and Konishi, 1999). It should be pointed out that triploid as well as diploid molluscs of the genus Corbicula from several examined localities of the Eastern Asia produce non-reductional spermatozoa containing the amount of DNA equal to that of somatic cells (Okamoto and Arimoto, 1986; Komaru et al., 1997; Komaru and Konishi, 1999).