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FORECAST ON INVESTIGATIONS ON POLYPLOID HONEY BEES BY THE TEST OF HYPOTHESES OF GENIC BALANCE, AND OF THE HETEROZYGOSITY OF MULTIPLE LOCI

J. WOYKE

Bee Division, Agricultural University, Warszawa-Ursynów
POLAND

Chairman of the "Instrumental Insemination" Working Group of the
Bee Biology Standing Commission of APIMONDIA

There are various ways to breed better honey bees: 1) to select bees with desirable characters; 2) taking advantage of heterosis effect and 3) breeding of polyploid bees. The two first methods are known and are used in practice. The third is now being perfected. Polyploid bees can be obtained by two means:

a) administration of chemicals which cause polyploidization of germ cells or b) attaining polyploidization genetically. The latter can be done by rearing diploid drones producing diploid spermatozoa and insemination of queens with semen of these drones. Drones producing diploid spermatozoa have been reared during the last years. But there are difficulties in obtaining the spermatozoa for artificial insemination. Among other difficulties, the diploid drones have small testes and produce low number of spermatozoa. Thus maleness of diploid drones should be increased.

There are some hypotheses concerning the sex determination and maleness of diploid drones. CUNHA and KERR (1957) presented a genic balance hypothesis according to which the multiple X alleles are interpreted as femaleness genes which had lost the cumulative effects — unless they are heterozygous. Therefore homozygous XX individuals are males, but they have some female-like characters. KERR (1967) suggested that the different X alleles have lost the additive capacity to various extents. Thus for instance, X_1X_1 individuals can be more female-like, while X_5X_5 ones more male-like.

WOYKE (1966) suggested a working hypothesis for the USDA. A similar one was lately published by CROZIER (1971). According to it, the heterozygosity of several loci on various chromosomes leads to feminization of the individual. Thus an increase of homozygosity of diploid drones should increase the size of their testes.

We tested both hypotheses. To this aim, crosses were made which enabled us to determine the X allele composition in the offspring, and which resulted in different degrees of heterozygosity. *Apis mellifera adansonii* and *Apis mellifera ligustica* were used. Sibling mating within both races were made as well as crosses and backcrosses between them. Haploid and diploid drones originating from 23 queens were reared and investigated.

Results

Fig. 1 presents the possible composition of the X alleles. Concerning these alleles, any queen mated with one drone can produce only one type of diploid drones. But all

the Italian sibling mated queens can produce two different types of drones: the X_1X_1 and X_2X_2 .

The African ones also can produce two types of drones: X_4X_4 and X_5X_5 .

Crosses of the two races (queen No. 120 and some others not used in the subsequent tests) have not produced brood of low survival rate, which indicates that the X alleles of the two crossed races were not identical. The backcross to the African bee with the drones of F_1 queens did not result in any queen producing brood of low survival rate. Possibly, the African drones originated from a laying worker.

Since the original Italian queen mated naturally with several drones, there was little chance to meet the exact father X_3 allele in the backcross. Thus, backcrossed Italian queens produced practically only one type of diploid drones namely the X_1X_1 . Sibling matings within offsprings of the backcrosses resulted in two types of diploid drones X_1X_1 and X_3X_3 . Queens inseminated with several brothers could produce both types of diploid drones. Thus, according to the X alleles composition, the crosses made produce the following types of diploid drones: two types produced by the Italian X_1X_1 and X_2X_2 , two other types produced by the African: X_4X_4 and X_5X_5 ; practically only one type produced by the Italian backcross: X_1X_1 , which is the same as half of the pure Italian, and two types: X_1X_1 and X_3X_3 produced by the next generation of sibling mated queens resulted from the backcross. One type of the latter, X_1X_1 , is the same as of the pure Italian and of the backcross. The other type, X_3X_3 , is different from any other reared. The level of homozygosity is also different in the various crosses. The diploid drones resulting from the sibling matings of Italian as well as of the African bees had 25% homozygous loci, those of the backcross 12.5% and the next generation of the backcrosses — 30.75%.

In all, 1460 testes were measured.

After the diploid and haploid drones were reared it turned out that the average volume of testes of various groups of diploid drones were 2.7 to 6.5 times smaller than those of the haploids of the same groups. The African bees produced diploid drones with bigger testes (avg. 3.32 mm³), and the Italian — with smaller ones (avg. 2.17 mm³). Backcrosses to the Italian queens resulted in the medium size of testes (avg. 2.75 mm³) shifted toward the Italian size. The next generation of the backcross had smaller testes (2.48 mm³) than the backcross and bigger than the Italian ones.

Within any group of diploid drones, the populations of testes could not be separated into one or two groups according to the X alleles composition. Nor two peaks were found in populations resulting from inseminations with two or three drones, where the presence of two pairs of different X alleles could be expected. The size of testes of diploid drones did not follow the composition of the X alleles. Thus, in this case, no difference of the additive ability of various X alleles was recorded.

With respect to the second hypothesis, mention should be made that the African and Italian diploid drones resulting from the sibling mating had 25% homozygous loci, whereas those resulting from backcrosses had only 12.5% homozygous loci. Nevertheless, both groups of diploid drones of the same homozygosity $F = 0.25$ had testes differ-

ing in size very significantly. The more heterozygous group of diploid drones of the backcross $F = 0.125$ had testes smaller than those of the African ones, but bigger than the Italian group — with 25% homozygous loci. The next generation of the backcrosses with the highest homozygosity level (30.75%) had smaller testes than the backcross generation with the lowest homozygosity/12.5%. Hence, the size of testes of diploid drones did not follow the level of heterozygosity.

The heredity of the size of testes of diploid drones was in accordance with the additive action of the specific polygenes controlling the size of testes.

Thus, for further investigations account should be taken of the fact that in order to rear triploid bees it is neither necessary to test all the X alleles in search of those resulting in the biggest testes, nor to increase the homozygosity of various loci.

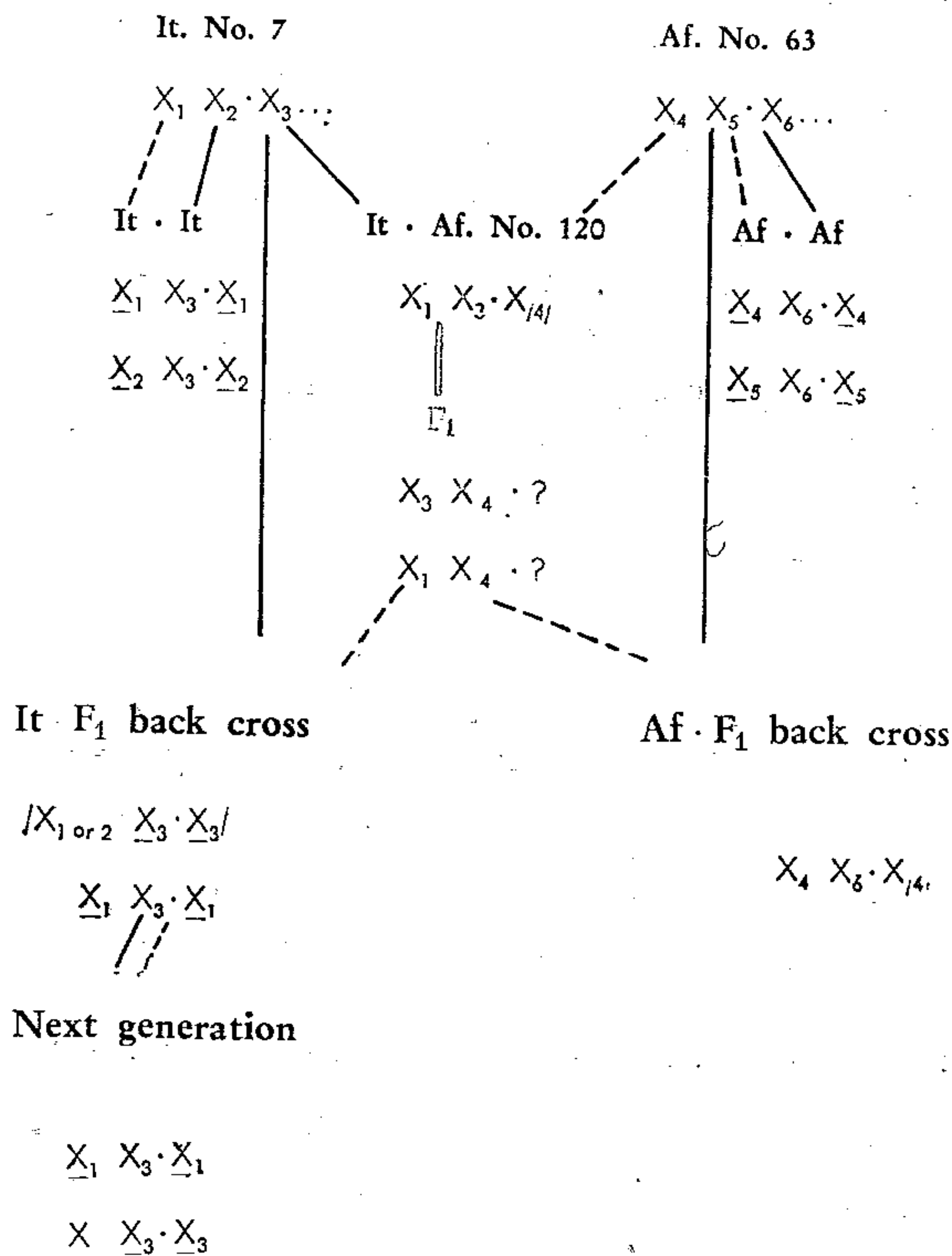


Fig. 1. Crosses made and composition of X alleles

But since significant differences in the size of testes of diploid drones of various races were found, diploid drones of races or even species not yet investigated should be reared and examined. Next, selection among those producing diploid drones with the biggest testes should be made. Crosses between those lines can be made with no risk of decrease in size of testes entailed by the increase in heterozygosity.

There seems to be worth while to continue the tests for obtaining a triploid bee, which may differ in many features from the diploid honey bee which we have already exist.