Chapter 3

Differences in Body Colour Expression between European and Asian Honeybees

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Body colour is an extremely distinctive characteristic among honeybee species and subspecies. Woyke (1977) reviews earlier papers concerning the heredity of body colour in honeybees. The purpose of this investigation was to find the differences in body colour expression between European and Asian honeybees.

Material and Methods

Honeybees were reared or collected during 25 years in Poland, Germany, India, Afghanistan, Vietnam, China, Thailand and Malaysia (Borneo). Special instrumental crosses of queens and drones were made, or bees originating from natural matings were investigated.

Results

The gross appearance of the body colour of European honeybees is similar in workers, queens and drones. The Italian bee, *A. mellifera ligustica*, has a yellow abdomen with black bands (Fig. 1). The yellow and black colour is the same in all three forms of the bee; however, the pattern of the black areas is different. Gene *Y* is responsible for this body-colour expression. Within the same form of bee, variation in the pattern of the black area occurs. The variation is caused by several modifiers to expression of the major body-colour gene *Y*.

Workers, queens and drones of the black European bees, *A. m. mellifera*, *A. m. carnica* and *A. m. caucasica* are black (Fig. 2). They have small areas of yellow on the sides of the abdomen. Gene y^{bl} is responsible for this body-colour expression. The pattern on the abdomen varies. Modifiers of the major body-colour gene y^{bl} are responsible for the variation.

A cross between yellow Italian queen (gene *Y/Y*) and black European drone (gene y^{bl}) results in yellow hybrid workers (Y/y^{bl}). This occurs because yellow colour is dominant over black. The hybrid queens (Y/y^{bl}) produce two types of body-coloured drones: yellow and black. Wide variation in the colour pattern occurs, ranging from yellow to black. Two peaks of frequency distribution appear, one within the yellow range, and the other within the black. This occurs because the two major body-colour genes *Y* and y^{bl} are modified by several modifiers (Woyke, 1977).

The Asian *A. florea* queens and workers are yellow banded, and the drones are black (Fig. 3). The gene responsible for body-colour

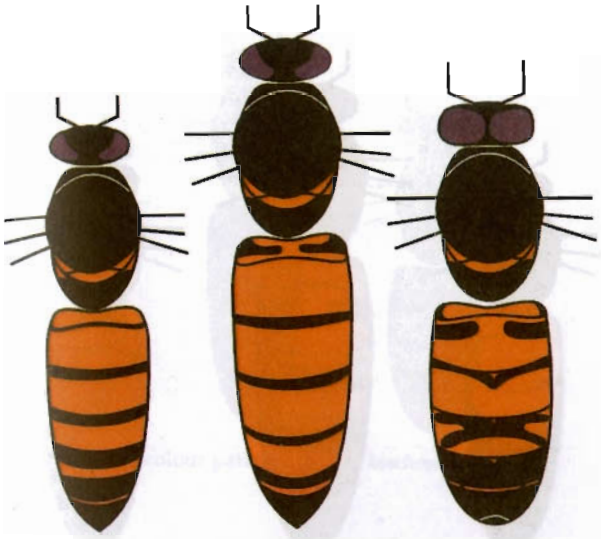

Fig. 1. Body-colour patterns in *Apis mellifera ligustica.*

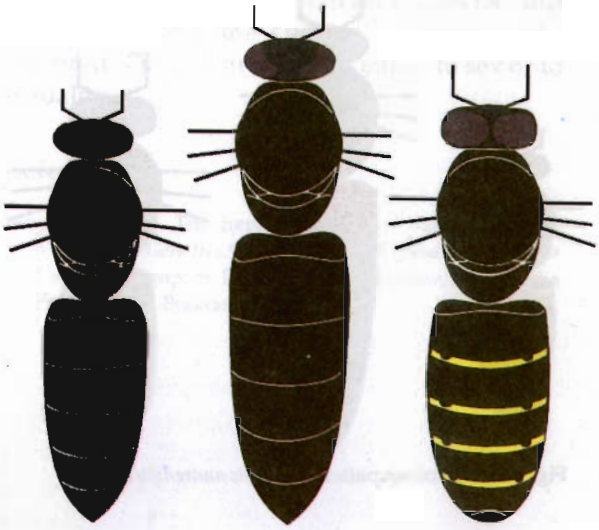

Fig. 2. Body-colour patterns in *Apis mellifera mellifera.*

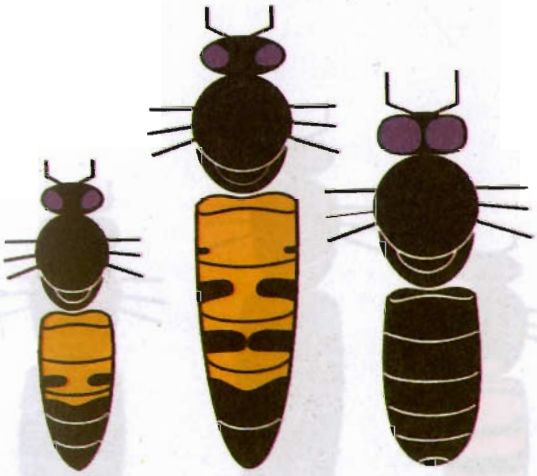

Fig. 3. Body-colour patterns in *Apis florea.*

expression in *A. florea* is designated *Fl.* Yellow queen produces black drones. A cross of yellow queen with black drone results in yellow workers. Drones produced by yellow laying-workers are also black. Thus, the expression of the *Fl* body-colour gene depends upon the sex: females (queens and workers) are yellow and males are black. However, the pattern of black and yellow colour is different in queens and workers. The queen has larger yellow areas than the workers. Thus, the expression of the patterns of body colour in the same sex depends upon their sexuality.

Apis andreniformis workers are yellow although they are the darkest of all five Asian honeybee species described here. Queens and drones are black (Fig. 4). A cross between a black queen and black drones results in yellow workers. Thus the expression of body colour is linked to sexuality. Infertile workers are yellow banded, and the sexes (queens and drones) are black.

Apis dorsata workers are yellow, and queens and drones are brown (Fig. 5). The thoraces of queens and drones are dark brown. The scutellum is brown. The abdominal segments are light brown, with darker brown areas or bands. The gene governing body colour in *A. dorsata* is designated *Do.* Crossing a brown queen with a

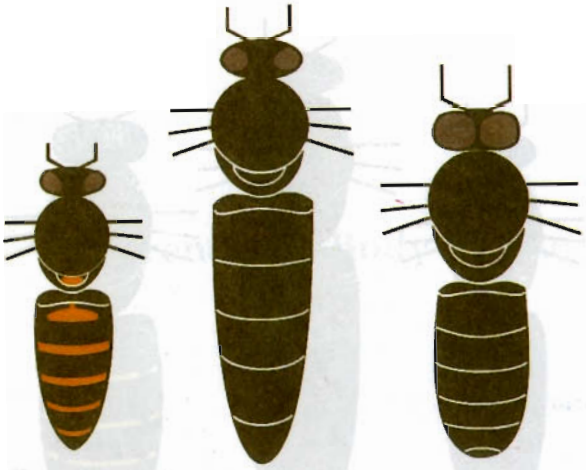

Fig. 4. Body-colour patterns in *Apis andreniformis*.

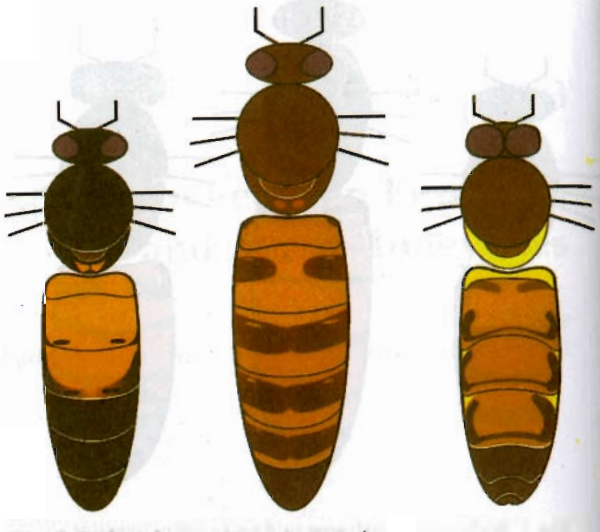

Fig. 5. Body-colour patterns in *Apis dorsata*.

brown drone results in yellow workers. Thus the expression of body colour in *A. dorsata* depends upon sexuality: infertile workers are yellow and sexuals (queens and drones) are brown.

Apis cerana workers are yellow, and queens and drones brownish-black (Fig. 6). The gene responsible for the expression of body colour in *A. cerana* is designated *Ce*. A cross between a brownish-black queen and a brownish-black drone results in yellow workers. Diploid drones reared by Woyke in 1974 in India were also brownish-black, like the haploids. Thus the expression of the body colour in *A. cerana* depends upon sexuality: workers are yellow and the sexuals (queens and drones, independently haploid or diploid) are brownish-black.

All three adult forms of *A. koschevnikovi* are dark brown banded. However, the light abdominal bands are light orange in workers and light brown in queens and drones. The gene responsible for the expression of body colour in *A. koschevnikovi* is designated *Ko*. A cross between a brown dark-banded queen and a brown dark-banded drone results in orange dark-banded workers. So, body-colour expression is linked to sexuality.

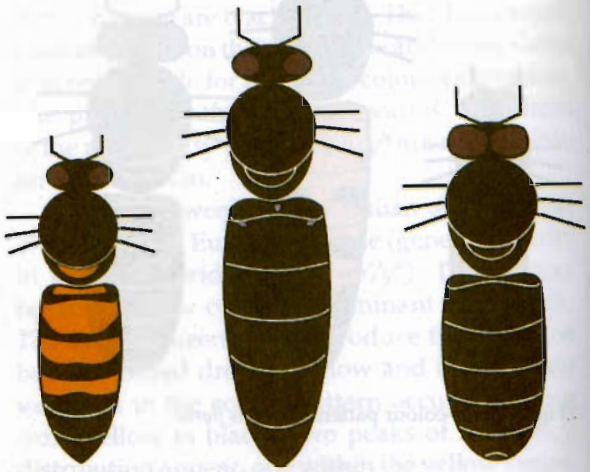

Fig. 6. Body-colour patterns in *Apis cerana*.

Thus two main types of body colour expression were found. In European bees workers, queens and drones of the same

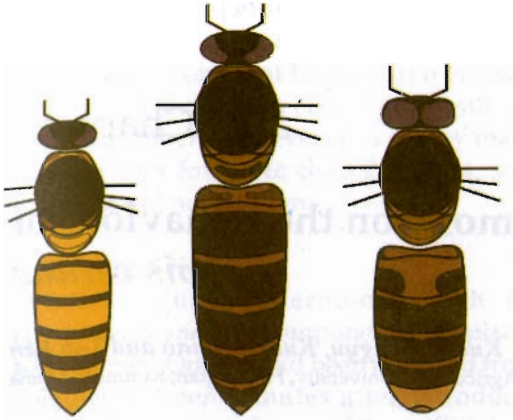

Fig. 7. Body-colour patterns in *Apis koschevnikovi*.

subspecies are of the same colour: black or yellow banded. In Asian bees, workers, queens, and drones of the same species are differently coloured. The colour is linked either to sex or to sexuality.

References

Woyke, J. 1977. The heredity of color patterns in the honeybee. *Genetics, Selection and Reproduction of the Honeybee*. Symp. on Bee Biology in Moscow, Apimondia Publ. House, Bucharest : 49–55.