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GYNANDROMORPHISM IN *CULEX TRITAENIORHYNCHUS*

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INTRODUCTION. Gynandromorphs have been found in fair numbers in laboratory strains of mosquitoes: e.g., in the hundreds in *Culex pipiens* (Laven, 1967) and *Aedes aegypti*, (Craig and Hickey, 1967). In natural populations they are comparatively rare; only 91 specimens belonging to 23 species have been described in the genera *Toxorhynchites, Trichoprosopon, Mansonia, Orthopodomyia, Aedes, Haemagogus, Culiseta,* and *Culex,* (for references to reported gynandromorphs see Kitzmiller, 1953, Brust, 1966, and Lee, 1967). All of these have occured in the subfamilies Culicinae and Toxorhynchitinae but surprisingly none in the subfamily Anophelinae. This report describes five gynandromorphs, the first reported in *Culex (Culex) tritaeniorhynchus* Giles.

MATERIALS AND RESULTS. The first gynandromorph was found in October 1967, in the F_1 offspring of a cross between two strains of *Culex tritaeniorhynchus* maintained in our laboratory. The mother was from the Dacca strain collected originally from Dacca, East Pakistan, and the father was from the Rattipindi strain, collected from a village of the same name near Mangowal District Gujrat, West Pakistan. The Dacca mother laid a raft of 75 eggs from which 43 larvae hatched. Of the remaining 32 eggs, 22 embryonated eggs did not hatch and 10 appeared to be non-embryonated. Only 18 of the larvae reached adult stage (4 normal females and 13 normal males and the 1 gynandromorph). The F_2 crosses using these males and females did not succeed. All other crosses between these two strains resulted in nearly 100 percent hatch. The F_1 males and females from these latter crosses all appeared to be fertile in subsequent F_2 crosses.

Gynandromorph No. 2 was found in May 1968, in the Karachi strain, originally collected near Karachi in November 1967, and maintained in a laboratory strain since that time. In the course of inbreeding for the recovery of mutants, one gynandromorph was found in the F_2 from an original brother-sister mating. No other abnormal mosquitoes were found in the egg raft, nor in the F_3 nor F_4 from the sibs.

However, the third gynandromorph was also found in the Karachi strain also in May 1968. A mutant, *hairy palpi,* had been discovered in the Karachi strain, and the sibs from the egg raft in which this mutant had occurred were inbred and selected for it. During the inbreeding the gynandromorph was discovered in the course of routine examination of adults.

The fourth gynandromorph occurred in May 1968 in a strain which was actually a hybrid between the Dacca and Karachi strains. These populations were being tested for possible incompatibility; the inbreeding had already produced a white-eyed mutant, and further selection for

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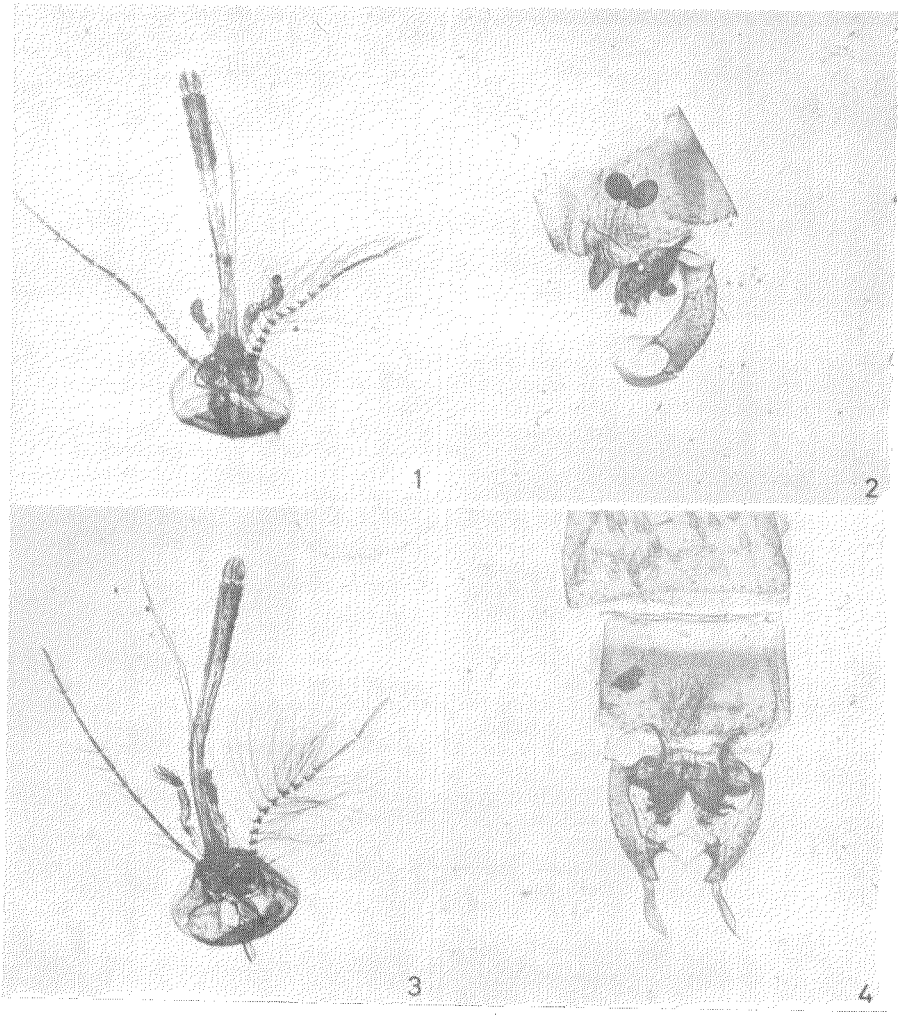


FIG. 1.—Gynandromorph No. 1: Showing male antenna and intermediate palpus (right) and female antenna and palpus (left).

FIG. 2.—Gynandromorph No. 1: Hypopygium showing female genitalia on the right side and male genitalia on the left.

FIG. 3.—Gynandromorph No. 2: Showing abnormal palpi, female antenna (left) and male antenna (right).

FIG. 4.—Gynandromorph No. 2: Showing normal male abdomen and genitalia.

white eye was in progress. This gynandromorph was the only example found in this inbred strain, although thousands of mosquitoes were screened for eye color mutants.

Gynandromorph No. 5 was found in June, 1968 in the F_2 of an inbred line from the Dacca strain, which was being examined for possible mutants. The inbreeding was continued through the F_4 without further discovery of gynandromorphs.

A summary of the characteristics of the gynandromorphs is given in Table 1, and photographs in Figures 1 through 10.

All examples were bilateral, with varying degrees of modification of the affected organs. Of the five specimens, four were chiefly female on the left side and one on the right, in the head region. Specimen number one was apparently normal female in antenna, torus and palpus. The right side had a male torus, a male antenna, and a modified palpus, definitely larger than the female, but not at all typically male. In specimen number two the torus and antenna were female on the left, male on the right; both palpi were abnormal, larger than female, but shorter than male. Specimen number three was similar to number one, with torus and antenna female and male, left and right sides respectively, but with a larger, abnormal, right palpus. Specimen number four showed the same type of modification, bilaterally sexually differentiated except for a larger palpus on the left side and with the female characteristics now expressed on the right side. The fifth specimen was almost perfect bilaterally female and male, the right palpus being somewhat shorter than in the normal male.

The right-left bilateral sexual differentiation continued in a posterior direction in four of the specimens, in which the wing shape and the form of the tarsal claws were female and male on the same sides as were the head parts. However, in specimen number one, the orientation was reversed; the head was female on the left, male on the right, whereas the thoracic differentiation was male on the left, female on the right. The abdominal segments of all five specimens were either male or female, not bilateral, as shown in Table 1. In two specimens (4 and 5) gonadal dissections were made, and conformed to the morphology of the abdomen and the hypopygium in both cases, male in No. 4 and female in No. 5. The spermathecae were absent, as expected, in specimens No. 2 and 4, which were evidently male posteriorly. In the other three specimens, two of which were sexually differentiated in the hypopygia (Nos. 1 and 3) and one of which was not (No. 5), only two spermathecae were present. However, the female abdomen of No. 5 was slightly dimorphic for sternal banding pattern with the left and right sides having female and male patterns respectively in accordance with other dimorphism of the body.

Two hypopygia were wholly male, one was wholly female, and two were female on one side, male on the other. In one of these, No. 3, the female side was the left, agreeing with the differentiation of the head and thoracic structures, but in No. 1 the orientation was similar to that of the thoracic, not the head structures. None of the genitalia had rotated.

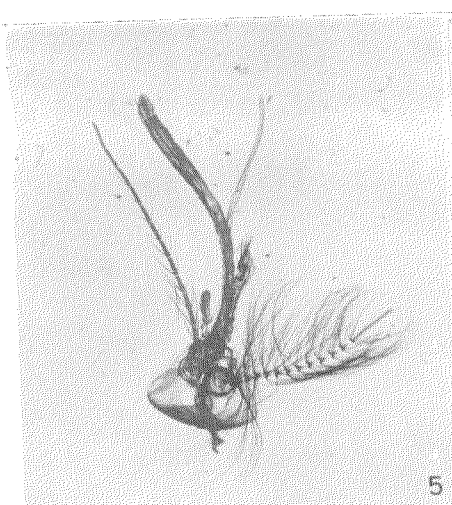
Discussion. Although the head and thoracic structures show an essentially bilateral distribution of sexually differentiated morphological characters, there is also an obvious anterior posterior differentiation. Specimens 2 and 4, although bilaterally differentiated anteriorly from the thorax are completely male with respect to the abdomen and genitalia. The same type of differentiation is apparent in the other three specimens which are predominantly of one sex posterior to the thorax, but with some bilateral differentiation in the spermathecae and genitalia.

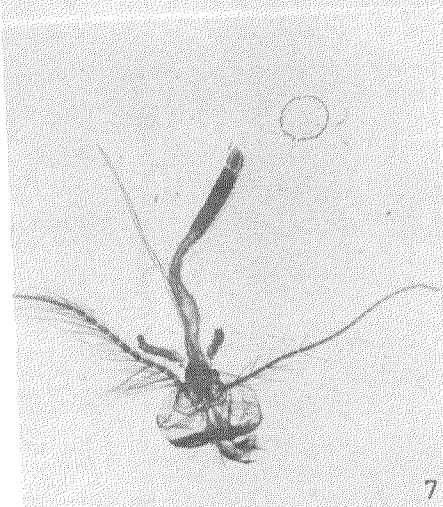
The reversal of orientation in specimen No. 1, from the head to the thorax is of special interest. If some sort of mechanism were affecting differentiation in either an anterior or posterior direction, as sometimes assumed, it is evidently possible to block or reverse this process.

Four of the five gynandromorphs were discovered during the period May 13–June

TABLE 1.—The morphology of gynandromorphs of *Culex tritaeniorhynchus*

	No. 1		No. 2		No. 3		No. 4		No. 5	
Structure	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Palpus	Female	Abnormal	Abnormal	Abnormal	Female	Abnormal	Abnormal	Female	Female	Abnormal
Antenna	Female	Male	Female	Male	Female	Male	Male	Female	Female	Male
Torus	Female	Male	Female	Male	Female	Male	Male	Female	Female	Male
Wing	Male	Female	Female	Male	Female	Male	Male	Female	Female	Male
Leg 1	Male	Female	Female	Male	Female	Male	Male	Female	Female	Male
Leg 2	Male	Female	Female	Male	Female	Male	Male	Female	Female	Male
Abdomen	Normal	Male	Normal	Male	Normal	Female	Normal	Male	Normal	Female
Testis	?	?	?	?	?	?	+	+	−	−
Ovary	?	?	?	?	?	?	−	−	+	+
Spermathecae	2		Absent		2		Absent		2	
Hypopygium	Male	Female	Male	Male	Female	Male	Male	Male	Female	Female
Figures	1,2		3,4		5,6		7,8		9,10	





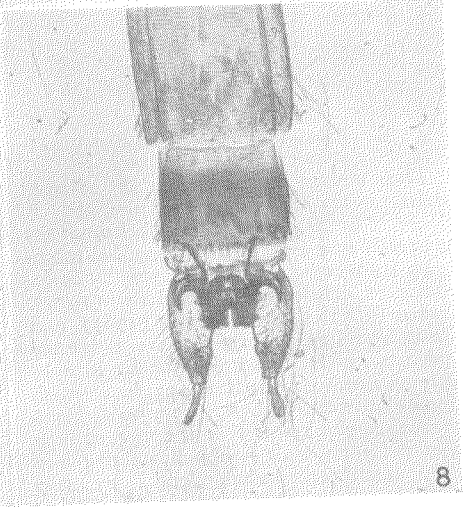


FIG. 5.—Gynandromorph No. 3: Showing female antenna and palpus (left) and male antenna and intermediate palpus (right).

FIG. 6.—Gynandromorph No. 3: Showing female abdomen and female genitalia on the left and male genitalia on the right.

FIG. 7.—Gynandromorph No. 4: Showing male antenna and intermediate palpus (left) and female antenna and palpus (right).

FIG. 8.—Gynandromorph No. 4: Showing normal male abdomen and genitalia.

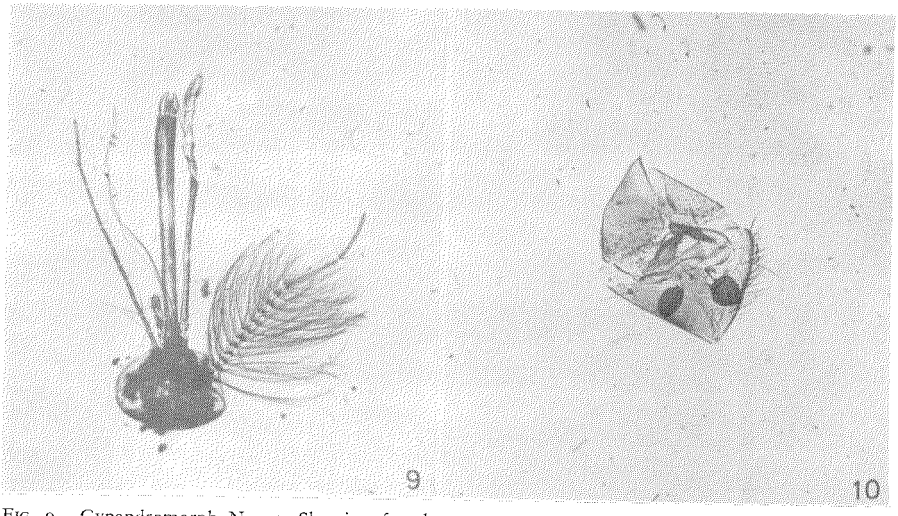


FIG. 9.—Gynandromorph No. 5: Showing female antenna and palpus (left) and male antenna and abnormal palpus (right).
FIG. 10.—Gynandromorph No. 5: Showing female genitalia with two spermathecae.

7, 1968, by the same technician. All five came from two strains, Dacca and Karachi. All were discovered in the course of inbreeding or selection procedures.

The explanation for the origin of gynandromorphs in mosquitoes is still in doubt. In *Drosophila,* gynandromorphs generally arise by the loss of one X chromosome from cells that would normally be female. Gilchrist and Haldane (1947), Laven (1957), Rai and Craig (1963), and Craig and Hickey (1967) have suggested mechanisms for gynandromorphs in culicine mosquitoes based on evidence with genetic mutant markers. One possible explanation given was that the egg nucleus and polar body or a binucleate egg had been fertilized independently by two sperms. Another explanation was that somatic crossing-over may have occurred. These explanations for the origin of gynandromorphs are supported by mosaics that are perfect or almost perfect half-and-half mosquitoes. However, our gynandromorphs will probably require a more complicated explanation.

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