ing about 200 cells) on nutrient agar plates. After 24-hour incubation at 37°C., the colonies present on these plates were replica-plated on minimal-lactose proline medium which had just been spread with 0·1 ml. of an overnight broth culture (about 2×10^3 cells) of *E. coli HfrCS*-101. The selection markers in this test were *met* (methio-nine requirement) in *CS*-101 and lac^- (inability to utilize lactose) in the *Salmonella*; and both these markers are so stable that no spontaneous revertants were observed. After 48-hour incubation at 37°C., samples were taken from colonies on the original nutrient agar plates which showed lac^+ recombinants on the printed plates. Cultures grown from single colonies derived from these samples were tested for fertility. The tests showed that many of the original colonies, grown without any contact with *E. coli*, possessed high fertility. The cells derived from them recombined at frequencies between 10^{-4} and 10^{-5} with all *Hfr* strains tested (*CS*-101, C^3, H^4, and $P4X_6$), and showed recombination also with the non-*Hfr* strain *K*-12 F^+ RT-18 (*met*), with frequencies between 10^{-7} and 10^{-8}. The last-mentioned strain was obtained from Prof. P. Fredericq, and strain $P4X_6$ was kindly supplied by Dr. F. Jacob.

These results indicate that a population of *S. typhimurium mut* is a mixture of fertile and infertile cells (about 1:100), and that only the former recombine with *E. coli Hfr*. Since attempts to obtain a fertile strain from mut^+ bacteria were not successful, it appears probable that the *mut* gene increases the frequency of changes from the infertile to the fertile condition.

As mentioned above, recombination occurred in experiments with the fertile strain of *Salmonella* and an F^+ strain of *E. coli*, although at lower frequencies. Therefore, it is possible that the fertile strain of *Salmonella* is F^- whereas the original strain is F^+, and that the percentage of change from F^+ to F^- is increased by the presence of the mutator factor.

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Induced Mutations of X-Ray Irradiations in *Culex fatigans* Wied (1828)

To explore the possibility of linking a visible morphological character with the resistant gene for the study of population genetics of resistance of insects to insecticide[1], mutations were induced in *C. fatigans* by exposing them to X-rays.

Normal laboratory-bred *C. fatigans* pupae were allowed to hatch individually in 3×1 in. specimen tubes. The mosquitoes on hatching were fed on 10 per cent glucose solution for 48 hr. 108 female and 74 males were irradiated with a total dose of 4150 r. (kV., 150; m.amp., 15; fod., 40 cm., filter, nil) during 60-min. exposure. 32 and 48 per cent mortality occurred among the irradiated male and female mosquitoes respectively within 24 hr. after exposure. The surviving mosquitos were allowed to mate, and the females were afterwards fed on a bird. 25 egg rafts were obtained of which 23 hatched out.

Out of a total of 3251 eggs, 2055 larvæ were obtained (174 eggs were embryonated but did not hatch and 1022 eggs were unembryonated). The total number of

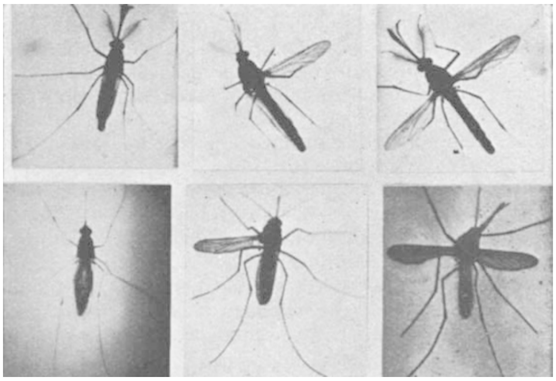

Fig.1 Male and female *C. fatigans*. *a*, both wings closed (normal); *b*, one wing spread (right or left); *c*, both wings spread

adults thus obtained were 1456. These were carefully examined for any morphological aberrations. The following were noticed:

(1) 7 female and 4 male mosquitoes with wings intact but incapable of flight.

(2) 3 female and 4 male mosquitoes with short wings.

(3) One single female with an additional branch to long wing vein No. 4.

(4) A single male with both wings spread out.

Efforts to rear the mosquitoes with the first three mutations failed.

A single male with the spread wing (*spw*) aberration, however, was successfully mated with 4 normal females in a glass jar 6×3 in. The females were afterwards fed on a bird. Three eggs rafts were obtained, out of which only one hatched to produce 72 larvæ (a high mortality among the embryonated eggs was recorded). These were reared in the laboratory to obtain the F_1 generation. 31 females and 19 males hatched out, of which 5 females and 4 male mosquitoes had one wing spread out (+/*spw*). These were inbred to obtain the F_2 generation. Details of the F_2 adults hatched are given in Table 1.

Total No. of mosquitoes hatched		No. with both wings spread out (*spw*/*spw*)		No. with one wing spread out: Right wing spread out (+/*spw*)		No. with one wing spread out: Left wing spread out (*spw*/+)		No. with both wings closed (+/+) Normal	
F	M	F	M	F	M	F	M	F	M
32	74	16	58	5	9	4	7	3	4

Male and females of the F_2 generation with both the wings spread out (*spw*/*spw*—phenotypes) were inbred. 13 egg rafts were obtained. Out of a total 1695 eggs 415 larvæ hatched. A total number 295 adults were thus obtained. 89 mosquitoes had both wings spread out, 100 had only one wing spread out, and 106 had both the wings closed.

'Spread-wing' is a non sex-linked mutation controlled by a single gene, most likely neutral and with high penetrance. As is evident from Fig. 1, this mutant character is easily detectable with the naked eye. The only other known mutations in this species are micro-mutations as described above and by Kitzmiller[2].

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