Table 1.—Progeny resulting from various testcrosses (repulsion combinations) utilizing mutants (markers) on each of the previously marked linkage groups for Tribolium castaneum.

<table>
<thead>
<tr>
<th>Linkage group</th>
<th>Group marker</th>
<th>Marker-ivory</th>
<th>Wild Marker</th>
<th>Ivory</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>pegleg</td>
<td>157</td>
<td>415</td>
<td>418</td>
</tr>
<tr>
<td>III</td>
<td>black</td>
<td>188</td>
<td>246</td>
<td>229</td>
</tr>
<tr>
<td>IV</td>
<td>sooty</td>
<td>85</td>
<td>109</td>
<td>74</td>
</tr>
<tr>
<td>V</td>
<td>jet</td>
<td>70</td>
<td>84</td>
<td>79</td>
</tr>
<tr>
<td>VI</td>
<td>microphthalmic</td>
<td>32</td>
<td>136</td>
<td>40</td>
</tr>
<tr>
<td>VII</td>
<td>Short antennae</td>
<td>44</td>
<td>99</td>
<td>31</td>
</tr>
<tr>
<td>VIII</td>
<td>antenapedia</td>
<td>59</td>
<td>106</td>
<td>63</td>
</tr>
</tbody>
</table>

Phenotype

The pegleg and ivory crosses. The F$_2$ yielded 307 wild-type, 264 ivory, 55 pegleg, and 59 pegleg-ivory individuals. These data are highly significantly different from an expected 9:3:3:1 ratio, and there are many less wild than would be expected with independent assortment, but many more wild than expected if linkage exists. Again misclassification of pegleg individuals is expected. Mather (1957) illustrates the use of the product method for the estimation of linkage with disturbed ratios. A recombination frequency of 28% was calculated with the product formula on the F$_2$ data. This recombination value is between the 2 previous estimates and is probably the best estimate.

Lasley and Sokoloff (1961) reported that pearl and pegleg were linked and they found 30% recombination. In the present study, reciprocal crosses of ivory and pearl gave wild-type offspring. The close resemblance between the 2 mutant phenotypes handicaps recombination study, but preliminary F$_2$ data suggest that ivory and pearl are closely linked and at approximately equal distance from pegleg. Precise estimation of recombination between these 3 loci in linkage group II must await the isolation of more useful markers.

The occurrence of this mutant (ivory) further emphasizes the need for study of possible homologies between mutants in other species, as well as the biochemical relationships between similar mutants of the same species.

Biochemical study of the 2 eye mutants, pearl and ivory, might yield significant information concerning the biosynthesis of eye pigments in both Tribolium and other insects.

REFERENCES CITED


A Method of Shipping Live Larvae of Simulium vitatum Long Distances (Diptera: Simulidae)

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During studies on the biology and ecology of black flies (Simulidae) at the Seney National Wildlife Refuge, Seney, Michigan, and at the Patuxent Wildlife Research Center, Laurel, Maryland, larvae of 3 species of black fly (Simulium vitatum Zetterstedt, S. aurem Fries, and S. dencei Walker) were collected and transported for distances of up to 50 miles in nonagitated jars of water. In each case the water used to transport the larvae was removed from the waterway where the particular larvae were taken. However, on numerous occasions it was found that larva could not be kept alive in nonagitated water jars for more than 1 hour.

To my knowledge, no one has reported a method for transporting live black fly larvae long distances, although

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1 Accepted for publication November 16, 1965.
Bequaert (personal communication, 1965) has had some success transporting them for short distances in wet moss.

My first attempt to transport live larvae long distances (Seney, Mich., to Laurel, Md.—1100 miles) was in 1964 (Tarshis 1965), when shipments of black fly larvae and eggs were transported in arctic hamperes cooled with Scott-ice refrigerants via a commercial passenger airline. The eggs came through in good condition, but none of the larvae were alive on arrival. Attempts to ship live larvae in packets of wet cotton via air mail, and first-class and fourth-class mail, from Seney to Laurel, also were unsuccessful. From these trials it was concluded that the only way successfully to transport live larvae the long distance from their breeding site to the laboratory would be to ship them by truck in a specially designed water tank containing equipment that would agitate the water in such a way that the larvae would not be harmed by the equipment. I have found that larval survival is not so much dependent upon water agitation for keeping the oxygen content of the water high as it is upon keeping the food particles in the water in constant motion. Water movement is essential to larval survival beyond 6 hr.

Agitating water in larval breeding jars was abandoned when it was found that a 50-lb. compressed air supply would last only 2 hr. More tanks of compressed air than practicable would have been needed for each trip from Michigan to Maryland. Gasoline-operated compressors for supplying air to tanks were not considered because of the safety hazard.

Since piston-driven aquarium pumps utilizing aquarium air stones had been used successfully in the laboratory for the agitation of water in black fly larval tanks, it was thought these same pumps might be used successfully in transporting the black fly larvae from Michigan. However, to use these pumps while transporting larvae, a 6-v d-c, 7/8 hp motor had to be substituted for the regular 115-v a-c electric motor of the pump.

When traveling, the 2 pumps were connected to the car generator while the car was in motion. At night, each pump was powered by a 6-volt battery supplied for this purpose. The batteries could not be used continuously, for they have a life of about 12 hr, and the trip from Michigan to Maryland takes about 35 hr. An extra battery was kept on hand in the event of the failure of one of the others.

A wooden box, 22 in. wide, 53 in. long, and 20½ in. high, was used to house the air pumps and larval transport jars. The air lines from the air pumps were connected in series with air valves, 1 valve to each of 16 2-quart jars and 2 valves to each of 6 1-gal larval jars. The air lines were placed through holes in the lids of these jars to prevent spillage of water from the jars while the truck was in motion. Two aquarium pumps were more than ample to supply air to the 22 jars used for transporting the larvae.

The utilization of this equipment has enabled me to transport without mishap several hundred thousand S. vittatum larvae in various stages of development, and the larvae developed normally in the Maryland laboratory into adult flies. As a result of this study, it now seems feasible to transport black fly larvae even longer distances than those I covered. Fig. 1 and 2 show the equipment used for the transportation of S. vittatum larvae from Seney, Mich., to Laurel, Md.

REFERENCE CITED

Chemoreception of Attractants from the Cotton Plant by Boll Weevils, Anthonomus grandis (Coleoptera: Curculionidae)¹, ²

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Most researchers believe that the organs of chemoreception in insects are situated chiefly in the antennae (Wigglesworth 1961). However, McIndoo (1926), though he did not conduct tests with attractants, con-

¹ In cooperation with the Mississippi Agricultural Experiment Station. Accepted for publication February 7, 1966.
² Mention of a proprietary product does not necessarily imply endorsement by the USDA.