Comparison of capturing tabanid flies (Diptera: Tabanidae) by five different color traps in the fields

Hitoshi Sasaki
Laboratory of Entomology, Department of Dairy Science, Rakuno Gakuen University, Ebetsu, Hokkaido 069–8501, Japan
(Received 23 April 2001; Accepted 4 June 2001)

Abstract
Five different NG2G colored traps were evaluated for capturing four Japanese tabanid flies: *Hybomitra olsoi*, *Hirosia iyoensis*, *Tabanus nipponicus* and *Haematopota tristis* in the fields. Blue and red colors were effective for all species. For *H. olsoi* blue was the most effective and, white and yellow were the least. All species were caught in small numbers with yellow traps. Black and blue were most effective for *H. iyoensis* and red was most effective for *T. nipponicus*. The behavior of *H. tristis* differed considerably from that of other species, namely they were captured in the large numbers in the blue, white and red traps but few were captured in the black traps.

Key words: Tabanid fly, colored trap, NG2G trap, attractant

INTRODUCTION
Tabanid flies (Diptera: Tabanidae) are of considerable significance in medical and veterinary entomology. Their importance is associated with both the transmission of disease and with the economic significance of stress resulting directly from bites, or indirectly from secondary infections, anemia through blood loss, allergic responses, etc.

As tabanid larvae are well-dispersed in the environment, control of early life stages has rarely been practical (Foil and Hogsette, 1994). Instead, most reports have focused on chemical or cultural methods of control of adult flies. Traps have also been designed for possible use in controlling tabanid flies (Ailes et al., 1992; French and Hagan, 1995), based on results obtained from trap designs optimized for research purposes (Hribar et al., 1991). Although many insights have been gained on the shapes and colors (Allan et al., 1987), considerable work remains to be done on the design of practical traps.

In the present paper, the author reports the catches of four Japanese tabanid flies in simple cloth traps made from various colors designed for tsetse flies in Africa.

MATERIALS AND METHODS
Experiments were done with the NG2G trap (Fig. 1) designed for *Glossina pallidipes* in Kenya (Brightwell et al., 1987). The trap resembles a blue and black “tent” about 1 m in height, 1 m in length and 1 m in width with a white polyester-netting triangular cone at the top. The traps were made in five different colors out of identical materials and weight (100% cotton cloth): black, blue, red, yellow and white; i.e. both the blue and the black portions were replaced with a single color. The reflectance of each color is shown in Fig. 2.

Each trap was set along transects through a constant habitat at intervals of 20 m using 1 kg dry ice or CO₂ (1,500 ml/min) as an attractant. Dry ice was set on the ground inside of the trap and CO₂ was released into the bottom of the trap from the gas tank by the tube. One hour after the traps were set, the captured tabanid flies in removable collecting containers at the top of the traps were collected. Then, the traps were interchanged according to a 5×5 Latin square on 1-h rotations.

For *Tabanus nipponicus*, the test was replicated three times (*n* = 75) in the pasture of the Hokkaido University Experimental Farm in Shizunai, Hokkaido, during 3 to 6 August, 1995 and 26, 27 July, and 12, 13, 26, 27 August in 1996. Other tests were duplicated (*n* = 50) for *Hybomitra olsoi*, *Hirosia iyoensis* and *Haematopota tristis* in the pasture of Chitose Municipal Farm in Chitose, Hokkaido, during 26 to 28 July in 1995, the riverside of Momose-Gawa in Toga, Toyama during 17 to 20 August in 1996 and the Kaminoko-Ike Park in Kiyosato, Hokkaido during 5 to 7 August, 1994.
respectively. All experimental days were fine or almost fine and air temperature was 23 to 28°C. The experimental fields are shown in Fig. 3. The captured flies were identified and counted. For comparison and to eliminate the factor of the time surveyed, numbers were transformed into indices. The indices were calculated as follows: the largest number of captured flies in the surveyed time was considered as 1.00 and the other numbers were shown as ratios to that largest number. The indices were analyzed by one-factor ANOVA and Fisher’s PLSD tests for differences among traps.

RESULTS

In total, 480 Tabanus nipponicus were caught at Shizunai. Red NG2G traps captured the most (190, 39.6%) followed by black (102, 21.3%) and blue (89, 18.5%) traps. These catch differences were highly significant ($F=20.506: \text{df}=4, 70: p<0.0001$). At Chitose, 133 H. olsoi were caught; the blue traps captured the largest number of flies (69, 51.9%) followed by red (33, 24.8%) and black (26, 19.5%) traps. These results were also highly significant ($F=16.996: \text{df}=4, 45: p<0.0001$). The number of H. iyoensis caught was 4,070; most of the insects again were caught in black (1,348, 33.1%), blue (1,326, 32.6%) and red (1,196, 29.4%) traps and a few were captured in other color traps. These results were highly significant ($F=27.857: \text{df}=4, 45: p<0.0001$). Finally, 4,720 H. tristis were caught at Kiyosato, with the largest number of individuals being captured in blue traps (1,384, 29.3%) followed by red (1,281, 27.1%) and white (1,241, 26.3%) traps. These results were highly significant ($F=9.162: \text{df}=4, 45: p<0.0001$) (Tables 1 and 2).

From the results of the multiple-comparison tests, tabanid flies were caught in small numbers by the yellow trap (Table 3). White traps also showed
poor catches for all genera except *Haematopota*. Blue, black and red traps generally performed well for all tabanids, with significant differences among species in their exact level of performance (Fig. 4).

### DISCUSSION

The results from this study in Japan are similar to the many North American studies reporting that

---

**Table 1.** The numbers and indices of tabanid flies caught by five colored NG2G traps

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>T. nipponicus</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shizunai Black</td>
<td>24</td>
<td>78</td>
<td>102 (6.173)</td>
<td>26</td>
<td>5.193</td>
<td>1,348 (7.918)</td>
</tr>
<tr>
<td>Shizunai Blue</td>
<td>34</td>
<td>55</td>
<td>89 (5.267)</td>
<td>69</td>
<td>8.667</td>
<td>1,326 (7.427)</td>
</tr>
<tr>
<td>Shizunai Red</td>
<td>79</td>
<td>111</td>
<td>190 (13.172)</td>
<td>33</td>
<td>7.061</td>
<td>1,196 (5.880)</td>
</tr>
<tr>
<td>Shizunai White</td>
<td>31</td>
<td>33</td>
<td>64 (5.009)</td>
<td>3</td>
<td>0.833</td>
<td>165 (0.673)</td>
</tr>
<tr>
<td>Shizunai Yellow</td>
<td>15</td>
<td>20</td>
<td>35 (1.298)</td>
<td>2</td>
<td>0.500</td>
<td>35 (0.121)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>183</td>
<td>297</td>
<td>480</td>
<td>133</td>
<td>4,070</td>
<td>4,720</td>
</tr>
</tbody>
</table>

( ) : indices.

**Table 2.** ANOVA tables for colors of catching tabanid flies

<table>
<thead>
<tr>
<th>Species</th>
<th>df</th>
<th>S.S.</th>
<th>M.S.</th>
<th>F-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>T. nipponicus</strong></td>
<td>4</td>
<td>5.857</td>
<td>1.464</td>
<td>20.506</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>4.999</td>
<td>0.071</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>H. olsoi</strong></td>
<td>4</td>
<td>5.383</td>
<td>1.346</td>
<td>16.996</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>3.563</td>
<td>0.079</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>H. iyoensis</strong></td>
<td>4</td>
<td>5.592</td>
<td>1.398</td>
<td>27.857</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>3.258</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>H. tristis</strong></td>
<td>4</td>
<td>3.102</td>
<td>0.775</td>
<td>9.162</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>3.809</td>
<td>0.085</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Model II estimate component variances are 0.093, 0.127, 0.135 and 0.069, respectively.
tabanid flies have been more attracted to dark rather than light objects (Granger, 1970; Roberts, 1970) and animals (Thompson and Pechuman, 1970).

Host seeking tabanid flies are typically attracted to blue, red and black (Bracken et al., 1962; Granger, 1970); yellow and white are much less attractive (Allan and Stoffolano, Jr., 1986a). Some species are attracted to white (Tashiro and Schwardt, 1953; Browne and Bennett, 1980), similar to the results for *H. tristis*, however, those North American species are not closely related to Japanese *H. tristis*.

From the spectral reflectance data (Fig. 2), black and blue were similar except for the small peak of reflectance in the blue region at 450 nm; black and red were similar, but not identical below 570 nm. Red-absorbing visual pigment has never been documented in tabanids, and is not considered to be present. Thus, red would have appeared dark gray or black to the flies. Hanec and Bracken (1962) reported that adult tabanid flies were photopositive to light between 380 and 430 nm and between 500 and 550 nm. The tabanid retina has peaks of sensitivity in the blue and ultraviolet region (Allan et al., 1991). Tabanid flies also react to ultraviolet features in traps (Hribar and Foil, 1994) as well as to polarized light (Bernard, 1971), and hence it is difficult to test for pure color responses using commercially-available fabrics that differ in many subtle features not evident to the human eye.

Contrast is an extremely important factor in the visual attraction of tabanid flies to objects (Allan and Stoffolano, Jr., 1986b). Hailman (1979) reported that a dark, saturated blue would provide the maximum contrast against a background of grass. The background color of the trap sites was mainly green owing to the leaves of grasses and trees (peak at about 550 nm). Hence, in simple experiments such as the ones conducted here, blue, black and red would be expected to produce grossly similar results based on the reaction of flies to dark objects. Because the contrast against a background is important, these may be shown more clearly in fine weather. With more sophisticated experiments (Allan and Stoffolano, Jr., 1986b), it should be possible to show that tabanid flies are able to discriminate the color blue, independent of contrast.

### Table 3. Five colors comparing catches of four species of tabanid flies using the indices

<table>
<thead>
<tr>
<th>Species</th>
<th>M.D.</th>
<th>C.D.</th>
<th>p-value</th>
<th>M.D.</th>
<th>C.D.</th>
<th>p-value</th>
<th>M.D.</th>
<th>C.D.</th>
<th>p-value</th>
<th>M.D.</th>
<th>C.D.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H. tristis</td>
<td>0.108</td>
<td>0.236</td>
<td>&lt;0.001</td>
<td>0.195</td>
<td>0.253</td>
<td>&lt;0.001</td>
<td>0.195</td>
<td>0.253</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. olsoi</td>
<td>0.049</td>
<td>0.202</td>
<td>0.0017</td>
<td>0.195</td>
<td>0.253</td>
<td>&lt;0.001</td>
<td>0.195</td>
<td>0.253</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. iyoensis</td>
<td>0.049</td>
<td>0.202</td>
<td>0.0017</td>
<td>0.195</td>
<td>0.253</td>
<td>&lt;0.001</td>
<td>0.195</td>
<td>0.253</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T. nipponicus</td>
<td>0.369</td>
<td>0.253</td>
<td>&lt;0.001</td>
<td>0.195</td>
<td>0.253</td>
<td>&lt;0.001</td>
<td>0.195</td>
<td>0.253</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Black vs. Blue**: 0.37 < 0.001, 0.195 < 0.001, 0.0017 < 0.001, 0.017 < 0.001
- **Black vs. Red**: 0.47 < 0.001, 0.195 < 0.001, 0.0017 < 0.001, 0.017 < 0.001
- **Black vs. White**: 0.125 < 0.001, 0.202 < 0.001, 0.033 < 0.001, 0.055 < 0.001
- **Black vs. Yellow**: 0.354 < 0.001, 0.202 < 0.001, 0.033 < 0.001, 0.055 < 0.001

- **Blue vs. Red**: 0.58 < 0.001, 0.195 < 0.001, 0.0017 < 0.001, 0.017 < 0.001
- **Blue vs. White**: 0.02 < 0.001, 0.202 < 0.001, 0.033 < 0.001, 0.055 < 0.001
- **Blue vs. Yellow**: 0.26 < 0.001, 0.195 < 0.001, 0.0017 < 0.001, 0.017 < 0.001

- **Red vs. White**: 0.61 < 0.001, 0.202 < 0.001, 0.033 < 0.001, 0.055 < 0.001
- **Red vs. Yellow**: 0.85 < 0.001, 0.202 < 0.001, 0.033 < 0.001, 0.055 < 0.001
- **White vs. Yellow**: 0.82 < 0.001, 0.202 < 0.001, 0.033 < 0.001, 0.055 < 0.001
ACKNOWLEDGEMENTS

The author would like to express his sincere thanks to Dr. Steve Mihok for his kind advice and reading of the manuscript.

REFERENCES


