Tabanus iyoensis (Diptera: Tabanidae) avoid white and pattern like zebra stripe traps in comparison with black one on the field studies

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Abstract: The role of zebra stripes has so far been described in four categories: camouflage and visual disturbance, reduced body temperature rise, social function, and avoidance of blood-sucking insects. Although there are various studies that prove this, a few are from the viewpoint of entomology. Therefore, we verified whether zebra stripes would avoid blood-sucking flies by trapping method at Toga, Toyama, Japan, using the Nzi trap (with attractant) made black, white and zebra-patterned cotton cloth. As a result, the zebra-striped Nzi traps and white ones could not significantly (p<0.01) attract and capture Tabanus iyoensis than the black ones, and significant difference between the zebra-striped and white ones were not recognized (p>0.05).

Key words: Tabanus iyoensis, zebra stripe, white trap, Nzi trap, avoidance, Japan

Introduction

Tabanid flies are a group of the most serious pest insects having blood sucking behavior causing transmission of many diseases to human being and domestic animals in the world (Foil, 1989; Mullen, 2002). Thus, so many studies on the control of this fly have been conducted and proposed many methods by many scientists (e.g. Anderson, 1985; Sasaki, 2016). Among those methods, reduction of the number of flies that attacking to human being and domestic animal by trapping is one of the valuable one. On the other hand, painting the object with color and pattern that have repellent effect to the fly is also considered to be the possible control methods (Kojima et al., 2019). Additionally, wearing the clothes with such color and pattern is considerable good method to avoid the flies attacking (Kondo et al., 1997; Caro et al., 2019).

Zebras have a bold black and white striped pattern on their body surface and the function of the stripes has been a source of scientific interest for over 150 years (e.g. Wallace, 1867; Darwin, 1889). The function of zebras’ stripe is hypothesized four categories: a cryptic form probably matching a woodland background and disrupting predatory attack, reducing thermal load, having a social function and avoiding biting fly attack (e.g. Cloudsley-Thompson, 1984; Kingdon, 1984; Mcleod, 1987; Morris, 1990; Louw, 1993; Ruxton, 2002; Ljetoff et al., 2007; Stevens and Merilaita, 2009; Caro et al., 2014; How and Zanker, 2014; Larison et al., 2015; Ireland and Ruxton, 2017). Recently, the disrupting predatory attack theory is negated (Melin et al., 2016) and the reducing thermal load theory is also negated by Horváth et al., (2018). On the other hand, the theory of avoiding biting fly attack is strongly supported by Caro et al. (2019) and Kojima et al. (2019).

Tabanus iyoensis Shiraki, 1919 is one of the most serious pest fly especially at Hokuriku area of Honshu in Japan (Watanabe, 2000), as it emerges so many individuals at once and its female has strong blood sucking desire to human being. Damage caused by this fly is, for example, all people of one village had to relinquish their houses during summer season and finally had relocated to a town at the foot of original area (Endo, 1973). Obstruction by attacking with blood sucking to people who enjoy their outdoor activities at the camping is also serious.

We conducted a survey to compare the capture abilities of three Nzi traps made of black, white and zebra stripe pattern cotton cloths at the riverside of Momose River in Toga, Nanto city, Toyama Prefecture in 2019 to determine the repellent effect of zebra stripe pattern against T. iyoensis.
city, Toyama Prefecture during from August 4 to 6 in 2019. In this survey, three Nzi traps (Mihok, 2002; Sasaki, 2016): black, white and zebra stripe patterned were used together with 1-okten-3-ol (Octenol) kept in a plastic bag soused 3 mL in a piece of cotton and released through originally poured micro fine holes of the bag as a subsequent chemical attractant. The fabric used as the Zebra stripe pattern is Black and White Zebra Stripe, Sevenberry (Sojitz Fashion Co. Ltd. Tokyo). The traps were set straightly about 15 m distance each other left along the river for two hours (Hayes, 1993). Each trap was set at every 3 positions at one trial and the trial was repeated three times in this survey i.e., each trap was set totally 9 times (Fig. 1). After 2 hours of setting, flies captured by each trap were collected then traps were set again at the three position changed in order. Weather conditions at start time of each trial were measured beside the trap set at center position by Climomaster Model 6511, Kanomax Japan, Inc. Osaka. Captured flies were transported to the laboratory and identified into the species under the binocular microscope (Olympus SZ60) and recorded the numbers. The captured numbers of each trap were compared with Steel-Dwass’s test (Genome Information Research Center, Osaka University).

**Results**

Weather of each trial was fine or nearly fine and the conditions were good for the fly’s activity (Table 1). The air temperatures at start time, varied from 5:20 a.m. to 16:20 p.m. were 20.7 to 32.1°C, and showed the tendency that morning and evening were low and day time was high. On the other hand, related humidity was 50.6 to 87.3%, and showed the tendency that morning and evening were high and day time was low. Wind velocity of each time was quite weak.

Six *Tabanus* species, namely *T. iyoensis* Shiraki, *T. rufidens* (Bigot), *T. nipponicus* Murdoch et Takahasi, *T. sapporoensis* Shiraki, *T. kinoshitai* Kono et Takahasi and *T. mandarinus* Coquillet, were captured in this survey (Table 2). Among them, almost all was *T. iyoensis*, and was captured 1,094 individuals and reached 91.9%.

| Species / Trap       | Black | White | Zebra | Total |
|----------------------|-------|-------|-------|-------|
| *Tabanus iyoensis*   | 1025  | 30    | 39    | 1094  |
| *T. rufidens*        | 72    | 3     | 0     | 75    |
| *T. nipponicus*      | 8     | 0     | 0     | 8     |
| *T. sapporoensis*    | 6     | 1     | 1     | 8     |
| *T. kinoshitai*      | 2     | 0     | 0     | 2     |
| *T. mandarinus*      | 4     | 0     | 0     | 4     |

Total 1117 34 40 1191

The traps were repeated three times.

| Trap | Mean±S.E.          |
|------|--------------------|
| Black| 113.89±33.94a      |
| White| 3.33±0.53b        |
| Zebra| 4.33±0.97b        |

Differences of alphabetical letters mean statistically significances (Steel–Dwass’s test, p<0.01)

Tabanid flies were captured 1,117 individuals (93.8%) by black, 34 individuals (2.9%) by white and 40 individuals (3.4%) by zebra stripe pattern which were settled with the Nzi traps. Among them, *T. iyoensis* was captured 1,025 individuals (93.7%) by the black, 30 individuals (2.7%) by the white and 39 individuals (3.6%) by the zebra stripe pattern. Black Nzi trap captured *T. iyoensis* 113.89 individuals (range 6-277, S.E. 33.94) per one trial. White and zebra stripe patterned Nzi traps captured 3.33 (range 2-7, S.E. 0.53) and 4.33 (range 1-8, S.E. 0.97) individuals per a trial respectively (Table 3). Between the mean captured number of *T. iyoensis* by black Nzi trap and both white and zebra stripe patterned ones were showed significantly difference (p<0.01) by Steel–Dwass’s test. No significant difference (p>0.05) was shown among the captured number of *T. iyoensis* by white and zebra stripe pattern.

![Figure 1. Surveyed site, Riverside of Momose River, Toga, Toyama.](image)
We captured nearly almost all (93.7%) individuals of *T. iyoensis* by the black Nzi trap in this survey. In the previous work, one of the authors explained that Japanese cleg, *Haematopota tristis*, Bigot that is attracted to white target was exceptional case (Sasaki, 2001) like North American tabanid flies described by Tashiro and Schwartd (1953), and Browne and Bennett (1980). Typically, many tabanid flies including *T. iyoensis* were attracted to black and blue traps strongly (Sasaki, 2001) in the same location.

From the results of this survey, we have confirmed the former descriptions (Bracken et al., 1962; Granger, 1970; Allan and Stoffolano, 1986; Sasaki, 2001) that explained that tabanid flies are usually attracted to black, blue and red targets, whereas not attracted by white and yellow ones. However, Caro et al. (2019) described that no significant differences in the rates at which tabanids circled and touched zebra patterns or horses in UK. The tabanid flies that they observed were *Haematopota pluvialis* (L.) and *Tabanus bromius* Walker, both common European species, but some doubts are remained whether the color preference of the two tabanids are same or different. Therefore, we want to point out that data should be needed on respective species.

We obtained the result that white Nzi trap captured few individuals of *T. iyoensis* same as zebra-stripe patterned Nzi trap. This showed that *T. iyoensis* avoid both white and zebra stripe patterned Nzi traps similarly. Britten et al. (2016) pointed out that flies avoid zebra stripe by reflecting light, therefore, our results may be caused such flies’ behavior. Thus, we should determine the difference of quality of avoidance in attack to zebra stripe patterned and white of another biting fly species in the next survey.

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