Research Note

LEG COLOR VARIATION OF FEMALE *SIMULIUM AOKII* (DIPTERA: SIMULIIDAE)

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Abstract: Color variations of legs (in particular hind femora and tibiae) were observed in female *Simulium aokii* (Takahasi, 1941) caught monthly at cattle shed in Oita, southwest Japan. Female flies were collected from November to April but not during warm and hot months (May to October). Female flies with legs darker than normal began to appear in the mid autumn (November) and increased in relative abundance up to the mid winter (January), and then decreased gradually until the mid spring (April). The intensity of darkness on both hind femora and tibiae varied similarly, with the darkest in January. During these cool or cold months, there was a positive correlation between the relative size of dark area on the tibia and the wing length. From these results the species status of *S. aokii* was discussed in relation to *S. oitanum* originally described from Oita.

INTRODUCTION

Coloration of adult blackflies is usually stable and is used as a character for species identification. There have been only a few reports on the color variations of adult simuliids (Garms, 1978; Garms *et al.*, 1982).

When working on the transmission of bovine *Onchocerca* spp. in Oita, Kyushu, Japan, we collected females of *Simulium aokii*, of which legs were darker to varying extent than those originally described (Takahasi, 1941). This is one of the common blackfly species in Oita, is abundant from autumn to spring (Takaoka, 1994) and is known as a potential vector of bovine *Onchocerca* sp. in Oita (Takaoka and Bain, 1990).

We examined whether the occurrence of the female *S. aokii* with darker legs is related to the cold months and also to the fly's body size.

The taxonomic status of *S. aokii* was also discussed in relation to *S. oitanum* described from Oita (Shiraki, 1935) which had been long thought, by some taxonomists, to be a senior synonym of the former species.

MATERIALS AND METHODS

The study was conducted at Imanaga cattle shed in the western part of Oita City, Oita Prefecture. The detailed information on the cattle shed, its locality and

environment were already given in Takaoka (1994). The collections were made twice per month from February 1993 to April 1995. The time used for one collection was 1-3 hrs in the afternoon (15:00-18:00 hr). Female flies landing or resting on the inside surface of glass windows of the cattle shed were collected by an aspirator, and preserved in 80% ethanol. After identification to species using the keys of Takaoka (1977), the wings of all *S. aokii* females were individually measured under dissecting microscope. The wing length was represented by the distance from arculus to the wing tip. The values were used as an index of body size. The coloration of hind femora and tibiae of each fly was recorded, and depending on the relative length of dark area(s) against the total length of segment, the flies were divided into four types (Fig. 1): for tibiae, 20-40% darkness to type I, 41-60% to type II, 61-80% to type III, 81-100% to type IV; for femora, 20-35% to type I, 36-50% to type II, 51-65% to type III and 66-80% to type IV.

RESULTS

The results of collections are presented in Table 1. Female *S. aokii* were collected from November to April but not from May to October. Fig. 2 shows the frequency distribution of four types of flies based on the

Figure 1 Color variations of hind femora and tibiae of female *Simulium aokii*. Numbers show type of color depending on the darkness. F and T mean femora and tibiae, respectively.

Table 1 Results of monthly collections of female *Simulium aokii* at Imanaga cattle shed in Oita city, Japan. Data obtained in 1993–1995 were combined.

Month	No. collections	No. flies caught	Air temp. (°C)
Jan.	4	19	6–10
Feb.	4	110	9–12
Mar.	4	63	12–14
Apr.	4	7	15–19
May	2	0	18–21
Jun.	2	0	22–28
Jul.	2	0	25–30
Aug.	2	0	28–33
Sep.	4	0	20–26
Oct.	4	0	17–22
Nov.	4	29	16–19
Dec.	4	22	6–11

coloration of the hind tibiae. It was clearly shown that the females with darker tibiae (types II–IV together) increased in relative abundance from November to January and then decreased until April, occupying 70–100% of the total catches during the winter months (December to March). The females with type III tibiae were the most abundant in January, February and March. The frequency distribution of four types based on the coloration of the femora showed a similar pattern (Fig. 3).

The coloration of tibiae had a significant positive correlation with the wing length ($Y = 2.62 + 0.0087X$; X : % darkness of tibia, Y : wing length; $r = 0.73$, $df = 248$, $P < 0.01$).

The average wing length (mm) was 2.95 ± 0.11 for type I ($n = 50$), 3.03 ± 0.10 for type II ($n = 63$), 3.24 ± 0.17 for type III ($n = 107$), and 3.39 ± 0.16 for type IV ($n = 29$).

Figure 2 Frequency distribution of four types of female *Simulium aokii* based on tibial coloration.

Figure 3 Frequency distribution of four types of female *Simulium aokii* based on femoral coloration.

DISCUSSION

It was found that the leg color variation of *S. aokii* in Oita was seasonal; flies with darker legs dominantly occurred in mid winter but rarely in autumn and spring.

In our observations, the leg color variation was also found to be related to the wing length (then, body size). The leg coloration became darker as the wing length became longer. It might be attributed to the sufficient nutrition during the prolonged larval development under low water temperatures, although it is not known why excess melanin is produced only in the larger adult flies.

Our results suggested that variations found in the leg coloring of female *S. aokii* were probably intraspecific, because of their continuous changes although flies were roughly classified into four types dependent on the coloration. The possibility that our material was composed of two or more species with different leg colors would be low, since no siblings were

detected so far in the populations of *S. aokii* in Oita according to our cytotaxonomic study of larval polytene chromosomes (Hadi *et al.*, 1996).

According to the original description (Takahasi, 1941) *S. aokii* was distinguished from *S. oitanum* in the female by the pale mid and hind femora. As shown in the present study, the females of *S. aokii* grouped into type III and IV for femora were indistinguishable from those of *S. oitanum*. This may support the claim that *S. aokii* and *S. oitanum* are the same species. However we hesitate to make such a conclusion. It is because there is a discrepancy in seasonal occurrence between these two species. It was in August that type female specimens of *S. oitanum* were collected (Shiraki, 1935) when adult *S. aokii* were almost nil in Oita (Takaoka, 1994). If the collection date given by Shiraki was not erroneously noted the two species will be regarded to be distinct from each other. At present, type specimens of *S. oitanum* can not be located, and no additional new specimen is available in Oita for comparative studies.

REFERENCES

- 1) Garms, R. (1978): Use of morphological characters in the study of *Simulium damnosum* s.l. populations in West Africa, *Tropenmed. Parasit.*, 29, 483-491
- 2) Garms, R., R.A. Cheke, C.G. Vajime and S. Sowah (1982): The occurrence and movements of different members of the *Simulium damnosum* complex in Togo and Benin, *Zeitschrift fur Angewandte Zoologie*, 69, 219-236
- 3) Hadi, U.K., H. Takaoka, and C. Aoki (1996): Larval polytene chromosomes of three Japanese blackfly species (Diptera: Simuliidae), *Med. Entomol. Zool.*, 47, 47-54
- 4) Shiraki, T. (1935): Simuliidae of the Japanese Empire, *Memoirs of the Faculty of Science and Agriculture Taihoku Imperial University*, 16, 1-90
- 5) Takahasi, H. (1941): Description of a new species of Simuliidae from Nippon, with other notes, *Ins. Mats.*, 15, 86-88
- 6) Takaoka, H. (1977): Studies on black flies of the Nansei Islands, Japan. IV. Keys to females, males, pupae and larvae of all the 18 species of the genus *Simulium* of the Nansei Islands, *Jpn. J. Sanit. Zool.*, 28, 219-224
- 7) Takaoka, H. (1994): Natural vectors of three bovine *Onchocerca* species (Nematoda: Onchocercidae) and seasonal transmission by three blackfly species (Diptera: Simuliidae) in central Kyushu, Japan, *J. Med. Entomol.*, 31, 404-416
- 8) Takaoka, H. and O. Bain (1990): Infections of blackflies (Diptera: Simuliidae) with three types of zoonotic *Onchocerca* larvae in Oita, Japan, *Jpn. J. Trop. Med. Hyg.*, 18, 1-10