

Studies on the Relation between Blood Sources and the Shape of Fore Tarsal Claw of the Female Black Flies in Hokkaido (Diptera: Simuliidae)

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Introduction

The shape of fore tarsal claws of female black flies are well known as one of the useful characters not only to identify the species³⁾ but also to know their blood sucking behaviour and blood sources⁴⁾. In the serological studies on the blood source of black flies in Hokkaido⁶⁾, we observed the shapes and the structures of the fore tarsal claws of female black flies in order to know the role in preference of the blood sources. Therefore, we examined the fore tarsal claws of 27 species of adult female black flies collected in Hokkaido by means of a scanning electron microscope (SEM). The results were compared with their known blood sources and reported in this paper.

Materials and Methods

In Hokkaido, 31 simuliids species⁶⁾ belonging to 13 genera including two undescribed species have been known up to present. Of these 27 species of 12 genera were examined in this study (Table 1).

The black fly specimens preserved in 70 percent ethanol were refixed with 2-ethoxyethanol for two days, then with xylene for three hours individually as described by Sabrosky⁵⁾.

Refixed specimens were dried on a sheet of filter paper in an open space for two hrs and their legs were arranged for the purpose of thorough observation by SEM then they were additionally dried with diphosphorus pentoxide and activated carbon in a desiccator for one week. The dried specimens were mounted on specimen stubs with a conductive adhesive and

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Table 1. List of black flies of Hokkaido

<i>Twinnia canivora</i>	<i>Cnetha rebunense*</i>
<i>T. subtibbelesi*</i>	<i>C. acmerium</i>
<i>Helodon multicaulis</i>	<i>C. konoii</i>
<i>Distosimulium daisetsense</i>	<i>C. sp.</i>
<i>Prosimulium jezonicum</i>	<i>Boophthora yonagoense makunbei</i>
<i>P. yezoense</i>	<i>Gnus daisense</i>
<i>P. karibaense*</i>	<i>G. fulvipes*</i>
<i>P. sarurensis</i>	<i>Odagmia aokii</i>
<i>P. apoinum</i>	<i>O. nishijimai</i>
<i>P. sp.</i>	<i>Simulium japonicum</i>
<i>Stegopterna nukabirana</i>	<i>S. arakawae*</i>
<i>Eusimulium erimoense</i>	<i>S. horokaense</i>
<i>Montisimulium sakhalinum</i>	<i>S. nikkoense</i>
<i>Gomphostilbia shogakii*</i>	<i>S. rufibasis</i>
<i>Cnetha subcostatum</i>	<i>S. suzukii</i>
<i>C. boldstentum</i>	<i>S. tobetsuense</i>
<i>C. uchidai</i>	

*: Not examined their fore tarsal claws in this study

incubated in a high vacuum chamber (ic. 10^{-6} torr.) for 6 hrs. The dried specimens were then sputter-coated with gold for 20 min (4 times of 5 min each). After coating, the fore tarsal claws of each species were observed and photographed with a scanning electron microscope (JEOL, JSM-T200), using an accelerating voltage of 10 kV.

Results and Discussion

The fore tarsal claws of female black flies examined were classified into three types according to their shapes and presence of basal tooth (Fig. 1). Of these, S-type claw is simple and has no tooth on the base of claw, and the carinulae of the claw formed longitudinal lines (Fig. 2). The P-type claw is a simple but with a small peg-like tooth on the base of claw, and the carinulae of the claw formed longitudinal lines (Fig. 3). A T-type claw has a strong and well developed tooth on the base of the claw, and the transversal sulcus on both claw and tooth are deep and centripetally located (Fig. 4).

Of these species, *Stegopterna nukabirana* was determined to bite the wild brown bear and human at the Onnebetsu-Dake wilderness area in the Shiretoko National Park by means of ELISA method[®], and *Prosimulium jezonicum*, *P. yezoense* and *Simulium suzukii* are determined to have biting

behaviours that include human, horse and cattle³⁾. The two species, *Boophtora yonagoense* and *Prosimulium* sp. have been unknown as to their blood sources, but the shapes of the fore tarsal claw suggest that their blood sources are mammals (Table 2).

The species estimated to have both mammalophilic and ornithophilic type biting behaviour all had P-type fore tarsal claws except *S. japonicum*

Table 2. Claw types and blood sources of the female of black flies from Hokkaido

Species	claw	blood source	group
<i>Twinnia canivora</i>	P	human*	B
<i>Helodon multicaulis</i>	T		O
<i>Distosimulium daisetsense</i>	P	human*, sika deer*, birds*	B
<i>Prosimulium japonicum</i>	S	human*, horse, cattle	M
<i>P. yezoense</i>	S	human, horse, cattle	M
<i>P. sarurensis</i>	T		O
<i>P. apoinum</i>	S	human	M
<i>P. sp.</i>	S		M
<i>Stegopterna nukabirana</i>	S	human*, wild brown bear*	M
<i>Eusimulium erimoense</i>	T		O
<i>Montisimulium sakhalinum</i>	T		O
<i>Cnetha subcostatum</i>	P	human*	B
<i>C. boldstemtum</i>	T		O
<i>C. uchidai</i>	T	sika deer*	O
<i>C. acmerium</i>	T		O
<i>C. konoii</i>	T		O
<i>C. sp.</i>	S		M
<i>Boophtora yonagoense</i>	S		M
<i>Gnus daisense</i>	P	goat	B
<i>Odagnia aokii</i>	P		B
<i>O. nishijimai</i>	S	human	M
<i>Simulium japonicum</i>	S	human*, horse, cattle, chicken, sika deer*	B
<i>S. horokaense</i>	S	human	M
<i>S. nikkoense</i>	S	horse, cattle	M
<i>S. rufibasis</i>	S	human, horse, cattle, goat, Bedford's red-backed vole*	M
<i>S. suzukii</i>	S	human*, horse, cattle	M
<i>S. tobetsuense</i>	P		B

T: with strong tooth; S: simple untoothed; P: with small peg-like tooth; O: ornithophilic type; B: broadly ornitho and mammalophilic type; M: mammalophilic type; *: determined by the ELISA method.

which has S-type fore tarsal claw (Table 2). *D. daisetsense* was also determined that its blood sources were human, sika deer and birds by means of ELISA methods⁶, *S. japonicum* is well known for its serious biting behaviour to both human and mammals¹⁾ and also, although less frequently, chicken⁷⁾, despite the results obtained in this study which indicate that it is a both mammalophilic and ornithophilic type blood sucker, the natural blood source of this species may be mammals. The species estimated to have ornithophilic type biting behaviour all have T-type fore tarsal claw and none of them except *Cnetha uchidai* have known blood sources (Table 2). *C. uchidai* collected at the Onnebetsu-Dake was determined to have its blood-meal from sika deer by means of ELISA method⁶, but that blood-meal may due to the continental biting.

The black flies having S-type fore tarsal claw are known to be the mammalophilic type blood sucker¹⁾ and P-type fore tarsal claws are also known to be both mammalophilic and ornithophilic type blood sucker, and the species estimated to have mammalophilic type biting behaviour all have S-type fore tarsal claw, and the results obtained in this study good support Crosskey's conclusion.

All species examined in this study having T-type fore tarsal claw are unknown as to their blood sources in Japan, but European species having T-type fore tarsal claw were concluded to have an ornithophilic type biting behaviour¹⁾. Because of the usual methods to determine the blood sources mainly use various domestic animal baited traps in Japan²⁾, Japanese black flies biting to various avian species are not known as to their blood sucking behaviours and their blood sources remain unknown.

The sulcus of both claw and tooth of the T-type claw were considered to be well developed to enable the black fly to grip the feather-barbs of the host bird and push aside the overlapping feathers to reach the skin of the host bird and these features well suggested that their blood sources are some avian species. Crosskey¹⁾ mentioned only the shape of the claw, but the sulcus and calinuræ are also important for the estimation of black fly blood sources because of their functional features.

According to the results obtained in this study (Table 2), their blood sucking behaviours and the blood sources of black flies will be scrutinized in detail in future studies.

Summary

The fore tarsal claw of 27 species of the female black flies in Hokkaido were examined by means of a scanning electron microscope (SEM) and the black flies were classified into three types, namely S-type, P-type and T-type, according to the shape of the fore tarsal claw and the presence and the

shape of basal tooth.

The black flies were also classified and estimated as to their blood sucking behaviours into three types, namely mammalophilic type, ornithophilic type and mammalophilic and ornithophilic type, according to the classified types of the shape of fore tarsal claw and their known blood sources.

All species estimated to have mammalophilic type blood sucking behaviour are shown to have S-type fore tarsal claws and all species estimated to have ornithophilic type blood sucking behaviour are shown to have T-type ones. Except *Simulium japonicum*, species estimated to have both mammalophilic and ornithophilic type blood sucking behaviour all have P-type fore tarsal claws.

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要 約

北海道に生息するブユのうち、12属27種の雌成虫の前跗節の爪を、走査型電子顕微鏡で観察し、爪の形状の特徴、および基部の歯の存在とその形状などの特徴によって、3つのグループに大別した。

さらに、これらの3グループと既知の吸血源に関する知見との関係を検討した結果、下記のグループに類別できた。

- 哺乳類吸血性 (S-type の爪): *Prosimulium jezonicum*, *P. yezoense*, *P. apoinum*, *P. sp. Stegopterna nukabirana*, *Cnetha* sp. *Boophthora yonagoense*, *Odagmia nishijimai*, *Simulium horokaense*, *S. nikkoense*, *S. rufibasis*, *S. suzukii*
- 鳥類吸血性 (T-type の爪): *Helodon multicaulis*, *Prosimulium sarurense*, *Eusimulium erimoense*, *Montisimulium sakhalinum*, *Cnetha uchidai*, *C. boldstemtum*, *C. acmerium*, *C. konoii*
- 哺乳類, 鳥類吸血性 (主に P-type の爪): *Twinnia canivora*, *Distosimulium daisetsense*, *Simulium japonicum*, *S. tobetsuense*, *Odagmia aokii*, *Gnus daisense*

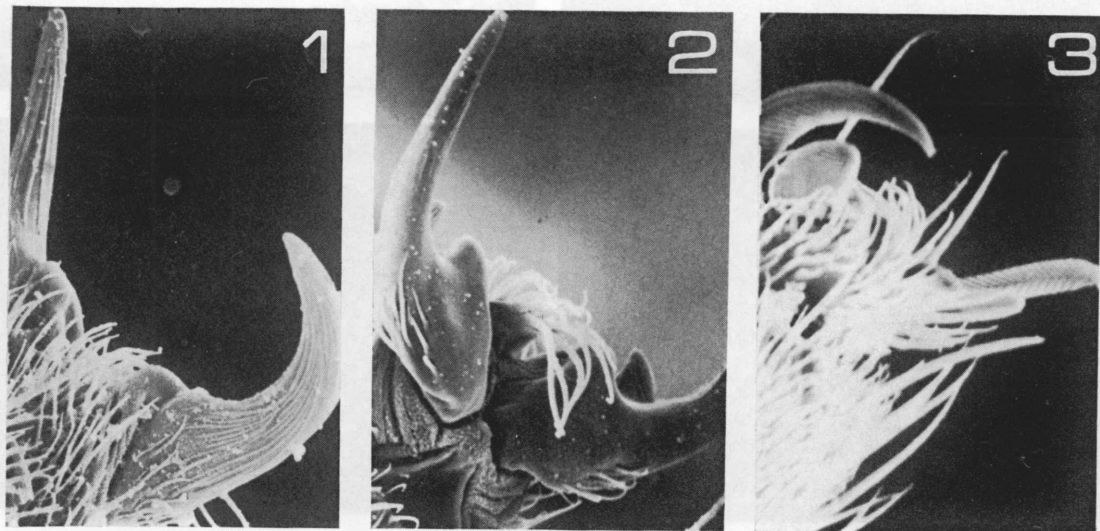


Fig. 1. Various types of fore tarsal claw.
1: S-type; 2: P-type; 3: T-type

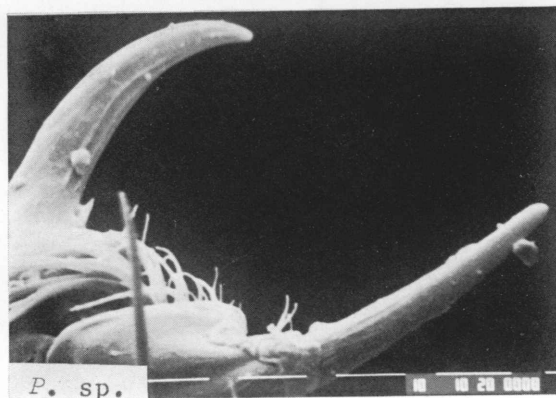
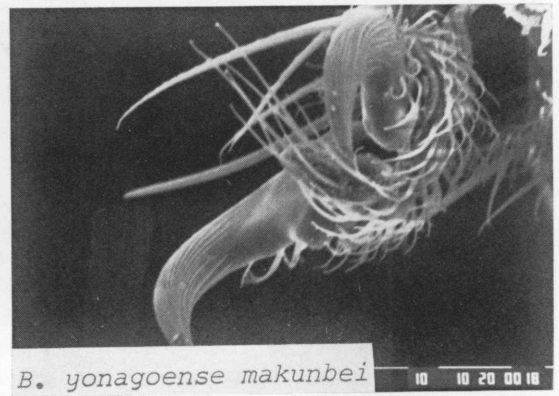
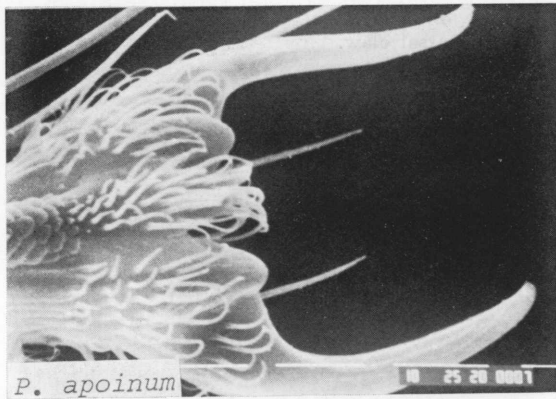
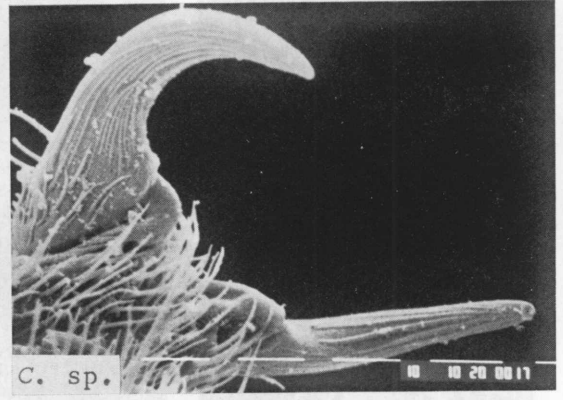
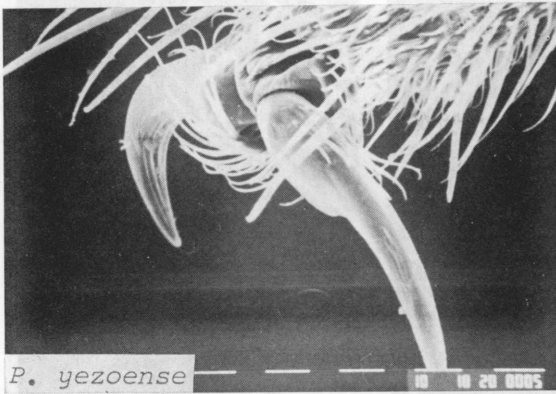
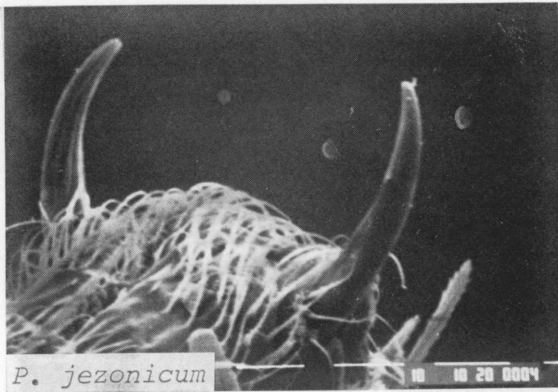


Fig. 2. Fore tarsal claws of S-type black flies. scale bar=10 μ m

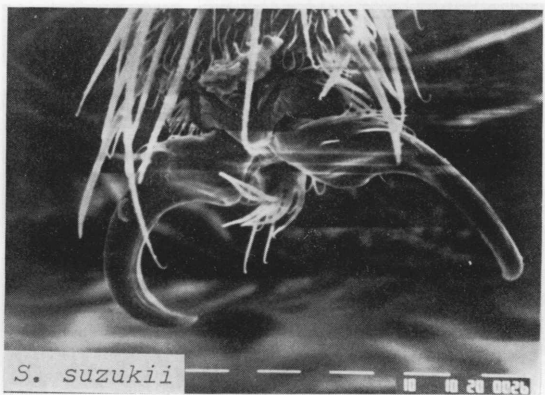
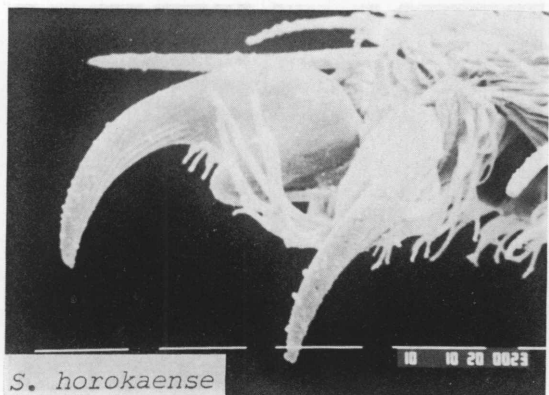
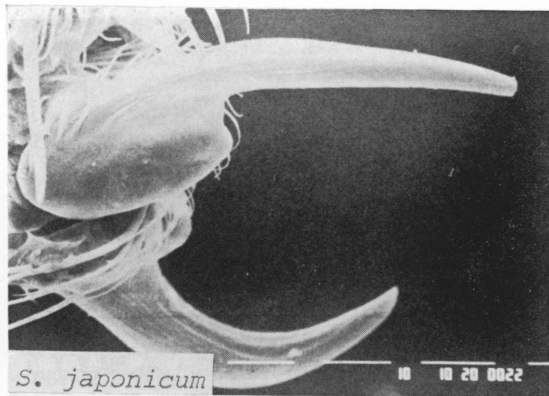
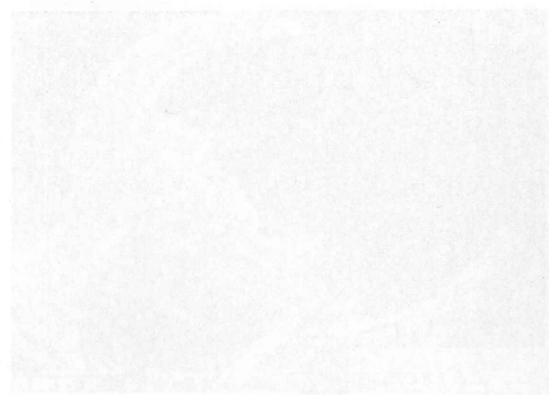
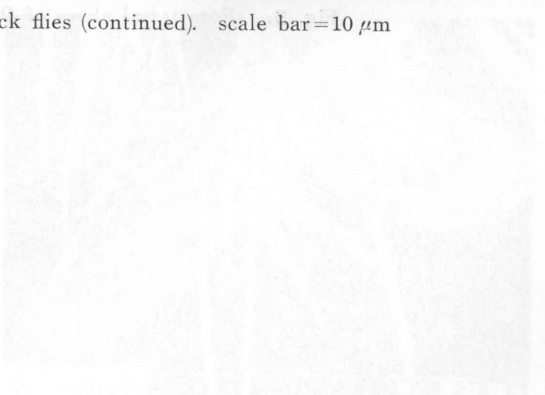
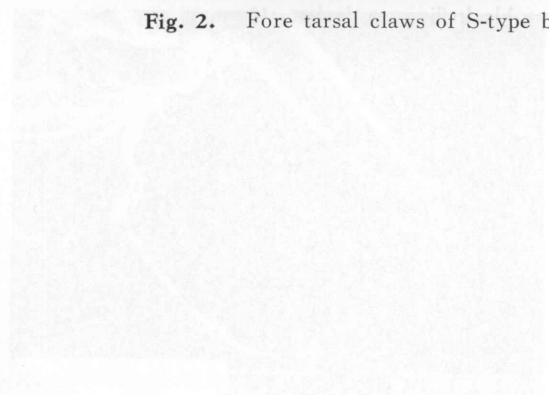


Fig. 2. Fore tarsal claws of S-type black flies (continued). scale bar = 10 μ m



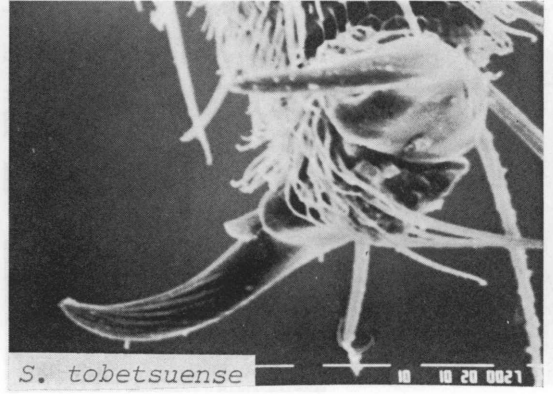
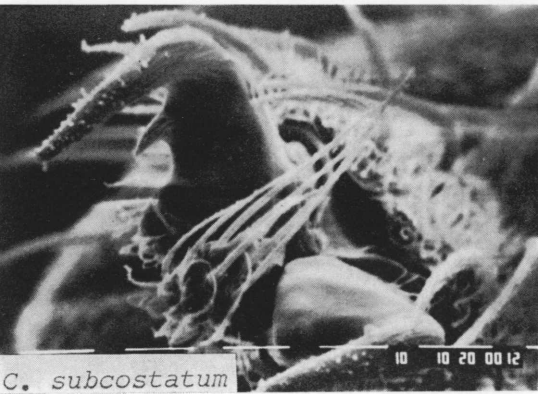
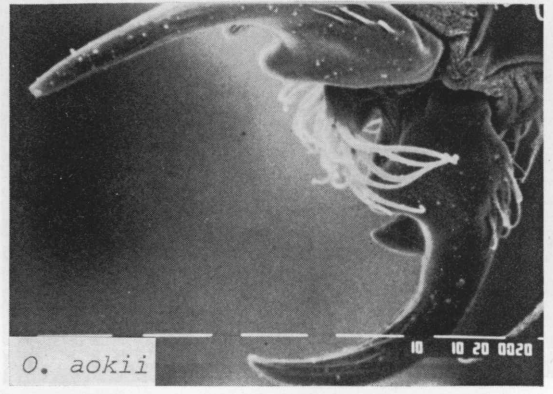
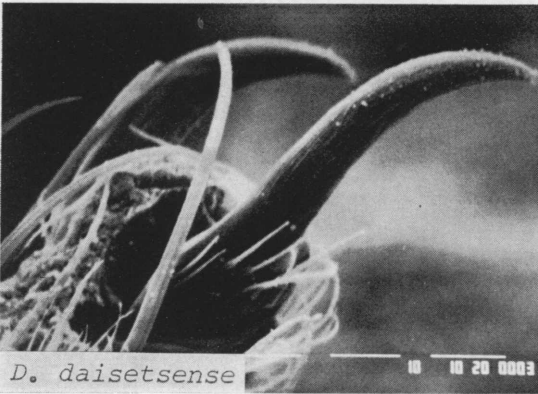
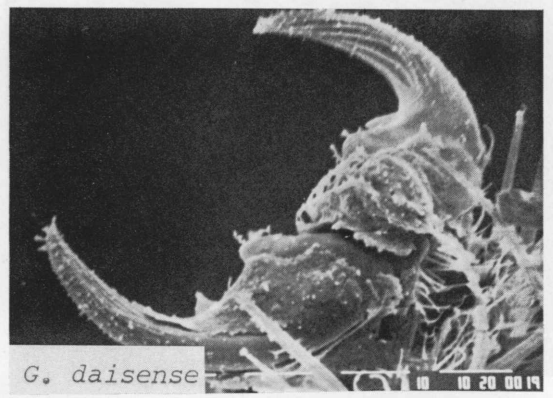


Fig. 3. Fore tarsal claws of P-type black flies. scale bar=10 μ m

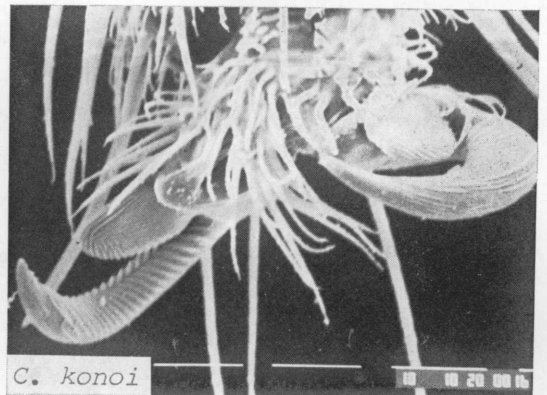
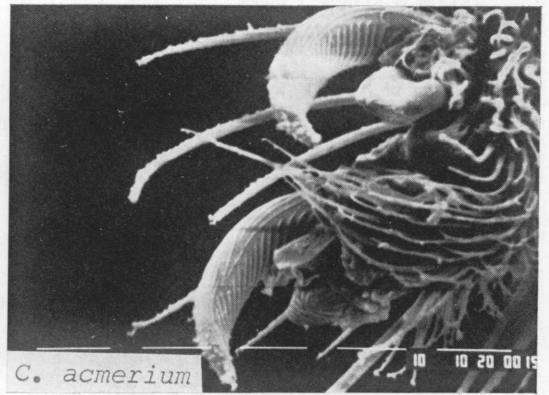
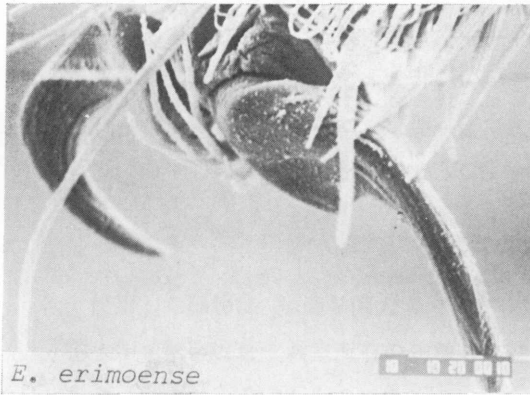
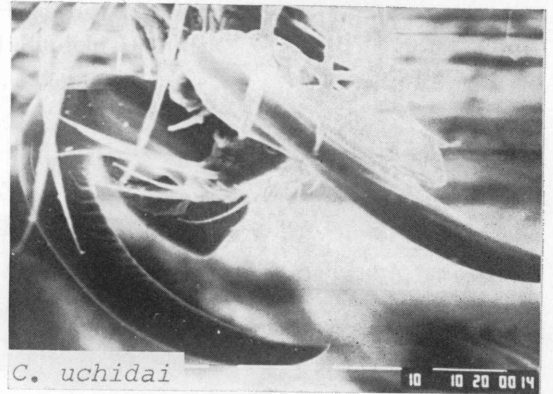
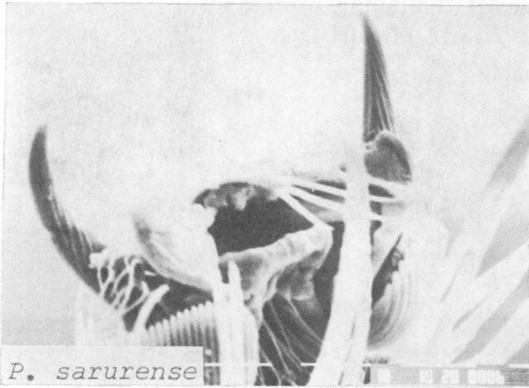
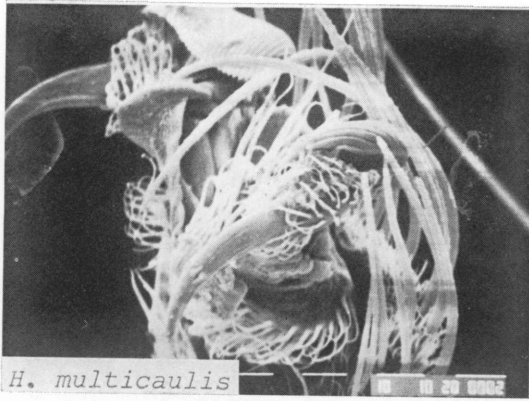


Fig. 4. Fore tarsal claws of T-type black flies. scale bar=10 μ m