

## SHORT COMMUNICATION

### New Host Records of the Ectoparasitic Biting Midge *Forcipomyia (Trichohelea) pectinunguis* (Diptera: Ceratopogonidae) on Adult Geometrid Moths (Lepidoptera: Geometridae)

AKITO Y. KAWAHARA,<sup>1</sup> ISAAC S. WINKLER,<sup>1</sup> AND WAYNE W. HSU<sup>2</sup>

Female biting midges of the subgenera *Microhelea* Kieffer, *Pterobosca* Macfie, and *Trichohelea* Goetghebuer of the genus *Forcipomyia* Meigen feed on the hemolymph of arthropod hosts, as do some species of the closely related genus *Atrichopogon* Kieffer. Arthropod hosts include Opiliones (Lane, 1947), Araneae (Clastrier and Legrand, 1991), Odonata (Macfie, 1932; Wirth, 1956a; Clastrier and Legrand, 1990), Phasmida (Wirth, 1971; Clastrier and Wirth, 1995), Orthoptera (Wirth and Castner, 1990; Perez-Gelabert and Grogan, 1999), Hemiptera (J. Reid, pers. comm. *vide* [Lane, 1977]; Clastrier and Delécolle, 1997), Neuroptera (Tokunaga and Murachi, 1959; Wirth, 1956a, 1966), Megaloptera (Wirth, 1956a), Coleoptera (Wirth, 1956b, 1980), Diptera (Wirth, 1956a), Hymenoptera (Wirth, 1956a), and Lepidoptera (e.g., Wirth, 1956a, 1972; Lane 1977, 1984).

At least four records of *Forcipomyia* species feeding from the wings of Geometridae exist: *F. (Trichohelea) tonnoiri* (Goetghebuer), which was reported from two geometrids, *Ectropis crepuscularia* (Denis and Schiffmüller) and *Alcis bastelbergi* Hirschke (previously *Boarmia repandata* L.) in Switzerland (Edwards, 1925); an unidentified species said to be near *F. (Synthyridomyia) murina* (Winnertz), discovered on the wing of *Perizoma didymata* (L.) in Denmark (Kryger, 1914); and *Forcipomyia (Trichohelea) pectinunguis* (de Meijere) on *Cleora immemorata* (Walker) in New Caledonia (Clastrier and Delécolle, 1991). We report new records for *F. (T.) pectinunguis* on Geometridae and a significant extension of the known geographical range of this ectoparasitic midge. Taxonomy for ectoparasites and hosts follows Borkent and Wirth (1997), and Scoble (1999), respectively.

*Forcipomyia (T.) pectinunguis* is known from the Caroline Islands (Tokunaga, 1940), Mariana Islands (Tokunaga and Murachi, 1959), New Caledonia (Clastrier and Delécolle, 1991), Samoa (Wirth, 1956a), Sumatra (de Meijere, 1923; Macfie, 1934), New Guinea and Australia (Debenham, 1987), and Viti Levu, Fiji (two female specimens examined in the collection of the National Museum of Natural History, Museum Support Center, Suitland, Maryland). Hosts noted in publications are moths in the families Arctiidae, Crambidae, Geometridae, Noctuidae, and Sphingidae. We report *F. (T.) pectinunguis* from Malaysia and Taiwan feeding on seven geometrid species, summarized in Table 1. Four hosts with attached midges are illustrated: *Ourapteryx* sp. (Fig. 1), *Hemithea aquamarina* Hampson (Fig. 2), *Tanaorhinus rafflesii* Moore (Fig. 3), and *Scopula* sp. (Fig. 4).

In total, we recorded twenty females of *F. (T.) pectinunguis* on the forewing dorsal surface of seven individual moths (Table 1). Parasites were collected from hosts attracted to 175-watt mercury vapor lights in Malaysia and Taiwan in August 2004 and 2005. Parasites and their hosts were collected by AYK and WWH. Additional ectoparasitic flies were observed; unfortunately we were unable to collect them. Data for collected specimens are: Taiwan, Nantou County, Shanlinhsi (=Sanlinchi, 23°38'11"N 120°46'50"E), 4-viii-2004; same locality, 15-viii-2005; Malaysia: Pahang, Cameron Highlands (4°29'1"N 101°27'1"E), 10-viii-2004; Kelantan, Route 4 between Gerik and Jeli (5°31'30"N 101°16'30"E), 12-viii-2004. One female fly from Taiwan was slide mounted in Euparal and the remaining specimens currently are stored in 1.5 ml vials containing 100% ethanol. Specimens were compared with the original description (de Meijere, 1923) and with six specimens from Samoa and Fiji. The six specimens are in the Museum Support Center, National Museum of Natural History, Suitland, Maryland; identification was further verified through taxonomic keys in Wirth (1956a) and Debenham (1987). Specimens are deposited in the National Museum of Natural History, Washington, D.C.

Fifteen of the flies were found on forewing vein A1+2, and two were found on the cubitus. Three additional flies were found in the anal cell several millimeters from vein A1+2. These three flies had their heads embedded in the scales, but it is unlikely that they were piercing a vein because of their distance from the vein. All flies were

<sup>1</sup> Department of Entomology, University of Maryland, College Park, Maryland 20742-4454.

<sup>2</sup> Department of Ecology, Evolution, and Environmental Biology, Columbia University, New York, New York 10027-7003.

Table 1. Feeding location and number of *F. pectinunguis* on geometrid wings.

Subfamily	Host species	Locality†	A 1+2‡		Cubitus‡		Anal cell
			L	R	L	R	
Ennominae	<i>Orthocobera sericea</i> Butler*	TN	0	1	0	0	0
	<i>Ourapteryx</i> sp.	TN	1	1	0	0	0
	<i>Ourapteryx</i> sp.	TN	1	0	0	0	0
	<i>Ourapteryx</i> sp.	TN	3	0	0	0	0
	<i>Tanaoctenia haliaria</i> (Walker)	TN	2	0	0	0	0
Geometrinae	<i>Hemitheia aquamarina</i> Hampson	TN	1	1	0	0	0
	<i>Pingasa tapungkanana</i> Strand	MK	1	0	0	0	0
	<i>Tanaorhinus rafflesii</i> Moore	MP	2	0	0	1	2
	<i>Tanaorhinus rafflesii</i> Moore	MP	0	0	0	0	1
Sterrhinae	<i>Scopula</i> sp.	TN	0	1	1	0	0
	Total		11	4	1	1	3

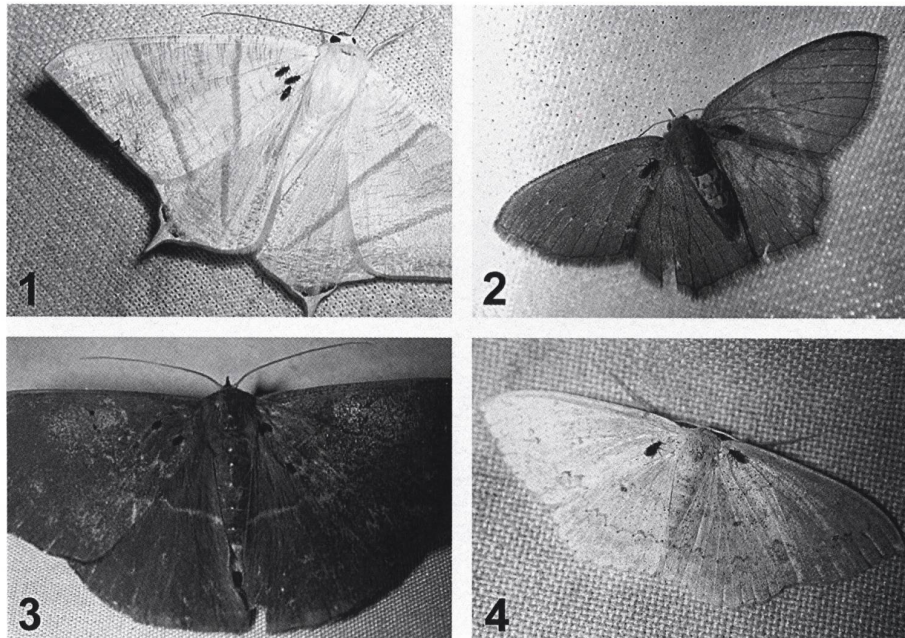
\* = observation made in 2005.

† MK = Malaysia, Kelantan; MP = Malaysia, Pahang; TN = Taiwan, Nantou.

‡ All wing veins refer to the moth forewing, "L" and "R" refer to the left and right wing respectively.

located closer to the moth wing base than the apex. It is possible that flies favor locations closer to the base of the wing because of reduced air resistance when the moths are in flight.

The female tarsal claws of *F. (T.) pectinunguis* are equipped with a distinctive basal spine and comb in the inner margin (see illustration in Clastrier and Delécolle, 1991). The spine and comb are hypothesized to provide added support when clinging to scales on wings of Lepidoptera (Lane, 1977). Although it has not been observed directly, claws are believed to hook under the lateral edge of a scale while the comb interlocks with ridges on the



Figs. 1-4. *Forcipomyia pectinunguis* feeding on wings of adult Geometridae. 1, *Ourapteryx* sp.; 2, *Hemitheia aquamarina*; 3, *Tanaorhinus rafflesii*; 4, *Scopula* sp.

dorsal surface of the scale, and the spine is thought to provide added support for the fly (Lane, 1977). Since all flies observed were found with their heads pointed toward the base of the moth wing, as was also illustrated by Ehrlich (1962) for *F. (T.) baueri* (Wirth), the orientation of the parasite on the host is consistent with this hypothesized mode of attachment. Unfortunately, we were unable to directly confirm this hypothesis. We believe there are many additional species of *Forcipomyia* ectoparasites on Lepidoptera and other arthropods, and we hope entomologists will continue to report additional host records of these flies and examine how these parasites attach themselves to their arthropod hosts.

#### Acknowledgments

We thank Soowon Cho (Chungbuk National University, Korea), William L. Grogan Jr. (Salisbury University, Salisbury, Maryland), Charles Mitter (University of Maryland, College Park) and an anonymous reviewer for providing comments on an earlier draft of the manuscript. We are indebted to Linda Pitkin (The Natural History Museum, London) and several anonymous Taiwanese collectors for assisting with the identification of geometrid species. Hollis B. Williams (NMNH) helped facilitate access to specimens at the Museum Support Center in Suitland, Maryland. Robert Dirig (Cornell University, Ithaca) deserves commendation for his assistance in accessing otherwise unobtainable literature. This project stemmed from a study supported by the National Science Foundation (DEB-0212910) to the Mitter Lab at the University of Maryland.

#### Literature Cited

- Borkent, A., and W. W. Wirth. 1997. World species of biting midges (Diptera: Ceratopogonidae). *Bulletin of the American Museum of Natural History* 233:1–257.
- Clastrier, J., and J.-C. Delécolle. 1991. Diptera Ceratopogonidae de Nouvelle-Calédonie. 8. Genre *Forcipomyia*. In J. Chazeau and S. Tillier (eds.). *Zoologia Neocaledonica*. Vol. 2. Mémoires Muséum national d'Histoire naturelle. Série A. Zoologie 149:177–231.
- Clastrier, J., and J.-C. Delécolle. 1997. Description de *Forcipomyia (Trichohelea) roubaudi* n. sp., ectoparasite de reduve, capture dans la canope de la foret guyanaise (Diptera, Ceratopogonidae; Reduviidae). *Bulletin de la Société Entomologique de France* 102(4):379–383.
- Clastrier, J., and J. Legrand. 1990. *Forcipomyia (Pterobosca) incubans* (Macfie) et *F. (Trichohelea) macheti* n. sp. Parasites des ailes de libellules en Guyane Française (Diptera, Ceratopogonidae; Odonata). *Revue Française d'Entomologie* 12(4):167–170.
- Clastrier, J., and J. Legrand. 1991. *Forcipomyia (Trichohelea) araneivora* n. sp. ectoparasite d'une araignée habitant les monts nimba en Guinée (Diptera, Ceratopogonidae; Araneae, Araneidae). *Revue Française d'Entomologie* 13(4):155–158.
- Clastrier, J., and W. W. Wirth. 1995. Révision des *Forcipomyia* du sous-genre *Microhelea* de la région néotropicale, parasites de phasmes (Diptera: Ceratopogonidae). *Annales de la Société Entomologique de France* 31(2):97–150.
- Debenham, M. L. 1987. The biting midge genus *Forcipomyia* (Diptera: Ceratopogonidae) in the Australasian region (exclusive of New Zealand). I. Introduction, key to subgenera, and the *Thyridomyia* and *Trichohelea* groups of subgenera. *Invertebrate Taxonomy* 1:35–119.
- Edwards, F. W. 1925. A midge attacking moths in Switzerland. *Entomologist's Monthly Magazine* 61:228–229.
- Ehrlich, P. R. 1962. A biting midge ectoparasitic on Arizona Lycaenids. *Journal of the Lepidopterists' Society* 16(1):20–22.
- Kryger, J. P. 1914. En myg, der angriber en sommerfugl. *Entomologiske Meddelelser* 10(3):83–88.
- Lane, J. 1947. A biologia e taxonomia de algumas especies des grupos *Forcipomyia* e *Culicoides* (Diptera, Ceratopogonidae [Heleidae]). *Arquivos da Faculdade de Higiene e Saúde Pública da Universidade de São Paulo* 1:159–170.
- Lane, R. P. 1977. Ectoparasitic adaptations in *Forcipomyia* from butterflies with two new African species (Ceratopogonidae). *Systematic Entomology* 2:305–312.
- Lane, R. P. 1984. Host specificity of ectoparasitic midges on butterflies. In R. I. Vane-Wright and P. R. Ackery (eds.). *Biology of Butterflies*, pp. 105–108. Academic Press, London. xxiv + 429 pp.
- Macfie, J. W. S. 1932. Ceratopogonidae from the wings of dragonflies. *Tijdschrift voor Entomologie* 75:265–283.
- Macfie, J. W. S. 1934. Fauna Sumatrensis: bijdrage 75, Ceratopogonidae. *Tijdschrift voor Entomologie* 77: 202–231.
- Meijere, J. C. H., de. 1923. Ceratopogon-arten als ectoparasiten anderer insekten. *Tijdschrift voor Entomologie* 66:137–142.

- Perez-Gelabert, D. E., and W. L. Grogan, Jr. 1999. *Forcipomyia (Microhelea) tettigonaris* (Diptera: Ceratopogonidae) parasitizing katydids (Orthoptera: Tettigoniidae) in the Dominican Republic. *Entomological News* 110(5):311–314.
- Scoble, M. J. 1999. *Geometrid Moths of the World: A Catalogue* (Lepidoptera, Geometridae). 2 volumes. CISRO Publications, Collingwood, Victoria.
- Tokunaga, M. 1940. Ceratopogonidae and Chironomidae from the Micronesian islands with biological notes by Teiso Esaki. *Philippine Journal of Science* 71:205–230.
- Tokunaga, M., and E. K. Murachi. 1959. Insects of Micronesia. Diptera: Ceratopogonidae. B. P. Bishop Museum, *Insects of Micronesia* 12(3):103–434.
- Wirth, W. W. 1956a. New species and records of biting midges ectoparasitic on insects (Diptera, Heleidae). *Annals of the Entomological Society of America* 49:356–364.
- Wirth, W. W. 1956b. The biting midges ectoparasitic on blister beetles (Diptera, Heleidae). *Proceedings of the Entomological Society of Washington* 58(1):15–23.
- Wirth, W. W. 1966. A new Jamaican blood-sucking midge from lacewings (Diptera Ceratopogonidae). *Proceedings of the Entomological Society of Washington* 68(1):29–32.
- Wirth, W. W. 1971. A review of the “stick-ticks,” Neotropical biting midges of the *Forcipomyia* subgenus *Microhelea* parasitic on walking stick insects (Diptera: Ceratopogonidae). *Entomological News* 82: 229–245.
- Wirth, W. W. 1972. Midges sucking blood of caterpillars (Diptera: Ceratopogonidae). *Journal of the Lepidopterists' Society* 26(1):65.
- Wirth, W. W. 1980. A new species and corrections in the *Atrichopogon* midges of the subgenus *Melohelea* attacking blister beetles (Diptera: Ceratopogonidae). *Proceedings of the Entomological Society of Washington* 82(1):124–139.
- Wirth, W. W., and J. L. Castner. 1990. New neotropical species of “stick-tick” (Diptera: Ceratopogonidae) from katydids. *Florida Entomologist* 73(1):157–160.