

Technical Report No. 20

FLIGHTLESS DOLICHOPODIDAE (Diptera) IN HAWAII

D. Elmo Hardy and Mercedes D. Delfinado

Department of Entomology
University of Hawaii
Honolulu, Hawaii

ISLAND ECOSYSTEMS IRP

U. S. International Biological Program

February 1973

ABSTRACT

The flightless dolichopodid fly being described here was recovered from leaf litter samples collected in native forest on the island of Hawaii, at 5100 ft. on Saddle Road, 19°40'32" N latitude and 155°20'30" E longitude in two adjoining kipukas. The average temperature in the kipukas is approximately 50°F and the humidity almost a constant 100%. This report is a part of our work in censusing the Diptera fauna in native forest litter (IBP-ISLAND ECOSYSTEMS IRP, C-1 Biosystematics of Hawaiian Diptera). In reporting this curious fly, we are directing attention to the possible effect of the introduction of predators (predaceous ants) and other factors with regards to wing reduction.

A key to stenopterous species of Hawaiian Campsicnemus is also included.

TABLE OF CONTENTS

	Page
ABSTRACT	i
INTRODUCTION	1
THE GENUS <u>CAMPSICNEMUS</u>	3
KEY TO KNOWN SPECIES OF <u>CAMPSICNEMUS</u> WITH REDUCED WINGS	4
CAMPSICNEMUS NEW SPECIES A	6
ACKNOWLEDGEMENTS	8
BIBLIOGRAPHY	8

INTRODUCTION

Wing reduction and flightlessness is rare in Dolichopodidae. Only eight known species have reduced wings and except for one from the alpine tundra in Nepal (Takagi, 1972) all are from oceanic and subantarctic islands (TABLE 1); five of these are from the Hawaiian islands. The first recorded species was collected by Perkins in 1900 in the Koolau Mountains, Oahu and described as a new genus and species (Emperoptera mirabilis) by Grimshaw (1902: 81). The latter species is apparently extinct (Zimmerman, 1948: 153 and Hardy and Kohn, 1964: 119) and would support the concept of Takagi (1972: 99): "Where predaceous ants (apterous) are ubiquitous, habitats for various flightless insects would largely be occupied by them. If this is true, the relatively abundant occurrence of free-living wing-reduced insects in high altitude, high latitude and oceanic island faunas is due at least partly to the lack of predaceous ants." Zimmerman (loc. cit.) in discussing the biotic pressure brought on by introduced predators says that: "It appears that this remarkable fly is now extinct - at least in the type location - because it was unable to withstand the new pressure created by the invasion of its environment by immigrant predaceous ants." Pheidole ants have invaded the entire Koolau mountain range and it is doubtful that a flightless species would be able to survive.

Concerning flightlessness, Mani (1962: 95) believes there seems to be a relation between wing reduction and flightlessness and the prevailing climatic conditions of the habitat, i.e. the interaction of abiotic factors. This supports Huxley (1942: 243) on flightlessness of insects of oceanic islands as "an example of ecological differentiation after divergence was made possible in the first instance by isolation, but the type of differentiation is here more directly in relation to the physical than to the biological environment, winglessness in insects constituting an adaptation to prevent being blown out to sea." Similarly,

TABLE 1. Oceanic Islands and Alpine Tundra Dolichopodidae with reduced wings.

Species	Locality	Habitat	Wings
<u>Campsicnemus</u> <u>bryophilus</u> (Adachi), 1954	Molokai 3700-4200 ft	on forest floor under dense ve- getation	Stenopterous
<u>C. aeptus</u> Hardy & Kohn, 1964	Maui, West (Puu Kukui) 4000-4500 ft	on forest floor under dense ve- getation	Stenopterous
<u>C. haleakalae</u> (Zimmerman), 1938	Maui, East (Haleakala) 6000-6500 ft	on forest floor under dense ve- getation	Stenopterous
<u>C. mirabilis</u> (Grimshaw), 1902	Oahu (Koolau Mts) 2000-3000 ft	on forest floor under dense ve- getation	Stenopterous
<u>C. n. sp. A</u>	Hawaii 5100 ft	reared from leaf litter	Stenopterous
<u>Schoenophilus</u> <u>pedestris</u> Lamb, 1909	Macquarie Island	under stones, moss leaf mould, low plants, flower head, etc.	Stenopterous
<u>S. pedestris</u> <u>campbellensis</u> Harrison, 1964	Campbell Island	under stones, moss leaf mould, low plants, flower head, etc.	Stenopterous
<u>Acropsilus</u> <u>borboroides</u> Oldroyd, 1956	Campbell Island	under stones, moss leaf mould, low plants, flower head, etc.	Apterous
<u>Hydrophorus</u> <u>celestialis</u> Takagi, 1972	Nepal 4200-4400 ft	alpine tundra, on snow above timber zone	Stenopterous

Perkins (1913: 50) suggests that wing reduction in Hawaiian insects is a result of their adaptation to living on the forest floor. He says: "Nearly all the flightless endemic insects are inhabitants of the forest. . . . There is no ground for supposing that in these islands, as has been suggested for flightless insects inhabiting other oceanic islands, the wings have been lost or degenerated through the agency of natural selection, as being a source of danger if used on small land areas, where flying insects are supposed to be liable to destruction from being blown out to sea. All the cases of flightlessness in Hawaiian insects are . . . to be explained simply by 'disuse'." Hackman (1964: 87-88) however, points out that in dealing with flightless Diptera on oceanic islands the wind theory can hardly have validity since the adults live predominantly in rather concealed terricolous habitats: among litter, under stones, in low dense vegetation on the ground, in cavities in the soil and in narrow galleries of social insects. And according to him (loc. cit.): "It seems very likely that the loss of wings is connected with these habits of life. A good running ability is there/fore/ more important than flight in escaping from enemies." In this respect, Takagi (1972) stated that "the shift of habit to terricolous, whether phenotypic or genetic, is a common prerequisite to wing reduction in free-living insects."

THE GENUS CAMPSICNEMUS

The genus Emperoptera Grimshaw was synonymized with Campsicnemus Haliday (Hardy and Kohn, 1964: 17) because of the close resemblance (other than flight characters) and obvious relationship to normal, fully winged species. It is apparent that wing reduction has occurred in at least two distinct evolutionary lines of Campsicnemus. One characterized by having the middle basitarsus of male short, not over one-third to one-fourth as long as second tarsomere and with a prominent spur developed at apex (FIG. 4) and the middle tibia strongly swollen

and flattened laterally. This group is represented by aeptus Hardy and Kohn, bryophilus (Adachi) and n. sp. A. The other is characterized by having the middle basitarsus slender, equal or longer than second tarsomere, with no spur at apex and middle tibia slender, with four or more bristles along dorsal surface. This is represented by haleakalae (Zimmerman) and mirabilis (Grimshaw). It is not completely improbable that Adachi (1954: 293) could be correct in her assumption that the stenopterous species in Hawaii could "have arisen from four different ancestral stocks in the genus Campsicnemus." More detailed studies are needed to gain a more complete knowledge of the relationships. Two species, mirabilis on Oahu and n. sp. A on Hawaii, completely unrelated, have the halteres rudimentary, represented by small stubby appendages (FIG. 1) and the wings reduced to thin strips along costal margin with only one faint longitudinal vein represented (FIG. 1). These two species obviously represent cases of convergent evolution in two phyletic lines of Campsicnemus and could have evolved separately from fully winged species. The other three species from Maui and Molokai have the halteres normal and the anterior half of the wing developed, with the radial veins and vein M_{1+2} present (Hardy and Kohn, 1964: 40, FIG. 2C and 53, FIG. 5a). The latter species are active jumpers, found hopping about on the ground litter like fleas.

KEY TO KNOWN SPECIES OF CAMPSICNEMUS WITH REDUCED WINGS

1. Middle basitarsus short, one-third to one-fourth as long as second tarsomere and with a prominent spur at apex (FIG. 4); middle tibia swollen, flattened laterally (FIG. 4) 2
- Middle basitarsus slender, equal or long than second tarsomere and with no apical spur; middle tibia slender, with four or more bristles arranged along dorsal surface 4

2. Anterior half of wing present and radial and first medial veins present (Hardy and Kohn, 1964: 53 FIG. 5a); halteres well developed; spur on middle basitarsus blunt at apex; and middle tibia with a dense clump of peg-like anterodorsal bristles at about apical fourth of segment or a row of close set anterodorsal bristles in the same position. (Hardy and Kohn, 1964: 40, FIG. 2e and 53, FIG. 5b) 3
- Only costal margin of wing represented and with a prominent bristle at apex (FIG. 1); halteres reduced to short, stubby knobs (FIG. 1); tibial spur of basitarsus sharp pointed and middle tibia lacking the dense set of preapical dorsal bristles and with numerous short, erect, blunt setae over anterior surface (FIG. 4). Hawaii. n. sp. A.
3. Spur on middle basitarsus strongly curved at right angle at about middle, enlarged and rounded at apex and with basal half of spur pilose (refer Hardy and Kohn, 1964: 40, Fig. 2e); preapical dorsal bristles of middle tibia not short and peg-like, arranged in a row near apical third
-aepus Hardy & Kohn
- Spur on middle basitarsus curved near base, otherwise straight, rather slender, parallel sided and bare, not enlarged at apex; middle tibia with a dense clump of short peg-like anterodorsal bristles at apical third (loc. cit. p. 53; FIG. 5b)Molokaibryophilus (Adachi)
4. Wings reduced to just the costal margin and with an apical bristle, very similar to n. sp. A (FIG. 1); halteres rudimentary, represented by small knobs; middle tibia with four dorsal bristles; mesonotum polished blackKoolau Mts. . . .Oahu.mirabilis (Grimshaw)
- Wings represented by approximately the anterior half with the radial and the first medial veins developed and lacking an apical bristle; halteres

rudimentary, represented by a small knob; middle tibia with seven long posterodorsal bristles; mesonotum subopaque bronze-brown . . . East Maui
 haleakalae (Zimmerman)

CAMPSICNEMUS N. SP. A (FIGS. 1-5)

Because of the development of the legs, with the middle basitarsus short and with a prominent apical spur and the middle tibia swollen, flattened laterally it fits in the grouping of species with aeptus Hardy and Kohn and bryophilus (Adachi). It differs strikingly from these species by the great reduction of the wings and halteres and obviously the total loss of flight ability; also the characteristics of the legs are distinctly different. The middle femora lack ventral bristles and the middle tibiae lack preapical anterodorsal bristles; also the spur of middle basitarsus is attenuated to a sharp point at apex and only two pairs of dorso-central bristles are present. Because of the development of the secondary sexual characters of the legs and the absence of acrostichal setae it would appear to be more closely related to nigroanalis Parent (fully winged) from Oahu, than to any of the stenopterous species.

MALE. Tiny predominantly brownish yellow species. Head: Higher than long with the eyes short pilose. Basal antennal segment yellow, third segment dark brown to black, triangular in shape and with prominent setae around margin. Arista pubescent. Thorax: Yellow to rufous, tinged with brown on mesonotum and scutellum. Halteres reduced to small rounded appendages, with three prominent subapical setae on posterior margin and densely covered with microscopic setae. Two pairs dorso-central bristles on anterior half of mesonotum; two humerals; one notopleural; one supraalar and one postalar; also one pair of large scutellar bristle, almost equal in length to mesonotum. The postalar is weak compared to bryophilus, scarcely over one-third the size of the supraalar. Mesonotum subshining, very faintly pollinose.

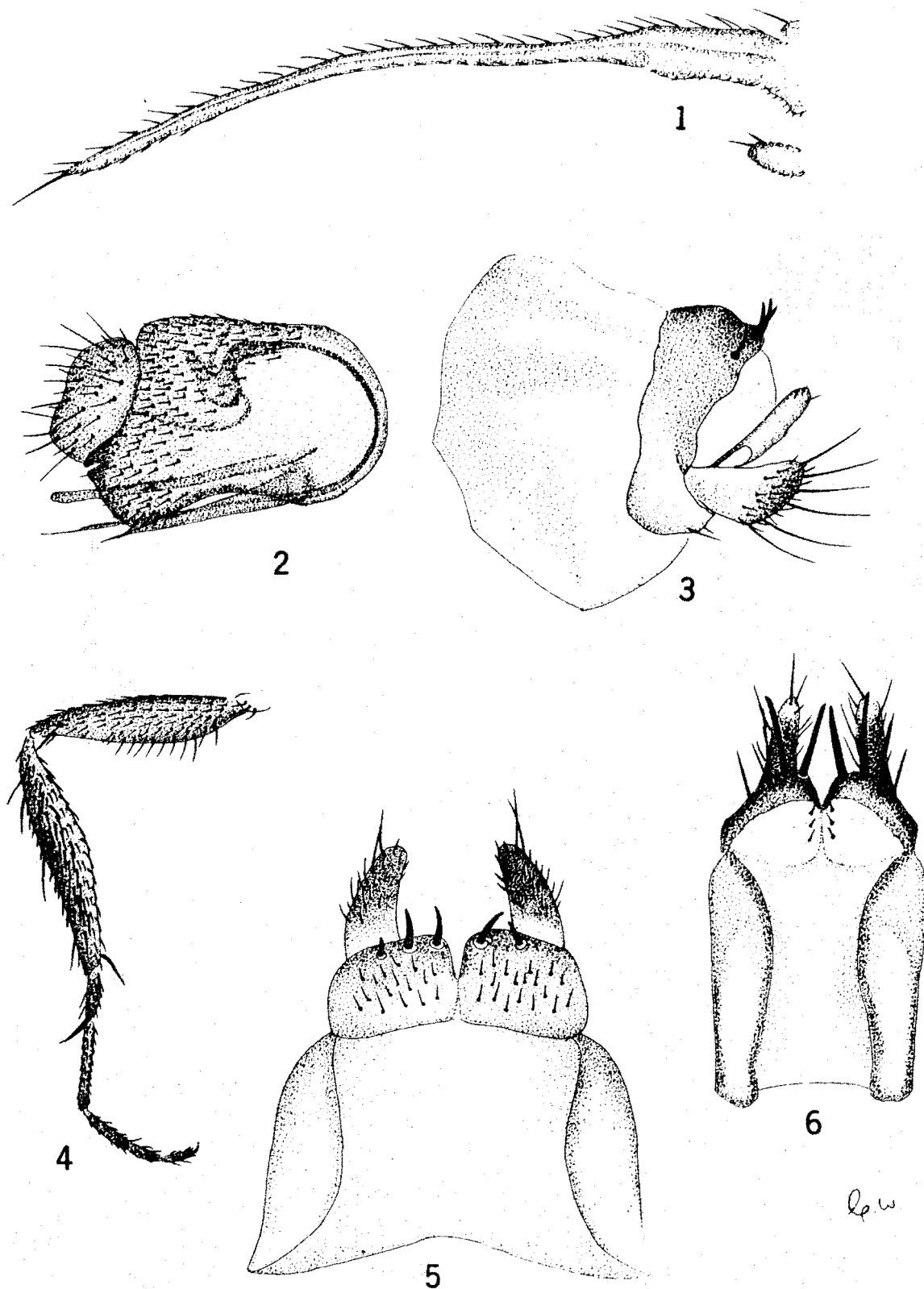
Legs: Entirely yellow except for a tinge of brown on middle coxae. Middle femur lacking ventral bristles but with a row of fine posteroventral hairs along basal half. Middle tibia with anterior surface rather densely covered with short, thick, blunt setae (FIG. 4); also with one prebasal posterodorsal bristle; one median anterodorsal; one preapical dorsal; one preapical anterior and one preapical ventral bristle. Middle tibia flattened, as wide as femur. Mid basitarsus short, scarcely over one-third as long as second tarsomere and apical spur gently curved, equal in length to basitarsus and sharp pointed at apex (FIG. 4). Hind tibia with opposing posterodorsal and anterodorsal bristles before base; one posterodorsal at basal third; one anterodorsal at middle and with opposing dorsal and anterodorsal preapical bristles. Wing: As in FIG. 1, with one longitudinal vein faintly developed, this is evidently the radius. Halteres as in FIG. 1. Abdomen: Mostly yellow, tinged with brown at apices of terga. Male genitalia as in FIG. 2. Aedeagus thin, needle-like.

Length: body, 1.4 - 1.5 mm.

FEMALE. Fitting description of male except for secondary sexual characters. Female terminalia as in FIGS. 3 and 5 with four short spines at apical margin of ninth tergum. The terminalia is distinctly different from that of bryophila which has four strong spines and four bristles on hind margin of tergum (FIG. 6).

Holotype male; allotype female, 18 paratypes, 5 males and 13 females taken at 5100 feet elevation on the Saddle Road, Hawaii, 19°40'32" N latitude and 155°20'30" E longitude collected in two adjoining Kipukas (islands of vegetation in lava fields) (about one-fourth mile apart) tentatively labeled Kipukas 9 and 14. The specimens were reared from leaf litter predominantly consisting of leaves from Metrosideros, Cheirodendron, Ilex, and tree ferns. February 25-27, 1972 (M. D. Delfinado). The average temperature in the Kipukas is approximately 50°F. and the humidity almost a constant 100%.

Holotype, allotype and some paratypes in the B. P. Bishop Museum. Other paratypes in the collections of the U. S. National Museum and the University of Hawaii.



FIGS. 1-5, Campsicnemus n. sp.; FIG. 6, C. bryophilus (Adachi).
1) wing and halter 2) ♂ terminalia, lateral view 3) ♀ terminalia, lateral view 4) ♂ middle leg 5) ♀ terminalia, dorsal view
6) ♀ terminalia, dorsal view

ACKNOWLEDGEMENTS

We appreciate the help we have received from Mr. Douglas Fujii as an assistant in the field and laboratory and Miss Camille Wong for doing the illustrations.

BIBLIOGRAPHY

- Adachi, M. S. 1954. Preliminary studies in Hawaiian Dolichopodidae (Diptera), Part II. The genus Campsicnemus Grimshaw. Proc. Haw. Ent. Soc. 15(2):293-296.
- Grimshaw, P. H. 1902. Diptera. In: Fauna Hawaiiensis, David Sharp, Ed. 3(2): 79-86. Cambridge Univ. Press.
- Hackman, W. 1964. On reduction and loss of wings in Diptera. Not. Ent. 44:73-93.
- Hardy, D. E. and M. Adachi Kohn. 1964. Insects of Hawaii, Vol. II, Diptera: Brachycera, Family Dolichopodidae. pp. 13-256.
- Huxley, J. 1942. Evolution. The modern synthesis. Harper and Brothers Pub., N. Y. and London. 645 pp.
- Kohn, M. A. 1962. Insects of Macquarie Island. Diptera: Dolichopodidae: Pac. Ins. 4(4):959-962.
- Lamb, C. G. 1909. The Diptera of the Subantarctic Islands of New Zealand. Art. VII, Vol. 1:124-145.
- Mani, M. S. 1962. Introduction to high altitude entomology. Insect life above the timber-line in the northwest Himalaya. 302 pp. London.
- Oldroyd, H. 1955. A wingless Dolichopodid (Diptera) from Campbell Island. Rec. of Dominion Mus. 2:243-246.
- Perkins, R. C. L. 1913. Introduction to Fauna Hawaiiensis, David Sharp, Ed. 1:xv-ccxxviii, pls. 1-16. Cambridge Univ. Press.
- Takagi, S. 1972. A micropterous dolichopodid fly from Nepal Himalaya (Diptera). Kontyu 40(2):90-99.
- Zimmerman, E. C. 1938. Emperoptera from Maui (Diptera, Dolichopodidae). Proc. Haw. Ent. Soc. 10(1):145-148.
- _____. 1948. Insects of Hawaii, Vol. I. Introduction, 206 pp. Univ. Haw. Press, Honolulu.