

Phoresy and kleptoparasitism of *Paramyia* (Diptera, Milichiidae) on tiger beetles (*Therates labiatus*; Coleoptera, Carabidae, Cicindelinae) in eastern Indonesia

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An association between kleptoparasitic Diptera and a predaceous beetle is documented for the first time with the description of phoretic and kleptoparasitic *Paramyia* (Diptera, Milichiidae) found on Southeast Asian tiger beetle *Therates labiatus* (Coleoptera, Carabidae, Cicindelinae).

Keywords : Phoront, commensal relationship, parasitism by theft.

Une association entre les diptères kleptoparasites et un dendroctone prédateur est documentée pour la première fois avec la description de *Paramyia* (Diptera, Milichiidae) phorétiques et kleptoparasites trouvés sur le *Therates labiatus* (Coleoptera, Carabidae, Cicindelinae).

Mots-clés : Phoronte, relation commensale, kleptoparasitisme.

1 INTRODUCTION

Alfred Russel Wallace (1890), writing about his time in the Moluccas (Maluku Islands of Indonesia), described the tiger beetle *Therates labiatus* (Fabricius 1801) (Coleoptera: Carabidae: Cicindelinae) as "*always found upon foliage, generally of broadleaved herbaceous plants, and in damp and gloomy situations, taking frequent short flights from leaf to leaf, and preserving an alert attitude, as if always looking out for its prey. Its vicinity could be immediately ascertained, often before it was seen, by a very pleasant odour, like otto of roses, [a fragrant essential oil], which seems to emit continually and which may probably be attractive to the small insects on which it feeds.*" Although Wallace made no mention of what other insects were attracted by the beetle's presumed pygidial gland secretions, the observations discussed below suggest that these active predaceous beetles are very attractive to an associated species of phoretic and kleptoparasitic fly.

Many kinds of small flies are kleptoparasites that feed on items captured by larger predaceous arthropods such as Mantodea (Marshall, 1998), Asilidae (Marshall, 1998), Reduviidae (Sivinski & Stowe, 1980) and spiders (Sivinski *et al.*, 1999). Spiders, especially web-making families, are routinely attended by kleptoparasitic flies in the families Cecidomyiidae, Ceratopogonidae, Milichiidae, and Chloropidae, but in most cases the kleptoparasites are not phoretic on their predaceous hosts but instead arrive only after the capture and extra-oral digestion of particular kinds of prey such as aculeate Hymenoptera or chemically defended Heteroptera. Sivinski *et al.* (1999) reviewed the associations of kleptoparasitic Diptera with predaceous arthropods, listing associations with several spider families, the bug family Reduviidae, the fly family Asilidae and the centipede family Scolopendridae.

Curiously, there are no published records of associations between predaceous Coleoptera and kleptoparasitic flies, so new observations of a consistent relationship between the Southeast Asian tiger beetle *Therates labiatus* and kleptoparasitic and phoretic flies are novel and significant.

2 OBSERVATIONS

Multiple individuals of *Therates labiatus* were followed and observed along a mostly dry riverbed in north Seram, Maluku Province, Indonesia (2°59'49.82"S 129° 4'53.05"E) between August 21-23, 2018. Since the beetles repeatedly made short flights and disappeared from view, it was difficult to distinguish between repeat observations of the same individual and observations of different individuals, but approximately 6 different beetles were photographed, and about 20 further individuals were observed but not photographed. Two other beetles were briefly observed at other sites in north Seram, one near a bridge on the trans Seram highway about 30 km south of Saleman, the other along the west boundary of Manusela National Park. Every individual carried at least one phoretic fly, and most carried several flies (**Figure 1**). Several beetles carried multiple individuals, usually facing posteriorly, on the top of the head or on the prothorax (**Figure 2**); some beetles were photographed with flies actively extending their geniculate mouthparts to the base of the beetle's mandibles, either laterally (**Figure 3**) or ventrally (**Figure 4**). The flies remained with the beetles in flight, as confirmed by following some individual beetles as they made short flights. Stationary beetles were repeatedly observed to accumulate further flies, sometimes attracting crowds of incoming flies. Although it was not practical to collect specimens because of Indonesian regulations on specimen collection and export, the photographs of the flies clearly show the wing venation and other characters diagnostic of the genus *Paramyia* (Williston 1897) (Milichiidae). As far as could be told from the photographs, all flies were females. A few flies were observed feeding at the bases of the very long mandibles of the beetles, leaving no doubt that they are both phoretic and kleptoparasitic. No beetles were observed with captured prey.

3 DISCUSSION

The *Paramyia* species observed does not appear to be any of the named taxa in the key to world *Paramyia* by Papp (2001), and it is probably an undescribed species (pers. comm, V. Levesque-Beaudin). Papp (2001) reported *Paramyia* from the Asian continent and the Afrotropical regions for the first time and Sabrosky (1989) catalogued the genus from Australia on the basis of "unidentified spp". Other species of the widespread genus *Paramyia* are kleptoparasites routinely associated with Araneidae, and in North America *P. nitens* females often appear in large numbers on partially consumed heteropteran prey in spider webs (but not on the host spiders). The persistent phoresy of multiple flies on every *Therates labiatus* observed is unusual for the genus *Paramyia*, and indeed for any kleptoparasitic flies associated with predaceous arthropods. Many kleptoparasitic flies are phoretic on dung-rolling beetles (Marshall, 1983; Marshall & Pont, 2013) but this seems to be the first record of such a relationship between a predaceous beetle and an associated fly.

After observing the beetles discussed above I searched online for images of *Therates* with phoretic flies. A photograph of the same beetle species from Papua New Guinea, on the commercial website for Laughing Frog Photography (<https://www.laughingfrogphotography.com/Nature/Asian-Fauna/i-BjVVgMr>) showed three *Paramyia* on the prothorax, suggesting that this remarkable association is general to the two species involved. It seems likely that the fly is attracted to the "pleasant odour" referred to by Wallace (1890), and it is possible that *T. labiatus* is an obligate host for the fly. This association seems to be neutral to the beetles, which make no attempt to dislodge or remove their hitchhiking dipterans. It seems probable that this unusual host-specific phoresy is a response to the host's high mobility and low frequency of prey capture. The limited available data on kleptoparasitic flies associated with other, relatively stationary, predaceous arthropods in Southeast Asia suggests that competition among kleptoparasites is fierce, as the majority of the feeding spiders, assassin bugs and robber flies observed during the same time period were attended by other kleptoparasitic Diptera. A phoretic relationship with their very active predaceous hosts presumably provides a significant advantage to the *Therates*-riding *Paramyia*.

4 ACKNOWLEDGMENTS

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REFERENCES

- Marshall, S. A. 1983. *Ceroptera sivinskii*, a new species of Sphaeroceridae (Diptera) in a genus new to North America, associated with scarab beetles in the southeastern United States. *Proceedings of the Entomological Society of Washington* **85**, 139–143.
- Marshall, S. A. 1998. Kleptoparasitic Chloropidae (*Olcella quadrivittata* (Sabrosky)) feeding and mating on staphylinid prey of Asilidae and on hemipteran prey of Mantodea. *Studia Dipterologica* **5**, 13–18.
- Marshall, S. A. and Pont A. C. 2013. The kleptoparasitic habits of *Musca albina* Wiedemann, 1830 (Diptera: Muscidae). *African Invertebrates* **54(2)**, 427–430.
- Papp, L. 2001. A revision of the species of *Paramyia* Williston (Diptera, Milichiidae) with the description of a new genus. *Acta zoologica Academiae Scientiarum Hungaricae* **47(4)**, 321–347.
- Sabrosky, C. W. 1989. Family Milichiidae. Chapter 78 In: Evenhuis, N. L. (ed.), *Catalog of the Diptera of the Australasian and Oceanian Regions*. Bishop Museum Press and E. J. Brill, 1155pp.
- Sivinski, J. and Stowe M. 1980. A kleptoparasitic cecidomyiid and other flies associated with spiders. *Psyche* **87**, 337–348.
- Sivinski, J., Marshall S. and Petersson E. 1999. Kleptoparasitism and phoresy in the Diptera. *Florida Entomologist* **82(2)**, 179–197.
- Wallace, A. R. 1890. *The Malay Archipelago*, tenth edition. Dover reprint, 515pp.

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Figure 1 : *Therates labiatus* with phoretic Milichiidae. Four head-riding flies apparently defending their position against incoming individuals on a perched beetle



Figure 2 : *Therates labiatus* with phoretic Milichiidae. Three *Paramyia* flies occupying the usual position on the head and prothorax of newly landed beetle

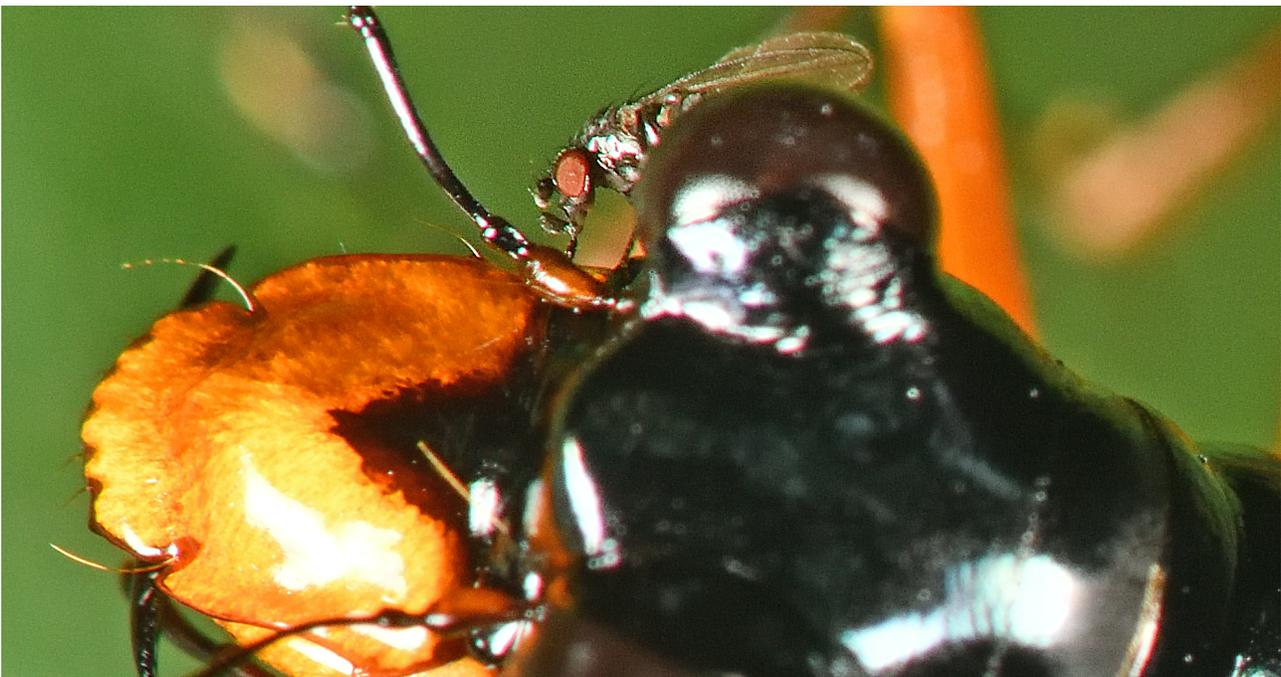


Figure 3 : *Therates labiatus* with phoretic Milichiidae. A *Paramyia* with its long, geniculate mouthparts extended to feed at the mandibular base; linguae



Figure 4 : *Therates labiatus* with phoretic Milichiidae. One *Paramyia* perched on top of the beetle's head, the other apparently feeding ventrally near the bases of the mouthparts