Borneo Journal of Resource Science and Technology (2020), 10(2): 190-195
DOI: https:doi.org/10.33736/bjrst.2720.2020

SHORT COMMUNICATION

Species Composition and Ecological Distribution of the Subfamily Cicindelinae Latreille, 1801 (Coleoptera: Carabidae) Based on Voucher Specimens in Sarawak

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Received: 3 November 2020 Accepted: 8 December 2020 Published: 31 December 2020

ABSTRACT

The subfamily Cicindelinae which belongs to the family Carabidae are commonly known as tiger beetles. Despite the recent studies conducted on this taxon, current ecological knowledge on tiger beetles is limited. Thus, this study aimed to provide a current checklist of tiger beetles as well as their species distribution, abundances and habitat preferences in Sarawak based on voucher specimens from Universiti Malaysia Sarawak Insect Reference Collection (UIRC). A total of 76 specimens of tiger beetles were examined in which comprising of seven genera from eight species. The genus *Neocollyris* was represented with two species, namely *Neocollyris* (s. str.) *ermaginata* and *Neocollyris* (*Stenocollyris*) *sarawakensis macrodera*, while the other genera were represented by only one species, respectively. The most abundant species with 64 individuals (84.21%) were represented by *Cosmodela aurulenta*, followed by *Abroscelis tenuipes araneipes* and *Therates labiatus* with three individuals (3.95%) and *N. ermaginata* with two individuals (2.63%). In this study, there were eight ecological habitats being identified, namely heath forest, limestone forest, littoral forest, mixed dipterocarp forest, oil palm plantation, peat swamp forest, riverine forest and urban area. The data indicates that *C. aurulenta* being recorded at seven ecological habitats suggesting this species to have a wide distribution capability while species such as *A. tenuipes araneipes*, *Callytron doriai*, *Cicindela* sp., *Myriochila* (s. str.) *specularis brevipennis*, *N. ermaginata* and *N. s. macrodera* suggesting these species to have a very narrow habitat specialisation. The results of this preliminary study provide evidence on the need to conduct further studies on the ecological aspects of tiger beetles in Sarawak.

Keywords: Cicindelinae, ecological distribution, Sarawak, tiger beetles, voucher specimens

The subfamily Cicindelinae or commonly known as tiger beetles were formerly assigned to a separate family Cicindelidae (Carter, 1989; Pearson & Cassola, 2001; Pearson, 2007) and is now classified as a subfamily within Carabidae (Hill & Abang, 2010; Bosuang *et al.*, 2017; Gough *et al.*, 2018). The distinctive characteristics of these beetles can be observed from their large eyes, long narrow legs, and acutely toothed mandibles. Adult tiger beetles are known to be brightly coloured usually with iridescent or metallic and often with distinct colour pattern (Triplehorn & Johnson, 2005; Hill & Abang, 2010). When disturbed, they fly rapidly or run swiftly in short distances making them a challenge to capture. Moreover, most species are diurnal, usually found active in daylight in open habitats such as water edges, grasslands, woodland paths, and roads, but a few are nocturnal (Knisley, 1984). These beetles specifically, are ground surface predators and can be seen visually hunting with their sickle-like mandibles on a variety of smaller insects in which they feed on (Knisley, 1984). Area with enough sun light with the presence of bare soil are a necessary habitat requirement for the tiger beetle's predatory activities. Besides that, recent studies from

different regions emphasise that most tiger beetles have very narrow habitat specialization and as a consequence, the cicindelid beetles have become a crucial global flagship group for beetle and insect conservation, especially as a biological indicator of habitat health (Pearson & Vogler, 2001; Jaskula, 2011).

Notwithstanding the abundance and evident dominance of tiger beetles in habitats of Borneo, these beetles have little ecological study being properly understood, except for some recent work on the subfamily Cicindelinae in new descriptions of species (Wiesner, 2016) and notes on Bruneian tiger beetles (Damken *et al.*, 2017). Other than these, recent studies and the substantial amount of distribution information and notes from collectors published in Brunei, the habitat preference of tiger beetles in Borneo is poorly known especially in Sarawak. Hence, the objectives of this study were to identify tiger beetle species in Sarawak as well as their distribution, abundances and habitat based on specimens deposited in Universiti Malaysia Sarawak (UNIMAS) Insect Reference Collection (UIRC).

This study examined on voucher specimens of Cicindelinae deposited in the UIRC dated from 1994 to 2019. Collecting data such as scientific name, collecting date, locality and collector's name were recorded. Based on the specimen's locality data, their ecological habitats were identified and distribution map was generated. Specimens with insufficient information of georeferenced localities were excluded from the analysis. Specimens were then sorted according to the morphological characteristics for identification into respective genus, species and subspecies, whichever possible. Species identification follows available references by Chung (2003), Hill and Abang (2010) and Bosuang *et al.* (2017) for comparison and species confirmation. Relative abundance of each tiger beetle species recorded from UIRC was then calculated by a percentage of dividing the number of individuals of each species with the total number of individuals recorded for all species.

A total of 76 specimens of Cicindelinae beetles were recorded in this study representing eight species and seven genera, namely, *Abroscelis*, *Callytron*, *Cicindela*, *Cosmodela*, *Myriochila*, *Neocollyris* and *Therates*. Table 1 shows the current checklist of Cicindelinae documented in Sarawak based on specimens deposited in UIRC. *Neocollyris* was represented by two species, namely, *Neocollyris* (s. str.) *ermaginata* and *Neocollyris* (*Stenocollyris*) *sarawakensis macrodera*, while the other genera were represented by only one species, respectively.

Cosmodela aurulenta or commonly known as the golden-spotted tiger beetle was the most abundant species with 64 individuals (84.21%), followed by *Abroscelis tenuipes araneipes* and *Therates labiatus* with three individuals (3.95%), whereas *N. ermaginata* with two individuals (2.63%) respectively (Table 2). *Cosmodela aurulenta* is among the largest and the most common tiger beetle in Borneo (Hill & Abang, 2010; Bosuang *et al.*, 2017). Specimens of this species are widely available as voucher specimens in both private and public collections (López-López *et al.*, 2015; Damken *et al.*, 2017). In addition, *C. aurulenta* has conspicuous and bold colour pattern in which can easily attract the attention of naturalist as well as amateur collectors.

Three new distributional records of tiger beetles were documented in the current study, namely, *Cicindela* sp., *N. s. macrodera* and *T. labiatus* that were not listed in previous study by Damken *et al.* (2017) (Figure 1). There are eight types of ecological habitats documented in this study, namely, heath forest (HF), limestone forest (LMF), littoral forest (LTF), mixed dipterocarp forest (MDF), oil palm plantation (OP), peat swamp forest (PSF), riverine forest (RF) and urban area (UB) (Figure 2). Table 3 shows the tiger beetles in Sarawak and their ecological distribution. *C. aurulenta* was widely distributed in seven habitats except littoral forest, followed by *T. labiatus* with three ecological habitats, namely limestone forest, oil palm plantation and peat swamp forest. *N. emarginata* can be found in mixed dipterocarp forest and oil palm plantation. Five species of Cicindelinae were documented in only one ecological habitat: *A. t. araneipes* (LTF), *Callytron doriai* (PSF), *Cicindela* sp. (OP), *N. s. macrodera* (OP) and *Myriochila* (s. str.) *specularis brevipennis* (UB).

This study suggests that most tiger beetle species (six species) showed very narrow habitat specialisation and restricted to one or at most two ecological habitats. This finding is in accordance to Jaskula (2015) who studied tiger beetles in Maghreb, the Mediterranean region, where these tiger beetles were found to be restricted to only a very small part within a specific habitat. Moreover, some other studies also indicated that narrow

Table 1. A checklist of Cicindelinae species documented from Universiti Malaysia Sarawak Insect Reference Collection (UIRC)

Genera	Species
Abroscelis	*Abroscelis tenuipes araneipes* (Schaum, 1863)
Callytron	*Callytron doriai* (Horn, 1897)
Cicindela	*Cicindela* sp.
Cosmodela	*Cosmodela aurulenta* (Fabricius, 1801)
Myriochila	*Myriochila* (s. str.) *specularis brevipennis* (Horn, 1897)
Neocollyris	*Neocollyris* (s. str.) *ermarginata* (Dejean, 1825)
	Neocollyris (*Stenocollyris*) *sarawakensis macrodera* (Chaudoir, 1864)
Therates	*Therates labiatus* (Fabricius, 1801)

Table 2. The relative abundance of Cicindelinae species deposited in Universiti Malaysia Sarawak Insect Reference Collection (UIRC)

Genera	Species	Number of Individuals	Relative Abundance (%)
Abroscelis	*Abroscelis tenuipes araneipes* (Schaum, 1863)	3	3.95
Callytron	*Callytron doriai* (Horn, 1897)	1	1.32
Cicindela	*Cicindela* sp.	1	1.32
Cosmodela	*Cosmodela aurulenta* (Fabricius, 1801)	64	84.21
Myriochila	*Myriochila* (s. str.) *specularis brevipennis* (Horn, 1897)	1	1.32
Neocollyris	*Neocollyris* (s. str.) *emarginata* (Dejean, 1825)	2	2.63
	Neocollyris (*Stenocollyris*) *sarawakensis macrodera* (Chaudoir, 1864)	1	1.32
Therates	*Therates labiatus* (Fabricius, 1801)	3	3.95
Total	**8**	**76**	**100**

Table 3. Tiger beetles of Sarawak and their ecological distribution: HF – heath forest, LMF – limestone forest, LTF – littoral forest, MDF – mixed dipterocarp forest, OP – oil palm plantation, PSF – peat swamp forest, RF – riparian forest and UB – urban area.

Species	Ecological Distribution of Cicindelinae in Sarawak							
	HF	LMF	LTF	MDF	OP	PSF	RF	UB
Abroscelis tenuipes araneipes (Schaum, 1863)			/					
Callytron doriai (Horn, 1897)						/		
Cicindela sp.					/			
Cosmodela aurulenta (Fabricius, 1801)	/	/		/	/	/	/	/
Myriochila (s. str.) *specularis brevipennis* (Horn, 1897)								/
Neocollyris (s. str.) *emarginata* (Dejean, 1825)					/			
Neocollyris (*Stenocollyris*) *sarawakensis macrodera* (Chaudoir, 1864)					/			
Therates labiatus (Fabricius, 1801)		/			/	/		

(a) (b) (c)

Figure 1. Habitus images. (a) *Cicindela* sp.; (b) *Neocollyris* (*Stenocollyris*) *sarawakensis macrodera* (Chaudoir, 1864); (c) *Therates labiatus* (Fabricius, 1801). Scale bar= 1 mm

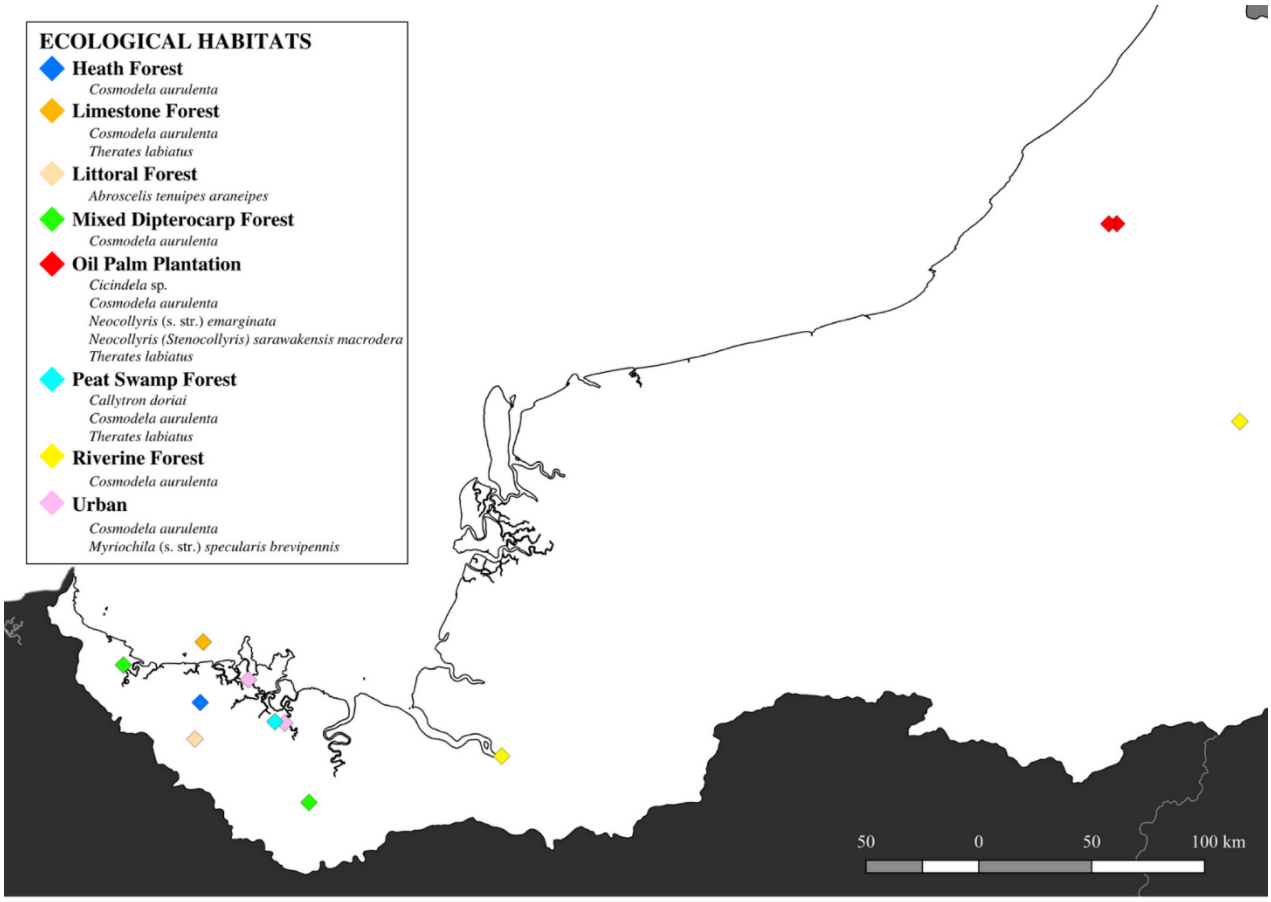

Figure 2. Ecological habitats of tiger beetle in Sarawak based on specimens deposited in UIRC

habitat specialisation were resulted from morphological, physiological or behavioural adaptations in both adult and larval stages (Pearson & Lederhouse, 1987; Hadley *et al.*, 1990; Dangelle *et al.*, 2013).

Meanwhile, *T. labiatus* and *C. aurulenta* can be encountered at three or more ecological habitats suggesting a wider distribution capability. The crucial role of some tiger beetles portraying an opportunistic feeding behavior helps in

colonization at different habitat types. This can be observed especially in *C. aurulenta*, which is a typical predatory beetle and habitat generalists (Bosuang *et al.*, 2017).

Hence, this widely distributed species may be useful as the potential indicator to human disturbance effect especially in varying habitat types of Sarawak (Arndt *et al.*, 2005). A similar finding by Aydin *et al*. (2005) also suggested that *Megacephala euphratica euphratica, Lophyridia concolor, L. littoralis winkleri,* and *Myriochile melancholica melancholica* which were widely distributed in Çukurova Delta of Southern Turkey as potential indicator species.

In addition, the use of voucher specimens serves as an important study material as they are maintained to provide the permanent, physical documentation of species and as evidence of their presence at a particular point in time (Abang & Hill, 2007). Therefore, this study on tiger beetles benefited from the knowledge on voucher specimens for an effective communicating information on science, conservation of biodiversity as well as a potential biological indicator of habitat health. Hence, a data on distribution of these tiger beetles species documented from voucher specimens in UIRC is one step towards the direction of providing knowledge on the subfamily Cicindelinae as potential biological indicator in Sarawak.

Knowledge on tiger beetles' species distribution and abundances is a preliminary step towards providing more information on the subfamily Cicindelinae as a potential biological indicator. In this study, two species, *C. aurulenta* and *T. labiatus*, being found in most habitat types suggests that this group has a wide distribution capability, therefore a habitat generalist. Habitat generalist allows survival in a larger environmental gradient due to their broader environmental tolerances.

Meanwhile, a majority of tiger beetles species from this study, namely *A. t. araneipes*, *C. doriai*, *Cicindela* sp., *M. s. brevipennis*, *N. emarginata* and *N. s. macrodera*, were found in one or at most two habitats suggesting them having a narrow habitat specialisation, therefore habitat specialist. These habitat specialists live in only particular habitats since they are more sensitive towards environmental changes.

In addition, the role of voucher specimens deposited in depositories like UIRC not only bring advantages on systematic, faunistic and ecological studies but also when voucher specimens made physically available in collections, they are beneficial for future studies regarding a certain taxon. A detailed ecological distribution on tiger beetles and its faunistic composition should be done in future to further evaluate on the potential of tiger beetles as bio indicator species in Sarawak as well to improve understanding of these beetles for a better conservation plan on this subfamily.

ACKNOWLEDGMENTS

We would like to thank the Faculty of Resource Science and Technology, Universiti Malaysia Sarawak for providing administrative support and research facilities to conduct this study. We would also like to extend our thanks and gratitude to UIRC for the permission to study the tiger beetle collections. We are also grateful for the collectors who had contributed for the voucher specimens used in this study such as students of STH2093 Entomology as well as final year project students (session 2018/2019). This study was partially funded by UNIMAS Top Down Grant SpTDG F07/SpTDG/1766/2018 awarded to Sazali S.N., Hazali, R. and Ismail, W.N.W.

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