

NEW RECORDS ON DISTRIBUTION AND HOSTS OF *Brachytarsina cucullata* AND *Raymondia pseudopagodarum* (DIPTERA: STREBLIDAE) IN VIETNAM

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Abstract. Bat flies are highly specialized ectoparasites of the superfamily Hippoboscoidea and only associate with bats. They were rarely documented in Vietnam due to limited study in the country. Between 2017 and 2020, we conducted a series of field surveys in six localities in northern and central Vietnam with an emphasis on bat flies. Bats were captured using mist nets, harp traps, and handnets then morphologically identified following literatures relevant to the bats of each study site. Bat flies were collected using fine forceps and preserved in 70% alcohol for morphological identification. Twelve individuals of *Brachytarsina cucullata* and thirty-five individuals of *Raymondia pseudopagodarum* of the family Streblidae were collected over the surveys. Of which, *B. cucullata* is new to two localities in northern Vietnam (Nham Duong Mountain Area and Ha Long Bay) while *R. pseudopagodarum* is new to five localities in both northern and southern Vietnam (Bach Ma National Park, Cat Ba National Park, Ha Long Bay, Cu Lao Cham Island and Sop Cop Nature Reserve). Within Vietnam, *B. cucullata* and *R. pseudopagodarum* were only recorded from Cat Ba National Park and Vu Quang National Park, respectively. Notably, the previous records from Vietnam did not include either description or illustration. We here provide brief descriptions and illustrated photos of each species for morphological identification of these two bat fly species. A map showing the distributional records of each species is also included in this paper.

Keywords: Bat fly, biodiversity, ectoparasites, Hippoboscoidea, Streblidae.

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1. Introduction

Cat Ba National Park and Ha Long Bay are two of the most well-known sites in Vietnam for their majestic natural scenery. They contain mature karst landscape with hundreds of caves which would be ideal homes to highly bat faunas. To date, bats have been well studied in Cat Ba National Park but still poorly studied in Ha Long Bay [1]

Bat flies are referred to nycteribiids and streblids of two families, Nycteribiidae and Streblidae, respectively. They are the most common bat ectoparasites [2]. To date, at least 275 nycteribiid species of 21 genera and 227 streblid species of 31 genera are described worldwide [2]. In Vietnam, 11 nycteribiid species of four genera (*Basilia burmensis*, *B. cucullata*, *B. magnoculus*, *B. majuscula*, *B. roylii*, *B. pudibunda*, *Leptocyclopodia ferrarii*, *Phthiridium fraternum*, *P. tonkinense*, *Eucampsipoda latisternum*) and six streblid species of four genera (*Brachytarsina amboinensis*, *B. falcozi*, *Raymondia pseudopagodarum*, *Ascodipteron phyllorhinae*, *A. wenzeli* and *Maabella stomalata*) have been recorded from different localities [3-6]. However, the previously published records of those 17 bat fly species from the country did not contain any either description or illustration. Based on specimens collected over the present study in Cat Ba National Park and Ha Long Bay, we here provide basic descriptions and illustrated images of *B. cucullata* and *R. pseudopagodarum* with highlights of new records for six study sites.

2. Content

2.1. Material and methods

Bats were captured and handled following guidelines recommended by the American Society of Mammalogists [7, 8]. A number of field surveys at six localities including Cat Ba National Park, Ha Long Bay were conducted following Thong et al. [9-11] between May 2017 and October 2020. Four-bank harp traps and mist nets of 6.0 m (height) × 9.0-12.0 m (length), mesh size 16 × 16 mm, were set up in front of or nearby caves or under canopy of natural vegetation. All captured bats were morphologically identified based on their morphological diagnoses which are identical to descriptions in previous publications relevant to the bat faunas of Cat Ba National Park and Ha Long Bay [1, 12-20]. Every bat was released after identification in the field.

Bat flies were collected using fine forceps and stored in 70% ethanol. Bat flies from each bat individual were stored in a single tube. Every collected bat fly individual was identified under stereomicroscope with reference to the morphological keys in Jobling [21]. The voucher specimens were deposited at the Department of Zoological Museum, Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology.

2.2. Results

2.2.1. First records of *Raymondia pseudopagodarum* from five localities in Vietnam

Three males and three females of *R. pseudopagodarum* were recorded from one leaf-nosed bat species (*Hipposideros grandis*) in Cat Ba National Park, Hai Phong city

and Ha Long Bay, Quang Ninh province (Figure 1; Table 1). Additionally, 12 males and 17 females of *R. pseudopagodarum* were recorded from two horseshoe bat species (*Rhinolophus affinis* and *R. pusillus*) in Bach Ma National Park, Thua Thien Hue province; Cu Lao Cham Island (an island of the Cham Marine Protected Area), Quang Nam province; Nham Duong Mountain Area, Hai Duong province (Figure 2). Morphological features of 35 collected bat flies from the study sites fit the diagnoses of *R. pseudopagodarum*: head rounded laterally; eyes absent; alula is not well-developed; setae are also absent on both occiput and alula. These first records indicated that *R. pseudopagodarum* is widespread species in Vietnam.

Table 1. *Raymondia pseudopagodarum* and its host species recorded from the study sites

Bat fly individuals	Host species	Study sites	Coordinates
2♂♂; 2♀♀	<i>H. grandis</i>	CB	20°47'22"N; 106°46'54"E
1♂; 1♀	<i>H. grandis</i>	HL	20°52'54"N; 107°1'40"E
7♂♂; 13♀♀	<i>R. affinis</i> ; <i>R. pusillus</i>	BM	16°11'48"N; 107°51'43"E
2♂♂	<i>R. affinis</i>	CLC	15°56'52"N; 108°31'51"E
3♂♂; 4♀♀	<i>R. pusillus</i>	SC	20°56'0"N; 103°42'0"E

Notes: CB = Cat Ba National Park; HL = Ha Long Bay; BM = Bach Ma National Park; CLC = Cham Islands Marine Protected Area; SC = Sop Cop Special Use Forest.

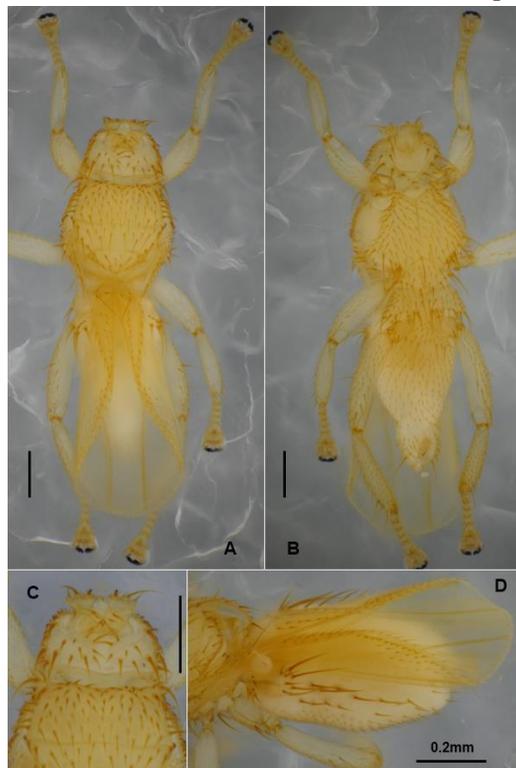


Figure 1. Dorsal (A), ventral (B), frontal (C), and lateral (D) views of *R. pseudopagodarum* (♀) from Cat Ba National Park. Scale = 0.2 mm

Three currently known host species of *R. pseudopagodarum* belong to two bat families, Hipposideridae and Rhinolophidae, of the superfamily Rhinolophoidea (Table 1). Each of these bat species was observed in colonies at different caves up to 50 individuals within each study site.

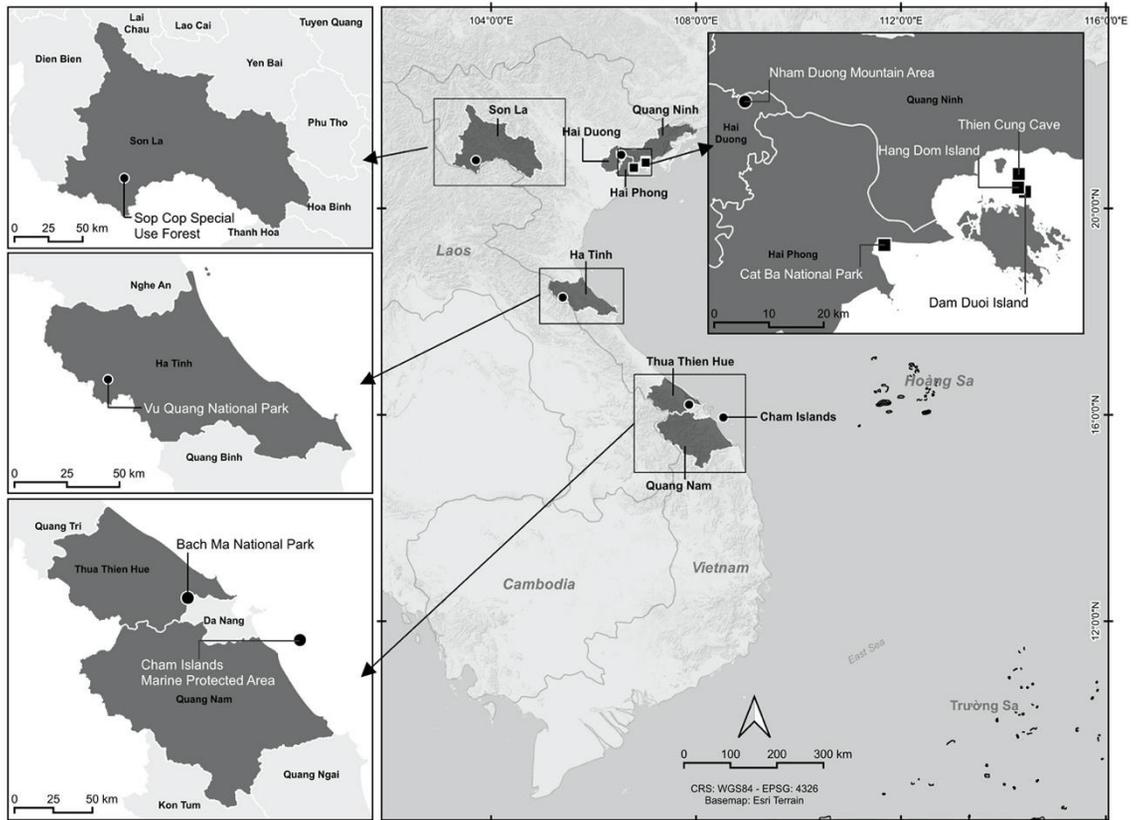


Figure 2. Study sites with records of *R. pseudopagodarum* (solid circle) or both *B. cucullata* and *R. pseudopagodarum* (solid square)

2.2.2. First records of *Brachytarsina cucullata* from two localities in Vietnam

Twelve individuals of *Brachytarsina cucullata* were recorded from an emballonurid bat species (*Taphozous menalopogon*) in three study sites: Cat Ba National Park (two males and two females), Ha Long Bay (three males and two females) and Nham Duong Mountain Area (two males and one female). Their morphological characteristics fit well the diagnoses of *B. cucullata*: body length is less than 2 mm; head is much more darkly pigmented than the body; postvertex is large and triangular; eyes are distinct and projected laterally; mediovertex is very distinct and broad; occiput is bare and just behind the postvertex; strong setae on laterovertices (Figure 3). These records are new to both Ha Long Bay and Nham Duong Mountain Area (Figure 1, Table 2).

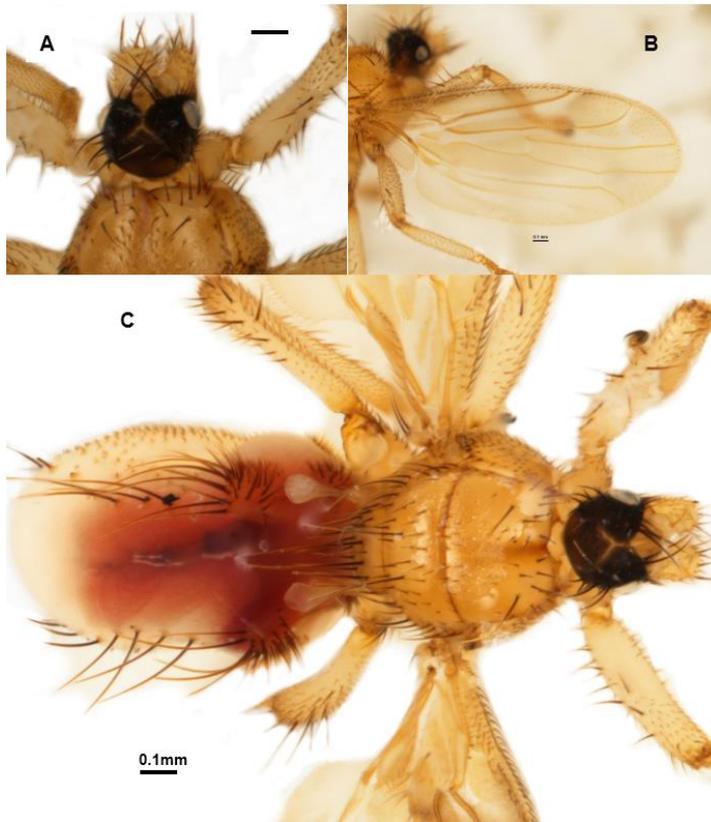


Figure 3. Head (A), wing (B) and dorsal view (C) of a female *Brachytarsina cucullata* from Cat Ba National Park (scale: 0.1 mm)

Table 2. *Brachytarsina cucullata* and its host species recorded from the study sites

Bat fly individuals	Host species	Study sites	Coordinates
2♂♂; 2♀♀	<i>T. menalopogon</i>	CB	20°47'22"N; 106°46'54"E
3♂♂; 2♀♀	<i>T. menalopogon</i>	HL	20°52'54"N; 107°1'40"E
2♂♂; 1♀	<i>T. menalopogon</i>	ND	21°2'19"N; 106°32'14"E

Notes: CB = Cat Ba National Park; HL = Ha Long Bay;

ND = Nham Duong Mountain Area.

2.3. Discussion

Although bats in these five study sites are highly diverse, *R. pseudopagodarum* was only found from three host species [22]. *Raymondia pseudopagodarum* was described in the Philippines by Jobling [21]. To date, *R. pseudopagodarum* is one of 21 described species of *Raymondia* worldwide (www.animaldiversity.org). Prior to the present study, *R. pseudopagodarum* was found in 24 host species belonging five families:

Pteropodidae (*Rousettus amplexicaudatus*, *Eonycteris spelaea*), Hipposideridae (*Hipposideros armiger*, *H. bicolor*, *H. cervinus*, *H. cineraceus*, *H. diadema*, *H. galeritus*, *H. gentilis*, *H. larvatus*, *H. lekaguli*, *H. pendleburyi*, *H. pygmaeus*, *H. speoris*), Rhinolophidae (*Rhinolophus affinis*, *R. arcuatus*, *R. blythi*, *R. malayanus*, *R. rufus*, *R. virgo*), Emballonuridae (*Mosia nigrescens*) and Miniopteridae (*Miniopterus australis*, *M. schreibersi*) [21, 23] from different countries in Asia (India, Malaysia, Myanmar, Philippines, Thailand, Vietnam and Africa (Uganda) [21, 24, 25]. Therefore, results from the present study provide new records in both geographical distribution and host (*H. grandis* and *R. pusillus*) of *R. pseudopagodarum*. Morphological characteristics of every captured individual of *R. pseudopagodarum* at the study sites are almost identical to descriptions in a previous publication [21, 26].

Brachytarsina cucullata was first described from Sri Lanka as *Nycteribosca cucullata* [27]. Its current taxonomic status (*Brachytarsina cucullata*) has been applied since 1965 [27, 28]. It is one of the 36 species belonging to *Brachytarsina* worldwide (www.animaldiversity.org). Prior to the present study, *B. cucullata* was known from nine bat species of six families: Pteropodidae (*Cynopterus brachyotis*), Hipposideridae (*H. diadema*) Megadermatidae (*Megaderma spasma*), Miniopteridae (*M. australis*, *M. schreibersi*), Rhinolophidae (*R. arcuatus*, *R. philippinensis*), and Emballonuridae (*T. melanopogon*, *T. theobaldi*) [21]. Over the present study, all specimens of *B. cucullata* were only recorded from one bat species (*T. melanopogon*) in both Cat Ba National Park and Ha Long Bay. Prior to the present study, within Vietnam, the only record of *B. cucullata* from Cat Ba National Park was published in 2018 [6]. Morphological characteristics of every captured individual of *B. cucullata* from the study sites are also identical to descriptions of this species in previous publications [23-29].

To date, bat flies in Vietnam are still poorly studied while bats in the country are quite diverse. It is very likely that further studies on bat flies in Vietnam can lead to discoveries in different aspects including taxonomy and ecology. The distribution and host species of *B. cucullata* and *R. pseudopagodarum* must be broader and more diverse, respectively.

3. Conclusions

Cat Ba National Park and Ha Long Bay are promising localities for not only bat research and conservation but also bat fly research. *Raymondia pseudopagodarum* is a widespread species in Vietnam while *B. cucullata* has been only recorded within three localities: Cat Ba National Park, Ha Long Bay, and Nham Duong Mountain Area. Within the country, currently known hosts of *R. pseudopagodarum* are three rhinolophoid bat species (*H. grandis*, *R. affinis* and *R. pusillus*) while the host of *B. cucullata* is an emballonurid bat species (*T. melanopogon*).

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