BIODIVERSITAS
Volume 26, Number 9, September 2025
Pages: 4606-4617

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d260931

Insect diversity and new records from mangrove forests of Cat Ba National Park, Vietnam, using multi-method sampling

THI ANH NGUYET NGUYEN[1], PHU VAN PHAM[2], TRANG QUYNH LE[3], THANH SON NGUYEN[1], ANH DUC TRAN[1], CUONG VAN DUONG[1,♥]

[1]Department of Applied Zoology, Faculty of Biology, VNU University of Science, Vietnam National University. 334 Nguyen Trai Street, Thanh Xuan, Hanoi 100000, Vietnam. Tel./fax.: +84-24-38585279, ♥email: duongvancuong@hus.edu.vn

[2]Department of Entomology, Institute of Biology, Vietnam Academy of Science and Technology. 18 Hoang Quoc Viet Street, Cau Giay, Hanoi 100000, Vietnam

[3]Center for Ecology and Resources, Institute of Advanced Technology, Vietnam Academy of Science and Technology. 1B TL29 Street, Quarter 1, Thạnh Loc Ward, District 12, Ho Chi Minh City 700000, Vietnam

Manuscript received: 21 May 2025. Revision accepted: 23 September 2025.

Abstract. *Nguyen TAN, Pham VP, Le TQ, Nguyen TS, Tran AD, Duong VC. 2025. Insect diversity and new records from mangrove forests of Cat Ba National Park, Vietnam, using multi-method sampling. Biodiversitas 26: 4606-4617.* Insects play key ecological roles in mangrove ecosystems, contributing to pollination, decomposition, and trophic interactions. These functions are critical for maintaining the structure, productivity, and resilience of mangrove habitats. Despite their ecological importance, insect communities in mangroves remain poorly studied in many parts of Southeast Asia, including Vietnam. Cat Ba National Park, located on an archipelago in northern Vietnam, encompasses diverse ecosystems such as tropical evergreen forests, mangrove forests, tidal flats, marine lakes, coral reefs, and soft-bottom habitats. Among these, mangrove forests are a vital natural resource for tropical coastal regions, including those of Cat Ba. This study presents the first comprehensive survey of insect diversity in the mangrove forests of Cat Ba National Park. Using multiple sampling methods, including sweep nets, light traps, and yellow pan traps, we recorded 163 insect species, representing 135 genera, 57 families, and 11 orders. Hemiptera was the most species-rich order (37 species), followed by Lepidoptera (31 species) and Diptera (28 species). Notably, eight species and four genera are newly recorded for Vietnam, highlighting the potential of mangrove habitats as reservoirs of undocumented biodiversity. Sweep nets proved most effective (which obtained 110 species), particularly for Hemiptera and Hymenoptera, followed by light traps (62 species), which primarily captured Lepidoptera (moths). Yellow pan traps yielded only 10 species, mainly Diptera. This study establishes a crucial baseline for future monitoring and offers insights applicable to other mangrove ecosystems in Southeast Asia that remain understudied.

Keywords: Cat Ba National Park, diversity, insects, mangroves

INTRODUCTION

Mangrove forests are among the most biologically diverse and productive ecosystems, offering vital ecological services such as coastal protection, carbon sequestration, and habitat provision for a wide range of terrestrial and aquatic species (Alongi 2002; Chen et al. 2024). The ecosystem, however, is highly vulnerable to environmental changes and anthropogenic disturbances, leading to significant biodiversity loss (Duke et al. 2007; Bhowmik et al. 2022; Chatting et al. 2022; Roy et al. 2023). Insects, one of the most diverse and ecologically significant groups in mangrove ecosystems, play key roles as pollinators for flowering mangrove plants, decomposers that facilitate nutrient cycling, and prey for birds, reptiles, amphibians, and fish, thereby maintaining food web stability (Yeo et al. 2021; Ferreira et al. 2024). Despite their importance, insect biodiversity in mangrove forests remains poorly documented, particularly in Southeast Asia, where habitat destruction and climate change threaten these fragile ecosystems (Basyuni et al. 2022; Roy et al. 2023; Chen et al. 2024; Ferreira et al. 2024). Noteworthy, Yeo et al. (2021) documented high insect species richness in Singapore mangroves using barcodes, identifying over 3,000 species with more than half being mangrove specialists. Similarly, Liu et al. (2018) used DNA barcoding to uncover over 200 insect species in the mangroves of Hainan Island, China, including pests, predators, and parasitoids. In Indonesia, Setyawan et al. (2020) found significant differences in insect community structure linked to canopy density, with richer assemblages in older mangroves.

In Vietnam, information on mangrove-associated insects remains fragmented and limited to a few taxonomic groups. Most studies have focused on pest species, such as the three leaf-insect pests reported from mangroves in the south-central coast (Do et al. 2020), or the leaf-insect pests and stem-borer beetles studied under integrated pest management programs in *Acacia* plantations (Vietnamese Academy of Forest Sciences 2023). Other studies have reported general insect fauna, for example, 24 species documented in the Tien Hai Wetland Nature Reserve in northern Vietnam (Bui and Ngo 2020). The scarcity of comprehensive and standardized data underscores a critical knowledge gap in understanding the ecological roles of insects in mangrove ecosystems and in evaluating biodiversity responses to environmental change within the country.

Cat Ba National Park, located on an archipelago in northern Vietnam, encompasses a variety of ecosystems, including limestone forests, coastal wetlands, seagrass beds, coral reefs, and mangrove forests. This region is of particular interest due to its rich biodiversity and unique environmental conditions, making it a critical area for conservation efforts (Cao and Nguyen 2018). The mangrove forests of Cat Ba National Park, covering approximately 650 hectares or 3.21% of the park's vegetation and 2.11% of its natural land area, are predominantly located in Phu Long commune and recently planted in Xuan Dam commune. These ecosystems support around 30 mangrove plant species, including 10 true mangrove species and 20 associated species, with dominant taxa such as *Aegicera corniculatum* (L.) Blanco, *Bruguiera gymnorrhiza* (L.) Lam., *Rhizophora mucronata* Lam. and *Kandelia candel* (L.) Druce (Cao and Nguyen 2018). Mangroves play a vital role in coastal protection, biodiversity conservation, and sustaining local livelihoods through fisheries and ecotourism. However, over recent decades, these forests have faced significant threats from expanding aquaculture and tourism, resulting in an estimated 15% reduction in mangrove area between 1994 and 2014 (Pham et al. 2014). This degradation, driven by habitat fragmentation and land-use changes, underscores the urgent need for targeted conservation strategies to protect these critical coastal ecosystems.

Given the ecological significance of Cat Ba National Park's mangroves, studies on their biodiversity remain limited, particularly those addressing insect communities. Previous surveys of insect fauna in the area have documented 274 species belonging to 79 families and 14 orders, with Lepidoptera being the most studied, comprising 186 species in 131 genera and 10 families (Pham et al. 2014). Notably, most insect species have been investigated within the tropical evergreen forests of the national park, leaving the mangrove ecosystems entirely unexplored to date. This knowledge gap requires a comprehensive understanding of the ecological roles and diversity of insects within these vital habitats. Further, investigating insect species composition and their distribution in Cat Ba's mangrove forests is critical for informing effective conservation and restoration strategies. Such studies are essential to address the impacts of ongoing habitat degradation, enhance ecosystem resilience, and support the long-term sustainability of this unique coastal environment.

This study aims to provide the first comprehensive assessment of insect fauna in the mangrove ecosystems of Cat Ba National Park, with a focus on documenting species composition. Furthermore, because insects occupy diverse microhabitats and exhibit varied behaviors, the application of multiple sampling methods is essential for obtaining comprehensive data on species richness and producing more standardized datasets. As the effectiveness of sampling techniques has not been evaluated in mangrove forests in Vietnam, this study provides a baseline for selecting sampling methods, enhances understanding of mangrove insect diversity, and supports the sustainable management of this important ecosystem in Vietnam.

MATERIALS AND METHODS

Sampling sites

Given that mangroves of Cat Ba National Park in Vietnam are predominantly present in Phu Long and Xuan Dam, a total of five transects (T1-T5) were established to encompass the majority of the mangrove forest area, with four located in Phu Long and one in Xuan Dam (Figure 1). Each transect was 1.0 km long and was spaced at least 100 meters apart to avoid overlapping sampling areas. The field surveys were conducted in two periods during the hot-rainy season in northern Vietnam, from July 10 to 20 and from October 20 to 30, 2024 (Table 1).

Table 1. Sampling design across five transects in Cat Ba National Park, Hai Phong Province, Vietnam. Transect abbreviations correspond to Figure 1; S: starting point, E: ending point.

Transect	Collection date	Coordinates	Sampling methods	Sampling effort
T1	10-11/07/2024	S: 20.814961, 106.926168	Sweep net	1 time/period
	20-21/10/2024	E: 20.824449, 106.923307	Light trap	1 trap/period
			Yellow pan trap	20 traps/period
T2	12-13/07/2024	S: 20.811399, 106.930060	Sweep net	1 time/period
	22-23/10/2024	E: 20.807963, 106.927472	Light trap	1 trap/period
			Yellow pan trap	20 traps/period
T3	14-15/07/2024	S: 20.801251, 106.929470	Sweep net	1 time/period
	24-25/10/2024	E: 20.800435, 106.924751	Light trap	1 trap/period
			Yellow pan trap	20 traps/period
T4	16-17/07/2024	S: 20.797081, 106.944240	Sweep net	1 time/period
	26-27/10/2024	E: 20.797444, 106.933348	Yellow pan trap	20 traps/period
T5	18-20/07/2024	S: 20.765714, 106.975397	Sweep net	1 time/period
	28-30/10/2024	E: 20.758923, 106.976085	Light trap	1 trap/period
			Yellow pan trap	20 traps/period

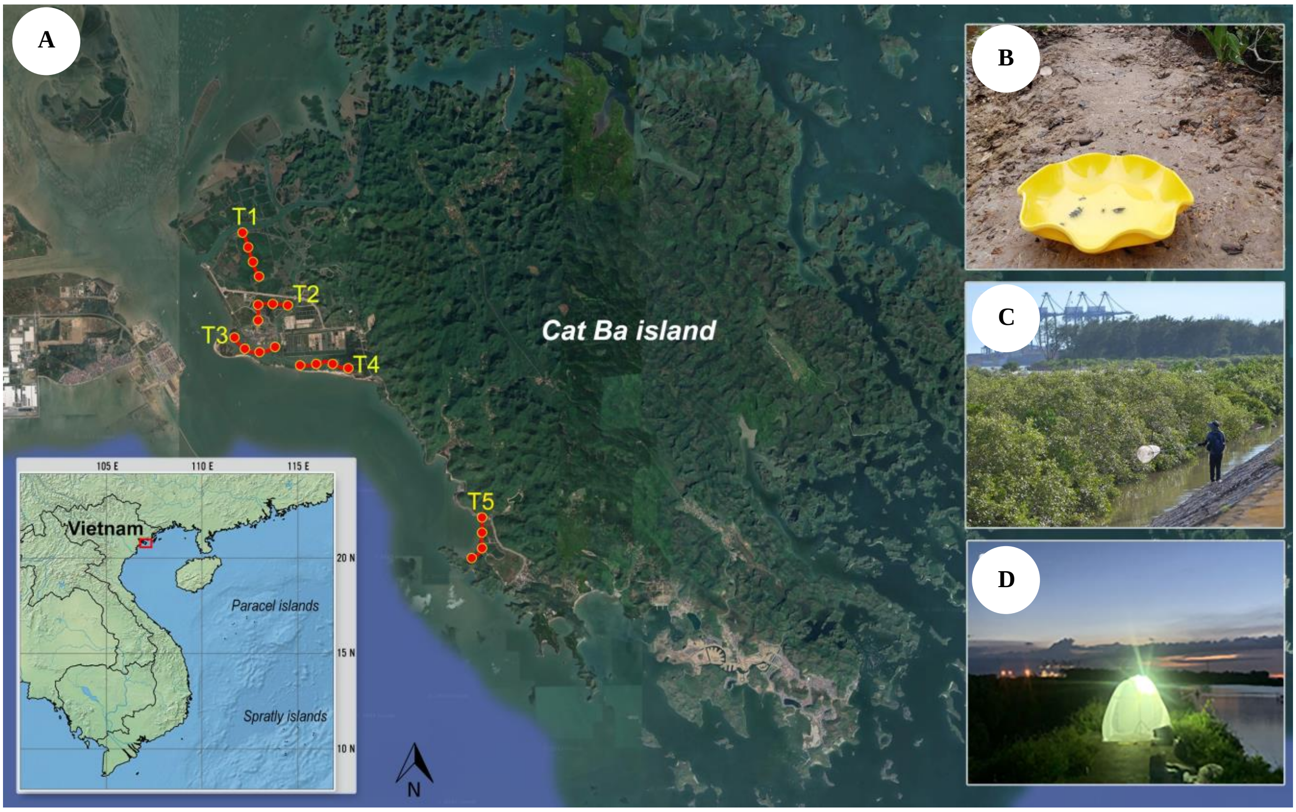

Figure 1. The survey transects and sampling methods in the mangrove forest in Cat Ba National Park, Hai Phong Province, Vietnam. A: Sampling transects, B: Sweep net, C: Light trap, D: Yellow pan trap. The red dot represents a sampling point in each transect. The basemap was retrieved from Google Earth on 26/4/2025

Sampling methods

Three standard sampling methods, including sweep nets, light traps, and yellow pan traps, were used in all transects to capture a broader range of insects (Southwood and Henderson 2000). Specifically, sweep nets were applied systematically at each 250-meter interval along each transect (4 sampling points per transect, Figure 1) in vegetated areas, including grass, shrubs, and herbaceous layers, where insects are known to be active and abundant. An additional sweep was performed along coastal zones characterized by rock pools, sandy substrates, and accumulations of seaweed, which often serve as important microhabitats for detritivores and salt-tolerant species. For passive sampling of flying and surface-active insects, yellow pan traps were utilized due to their proven attractiveness to a wide range of insect taxa. They were placed at 50-meter intervals, resulting in a total of 20 traps per transect. The traps were placed on the ground for 10 hours during the day. Additionally, a light trap was placed at the center of each transect, generally located in open mangrove clearings near the shoreline. The light traps were equipped with two 250W mercury vapor lamps, chosen for their broad-spectrum emission and intense attraction to a wide range of nocturnal insects. The traps were positioned at least 1.5 meters above ground level to optimize visibility and minimize ground interference. Trapping was conducted nightly from 18:00 to 23:00, corresponding to peak activity periods of many nocturnal insect species. It is well known that different types of traps are biased toward different taxa (Spence and Niemela 1994). Therefore, we used only qualitative data (species richness) to compare the effectiveness of the methods.

Taxonomic identification

Samples were sorted and preserved either dry or in 80% ethanol, depending on the specimen type and intended analysis, at the laboratory of the Department of Applied Zoology, Faculty of Biology, VNU University of Science, Vietnam National University, Vietnam. The specimens were identified using relevant taxonomic references and keys (Wiedemann 1821; Dolling 1978; Murphy 1990; Schaefer 1995; Schuh and Slater 1995; Yélamos and Vienna 1995; Evenhuis and Greathead 1999; Nieser 2004; Rattanarithikul et al. 2005; Zhao et al. 2005; Cassis and Vanags 2006; Rédei 2009; Lee 2010; Henry 2012; Kononenko and Pinratana 2013; Tomasovic et al. 2013; Tkoč and Rozkošný 2014; Salini and Viraktamath 2015; Bouchard et al. 2017; Jung et al. 2017; Yasunaga and Duwal 2017; Kailash et al. 2019; Nguyen 2020; Yasunaga and Shishido 2020; Tran et al. 2023; Kim et al. 2025).

RESULTS AND DISCUSSION

Species composition

A total of 163 insect species belonging to 135 genera and 57 families were recorded across 11 orders (Figure 2, Table S1). Among these, Hemiptera was the most taxonomically diverse, with 16 families, 30 genera, and 37 species, followed by Lepidoptera (7 families, 29 genera, 31 species), and by Diptera (9 families, 20 genera, 28 species). The orders Blattodea, Dermaptera, Mantodea, and Neuroptera were represented by only one family, one genus, and one species each (Figure 2).

Notably, we recorded the butterfly species *Troides aeacus* (C. & R. Felder, 1860), listed in the Vietnam Red List of Threatened Species, from Xuan Dam (Figure 3). Furthermore, we obtained eight species as first records for Vietnam, among which four also represent four newly recorded genera for the country. Further details about these taxa are presented as follows.

Order: Hemiptera

Family: Miridae

Genus: *Melanotrichus* Reuter, 1875

Species: *Melanotrichus halimus* Yasunaga, 2020

Material examined: Vietnam: 18♂, 15♀, Hai Phong, Cat Ba National Park (20.812730, 106.924769; 20.800416, 106.923924), 10-11.VII.2024, 21.X.2024 (Nguyen, TAN; Duong, CV) (Figures 4.A-B, 5.D-F).

Distribution: Vietnam (first record), Japan (Yasunaga and Shishido 2020).

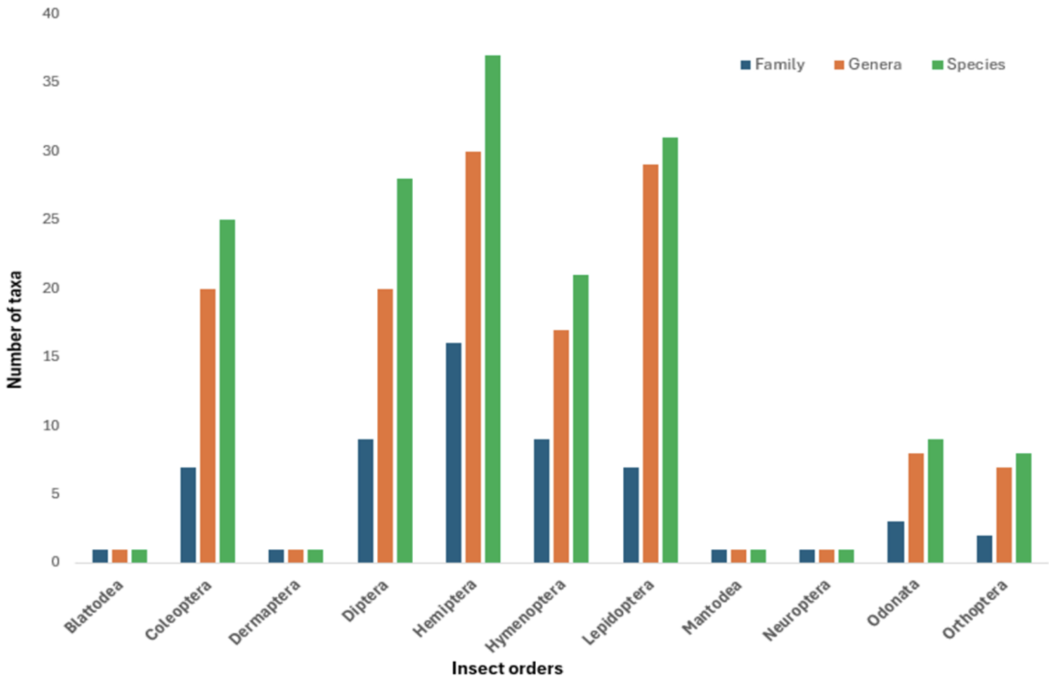

Figure 2. Number of insect families, genera, and species recorded in mangrove forests in Cat Ba National Park, Vietnam, from field surveys in 2024

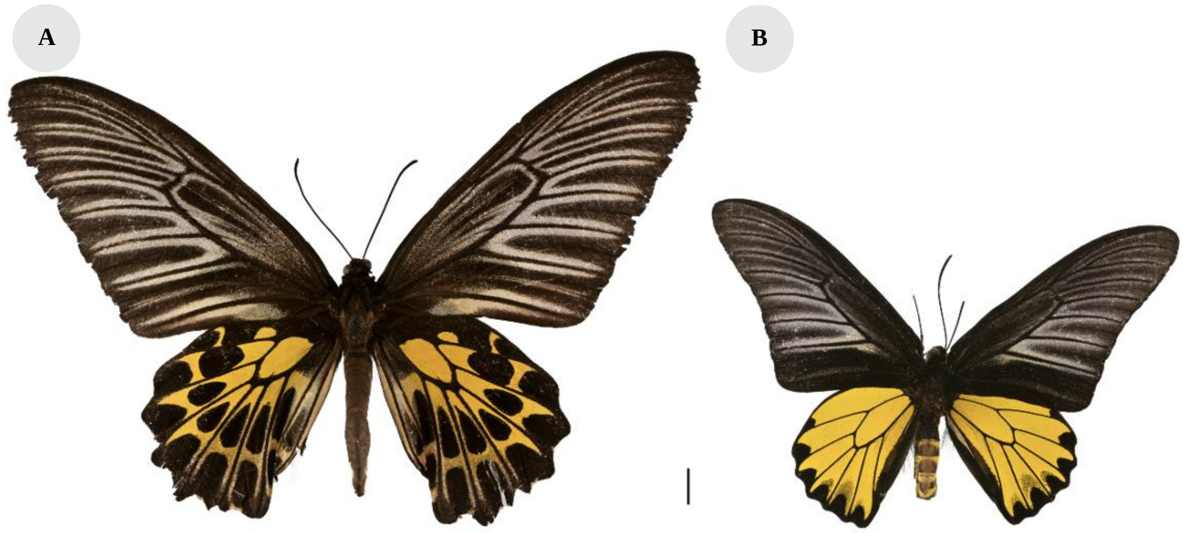

Figure 3. *Troides aeacus*, a threatened species of Vietnam, was recorded from the mangrove forests in Cat Ba National Park. A: Female, B: Male. Scale bar: 1 cm

Taxonomic note: This species is characterized by the following characteristics: the small size (male body length 2.4-2.6 mm, female body length 2.5-2.6 mm); the short labium reaching only the base of the mesocoxa; the shiny dorsal surface lacking dense microvestiture, bearing uniformly distributed dark, simple, semierect setae along with silvery, flattened setae; the strongly curved left paramere (Figure 5.E), with the two tips of sensory lobe nearly contiguous; and a wide, flattened hypophysis of the right paramere (Figure 5.F). The samples of *M. halimus* and *M. parvulus* (Reuter, 1879) in this study also present the first records of the genus *Melanotrichus* in Vietnam.

Host plant: This species was only collected on *Suaeda maritima* (L.) Dumort 1827 (family Amaranthaceae) in this study, similar to the observation by Yasunaga and Shishido (2020).

Order: Hemiptera

Family: Miridae

Genus: *Melanotrichus* Reuter, 1875

Species: *Melanotrichus parvulus* (Reuter, 1879)

Material examined: Vietnam: 7♂, 8♀, Hai Phong, Cat Ba National Park (20.812730, 106.924769), 11.VII.2024 (Nguyen, TAN; Duong, CV) (Figures 4.C-D, 5.G-I).

Distribution: Vietnam (first record), Japan, Korea, China, Russia, Kazakhstan, Ukraine, Mongolia (Yasunaga and Shishido 2020).

Taxonomic note: This species is recognized by the following characteristics: the long labium extending beyond the apex of the mesocoxa; uniformly and rather densely distributed silvery setae on the dorsum; sparser micro-vestiture on the head, scutellum, propleuron, and forewing; and the left paramere (Figure 5.H) bearing a triangular sensory lobe and a long, curved, apically pointed hypophysis.

Host plant: This species was only collected on *Suaeda maritima* in the mangrove of Cat Ba National Park, while they have been found in other plants in northern Asia, such as *Suaeda japonica* Makino (Amaranthaceae), *Salicornia* sp. (Chenopodiaceae) (Jung et al. 2017).

Order: Hemiptera

Family: Miridae

Genus: *Tytthus* Fieber, 1864

Species: *Tytthus parviceps* (Reuter, 1890)

Material examined: Vietnam: 1♂, 2♀, Hai Phong, Cat Ba National Park (20.812730, 106.924769), 11.VII.2024 (Nguyen, TAN; Duong, CV) (Figures 4.E, 5A-C).

Distribution: Vietnam (first record), Central and South America, southern Europe, the Middle East, Africa, eastern and southeastern Asia, Australia, India, islands in the Indian, Pacific, and southern Atlantic oceans. In Southeast Asia, this species has been recorded in the Philippines (Henry 2012).

Taxonomic note: This species is recognized by the combination: the black head bearing large yellow interocular spots; the pale yellow anterior pronotal area in almost all specimens; the left paramere (Figure 5.A) with a long, broad, nearly triangular, and apically blunt right arm and a comparatively long and apically pointed left arm.

The sample of *T. parviceps* in this study also presents the first record of the genus *Tytthus* in Vietnam.

Host plant: In the New World, *T. parviceps* has been recorded on sugarcane in Florida and Ecuador, associated with the delphacids *Saccharosydne saccharivora* (Westwood, 1833) and *Perkinsiella saccharicida* (Kirkaldy, 1903). It has also been collected on *Spartina alterniflora* Loisel (Poaceae) in North Carolina. In the Old World, the species preys on eggs of *Nilaparvata lugens* (Stål, 1854) in India and the sugarcane delphacid in Australia.

Order: Hemiptera

Family: Pyrrhocoridae

Genus: *Dysdercus* Guerin-Méneville, 1831

Species: *Dysdercus decussatus* (Boisduval, 1835)

Material examined: Vietnam: 2♂, 2♀, Hai Phong, Cat Ba National Park (20.800416, 106.923924), 10.VII.2024 (Nguyen, TAN; Duong, CV) (Figure 4.F).

Distribution: Vietnam (first record), Sri Lanka, Australia, India, Japan, China, Taiwan, Indonesia, Malaysia, Philippines, Singapore (Murphy 1990; Rédei et al. 2009).

Taxonomic note: This species is distinguished by its X-shaped white pattern on the forewings.

Host plant: *Hibiscus* and *Thespesia* spp. (Malvaceae) have been recorded as host plants of the species (Murphy 1990; Rédei et al. 2009). In Cat Ba National Park, this species was collected on *Hibiscus tiliaceus* L.

Order: Diptera

Family: Asilidae

Genus: *Emphysomera* Schiner, 1866

Species: *Emphysomera conopsoides* (Wiedemann, 1828)

Material examined: Vietnam: 2♂, 3♀, Hai Phong, Cat Ba National Park (20.812730, 106.924769; 20.797305, 106.942971; 20.763539, 106.975417), 10.VII.2024 (Nguyen, TAN; Duong, CV) (Figure 6.A).

Distribution: Vietnam (first record), China, Indonesia, Malaysia, Laos, and Taiwan (Scarbrough and Marascia 1999; Tomasovic et al. 2013).

Taxonomic note: *Emphysomera conopsoides* is distinguished by the cylindrical, unbanded abdomen, the scutellum bearing a complete marginal row of setae, and hyaline wings with veins R4+5 and M1 nearly straight and parallel apically. The mystax, composed of mixed black and yellow setae, also separates this species from its congeners in the Oriental Region (Scarbrough and Marascia 1999).

Order: Diptera

Family: Bombyliidae

Genus: *Toxophora* Meigen, 1803

Species: *Toxophora iavana* Wiedemann, 1821

Material examined: Vietnam: 3♀, Hai Phong, Cat Ba National Park (20.812730, 106.924769), 10.VII.2024 (Nguyen, TAN; Duong, CV) (Figure 6.B).

Distribution: Vietnam (first record), India, China, India, Hong Kong, Indonesia, Laos, Malaysia, Philippines (Wiedemann 1821; Evenhuis and Greathead 1999).

Taxonomic note: *Toxophora iavana* can be distinguished by the coppery abdomen bearing a narrow whitish median stripe and broad serrate lateral stripes, the elongate first antennal segment, the smoky wings with a yellowish base and costal area, and white halteres. Other Oriental *Toxophora* species have different abdominal and wing patterns (Wiedemann 1821).

The specimen of *T. iavana* in this study also presents the first record of the genus *Toxophora* in Vietnam.

Order: Diptera

Family: Stratiomyidae

Genus: *Oplodontha* Rondani, 1863

Species: *Oplodontha minuta* (Fabricius, 1794)

Material examined: Vietnam: 2♂, 5♀, Hai Phong, Cat Ba National Park (20.812730, 106.924769), 10/7/2024 (Nguyen, TAN; Duong, CV) (Figure 7).

Distribution: Vietnam (first record), Palearctic, Afrotropical, and Oriental Region (Afghanistan, Egypt, India, Sri Lanka, United Arab Emirates, Yemen: Socotra Island) (Tkoč and Rozkošný 2014).

Taxonomic note: This species of soldier fly is characterized by the following characteristics: small size (body length ca. 5-9 mm); the head with a typically conspicuous, though variable, ivory-to-pale facial and pleural pattern; antenna about 0.7× head length; the spindle-shaped flagellum composed of several flagellomeres; the tiny discal (d) wing cell fused with R; R2+3 fused with R1; and the absence of R4 and M3 veins (a genus-level character); abdomen typically with pale posterior marginal vittae on tergites I-III (variable); and the pale ivory venter (Figure 7). The sample of *O. minuta* in this study also presents the first record of the genus *Oplodontha* in Vietnam.

Order: Coleoptera

Family: Histeridae

Genus: *Nasaltus* Mazur and Wegrzynowicz, 2008

Species: *Nasaltus orientalis* (Paykull, 1811)

Material examined: Vietnam: 2♂, Hai Phong, Cat Ba National Park (20.812730, 106.924769), 10.VII.2024 (Nguyen, TAN; Duong, CV) (Figure 8).

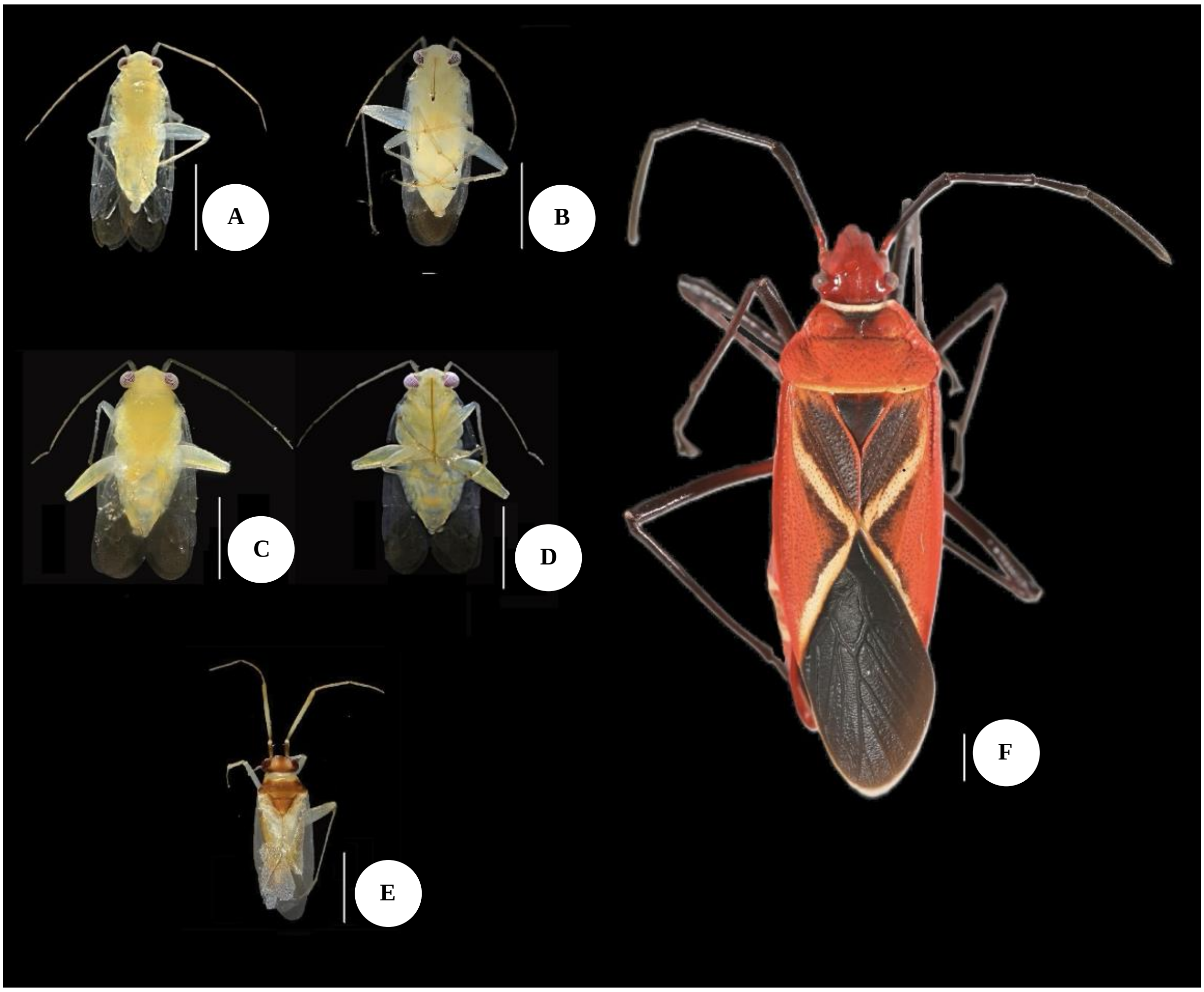

Figure 4. Habitus of hemipteran species which are first records for Vietnam. A: *Melanotrichus halimus* (male), B: Ventral view *Melanotrichus halimus* (male), C: *Melanotrichus parvulus* (male), D: Ventral view *Melanotrichus parvulus* (male), E: *Tytthus parviceps* (male), F: *Dysdercus decussatus* (female). Scale bar: 1 mm

Distribution: Vietnam (first record), Pakistan, East India, Nepal, China, Sri Lanka, Seychelles (Yélamos and Vienna 1995).

Taxonomic note: *Nasaltus orientalis* can be recognized by an oval, convex body form; the elytra with the first to fourth striae complete and the fifth strip abbreviated; and the prosternal keel that is narrow and anteriorly truncate. The species also exhibits a mesoventrite bearing a median carina and the protibia bearing three outer teeth (Figure 8). These characters differentiate it from related Oriental *Nasaltus* species.

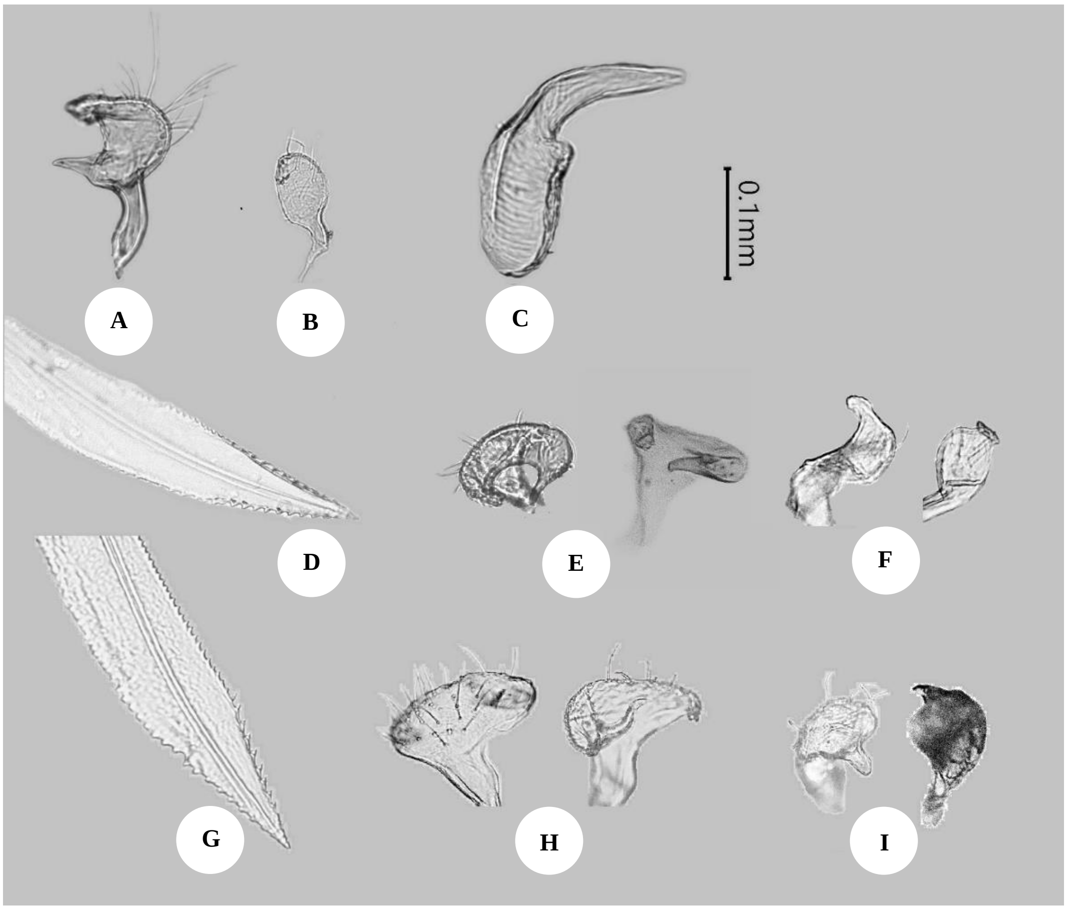

Figure 5. Genitalic structures of three species of Miridae, which are the first records for Vietnam. A-C: *Tytthus parviceps*; D-F: *Melanotrichus halimu*; G-I: *Melanotrichus parvulus*; A, E, H: Left paramere; B, F, I: Right paramere; C: Phallotheca; D, G: Apex of ovipositor (gonapophysis II)

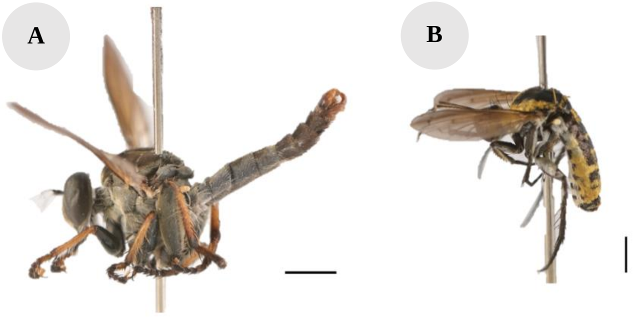

Figure 6. Habitus of dipteran species, which are first records for Vietnam. A: *Emphysomera conopsoides* (male), B: *Toxophora iavana* (female). Scale bar: 1 mm

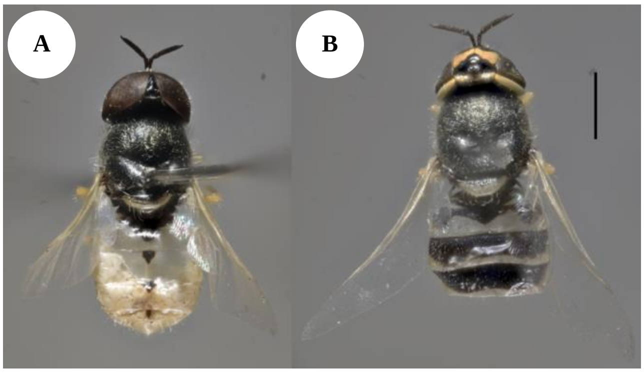

Figure 7. Habitus of *Oplodontha minuta* (order Diptera), first record for Vietnam (A: male, B: female). Scale bar: 1 mm

Collection methods' efficiency

Three collection methods demonstrated varying levels of efficiency. The sweep net method yielded the highest number of species (110 species), followed by light traps (62 species) and yellow pan traps (10 species) (Figure 8). Sweep nets were particularly effective for collecting Hemiptera (30 species), Hymenoptera (19 species), and Diptera (21 species). Light traps were particularly effective for sampling Lepidoptera (27 species) and contributed significantly to the collection of Hemiptera (14 species) and Coleoptera (9 species). The yellow pan trap contributed only marginally, yielding 8 species of Diptera, and only one species of Hymenoptera and Orthoptera each (Figure 9).

Discussion

This study provides the first comprehensive assessment of insect fauna in a mangrove forest ecosystem in Vietnam, revealing high species richness across 11 orders. Notably, eight species and four genera are newly recorded for Vietnam, underscoring the biodiversity value of this habitat in tropical regions. Additionally, sweep nets indicated the most effective method for sampling a broad spectrum of insects in mangrove forests, especially Hemiptera and Hymenoptera. At the same time, light traps were more effective for Lepidoptera. Although yellow pan traps yielded fewer species, they helped capture unique Diptera taxa. These results highlight the potential of mangroves as a hotspot of insect biodiversity and reservoirs of undocumented fauna. These results also emphasize the importance of applying multiple sampling methods to capture taxonomic breadth in complex ecosystems such as mangroves.

Our results also highlight the ecological value of Cat Ba's mangrove insect fauna while acknowledging that the number of recorded taxa is lower compared to other Southeast Asian sites such as Singapore, where more than 3000 species were estimated (Yeo et al. 2021), or in Hainan, where 219 species were reported (Liu et al. 2018). This discrepancy may be due to the absence of molecular tools like DNA barcoding, which can reveal cryptic diversity. Furthermore, Cat Ba National Park includes several islands with fragmented mangroves disconnected from the mainland, which may naturally sustain fewer specialized insect niches than larger or more continuous mangrove systems. Nonetheless, the distinct composition observed and the findings of a vulnerable species and eight newly recorded species in mangrove forests in Cat Ba National Park reinforce the role of mangrove ecosystems as biodiversity hotspots, supporting a wide range of insect taxa, including conservation-priority and endemic species (Yeo et al. 2021).

Among insect orders recorded in this study, Hemiptera was the most species-rich group (37 species), probably because species of this order have various feeding types, such as sap-sucking, seed and leaf feeding, and predation (Schuh and Slater 1995). Furthermore, this group includes several aquatic and semi-aquatic taxa, which are well-adapted to brackish, stagnant, or intertidal zones found in mangroves, including *Asclepios apicalis* (Esaki, 1924), *Asclepios esakii* Tran, Le & Nguyen, 2023, and *Xenobates murphyi* Andersen, 2000 (Andersen 1999; Tran et al. 2023). Likewise, the high diversity of Lepidoptera (31 species) and Diptera (28 species) is often linked to the presence of flowering plants and decaying organic matter, respectively, both of which are prevalent in mangrove environments (Kailash et al. 2019). Several orders, such as Blattodea, Dermaptera, Mantodea, and Neuroptera, were represented by only one species each, which may reflect the specialized or cryptic nature of these groups in mangrove ecosystems or the limitations of identification keys in Southeast Asia (Giangrande 2003). Further long-term and seasonal sampling would likely uncover additional species, especially those with specific life-history traits or phenologies (Kailash et al. 2019).

Among the 163 species collected, several can be considered characteristic of the mangrove ecosystem, such as *Calliphara nobilis* (Linnaeus, 1763), which is associated with true mangrove host plants such as *Rhizophora* sp. (Cassis and Vanags 2006). Additionally, three newly recorded Hemipteran species, including two species of Miridae, *M. halimus* and *M. parvulus*, are linked to the mangrove-associated plant *Suaeda maritima*. In contrast, a species of Pyrrhocoridae-*D. decussatus* is strongly associated with *Hibiscus tiliaceus*.

Figure 8. Habitus of *Nasaltus orientalis* (order Coleoptera, male), first record for Vietnam. Scale bar: 1 mm

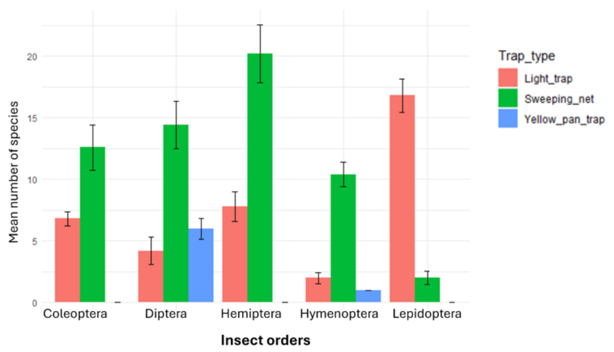

Figure 9. Mean number of species (±standard error) collected from major insect orders using three different sampling methods (light trap-red, sweep net-green, and yellow pan trap-blue) in Cat Ba National Park, Vietnam

Furthermore, several mosquito species identified in the mangrove forest of Cat Ba National Park are known or suspected vectors of human diseases, highlighting potential public health concerns. *Anopheles barbumbrosus* Strickland & Chowdhury, 1927 has been implicated as a secondary vector of malaria in some Southeast Asian regions (Elyazar et al. 2013), whereas *Culex sitiens* Wiedemann, 1828 and *Culex vishnui* Theobald, 1901 have been recorded as vectors of Japanese encephalitis virus, particularly in coastal and rice-growing areas (Auerswald et al. 2021). Given the sensitivity of insects to environmental change, insect communities in this study demonstrate strong potential as bioindicators for mangrove ecosystem health and underscore the importance of mosquito surveillance and vector control in mangrove habitats located close to residential or tourism areas.

Among the three trapping methods used, sweep nets yielded the highest species richness (110 species), particularly for Hemiptera, Diptera, and Coleoptera. This active sampling method proved especially effective in structurally complex environments such as mangrove ecosystems, characterized by a strong association between insect fauna and vegetative strata (Giangrande 2003). Additionally, light traps recorded 62 species, with high efficiency in capturing nocturnal and phototactic taxa such as Lepidoptera and Diptera. This confirms previous observations that light traps are valuable tools for assessing night-active insect communities, especially moths and mosquitoes (Giangrande 2003). Notably, Lepidoptera was the most represented order in light traps (27 species), highlighting the method's taxon-specific selectivity and suggesting the importance of light traps in studying the diversity of this group in tropical mangrove forests. In addition, many families of other orders were only collected by light traps, including Histeridae, Lucanidae, and Tenebrionidae (Coleoptera), Cydnidae, Largidae, Reduviidae, and Rhyparochromidae (Hemiptera). This may reflect their elusive behavior during the daytime, which was not captured by sweep nets in this study, and their attraction to light traps at night (Southwood and Henderson 2000). Notably, our results revealed an atypical pattern in the distribution of insect groups across sampling methods. Specifically, light traps yielded unusually high species richness of Lepidoptera but relatively low numbers of Hemiptera and Coleoptera compared to expectations from other tropical forest studies (Gadagkar et al. 1990). The structural and environmental characteristics of mangrove habitats likely influence this pattern. Light traps were placed in open clearings near the shoreline, where strong phototactic responses of moths contributed to the high Lepidoptera capture. In contrast, wind exposure and reduced canopy density may have limited nocturnal flight activity of smaller insects such as Hemiptera and Coleoptera. These factors may have biased trap effectiveness toward moths while underrepresenting other groups. Therefore, future surveys in mangroves should incorporate a combination of light traps in both open and canopy-dense sites, alongside complementary techniques such as suction sampling or canopy fogging, to obtain a more balanced representation of insect diversity.

Yellow pan traps, though being the least effective method with only 10 species captured, yielded a unique subset of insects, mainly small-bodied dipterans (Table S1). While these traps are often used to sample pollinators and parasitoids in flowering habitats (Giangrande 2003), their limited efficiency in mangrove environments may be due to lower flowering plant density or insect color preferences. Furthermore, previous studies have showed that Malaise traps are more effective in collecting dipteran species in mangrove forests (Yeo et al. 2021). Therefore, we encourage the application of malaise traps in future studies on mangrove insects. The complementarity of different trapping methods emphasizes the need for a multi-method approach in biodiversity surveys in tropical mangrove forests. Additionally, while this study focuses on qualitative assessments of insect composition, we acknowledge the absence of quantitative diversity analyses. This limitation reflects the exploratory nature and non-uniform effort across methods. Future studies should also incorporate standardized sampling protocols to enable robust diversity metrics and facilitate temporal comparisons.

In conclusion, this study provides the first comprehensive assessment of insect biodiversity in the mangrove forests of Cat Ba National Park, offering essential baseline data for one of Vietnam's most ecologically significant and vulnerable ecosystems. Our findings reveal a diverse and taxonomically rich insect community closely associated with the heterogeneous mangrove flora and demonstrate that trapping methods significantly influence observed taxonomic composition. While the recorded species richness is lower than in other nearby mangrove regions, this may reflect limited use of DNA barcoding-based identification methods rather than true diversity, underscoring the need for improved approaches alongside expanded and repeated surveys. The species inventory presented here serves as a baseline for future taxonomic studies, ecological monitoring, and conservation planning. To better capture the full extent of insect diversity and its spatial-temporal dynamics, future research should incorporate broader seasonal coverage, additional trapping techniques, and finer-scale habitat differentiation. These efforts will strengthen the use of insects as sensitive bioindicators for environmental change in mangrove ecosystems.

ACKNOWLEDGEMENTS

We thank colleagues and students from the Department of Applied Zoology, University of Science, Vietnam National University, Vietnam, for their valuable technical assistance in the field, as well as the local communities at the sampling sites for their kind cooperation. We are especially grateful to Prof. Nguyen Thi Phuong Lien, Dr. Pham Thi Nhi, Dr. Phan Quoc Toan, and Dr. Tran Thi Ngat for their support in species identification. We also extend our sincere thanks to Ms. Nguyen Nguyet Minh, English lecturer at the University of Languages and International Studies, Vietnam National University, for her assistance with English proofreading and language refinement. This research was supported by the Rufford Small Grant (Grant number: 42278-1).

REFERENCES

Andersen NMS. 1999. The evolution of marine insects: Phylogenetic, ecological and geographical aspects of species diversity in marine water striders. Ecography 22: 98-111. DOI: 10.1111/j.1600-0587.1999.tb00458.x.

Alongi DM. 2002. Present state and future of the world's mangrove forests. Environ Conserv 29: 331-49. DOI: 10.1017/S0376892902000231.

Auerswald H, Pierre OM, Véronique C, Sebastien B. 2021. Mosquito vector competence for Japanese encephalitis virus. Viruses 13 (6): 1-26. DOI: 10.3390/v13061154.

Basyuni M, Sigit DS, Kangkuso A, Tengku ZU, Meli FS, Syaiful E, Noril M. 2022. Mangrove biodiversity, conservation and roles for livelihoods in Indonesia. In: Das SC, Pullaiah, Ashton EC (eds). Mangroves Biodiversity, Livelihoods Conservation. Springer Nature, Singapore.

Bhowmik AK, Rajchandar P, Pedro C, Maria MR. 2022. Global mangrove deforestation and its interacting social-ecological drivers: A systematic review and synthesis. Sustainability 14 (8): 1-24. DOI: 10.3390/su14084433.

Bouchard P, Andrew BTS, Hume D, Matthew LG, Adam JB, Kojun K. 2017. Biodiversity of coleoptera. In: Foottit RG, Adle PH (eds). Insect Biodiversity: Science and Society. John Wiley and Sons Ltd, United States.

Bui MH, Ngo TH. 2020. Diversity of insect species in Tien Hai wetland nature reserve, Thai Binh province. TNU J Sci Technol 225: 17-23.

Cao TTN, Nguyen ST. 2018. Biodiversity research and conservation in Cat Ba National Park with Updated records from recent field surveys. J Vietnam Environ 9: 285-90. DOI: 10.13141/jve.vol9.no5.pp285-290.

Cassis G, Vanags L. 2006. Jewel bugs of Australia (Insecta, Heteroptera, Scutelleridae) Hug the Bug-For Love of the True Bugs. Denisia 19, Zugleich Kataloge der OÖ. Landesmuseen Neue Serie 50: 275-398.

Chatting M, Ibrahim A, Mark W, Martin WS, Hilary K, Sinan YH, Lewis LV. 2022. Future mangrove carbon storage under climate change and deforestation. Front Mar Sci 9: 781876. DOI: 10.3389/fmars.2022.781876.

Chen W, Tianci G, Jingwei X, Ting L, Jie Z, Yanghaoyue Y. 2024. Ecological Restoration zoning of territorial space in China: An ecosystem health perspective. J Environ Manag 364: 121371. DOI: 10.1016/j.jenvman.2024.121371.

Do QM, Trinh VH, Nguyen QH, Le VT, Nguyen HH. 2020. Mangroves in the South Central Coast of Vietnam. Agricultural Publish House, Vietnam.

Dolling WR. 1978. A revision of the oriental pod bugs of the tribe Clavigrallini (Hemiptera: Coreidae). Bull Br Mus Entomol 36: 281-321.

Duke NC, Meynecke JO, Dittmann S, Ellison AM, Anger K, Berger U, Cannicci S. 2007. A world without mangroves? Science 317: 41-42. DOI: 10.1126/science.317.5834.41b.

Elyazar IRF, Marianne ES, Peter WG, Siti NT, Asik S, Rita K, Winarno JKB, Simon IH, Michael JB. 2013. The distribution and bionomics of *Anopheles* malaria vector mosquitoes in Indonesia. Adv Parasitol 83: 173-266. DOI: 10.1016/b978-0-12-407705-8.00003-3.

Evenhuis NL, Greathead DJ. 1999. World Catalog of Bee Flies (Diptera: Bombyliidae). Backhuys Publishers, Leiden.

Ferreira AC, Elizabeth CA, Raymond DW, Ian H, Luiz DL. 2024. Mangrove biodiversity and conservation: Setting key functional groups and risks of climate-induced functional disruption. Diversity 16 (7): 423. DOI: 10.3390/d16070423.

Gadagkar R, Chandrashekara K, Nair P. 1990. Insect species diversity in tropics: Sampling methods and a case study. J Bombay Nat Hist Soc 87: 337-353.

Giangrande A. 2003. Biodiversity, Conservation, and the "Taxonomic Impediment." Aquat Conserv Mar Freshw Ecosyst 13: 451-59. DOI: 10.1002/aqc.584.

Henry TJ. 2012. Revision of the plant bug Genus *Tytthus* (Hemiptera, Heteroptera, Miridae, Phylinae). Zookeys 220: 1-114. DOI: 10.3897/zookeys.220.2178.

Jung S, Kim J, Ram KD. 2017. An annotated catalogue of the subfamily Orthotylinae (Hemiptera: Heteroptera: Miridae) from the Korean Peninsula. J Asia-Pac Biodivers 10: 403-408. DOI: 10.1016/j.japb.2017.05.006.

Kailash C, Raghunathan SSM, Gopi K. 2019. Fauna Diversity of Mangrove Ecosystem in India. Zoological Survey of India, New Alipore, Kolkata

Kim J, Frédéric C, Phan QT, Tosaphol SK, Jung S. 2025. A catalogue of the subfamily Mirinae (Insecta: Hemiptera: Heteroptera: Miridae) of Vietnam 2: 23-37. DOI: 10.11646/jihs.2.1.3.

Kononenko VS, Pinratana A. 2013. Moths of Thailand. Noctuoidea. An Illustrated Catalogue of Erebidae, Nolidae, Euteliidae and Noctuidae (Insecta, Lepidoptera) in Thailand. Brothers of Saint Gabriel, Thailand.

Lee YJ. 2010. A checklist of Cicadidae (Insecta: Hemiptera) from Cambodia, with two new species and a key to the genus *Lemuriana*. Zootaxa 2487: 19-32. DOI: 10.11646/zootaxa.2487.1.2.

Liu L, Guo Z, Zhong C, Shi S. 2018. DNA barcoding reveals insect diversity in the mangrove ecosystems of Hainan Island, China. Genome 61: 797-806. DOI: 10.1139/gen-2018-0062.

Murphy DH. 1990. The natural history of insect herbivory on mangrove trees in and near Singapore. Raffles Bull Zool 38: 119-203.

Nguyen TPL. 2020. The Social Wasps of Vietnam. Publishing House for Science and Technology, Vietnam.

Nieser N. 2004. Guide to aquatic Heteroptera of Singapore and Peninsular Malaysia III. Pleidae and Notonectidae. Raffles Bull Zool 52: 79-96.

Pham VD, Tran TH, Hoang VH, Vu QN. 2014. Biodiversity Resources of Cat Ba National Park. Agriculture Publisher, Hanoi.

Rattanarithikul R, Harrison BA, Panthusiri P, Coleman RE. 2005. Key to the genera of mosquitoes in Thailand fourth-instar larvae. Southeast Asian J Trop Med Public Health 37 (2): 1-65.

Rédei D. 2009. Heteropteran Fauna of Taiwan: Cotton Stainers and Relatives (Hemiptera: Heteroptera: Pyrrhocoroidae). National Chung Hsing University, Taichung.

Roy P, Subodh CP, Rabin C, Indrajit C, Asish S, Manisa S. 2023. Effects of climate change and sea-level rise on coastal habitat: Vulnerability assessment, adaptation strategies and policy recommendations. J Environ Manag 330: 117187. DOI: 10.1016/j.jenvman.2022.117187.

Salini S, Viraktamath CA. 2015. Genera of Pentatomidae (Hemiptera: Pentatomoidea) from South India-An Illustrated key to genera and checklist of species. Zootaxa 3924: 1-76. DOI: 10.11646/zootaxa.3924.1.1.

Scarbrough AG, Marascia C. 1999. Synopsis of the Oriental and Australian species of *Emphysomera Schiner* (Diptera, Asilidae). Dtsch Entomol Zeitschrift 46: 203-229. DOI: 10.1002/mmnd.4800460208.

Schaefer CW. 1995. A Revision of Oriental Burrower Bugs (Heteroptera: Cydnidae). Upper Silesian Museum, Bytom. DOI: 10.1093/aesa/88.4.595.

Schuh RT, Slater JA. 1995. True Bugs of The World (Hemiptera: Heteroptera): Classification and Natural History. Cornell University Press, New York.

Setyawan YP, Wakhid, Suhadi. 2020. The denser canopy of mangrove drives the structure of insect communities. Trop Life Sci Res 31:77-90. DOI: 10.21315/tlsr2020.31.3.6.

Southwood TRE, Henderson PA. 2000. Ecological Methods, Third Edition. Blackwell Scientific, United States.

Spence JR, Niemela JK. 1994. Sampling carabid assemblages with pitfall traps: The madness and the method. Can Entomol 126: 881-94. DOI: 10.4039/Ent126881-3.

Tkoč M, Rozkošný R. 2014. New synonymy of *Oplodontha minuta* (Diptera: Stratiomyidae) with its first record from Socotra Island. Acta Entomologica Musei Nationalis Pragae 54: 429-439.

Tomasovic G, Constant J, Grootaert P. 2013. Robber flies from mangroves in Hong Kong (Diptera: Asilidae). Belg J Entomol 69: 1-19.

Tran AD, Le TPL, Nguyen TAN. 2023. The taxonomy of the Genus *Asclepios* distant (Heteroptera, Gerromorpha, Gerridae), with description of a new species from Vietnam. J Asia Pac Entomol 26: 102144. DOI: 10.1016/j.aspen.2023.102144.

Wiedemann CRW. 1821. Diptera Exotica. s.n., Kiliae.

Vietnamese Academy of Forest Sciences. 2023. Project: Study on Integrated Pest Management of Major Leaf Insect Pests and Stem

Borer Beetles in *Acacia* hybrid, *A. mangium* and *A. auriculiformis* in Vietnam. Ministry of Agriculture and Rural Development, Vietnam.

Yasunaga T, Shishido T. 2020. Two new species of the plant bug genus *Melanotrichus* inhabiting halophytes in Southwestern Japan (Hemiptera : Heteroptera : Miridae). Heteropterus Revista de Entomología 20: 1-2.

Yasunaga T, Duwal RK. 2017. Plant Bugs of the tribe Orthotylini (Heteroptera: Miridae: Orthotylinae) in Thailand, with descriptions of five new species. Raffles Bull Zool 65: 280-98.

Yélamos T, Vienna P. 1995. Contribution to the knowledge of the histerid beetles from Namibia. (Coleoptera, Histeridae). Mitteilungen aus dem Museum für Naturkunde in Berlin. Zoologisches Museum und Institut für Spezielle Zoologie 71: 277-85. DOI: 10.1002/mmnz.19950710207.

Yeo D, Amrita S, Jayanthi P, Foo M, Patrick G, Lena C, Benoit G. 2021. Mangroves are an overlooked hotspot of insect diversity despite low plant diversity. BMC Biol 19: 1-17. DOI: 10.1186/s12915-021-01088-z.

Zhao P, Wanzhi C, Tomokuni M. 2005. A review of the Genus *Aulacogenia* Stal (Heteroptera: Reduviidae: Stenopodainae) from China. Zootaxa 1055: 23-40. DOI: 10.11646/zootaxa.1055.1.2.

Table S1. Checklist of insect species recorded and their corresponding collection methods in the mangrove forests of Cat Ba National Park, Hai Phong Province, Vietnam. "+" indicates presence, "–" indicates absence. Species newly recorded for Vietnam are marked with an asterisk

Taxon	**Collecting method**		
	Sweep net	**Light trap**	**Yellow pan trap**
Blattodea			
Blatellidae	-	-	-
Blattella germanica (Linnaeus, 1767)	+	-	-
Coleoptera	-	-	-
Brentidae	-	-	-
Cylas formicarius (Fabricius, 1798)	+	-	-
Carabidae	-	-	-
Callytron nivicinctum (Chevrolat, 1845)	+	-	-
Chrysomelidae	-	-	-
Aulacophora indica (Gmelin, 1790)	+	-	-
Aulacophora lewisii Baly, 1866	+	-	-
Cassida circumdata Herbst, 1799	+	-	-
Chaetocnema concinna (Marsham, 1802)	+	-	-
Colasposoma sp.	+	-	-
Phola octodecimguttata (Fabricius, 1775)	+	-	-
Coccinellidae	-	-	-
Bothrocalvia albolineata (Gyllenhal, 1808)	+	-	-
Coccinella transversalis Fabricius, 1781	+	-	-
Harmonia octomaculata (Fabricius, 1781)	+	-	-
Harmonia sp. 1	+	-	-
Harmonia sp.2	+	-	-
Henosepilachna vigintioctopunctata (Fabricius, 1775)	-	+	-
Micrapis discolor (Fabricius, 1798)	+	-	-
Curculionidae	-	-	-
Hypomeces squamosus (Fabricius, 1792)	-	+	-
Histeridae	-	-	-
Nasaltus orientalis (Paykull, 1811) *	-	+	-
Lucanidae	-	-	-
Aegus sp.	-	+	-
Scarabaeidae	-	-	-
Adoretus (Lepadoretus) compressus (Weber, 1801)	-	+	-
Alissonotum impressicolle Arrow, 1908	-	+	-
Anomala cupripes (Hope, 1839)	+	-	-
Oniticellus cinctus Fabricius, 1775	+	-	-
Rhyssemus inscitus (Walker, 1858)	-	+	-
Staphylinidae	-	-	-
Paederus fuscipes (Curtis, 1826)	-	+	-
Tenebrionidae	-	-	-
Gonocephalum sp.	-	+	-
Dermaptera	-	-	-
Labiduridae	-	-	-
Labidura riparia (Pallas, 1773)	+	-	-
Diptera	-	-	-
Asilidae	-	-	-
Michotamia aurata (Fabricius, 1794)	+	-	+
Pogonosoma cyanogaster Bezzi, 1917	+	-	-
Emphysomera conopsoides (Wiedemann, 1828)*	+	-	-
Bombyliidae	-	-	-
Toxophora iavana Wiedemann, 1821*	+	-	-
Calliphoridae	-	-	-
Chrysomya megacephala (Fabricius, 1794)	+	-	+
Chrysomya rufifacies (Macquart, 1844)	+	-	+
Lucilia cuprina (Wiedemann, 1830)	+	-	+
Culicidae	-	-	-
Anopheles barbumbrosus Strickland & Chowdhury, 1927	-	+	-
Anopheles vietnamensis Phan, 1979	-	+	-
Coquillettidia ochracea (Theobald, 1903)	-	+	-
Culex brevipalpis (Giles, 1902)	-	+	-
Culex sitiens Wiedemann, 1828	-	+	-
Culex vishnui Theobald, 1901	-	+	+
Culex whitei Stone & Bohart, 1944	-	+	-
Dolichopodidae	-	-	-
Condylostylus conspectus Becker, 1922	+	-	+
Condylostylus damingshanus Wang, Zhu & Yang, 2012	+	-	+
Condylostylus latipennis Parent, 1941	+	-	+
Muscidae	-	-	-
Atherigona reversura Villeneuve, 1936	+	-	-
Haematobia irritans (Linnaeus, 1758)	+	-	-
Musca domestica Linnaeus, 1758	+	+	-
Stratiomyidae	-	-	-
Oplodontha minuta (Fabricius, 1794)*	+	-	-
Syrphidae	-	-	-
Dideopsis aegrota (Fabricius, 1805)	+	-	-
Eristalinus quinquestriatus (Fabricius, 1794)	+	-	-
Ischiodon scutellaris (Fabricius, 1805)	+	-	-
Melanostoma univittaum (Wiedemann, 1824)	+	-	-
Paragus serratus (Fabricius, 1805)	+	-	-
Phytomia (Phytomia) errans (Fabricius, 1787)	+	-	-
Tabanidae	-	-	-
Tabanus rusticus Linnaeus, 1767	+	-	-
Hemiptera	-	-	-
Alydidae	-	-	-
Leptocorisa acuta (Thunberg, 1783)	+	-	-
Riptortus pedestris (Fabricius, 1775)	+	+	-
Cicadidae	-	-	-
Platypleura hilpa Walker, 1850	+	-	-
Coreidae	-	-	-
Cletomorpha simulans Hsiao,1963	+	-	-
Cletus graminis Hsiao & Zheng, 1964	+	-	-
Cletus trigonus (Thunberg, 1783)	+	-	-
Gralliclava horrens (Dohrn, 1860)	+	-	-
Cydnidae	-	-	-
Byrsinus varians (Fabricius, 1803)	-	+	-
Gerridae	-	-	-
Asclepios apicalis (Esaki, 1924)	+	-	-
Asclepios esakii Tran, Le & Nguyen, 2023	+	-	-
Limnogonus fossarum (Fabricius, 1775)	+	-	-
Largidae	-	-	-
Physopelta gutta (Burmeister, 1834)	-	+	-
Lygaeidae	-	-	-
Nysius ceylanicus (Motschulsky, 1863)	+	+	-
Mesoveliidae	-	-	-
Mesovelia vittigera Horváth, 1915	+	+	-
Miridae	-	-	-
Campylomma chinense Schuh, 1984	+	-	-
Cyrtorhinus lividipennis Reuter, 1884	+	+	-
Melanotrichus halimus Yasunaga, 2020*	+	-	-
Melanotrichus parvulus (Reuter, 1879)*	+	-	-
Nesidiocoris tenuis (Reuter, 1895)	+	+	-
Taylorilygus apicalis (Fieber, 1861)	+	+	-
Tytthus parviceps (Reuter, 1890)*	+	-	-
Notonectidae	-	-	-
Anisops tahitiensis Lundblad, 1934	+	-	-
Pentatomidae	-	-	-
Erthesina fullo (Thunberg, 1783)	+	-	-
Eysarcoris guttiger (Thunberg, 1783)	+	+	-
Eysarcoris ventralis (Westwood, 1837)	-	+	-
Piezodorus hybneri (Gmelin, 1790)	+	-	-
Plautia crossota (Dallas, 1851)	+	-	-
Pyrrhocoridae	-	-	-
Dysdercus cingulatus (Fabricius, 1775)	+	-	-

Dysdercus decussatus Boisduval, 1835*	+	-	-
Reduviidae	-	-	-
Aulacogenia errabunda (Distant, 1903)	-	+	-
Rhyparochromidae	-	-	-
Botocudo signanda (Distant, 1903)	-	+	-
Pseudopachybrachius guttus (Dallas, 1852)	-	+	-
Pseudopachybrachius vinctus (Say, 1831)	-	+	-
Scutelleridae	-	-	-
Calliphara nobilis (Linnaeus, 1763)	+	-	-
Chrysocoris patricius (Fabricius, 1789)	+	-	-
Chrysocoris stollii (Wolff, 1801)	+	-	-
Veliidae	-	-	-
Xenobates murphyi Andersen, 2000	+	-	-
Hymenoptera	-	-	-
Apidae	-	-	-
Apis cerana Fabricius, 1793	+	+	-
Apis dorsata Fabricius, 1793	+	-	-
Ceratina nigrolateralis Cockerell, 1916	+	-	-
Xylocopa aestuans (Linnaeus, 1758)	+	-	-
Xylocopo nasalis Westwood, 1842	+	-	-
Crabronidae	-	-	-
Dasyproctus buddha (Cameron, 1904)	+	-	-
Halictidae	-	-	-
Halictus sp.	+	-	-
Ichneumonidae	-	-	-
Ichneumon agrestorius Swederus, 1787	+	+	-
Echthromorpha agrestoria (Swederus, 1787)	-	+	-
Megachilidae	-	-	-
Megachile amputata Smith, 1857	+	-	-
Megachile faceta Bingham, 1897	+	-	-
Scoliidae	-	-	-
Phalerimeris phalerata phalerata (de Saussure, 1858)	+	-	-
Sphecidae	-	-	-
Sceliphron madraspatanum (Fabricius, 1781)	+	-	-
Trypoxylon bicolor F. Smith, 1856	+	-	-
Vespidae	-	-	-
Antepipona biguttata (Dalla Torre, 1904)	+	-	-
Polistes olivaceus (De Geer, 1773)	+	-	-
Ropalidia fasciata (Fabricius, 1781)	+	-	-
Vespa tropica (Linnaeus, 1758)	+	-	-
Formicidae	-	-	-
Anoplolepis gracilipes (Smith, 1857)	-	-	+
Camponotus rufoglaucus (Jerdon, 1851)	+	-	-
Camponotus mitis (Smith, 1858)	+	-	-
Lepidoptera	-	-	-
Crambidae	-	-	-
Glyphodes pulverulentalis Hampson, 1896	-	+	-
Parotis marginata complex Hampson, 1893	-	+	-
Spoladea recurvalis (Fabricius, 1775)	-	+	-
Erebidae	-	-	-
Amata polymita (Walker, 1854)	-	+	-
Amerila omissa (Rothschild, 1910)	-	+	-
Artaxa guttata (Walker, 1855)	-	+	-
Artena dotata (Fabricius, 1794)	-	+	-
Asota caricae (Fabricius, 1775)	-	+	-
Birthamoides junctura (Walker, 1865)	-	+	-
Creatonotos transiens (Walker, 1865)	-	+	-
Euchromia elegantissima (Wallengren, 1861)	+	-	-
Euplocia membliaria (Cramer, 1780)	-	+	-

Hulodes caranea (Cramer, 1779)	-	+	-
Ophiusa disjungens (Walker, 1858)	-	+	-
Othreis fullonia (Clerck, 1764)	-	+	-
Oxyodes scrobiculata (Fabricius, 1775)	-	+	-
Spirama helicina (Hübner, 1831)	-	+	-
Thyas coronata (Fabricius, 1775)	-	+	-
Utetheisa pulchelloides (Hampson, 1907)	-	+	-
Geometridae	-	-	-
Thalassodes immissaria (Walker, 1861)	-	+	-
Noctuidae	-	-	-
Sesamia inferens (Walker, 1856)	-	+	-
Nymphalidae	-	-	-
Euploea core (Cramer, 1780)	+	-	-
Papilionidae	-	-	-
Papilio demoleus Linnaeus, 1758	+	-	-
Troides aeacus (C. & R. Felder, 1860)	+	-	-
Sphingidae	-	-	-
Ambulyx moorei Moore, 1858	-	+	-
Cephonodes hylas (Linnaeus, 1771)	-	+	-
Hippotion velox (Fabricius, 1793)	-	+	-
Hippotion sp.	-	+	-
Macroglossum gyrans (Linnaeus, 1758)	-	+	-
Theretra alecto (Linnaeus, 1758)	-	+	-
Theretra lucasi Rothschild, 1904	-	+	-
Mantodea	-	-	-
Mantidae	-	-	-
Leptomantella tonkinae (Hebard, 1920)	+	-	-
Neuroptera	-	-	-
Chrysopidae	-	-	-
Chrysoperla carnea (Stephens, 1836)	+	-	-
Odonata	-	-	-
Coenagrionidae	-	-	-
Ischnura senegalensis (Rambur, 1842)	+	+	-
Gomphidae	-	-	-
Ictinogomphus pertinax (Needham, 1930)	+	-	-
Libellulidae	-	-	-
Brachydiplax chalybea flavovittata Ris, 1911	+	-	-
Brachythemis continentata (Fabricius, 1793)	+	-	-
Diplacodes trivialis (Rambur, 1842)	+	-	-
Neurothemis fulvia (Drury, 1773)	+	-	-
Neurothemis tullia (Drury, 1773)	+	-	-
Orthetrum chrysis (Selys, 1891)	+	-	-
Rhyothemis variegata (Linnaeus, 1763)	+	-	-
Orthoptera	-	-	-
Acrididae	-	-	-
Acrida turrita (Linnaeus, 1758)	+	-	-
Acrida cinerea (Thunberg, 1815)	+	-	-
Aiolopus thalassinus tamulus (Fabricius, 1798)	+	-	-
Atractomorpha sinensis sinensis Bolívar, 1905	+	-	-
Gesonula mundata (Walker, 1870)	+	-	-
Oxya chinensis chinensis (Thunberg, 1815)	+	-	-
Patanga japonica (Bolivar 1898)	+	-	-
Gryllidae	-	-	-
Metioche vittaticollis (Stål, 1860)	-	-	+