Taiwania 71(2): 237–242, **2026**
DOI: 10.6165/tai.2026.71.237

The first record of Nocticolidae (Blattodea) and a new species description of *Nocticola* from Taiwan

Mu-Hsuan CHEN[1,*], Wen-Jun LIN[2], Wei-Ren LIANG[3]

1. Applied Zoology Division, Taiwan Agricultural Research Institute, 189 Zhongzheng Rd., Taichung city, 413008, Taiwan. ***2.*** *Department of Entomology, National Chung Hsing University, 145 Xingda Rd., Taichung city, 40227, Taiwan. E-mail: wenjun@email.nchu.edu.tw* ***3.*** *MICRODO Ltd., No. 107, Junhe St., Beitun Dist., Taichung City, 406056, Taiwan. E-mail: leif2051@gmail.com. [*]Corresponding author's email: muhsuanchentw@gmail.com*

(Manuscript received 17 August 2025; Accepted 1 February 2026; Online published 20 March 2026)

ABSTRACT: We report the first record of the family Nocticolidae (Blattodea: Corydioidea Saussure, 1864) in Taiwan and describe a new species of *Nocticola*, *N. formosana* sp. nov. Detailed morphological observations place the species in the *uenoi*-species group, characterized by a specialized tergal gland on the fourth abdominal segment. Males exhibit unique features, including complete eye loss, broad tegmina, and specific genital structures. High genetic distances between *N. formosana* sp. nov. and related Chinese species support support its status as a distinct species. The type specimens were discovered from the foraging tunnel of *Odontotermes formosanus* (Shiraki) inside a decaying wood. This study provides new taxonomic evidence on *Nocticola* diversity and offers new data for understanding the phylogeny of Nocticolidae in East Asia.

KEY WORDS: cockroach, fungus-growing termite, *Nocticola formosana*, rotten wood, taxonomy, termite tunnel.

INTRODUCTION

Cockroaches of the family Nocticolidae Bolívar, 1892 (Blattodea: Corydioidea Saussure, 1864) have long been regarded as a poorly understood group due to their cryptic ecology and habitat. They typically inhabit dark environments such as caves, under rocks, or within termite nests (Bell *et al*., 2007). Due to the close phylogenetic relationship between Nocticolidae and Latindiinae Handlirsch, 1925 within the superfamily Corydioidea, the taxonomic status of Nocticolidae and its relationship with Latindiinae remain uncertain. Recent molecular evidence provided by Han *et al*. (2024) confirmed that Latindiinae should be placed within Nocticolidae, and which is phylogenetically distinct from Nocticolinae (Djernæs *et al*., 2014; Legendre *et al*., 2015; Wang *et al*., 2017; Liu *et al*., 2023). According to Kovacs *et al*. (2024), two highly divergent lineages—Clade A and Clade B—are present within the family. Presently, Nocticolidae comprises 9 genera with *Nocticola* Bolívar, 1892 containing the highest number of species within the family (Bolívar, 1892; Li *et al*., 2025). *Nocticola* was first described by Bolívar (1892), based on troglobytic *N. simoni* Bolívar, 1892 and *Nocticola caeca* Bolívar, 1892, from the Philippines. Species of this genus are small and delicate, with complex phallomeres in the male genitalia, often featuring a hook (Roth, 1988). Silvestri (1946) later described two termitophilous species: *Nocticola termitophila* Silvestri, 1946, collected from termite nests in Tonkin (northern Vietnam) and Penang, and *Nocticola sinensis* Silvestri, 1946, found in *Termes* sp. and *Odontotermes* sp. nests in Hong Kong and Kowloon. Silvestri (1946) suggested that these cockroaches may feed on termite corpses, supported by the presence of termite setae in their gut. With the ongoing discovery of *Nocticola* species in recent years, the genus now comprises 31 formally described species distributed across East, Southeast, and South Asia, Australia and Africa (Roth *et al*., 1988; Cockroach Species File, 2025), and introduced into America, and Europe (Wang *et al*., 2025). Most *Nocticola* species are cavernicolous, some are epigean, and only three are regarded as termitophilous (Silvestri, 1946; Roth, 2003a; Bell *et al*., 2007; Liu *et al*., 2017). Kovacs *et al*. (2024) demonstrated that the genus *Nocticola* includes species from both Clade A and Clade B within Nocticolidae, indicating that *Nocticola* is a polyphyletic genus.

Sexual dimorphism is pronounced in *Nocticola*, with females typically exhibiting neoteny, while males possess diverse and species-specific traits (Trotter *et al*.2017; Li *et al*. 2025). Asahina (1974) described *Nocticola uenoi* from Ryukyu Islands, Japan, with three subspecies—*Nocticola uenoi uenoi* Asahina, 1974, *Nocticola uenoi kikaiensis* Asahina, 1974, and *Nocticola uenoi miyakoensis* Asahina, 1974. These subspecies represented the first known occurrence of a specialized tergal gland on the 4th abdominal tergum in *Nocticola*. The presence or absence of this structure divides the genus into the *uenoi*-species group and the *simoni*-species group (Roth, 1988). Only four species have been recorded in the *uenoi*-species group — *N. uenoi*, *Nocticola appendiculata* Li, Liu, Chan, Wei, Yue and Qui, 2025, *Nocticola australiensis* Roth, 1988, and *Nocticola currani* Trotter, McRae, Main and Finston, 2017 and the morphological character of their tergal gland vary among them (Asahina, 1974; Roth, 1988; Trotter *et al*., 2017; Li *et al*., 2025). Among the 31 species of

Nocticola, in addition to the special variation in the tergal gland, macropterous males have been recorded in certain species, such as *Nocticola adebratti* Roth, 1994 in Malaysia, *Nocticola wliensis* Andersen and Kjaerandsen; 1995, *Nocticola clavata* Andersen and Kjaerandsen; 1995; *Nocticola scytala* Andersen and Kjaerandsen, 1995 in Ghana, *Nocticola baumi* Lucañas, Blaha, Rahmadi and Patoka, 2021 in Papua New Guinea, *Nocticola pheromosa* Lucañas and Maosheng, 2023 in Singapore, and *Nocticola umedai* Yanagisawa and Ohgita 2025 in Japan (Roth, 1994; Andersen and Kjærandsen, 1995; Lucañas *et al*., 2021; Lucañas and Maosheng, 2023; Li *et al*., 2025; Yanagisawa and Ohgita, 2025). Additionally, both *N. uenoi uenoi* and *N. uenoi kikaiensis* have also been found to exhibit macroptery (Yanagisawa and Ohgita, 2025).

In this study, we report the first record of Nocticolidae in Taiwan and the description of a new species. Through detailed morphological descriptions and molecular evidence, we provide the taxonomic diagnosis and characterization of this new species.

MATERIALS AND METHODS

Specimen collection

The specimens were collected at Dakeng Hiking Trail, Taichung, Taiwan. The cockroaches were found in the rotten wood with the tunnels of fungus-growing termite *Odontotermes formosanus* Shiraki, 1909. The cockroaches, including adult males, adult females, and nymphs, were suctioned out from the rotten wood using an aspirator. The cockroach specimens were preserved in 95% alcohol. After dissection, the genitalia of the male cockroach were preserved in glycerin. The holotype and paratype were deposited in the collection of Entomology Division, National Museum of Natural Science, Taichung, Taiwan (NMNS).

DNA extraction, amplification, and sequencing

Four nymphs were used for DNA extraction. Each nymph's DNA was extracted from the thorax and leg using the standard protocols provided by the QuickExtract DNA extraction kit from Epicentre Biotechnologies (Madison, WI). Cytochrome C oxidase subunit I (COI) genes were amplified by universal primer: LCO1490 (5'-GGTCAACAAATCATAAAGATATTGG-3') and HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3') (Folmer *et al*. 1994). The polymerase chain reaction (PCR) was conducted in 25 µL reactions containing 1 µL DNA sample, 12.5 µL master mix (amaR OnePCRTM), 0.5 µL LCO1490 primer (10 µM), 0.5 µL HCO2198 primer (10 µM). Target sequence was amplified on SensoQuest Labcycler (SensoQuest Biomedizinische Elektronik GmbH, Gottingen, Germany). The following cycling condition was used: initial denaturing at 95 °C for 5 min; 35 cycles of denaturing at 95 °C for 30 s, annealing at 50 °C for 30 s, extension at 72 °C for 1 min; and then final extension at 72 °C for 10 min. The amplified products were sequenced by Tri-I Biotech Inc.

Molecular analysis

The four sequences of *Nocticola formosana* sp. nov. have been submitted to GenBank with accession numbers LC878916–LC878919 (Table 1). Additional COI sequences of *Nocticola* from China were obtained from GenBank listed in Table 1. Although there are several species distributing in Japan and southeast Asia, most of Nocticolidae species did not have COI sequences published, and we did not include these species in analysis.

The sequence alignment was conducted through MUSCLE algorithm within MEGA 12 (Kumar *et al*. 2024). The pairwise genetic distances were calculated using the Kimura-2-parameter (K2P) with 1,000 bootstrap replicates within MEGA 12 (Kumar *et al*. 2024). The nucleotide substitutions model for maximum likelihood tree inference was general time reversible model, and evolutionary rate differences among sites were modeled with a discrete gamma distribution across five categories, with 18.51% of sites considered evolutionarily invariant.

Table 1. Sequences used in the molecular analysis

Species	Genebank number	Location	Reference
Nocticola formosana **sp. nov.**	LC878916	Taichung, Taiwan	this study
	LC878917		
	LC878918		
	LC878919		
N. baiguensis	PQ601347,	Guangxi, China	Li *et al*. 2025
	PQ601353		
	PQ601355		
N. cordiformis	PQ601349	Guangxi, China	Li *et al*. 2025
	PQ601352		
	PQ601358		
N. appendiculata	PQ601350	Guangxi, China	Li *et al*. 2025
	PQ601351		
N. sinensis	PQ601361	Hunan, China	Li *et al*. 2025

Morphological analysis

The morphological terminology used for male genitalia followed Klass (1997), whereas other characters followed Roth (2003b). The photographs were taken with Canon EOS 77D camera using an MP-E65mm f/2.8 1-5x Macro Photo lens. The degree of sclerotization is represented by the dot density in the drawings.

RESULTS

The four COI sequences of *N. formosana* sp. nov. were almost identical and different from those of nearby species from China. The interspecies K2P genetic distance of *N. appendiculata*, *N. baiguensis* and *N. cordiformis* from

China was 4.26% to 21.05 % while intraspecific genetic distance is lower than 1 % in these 3 species (Li *et al.*, 2025). The interspecies genetic distances among *N. cockingi*, *N. currani* and *Nocticola quartermainei* from Australia was 17.3% to 25.8 % while intraspecific genetic distances were lower than 3.9 % in these 3 species by using p-distances (Trotter *et al.*, 2017). In this study we found that the interspecies genetic distance between *N. formosana* sp. nov and those of *N. appendiculata*, *N. baiguensis, N. cordiformis* and *N. sinensis* from China ranged from 21.7 % to 23.8 % by using K2P distance and ranged from 18.2 % to 20.2 % by using p-distance. The large genetic distances when compared to the species of China support that the *N. formosana* sp. nov. is a distinct species. The nocticolid species exhibit a high rate of mitochondrial nucleotide substitution (Kovacs *et al.*, 2024). The large mitochondrial genetic distances in interspecies have also been reported on the other nocticolids (Wang *et al.*, 2025). Because the molecular data is limited in Nocticolidae, the more comprehensive phylogenetic relationship needs further examination in the future.

TAXONOMIC TREATMENT

Nocticola formosana M.-H. Chen, W.-J. Lin, W.-R. Liang, ***sp. nov.*** **臺灣穴蠊 Fig. 1**

urn:lsid:zoobank.org:pub:9EBE1419-DDB4-4660-8007-F2D53D1CF160

Holotype: TAIWAN, 1♂; Dakeng No.5 Hiking Trail, Taichung. 31 October 2021, Mu-Hsuan Chen, Wen-Jun Lin, leg. (NMNS_009040-00001). ***Paratypes***: TAIWAN, 2♂, 7♀, same data as holotype (NMNS_009040-00002–NMNS_009040-00010).

Diagnosis: Male pale yellowish. Tegmina well developed; hindwings scale-like. Vertex of head exposed. Eyes completely absent. Pronotum hyaline, with marginal setae. Foreleg femur Type C1 (row of hair-like spinules ending in one thick spine). Tarsi symmetrical; pulvilli and arolia absent. Tergal gland present and specialized on abdominal tergite IV. Supra-anal plate subhyaline, symmetrical. Subgenital plate weakly asymmetrical, with marginal setae.

Species assigned to *uenoi*-species based on the presence of specialized tergal gland. Within the *uenoi*-species group, *N. formosana* sp. nov. differs from *N. australiensis*, *N. currani*, and *N. appendiculata* by the presence of arcuate protrusions on the tergal gland, which are absent in the other species. Only the brachypterous forms of *N. uenoi* shares the most similar morph of the tergal gland with *N. formosana*. Smaller than *N. uenoi* Asahina, 1974 (2.5–2.6 mm vs. 4.0–4.5 mm). Eyes absent vs. present in *N. uenoi*. Tegmina broad and round vs. narrow and elongate in brachypterous forms of *N. uenoi*. Cerci with 8 segments vs. 7 in *N. uenoi*. Subgenital plate weakly asymmetrical. Genitalia L3 with five setae vs. more than five in *N. uenoi*. Cerci without specialized setae in female; species likely belongs to Nocticolidae Clade B.

Description: Male (Fig. 1: A–D, F–H, J–L): Body length 2.5–2.6 mm. Vertex exposed. Eyes absent. Maxillary palpus slender. Antennae with 36–42 segments. Pronotum hyaline, with 10 marginal setae; anterior margin semi-circular; posterior margin weakly concave, lateral margins slightly raised. Forewing subquadrate hyaline, sparse venational setae. Hindwing scale-like; venation weak, retreating at margin. Legs slender. Foreleg femur Type C1. Tibia and first four tarsomeres with dense piliform setae. Pulvilli and arolia absent. Tarsal claws symmetrical, unspecialized. Abdomen cylindrical. Tergal gland opening on tergite IV. Structure three-layered. First layer flattened, apex forming flat arcuate edge. Second layer composed of dense, dark brown microsetae centrally aggregated. Third layer extending into symmetrical, arcuate protrusions. Cerci with 8 segments; terminal segment needle-like, similar to female. Styli absent. Subgenital plate weakly asymmetrical. Supra-anal plate symmetrical. L3 hook-like, slightly protruding beyond plates, bearing five setae. L1 flat, sclerotized, with rod-like apical structure. L2 narrow, flat, sickle-shaped. L4C sclerotized, hook-tipped. L4D plate-like, nearly transparent. L4G flat, with highly sclerotized hook-like apical structure. R1G flat, transparent, densely setose ventrally; merges into sclerotized area. R2 thin, shallowly concave. R3 more sclerotized, bowl-shaped.

Female (Fig. 1: E, I): Body length 2.5–2.9 mm. Head, legs similar to male. Pronotum slightly larger than male; overall outline more rounded; hyaline, with similar marginal setae; anterior margin semi-circular; posterior margin weakly concave; lateral margins slightly raised. Antennae ca. 42 segments. Tegmina, hindwing, and tergal gland absent. Abdomen cylindrical, posteriorly flattened, wider than male. Subgenital valves bilobed. Cerci same as in male.

Distribution: Taichung, Taiwan.

Etymology: Derived from "*formosa*" after Taiwan, the locality of collection.

Ecology: Found in abandoned tunnels of *Odontotermes formosanus* within decaying woods (Fig. 2). No interaction was observed with living termites; thus, termitophily is uncertain.

ACKNOWLEDGMENTS

We would like to express our sincere gratitude to Dr. George Beccaloni for providing us with access to the Global Cockroach Library, which helped us overcome difficulties in finding relevant literature. We also thank Dr. Hou-Feng Li for providing the photographic equipment. Our thanks go to Dr. Mei-Er Chen and Dr. Hou-Feng Li for supporting the resources and laboratory space for experiments involving DNA extraction and PCR. We are grateful to Prof. Chung-Jan Chang for his insightful feedback on the manuscript. Additionally, we are thankful to Dr. Hauchuan Liao and Ms. Chia-Chien Wu for their valuable suggestions on specimen preservation and morphological drawings.

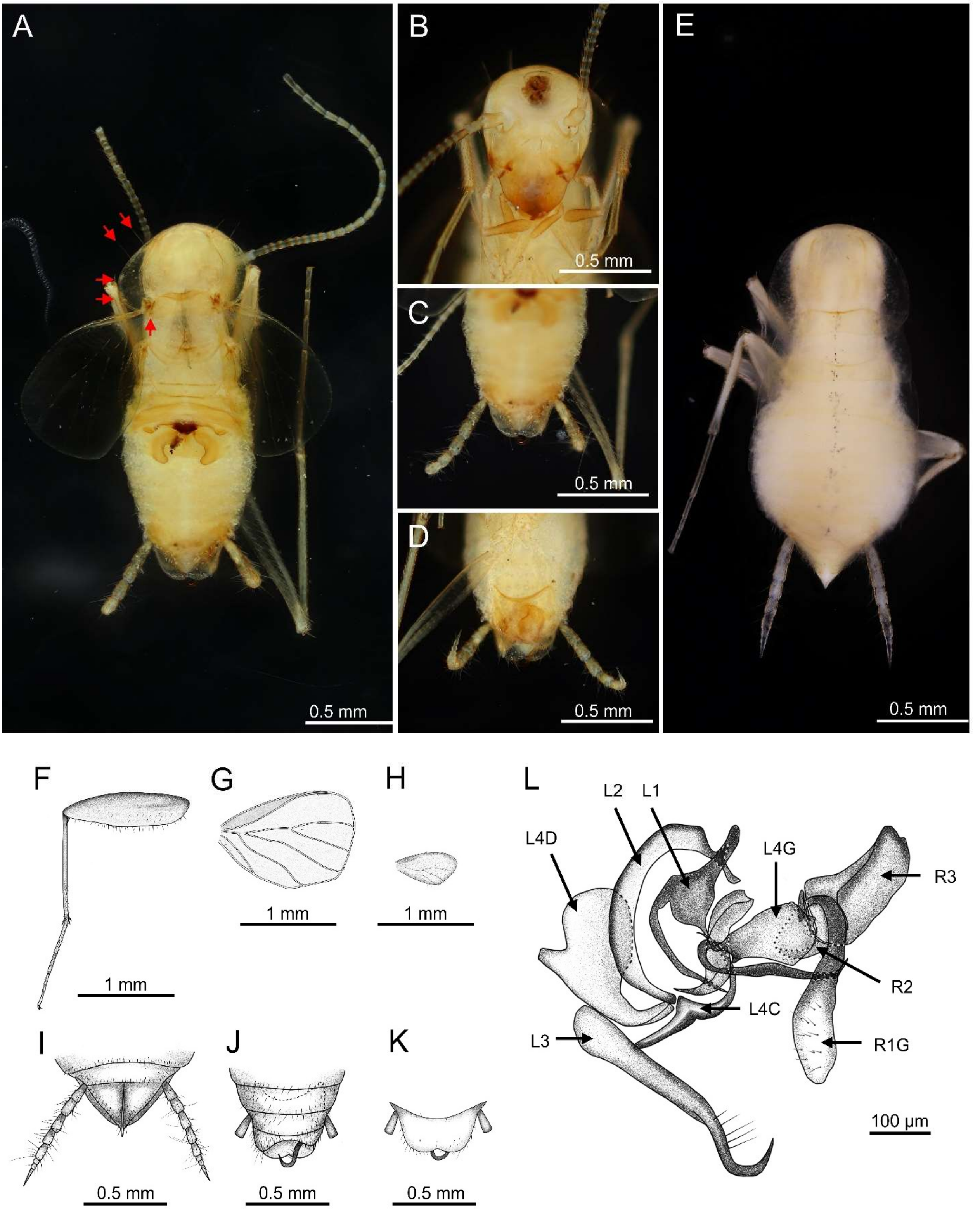

Fig. 1. ***Nocticola formosana*** sp. nov.: **A.** dorsal view of male, with the position of the left pronotal marginal setae indicated by red arrows; **B.** anterior view of head; **C.** supra-anal plate, dorsal view; **D.** subgenital plate, ventral view; **E.** dorsal view of female; **F.** foreleg; **G.** tegmina; **H.** hind wing; **I.** ventral view of female abdomen; **J.** ventral view of male abdomen, with subgenital plate; **K.** dorsal view of supra-anal plate; **L.** dorsal view of the phallomeres of male genitalia, abbreviations: L1, L2, L3, L4C, L4D, and L4G – sclerites of left phallomere; R1G, R2, and R3 – sclerites of right phallomere.

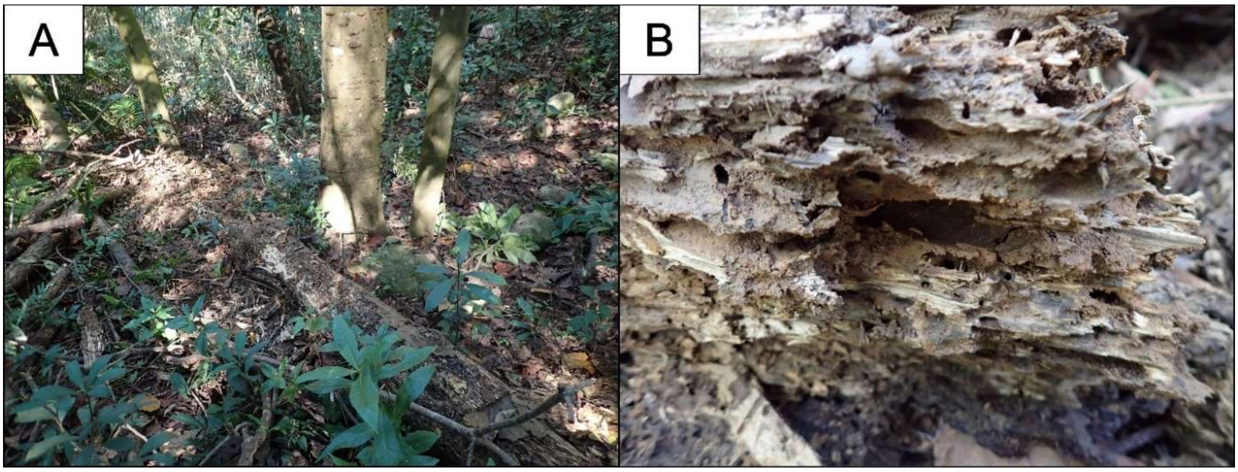

Fig.2. The habitat of ***Nocticola formosana***. **A.** the decaying wood in the understory of low-altitude broadleaf forests. **B.** the cockroaches were found in the termite tunnel within decaying wood.

LITERATURE CITED

Andersen, T., Kjærandsen, J. 1995 Three new species of *Nocticola* Bolívar from Ghana, West Africa (Blattaria, Nocticolidae). J. Afr. Zool. **109(4)**: 377–385.

Asahina, S. 1974 The cavernicolous cockroaches of the Ryuku Islands. Natl. Sci. Mus. Tokyo **7**: 145–155.

Bell, W.J., Roth, L.M., Nalepa, C.A. 2007 Cockroaches: Ecology, behavior, and natural history. Johns Hopkins Univ. Press, Baltimore, USA.

Bolívar, I. 1892 Voyage de M. E. Simon aux îles Philippines (Mars et Avril 1890). Ètude sur les Arthropodes cavernicoles de l'île de Luzon. Orthoptères. Ann. Soc. Entomol. Fr. **61**: 29–34.

Cockroach Species File 2025 Available at: https://cockroach.speciesfile.org. (Accessed 9 Nov., 2025)

Djernæs, M., Klass, K.D., Eggleton, P. 2014 Identifying possible sister groups of Cryptocercidae + Isoptera: A combined molecular and morphological phylogeny of Dictyoptera. Mol. Phylogenet. Evol. **84**: 284–303.

Folmer, O., Black, M., Hoeh, W., Lutz, R., Vrijenhoek, R. 1994 DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. Mol. Mar. Biol. Biotechnol. **3**: 294–299.

Han, W., Qiu, L., Zhang, J., Wang, Z., Che, Y. 2024 Phylogenetic reconstruction of Corydioidea (Dictyoptera: Blattodea) provides new insights on the placement of Latindiinae and supports the proposal of the new subfamily Ctenoneurinae. Syst. Entomol. **49(1)**: 156–172.

Klass, K.D. 1997 The external male genitalia and the phylogeny of Blattodea and Mantodea. Bonn. Zool. Monogr. **42**: 1–341.

Kovacs, T.G., Walker, J., Hellemans, S., Bourguignon, T., Tatarnic, N.J., McRae, J.M., Ho, S.Y.W., Lo, N. 2024 Dating in the dark: Elevated substitution rates in cave cockroaches (Blattodea: Nocticolidae) have negative impacts on molecular date estimates. Syst. Biol. **73(3)**: 532–545.

Kumar, S., Stecher, G., Suleski, M., Sanderford, M., Sharma, S., Tamura, K. 2024 MEGA12: Molecular Evolutionary Genetic Analysis version 12 for adaptive and green computing. Mol. Biol. Evol. **41(12)**: msae263.

Legendre, F., Nel, A., Svenson, G.J., Robillard, T., Pellens, R., Grandcolas, P. 2015 Phylogeny of Dictyoptera: dating the origin of cockroaches, praying mantises and termites with molecular data and controlled fossil evidence. PLoS One **10(7)**: e0130127.

Li, T.T., Liu, D.X., Chen, J., Wei, X.Y., Yue, Q.Y., Qiu, D.Y. 2025 Three new species of the cockroach genus *Nocticola* Bolívar, 1892 (Blattodea, Corydioidea, Nocticolidae) from China. ZooKeys **1232**: 267–288.

Liu, J.L., Zhang, J.W., Han, W., Wang, Y.S., He, S.L., Wang, Z.Q. 2023 Advances in the understanding of Blattodea evolution: Insights from phylotranscriptomics and spermathecae. Mol. Phylogenet. Evol. **182**: 107753.

Lucañas, C.C., Maosheng, F. 2023 A new macropterous *Nocticola* Bolívar, 1892 (Blattodea: Nocticolidae) from Singapore. J. Asia-Pac. Entomol. **26(2)**: 1–5.

Lucañas, C.C., Blaha, M., Rahmadi, C., Patoka, J. 2021 The first *Nocticola* Bolívar 1892 (Blattodea: Nocticolidae) from New Guinea. Zootaxa **5082(3)**: 294–300.

Roth, L.M. 1988 Some cavernicolous and epigean cockroaches with six new species, and a discussion of the Noticolidae (Dictyoptera: Blattaria). Rev. Suisse Zool. **95**: 297–321.

Roth, L.M. 2003a Some cockroaches from Africa and islands of the Indian Ocean, with descriptions of three new species (Blattaria). Trans. Am. Entomol. Soc. **129**: 163–182.

Roth, L.M. 2003b Systematics and phylogeny of cockroaches (Dictyoptera: Blattaria). Orient. Insects **37(1)**: 1–186.

Roth, L.M., McGavin, G.C. 1994 Two new species of Nocticolidae (Dictyoptera: Blattaria) and a rediagnosis of the cavernicolous genus *Spelaeoblatta* Bolívar. J. Nat. Hist. **28(6)**: 1319–1326.

Shiraki, T. 1909 Japanese termites. Trans Entomol Soc Japan. 2: 229–242. (In Japanese)

Silvestri, F. 1946 Prima nota su alcuni termitofili dell'Indochina. Boll. Lab. Zool. Gen. Agr. R. Scuola Sup. Agric. Portici **8**: 313–330.

Saussure, H. de. 1864 Mémoires pour servir à l'histoire naturelle du Mexique, des Antilles, et des États-Unis. Orthoptères de l'Amérique moyenne. Famille des Blattides. Ramboz et Schuchardt, Genève, Switzerland.

Trotter, A.J., McRae, J.M., Main, D.C., Finston, T.L. 2017 Speciation in fractured rock landforms: towards understanding the diversity of subterranean cockroaches (Dictyoptera: Nocticolidae: *Nocticola*) in Western Australia. Zootaxa **4250(2)**: 143–170.

Wang, J., Jeon, A., Cognato, A.I. 2025 A new adventive parthenogenetic *Nocticola* species (Blattodea: Nocticolidae) found in Florida, USA and Vienna, Austria. Zootaxa **5642(5)**: 493–500.

Yanagisawa, S., Ohgita, S. 2025 New Macropterous Species of the Genus *Nocticola* Bolívar, 1892 (Blattodea: Nocticolidae) from Japan, and Description of Macropterous Form of *N. uenoi* Subspecies. Jpn. J. Syst. Entomol **31(1)**: 158–166.