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FIRST REPORT OF *ACHAEA SERVA* (F.) DEFOLIATING *POUTERIA OBOVATA* IN VIETNAM

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ABSTRACT

In 2021, widespread defoliation of *Pouteria obovata* occurred in the Co To Island, Vietnam. The damage incidence from defoliation ranged from 23 to 82%, and the average damage index was from 0.4 to 3.1. Based on morphological and molecular data, this paper establishes *Achaea serva* (F.) as a serious new pest of *P. obovata.* This pest should be included in future forest health monitoring programs in coastal Vietnam to determine its spread, host range and pest status.

Key words: *Achaea serva, Pouteria obovata*, defoliation, folivore, Noctuoidea, pest, phylogeny, identification, morphology, genitalia, molecular, damage index

Pouteria obovata (Sapotaceae) occurs in many coastal areas of Asia and Australasia (Shimizu and Tabata, 1991) where it plays important roles in the coastal protection (Suzuki et al., 2005). In Malaysia and Indonesia, *P. obovata* is grown in many localities for the purpose of protecting the coast, growing on peat soil and to improve the ecological environment in the areas around the city (Astiani, 2016; Pesiu et al., 2022). Furthermore, due to its ability to survive in sandy soils, *P. obovata* is favored for rehabilitation of coastal forests in Vietnam (Hoang and Thao, 2015). In 2014, the Agricultural Service Centre of Co To District received local reports concerning a new emerging pest defoliating *P. obovata* in mixed forests on Co To Island, northern Vietnam (unpublished data). The pest was preliminarily identified to *Achaea* (Lepidoptera: Erebidae) and the extent of damage was not assessed. In 2021, widespread defoliation of *P. obovata* occurred in the Co To Island and a study was undertaken. Based on morphological and molecular evidence, this paper establishes *Achaea serva* (F.) as the pest species damaging *P. obovata*.

MATERIALS AND METHODS

Eggs and final larval instars of *Achaea* were collected in September and October 2021, respectively, on damaged *P. obovata* trees from the natural coastal forests in Nam Dong (21°01'286"N; 107°74'731"E), Mon Quan Y (21°01'182"N; 107°75'501"E) and Hong Hai (21°00'248"N; 107°76'166"E), and taken to the laboratory in Hanoi (21°04'19"N; 105°46'36"E) where they were reared individually in net cages on fresh host leaves (26±2 ^{0}C, 65-70% RH). Initial identification was based on morphological characteristics of 12 male and 13 female adults using the descriptions of Edwards (1978). Morphometric observations and measurements of eggs, larvae and pupae were made using a Leica M165C stereozoom microscope. Genitalia of male and female adults were prepared as described by Wanke and Rajaei (2018) and these compared with the description of *A. serva* (Edwards, 1978).

Legs of adult specimens AS003 obtained in Nam Dong and AS016 in Mom Quan Y were subjected to DNA extraction using DNeasy blood and tissue kit (Qiagen, Valencia, California) and COI-LEP-F (ATTCAACCAATCATAAAGATATTGG) and COI-LEP-R (TAAACTTCTGGATGTCCAAAAAATCA) primers (Hajibabaei et al., 2006). Protocols were performed as described by Sivasankaran et al. (2013) and Kang et al. (2019). The sequences were aligned using the multiple alignment sequence program MAFFT version 7, and then evaluated using MEGA 7 software. Phylogenetic tree was constructed using maximum-likelihood (ML) method based on the selected Hasegawa–Kishino–Yano (HYK) model, invariant sites (I) with bootstrapping analyses of 1000 random replications. The resulting tree was viewed using MEGA 7 and edited using PowerPoint

Five temporary plots, each 1000 m^2 (25 × 40 m), were established in each of the three sites and the canopies of 30 random host trees were assessed using binoculars. Damage was classified into five levels as follows: 0 = no damage; 1 = the leaf area loss is <25%; 2 = the leaf area loss is 25 to <50%; 3 = the leaf area loss is 50 to <75%; 4 = the leaf area loss is ≥75%. The damage incidence (*P%*) was calculated using equation 1 (Chi et al., 2021):

$$P\% = (n/N) \times 100 \quad \ldots(1)$$

where, *n* is the number of trees defoliated by *Achaea*; *N* is total number of trees evaluated.

The average damage index (*DI*) in each plot was calculated using equation 2 (Chi et al., 2021):

$$DI = (\Sigma n_i \times v_i)/N \quad \ldots(2)$$

where: n_i is the number of defoliated trees at damage index *i*; v_i is the damage index at level *i*; and N is total number of trees evaluated. The damage severity level was categoried based on the average damage index as follows: $DI = 0$, no damage; $0 < DI \leq 1$, slight damage; $1 < DI \leq 2$, medium damage; $2 < DI \leq 3$, severe damage; $3 < DI \leq 4$, very severe damage.

RESULTS AND DISCUSSION

Based on the morphological characters of *Achaea* adults and the genital structures of male and female given by Edwards (1978), and the DNA sequence of the samples in this study (OL851530, OL851531) compared to KT988710 in Kang et al. (2019) and HQ006179 in Zahiri et al. (2011) with the homogeneity of 99.8-99.9%, the pest infesting *P. obovata* trees in Co To Island was identified as *Achaea serva* (F., 1775) (Lepidoptera: Erebidae).

Females larger than males; males pale-brown, body length 23-26 mm and wingspan 52-60 mm (n = 12) (Fig. 1a); females darkish-brown, body length 25-27 mm and wingspan 56-64 mm (n = 13) (Fig. 1b). Forewing ground colour pale brown, with darker brown at the terminal and subterminal lines area, crossing line slender in male (Fig. 1a); in female (Fig. 1b), forewing plain dark-brown, with mixed black scale, and the crossing line rather broader than the male. The median line white, especially obvious at middle part, subterminal line white and thin, and with one white dot at apex and M_{1-2} of the terminal line area. Ventral surface of forewing and hindwing paler in males than in females (Fig. 1a, b). Female genitalia (Fig. 1c): Papillae analis short, broadly conical; seventh segment of abdomen strongly sclerotized. Apophyses anteriores 1/2 long as apophyses posteriores, slender. Ductus bursae long, hardly sclerotized, and bent. Corpus bursae curved. Antevaginalis lamella rectangular and sclerotized. Appendix bursea medium sclerotized. Corpus bursae oval-shaped. Male genitalia (Fig. 1d-f): Uncus short, sclerotized and claw-shaped, with two long and asymmetric superuncus. Valva medium sclerotized, knife-shaped, with well separated costa and sacculus processes, the former trifid, and asymmetrical, the latter slender and rodlike. Aedeagus sclerotized and curved; caecum rather swollen; carina with a small horn.

Eggs round in outline, green. Larvae initially black, about 30-35 mm long but gradually change to blackish-gray, about 58-62 mm long (n = 200). Six interrupted orange-red stripes along the length of each side in young larval instars. Three white spots on the head and four white spots on the sides of the abdominal legs in last larval instars. Pupae oblong, reddish-brown immediately after pupation, and then gradually

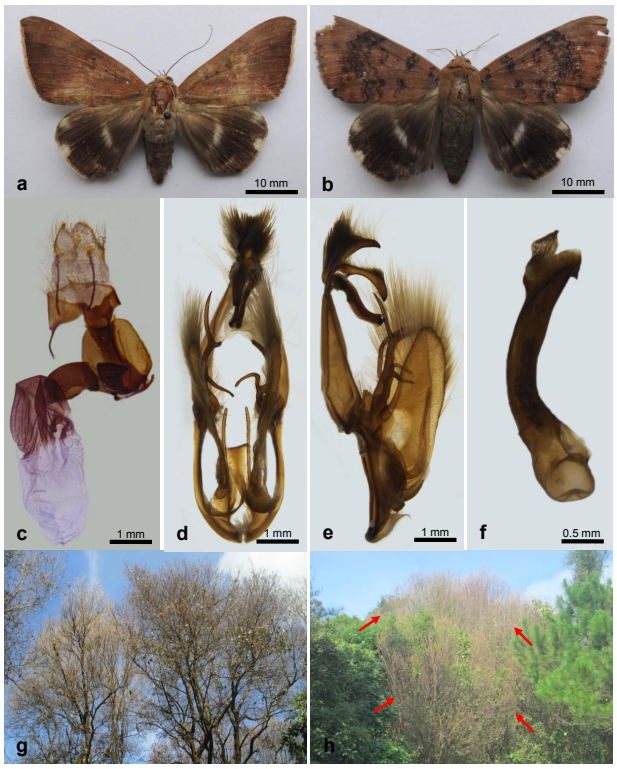

Fig. 1. Morphological characteristics of *Achaea serva* adults and symptoms of its damage in *Pouteria obovata* in Co To Island: a. male, specimen #AS003 collected in Nam Dong; b. female, specimen #AS016 collected in Mom Quan Y; c. female genitalia lateral view; d-f. male genitalia (d, e. aedeagus removed, f. aedeagus, c-f. right lateral view, d. dorsal view); g. damaged tree with all its foliage consumed by caterpillars; h. damaged *P. obovata* trees (red arrows) in a natural coastal forest.

Table 1. Damage incidence and average damage index of *Achaea serva* in *Pouteria obovata* in coastal forests, Co To Island, Vietnam

Location	Total forest area (ha)	Percentage of *P. obovata* trees in the forest (%)	September 2021		October 2021	
			P%	*DI*	*P%*	*DI*
Nam Dong	16.1	81.2	61.5±3.6	2.04±0.10	81.8±3.7	3.11±0.09
Mom Quan Y	68.5	45.7	25.3±1.8	1.03±0.06	44.6±2.1	1.62±0.07
Hong Hai	200.3	25.3	14.6±1.6	0.29±0.05	23.5±1.9	0.43±0.06

Note: *P%* is damage incidence (%), *DI* is mean damage index. Values are mean (n = 150)±SE.

changing to dark reddish brown, 20-27 mm long and 7-8 mm wide. *A. serva* was associated only with *P. obovata* trees in natural coastal forests (Fig. 1h). The larvae of *A. serva* feed on the entire leaf blade, from the outside to the main vein and from the apex of the leaf down to the petiole. Heavy infestations can lead to complete defoliation (Fig. 1g). *P. obovata* populations were most concentrated in Nam Dong, and the most damaged trees were observed in this site (Fig. 1g), with the *P%* and the *DI* being 81.8% and 3.11, respectively. In contrast, *P. obovata* populations were less concentrated in Hong Hai (25.3%), where they suffered the least damage, with *P%* of 23.5% and *DI* of 0.43. In Mom Quan Y, the *P%* and *DI* were intermediate, being 44.6% and 1.62, respectively.

The mtCOI gene of specimens AS003 (OL851530) and AS016 (OL851531) were sucessfully amplified and the phylogenetic analysis revealed 100% homology with reference specimens from Malaysia and Korea (Fig. 2) (Zahiri et al., 2011; Kang et al., 2019). This study is the first report of damage caused by *A. serva* on *P. obovata* in natural coastal forests of Vietnam. *A. serva* occurs in the Trang An landscape complex of Ninh Binh province, but its host is unknown (Nhi et al., 2019). Recently, *A. serva* has been observed causing severe damage to *Mimusops elengii* (Sapotaceae) in southern Vietnam (Vu Thi Nga, personal communication). Large-scale plantings of *P. obovata* are being promoted for coastal protection (Hoang and Thao, 2015). Therefore this species should be considered in monitoring programs on forest pests to determine its pest status.

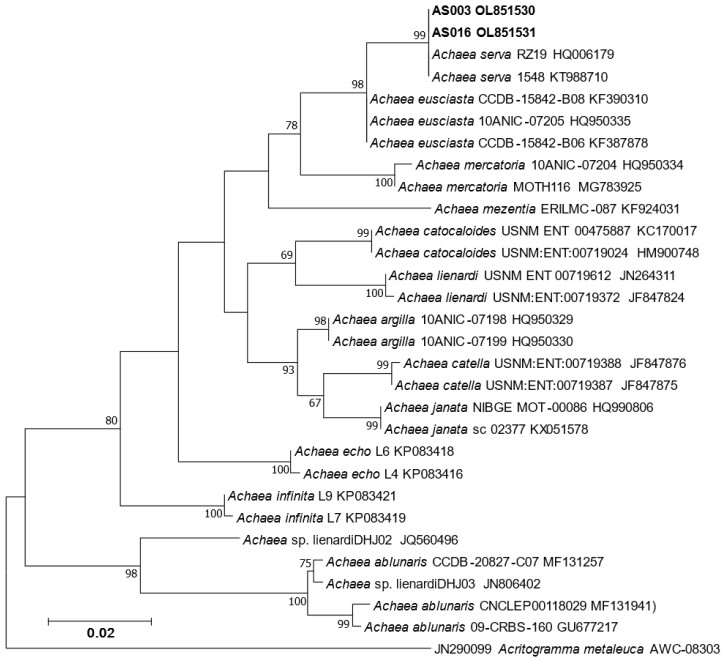

Fig. 2. Phylogenetic relationship of two specimens #AS003 and #AS016 collected from *Pouteria obovata* trees and other species within the GenBank database within the genus *Achaea*. The tree is rooted with *Acritogramma metaleuca* JN290099 as the outgroup. The bar indicates an expected sequence variation of 2.0%.

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AUTHOR CONTRIBUTION STATEMENT

TXH, NMC, DLP conveied and designed research. HLH identified and described the insect. TXH, NMC, DLP, LVP, VVT, BTT, PTTT conducted field surveys. TXH, NMC, DLP carried out laboratory experiments. TXH wrote the manuscript. All authors read and approved the manuscript.

CONFLICT OF INTEREST

Authors declares, there is no conflict of interest.

REFERENCES

Astiani D. 2016. Tropical peatland tree-species diversity altered by forest degradation. Biodiversitas Journal of Biological Diversity. 17(1).

Chi N M, Thanh N V, Quang D N, Thanh L B, Thao D V, Son L T, Hinh T X, Thu P Q, Dell B. 2021. First report of *Tapinolachnus lacordairei* (Coleoptera: Cerambycidae) damage in *Chukrasia tabularis*. International Journal of Tropical Insect Science 41: 909-914.

Edwards E D. 1978. A review of the genus *Achaea* Hübner in Australia (Lepidoptera: Noctuidae). Australian Journal of Entomology 17: 329-340.

Hajibabaei M, Janzen D H, Burns J M, Hallwachs W, Hebert P D N. 2006. DNA barcodes distinguish species of tropical Lepidoptera. Proceedings of the National Academy of Sciences 103: 968-971.

Hoang H D T, Thao T T H. 2015. Flora systems in the coastal sandy areas in central Vietnam. Hue University Journal of Science 111: 59-67.

Kang T H, Kim S, Hong K J, Lee H S. 2019. DNA barcoding in quarantine inspection: a case study on quarantine insect monitoring for Lepidoptera obtained through quarantine inspection on foreign vessels. Mitochondrial DNA Part B. 4: 43-48.

Nhi P T, Tru H V, Nam N H. 2019. First report of lepidopteran insects from the Trang An landscape complex, Ninh Binh province, with two new country records. Academia Journal of Biology 41: 25-30.

Pesiu E, Lee G E, Salam M R, Salim J M, Lau K H, Yong J W H, Abdullah M T. 2022. Species composition, diversity, and biomass estimation in coastal and marine protected areas of Terengganu, Peninsular Malaysia. Agronomy 12(10): 2380.

Shimizu Y, Tabata H. 1991. Forest structure, composition, and distribution on a Pacific island, with reference to ecological release and speciation. Pacific Science 45: 28-49

Sivasankaran K, Parandhaman D, Ramakrishnan M, Ignacimuthu S. 2013. Molecular studies of family Erebidae moths (Lepidoptera: Noctuoidea) using RAPD-PCR technique. Elixir Appl. Zoology 62: 17634-17639.

Suzuki K, Laongpol C, Sridith K. 2005. Phytosociological studies on vegetation of coastal dunes at Narathiwat, Thailand. Tropics 14: 229-244.

Wanke D, Rajaei H. 2018. An effective method for the close up photography of insect genitalia during dissection: a case study on the Lepidoptera. Nota lepidopterologica 41: 219-223.

Zahiri R, Kitching I J, Lafontaine J D, Mutanen M, Kaila L, Holloway J D, Wahlberg N. 2011. A new molecular phylogeny offers hope for a stable family level classification of the Noctuoidea (Lepidoptera). Zoologica Scripta 40: 158-173.

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