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**Research Note**

# Novel records of parasitoids targeting fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), in rice-corn-based cropping systems in the Philippines

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**ABSTRACT:** In the Philippines, the Fall Armyworm (FAW) was initially documented infesting corn in June 2019 and rice in May 2021. Relying on commercially available insecticides as the primary, if not exclusive, management strategy raises concerns about potential issues arising from FAW developing resistance to these chemicals, and the associated risks these insecticides pose to non-target organisms and the environment. To address these challenges, it is imperative to explore potential naturally occurring indigenous biological control agents and entomopathogens of the FAW. Regular field samplings and monitoring of FAW and its natural enemies were systematically conducted in selected municipalities of Central and Northern Luzon, as well as the Cagayan Valley regions of the Philippines. FAW larvae suspected of parasitization were collected from the field and subsequently reared in the laboratory for parasitoid emergence and other natural enemies. The parasitoids that emerged were sent to the Centre for Agriculture and Biosciences International United Kingdom (CABI UK) Diagnostic and Advisory Service for identification. Two hymenopteran parasitoids, *Brachymeria lasus* Walker (Family: Chalcididae) and *Copidosoma floridanum* (Ashmead) (Family: Encyrtidae), were identified from the lab-reared FAW larval samples. These two FAW parasitoids are new records in the Philippines and elsewhere.

**KEYWORDS:** *Brachymeria lasus*, *Copidosoma floridanum*, parasitoid, *Spodoptera frugiperda*

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The polyphagous Fall Armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), has emerged as a pervasive global threat, wreaking havoc on corn-producing nations (Abro *et al.*, 2021). Its rapid global spread has led to catastrophic consequences for agricultural economies. The Philippines, in particular, experienced its initial encounter with FAW-induced damage on corn in Piat, Cagayan, on June 7, 2019 (Navasero *et al.*, 2019), and later on rice in Pateng, Gonzaga, Cagayan, on May 17, 2021, subsequently spreading to 13 other municipalities in the Cagayan Valley Region and extending into rice growing areas of Nueva Ecija in Central Luzon (Valdez *et al.*, 2021; Valdez *et al.*, 2023a; Valdez *et al.*, 2023b). In response to the FAW menace, various control tactics, such as biological and chemical interventions, are being implemented globally, as witnessed in countries like the USA (FAO, 2022). However, in the Philippines, specifically in Cagayan Province where FAW has been observed since 2021, farmers predominantly, if not exclusively, resort to the use of commercially available synthetic insecticides to manage FAW infestations in both corn and rice crops. This heavy, and largely unilateral, reliance on insecticides, not only proves to be unsustainable but also poses threats to non-target organisms and the environment. Moreover, such practices are likely to contribute to the development of insecticide resistance in FAW populations, mirroring reports from the Americas where resistance has been observed to at least 29 insecticide active ingredients across six mode of action groups, including Bt proteins (Mota-Sanchez & Wise, 2017; Huang *et al.*, 2016; Li *et al.*, 2016). Recognizing the limitations and potential hazards associated with the prevalent insecticide-centric approach, there arises a critical need to explore alternative and sustainable pest management strategies. The utilization of naturally occurring beneficials, such as parasitoids, has proven to be effective in numerous crop systems. These beneficial, viz., biological control agents, are host-specific, economically viable, environmentally friendly, and contribute to sustainable agricultural practices. Considering its imperative, a comprehensive survey of indigenous natural enemies of FAW in the infested areas of Central and

Northern Luzon, Philippines, was undertaken. This study was an integral part of a project funded by the Department of Agriculture - Bureau of Agricultural Research (DA-BAR) and conducted in collaboration with the Philippine Rice Research Institute (PhilRice) and the Centre for Agriculture and Biosciences International (CABI), focused on the collection and identification of potential indigenous natural enemies of FAW.

The study conducted field samplings, ocular field and plant examinations and monitoring for FAW and its natural enemies including parasitoids and entomopathogens, in three selected rice-corn growing municipalities of Central Luzon (Pura, Tarlac; Concepcion, Tarlac; and Magalang, Pampanga), one neighbouring municipality in Northern Luzon (Rosales, Pangasinan) and two rice-growing municipalities in Cagayan (Santa Ana and Gonzaga) (Figure 1). FAW egg masses and larvae were gathered from corn and rice plants, placed in glass vials lined with moistened tissue paper, and transported to the laboratory for rearing until parasitoids emerged. Suspected parasitized and disease-infected larvae were isolated in individual vials. The emerging parasitoids were preserved in 99.9% technical grade ethanol and sent to the Centre for Agriculture and Biosciences International United Kingdom (CABI UK) Diagnostic and Advisory Service for identification. Some of the samples of the larval parasitoid were preserved in the PhilRice Entomology Laboratory, and voucher specimens were deposited in the University of the Philippines Museum of Natural History (accession codes: UPLBMNH HYM-02488, -02489, -02490, -02491, -02492) and at the National Bureau of Agricultural Insect Resources, India. The specimens underwent processing by the CABI UK Molecular Identification team, including DNA extraction provided by CABI's Diagnostic and Advisory Services. Successful DNA extracts were processed using sequencing analysis and subsequent identifications were conducted by comparing the Reverse Complement of the obtained sequence obtained with those available from the Barcode of Life Data system (BOLD) (http://www.boldsystems.org/index.php/databases). The sequence data was also compared to the database available from the National Center for Biotechnology Information (NCBI) https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Web&PAGE_TYPE=BlastHome.

From the various collection sites, parasitized FAW larvae were specifically obtained from corn in two barangays of Magalang, Pampanga, namely Barangay Escaler (15° 16' 12.0720'' N; 120° 43' 39.7200'' E) and Sitio Balitucan, Barangay San Ildefonso (15° 15' 46.9440'' N; 120° 43' 1.5600'' E) (Figure 2). In the laboratory, where samples were reared on corn leaves, a remarkable 1,577 parasitoid wasps of the same species emerged from a single larva, and a solitary larval-pupal parasitoid emerged from a pupa. Molecular analysis revealed that the larval-pupal parasitoid was *Brachymeria lasus* Walker (Hymenoptera: Chalcididae) (Figure 3A), while the larval parasitoid was *Copidosoma floridanum* (Ashmead) (Hymenoptera: Encyrtidae) (Figure 3B). Notably, these two parasitoids represent new records for FAW in the Philippines and amongst those recorded globally. No egg parasitoids emerged from the FAW egg masses.

*Brachymeria lasus* is recognized as a solitary idiobiont pupal parasitoid, predominantly targeting lepidopteran species. Noyes (2019) reported 128 host species, while CABI (2019) documented 74**.** Notably, according to the CABI datasheet *B. lasus* has no recorded attacks on *S. frugiperda*. Instead, it is known to parasitize two other *Spodoptera* species (*S. littoralis* and *S. litura*), and various other Lepidopteran insects including several insect pests of rice such as *Mythimna separata* Walker (CABI, 2019; Noyes, 2019), *Cnaphalocrocis medinalis* (Guenée) (CABI, 2019; Noyes, 2019; Hu and Wu, 1987) and *Naranga aenescens* Moore (CABI, 2019; Noyes, 2019). Additionally, *B. lasus* has been reported as a pseudo-hyperparasitoid of certain developmental stages of the Ichneumonid and Tachinid parasitoids of Lepidoptera (CABI, 2019; Noyes, 2019). It is important to note that there were 175 reported parasitoids of FAW in the Americas and Caribbean basin (Molina-Ochoa *et al.*, 2003) however, neither of the two parasitoids recorded in this study i.e *B. lasus* and *C. floridanum*, are included in the list although *Brachymeria ovata* (Say) and *Brachymeria robusta* (Cresson) were included (Virla *et al.*,1999; Wilson 1923). A study conducted by Husni *et al.* (2001) revealed that *B. lasus* female does not discriminate against host pupal age and that it oviposited on the pupal host irrespective of the host's age. However, there was a variation in the number of the progenies that emerged and their body weight. Although generally *Brachymeria* spp., including *B. lasus*, are recorded as pupal parasitoids, the observation in this study tended to suggest that it could also be a larval-pupal parasitoid as exhibited by other species of *Brachymeria* such as *Brachymeria plutellophaga* (Girault) as reported in the case of the groundnut leafminer, *Aproaerema modicella* Deventer (Lepidoptera: Gelechiidae), in India (Shanower *et al.*, 1992)

*Copidosoma floridanum* is identified as a polyembryonic parasitoid with a host range encompassing 46 lepidopteran and two hemipteran host insects (Noyes, 2019). The reproductive strategy involves the deposition of a primary clutch, typically consisting of one or two eggs, per host. This distinctive feature leads to the development of multiple embryos from each laid egg (Ode & Strand, 1995; Strand, 1989).

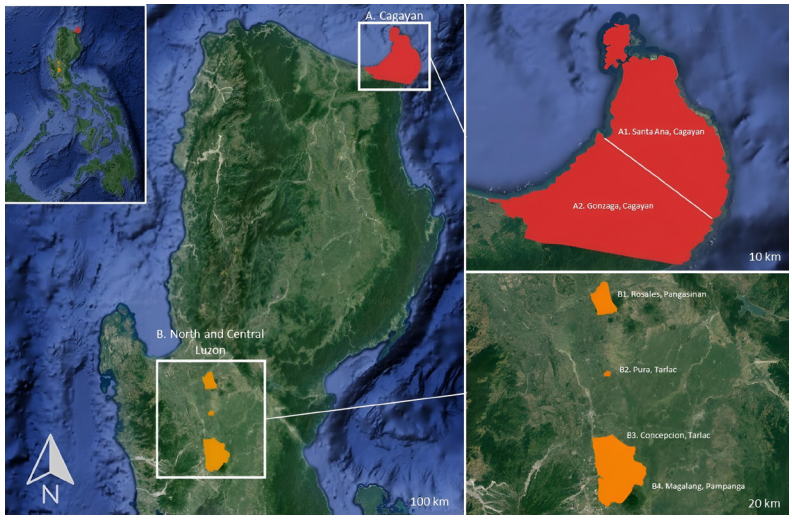


**Figure 1.** Collection sites in two rice-growing municipalities in Cagayan: Gonzaga (A1) and Santa Ana (A2); one neighbouring municipality in Northern Luzon: Rosales, Pangasinan (B1); and three rice-corn growing municipalities of Central Luzon: Pura, Tarlac (B2), Concepcion, Tarlac (B3), and Magalang, Pampanga (B4).


**Figure 2.** Locations where the parasitized FAW larvae were collected.

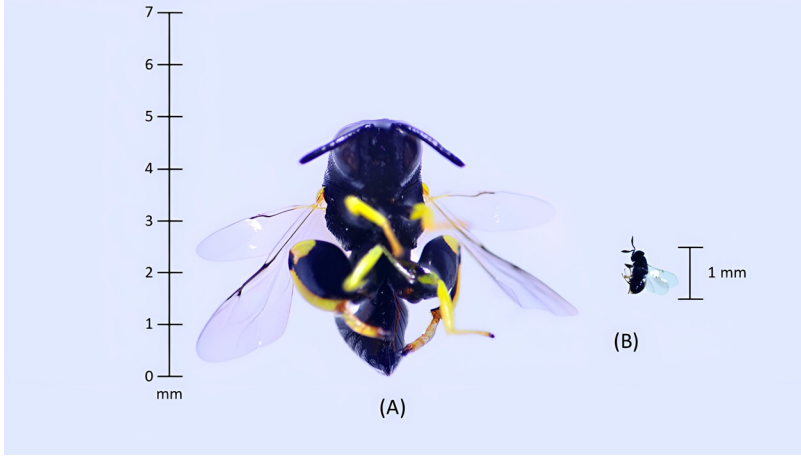


**Figure 3.** The (A) larval-pupal parasitoid *Brachymeria lasus*, and the (B) larval parasitoid *Copidosoma floridanum*. These parasitoids emerged from the FAW larvae collected in the corn plants in Magalang, Pampanga, during the 2021 wet season and were subsequently reared in the Entomology Laboratory of the Philippine Rice Research Institute Central Experiment Station, Maligaya, Science City of Muñoz, Nueva Ecija, Philippines.

## CONCLUSION AND FUTURE UNDERTAKINGS

This study underscores the seminal documentation of *B. lasus* and *C. floridanum* parasitizing FAW in the Philippines, which constituted a new record of these two wasp species as FAW parasitoids. In future, continued assessments to map the distribution, abundance etc. and in-depth research on the biology and efficiency of these parasitoids as potential biological control agents against FAW are imperative to essentially elucidate their potential role in the effective management of FAW.

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