

DOI: 10.21608/alexja.2024.333030.1103

First Record of *Barylypa rufa* (Hölmgren 1857) as Parasitoid on *Spodoptera frugiperda* (Smith) from the Egyptian Fauna

Hadeer Shawky Rashed¹, Mohammed Ridha Abd El-Salam²,
Ibrahim Abd El-Samea El-Ghabawy^{1*}

¹Plant Protection Department, Faculty of Agriculture, Benha University, Al-Qalyubia, Egypt

²Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt

*Corresponding author: Ibrahim.abdelsamea@fagr.bu.edu.eg

ARTICLE INFO

Article History

Received: 1/11/2024

Revised: 18/11/2024

Accepted: 21/11/2024

Key words: *Barylypa rufa*,
Spodoptera frugiperda,
larval and pupal parasitoid.

ABSTRACT

Fall Armyworm *Spodoptera frugiperda* is a new pest that invaded Egyptian fields and has destroyed many economic crops, including maize, sorghum, and rice due to its voracious appetite. Natural enemies play a great role in controlling population densities of this pest, the parasitoid *Barylypa rufa* is a successful parasitoid on genus *Spodoptera* i.e. *S. littoralis* and *S. exigua* in nature. In this study, *B. rufa* was observed and recorded as a larval - pupal parasitoid on *S. frugiperda* for the first time from the Egyptian fauna. The present work also covers the diagnostic and recognition characteristics of *B. rufa* adults (head capsule, antenna, wings, legs, and abdomen). Ultimately, with this discovery of the parasitoid *B. rufa* as an important bio-control agent, which biologically participates in the suppression of FAW populations naturally under Egyptian conditions, its role in the Egyptian agricultural environment should be enhanced to contribute to the development of FAW control strategies.

INTRODUCTION

Some biocontrol agents play great roles in the development of sustainable integrated pest management (IPM) of fall armyworms (up to 42%) in their native continent (Ahissou *et al.*, 2021). So, the importance of this parasitoid lies in the fact that it may be one of the most important natural enemies that may share in combating the invasive insect pest, FAW *S. frugiperda* (J.E. Smith, 1797) (Lepidoptera: Noctuidae). This pest is considered the most important noctuid insect pest in the Americas and has recently become an invasive pest in Africa (Montezano *et al.*, 2018). It is pest is a highly polyphagous insect that feeds on more than 80 crops and plant species including sorghum, millet, vegetables, and others (Prasanna, 2018 and Sisay *et al.*, 2018). Presently, fall armyworm invasion has become the biggest threat to maize production and maize's value chain in Africa. FAW is alien to Africa and was not accompanied by its natural enemies, allowing the population to increase unabatedly and unchecked (FAO, 2018). Similarly, a few new species of FAW natural enemies were recorded in maize fields in Ethiopia, Kenya, and Tanzania in 2017 (Sisay *et al.*, 2018). This serves as a good indicator for possible biological control of FAW in Africa.

The Ichneumonidae, also known as ichneumon wasps, ichneumonid wasps, ichneumonids, or Darwin wasps, are a family of parasitoid wasps of the insect order Hymenoptera. They are one of the most diverse groups within the Hymenoptera with roughly 25,000 described species (Yu *et al.*, 2016). The species of subfamily Anomaloninae are solitary koinobiont endoparasitoids mostly on Lepidoptera

and some Coleoptera. The female parasitoids oviposit into early instar larvae, but the adults emerge always from the pupa (Townes, 1971 and Bolton & Gauld, 1988). Information on the description of the subfamily Anomaloninae is very scarce. The anomalonines are recognized by the combination of the following characteristics: gracile appearance, lack of areolet in the forewing, lack of regular carinae on the propodeum, and in having the posterior ocelli separated from the occipital carina by a distance of less than their maximum diameter (Townes, 1971 and Gauld, 1980). The genus *Barylypa* Förster, 1869 is belonging to the tribe Gravenhorstiini of the subfamily Anomaloninae distinguished through occipital carina complete; aedeagus without keels, heavily and rather evenly sclerotized; epomia weakly divergent from anterior margin of pronotum (Gauld, 1984).

Barylypa rufa Hölmgren, 1857 is a Hymenopteran parasitoid belonging to the family Ichneumonidae. The genus *Barylypa* has been recorded as a natural enemy for some species of the genus *Spodoptera* e.g. *S. littoralis* (Kamal, 1951) and *S. exigua* (Ismail & Swailem, 1975). In Egypt, *B. rufa* was recorded for the first time in 1950 on the lesser cotton leafworm *S. exigua* in clover fields in Giza (Ahmed, 1950), then on *S. littoralis* (El-Sheikh *et al.*, 2020). Also, it was recorded in Egypt as a pupal parasitoid on *Heliothis armigera* (Ismail & Swailem, 1975).

In the field of this study, many authors recorded new parasitoids from Ichneumonidae, and others studied the biology of some native ichneumonids on *S. frugiperda*. Patel & Habib (1987) worked on some biological studies of *Campoletis flavicincta* as

a parasitoid on *S. frugiperda*. Also, Camargo *et al.*, (2015) surveyed the parasitoid fauna of *S. frugiperda* in maize crops throughout Brazil and recorded two species *Campoletis sonorensis* and *C. flavicincta*. In Indian geographical boundaries, *Temelucha sp.* (Hymenoptera: Ichneumonidae) was first reported as a parasite of the FAW (Sagar *et al.*, 2022). Recently, Kamble & Jadhav (2023) studied the biology of the ichneumonid parasitoid, *Campoletis chlorideae* on *S. frugiperda* under laboratory conditions. Finally, the objective of this study is to record *Barylypa rufa* as a new larval and pupal ichneumonid parasitoid of *S. frugiperda* in Egypt.

MATERIAL AND METHODS

FAW samples collection

In continuation of our previous study, which

recorded the emergence of *S. frugiperda* as a new invasive insect pest on maize plants in the Nile Delta in Egypt (Rashed *et al.*, 2022). In July 2022, the sixth instar larvae of FAW *S. frugiperda* were collected by hand from corn fields at the faculty of agriculture, Benha University, Toukh, Qalyoubia, Egypt "30°21'25.8" N 31°13'16.8"E".

The collected samples were then placed in plastic plats covered with a muslin cloth (fig. 1) and transferred to the biological studies lab in the Plant Protection Department, Faculty of Agriculture, Benha University until reaching the pupal stage and the parasite emerged from the pupae. Afterward, the obtained parasitoids were transferred to 15 ml vials containing 70% ethyl alcohol with a few drops of glycerin to maintain the freshness of the samples and placed in the refrigerator (8-9°C) until identified.



Fig. 1: Last larval instar and pupal stage of *S. frugiperda* collected from maize fields.



Fig. 2: Adults of the parasitoid *B. rufa* emerged from *S. frugiperda* pupae



Fig. 3: *B. rufa* adult and the pupa of *S. frugiperda* with exit hole of the parasitoid

Identification

Comparisons of specimens were, mostly, carried out using (Gauld, 1976 and Goulet & Hüber, 1993), and all Ichneumonidae species that were saved in the main collection of the Egyptian agriculture Ministry by Dr. Mohammed R. Abd El-Salam using OLYMPUS stereomicroscope and photographed using Olympus Soft Imaging Solutions EP50.

Synonym:

Anomalon rufum Hölmgren, 1857 and *Laphyctes rufus* Schmiedeknecht, 1903. Oefvers. Kong. Vet. Akad. Forh. 14: 178.

Material examined:

2♀, 7.2022, Egypt, Moshtohor, Toukh 30°21'35"N 31°13'21"E, on Maize

RESULTS

After collecting 6th larval instar and pupae of *S. frugiperda*, and placed on plastic plates covered with muslin, and left for adult emergence, noticed that adults of insect parasitoid were found between the hollow pupae (fig. 3). Emerged individuals of parasitoid adults (fig. 2) were sent to the Plant Protection Research Institute for classification and

identification, and after classification, it was proven that it is belonging to family; Ichneumonidae, order; Hymenoptera, called *B. rufa* Hölmgren. *B. rufa* is one of the parasites that have been identified as being an insect parasitoid of *Spodoptera* species and recorded on both *S. littoralis* and *S. exigua*. The type of name was first given in 1857 by the publishing house Hölmgren.

Morphological characters of *B. rufa*

Description:

Body length of adults (Fig. 4) is 16 mm. Color generally reddish brown except scapula, mouth, clypeus, face, gena apex and radicle, yellow; inner eyes orbital and scutellum yellow; ocelli and thorax with black patches.

Head capsule:

The head (Fig. 5) red; with wide face and Ocelli; vertex black, Ocelli oblong-ovate, slightly emarginated near antennae base; front flat, little impress anteriorly, strongly punctate, hardly rough; face slightly narrowed towards mouth with silk pubescent. discernible, apices impress on both sides, short, appiculate. Mandible bidentate with subequal tooth, somewhat short.

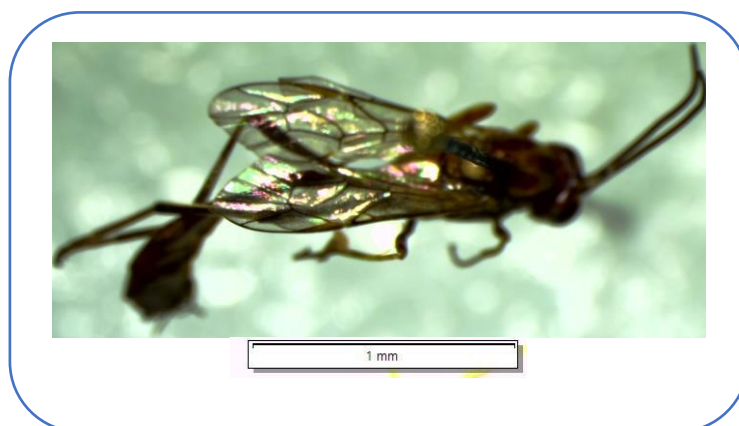


Fig. 4: *Barylypa rufa* (Hölmgren, 1857)

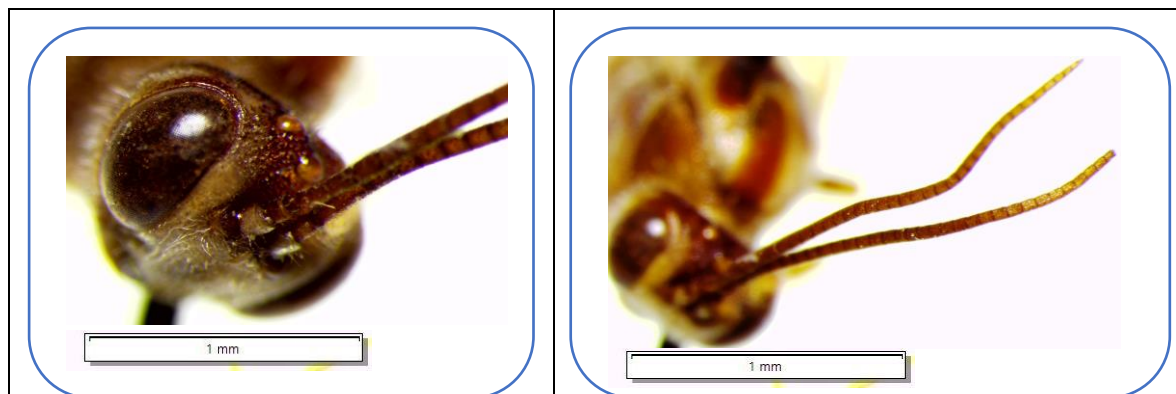


Fig. 5: Head

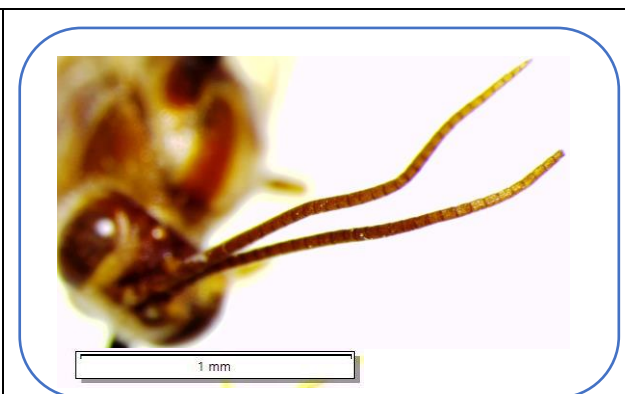


Fig. 6: Antenna

Antenna (Fig. 6): dark rusty, below thin and tapered end, elongated with 33 flagellomeres, filiform, half the length of body; first flagellum segment twice as long as the second, below the antennae with light rusty brown; scape reddish-brown above scape rufous with yellowish radicle.

Thorax (Fig.7): red, a little narrower of head, robust; mesothorax rough, punctate and shiny; mostly strong punctate, marked 3 longitudinal black stripes, above almost entirely black apex and laterals red; notaulus reaching meso-scutum center; mesonotum with blackish longitudinal dark brown band; metathorax suture light; scutellum with a little protuberance, convex; mid metathorax pitted especially a pix; spiracle oval.

Wings (Fig. 8): smoky hyaline, veins brownish yellow; fore wing with recurrent nerve post-furcate, Rs yellow, stigma brownish. Legs slender red; coxae apex and trochanters beginning blacken; hind legs with blackish patches and reddish- orange or red; coxae and femora mostly red, base and apex blackened; posterior trochanters equal length; tibia base yellowish white; tarsus not thickened, base rusty.

Abdomen (Fig. 9): reddish; 2nd segment linear shaped dorsally, 5 apex, 6 and 7 mostly black entirely. Ovipositor short and brown, quarter as long as metatibia, apically constricted, with a short tooth directly below the constriction in the lower valve.



Fig. 7: Thorax

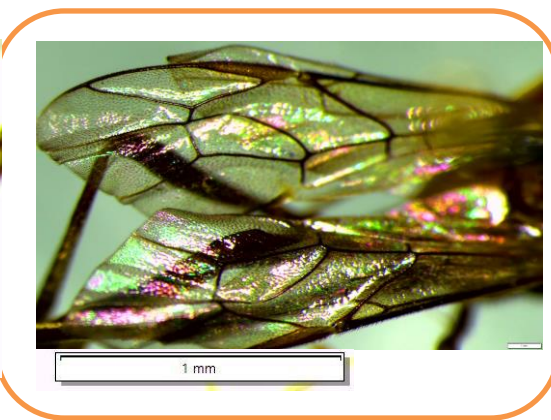


Fig. 8: Wings



Fig. 9: Abdomen and legs

Remark:

The species is distinguished from its relatives by the red painting and the color of the hind legs.

Host records in Egypt:

Recorded as a larval-pupal parasitoid of *Spodoptera littoralis* (Boisduval 1833) (Lepidoptera: Noctuidae) (Kamal, 1951), *Spodoptera exigua* (Hübner 1808) (Lepidoptera: Noctuidae) (Ismail & Swailem, 1975), *Helicoverpa armigera* (Hübner, 1809) (Lepidoptera: Noctuidae)

(Ismail & Swailem 1975; Megahed *et al.*, 1977 and Yu *et al.*, 2012).

Distribution in Egypt:

Ain Shams, Biala, Borg El-Arab, El-Aanayat, Ezbet El-Nakhl, Ghazirah, Helwan, Kafr Hakim, Khanka, Maadi, Mansouria, Marg, Saqara, Sherbin, Sids, Wadi Hoff, Wadi El-Mallah (El Azab, 2007), Farafra Oasis (Gadalla *et al.*, 2015).

World distribution:

Afghanistan, Albania, Algeria, Austria, Azerbaijan, Bulgaria, Cyprus, former Czechoslovakia, Egypt, Finland, France, Germany, Hungary, Iran, Libya, Palestine, Poland, Romania, Russia, Spain, Sweden, Tunisia, Turkmenistan, Ukraine, Uzbekistan, former Yugoslavia (Yu *et al.*, 2012).

DISCUSSION

In similar survey studies on genus *Barylypa*, *B. humeralis* Brauns recorded on *S. exigua* by (Willcocks & Bahgat, 1937), and on *S. littoralis* (Boisd.) by (Kamal, 1951) and on *H. armigera* by (Tawfik, 1977), and also, genus *B. paradoxus* Schmed. was recorded on *S. exigua* (Willcocks, 1925), and *B. rufa* on *S. exigua* by (Ismail & Swailem, 1975). And recently El-Husseini *et al.*, (2018) reported that the ichneumonids *B. humeralis* Braun., *B. rufa* Holmgren, and *Campoplex xanthostoma* Grav are parasitoids on the American cotton bollworm, *Helicoverpa armigera* Hübner (Noctuidae) (Final report of the Egyptian project on natural enemies of *H. armigera* in Egypt). Also, *B. rufa* was recorded on alfalfa fields during two successive seasons (2018 -2019) on *S. littoralis* the Western Desert in Egypt (El-Sheikh *et al.*, 2020).

CONCLUSION

As for the importance role of natural enemies on controlling agriculture insect pests, focusing on using it, especially, for controlling the new invasive pest, *S. frugiperda* in Egypt is one of the important points which must be concerned on it. This study recorded a new parasite on *S. frugiperda* as one of important insect parasite on this pest in Egyptian fields. This study recommended that this parasite needs many studies to enhance its role in biological control by more future studies.

AUTHOR CONTRIBUTION

Authors 1 and 3 collected the samples from corn fields and conceived the research. Author 2 determined the species. All authors participated in writing the manuscript; also, all authors read and approved the final manuscript.

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الملخص العربي

أول تسجيل لطفيل *Barylypa rufa* (Hölmgren 1857) على حشرة دودة الحشد الخريفية *Spodoptera frugiperda* (Smith) من الفونا المصرية

هدير شوقي راشد^١، محمد رضا عبدالسلام^٢، إبراهيم عبدالسميع الغباوي^١

^١قسم وقاية النبات، كلية الزراعة، جامعة بنها، القليوبية، مصر.

^٢معهد بحوث وقاية النبات، مركز البحوث الزراعية، الدقى، الجيزة، مصر.

تعتبر دودة الحشد الخريفية آفة جديدة غزت الحقول المصرية ودمرت العديد من المحاصيل الإقتصادية الهامة بما في ذلك الذرة والذرة الرفيعة والأرز بسبب شراحتها في التغذية. تلعب الأعداء الطبيعية دوراً كبيراً في السيطرة على تعداد هذه الآفة تحت الظروف الحقلية. الطفيل *Barylypa rufa* يعتبر طفيل ناجح على جنس *Spodoptera* خاصة *S. littoralis* و *S. exigua* في الطبيعة. في هذه الدراسة تمت ملاحظة وتسجيل الطفيل *B. rufa* كطفيل يرقات-عذاري علي دودة الحشد الخريفية لأول مرة في الحقول المصرية. كما أهتمت الدراسة الحالية أيضاً بدراسة بعض صفات المورفولوجية للحشرات الكاملة لطفيل *B. rufa* (كبسولة الرأس، قرن الإستشعار، الأجنحة، الأرجل والبطن). وفي النهاية، مع اكتشاف الطفيل *B. rufa* كعامل للمكافحة الحيوية، والذي يشارك بيولوجياً في الحد من تعداد دودة الحشد الخريفية بشكل طبيعي في ظل الظروف المصرية، يجب تعزيز دورها في البيئة الزراعية المصرية للمساهمة في تطوير استراتيجيات مكافحة دودة الحشد الخريفية.