



E-ISSN: 2320-7078

P-ISSN: 2349-6800

JEZS 2020; 8(1): 1521-1524

© 2020 JEZS

Received: 06-11-2019

Accepted: 10-12-2019

Ankita Gupta

ICAR-National Bureau of
Agricultural Insect Resources, H.
A. Farm Post, Bellary Road,
Hebbal, Bengaluru, Karnataka,
India

Y Lalitha

ICAR-National Bureau of
Agricultural Insect Resources, H.
A. Farm Post, Bellary Road,
Hebbal, Bengaluru, Karnataka,
India

Richa Varshney

ICAR-National Bureau of
Agricultural Insect Resources, H.
A. Farm Post, Bellary Road,
Hebbal, Bengaluru, Karnataka,
India

AN Shylesha

ICAR-National Bureau of
Agricultural Insect Resources, H.
A. Farm Post, Bellary Road,
Hebbal, Bengaluru, Karnataka,
India

Cornelis Van Achterberg

Naturalis Biodiversity Center,
Darwinweg 2, 2333 CR Leiden,
the Netherlands, Europe

Corresponding Author:**Ankita Gupta**

ICAR-National Bureau of
Agricultural Insect Resources, H.
A. Farm Post, Bellary Road,
Hebbal, Bengaluru, Karnataka,
India

Chelonus formosanus Sonan (Hymenoptera: Braconidae) an egg-larval parasitoid of the invasive pest *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) amenable to laboratory mass production in India

Ankita Gupta, Y Lalitha, Richa Varshney, AN Shylesha and Cornelis Van Achterberg

Abstract

Field surveys conducted during 2018 in the maize fields infested with *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) in Karnataka and during 2019 in Andhra Pradesh yielded an egg-larval parasitoid *Chelonus formosanus* Sonan (Hymenoptera: Braconidae). This is the first report of *C. formosanus* parasitizing *S. frugiperda* in India (in natural field conditions) and which is amenable to mass production (in laboratory conditions). The present study provides morphological identification details along with mass production procedure and biology of *C. formosanus*.

Keywords: *Chelonus formosanus*, fall armyworm, identification, laboratory rearing, India

Introduction

Indian maize fields are at present under the gruesome attack of the invasive species *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), the fall armyworm (FAW), which is considered as one of the most problematic pests of maize (Rakshit *et al.* 2019)^[5]. The challenge for the Indian researchers is to find an ecofriendly and sustainable pest management strategy for the control of this pest. Shylesha *et al.* 2018^[8] and Gupta *et al.* 2019^[4] have reported many species of parasitoids viz., *Telenomus* sp. (Platygastridae), *Trichogramma* sp. (Trichogrammatidae), *Glyptapanteles creatonoti* (Viereck) (Braconidae), *Campoletis chlorideae* Uchida (Ichneumonidae), and *Cotesia ruficrus* (Haliday) (Braconidae) infesting *S. frugiperda* in the natural field conditions. From FAW, many species of *Chelonus* Panzer (Braconidae) have been reported from various parts of the world. *Chelonus formosanus* Sonan is Neotropical and Oriental in distribution (Yu *et al.* 2016)^[10]. Gupta *et al.* (2019)^[4] mentioned that many native parasitoids are targeting this notorious invasive pest - *S. frugiperda* in India, which is a good indication of its expanding parasitoid complex. However for the first time a successful attempt to mass produce one of the native parasitoids has been achieved. In this paper a brief diagnosis of the wasp is provided along with mass production procedure and biology with an aim to serve our farming community in an ecofriendly manner.

Materials and Methods

Eggs and larvae of *S. frugiperda* were collected by NBAIR team from the maize fields (Indrasanahalli surrounded by Doddaballapura Taluk, Karnataka) in southern India on 3rd December, 2018 and from Hindupur, Andhra Pradesh in September-October, 2019. Parasitoids emerged from laboratory rearing were subjected to morphological studies at the ICAR-National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru by AG. The specimens reared from *S. frugiperda* were compared with the voucher specimens present in the Natural History Museum, London (BMNH) and cotype images of the Digital Insect of Taiwan Agricultural Research Institute, Taichung (TARI, 2020)^[9]. The specimens of the present study are deposited in the National Insect Museum of ICAR- NBAIR.

Results

In the present study *Chelonus formosanus* Sonan, 1932^[7] (Hymenoptera: Braconidae) was found parasitizing *S. frugiperda* in the maize field which is an egg-larval parasitoid of *Spodoptera litura* (F.) on cotton and other host plants and is already a well-established parasitoid in Karnataka (Singh 1994)^[6]. The parasitoid was identified as *C. formosanus* after examining the voucher specimen present at BMNH, London and comparing with the cotype images present in TARI, Taiwan. The diagnostic and life cycle details are mentioned below.

Diagnosis of *Chelonus formosanus* Sonan, 1932 (Figs 1–5)

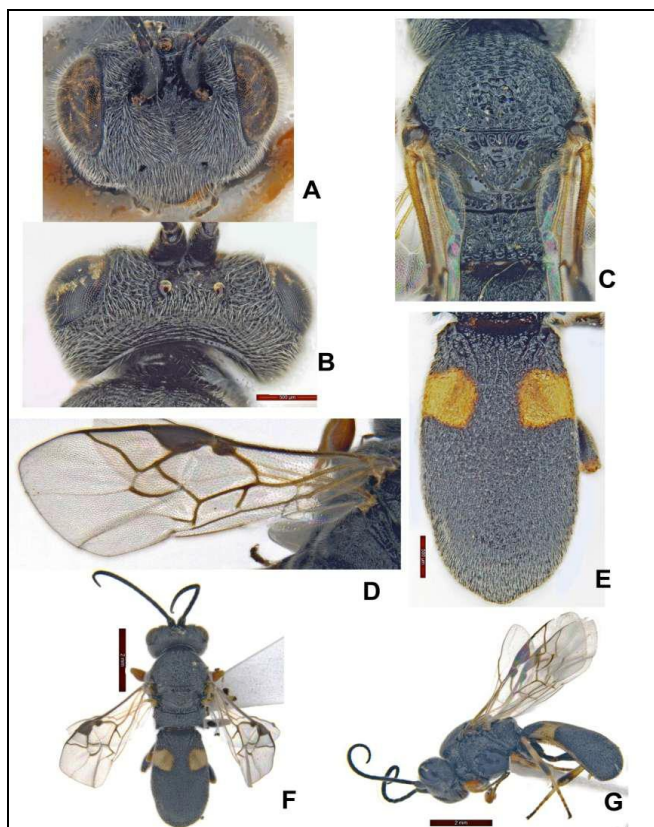


Fig 1: *Chelonus formosanus* Sonan, India, female, ex *Spodoptera frugiperda* (J. E. Smith): A. Head, frontal aspect; B. Head, anterior aspect; C. Mesosoma, dorsal aspect; D. Forewing; E. Metasoma, dorsal aspect; F. Female, dorsal habitus; G. Female, lateral habitus

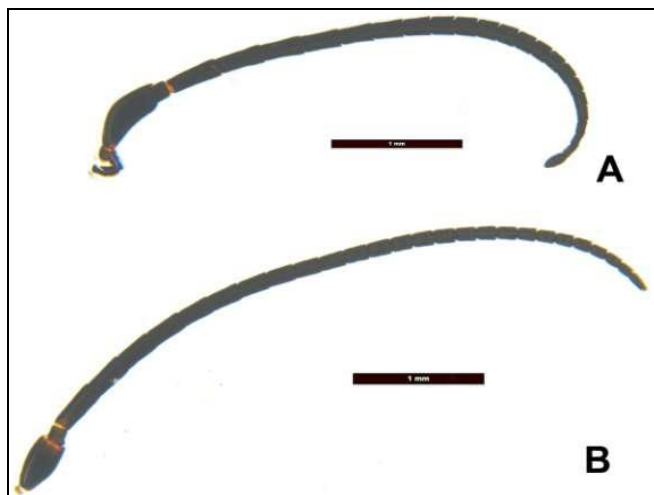


Fig 2: *Chelonus formosanus* Sonan, India, antenna. A. Female; B. Male



Fig 3: Voucher specimen of *Chelonus formosanus* Sonan, female: C.T.R.I.: RJY, C.I.E. COLL. A. 8251 [India] (BMNH)

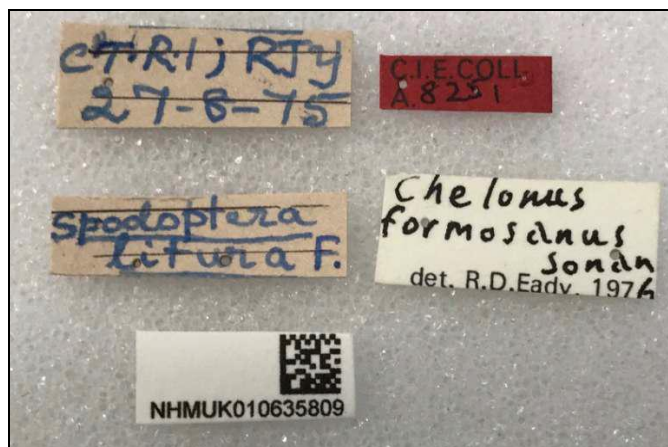


Fig 4: Label data of voucher specimen of *Chelonus formosanus* Sonan, female: C.T.R.I.: RJY, C.I.E. COLL. A. 8251 [India] (BMNH)

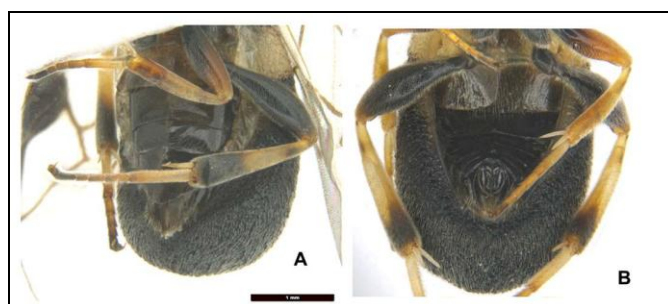


Fig 5: *Chelonus formosanus* Sonan, India, metasoma in ventral view. A. Female; B. Male

Vouchers specimens examined: Natural History Museum (BMNH), London, non-type specimen with label data (Fig. 4): C.T.R.I.: RJY (India: Central Tobacco Research Institute: Rajahmundry); 27.viii.75; C.I.E. COLL. A.8251; ex *Spodoptera litura* F.; *Chelonus formosanus* Sonan, det. R. D. Eady, 1976; barcode NHMUK010635809; drawer no. C-15, No. 479 and Digital Insect Collection of TARI, Taichung: Brac11020002- *Chelonus formosanus* Sonan; Taiwan: Taihoku; 28.ix.1930; coll. J. Sonan; cotype 230.

Material examined: 2 ♀ + 5 ♂, INDIA: Karnataka: Dodballapur: Indrasanahalli, 3.xii.2018, 13.2252°N, 77.6146°E, ex *Spodoptera frugiperda* (J. E. Smith), coll. M. Muralidhara, specimen code: ICAR/ NBAIR/Brac/Microg/Chel/31218; 7 ♀ + 6 ♂, INDIA: Andhra Pradesh: Hindupur, 10.x.2019, 13.8223° N, 77.5009° E, ex *Spodoptera frugiperda* (J. E. Smith), coll. NBAIR, specimen code: ICAR/ NBAIR/Brac/Microg/Chel/101019.

Diagnosis

Female: Body length 6.9 mm (lateral view); general body colour black; head including antenna and mesosoma black; fore and mid legs yellowish orange but coxa, trochanter and

infuscation at base of femur black; hind leg black with apex of hind femur, middle one third of tibia and base of tibia yellowish white; tegulum black with yellowish apical tip and humeral plate entirely dark brown; wings slightly infuscate, pterostigma and parastigma completely dark brown; metasomal carapace with a pair of subbasal ivory lateral spots, remainder black.

Head: Frons and clypeal region densely setose, setae white in colour; vertex densely setose and coarsely punctate, transversely rugose near occipital margin and eyes setose. Antenna with 24–25 segments (scape, pedicel and 22–23 flagellomeres), basal flagellomeres thicker and stouter and apical flagellomere club shaped, shorter and thicker than in male.

Mesosoma

Mesosoma coarsely rugose and irregularly areolate, areolation coarser in apical half and more transverse in basal half; scutellum coarsely areolate. Propodeum distinctly reticulate and with strong latero-apical tubercles. Fore wing with vein SR1 curved medially; vein r-m inclivous and pale; vein r much longer than wide; veins 2-M and M+CU1 curved; first submarginal and first discal confluent because of absent vein 1-SR+M.

Metasoma: carapace convex and coarsely punctate, punctations turning denser and smaller apically; length of carapace 1.5 times as long as its maximum width in dorsal view and 2.5 times as long as its maximum height in lateral view; truncate posteriorly (cf. Fig. 3A); carapace slightly widened apically in dorsal view and its apex truncate; basally carapace with longitudinal striation between coarse and

areolate punctation.

Male: antenna longer and thinner as compared to female, with 28 segments (scape, pedicel and 26 flagellomeres), terminal flagellomere tapering. Metasoma parallel-sided and apically less truncate in dorsal view.

Discussion

Chelonus formosanus differs from the other two closely allied *Chelonus* species attacking *Spodoptera frugiperda* as follows: from *C. insularis* Cresson 1865^[3], by the black or dark brown hind femur (yellow in *C. insularis*) and from *C. curvimaculatus* Cameron 1906^[2], by the black scape (orange in *C. curvimaculatus*). The reared specimens of *C. formosanus* were compared with the cotype images at the site of the Taiwan Agricultural Research Institute and the voucher specimen (from India: CTRI: RJY; drawer no. C15-479) in BMNH, London.

Notes. The female and male of *C. formosanus* can be identified (in addition to the genitalia) by the shape of subapical antennal segments and the antennal length (Fig. 2) [females have up to 30 segments]. The difference between male and female adults, based on genitalia, can be noticed in live specimens (required for separating male and female pairs for rearing) where the female genitalia is visible in the form of pointed ovipositor (cylindrical in shape) near to the apex (Fig. 5A) and the male genitalia is visible in the form of spherical apparatus much away from the apex.

II. Laboratory rearing and biology of *C. formosanus* (Fig. 6)

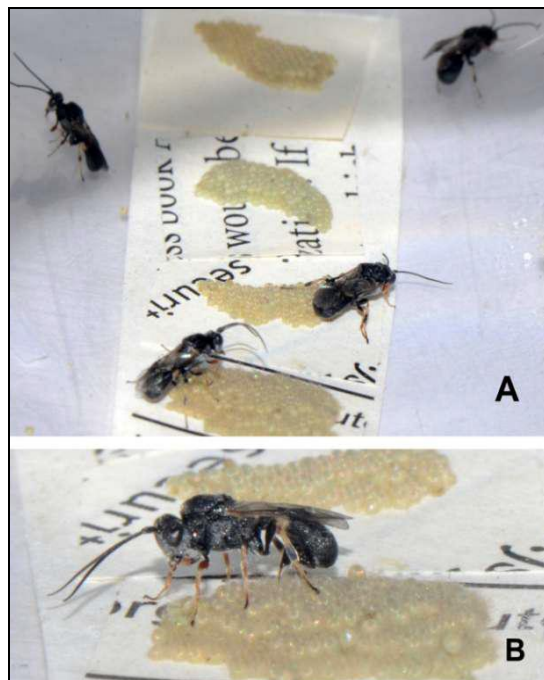


Fig 6: *Chelonus formosanus* Sonan F2 progeny of Anantpur (Andhra Pradesh) population parasitizing *S. frugiperda* egg mass in the laboratory

The neonates of *S. frugiperda* hatched from the field collected eggs were reared initially on the maize leaves. Five days old larvae were reared on the artificial diet (Ballal *et al.* 1995)^[1] in the BOD incubator (KCS/BI-50) set at 27±2°C and 65±2% RH. Cocoons of *C. formosanus* collected from parasitized FAW larvae were kept for the adult emergence. Parasitoids were subjected to further multiplication. Adults of *C. formosanus* were paired and after 24 hours exposed with the

laboratory reared *S. frugiperda* eggs for parasitism in borosil test tubes (measuring 150 mm × 25mm) and pearl pet jars (1000 ml). Neonates of *S. frugiperda* hatched from parasitized eggs were reared on the artificial diet in BOD incubator. Adult longevity of *C. formosanus* varied from 2 – 7 days. Developmental period was found to be 20 to 25 days on *S. frugiperda*. Percent parasitism was 10 to 19.4 and 45 to 57.5% of *C. formosanus* adults could successfully emerge

from the cocoons. *Chelonus formosanus* is being mass multiplied continuously in the ICAR- NBAIR laboratory. Partial culture of the parasitoids emerging from the cocoons was retained for further maintenance and rest were released in the farmer's maize fields. Attempts are also in progress to rear *C. formosanus* on the other lepidopteran eggs available in the Insectary of ICAR – NBAIR, Bengaluru, Karnataka, India.

Conclusion

Our research findings confirm that *C. formosanus* is capable to naturally parasitize *S. frugiperda* in the maize fields and is successfully able to complete its life cycle in the laboratory and is amenable to mass production. *Chelonus formosanus* has already been recorded as a well-established parasitoid of *S. litura* in Karnataka (Singh 1994) ^[6]. This incidence is perhaps the case of host range expansion of *C. formosanus* under the same genus - *Spodoptera* targeting the new invasive pest species - *S. frugiperda*. Any species of biological control agent which naturally establishes well in the fields and simultaneously is amenable to laboratory mass production can be considered as a potential weapon to deal with the respective pest in an ecofriendly manner.

Acknowledgements

We are grateful to the Indian Council of Agricultural Research and to Dr. C. R. Ballal, Director ICAR–NBAIR for providing research facilities and encouragement. Senior author is grateful to Dr Gavin R. Broad (Principal Curator in Charge - Insects) for hosting her study visit at the NHM, London and for providing access to examine and image the types and voucher specimens.

References

1. Ballal CR, Kumar P, Ramani S. Laboratory evaluation, storability and economics of an artificial diet for rearing *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae). Journal of Entomological Research. 1995; 19(2):135-141.
2. Cameron P. Descriptions of new species of parasitic Hymenoptera chiefly in the collection of the South African Museum, Cape Town. Annals of the South African Museum. 1906; 5:17-186.
3. Cresson ET. On the Hymenoptera of Cuba. Proceedings of the Entomological Society of Philadelphia. 1865; 4:1-200.
4. Gupta A, Ramesh Babu S, Sampath Kumar M. *Cotesia ruficrus* (Haliday, 1834) (Hymenoptera: Braconidae) emerging as a common natural parasitoid of *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) in Indian maize fields. Journal of Biological Control. 2019; 33(3):193-196. DOI: 10.18311/jbc/2019/24118
5. Rakshit S, Ballal CR, Prasad YG, Sekhar JC, Lakshmi Soujanya P, Suby *et al.* Fight against fall armyworm *Spodoptera frugiperda* (J. E. Smith). ICAR-Indian Institute of Maize Research, Ludhiana, Punjab, 2019, 52.
6. Singh SP. Fifteen years of AICRP on biological control. Project Directorate of Biological Control, Bangalore, 1994. Technical Bulletin No. 8.
7. Sonan J. Notes on some Braconidae and Ichneumonidae from Formosa, with descriptions of 18 new species. Transactions of the Natural History Society of Formosa. 1932; 22:66-87.
8. Shylesha AN, Jalali SK, Gupta A, Varshney R, Venkatesan T, Shetty P *et al.* Studies on new invasive pest *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera:

Noctuidae) and its natural enemies. Journal of Biological Control. 2018; 32:1-7.

9. TARI. Digital Insect of Taiwan Agricultural Research Institute. <https://digiins.tari.gov.tw/tarie/treelist003E.php?id=Brac11020002&lev1=2&lev2=0/37//&lev3=01&page=>. 10 January, 2020.
10. Yu DS, Van Achterberg C, Horstmann K. World Ichneumonoidea 2015: Taxonomy, Biology, Morphology and Distribution. Canada. 2016; CD/DVD, Taxapad, Nepean.