

**Illustrated Notes on Some Reared Parasitic Wasps
(Braconidae: Microgastrinae) with New Host
and Distribution Records from India Along with
Reassignment of *Glyptapanteles aristolochiae*
(Wilkinson) as a New Combination**

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ILLUSTRATED NOTES ON SOME REARED PARASITIC WASPS (BRACONIDAE: MICROGASTRINAE) WITH NEW HOST AND DISTRIBUTION RECORDS FROM INDIA ALONG WITH REASSIGNMENT OF *GLYPTAPANTELES ARISTOLOCHIAE* (WILKINSON) AS A NEW COMBINATION¹

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ABSTRACT: *Glyptapanteles aristolochiae* (Wilkinson) **comb. nov.** is reassigned and notes on host-parasitoid interactions are provided. The extended host range of the genus *Glyptapanteles* includes four families—Papilionidae, Nymphalidae, Arctiidae and Noctuidae from India. Five braconid parasitoids viz., *Glyptapanteles aristolochiae* (Wilkinson) **comb. nov.**, *Apanteles folia* Nixon, *Apanteles javensis* Rohwer, *Apanteles phycodis* Viereck and *Apanteles machaeralis* Wilkinson are documented with diagnostic details including illustrations of various life stages of the unparasitized host. *Spindasis vulcanus* (Fabricius) (Lepidoptera: Lycaenidae), a solitary endoparasitoid, is reported for the first time as a host of *A. folia*. Both wasps, *G. aristolochiae* parasitizing larva of *Pachliopta hector* (Linnaeus) (Lepidoptera: Papilionidae) and *A. javensis* parasitic on larva of *Pelopidas conjuncta* (Herrich-Schäffer) (Lepidoptera: Hesperidae), exhibit a gregarious habit. For all the species, information on parasitoid distribution, brief diagnosis with illustrations, host association, host caterpillar, and caterpillar host plant are provided for easy identification. Also host specificity of *Glyptapanteles* species is discussed in context with an extensive literature review of host records from India.

KEYWORDS: Host-parasitoid interactions, *Glyptapanteles aristolochiae*, *Pachliopta hector*, *Apanteles folia*, *Spindasis vulcanus*, *Apanteles javensis*, *Pelopidas conjuncta*, *Apanteles phycodis*, *Apanteles machaeralis*, larval parasitoid

INTRODUCTION

The diversity and host specificity of parasitic wasps is much more fascinating than documented. Parasitoids are the key players of any successful biological control program. Morphospecies identification in combination with host records leads to astounding host specificity. For complete understanding of microgastrine biodiversity and for resolving cryptic species complexity a synergistic approach encompassing field ecology, morphological alpha-taxonomy and molecular biology is required (Smith et al., 2008).

The species of the genus *Apanteles* Förster are the most frequently encountered amongst all the microgastrines with an estimate of roughly 2,000 species reported across the world (Mason, 1981 and Whitfield et. al., 2009). From India

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approximately 125 species of the genus *Apanteles* are reported and that accounts for hardly 6% of the rough estimated percentage of the highly speciose genus. Species of *Apanteles* are mostly reported as solitary parasitoids of microlepidoptera, with few known exceptions as gregarious forms from macrolepidopterans. Pyraloids are the main hosts recorded along with scattered records from Geometridae, Noctuidae, HesperIIDae, ArctIIDae, Choreutidae, Saturniidae and many indeterminate families.

Mason (1981) correctly pointed that the paucity of host records reflects the taxonomically uncharacterized composition of the genus. Fernández-Triana (2010) estimated the Lepidoptera-microgastrine ratio (L/M) which varies from 7-17% in few areas of Canada. From India there is no comprehensive list of total species of Lepidoptera published in recent times. In current scenario, nearly 10,000 species of moths are estimated (Hampson, 1892-1937 and Beccaloni et al., 2003). Evans (1932) recorded around 1439 species of butterflies from British India (including Ceylon and Burma). The geographical boundary of independent India, post 1947, accommodates a superficial count of 1800 species/subspecies of butterflies. After reviewing many resources, a rough estimate of approximately 10,000 species of moths and 1800-odd species/subspecies (Kunte, 2013) of butterflies comes to highlight. Hitherto some 230 species of microgastrine wasps, including introduced species for various biological control programs, are documented from the Indian region. The L/M ratio for some regions (Canada) with well-known Microgastrinae and Lepidoptera faunas gives the average of the resulting quotients as 12 (Fernández-Triana, 2010). Hence comparing both these diverse groups from Indian region, the estimated microgastrinae fauna is at least 1000 species. Hence it is evident that only 25% of the microgastrinae fauna is documented and a lot more is yet to be discovered.

Wilkinson (1928), Bhatnagar (1948), Rao (1961), Nixon (1965), Sumodan and Narendran (1990) and many other researchers have worked on alpha-taxonomy of the genus *Apanteles* from the Indian region. Recently, rearing attempts to document these koinobiont parasitoids attacking lepidopteran hosts have been made from various parts of peninsular India (Gupta & Kalesh, 2012 and Gupta and Pereira, 2012), also molecular characterization to resolve some cryptic *Apanteles* species was initiated (Gupta et al., 2012). Keeping the scarce count of known Indian microgastrine fauna in mind more agroecosystem specific systematic rearing studies have to be focused. The present study is thus an attempt to present some reared parasitic wasps with illustrated host details, and add to the knowledge of host-parasitoid association of the Indian microgastrine fauna.

METHODS

Collection methods include random field collection of caterpillars and rearing in the laboratory on the natural host plant. Unparasitized caterpillars from the same brood were reared to adult stage for host confirmation. Microgastrine spec-

imens were identified consulting Wilkinson (1928), Nixon (1965), and Mason (1981). The specimens were preserved in 70% alcohol and critically point dried using Hexamethyldisilazane as described by Brown (1993) and later mounted on cards. Some were slide mounted in order to highlight the microsculpture. The specimens were first cleared in 10% KOH with overnight immersion, later washed in distilled water and subsequently exposed to normal dehydration process keeping 15 minutes each in 50%, 70%, 90%, and 100% alcohol. Later they were transferred to 100% alcohol+ Terpeneol in the ratio 50:50 for 15 minutes and finally mounted on natural Canada balsam. The parasitoid images were taken using Leica M 205 A stereozoom microscope with Leica DC 420 inbuilt camera using Image Automontage software (version 3.8) coupled with Combine ZP software. Images of the host were captured using Canon EOS 50D with Tamron 90mm Macro Lens. The slide mounted specimens were photographed using Leica DFC 425 camera attached to Leica DMLB compound microscope. The images were further processed using Adobe Photoshop. The specimens were studied in the Biosystematics laboratory of the National Bureau of Agriculturally Important Insects (NBAII), Bangalore, India.

RESULTS

In this study five species of parasitic wasps are treated with brief diagnosis, distribution and host record.

1. *Glyptapanteles aristolochiae* (Wilkinson), 1928 (Plate I & II) new combination

Apanteles aristolochiae Wilkinson 1928. F. Ceylon. 85. BMNH.

Generic placement: Mason (1981) provided detailed description of the genus *Glyptapanteles* Ashmead. The generic characters that assure the correct placement of *Apanteles aristolochiae* into the genus *Glyptapanteles* include: Hind wing with distal margin of vannal lobe convex, with a fringe of hairs. Propodeum smooth without any prominent sculpture except few faint oblique striations diverging forwardly from metasomal foramen. Medio-longitudinal carina and areola absent. First tergum 1.6 x longer than its greatest width, its margin subparallel for the basal 0.8 then narrowing toward apex. Second tergum with basal margins strongly diverging toward apex leading to subtriangular shape. Median length of 2nd tergum 0.8 x 3rd tergum. Terga I–III smooth and shining. Hypopygium evenly sclerotized, without a medio-longitudinal crease. Ovipositor and sheath short and inflexible, concealed by hypopygium.



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Plate I. *Glyptapanteles aristolochiae* Wilkinson. Fig. 1. Parasitized caterpillar of *Pachliopta hector* (L.) with cocoon bunch. Fig. 2. *A. aristolochiae*; habitus view. Fig. 3. Mesosoma and metasoma; dorsal view. Fig. 4. Mesosoma, metasoma with forewing and hindwing; dorsal view.



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Plate II. *Pachliopta hector* (Linnaeus). Fig. 5. Unparasitized caterpillar. Fig. 6. Parasitized caterpillar. Fig. 7. Prepupa. Fig. 8. Pupa. Fig. 9. Adult.

Brief diagnosis (species): Female. Black; scape, tegulae, mouth parts and lateral margins of first three basal tergites of metasoma yellow-red testaceous; pterostigma brown; legs yellow testaceous except hind tarsi and apices of hind tibiae; hind coxa punctuate and basally dark red in color. Ovipositor sheaths equal to length of hind tibial spur. Head, mesoscutum and scutellum finely and evenly punctuate. The lateral sulci of the second tergite of metasoma slightly curved and not closely placed basally.

Distribution. India: Karnataka and Sri Lanka: Ceylon.

Material Examined. 6 females mounted on card, 6 females wet preserved in 70% alcohol, 14.vii.2010, Bannerghatta, Karnataka, India, emerged from parasitized larvae of *Pachliopta hector* (L.) feeding on host plant *Aristolochia indica* L., coll. Ankita Gupta. All specimens deposited in NBAIL, Bangalore, India. Code. NBAIL/Bra/Mic/Apan/aris/0710.

Host Record. Gregarious parasitoid bred from larvae of *Pachliopta hector* (Linnaeus) (Lepidoptera: Papilionidae), commonly known as Crimson rose butterfly, feeding on *Aristolochia indica* L.

Comments on host association: The genus *Glyptapanteles* is highly speciose and shows marked host specificity. It is prominently associated with tropical countries. Gupta and Pereira (2012) provided a list of Indian species for the genus *Glyptapanteles* and their associated hosts. The list includes *G. hypermnestrae* Gupta and Pereira from host *Elymnias hypermnestra* (Linnaeus) (Nymphalidae), *G. bhupali* Sathe, Inamdar & Dawale and *G. indica* Sathe & Dawale from *Spilosoma obliqua* Walker (Arctiidae), *G. nr. nepitae* from *Amata passalis* Fabricius (Arctiidae), *G. melanitisi* Sathe & Bhoje from *Melanitis leda ismene* Cramer (Nymphalidae) and *G. spodopterae* Ahmad from *Spodoptera litura* Fabricius (Noctuidae). Thus, the host range associated with the genus *Glyptapanteles* from India is apparently extended to Papilionidae, Nymphalidae, Arctiidae and Noctuidae.

From neotropics, the most frequently attacked host families are Noctuidae, Arctiidae, Notodontidae, Geometridae and Sphingidae, along with less attacked ones: Nymphalidae, Bombycidae, Hesperidae, Saturnidae, Pieridae, Riodinidae, Crambidae, Elasmidae, Limacodidae, Lycaenidae, and Tortricidae (Penna, 2011).

Reviewing literature from various regions of the world, noctuids and arctiids appear to be the most attractive hosts for *Glyptapanteles* species.

II. *Apanteles javensis* Rohwer, 1919 (Plate III & IV)

Apanteles javensis 1919. F. Java. 567.

Apanteles javensis Rohwer is reported for the first time from Maharashtra, India, parasitizing larvae of *Pelopidas conjuncta* (Herrich-Schaffer). The species is reported from larvae of *Pelopidas mathias* (Fabricius) from Kerala, India

(Gupta and Kalesh, 2012) and from *Mycalesis perseus* (Fabricius), and *Polytre-mis pellucida* (Murray) (Yu, 2012).

Brief Diagnosis: Female. Black; antennae, tegulae, hind legs largely, mid legs except apex of femora, front legs at base of femora, basal sternites and first latero-tergite deep brown red; remainder of legs red testaceous. Basal part of hind tibiae lighter than apical part. Stigma pallid with margins brown. Propodeum with areola well marked in the apical half; areola shining. Ovipositor sheath equal in length to basal joint of the hind tarsus. First tergite of metasoma narrow apically and broad basally; punctuate along the marginal third in apical half (except at apex); second tergite completely smooth and shining.

Distribution. India: Maharashtra (New record), Indonesia: Java, China, Japan, Srilanka, Thailand and Vietnam.

Material Examined. 10 females mounted on card, 10 females wet preserved in 70% alcohol, 6.ii.2012, Mumbai, Maharashtra, India, emerged from parasitized larvae *Pelopidas conjuncta* (Herrich-Schaffer) (Lepidoptera: Hesperidae) on *Sorghum* sp. (Poaceae), coll. Blaise Pereira. All specimens deposited in NBAII, Bangalore, India. Code. NBAII/Bra/Mic/Apan/jav/0212.

Host Record. Gregarious parasitoid of larvae of *Pelopidas conjuncta* (Herrich-Schaffer) (Lepidoptera: Hesperidae).

III. *Apanteles folia* Nixon, 1965 (Plate V & VI)

Apanteles folia 1965. F. Malaya. 99. BMNH.

Brief Diagnosis. *Apanteles folia* is known to have variable forms or subspecies (Nixon, 1965). In the material examined from western and southern India, females have a reddish-yellow hind tibia, becoming infusate on apical third. Face coarsely punctuate, much duller and rugose towards antennal insertions. Mesopleuron strongly, coarsely punctuate all over its median part, the sculpture extending into vague striations on the depressed posterior part. Fore wing with stigma pallid with brown border and costula present. Propodeum strongly areolate; the dorsal areas dull, rugose and contrasting sharply with shining smooth posterior fields. Hind coxa dull, rugose dorsally. First tergite of metasoma as wide as long, rugose. Ovipositor sheath as long as first segment of hind tarsus.

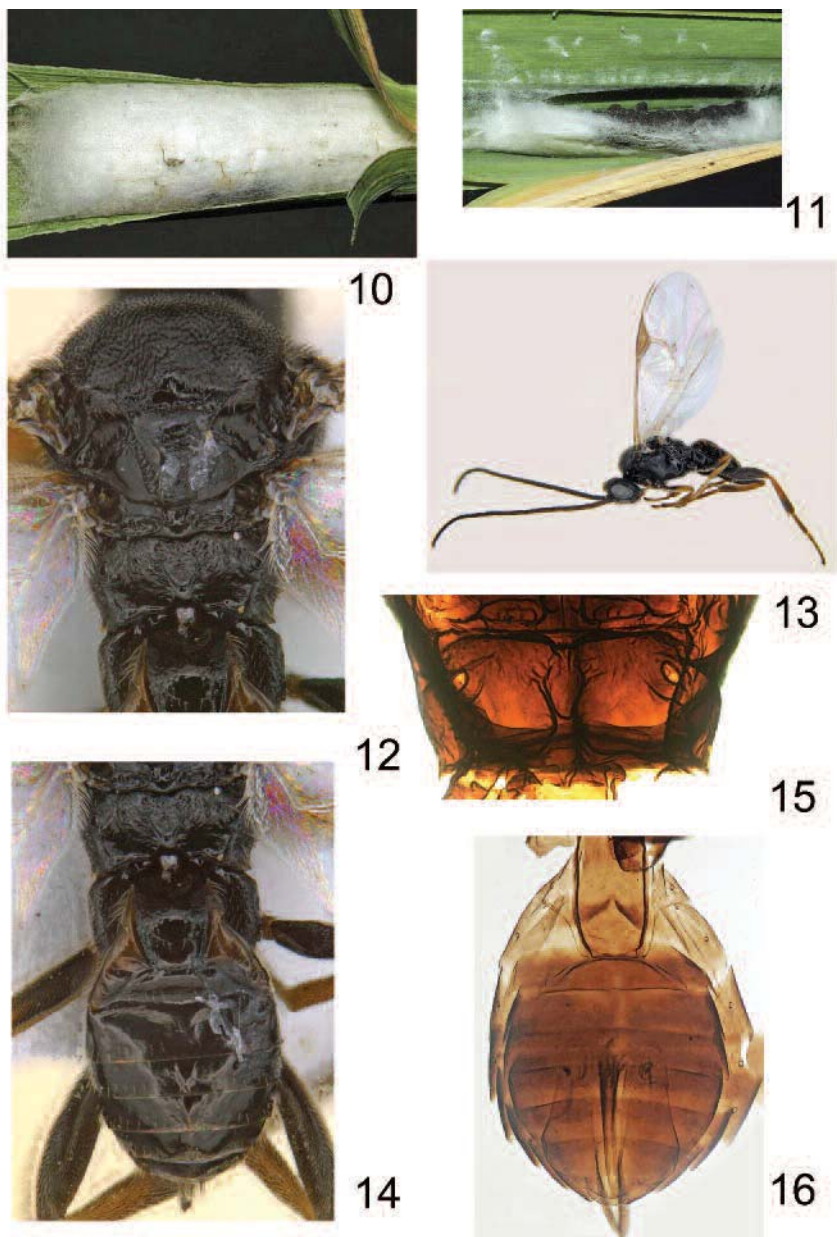


Plate III. *Apanteles javensis* Rohwer. Fig. 10. Cocoon mass of *A. javensis*. Fig. 11. Parasitized caterpillar of *Pelopidas conjuncta* (Herrich-Schaffer) on *Sorghum* sp. Fig. 12. Mesosoma with part of first metasomal tergite. Fig. 13. *A. javensis*; habitus view. Fig. 14. Propodeum; KOH treated. Fig. 15. Propodeum. Fig. 16. Metasoma; KOH treated.



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Plate IV. *Pelopidas conjuncta* (Herrich-Schaffer). Fig. 17. Unparasitized caterpillar. Fig. 18. Pupa. Fig. 19. Adult.



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Plate V. *Apanteles folia* Nixon. Fig. 20. Parasitized caterpillar of *Spindasis vulcanus* (Fabricius) with solitary cocoon of *A. folia*. Fig. 21. *A. folia*; habitus view. Fig. 22. Mesosoma with part of first metasomal tergite. Fig. 23. Propodeum with metasoma.



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Plate VI. *Spindasis vulcanus* (Fabricius). Fig. 24. Caterpillar. Fig. 25. Pupa. Fig. 26. Adult; lateral view. Fig. 27. Adult; dorsal view.

Distribution. India: Maharashtra (new state record) and Karnataka, Australia, Malaysia, Philippines, China and Papua New Guinea.

Material Examined. One female and male mounted on card, 28.v.12, Vasai fort, Maharashtra, India, coll. Paresh V. Churi, *Spindasis vulcanus* (Fabricius) (Lepidoptera: Lycaenidae) on the host plant *Ziziphus mauritiana* Lam. All specimens deposited in NBAII, Bangalore, India. Code NBAII/Bra/Mic/Apan/fol/28512.

Host Record. Solitary parasitoid of larva of *Spindasis vulcanus* (Fabricius) (Lepidoptera: Lycaenidae) on the host plant *Ziziphus mauritiana* Lam. This is the first report from the above mentioned host. This study further extends the known host range of *A. folia* while also extending the distribution of the parasitoid to western India. The extended host range thus includes *Arhopala amantes* (Hewitson) from India (Gupta and Pereira, 2012), *Spindasis lohita* (Horsfield) from Malaysia, *Jalmenus evagoras eubulus* Miskin from Australia, *Luthrodes cleotas kaiphys* Fruhstorfer from New Guinea (Nixon, 1965) (Yu, 2012).

IV. *Apanteles phycodis* Viereck, 1913 (Plate VII & VIII)

Apanteles phycodis 1913. F. India. 557.

Brief Diagnosis. Follows the detailed description in Wilkinson (1928). Legs mostly brown red testaceous except apical one third of hind tibia red black; coxae black. Tegulae black; stigma pale white with its margins brown. First tergite of metasoma nearly twice as long as broad; longitudinally striate. Second tergite slightly sculptured. Ovipositor sheaths longer than hind tarsi.

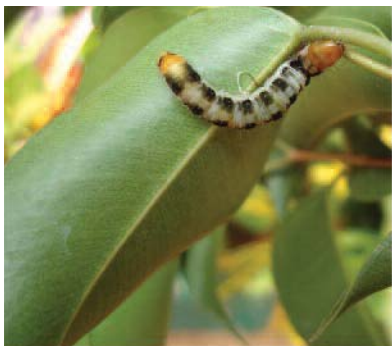
Distribution. India: Karnataka.

Material Examined. 6 females mounted on card, 28.v.12, Ganganagar, Karnataka, India, coll. Ankita, *Phycodes radiata* Ochseneheimer (Lepidoptera: Brachodidae) on *Ficus* sp. All specimens deposited in NBAII, Bangalore, India. Code NBAII/Bra/Mic/Apan/phy/28512.

Host Record. Gregarious parasitoid of larva of *Phycodes radiata* Ochseneheimer (Lepidoptera: Brachodidae) on *Ficus* sp. Kallies (2004) reviewed Brachodidae of the Oriental region and Kumar and Ramamurthy (2010) studied *P. radiata* in detail. The cocoons along with the host caterpillar are illustrated for the first time. The parasitized caterpillar with the cocoon mass remains confined inside the silken web of the leaves. The infested leaves can be easily recognized by having silken webs, yellow coloration and dry curled appearance (Plate VIII). The percent parasitization noticed by *A. phycodis* was around 85-90%.



Plate VII. *Apanteles phycodis* Viereck. Fig. 28. Parasitized caterpillar of *Phycodes radiata* Ochsenheimer with wasp of *A. phycodis* emerging from cocoon bunch. Fig. 29. *A. phycodis*; dorsal view. Fig. 30. *A. phycodis*; habitus view.



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Plate VIII. *Phycodes radiata* Ochsenheimer. Fig. 31. Unparasitized caterpillar. Fig. 32. Parasitized caterpillar with cocoon mass inside silken web. Fig. 33. *Ficus* sp. leaves with cocoons inside the silken web. Fig. 34. Parasitized caterpillar with cocoon mass. Fig. 35. Adult; dorsal view.

V. *Apanteles machaeralis* Wilkinson, 1928 (Plate IX)

Apanteles machaeralis 1928. F. India. 123. BMNH.

Brief Diagnosis. Follows the detailed description in Wilkinson (1928). Mid tibia nigrescent, basal third of hind tibia red testaceous. First tergite with median longitudinal excavation not very clear; second tergite dull and rough. Ovipositor sheaths little shorter than hind tibia.

Distribution. India: Gujarat, Uttarakhand, Uttar Pradesh, Orissa, Bihar, Madhya Pradesh, Tamil Nadu, West Bengal, Karnataka and Punjab; Srilanka; China; Myanmar and Vietnam.

Material Examined. 3 females mounted on card, 16.v.10, Gujarat, India, coll. VHV, *Paliga (Eutectona) machoeralis* (Walker) (Lepidoptera: Pyralidae) on *Tectona grandis* L. All specimens deposited in NBAII, Bangalore, India. Code NBAII/Bra/Mic/Apan/mach/16510.

Host Record. Gregarious parasitoid of teak leaf skeletonizer, *Paliga (Eutectona) machoeralis* (Walker) (Lepidoptera: Pyralidae) on *Tectona grandis* L.

DISCUSSION

Parasitic wasps often lack sufficient host information when collected through sweep nets, malaise traps and yellow pan traps. For success of any biological control program, host-specific parasitoids play a key role. Systematic rearing of parasitized caterpillars aid in generation of sound host-specific information that can be used in the future. Field ecology studies reveal solitary or gregarious nature of the parasitic wasps. In the present study, four gregarious species *Glyptapanteles aristolochiae* (Wilkinson) **comb. nov.**, *Apanteles javensis* Rohwer, *Apanteles phycodis* Viereck and *Apanteles machaeralis*, along with one solitary species *Apanteles folia* Nixon Wilkinson, were documented with their respective hosts. Also host specificity of Indian *Glyptapanteles* species is discussed in context with an extensive literature review. Results show that from India four families Papilionidae, Nymphalidae, Arctiidae and Noctuidae fall under the host range of the genus *Glyptapanteles*. *G. aristolochiae* cocoons are clustered together in one attractive mass attached to the posterior end of the host caterpillar. For *A. javensis* only two Hesperidae hosts, *Pelopidas conjuncta* (Herrich-Schäffer) and *Pelopidas mathias* (Fabricius), are known from India. The parasitized caterpillar of *P. conjuncta* remains inside the silken web along with the cocoons. *Spindasis vulcanus* (Fabricius) and *Arhopala amantes* (Hewitson) are the two Lycaenidae hosts associated with *A. folia*. The solitary cocoon of *A. folia* remains confined beneath the parasitized caterpillar of *S. vulcanus* and *A. amantes* respectively. The parasitized caterpillar of *Phycodes radiata* lies enclosed inside the silken web along with the cocoon mass of *A. phycodis* while the cocoons of *A. machaeralis* are laid loose, usually 7-9 in number, below the silken web. This study was initiated to document the host along with the associated parasitoid explaining its host range and distribution.

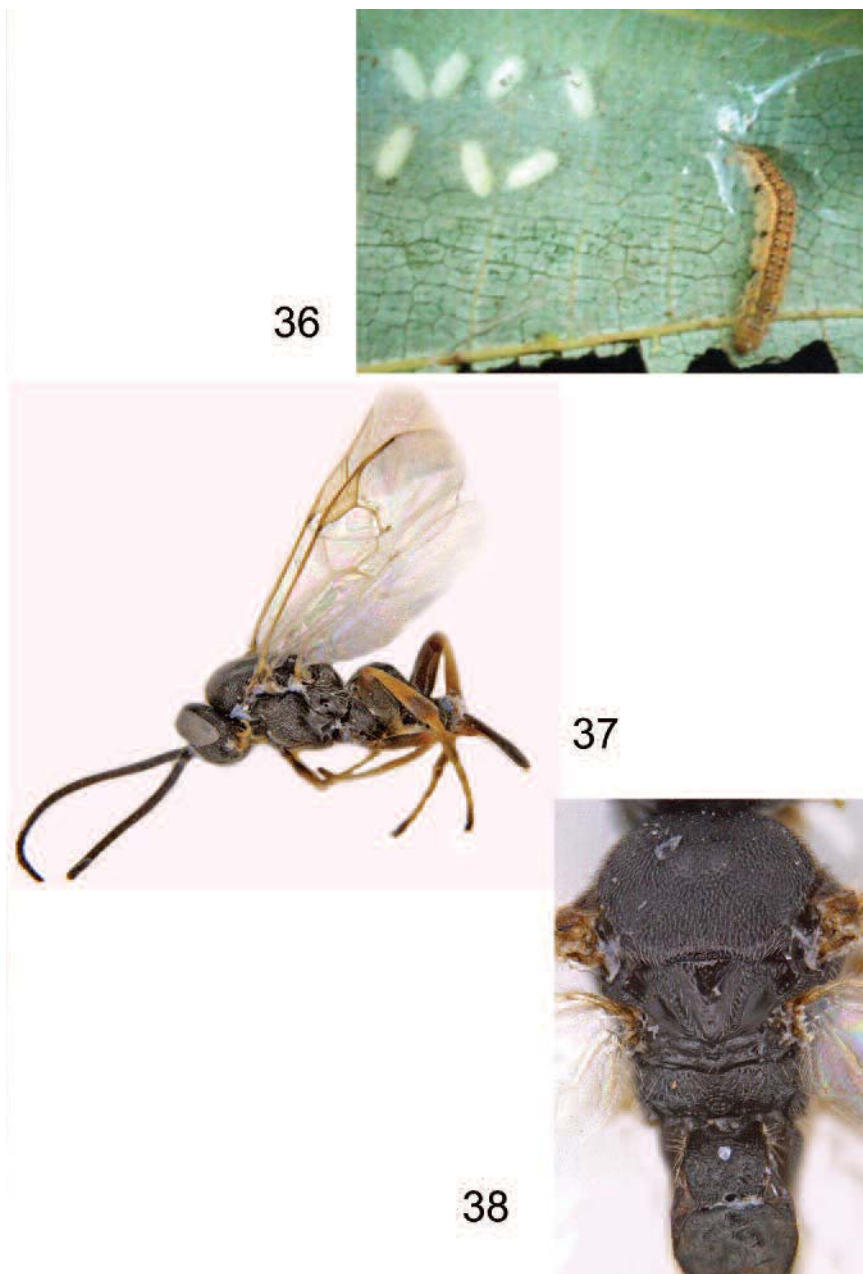


Plate IX. *Apanteles machaeralis* Wilkinson. Fig. 36. Solitary cocoons of *A. machaeralis* with parasitized caterpillar of *Paliga (Eutectona) machoeralis* (Walker) on leaf of *Tectona grandis* L. Fig. 37. *A. machaeralis*; habitus view. Fig. 38. Mesosoma with first and second metasomal tergite.

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