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Parasitoids (Hymenoptera, Braconidae, Aphidiinae) of *Aphis gossypii* (Hemi., Aphididae) in Bengaluru, India

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ABSTRACT. A survey was conducted in fields of cucumber and watermelon in Bengaluru, India during April, 2014 for determination of the common parasitoids (Hym.: Braconidae, Aphidiinae) attacking melon aphid, *Aphis gossypii* Glover (Hemi.: Aphididae). Three species of Aphidiinae, including *Aphidius platensis* Brethes, 1913; *Binodoxys acalephae* (Marshall, 1896) and *Lipolexis oregmae* (Gahan, 1931) were collected and identified, from which *Aphidius platensis* is newly recorded for India. The early evidence of *Aphidius colemani* Viereck, 1912 in India can also be contributed to *A. platensis*. Diagnostic characters of three species were compared with closely related species in brief.

Key words: *Aphidius platensis*, *Lipolexis oregmae*, *Binodoxys acalephae*, New record, biological control

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Introduction

The melon aphid, *Aphis gossypii* Glover (or cotton aphid) is highly polyphagous species, marked as a pest of various cultivated plants from the families Cucurbitaceae, Rutaceae and Malvaceae (Blackman and Eastop 2000). This aphid is a serious pest of cucurbits in temperate zones principally in fields and green houses (Leclant and Deguine 1994). The aphids feed on the underside of the leaves sucking nutrients from the host plant. When they are in dense populations, aphids cause the leaves to become chlorotic, curled and distorted, hindering photosynthetic capacity of the plant (Shannag *et al*. 1998). A further problem for plant is excretion of honeydew by aphids, which provides a substrate for growth of sooty mold directly reducing the photosynthesis and eventually the quality of the fruits. The melon aphid effectively transmits important plant pathogenic viruses such as cucumber mosaic virus (CMV) and watermelon mosaic virus (WMV) (Castle *et al*. 1992).

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The control of aphid pests depends mainly on the frequent application of synthetic insecticides, which often results in many negative effects, such as development of insecticide resistance (Herron *et al*. 2001) and other associated environmental problems. The application of insecticides leads to the outbreaks of the melon aphid by destruction of natural enemies (Pimentel *et al*. 1992). Furthermore, resistance by melon aphid to all the usual organophosphate, carbamate and synthetic pyrethroid aphicides is also widely documented (Herron *et al*. 2001).

Many insects as natural enemies may be very effective against melon aphid, including ladybirds (Coleoptera: Coccinellidae), hoverflies (Diptera: Syrphidae) and braconid wasps (Hymenoptera: Braconidae). Under the influence of natural enemies the aphid populations increase only by fraction of their potential rates, in field experiments (Frazer 1988; Starý 1988). Aphid parasitoids such as Aphidiinae have been considered as useful agents for biocontrol of *A. gossypii*, both in greenhouses and in the fields (van Schelt *et al*. 1990; Vásquez *et al*. 2006). For successful biological control of aphids, it is necessary to search for effective natural enemies, particularly those that can be used to control aphids on crops (Rabasse and van Steenis 1987; Burgio *et al*. 1997).

The subfamily Aphidiinae is a group of solitary endoparasitoids that attack only aphids, playing a significant role in the structure of their populations (Starý 1970, 1988). Taxonomy and the diversity of plant –host-parasitoid associations concerning aphidiines in India have been investigated by several authors and the data are summarized within a recently published catalogue by Akhtar *et al*. (2011), since then, supplemented with few other contributions (e.g. Rakhshani *et al*. 2012).

Very few species of Aphidiinae have been recorded from Karnataka province (India), including *Aphidius absinthii* Marshall (Starý and Ghosh 1983), *Aphidius colemani* Viereck (Starý and Ghosh 1983), *Binodoxys acalephae* (Marshall) (Dharmadhikari and Ramaseshiah 1970), *Binodoxys brevicornis* (Haliday) (Starý and Ghosh 1983), *Binodoxys indicus* (Subba Rao and Sharma) (Ramaseshiah 1972), *Diaeretiella rapae* (M'Intosh) (Sethumadhavan and Dharmadhikari 1969), *Lipolexis oregmae* (Gahan) (Dharmadhikari and Ramaseshiah 1970), *Lysiphlebus testaceipes* (Cresson) (Ramaseshiah *et al*. 1968), *Praon abjectum* Haliday (Dharmadhikari and Ramaseshiah 1970), *Praon volucre* (Haliday) (Dharmadhikari and Ramaseshiah 1970) and *Toxares shigai* Takada (Dharmadhikari and Ramaseshiah 1970). Among the recorded species, only *Aphidius colemani*, *Binodoyxs indicus*, *Diaeretiella rapae*, *Lipolexis oregmae* and *Praon volucre* have been recorded in the association with the melon aphid on various host plants (Akhtar *et al*. 2011). The objective of this research was to provide the background systematics information on the Aphidiinae parasitoids of melon aphid, *Aphis gossypii* in Bengaluru, India.

Material and methods

The survey was conducted in fields of cucumber and watermelon cultivated in the experimental plot maintained at the Indian Institute of Horticultural Research (IIHR), Bengaluru, India during April 2014. Bengaluru, known as Bangalore is situated in the southeast of the South Indian state of Karnataka, positioned at 12.97° N 77.56° E covering an area of 2.190 square kilometers. It has a tropical wet and dry savanna climate with a pronounced dry season in the low-sun months (Kottek *et al*. 2006). The district is endowed with various agricultural and horticultural crops including cotton, pumpkins, rice, groundnut, peppers, sugarcane, grapes and mulberry. Leaf samples infested with the colonies of melon aphids, were collected from field and carefully places into semi-transparent rearing

plastic boxes, immediately covered by mesh for ventilation. The reared material was transferred to the laboratory, where it was subsequently maintained for 2–3 weeks until parasitoids' emergence. Once they were detected, they were carefully picked up using an aspirator and dropped into the 75% ethanol kept for identification. The external morphology of parasitoids was studied using NIKON SMZ645 stereo-microscope and a NIKON Eclipse E200 microscope. Terminology for the selected morphological characters follows Sharkey and Wharton (1997). Distributional data of the recorded species followed Yu *et al.* (2012). The specimens were deposited at the Insect Collection of Zabol University, Zabol, Iran.

Results

As a result of our investigation of parasitoids of melon aphids three Aphidiinae species belonging to two genera listed below.

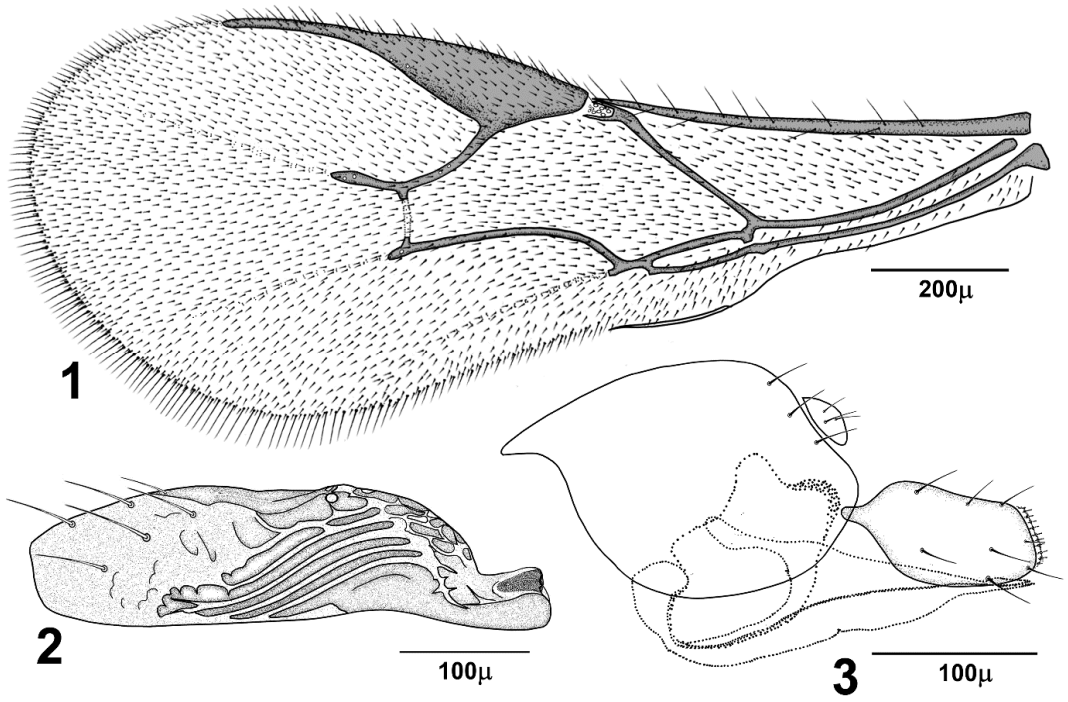
***Aphidius platensis* Brethes, 1913 (Figs. 1–3)**

Material examined: 4♀♀2♂♂, reared from *A. gossypii*, on *Cucurbita pepo* L., April, 2014, IIHR, Bengaluru; 2♀♀, reared from *A. gossypii*, on *Gossypium hirsutum* L., April 2014, IIHR, Bengaluru, Leg. D. Lokeshwari.

Diagnosis: *Aphidius platensis* is closely related to *A. colemani* Viereck on the basis of wing venations (Fig. 1) and shape of ovipositor sheath (Fig. 3), from which it can be immediately differentiated by having a shorter R1 vein (0.77–0.89X as long as stigma in *A. platensis*, vis1.0–1.1X as long as stigma in *A. colemani*). Anterolateral area of petiole in *A. platensis* bearing 4–5 sharply prominent costae (Fig. 2), while in *A. colemani* 2–3 bluntly shallow costae occur.

Distribution in India: New record for India.

General distribution: Neotropical, Central Asia (Iran), Oriental (New record).



Figures 1–3. Diagnostic characters of *Aphidius platensis* Brethe, **1.** Forewing, **2.** Lateral aspect of petiol, **3.** ovipositor sheath.

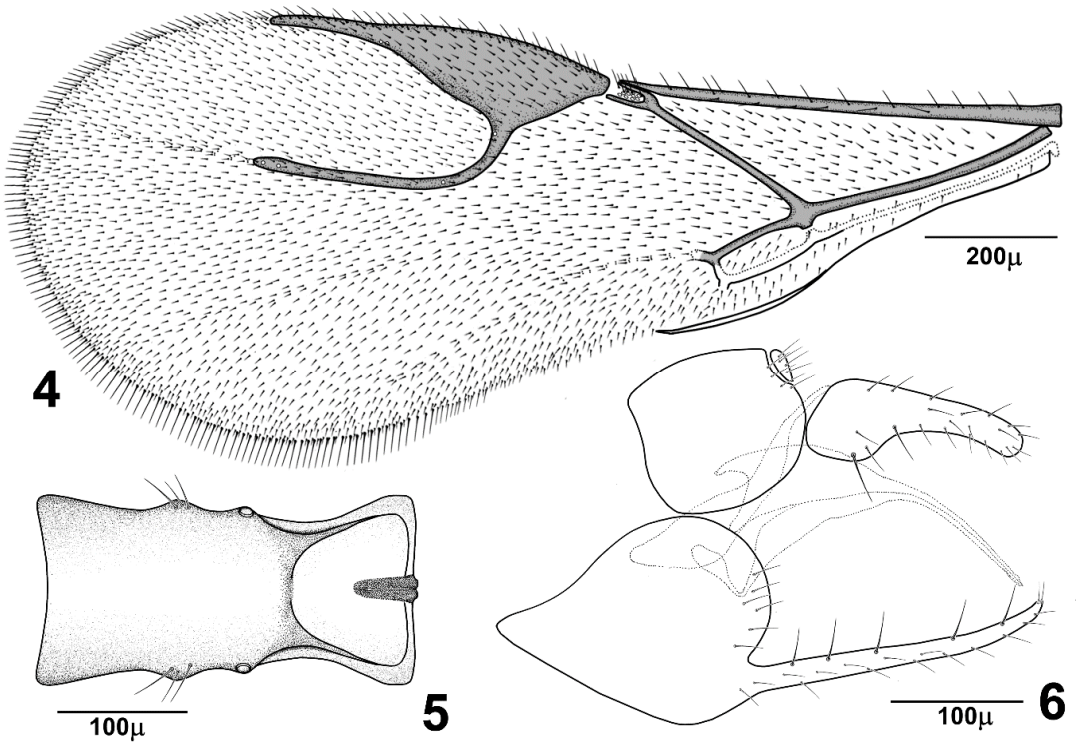
***Binodoxys acalephae* (Marshall, 1896) (Figs. 4–6)**

Material examined: 2♀♀ 2♂♂, reared from *A. gossypii* Glover, on, *Gossypium hirsutum* L., April 2014, IIHR, Bengaluru, Leg. D. Lokeshwari.

Diagnosis: *Binodoxys acalephae* is closely related to *B. angelicae* (Haliday) and *B. indicus* (Subba Rao and Sharma) from which it can be readily distinguish by the characters of the wing venation (Fig. 4), and petiole (Fig. 5). *Binodoxys acalephae* has shorter R1 vein (0.42–0.48X as long as stigma in *B. acalephae*, vis 0.65–0.68X and 0.64–0.66X as long as stigma in *B. angelicae* and B. indicus, respectively). In petiole of *B. acalephae* the distance between the primary and secondary tubercles at spiracles is smaller than its width; while in two other species it is clearly larger.

Distribution in India: Jammu and Kashmir, Karnataka, Manipur (Akhtar *et al*. 2011).

General distribution: Holarctic.



Figures 4–6. Diagnostic characters of *Binodoxys acalephae* (Marshall), **4.** Forewing, **5.** Lateral aspect of petiol, **6.** ovipositor sheath.

***Lipolexis oregmae* (Gahan, 1931) (Figs. 7–9)**

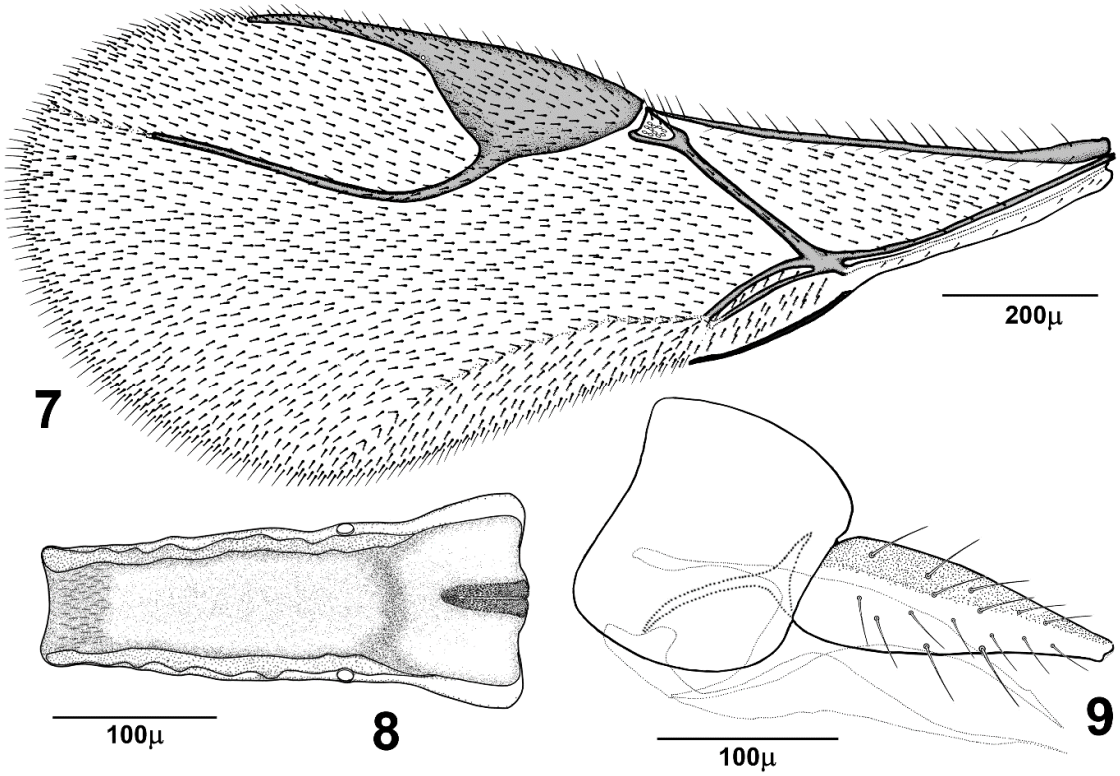
Material examined: 3♀♀ 2♂♂, reared from *A. gossypii* Glover on *Capsicum annuum* L., April 2014, IIHR, Bengaluru, Leg. D. Lokeshwari.

Diagnosis: *Lipolexis oregmae* is closely related to *L. gracilis* from which can be separated by a series of characters pertaining to the dorsal surface of petiole and female genitalia. In *L. oregmae*, the petiole is smooth dorsally, bearing crenulated longitudinal carinae laterally (Fig. 8); while petiole in *L. gracilis* has a prominent central carina bifurcated near the middle. The ovipositor sheaths in *L.*

oregmae are short and slightly curved downwards (Fig. 9), in contrast to *L. gracilis* where those structure are long, and strongly curved downwards. In the forewing of *L. oregmae* the ratio of R1/stigma is 1.0–1.1 (Fig. 7), but 1.25–1.3 in *L. gracilis*.

Distribution in India: Widely distributed in India, Jammu and Kashmir, Karnataka, Manipur, Meghalaya, Sikkim, Tripura, Uttar Pradesh and West Bengal (Akhtar *et al*. 2011).

General distribution: Oriental, introduced to Central America.



Figures 7–9. Diagnostic characters of *Lipolexis oregmae* (Gahan), **7.** Forewing, **8.** Lateral aspect of petiol, **9.** ovipositor sheath

Discussion

The association of two common, but very efficient parasitoids on melon aphid in Bengaluru brings potentially powerful biological control agents. *Lipolexis oregmae* has already successfully been used as biological control agent against *Toxoptera citricia* Kirkaldy (Persad *et al*. 2007). The second parasitoid, *Aphidius platensis* was classified as a native species in South America (Starý 1970). Later, its origin was again considered revealing Indian source, which was explained by a series of accidental introductions to other continents (Starý 1972). *Aphidius platensis* was synonymized by *Aphidius colemani* Viereck which also showed the same host range and wide distribution (Starý 1975), therefore it was subsequently studied under the name of *A. colemani*. True *Aphidius colemani* has been frequently evaluated as the most efficient parasitoid of *A. gossypii* in greenhouses (van Steenis 1995). This parasitoid was widely used in the biological control of *A. gossypii* (van

Schelt *et al*. 1990). Existence of morphological differences and the discrete pattern of distribution for *A. colemani* have later been criticized (Takada 1998; Barahoei *et al*. 2013) and finally clarified by Tomanović *et al*. (2014). Based on this study, *A. platensis* has been re-validated, sharing the same host range pattern and the same origin as *A. colemani*. Furthermore, all the material from the central Asia (Iran) (Rakhshani *et al*. 2008; Zamani *et al*. 2007) is classified as *A. platensis* with no trace of true *A. colemani*. Consequently, the early evidence of *A. colemani* in India (Akhtar *et al*. 2011) may contribute to *A. platensis*. The occurrence of both species in the Oriental and Eastern Palaearctic regions need to be investigated in future works.

Lipolexis oregmae has a wide distribution in the Eastern Palaearctic and the Oriental including Guam (Miller *et al*. 2002), India (Starý and Bhagat 1978; Starý and Ghosh 1983); the Philippines, Hong Kong and Taiwan (Starý and Schlinger 1967; Chou 1981); Korea (Starý and Choi 2000) and Vietnam (Starý and Zelený 1983). Miller *et al*. (2002) re-examined the paratypes of *L. oregmae* and compared the petiole with that of *L. scutellaris*. As a result, the two species appear to be identical, and *L. scutellaris* was classified as a junior synonym of *L. oregmae*. Two other species, *L. pseudoscutellaris* Pramanik & Raychaudhuri and *L. myzakkaiae* Pramanik & Raychaudhuri were also described from India (Pramanik and Raychaudhuri 1984). The original description of the first species leads to *L. oregmae*, and it was possibly classified as a new species because the authors may have overlooked drawings in the re-description of *L. oregmae* by Starý (1960). Also, in the case of *L. myzakkaiae* there are some discrepancies between the description and the drawing of the petiole. Although (Pramanik and Raychaudhuri 1984) based the description of this species noting that the petiole laterally posses longitudinal carinae, they were not shown in the attached figures. While we did not revise the type material, both species can be considered as conspecific with *L. oregmae*. In China, both *L. gracilis* (syn., Lipolexis chinensis Chen) and *L. oregmae* are present (Chen and Shi 2001). The third species, *L. wuyiensis* Chen, parasitoid of *Oregmala nigera* (Zehnt.) described as a distinct species (Chen, 1981). However, in our opinion, it appears to be another synonym of *L. oregmae* revealing that it parasitizes the same hosts as true *L. oregmae* in its original area in the Philippines (Miller *et al*. 2002).

Further investigations including DNA analyses become necessary in order to reveal the entire parasitoid complex of *A. gossypii* in Bengaluru; especially the other host plants as refugia for this aphid. Collecting the additional material of *A. platensis* or the examination of previously recorded material from India is also necessary to confirm the coincidence of *A. colemani*.

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پارازیتوییدهای (Hymenoptera, Braconidae, Aphidiinae) شتهٔ *Aphis gossypii* Glover در بنگلور، هندوستان

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چکیده: این تحقیق در بهار سال ۱۳۹۳ به منظور شناسایی پارازیتوییدهای (Hym.: Braconidae, Aphidiinae) شتهٔ *Aphis gossypii* Glover (Hemi.: Aphididae) در مزارع خیار و هندوانه بنگلور هندوستان انجام گردید. سه گونه از زنبورهای زیرخانوادهٔ Aphidiinae شامل *Aphidius platensis* Brethes, 1913، *Binodoxys acalephae* (Marshall, 1896) و *Lipolexis oregmae* (Gahan, 1931) جمع‌آوری و شناسایی شدند که از بین آنها گونه *Aphidius platensis* برای اولین بار از کشور هند گزارش می‌شود. به نظر می‌رسد گزارشات قبلی گونه *Aphidius colemani* Viereck, 1912 در هندوستان مربوط به گونه *A. platensis* باشد. خصوصیات مرفولوژیک این سه گونه در مقایسه با گونه‌های نزدیک به طور مختصر مقایسه شد.

واژگان کلیدی: *Aphidius platensis*، *Lipolexis oregmae*، *Binodoxys acalephae*، گزارش جدید، مهار زیستی