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Genitalic studies of four Limacodid species (Limacodidae Lepidoptera) including the description of a new species from Western Ghats, India

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Abstract

During the present studies, four species i.e., *Aergina hilaris* (Westwood), *Thespea bicolor bicolor* (Walker), *Parasa herbifera* Walker and *P. neoherbifera* sp. nov. have been studied from the Western Ghats of India. Besides reporting a new species, all others species are recorded for the first time in the area mentioned above.

Keywords: Genitalia, Lepidoptera, Limacodidae, Species, Western Ghats

Introduction

One of the family Limacodidae is present under order Lepidoptera, which are mainly tropical and subtropical and are also reported from all region of the world. Presently, 1672 species belonging to 301 genera known on world basis (Nieukerken *et al.*, 2011). The adults are of different sizes, wing colouration and patterns and are nocturnal in behavior. The main characters are the presence of silky shine forewings and filiform antennae in females and bipectinate to filiform antennae in male. They placed their body at an angle to the substrate supported by the extended legs with wings draped laterally (Godfray *et al*., 1987). Earlier work shows that this family is poorly represented in India.

During the present research work large number of survey tours was undertaken from the different localities of Western Gahts, India. After critical examination of the collected material, four species were identified. The collected material were sorted out and segregated taxonomically with the help of literature (Hampson, 1892; Holloway, 1986; Meyrick,1894,1905, 1907, 1908, 1909, 1910, 1911, 1912-1916, 1913, 1914, 1916-1923, 1923-1930, 1930-1936; Fletcher, 1921, 1929; Gaede,1937; Rose, 2004; Roonwal *et al.*,1964; Clarke, 1955,1965, 1969, 1969a; Bhutani, 1984; Carter, 1984; Carter and Hargreaves, 1986; Holloway *et al.*, 1992; Nye and Fletcher, 1991; Robinson *et.al*., 1994; Solovyev and Witt, 2009; Solovyev, 2009a,b,c; Solovyev, 2014) and by comparison of the collected species with the identified collections housed in the IARI, Pusa, New Delhi and ZSI, Kolkata.

Material and Methods

The collections were made with the help of fluorescent lights and by the portable light trap at night hours from different localities of three states i.e., Kerala, Karnataka and Gujarat of Western Ghats of India (Map 1 and Photo 1). All the collected moths of the family Limacodidae were collected by using the ethyl acetate vapors in the killing jars. They were processed as per standard techniques of Lepidoptera. The permanent slides of wings were made for the study of the wing venation. The method given by Lindquist (1956), Common (1970), Landry and Landry (1994) and by Zimmerman (1978) has been followed for the preparation of permanent slides of fore and hind wings. The methodology given by Robinson (1976) has been followed for the study of external male and female

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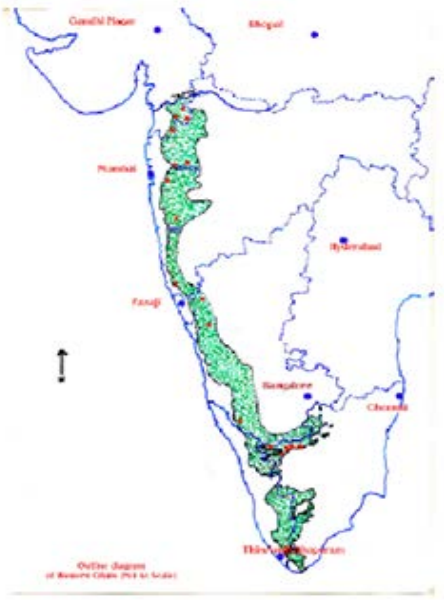
genitalia. The genitalic photographs were taken with the help of a stereo zoom microscope. Multiple dissections of the studied species were made to examine the population variations, if any. Klots (1970) has been followed in the present studies for writing terminology and nomenclature.



Map 1. Area surveyed

Photo 1. Portable light trap

Results and Discussion

Four species i.e., *Aergina hilaris* (Westwood), *Thespea bicolor bicolor* (Walker), *Parasa herbifera* Walker and *P. neoherbifera* sp. nov have been identified. Besides reporting a new species, others three species are recorded for the first time in the area under reference. The details of identified species are provided below:

Systematic Account

Order LEPIDOPTERA

Superfamily COSSOIDEA

Family LIMACODIDAE (Slug Caterpillar Moths)

Genus ***Aergina*** Solovyev

Aergina Solovyev, 2014, *Proc. Mus. Witt Munich* 1: 59. Type-species: *Limacodes hilaris* Westwood, 1848

Remarks: This genus is represented by medium-sized moths and the members of this genus were placed in *Parasa* Moore, 1859 before 2014. The main characteristics are head, thorax and forewings are green in colour, and the green pattern can be lost in forewing in some species, forewing with basal pentagon-shaped brown spot (Irungbam, 2017).

Aergina hilaris (Westwood, 1848)

(Plate 1, Photo A-B, Figures.C-G)

Limacodes hilaris Westwood, 1848, *Cab. Orient. Ent*. 50, t. 24: fig. 3. Type-locality: Central India.

Parasa hockingii Moore, 1888, *Proc. Zool. Soc. Lond.*: 403. Type-locality: Kangra Valley, HP (3000 feet).

Parasa argalea West, 1937, *Ann. Mag.nat. Hist*. 10(10): 80, pl. II: fig. 7. Type- locality: India, Jubbulpore, MP.

Male and female: Alar expanse : 20-26 mm, 30-34 mm. Vertex dark green; upper scales of frons pale green, lower scales reddish brown, antenna bipectinate upto one-thrid in males, simple in females, yellowish brown; labial palpus porrect, dark brown, 1.2 times diameter of eye, second segment expanded, third segment hardly visible, tip yellowish; thorax dark green throughout; forewing with costa straight, apex rounded, termen oblique, convex, pea green in color, basal patch pale brownish, irregularly expanded in middle, outer patch fuscous, with yellowish scales, expanded towards posterior margin in males, green band wider

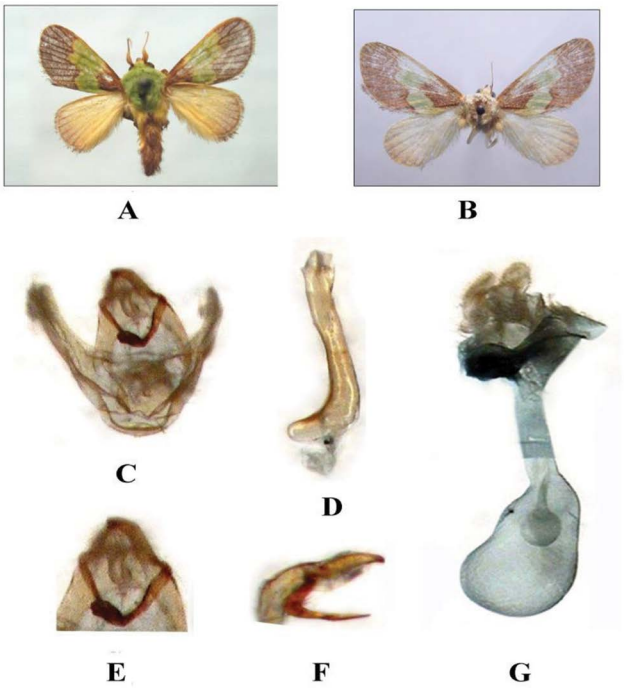


Plate 1. *Aergina hilaris* (Westwood): **(A-B)** adults, **(C)** male genitalia (ventral view)**, (D)** aedeagus, **(E-F)** uncus**, (G)** female genitalia.

in females; hindwing pale yellow, termen light brown, cilia on termen also light brown, hairy towards anal margin, undersurface pale green, costa brown; legs covered with yellowish scales, with scattered brownish scales throughout, joints brown, hairy.

Male genitalia: Uncus well developed, broader at base, narrowing apically, pointed with a distinctly sclerotized small knob-like structure; gnathos arms joined medially upto apex, clavate and rounded apically; tegumen moderately broad, high; vinculum moderate, band-like; transtilla somewhat sclerotized, flap-like; juxta produced into two asymmetrical arms, right arm slightly longer and slender then left; valva simple, much broader at base, gradually but strongly narrowing apically, costa concave, sacculus short, cucullus tip narrow, rounded; aedeagus moderate in size, strongly simulate, somewhat narrowing apically, upper lip pointed, sharply curved, coecum moderate, curved, ductus ejaculatorious wide, opening dorsally, vesica without cornuti.

Female genitalia: Papillae anales flat, elongated, setae absent; apophyses weakly developed; antrum present; ductus bursae long, narrow, memberanous, gradually widening towards corpus bursae; corpus bursae oval, weakly sclerotized with marginal area membranous, signum small, triangular.

Material examined: Kerala: Dist. Kollam, Chendruni, 70m, 03.ix.2004, 01♀.; Karnataka: Dist. Belgaum, FRH, Khanapur, 370m, 21.iii.2003. 01♂; Dist. Kodagu, Medikeri, 1100m, 16.xi.2002, 01♂; Dist. Uttar Kannada, Ganeshgudi, 480m, 13.xi.2003, 03♂♂, 22.vii.2004, 01♂, 16.x.2005, 01♂; Dist. Dakshin Kannada, Gundya, 40m, 28.vii.2004, 04♂♂, Dist. Shimoga, Shettihalli WLS, 320m, 10.vi.2003, 01♂; Dist. Kodagu, Nisergdhama, 1080m, 17.xi.2002, 01♂; Gujarat: Dist. The Dangs, Ahwa, 520m, 29.ix.2005, 01♂. (coll. A. Katewa and party).

Distribution: India, Sri Lanka (Hampson, 1892) and Punjab (Rose, 2004), Bhutan (Dudgeon 1900), Pakistan, India, Nepal (Irungbam, 2017),

Remarks: Earlier this species was recorded in Bhutan by Dudgeon (1900). The species is known to occur throughout India (Hampson, 1892), but according to Rose (2004) it is quite uncommon in north-west India. On the basis of present surveys and collection of twenty-eight specimens from the Western Ghats, it can be inferred that the species is quite common to this hot biodiversity spot.

Genus ***Thespea*** Solovyev, 2014

Thespea Solovyev, 2014, *Proc. Mus. Witt Munich* 1: 57. Type-species: *Neaera bicolor* Walker, 1855.

Remarks: On the basis of species Neaera *bicolor* Walker the genus *Thespea* was erected (Solovyev, 2014). The main characteristics are medium sized moths with green thorax, small, rounded terminal segment of labial palpus, antennae bipectinate basally and shortly unipectinate distally in male, filiform in female, two spurs in Hind tibia. Male forewing length is 11–17.5 mm and 14–22 mm in females. Hindwings yellowish in both sexes (Solovyev, 2014).

Thespea bicolor bicolor (Walker, 1855)

(Plate 2, Photo A, Figures. B-F)

Neaera bicolor Walker, 1855, *List Specimens lepid. Ins. Colln Br. Mus.* 5: 1142. Type-locality: North India.

Latoia oryzae Cai, 1983, *Acta Entomologica Sinica* 26(4): 445, pl. 1:15, fig. 19. Type-locality: China: Rong Xian, Guangxi.

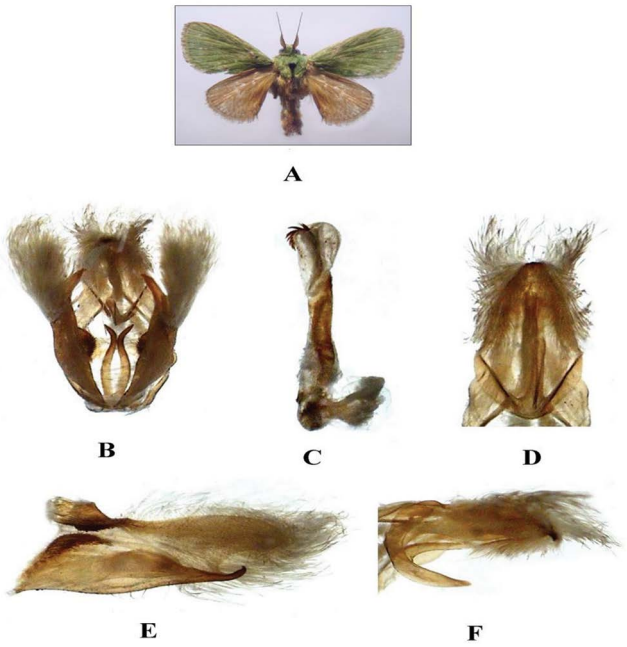


Plate 2. *Thespea bicolor bicolor* (Walker): **(A)** adult, **(B)** male genitalia (ventral view), **(C)** aedeagus, **(D)** uncus, **(E)** (valva), **(F)** (uncus & gnathos (lateral view).

Male: Alar expanse 32 mm. Vertex pea green, frons brown; antennae bipectinate, basal half strongly bipectinate, pale brown, scape brown scaled; labial palpus expanding upto frons, brown scaled, third segment larger than first and second, first segment with long brown scales; thorax pea-green throughout edged with brown scales; forewing with costa straight, apex rounded, termen oblique, convex, anal margin straight, ground color pea-green, costa and cilia brown, a small brown speck near inner margin between 2A and 3A, a brown speck between M_2 and M_3; hind wing rounded, ground color pale yellow, legs covered with brown scales, scattered white scales throughout, hairy, abdomen yellowish brown.

Male genitalia: Uncus long, comparatively narrow, slightly wavy, broad at base, setae absent, tip ending to a small spine; gnathos spine like, prominent; tegumen small, V-shaped, shoulders weakly developed, vinculum narrow, U-shaped, saccus weakly developed, valvae simple weakly sclerotized, setosed with well formed setae, costa and sacculus well differentiated, ampula and harpe absent, cucullus and valvula not separated from each other, tip of valvae blunt, juxta weakly developed, almost rectangular, transtilla weakly sclerotized, aedeagus weakly sclerotized, short and narrow, weakly elbowed at centre, ductus ejaculatorius enters laterally.

Female genitalia: Not studied.

Material examined: Karnataka: Dist. Dakshin Kannada, FRH, Gundya, 40m, 28.xi.2004, 03♂♂ (coll. A. Katewa and party).

Distribution: Bhutan (Mendrelgang, Sarpang Tar, Phuentsholing), Nepal, Myanmar, China, Thailand, Laos, Vietnam, northeastern India, Sumatra and Java, (Solovyev, 2014); Bhutan (Tsirang District, Mendrelgang), (Sarpang District, Sarpang Tar) (Irungbam, 2017).

Remarks: Earlier, the species has reported from Bhutan by Dudgeon (1900) and from Phuentsholing as *Parasa bicolor* by W. Dierl (1975) and D.B. Chettri (2014) and reported as minor pest of the family Poaceae and damage to rice crops, sugarcane (defoliator) and bamboos trees (Solovyev *et al.,* 2009). During the course of present surveys, only three male specimens could be collected from a single locality *i.e.,* Gunya in the state of Karnataka. It seems that this species is quite uncommon in the Western Ghats of India.

Genus ***Parasa*** Moore, 1859

Parasa Moore (1860) 1858-9, *in* Horsfield and Moore, *Cat. lepid. Insects Mus. Nat. Hist. East-India House,* **2**: 413. Type-species: *Neaera chloris* Herrich-Schäffer, 1854, by subsequent designation by Fletcher and Nye, 1982: 120. =*Neaera* Herrich-Schäffer, *1854 Samml. aussereurop. Schmett.* 1(1): wrapper, pl. 37, figs 176, 177.

Remarks: The genus Parasa was established on its type species *Neaera lepida* Cramer (1777) by Moore in 1860. A total number of 14 species of genus *Parasa* from the then limits of India was reported at that time. Out of 14 species, 04 species were reported from India. The genus is thoroughly revised by Solovyev and Witt (2009) and Solovyev (2014). The forewing is decorated with green scales make this genus most colorful genera of family Limacodidae. Down the middle of the thorax, a narrow line of brown scales, vertex green, frons and labial palpus brownish in colour. The most of the fore wing is covered with green in genus *Parasa* or be in the form of bands or spots. Male genitalia with claw at the uncus apex, which is not strongly downcurved and lateral lobes laking. Transtilla is simple or elongated, hairy and bifurcate

processes. The genitalia in female are variable, ductus bursae long, short or coiled. The signum is wanting and present in the few Neotropics known species.

Key to the presently studies species of genus *Parasa* Moore

Hind wing not yellow, without brown irritated scales Male genitalia with aedeagus deeply bent near anterior end ..... ***herbifera*** Walker
Forewing and hindwing dark brown, Male genitalia with aedeagus not bent as above .....***neoherbifera*** sp. nov

Parasa herbifera Walker
(Plate 3, Photo A, Figures. B-F)

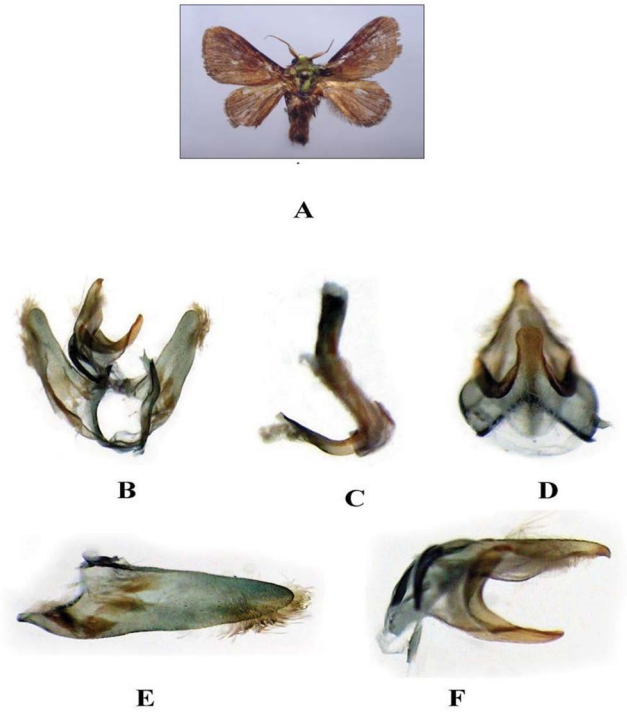


Plate 3. *Parasa herbifera* Walker: **(A)** adult, **(B)** male genitalia (ventral view), **(C)** aedeagus, **(D)** uncus, **(E)** valva, **(F)** uncus and gnathos (lateral view).

Parasa herbifera Walker 1855. *List. Lep. Ins. br. Mus*. **5:** 1136.

Parasa fumosa Swinhoe, P.Z.S. 1889, p. 408, pl. 43. fig. 12.

Male: Alar expanse: 23 mm. Vertex pea-green, frons brown; antennae bipectinate, basal one-third strongly bipectinate, pale brown, scape brown scaled; labial palpus expanding upto frons, brown scaled, pale yellow scales on inner side, second segment larger than first and third, tip with pale yellow scales; thorax pea-green throughout; forewing with costa straight, apex rounded, termen oblique, convex, basal two-third dark purplish brown, outer margin light brown; hindwing rounded, purplish brown, cilia on termen dark brown, costa pale brown; legs covered with brown scales, scattered white scales throughout, hairy; abdomen brown dorsally, yellowish brown ventrally.

Male genitalia: Uncus well sclerotized, broad at base, tapering towards tips, slightly wavy at dorsal side, a membranous structure present at ventral side, a bunch of spines present, tip ending to a small spine; gnathos prominent, biarmed at base, tip pointed; tegumen V-shaped moderately broad, well sclerotized; vinculum short, V-shaped, saccus well developed, valva simple, costa and sacculus well differentiated, ampulla and harpae absent, cucullus and valvulla not separated from each other, tip of valva membranous setosed with well formed setae; juxta almost rectangular, transtilla weakly sclerotized, aedeagus long and narrow, aedeagus deeply bent near anterior end, whip-like, ductus ejaculatorius enters subapically.

Female genitalia: Not studied.

Material examined: Karnataka: Dist. Belgaum, FRH, Londa, 420m, 24.iii.2003, 01♂; Dist. Kodagu, Baghamandala, 900m, 25.xi.2003, 03♂♂, Dist. Uttar Kannada, Ganeshgudi, 480m, 13.xi.2003, 01♂, 21.vii.2004, 01♂, 16.x.2005, 01♂; Dist. Kodagu, Sampaje, 100m, 13.xi.2002, 01♂; Gujarat: Dist. The Dangs, Saputara, 970m, 30.ix.2005, 04♂♂; Dist. The Dangs, Ahwa, 520m, 27.xi.2005, 01♂, coll. A. Katewa and Party.

Distribution: Nepal, Nilgiris (Hampson, 1892).

Remarks: The species *P. herbifera* Walker has conspicuous coloration of its forewing and hindwing and, this coloration separates it from other species described under this genus by Hampson (1892). The presently collected specimens are smaller than those referred by Hampson (30mm). However, on the basis of morphological characters, particularly coloration and venation, the species has been identified as *P. herbifera* Walker.

Parasa neoherbifera sp. nov.
(Plate 4, Photo A, Figures. B-F)

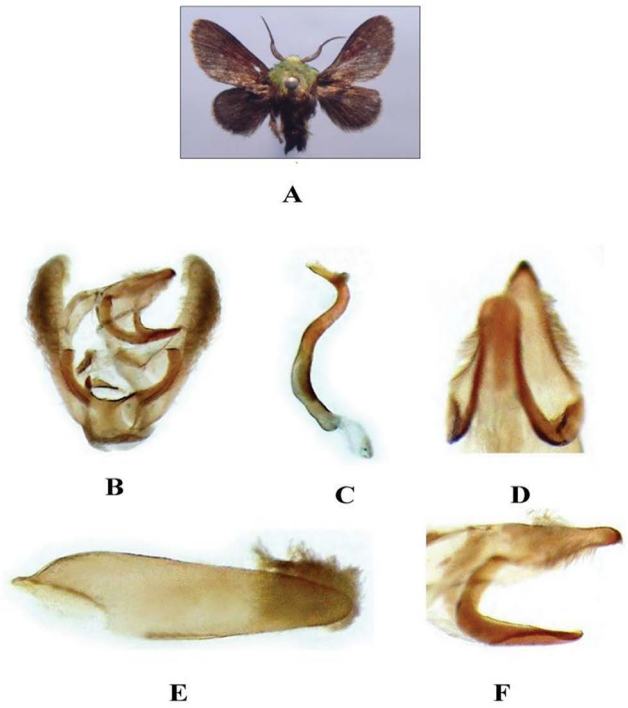


Plate 4. *Parasa neoherbifera* sp. nov.: **(A)** adult, **(B)** male genitalia (ventral view), **(C)** aedeagus, **(D)** Uncus, **(E)** valva, **(F)** uncus and gnathos (lateral view).

Male: Alar expanse: 17 mm. Vertex pea-green, frons brown; antennae bipectinate, basal one-third strongly bipectinate, brown, scape brown scaled; labial palpus expanding upto frons, brown scaled, pale yellow scales on inner side, second segment larger than first and third, tip with pale yellow scales; thorax pea-green throughout; forewing with costa straight, termen oblique, straight, basal two-third reddish brown, outer margin light brown; cilia on termen dark brown, costa dark brown, hind wing rounded, blackish dark brown; cilia on termen brown; legs covered with brown scales, scattered white scales throughout, hairy; abdomen brown dorsally, yellowish brown ventrally.

Wing venation: Forewing with Sc ending beyond anterior two-third of costal margin, R_1 arising well before middle of cell, R_2 arising near upper angle of cell, R_3, R_4 and R_5 stalked, stalk originating from upper angle of cell, M_1 and M_2 almost straight and parallel to each other, M_2 and M_3 connate at lower angle of cell, CuA_1 arising well before lower angle of cell, CuA_2 originating before posterior one-third of cell, CuP well represented, 1A + 2A straight; hind wing with Sc + R1 anastomosing with Rs basally after origin, Rs and M_1 closely approximating basally, M_2 and M_3 slightly diverging distally, M_3 arising from lower angle of cell, CuA_1 arising well before lower angle of cell, CuA_2 arising almost in middle of cell, CuP well developed, 1A+2A and 3A present, well developed, somewhat diverging distally.

Male genitalia: Male genitalia with uncus well formed, broadens towards middle region, then tapering towards distal end, setosed with long setae, tip ending to a small spine; gnathos present, bifurcated at tip; tegumen moderately broad; vinculum short, broad U-shaped; saccus developed; valva simple without any projections, broad at base, tapering towards proximal end, tip blunt, setosed with hairs; transtilla membranous; juxta present; aedeagus long and narrow, shallowly S-shaped, ductus ejaculatorious enters subapically.

Female genitalia: Not studied.

Material examined: Karnataka: Dist. Belgaum, FRH, Londa, 420m, 24.iii.2003, 01♂; Dist. Kodagu, Baghamandala, 900m, 25.xi.2003, 02♂♂; Dist. Uttar Kannada, Ganeshgudi, 480m, 13.xi.2003, 1♂, 16.x.2005, 01♂.; Gujarat: Dist. The Dangs, Saputara, 970m, 30.ix.2005, 04♂♂; Dist. The Dangs, Ahwa, 520m, 29.ix.2005, 01♂, coll. A. Katewa and Party.

Etymology: The specific name is derived as *Parasa neoherbifera* sp. nov. being sibling to *P. herbifera* Walker.

Remarks: Ten nonspecific specimens completely conform to the characteristics of the genus *Parasa* Moore were collected. However, they differ from other species of the genus as far as the coloration of the wings is concerned. In fact, these individuals represent an unnamed species, which is somewhat closely allied to *P. herbifera* Walker on the basis of the maculation of the wings. It differs from the same in the structure of the aedeagus, besides being somewhat smaller in alar expanse. Accordingly, the phenomenon is named as *i.e., P. neoherbifera* sp. nov.

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Abbreviations

1A+2A= Vein representing fused first and second anal vein , 3A= Third anal vein, CuA_1= Fist anterior cubital vein, CuA_2 = Second Anterior cubital vein, CuP = Posterior cubital vein, M_1= First median vein, M_2= Second median vein, M_3= Third median vein, R_1= First radial vein, R_2= Second radial vein, R_3= Third radial vein, R_4= Fourth radial vein, R_5= Fifth radial vein, Rs= Radial sector, Sc= Subcostal vein, $Sc+R_1$= Stalk of subcostal and first radial vein, sp. nov.= New species.