Submitted: 26.02, 2023; Accepted: 04.03, 2023; Published: 30.03, 2023

Revision on the genus *Bubopsis* MacLachlan, 1898 known in India (Neuroptera: Myrmeleontidae: Ascalaphinae)

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SURYANARAYANAN, T. B, ÁBRAHÁM, L., BIJOY, C. & TRIPATHI, R.: Revision on the genus Bubopsis MacLachlan, 1898 known in India (Neuroptera: Myrmeleontidae: Ascalaphinae).

Abstract: The ascalaphid, *Bubopsis zarudnyi* Martynova, 1926 is recorded for the first time from India. *Bubopsis rubrapunctata* Ghosh, 1981 was the only owlfly species previously described from India from the genera. The two species are revised from a taxonomic point of view and *Bubopsis zarudnyi* is redescribed. The habitat and flight activity of the species is documented. Based on the re-identified specimens preserved in different collections, the distribution of the species is outlined. After examining type specimens, *Bubopsis rubrapunctata* is removed from the genus *Bubopsis* MacLachlan, 1898 and *Pseudobubopsis* gen. n. is erected for *Pseudobubopsis rubrapunctata* (Ghosh, 1981) (comb. n.). Also, the new genus is compared with *Bubopsis*, and generic key is provided.

Keywords: owlfly, ascalaphid, Ascalaphinae, Bubopsis, taxonomy, redescription, new genus, India.

Introduction

According to MACHADO et al. (2019), Ascalaphini is the largest tribe with 286 species belonging to 70 genera. *Bubopsis* which belongs to Ascalaphini was described by MACLACHLAN (1898) and is distributed mainly in Southern Europe, North Africa, the Middle East, and Arabian Peninsula (MCLACHLAN 1898, VAN DER WEELE 1909, MARTYNOV 1926, ASPÖCK et al. 1978, ASPÖCK et al. 1980, SZIRÁKI 1998, SZIRÁKI 2000, HÖLZEL 2004). *Bubopsis* currently includes 7 species in the world, i.e., *B. agrionoides* (Rambur, 1838), *B. andromache* U. Aspöck et al. 1978, *B. eatoni* McLachlan, 1898, *B. hamata* (Klug in Ehrenberg, 1834), *B. rubrapunctata* Ghosh, 1981, *B. tancrei* van der Weele, 1909 and *B. zarudnyi* Martynova, 1926 (OSWALD 2023). In India, only one *Bubopsis* species was reported so far, i.e., *B. rubrapunctata* which was distributed in the

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

state Karnataka (Maruti Hills, Belgaum) (GHOSH 1981, CHANDRA & SHARMA 2009). Through this paper, we report another *Bubopsis* species, *B. zarudnyi* for the first time from India. It was previously recorded in Iran, Oman, Turkey and the United Arab Emirates.

The main aim of this paper is to redescribe and illustrate *B. zarudnyi* based on the freshly collected specimens (and museum specimens), and check the earlier faunistic data as well as revise of taxonomic status of *B. rubrapunctata*.

Material and methods

The adult owlflies were collected by hand from Desert National Park and Wildlife Sanctuary (Fig. 6). The collected specimens were transferred into a killing jar with ethyl acetate. After that, specimens were pinned, stretched, dried, labeled, and preserved.

The specimens were examined through Labored Luxeo 6Z Stereomicroscope. Specimens were identified after MARTYNOVA (1926) and compared to the lecto-, and paratype specimens.

The photos were prepared with Canon 7D Mark II digital camera with a 100 mm F/2.8L macro lens. For the preparation of male genitalia, the last 3-4 abdominal segments were removed and put in 10% KOH overnight. These were then washed in distilled water and kept in 80% ethyl alcohol with a drop of glycerol for observation. The photography was done under Leica M205 Stereomicroscope with LAS V3.7 software. After photography, the genitalia of each specimen was transferred to a glass vial with 60-70% glycerin. The terminology for male and female genitalia follows ASPÖCK et al. 1980, ASPÖCK & ASPÖCK 2008. The voucher specimens were deposited in the Shadpada Entomology Research Lab (SERL) at Christ College (Autonomous), Irinjalakuda, Thrissur, Kerala, India. Distribution maps were produced using the Simplemappr software.

Abbreviations:

Chlist – checklist, Comb – new combination, Dist – distribution, Faun – faunal record, Mon – monograph, Nom – nomenclature, Odescr – original description, Redescr – redescription, Syn – Synonym, Typ – type sp. FW – forewing, HW – hindwing, C – Costa, Sc – Subcosta, R – Radius, Sc+R – Subcosta + Radius, Rs + Ma – Radial vein + Media anterior, Mp – Media posterior, Mp₁ – Media posterior 1, Mp₂+Cua₁ – Media posterior 2 + Cubitus anterior 1, Cua – Cubitus anterior, Cua₁ – Cubitus anterior 1, Cua₂ – Cubitus anterior 2, Cup – Cubitus posterior, Cup+A1 – Cubitus posterior + Anal vein 1, A1, A2 and A3 – Anal veins 1, 2 and 3, Av – ambient vein, aa – apical area, ps – pterostigma, ca – costal area, sca – subcostal area, t1-t5 – tarsomeres 1-5, ts – tibial spurs, gx – gonocoxites, T8 and T9 – tergite 8, and 9, ep – ectoproct, S8 and S9 – sternite 8, and 9, dmp – dorso-medial processus, vp – ventral processus, L. gon. – lateral gonopophysis, P. gon. – posterior gonopophysis, A. gon. – anterior gonopophysis.

Referred collections:

- CMC Private reference collections of C. Monerrat, Switzerland
- NZSI Zoological Survey of India, National Zoological Collection, Calcutta, India
- SCM Rippl-Rónai Museum, Kaposvár, Hungary

SERL – Shadpada Entomology Research Lab Christ College (Autonomous), Irinjalakuda, Thrissur, Kerala, India ZIN – Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia

Results

Bubopsis MacLachlan, 1898

Type species: *Ascalaphus agrionoides* Rambur, 1838. Subsequent designation by van der Weele, 1909: 271. *Bubo* Rambur, 1842: 353 (Odescr), Brauer & Löw 1857: 63 (Redescr), Oswald 1988: 90 (Nom), Oswald and Penny 1991: 14 (Nom), Aspöck et al. 2001 (Mon). *Bubopsis* MacLachlan, 1898: 159 - (Nom), Oswald & Penny 1991: 14 (Nom), Aspöck et al. 2001 (Mon).

Phyurus Navás, [1901] 1900–1901: 95 (Odescr), Oswald & Penny 1971: 14 (Ivolii), Aspöck et al. 2001 (Ivolii). Aspöck et al. 2001 (Mon).

Diagnosis: Medium-sized species. Sexual dimorphism insignificant. Head as wide as thorax. Vertex narrow with long hairs. Frons with dense hairs. Eye large, divided by transverse furrow, lower part smaller than upper one. Antenna subglobular shaped, straight, not reaching pterostigma in forewing. Basal flagellomeres with long hairs. Wings elongated, hyaline, without markings but subcostal area regularly discoloured on both wings and sometimes apical area of hindwing fumated. Pterostigma rhomboid-shaped, yellow to dark brown. Venation rather dense. Apex of wings rounded, forewing with round projection on anal area. Apical area beyond Sc+R with three rows of cells in forewing, and with two or three rows in hindwing. More than two rows of cells between Mp_2+Cua_1 and hind margin. Legs rather short, and tibial spurs as long as tarsal segments 1-2 together. Hairs on abdomen short and sparse. Ectoproct forceps of males about as long as 6-9 abdominal segments together with long ventral projection (short dorsome-dial projection in *B. eatoni* MacLachlan, 1898).

Distribution: South Europe, North Africa, Southwest and Central Asia.



Fig. 1: Adult male *Bubopsis zarudnyi* in resting position in natural habitat of Desert National Park, Rajasthan, India (Photo: Tripathi, R.)

Bubopsis zarudnyi Martynova, 1926

Bubopsis zarudnyi Martynova 1926: 198 (Odescr), Kimmins 1938: 254 (Faun), Krivokhatsky 1995: 6 (Typ), Sziráki 1998: 61 (Chlist), Hölzel 2004: 220 (Dist), Sziráki 2011: 63 (Faun).

Material examined:

CMC: 1 \bigcirc - 29.III.2011 OMN Wadi Dima 22,97824 58,55437 491 m Christian Monnerat day collect; 1 \bigcirc - 31.III.2013 OMN Ar Raddah 23,14078 52,12208 615 m Christian Monnerat & Andreas Sanchez light trap; 1 \bigcirc - 12.IV.2013 OMN Wadi Abyad 23,44212 57,65541 240 m Christian Monnerat & Andreas Sanchez light trap

SCMK: 1 ♀ - Oman Prov. Al Batinah South Balad Seet 914 m oasis, spring N23°11,794' E57°23,426' 06.V.2019. Leg: L. Ábrahám, S. Ilniczky, G. Körtési.

SERL: 2 ♂ - India: Rajasthan State: Jaisalmer District, Thar Desert, Desert National Park and Wildlife Sanctuary, Myajlar area, asl. 275 m, (coordinates: 26°17'10.8"N, 70°24'25.7"E), R. Tripathi, SERLNR315, 20.VIII.2022.

ZIN: Lectotype: 1 \bigcirc , Karvandar-Bampur, SE Persia [SE Iran] 25.IV.[19]01 Zarudny (Fig: 2); Paralectotype: 1 \bigcirc , River Kir, Ge, Makran, SE Persia [SE Iran], Zarudny 22-26.III.[19]01.



Fig. 2: Lectotype female *Bubopsis zarudnyi* with labels, deposited in ZIN, St. Petersburg, Russia

Redescription

Diagnosis: Vertex, frons, and thorax are densely hairy. Wing tips are rounded, and forewing has a small blunt projection on anal margin. The membrane is transparent, only subcostal area discoloured on both wings. The apical part of the membrane is more or less fumed in the hindwing of female. Pterostigmas are rather narrow. Legs are short and

strong. Large yellow spots distally on both sides of tergal segments. The ectoproct with an extraordinary processus of males is broken at an obtuse angle, and the end of the ventral processus flattens and becomes bifurcated. (Figs. 3 A and B).

Head. Vertex narrow; frontal and dorsal parts shining black, and densely covered with long, soft and white hairs intermingled with some black ones. Caudal part of vertex yellow without hairs. Frons shining black, with long dense soft, and white hairs. Long dense tuft of white hairs intermingled with some black ones between scapes. Gena yellow with white hairs on inner margins. Clypeus yellow, hairless, labrum yellow with ochreous setae directed to mouth part. Mandible yellow, apices and on inner margin, brown to



Fig. 3. Bubopsis zarudnyi, A - Male habitus; B - Female habitus, Scale: 10 mm

dark brown, hairless. Maxillary and labial palpi yellow, with short black setae at joints. Eye divided by a transverse furrow. Scape dark brown and pedicel yellow, covered with long soft and white hairs intermingled with some black ones. Basal flagellomeres (5-6 segments) yellow, and become brown. Club subglobular with flattened apex, basal part yellow, distal part brown with distal yellow ring, and with black verticils. (Fig. 4 A).

Thorax. Pronotum narrow, both margins yellow, and with transverse dull black stripe, posterior margin with long soft and white hairs intermingled with some black ones. Mesonotum: Prescutum black with large yellow marks dorso-laterally, and with dense long soft, and white hairs intermingled with some black ones on anterior margin; scutum black with two large yellow spots dorso-laterally; scutellum black with two large yellow lateral spots. Dense long white hairs laterally, sparse short white hairs dorsally on scutum and scutellum. Metanotum: Postnotum black, postscutum with large yellow spots on both sides, postscutellum black. Dense decumbent and white hairs on metanotum laterally. (Fig. 4 B). Sides brown with very dense long and white hairs.

Wings (Fig. 4 C). Forewing, length 28-30 mm, 7 mm wide, longer than hindwing. Membrane completely transparent, sca light brown. Wing tips rounded; wing tapering basally; anal area with obtuse projection. Costa and basal part of Mp, Cua, Cup, and anal veins yellow, otherwise brown. Pterostigma about as wide as long, rhomboid-shaped, yellow to light brown, with 4-5 crossveins; apical area beyond Sc+R with three rows of cells. Rs with 6 branches. In front of Rs+Ma with 5-6 cross-veins.

Hindwing length 27 mm, 7 mm wide. Membrane dominantly transparent, cross-veins with brown shaded in costal area, subcostal area completely light brown, considerable brown pigmentation on membrane in apical area. Pterostigma about as wide as long, rhomboid-shaped, yellow to brown with 4-5 cross-veins; apical area beyond Sc+R with two- three rows of cells. In front of Rs+Ma with 4 cross-veins. Rs with 6 branches.

Legs. short yellow and hairy. Coxae and trochanters with long dense and white hairs. Femora with dominantly long dense white hairs. Femora and tibiae equal sized. Tibiae yellow with short and long black setae; tibial spurs equal in length to t1-t2. Tarsomeres with short black setae; t1-t4 subequal in length; t5 as long as t1-t4 combined (Figs. 4 D and E).

Abdomen. Shorter than hindwing, Tergites dark brown with alternate yellow patches in caudal margins, covered with short black and white setae; sternites black with short white hairs.

Male genitalia. Tergite 9 somewhat quadrate, yellow with black hairs dorsally, ectoproct yellow equipped with extraordinary forceps, which breaks at obtuse angle at dmp. Proximal and distal parts of forceps almost equal. Proximal part of forceps (occasionally with brown stripe laterally), covered with dense white hairs on inner side. Ventral processus slightly bent forward and bifurcated apically, with stiff and black hairs on inner side. Distal part of processus with very dense stiff and black hairs on inner side and rather long black hairs on outside. Gonocoxites elongated arch-like, connected with gonocoxites 9 (gonarcus and parameres complex) as in Figs. 5 A and B in lateral and ventral views.

Female genitalia: Tergite 9 subrhomboid-shaped, dominantly yellow with dark brown mark ventro-caudally covered evenly with short brown hairs. Ectoproct oval plate, yellow covered with dense dark brown hairs caudally and ventrally. Gonocoxites 8 (ventro-valvae) finger-like yellow with dark brown hairs, gonocoxites 9 (distivalvae) small hemispherical with brown hairs in lateral view. (Fig. 5 C). Interdens not seen, linguella weekly sclerotized in ventral view.



Fig. 4: *Bubopsis zarudnyi*, A – head in frontal view; B – head and thorax in dorsal view, C – female wing venation, D – foreleg; E – hindleg in lateral view

Distribution. The collected specimens of the species have been revised. This was easy because in total only 5 males and 9 females published are known (KRIVOKHATSKY 1995, HÖLZEL 2004, SZIRÁKI 2011). Of the syntype specimens, two females were studied, and they were designated as lectotype and paratype females by KRIVOKHATSKY (1995) from Iran. Several specimens were found in the SE Arabian Peninsula, in the Al-Hajar Mountains (Oman: 1_{\circ}° 5 $^{\circ}_{\circ}$ - HÖLZEL 2004; 2_{\circ}° and 3_{\circ}° in the UAE - SZIRÁKI 2011) Other unpublished specimens are kept (1_{\circ}° in coll: SCMK, and 3_{\circ}° in coll: CMC).



Fig. 5: *Bubopsis zarudnyi* A – Male genitalia, in lateral view; B – the same, in ventral view, C – Female genitalia, in lateral view, Scale 0.5 mm

SATAR & ÖZBAY (2002) identified *Bubopsis zarudnyi* as a new record in the fauna of SE Turkey and figured it in a short paper. Unfortunately, the specimen in the figure (SATAR & ÖZBAY 2002: 192, Fig. 1) cannot be found anymore (Satar pers. comm.). Based on figure 1, it is only a specimen of *Bubopsis hamata* (Klug in Ehrenberg, 1834) with a dark hindwing tip, which is otherwise not such a common colour variation. Satar also collected other similar specimens, which belonged to the species *B. hamata*. He mailed photos of the collected specimens for revision.

Both pterostigma of *B. hamata* are typically light yellow, and the subcostal area is transparent, not shaded while *B. zarudnyi* has darker pterosigma, especially in the hindwing and the membrane in the subcostal area of both wings always shaded. CANBULAT (2007) later cited this data in the Turkish checklist. DOBOSZ & ÁBRAHÁM (2007) already proposed a revision of this Turkish specimen. Thus, the species should be deleted from the fauna of Turkey.

The collecting site in India, Rajasthan, Jaisalmer (Myajlar) is a new record for the Indian fauna. The occurrence of the species was expected in Rajasthan since this state of India is associated with the eremial area (Fig. 7).

Based on the currently known distribution data of *Bubopsis* species, *B. zarudnyi* does not overlap with the distribution of either species. The area of *B. hamata* (Klug in Ehrenberg, 1834) in Iran does not cross the Zagros Mts. Its area stretches towards Central Asia. *Bubopsis tancrei* van der Weele, 1909 is a typically Central Asian species. *B. zarudnyi* is an eremial species whose area continues in Baluchistan in the southeastern part of Iran and presumably in Pakistani Baluchistan, and it can also be potentially found in several parts of Rajasthan, the driest state of India. Similar to this region is the Al-Hajar Mountains in the northeastern part of Oman, whose northern extension is the United Arab Emirates mountainous region.

Habitat: The new collection site in India, the Thar Desert or the Great Indian Desert located in the north-western part of India covering about 10% of India's total geographic area with more than 60% lying in the state of Rajasthan (SIVAPERUMAN et al. 2009; SHARMA 2013, RAO et al. 2015). Being an arid biogeographic zone, it is a hydrologically deficient landscape with 250 mm mean annual precipitation (100 to 500 mm) and around 24°C mean annual temperature (-2 to 51°C) (SHARMA & MEHRA 2009). It is occupied either by dry two open grasslands or by grasslands interspersed with trees and shrubs and holding a wide range of topographic features such as plains, gravels, sandsoil mix, sand dunes, and rocky hillocks (SHARMA & MEHRA 2009). Despite the xeric and inhospitable climatic conditions, the Thar Desert provides dynamic micro-ecosystems for various taxa, thus exhibiting high levels of biodiversity, mostly due to its juxtaposition of Palaearctic, Oriental and Saharan elements (SHARMA & MEHRA 2009, Roy & SINGHVI 2016).

Flight period: Based on the collection data of *B. zarudnyi*, adults are active at night, and the majority of specimens known so far are females. Similar to other Bubopsis species, the adults are on wings already at dusk and show hill-topping behavior. During the day, as long as the daily temperature is not so high that it would hinder the daily activity of the insects, the adults are active in the morning hours (till 10 O'clock). After that, they typically settle on the stems of plants (Fig. 1).

Based on collecting data, the seasonal activity of adults lasts from the end of March to the end of August. The peak of seasonal activity is in April and May.



Fig. 6: Habitat of *Bubopsis zarudnyi* in the Thar Desert, Rajasthan (Photo: Tripathi, R.)

Pseudobubopsis Suryanarayanan, Ábrahám & Bijoy **gen. n**. Type species: *Bubopsis rubrapuncta* Ghosh, 1981

Diagnosis: The new genus is very similar to the genus *Bubopsis*. The main differences are that the head is wider than the thorax; the base of the antenna is bare; the costal and hind margins of the wings are strikingly parallel; the venation is loose; there are only two rows of cells between Cua_1 and hind margin in the hindwing; the male ectoproct forceps curved and not broken at an angle as well as without long ventral projection.

Description: Small to medium-sized species (forewing length 21-23 mm, hindwing length 17-20 mm). Sexual dimorphism insignificant. Head wider than thorax. Vertex narrow with long dense hairs. Frons with dense hairs. Eye large, divided by transverse furrow, lower part about same size as upper one. Antenna subglobular shaped, straight, and not reaches pterostigma in forewing. Basal flagellomeres without hairs. Wings, elongated, both sides parallel, hyaline, without markings but sometimes subcostal area on both wings shaded. Pterostigma rhomboid-shaped. Apex of wings rounded, forewing with round projection on anal area. Apical area beyond Sc+R with two or three rows of cells in forewing and two cells in hindwing. Legs rather short, and tibial spurs as long as 11-t2 together. Hairs on abdomen short and sparse. Ectoproct forceps of males about as long as 6-9 abdominal segments together only with small internal protrusion.

Distribution: Known only in India.

Etymology: The name of the new genus, *Pseudobubopsis*, is based on its morphological similarity to the genus *Bubopsis*. The Greek word *pseudo* means false.

Pseudobubopsis rubrapuncta (Ghosh, 1981)

Material examined:

NZSI: Holotype: \mathcal{Q} , India: Karnataka, Maruti Hills, Belgaum; call. nil, 27. xii. 1971, Regd. no. 963/H12; Paratype \mathcal{J} (Allotype): same as holotype, Regd. no. 964/H12 (Figs. 7 A and B).



Fig. 7: *Pseudobubopsis rubrapuncta* (Ghosh, 1981) comb. n. A – Dorsal habitus of holotype female (wings discoloured basally); B – Lateral habitus of paratype male

Remarks: GHOSH's (1981) description of the species is detailed and thorough. Unfortunately, the condition of the type specimens is very bad. *Pseudobubopsis rubrapuncta* (Ghosh, 1981) needs to be examined with the help of freshly collected specimens and genitalia preparation.



Fig. 7: Known distribution of *Bubopsis zarudnyi* (red circle) and *Pseudobubopsis rubrapuncta* (yellow circle) in the World

Key to related Indian genera

Discussion

In recent years, many conflicting publications have been published on the phylogenetic status of owlflies in the traditional sense. They supplemented the traditional morphological division (TJEDER 1992) with the results of genetic studies (JONES 2019, MACHADO et al. 2019). Further studies will probably be needed to clarify the phylogenetic status of taxa in the future (WU et al. 2022).

Owlflies are interesting members of Myrmeleontidae with minimum taxonomic studies and documentation from India (MACHADO et al. 2019). India currently includes 156 species under 52 genera of Myrmeleontidae, of which only 33 species under 17 genera are owlflies (CHANDRA & SHARMA 2009; SURYANARAYANAN et al. 2022). More in-depth and concentrated studies will give a way for discovering new species and new distributional records of owlflies from India. Previously CHANDRA & SHARMA (2009) reported only one species of *Bubopsis* from India. After examining type specimens of *Bubopsis rubrapunctata*, it is removed from the genus *Bubopsis* MacLachlan, 1898 into *Pseudobubopsis* gen. n. i.e., *Pseudobubopsis rubrapunctata* (Ghosh, 1981) (comb. n.). Through this paper, the less known owlfly species, *B. zarudnyi* is redescribed. Also, the new genus is compared with *Bubopsis*, and genus keys are provided.

Acknowledgments

We are grateful to the Principal, Christ College (Autonomous), Irinjalakuda, Kerala for providing us with the facilities for undertaking this work. The first author offers sincere gratitude to CSIR, Government of India, for financial support in the form CSIR Senior Research Fellowship (08/376(0010)/2019-EMR-I). We are thankful to the Chief Wildlife Warden, Rajasthan, for the collection permit to the Desert National Park and Wildlife Sanctuary (F19(29) Permission/cwlw/2017/5173). The collection at Desert National Park & Wildlife Sanctuary was part of the Bustard Recovery Programme of the Wildlife Institute of India, funded by the National Compensatory Afforestation Fund Management and Planning Authority, Government of India. We are thankful to Dhriti Banerjee, the Director, Zoological Survey of India, Kolkata for giving permission to study and access the type specimens photos from National Zoological Collection. Thanks to Nidheesh K. B. for photographing the specimen as well as Bálint Csernák (Hungary) for further excellent photos. We thank the late Victor Krivokhatsky (ZIN, St. Petersburg) for previously providing a photo of the lectotype in his collection. Christian Monerrat (CMC - Private reference collections, Switzerland) and Ali Satar (Dicle University, Diyarbakır, Turkey) for providing distribution data and revision of specimens in their collections.

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