Journal of Threatened Taxa

Building evidence for conservation globally

Open Access

10.11609/jott.2021.13.12.19675-19886
www.threatenedtaxa.org

26 October 2021 (Online & Print)
Vol. 13 | No. 12 | Pages: 19675–19886

ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road, Saravanampatti,
Coimbatore, Tamil Nadu 641035, India
Ph: +91 9385339863 | www.threatenedtaxa.org
Email: sanjay@threatenedtaxa.org

For Focus, Scope, Aims, and Policies, visit https://threatenedtaxa.org/index.php/JoTT/aims_scope
For Article Submission Guidelines, visit https://threatenedtaxa.org/index.php/JoTT/about/submissions
For Policies against Scientific Misconduct, visit https://threatenedtaxa.org/index.php/JoTT/policies_various

continued on the back inside cover

Caption: Stripe-backed Weasel *Mustela strigidorsa*. Medium—digital, Software—procreate, Device—iPad + Apple pencil © Dhanush Shetty.

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 October 2021 | 13(12): 19831–19836
ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)
https://doi.org/10.11609/jott.6568.13.12.19831-19836
#6568 | Received 13 August 2020 | Final received 16 June 2021 | Finally accepted 15 October 2021

SHORT COMMUNICATION

Flesh fly (Diptera: Sarcophagidae): male terminalia, diversity and expanded geographical distribution from India

Kanholi Sreejith [1], Shuvra Kanti Sinha [2], Santanu Mahato [3] & Edamana Pushpalatha [4]

[1,4] Department of Zoology, University of Calicut, Malappuram, Kerala 673635, India.
[2] Calyptrate Research Laboratory, Department of Zoology, Sreegopal Banerjee College, Hooghly, West Bengal 712148, India.
[3] Biopsychology Laboratory and Institution of Excellence, University of Mysore, Mysuru, Karnataka 570006, India.
[1] sreejithkanholi@gmail.com, [2] suvrosinha@gmail.com, [3] santanumahato94@gmail.com,
[4] drepushpalatha@gmail.com (corresponding author)

Abstract: Despite its veterinary, medical and forensic importance, the biodiversity of sarcophagid flies (Diptera: Sarcophagidae) has remained poorly investigated in India. We have performed a survey of Sarcophagidae species in connection with a study conducted on Diptera, which exposed the flesh fly diversity in and around the campus of the University of Calicut, Kerala, India. The survey was conducted using traps baited with decomposing fish and chicken liver and by the sweeping method. Eleven species were collected, including four species recorded from this state for the first time, one of which is new to the Indian mainland and the second record after Sundarbans Biosphere Reserve. Male terminalia of *Sinonipponia bengalensis, Parasarcophaga choudhuryi, Boettcherisca karnyi*, and *Boettcherisca nathani* are illustrated. This result expands the knowledge on the geographical distribution and habitat occupancy of sarcophagid species as well as their forensic relevance and provides a background for future systematic investigations.

Keywords: Abundance, *Boettcherisca karnyi, Boettcherisca nathani,* diversity, forensic importance, morphology, new record, *Parasarcophaga*, sarcophagid fly.

Abbreviations: AP—Apical plate of Paramere | LP—Lateral plate of Paramere | S—Styli of glans | T—Theca | V—Ventralia | UoC—University of Calicut.

Sarcophagid flies (Diptera: Sarcophagidae), commonly known as flesh flies, are abundant in all zoogeographic regions of the world with approximately 171 genera and 3,094 species (Pape et al. 2011). Out of these, 504 species in 50 genera have been described from India (Nandi 2002; Sinha & Nandi 2002a,b). Flesh flies show a large range of feeding habits, with adult flies feeding on nectar, fruit juice, and decomposing animal matters; they carry different types of germs on their body surface, which may cause diseases in humans and other animals, and larvae of some species are parasitic on various invertebrates, breed in vertebrate and invertebrate carrion, faeces or decaying organic matter (Pape 1987, 1996; Amoudi et al. 1992; Al-Misned 2000; Al-Misned et al. 2001; Graczyk et al. 2005; Pape et al. 2010; Al-Khalifa et al. 2020). This variety of feeding methods can have a direct impact on their capacity as pathogenic vectors and the larvae of some species cause myiasis in humans as well as in different animals (Dodge 1955; Zumpt 1965; Greenberg 1973, Crump & Pounds 1985; Guimaraes & Papavero 1999;

Editor: Anonymity requested.

Date of publication: 26 October 2021 (online & print)

Citation: Sreejith, K., S.K. Sinha, S. Mahato & E. Pushpalatha (2021). Flesh fly (Diptera: Sarcophagidae): male terminalia, diversity and expanded geographical distribution from India. *Journal of Threatened Taxa* 13(12): 19831–19836. https://doi.org/10.11609/jott.6568.13.12.19831-19836

Funding: This work was carried out by the Department of Zoology, University of Calicut in collaboration with Sonamukhi College, Sonamukhi and was supported by SPG of University of Calicut, Kerala.

Competing interests: The author declares no competing interests.

Acknowledgements: The authors are thankful to the Department of Zoology, University of Calicut for all the support given for fulfilling the work. The authors are also thankful to the Principals of Sonamukhi College, Sonamukhi, and Sreegopal Banerjee College, Hooghly, for giving the necessary permission for collaborative research with the Department of Zoology, University of Calicut, Kerala.

Hagman et al. 2005; Stevens et al. 2006; Bermudez et al. 2010; Mello-Patiu & Luna-Dias 2010; Kelehear et al. 2020). Whereas sarcophagid flies are associated with decomposing carcasses and human bodies (Cherix et al. 2012; Vasconcelos et al. 2014; Al-Khalifa et al. 2020), the study of larval and pupal developments found in carcasses improves their effectiveness as useful insects in forensic science investigations (Pape 1996; Wells et al. 2001; Sinha & Mahato 2016; Ren et al. 2018; Samerjai et al. 2020).

Nandi (1990) documented nine species of flesh flies from different parts of Kerala and reported *Parasarcophaga* (*Liosarcophaga*) *dux* (Thomson) for the first time from Kerala. Nandi (2002) documented 20 flesh fly species in Miltogramminae (one species) and Sarcophaginae (19 species) from Kerala (Table 1). In the present faunistic survey, we aimed to contribute to the knowledge of the flesh fly diversity on the campus of the University of Calicut and the distribution of Sarcophagidae in Kerala — the most biodiversity-rich state in southern India.

Materials And Methods

The present survey was carried out at the University of Calicut Campus, Thenjipalam, Kerala (Figure 1).

Study area

The main campus of the University of Calicut is located in Tirurangadi Taluk of the Malappuram District, Kerala, southern India. The main campus is spread over 600 acres on the rural outskirts of Malappuram between 11.1340°N, 75.8952°E, and the last five years have experienced a mean minimum temperature of 28.9°C and a mean maximum of 30.5°C. The main habitats around the campus include gardens, botanical gardens, rubber plantations, various aquatic habitats such as ponds, paddy fields, reservoirs, orchards with mango, jackfruit, zapota, and guava, and terrestrial habitats such as primary and secondary plant successions. The Calicut University Botanical Garden (CUBG) is the largest and most diverse botanical garden of any university garden in the country, covering 45 acres and home to over 2,500 species of vascular plants. CUBG is considered one of the

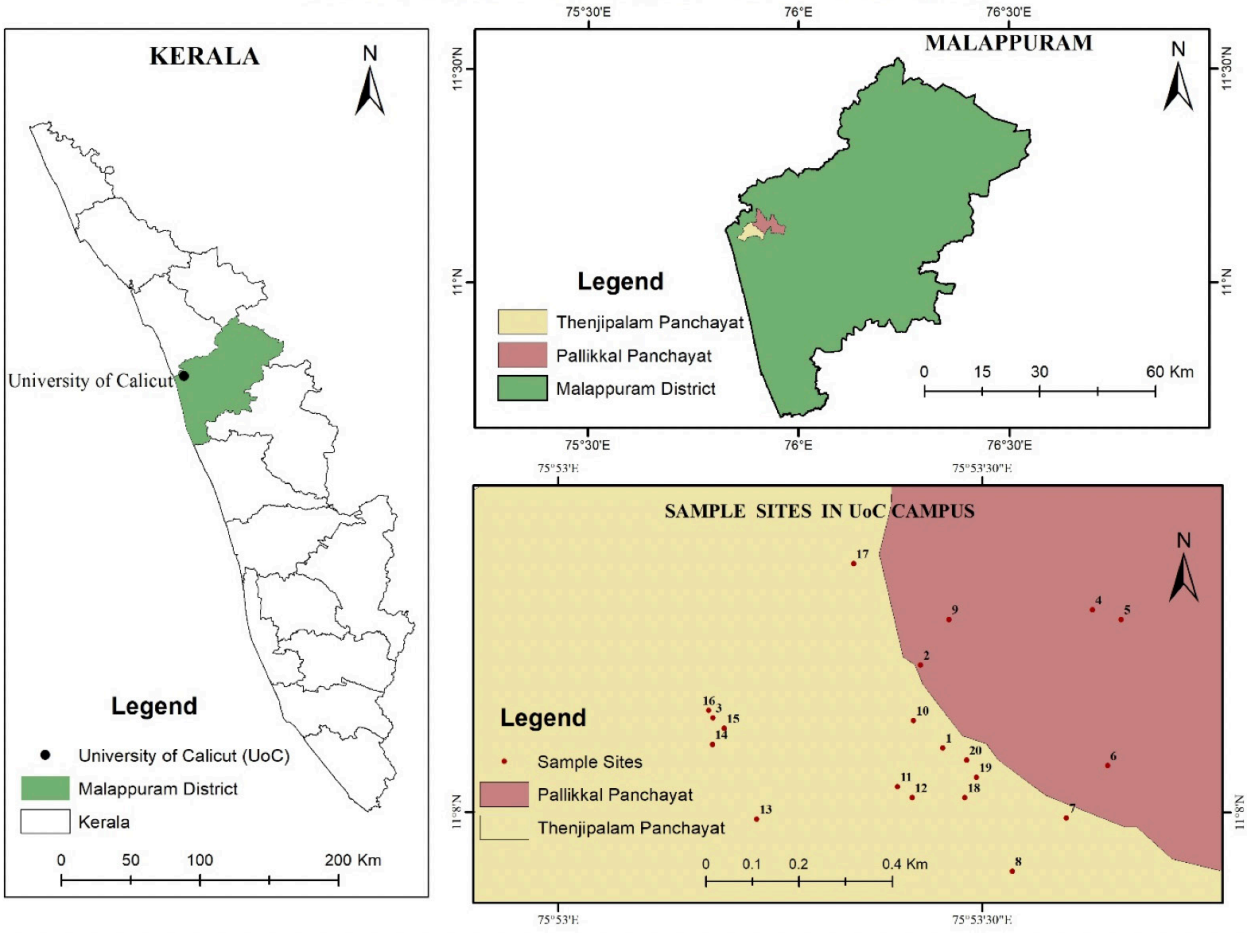

Figure 1. Sampling sites at University of Calicut (UoC).

most important ex situ conservation centres for the rare and endangered flora of the Western Ghats, a UNESCO World Heritage site. The area receives south-west and north-east monsoons, the greater portion of the rainfall, however, is received from the south-west monsoon between June and September. The average annual rainfall of the district is 2,741 mm (IMD 2020).

Field methods and identification

As part of the study of dipteran diversity, a field collection programme for a faunistic survey was conducted by the team in the university campus and adjacent areas to establish documentation of flesh fly species. Collections of specimens in the university campus were done using traps baited with decomposing fish and chicken liver combined with entomological hand nets by standard sweeping. The flies were clustered around the bait, but the flies were from the Calliphoridae family and more from Muscidae. The number of flesh flies was surprisingly low. One observation was that flies were more in shady areas than in open sunshine. Flesh flies have also been found throughout the day. The specimens were identified in the laboratory using the keys, drawing illustrations of the male terminalia in Nandi (2002), and by observing chaetotaxy (arrangement of setae and bristles on the body) and the four species reported for first time from Kerala were dissected for confirmation of species identity. Since sarcophagid flies are not considerably different from each other, therefore, the characteristics of the genitalia are the only criteria for identifying them up to species level. this key was primarily focused on the characteristics of the genitalia.

Male terminalia were photographed with a Nikon Coolpix camera by keeping dissected terminalia in a cavity block under stereoscopic trinocular microscope.

Results

A total of 23 individuals of flesh flies were collected from the University of Calicut campus and these were identified as comprising 11 species, of which, Nandi (2002) had previously reported seven from Kerala (Table 1). Four of the 11 species were newly recorded from the state of Kerala, i.e., *Sinonipponia bengalensis* Nandi, *Parasarcophaga* (*Liosarcophaga*) *choudhuryi* Sinha & Nandi, *Boettcherisca karnyi* (Hardy), and *Boettcherisca nathani* Lopes. *Boettcherisca karnyi* (Hardy) was recorded for the first time from the Indian mainland as previously recorded from Andaman Island (Nandi 2002). The characteristic features of the four new distributional records from Kerala are quite interesting:

Table 1. Species of flesh fly recorded during this study.

	Flesh fly species	Distribution	Source
1	*Protomiltogramma obscurior* (Villeneuve)	Coast of Malabar	Nandi 2002
2	*Blaesoxipha nathani* Lopes	Coast of Malabar	Nandi 2002
3	*Boettcherisca peregrina* (R-D)	Kerala	Nandi 2002
4	*Parasarcophaga ruficornis* (Fabricius)	UoC, Kerala	Nandi 2002, present study
5	*Parasarcophaga dux* (Thomson)	UoC, Kerala	Nandi 2002, present study
6	*Parasarcophaga brevicornis* Ho	UoC, Kerala	Nandi 2002, present study
7	*Parasarcophaga* (*Curranea*) *scopariiformis* (S-W)	Walayar Forest	Nandi 2002
8	*Parasarcophaga* (*Pandelleisca*) *bainbriggei* (S-W)	Kurumbagram	Nandi 2002
9	*Parasarcophaga sericea* (Walker)	Kerala	Nandi 2002
10	*Parasarcophaga hirtipes* (Wiedemann)	Kerala	Nandi 2002
11	*Parasarcophaga misera* (Walker)	UoC, Kerala	Nandi 2002, present study
12	*Parasarcophaga albiceps* (Meigen)	UoC, Kerala	Nandi 2002, present study
13	*Robineauella walayari* (S-W)	Karikal, Palghat, Walayar Forest	Nandi 2002
14	*Thyrsocnema* (*Pseudothyrsocnema*) *longistylata* Shinonaga & Lopes	Karikal, Palghat, Cinchona	Nandi 2002
15	*Thyrsocnema* (*Pseudothyrsocnema*) *indica* Shinonaga & Lopes	Calicut, Cinchona, Muttupatty, Munnar	Nandi 2002
16	*Harpagophalla kempi* (S-W)	Trivancore	Nandi 2002
17	*Iranihindia martellata* (S-W)	UoC, Kerala, Willingdon island	Nandi 2002, present study
18	*Iranihindia futilis* (S-W)	Several localities	Nandi 2002
19	*Seniorwhitea reciproca* (Walker)	UoC, Kerala	Nandi 2002, present study
20	*Leucomyia cinerea* (Fabricius)	Malabar Coast	Nandi 2002
*21	*Sinonipponia bengalensis* Nandi	UoC, Kerala	present study
*22	*Parasarcophaga* (*Liosarcophaga*) *choudhuryi* Sinha & Nandi	UoC, Kerala	Present study
**23	*Boettcherisca karnyi* (Hardy)	UoC, Kerala	Present study
*24	*Boettcherisca nathani* Lopes	UoC, Kerala	Present study

*—newly recorded from Kerala | **—newly recorded from Indian mainland. UoC—University of Calicut.

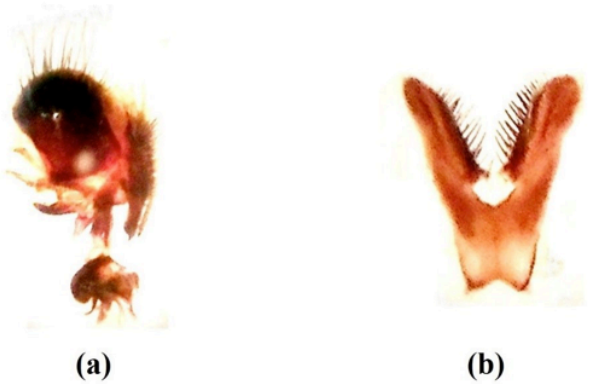

Image 1. Male genitalia of *Parasarcophaga choudhuryi* Sinha & Nandi: a—inner and outer forceps, lateral view | b—fifth sternite. © Department of Zoology, Sonamukhi College.

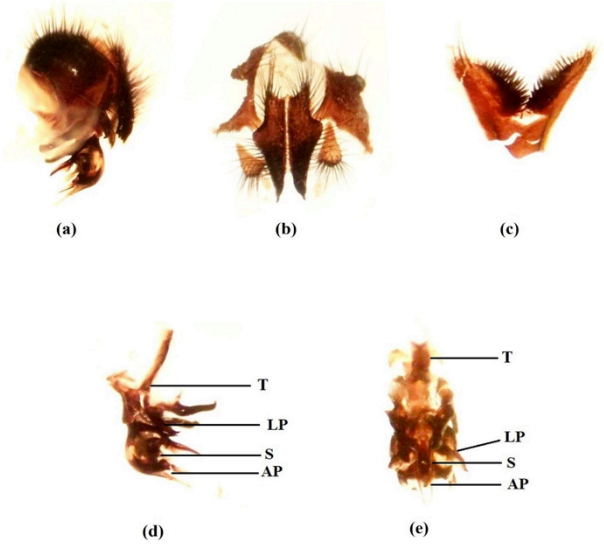

Image 2. Male genitalia of *Sinonipponia bengalensis* Nandi: a—inner and outer forceps, lateral view | b—inner and outer forceps, posterior view | c—fifth sternite | d—penis, lateral view | e—penis, ventral view. © Department of Zoology, Sonamukhi College.

***Parasarcophaga* (*Liosarcophaga*) *choudhuryi* (Sinha & Nandi)**

Parasarcophaga (*Liosarcophaga*) *choudhuryi* is a smaller fly with a slender body. Its ventralia is oval and wide, with a longer stylus of glans (Image 1). Body length 8–9 mm. Parafrontal and parafacial black with golden pollen, the former with short scattered hairs; the latter with a row of short black hairs near the eye margin of which lower 3 are stouter. Frontal bristles 9; acrostichal bristles 0+1, dorsocentral bristles 4+5, mesopleural bristles 7–8, hypopleural bristles 6–7. Prostigmatic and propleural bristles well developed and accompanied by short hairs. 5th sternite Y-shaped with stout spines on inner sides and long hairs terminally on arms; inner forceps slightly curved with the groove at the apex; outer forceps almost oval with few hairs terminally. Apical plate of paraphallus slightly curved backward with the anterior membranous region and elongated apical process; styli of glans slightly longer than apical plate of paraphallus and with serrations at tip; ventralia almost oval with wide trilobed, posterior lobe with the curved chitinous area.

***Sinonipponia bengalensis* Nandi**

Sinonipponia bengalensis also is rather small in size. Its fifth sternite is characterised by the presence of a long seta. Terminalia of this species also shows peculiar features having long and pointed styli of glans, and both an apical and a lateral plate of paraphallus (Image 2). Body length 6–9 mm. Width of frons about two-fifth that of one eye; frontal vita black, parafrontal and parafacial black with silvery pollen. Frontal bristles 10; acrostichal bristles 0+1, dorsocentral bristles 5+4, mesopleural bristles 6, hypopleural bristles 8–9. 5th sternite Y-shaped with short spines laterally and one long and several short hairs terminally on arms. Inner forceps almost straight, slightly curved and with a notch at the end; outer forceps dumb-bell shaped with hairs on distal end; apical plate of paraphallus pointed at end with backward projection; a lateral plate of paraphallus almost pointed, sclerotized and with basal membranous outgrowth; styli of glans long and crosses the apical part of paraphallus with anterior serrations. Ventralia black, pointed, hook-like and curved anteriorly.

***Boettcherisca karnyi* (Hardy)**

Boettcherisca karnyi is quite similar in external appearance to *Boettcherisca nathani* and has minute differences in the male terminalia (Images 3). Body length 8–12 mm. Frontal bristles 11. Outer vertical bristles absent, inner vertical well developed; acrostichal bristles 0+1, dorsocentral bristles 5+5, mesopleural bristles 5, hypopleural bristles 9. Prostigmatic and propleural bristles well developed and accompanied by short hairs. 5th sternite Y-shaped with short window and two rows of closely set bristles laterally on arms. Apical plate of paraphallus curved pointed at the apex and with a pair of long pointed lateral processes; a lateral plate of paraphallus well developed with a pair of large two pointed unequal lateral plates of which anterior one more developed. Ventralia bilobed, well developed, spinous, and anterior margin almost rounded.

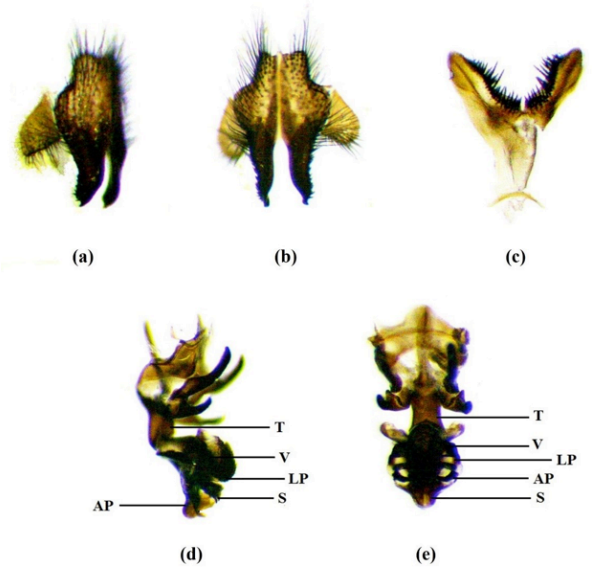

Image 3. Male genitalia of *Boettcherisca karnyi* (Hardy): a—inner and outer forceps, lateral view | b—inner and outer forceps, posterior view | c—fifth sternite | d—penis, lateral view | e—penis, ventral view. © Department of Zoology, University of Calicut.

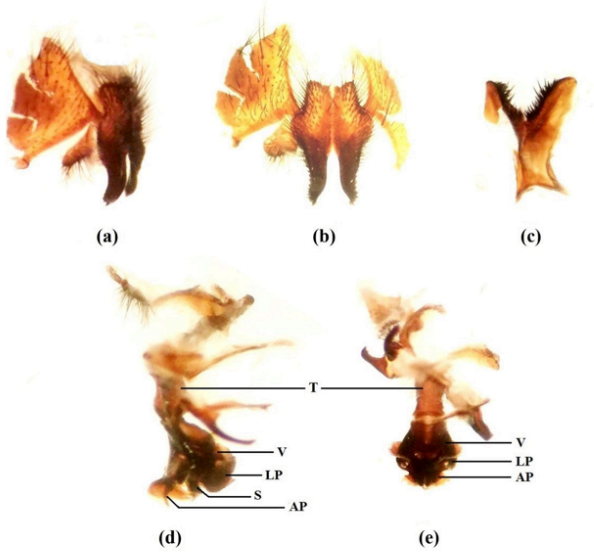

Image 4. Male genitalia of *Boettcherisca nathani* Lopes: a—inner and outer forceps, lateral view | b—inner and outer forceps, posterior view | c—fifth sternite | d—penis, lateral view | e—penis, ventral view. © Department of Zoology, Sonamukhi College.

Key to genera and species newly recorded from Kerala:

1. Ventralia large and almost rounded 2
   Ventralia pointed hook-like and curved anteriorly; an apical plate of paraphallus with a backward projection; styli of glans serrated anteriorly ..... *Sinonipponia bengalensis* Nandi

2. Styli of glans with or without apical incision 3
   Styli of glans slightly longer than apical plate of paraphallus and with serrations at tip ..... *Parasarcophaga* ..... (*Liosarcophaga*) *choudhuryi* (Sinha and Nandi)

3. Apical plate of paraphallus membranous; styli of glans with comb-like process anteriorly ..... *Boettcherisca nathani* Lopes
   Apical plate of paraphallus curved pointed at the apex and with two subapical hairs; styli of glans with a median and two lateral processes ..... *Boettcherisca karnyi* (Hardy)

***Boettcherisca nathani* Lopes**

The apical plate of paraphallus and styli of glans of *Boettcherisca nathani* are similar in appearance to *Boettcherisca karnyi*, but in *Boettcherisca nathani* only the ventralia part is with more digit form processes (Image 4). Body length 10–11 mm. Width of frons about three-fifth of one eye. Its width at the narrowest point of frons about more than twice that of each parafrontal; frontal bristles 12. Post gena black with numerous long brownish hairs; acrostichal bristles 0+1, dorsocentral bristles 5+5, mesopleural bristles 6, hypopleural bristles 8. Inner forceps almost triangular with hairs on its broad distal end; posterior paramere terminally hook-shaped; apical plate of paraphallus membranous, curved, pointed at the apex and with a pair of long lateral processes; a lateral plate of paraphallus sclerotized with two unequal pointed processes; styli of glans with apical incision and comb-like processes anteriorly. Ventralia large with short digit form processes and its anterior margin rounded.

Conclusions

The present study on flesh fly species in the University of Calicut campus revealed a relatively high level of diversity of flesh flies showing the presence of nearly 50% of previously reported species of Kerala, in the University Campus. The species density of pulp flies is exceptionally high, but there is no evidence of the threat to these flies in the study area. *Parasarcophaga* (*Liosarcophaga*) *choudhuryi* Sinha & Nandi was reported previously only from Indian Sundarbans by Sinha & Nandi (2002) and its presence in Kerala is surprising. *Boettcherisca karnyi* (Hardy) was reported in India only from Andaman Islands earlier. This trend of species diversity is very astonishing and more species may be

discovered if thorough surveys are conducted in the future. The present paper provides photographs of the male terminalia of *Parasarcophaga* (*Liosarcophaga*) *choudhuryi* Sinha & Nandi, *Sinonipponia bengalensis* Nandi, *Boettcherisca karnyi* (Hardy) and *Boettcherisca nathani* Lopes for the first time. Moreover, the first reports of four species of flesh flies from this state along with one species newly recorded from the Indian mainland are also very attractive. Efforts should be made to study the diversity and abundance of these flies in various parts of Kerala.

References

Al-Khalifa, M.S., A.M. Mashaly & A.H. Al-Qahtni (2020). Insect species colonized indoor and outdoor human corpses in Riyadh, Saudi Arabia. *Journal of King Saud University-Science* 32(3): 1812–1817. https://doi.org/10.1016/j.jksus.2020.01.034

Al-Misned, F.A.M. (2000). Developmental time, mortality and weight of the immature fleshfly *Bercaea cruentata* (Diptera: Sarcophagidae) larvae exposed to mercury. *The Journal of Agricultural Science* 5: 63–67. https://doi.org/10.24200/jams.vol5iss2pp63-67

Al-Misned, F.A.M., M.A. Amoudi & S.S.M. Abou-Fannah (2001). First record of *Sarcophaga* (*Liosarcophaga*) *dux* Thomson, 1868 (Diptera: Sarcophagidae) from Saudi Arabia. *Pakistan Journal of Zoology* 33: 313–315.

Amoudi, M.A., M. Leclercq & R. Richet (1992). Rearing of a newly recorded dipterous fly *Parasarcophaga* (*Liopygia*) *ruficornis* (Fabricius) (Diptera: Sarcophagidae) from Saudi Arabia under laboratory conditions. *Pakistan Journal of Zoology* 24: 181–186.

Bermudez, C., R. Buenaventura, M. Couri, R.J. Miranda & J.M. Herrera (2010). Mixed myiasis by *Philornis glaucinis* (Diptera: Muscidae), *Sarcodexia lambens* (Diptera: Sarcophagidae) and *Lucilia eximia* (Diptera: Calliphoridae) in *Ramphocelus dimidiatus* (Aves: Thraupidae) chicks in Panama. *Boletinde la* SEA 47: 445-446.

Cherix, D., C. Wyss & T. Pape (2012). Occurrences of flesh flies (Diptera: Sarcophagidae) on human cadavers in Switzerland, and their importance as forensic indicators. *Forensic Science International* 220: 158–163. https://doi.org/10.1016/j.forsciint.2012.02.016

Crump, M.L. & J.A. Pounds (1985). Lethal parasitism of an aposematic anuran (*Atelopus varius*) by *Notochaeta bufonivora* (Diptera: Sarcophagidae). *Journal of Parasitology* 71: 588–591. https://doi.org/10.2307/3281428

Dodge, H.R. (1955). Sarcophagid flies parasitic on reptiles (Diptera: Sarcophagidae). *Proceedings of the Entomological Society of Washington* 57: 183–187.

Graczyk, T.K., R. Knight & L. Tamang (2005). Mechanical transmission of human protozoan parasites by insects. *Clinical microbiology reviews* 18: 128–132. https://doi.org/10.1128/CMR.18.1.128-132.2005

Greenberg, B. (1973). *Flies and Disease. Vol. II. Biology and Disease Transmission*. Princeton University Press, New Jersey.

Guhathakurta, P., B.L. Sudeepkumar, P. Menon, A.K. Prasad, S.T. Sable & S.C. Advani (2020). Observed Rainfall Variability and Changes over Kerala State. *India Meteorological Department*, 27 pp. https://doi.org/10.13140/RG.2.2.25201.10087

Guimarães, J.H. & N. Papavero (1999). Myiasis in man and animals in the Neotropical Region: Bibliographical database. São Paulo, Editora Plêiades/FAPESP, 308pp.

Hagman, M., T. Pape & R. Schulte (2005). Flesh fly myiasis (Diptera: Sarcophagidae) in Peruvian poison frogs genus *Epipedobates* (Anura, Dendrobatidae). *Phyllomedusa*. *Journal of Herpetology* 4: 69–73.

Kelehear, C., R. Ibanez, C. Rodriguez, S. Buitrago & A.A. Durant-Archibold (2020). Sarcophagid Myiasis in the Bufonid *Rhinella alata* in Panama. *Journal of Wildlife Diseases* 56(3): 667–672. https://doi.org/10.7589/2018-05-121

Mello-Patiu C.A. & C. Luna-Dias (2010). Myiasis in the Neotropical amphibian *Hypsiboas beckeri* (Anura: Hylidae) by a new species of *Lepidodexia* (Diptera: Sarcophagidae). *Journal of Parasitology* 96: 685–688. https://doi.org/10.1645/GE-2423.1

Nandi, B.C. (1990). Sarcophagid Flies (Diptera: Sarcophagidae) from Tamil Nadu and Kerala, India. *Records of the Zoological Survey of India* 87: 151–155.

Nandi, B.C. (2002). Diptera: Sarcophagidae: Fauna of India and the adjacent countries. *Zoological Survey of India* 10: 1–608.

Pape, T. (1987). The Sarcophagidae (Diptera) of Fennoscandia and Denmark. *Fauna Entomologica Scand*inavica 19:1–203.

Pape, T. (1996). Catalogue of the Sarcophagidae of the World (Insecta: Diptera). *Memoirs on Entomology, International* 8: 1–558.

Pape, T., G.A. Dahlem, B.V. Brown, A. Borkent, J.M. Cumming, D.M. Wood, N.E. Woodley & M.A. Zumbado (2010). Sarcophagidae (Flesh flies), pp. 1297–1335. *Manual of Central American Diptera* vol. 2.

Pape, T., V. Blagoderov & M.B. Mostovski (2011). Order Diptera Linnaeus, 1758. In: Zhang, Z.-Q. (ed.). Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness. *Zootaxa* 3148: 222–229. https://doi.org/10.11646/zootaxa.3148.1.42

Ren, L., Y. Shang, W. Chen, F. Meng, J. Cai, G. Zhu & Y. Guo (2018). A brief review of forensically important flesh flies (Diptera: Sarcophagidae). *Forensic sciences research*, 3: 16-26. https://doi.org/10.1080/20961790.2018.1432099

Samerjai, C., K.L. Sukontason, N. Sontigun, K. Sukontason, T. Klong-klaew, T. Chareonviriyaphap & P. Somboon (2020). Mitochondrial DNA-Based Identification of Forensically Important Flesh Flies (Diptera: Sarcophagidae) in Thailand. *Insects* 11(1): 2. https://doi.org/10.3390/insects11010002

Shannon, C.E. & W. Weiner (1963). *The Mathematical Theory of Communication*. Urban University Illinois Press, 125 pp.

Sinha, S.K. & B.C. Nandi (2002a). *Parasarcophaga* (*Liosarcophaga*) *choudhuryi* sp. nov. (Diptera: Sarcophagidae) from Sagar Island, Sundarbans Biosphere reserve, India. *Records of the Zoological Survey of India* 100: 117–121.

Sinha, S.K. & B.C. Nandi (2002b). A new species of *Lioproctia Enderlein* (Diptera: Sarcophagidae) from Sundarbans Biosphere Reserve, India. *Proceedings of the Zoological Society, Calcutta* 55(2): 39–41

Sinha, S.K. & S. Mahato (2016). Intra-puparial development of flesh fly *Sarcophaga dux* (Thomson) (Diptera, Sarcophagidae). *Current Science* 111: 1063–1070. https://doi.org/10.18520/cs/v111/i6/1063-1070

Stevens, J.R., J.F. Wallman, D. Otranto, R. Wall & T. Pape (2006). The evolution of myiasis in humans and other animals in the Old and New Worlds (part II): biological and life-history studies. *Trends in Parasitology* 22: 181–188. https://doi.org/10.1016/j.pt.2006.02.010

Vasconcelos, S.D., T.F. Soares & D.L. Costa (2014). Multiple colonization of a cadaver by insects in an indoor environment: first record of Fannia trimaculata (Diptera: Fanniidae) and Peckia (Peckia) chrysostoma (Sarcophagidae) as colonizers of a human corpse. *International Journal of Legal Medicine* 128: 229–233. https://doi.org/10.1007/s00414-013-0936-2

Wells, J.D., T. Pape & F.A.H. Sperling (2001). DNA-based identification and molecular systematic of forensically important Sarcophagidae (Diptera). *Journal of Forensic Sciences* 46: 1098–1102. https://doi.org/10.1520/JFS15105J

Zumpt, F. (1965). *Myasis in man and animals in the Old World*. Butterworth's, London, 267pp.

Journal of Threatened Taxa is indexed/abstracted in Bibliography of Systematic Mycology, Biological Abstracts, BIOSIS Previews, CAB Abstracts, EBSCO, Google Scholar, Index Copernicus, Index Fungorum, JournalSeek, National Academy of Agricultural Sciences, NewJour, OCLC WorldCat, SCOPUS, Stanford University Libraries, Virtual Library of Biology, Zoological Records.

NAAS rating (India) 5.64

Print copies of the Journal are available at cost. Write to:
The Managing Editor, JoTT,
c/o Wildlife Information Liaison Development Society,
No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road,
Saravanampatti, Coimbatore, Tamil Nadu 641035, India
ravi@threatenedtaxa.org

Journal of Threatened Taxa

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

October 2021 | Vol. 13 | No. 12 | Pages: 19675–19886
Date of Publication: 26 October 2021 (Online & Print)
DOI: 10.11609/jott.2021.13.12.19675-19886

Publisher & Host

WILD ZOOREACH
Threatened Taxa