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Misidentifications of four native Indian mosquito species (Diptera: Culicidae) erroneously reported as new country records

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Abstract

The misidentifications of four native Indian mosquito species (Diptera: Culicidae) erroneously reported to be new country records are corrected. The misidentified species include *Aedes* (*Mucidus*) *scatophagoides*, *Ae*. (*Neomelanoconion*) *lineatopennis*, *Coquillettidia* (*Coquillettidia*) *crassipes* and a species of the Campestris Series of *Uranotaenia*, tentatively identified as *Ur*. (*Uranotaenia*) *rampae*. The four species were incorrectly identified as the Australasian *Ae*. *alternans*, the Afrotropical *Ae*. *mcintoshi*, the Australasian *Cq*. *xanthogaster* and the American *Ur*. *lowii*, respectively. Causes of the misidentifications are explained.

Key words: *Ae*des *lineatopennis*, *Ae*des *scatophagoides*, *Coquillettidia crassipes*, false records, *Uranotaenia rampae*

Introduction

In recent years, several mosquito species native to India have been incorrectly identified as new country records. To date, Burkett-Cadena & Harbach (2025) and Harbach & Burkett-Cadena (2025) corrected two such misidentifications reported from Rajasthan in western India: *Mansonia indiana* (Edwards, 1930) was misidentified as the Central and North American *Psorophora columbiae* (Dyar & Knab, 1906b) and *Aedes feegradei* (Barraud, 1934) was misidentified as the North American *Ae*. *infirmatus* (Dyar & Knab, 1906a). In the present communication, we report and correct four additional misidentifications of Indian mosquitoes that were recorded as new country records. The misidentified species were all collected as resting females from the same area of the Berhampur University campus, Ganjam District, Odisha State, eastern India during December 2018 to January 2019. The authors based their identifications principally on the use of online identification keys without thoroughly consulting appropriate literature sources available for the Indian and Oriental mosquito fauna. In the treatise below, we use the prevailing traditional nomenclature for the classification of aedine mosquitoes (Wilkerson *et al*. 2021).

Correction 1. Misidentification of *Aedes* (*Mucidus*) *scatophagoides* (Theobald, 1901a) as the Australasian *Aedes* (*Mucidus*) *alternans* (Westwood, 1835)

Goud *et al*. (2021) reported the identification of the Australasian *Aedes* (*Mucidus*) *alternans* as a new country record for India based on five adult females (identified as *Ochlerotatus alternans*). *Aedes alternans* is recorded from localities in Australia, Indonesia, New Caledonia, Papua New Guinea and Timor (Wilkerson *et al*. 2021). Goud *et al*. stated that the identification was made "using standard taxonomic keys and catalogues of mosquitoes of Christophers (1933), Barraud (1934), and other electronic online identification keys- A colour photo atlas of mosquitoes of Southeastern Australia, Medical Entomology, Westmead Hospital." Firstly, the use of Christophers

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(1933) is inapplicable because it is a treatment of anopheline mosquitoes. Secondly, it is inexplicable why the authors could not correctly identify their specimens using the keys and descriptions of Barraud (1934), which clearly means that the online key for Australian mosquitoes was used to identify the specimens. In their diagnosis, the authors stated that *Ae*. *alternans* could be easily distinguished from *Ae*. (*Muc*.) *scatophagoides*, which is known to occur in India, and *Ae*. (*Muc*.) *sudanensis* (Theobald, 1908), which is distributed in Africa, by the absence of an apical white band on the femora, stated as "apical white band is subapical in *alternans* and apical in *scatophagoides* and *sudanensis*". However, when the purported diagnostic characters mentioned by the authors are compared with their photographs (figure 1) of one of the five specimens, it is apparent that the femora of all legs have apical white bands. Goud *et al.* apparently confused the femora for the tibiae (see the next paragraph).

It is noted that the female illustrated by Goud *et al*. (2021) keys to the subgenus *Mucidus* (p. 136) and fits the description of *Ae. scatophagoides* (p. 145) provided in Barraud (1934). To further confirm this identification, we consulted Tyson (1970), who provided keys to the adult females of all known species of the subgenus *Mucidus* and detailed descriptions of the species that occur in the Oriental Region. Tyson divided the subgenus into two species groups, Group A and Group B. *Aedes alternans*, *Ae. laniger* (Wiedemann, 1820), *Ae. scatophagoides* and *Ae. sudanensis* (Theobald, 1908) are members of Group A. All tibiae of the last three species, as well as all other species of the group except *Ae. alternans*, have basal, middle and apical pale rings (see figure 6 in Tyson 1970). The apical pale rings are absent in females of *Ae. alternans*, which is the first species to key out in Tyson (1970). Because apical pale rings are clearly present on the tibiae of the specimen shown in figure 1A–C of Goud *et al*. (2021), the specimen cannot be *Ae. alternans*. When the female illustrated by Goud *et al*. is run through the key of Tyson (1970), it is reliably identified as *Ae. scatophagoides*.

Aedes scatophagoides is widely distributed in the Oriental Region, where it has been recorded from localities in Bangladesh, China, India, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand and Vietnam (Tyson 1970; Wilkerson *et al*. 2021). In India, it occurs throughout the central provinces and the former Madras State of Barraud (1934), which includes present-day Tamil Nadu, Kerala and parts of the neighbouring states of Andhra Pradesh and Karnataka. The species has been recorded more recently from the states of Assam (Dutta *et al*. 2010), Maharashtra (Shinde & Thete 2014), Puducherry (Rajavel & Natarajan, 2006; Rajavel *et al*. 2005b), Punjab (Kirti & Kaur 2004), Tamil Nadu (Tyagi *et al*. 2016) and Uttar Pradesh (Kanojia & Geevarghese 2005).

Correction 2. Misidentification of *Aedes* (*Neomelanoconion*) *lineatopennis* (Ludlow, 1905) as the African *Aedes* (*Neomelanoconion*) *mcintoshi* Huang, 1985

Aedes lineatopennis was originally described by Ludlow (1905) from two adult females collected in the Philippines. Later, Theobald (in Barraud 1928) noted variation in specimens from Africa and the Malay Peninsula, but African specimens were considered to be conspecific with the Philippine form in subsequent studies by Edwards (1915, 1941) and McIntosh (1971).

Huang (1985) examined specimens of *Ae*. *lineatopennis* from various localities in Africa and compared them with Philippine specimens. She concluded that the African specimens previously identified as *Ae*. *lineatopennis* represented a distinct species, which she described as *Ae. mcintoshi*. Huang also provided detailed diagnostic features, particularly of the wing and male genitalia, which distinguish *Ae*. *mcintoshi* from *Ae*. *lineatopennis*, and clarified their respective distributions, with *Ae*. *mcintoshi* confined to the Afrotropical Region and *Ae*. *lineatopennis* to the Oriental Region. She emphasized that *Ae*. *mcintoshi* closely resembles *Ae*. *lineatopennis*, and that is why it had previously been mistaken for *Ae. lineatopennis*.

Goud *et al.* (2022a) recorded *Ae*. *mcintoshi* as a new country record for India based on 17 adult females collected in Odisha State. Instead of preparing a complete morphological description of the specimens, the authors reproduced images and a brief description of *Ae*. *mcintoshi* obtained from online sources. Of the eight photographs included in their publication (figure 1A–H), only three (figure 1A–C) are photographs of specimens from their collection (four of the other five are reproduced from Wilkerson *et al*. 2021 without acknowledgement). In the absence of diagnostic details of the Indian specimens, the identification of those specimens as *Ae*. *mcintoshi* is highly problematic.

According to Huang (1985), *Ae*. *mcintoshi* occurs in Africa, whereas *Ae*. *lineatopennis* is widely distributed in the Oriental Region, including Bangladesh, Borneo, Cambodia, China, India, Indonesia, Laos, Malaysia, Nepal, Pakistan, Philippines, Russia, South Korea, Sri Lanka, Thailand, Timor and Vietnam, and it also occurs in Australia

(Wilkerson *et al*. 2021). In India, Barraud (1934) reported the occurrence of *Ae*. *lineatopennis* from localities across the country, and it has subsequently been recorded from the Andaman and Nicobar Islands (Rajavel & Natarajan 2006), the northeastern states (Dutta *et al*. 2010), Puducherry (Rajavel *et al*. 2004; Rajavel *et al.* 2005b), Punjab (Kirti & Kaur 2004), Tamil Nadu (Wilson *et al*. 2013) and Uttar Pradesh (Kanojia & Geevarghese 2005). This clearly indicates that *Ae*. *lineatopennis* is native and widespread in India.

More recently, Swain *et al*. (2025) collected resting adult mosquitoes from human dwellings located in semi-urban areas in Berhampur, Ganjam District, Odisha State, and identified them both morphologically and molecularly as *Ae*. *lineatopennis*. Notably, Goud *et al*. (2022a) collected their specimens from the nearby Berhampur University campus; thus, both collections were made in the same area.

Given the confirmed presence of *Ae*. *lineatopennis* in Berhampur on the eastern coastline of Odisha State and its established distribution across India, we are confident that the specimens reported by Goud *et al*. (2022a) as the African *Ae*. *mcintoshi* are misidentified specimens of *Ae*. *lineatopennis*, a very common and widespread species in India.

Correction 3. Misidentification of *Coquillettidia* (*Coquillettidia*) *crassipes* (van der Wulp, 1881) as the Australasian *Coquillettidia* (*Coquillettidia*) *xanthogaster* (Edwards, 1924)

Goud *et al*. (2022b) reported *Coquillettidia xanthogaster*, an Australasian species, as a new country record for India based on 16 adult females collected in Odisha State. To identify the specimens, the authors used Christophers (1933) (irrelevant), Barraud (1934) and the online photographic keys available on the NSW Arbovirus Surveillance and Vector Monitoring Program website (https://medent.usyd.edu.au/arbovirus/mosquit/photos/mosquitophotos_coquillettidia_mansonia.htm#xanth). It is apparent the authors did not use the verbal keys of Barraud (1934) in favour of the online photographs. The description of *Cq*. *xanthogaster* provided by Goud *et al*. appears to have been extracted from Australian sources.

Belkin (1962) noted that while the males, larvae and pupae of species of *Coquillettidia* Dyar, 1905 show distinct diagnostic features, the females are morphologically very similar and difficult to distinguish. He specifically stated that *Cq*. *xanthogaster* can be clearly recognised by features of the male genitalia whereas females cannot be reliably separated from those of other species of the Crassipes Group. The identification of *Cq*. *xanthogaster* by Goud *et al*. based solely on adult females without examination of male genitalia, which are essential for species confirmation, is unreliable. Indeed, the description and images provided by Goud *et al*. (figure 1A–C) cannot distinguish *Cq. xanthogaster* from *Cq. crassipes*.

Coquillettidia xanthogaster is recorded from localities in Australia, Indonesia, New Caledonia, Papua New Guinea and Vanuatu (Wilkerson *et al*. 2021). *Coquillettidia crassipes* is also recorded from localities in Australia, Indonesia and Papua New Guinea, as well as questionably from Fiji, Guam and the Mariana Islands, but it is otherwise very widely distributed in the Oriental Region, with records from Bangladesh, Cambodia, China, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand and Vietnam (Wilkerson *et al*. 2021).

In India, *Cq*. *crassipes* occurs from Punjab eastward to Assam and throughout peninsular areas of the country (Barraud 1934). Odisha State, where the specimens identified by Goud *et al*. (2022b) were collected, falls within this range of distribution. The species has also been recorded from the states of Kerala (Sumodan 2024), Madhya Pradesh (Rajput & Kulkarni 1991), Meghalaya (Gopalakrishnan *et al*. 2025), northeastern states (Dutta *et al*. 2003), Puducherry (Rajavel *et al*. 2004) and Uttar Pradesh (Kanojia & Geevarghese 2005). Rajavel *et al.* (2005a, 2005b) reported the occurrence of *Cq*. *crassipes*, confirmed by dissected male genitalia, at Bhitarkanika in the Kendrapara District, adjacent to the Ganjam District where Goud *et al*. (2022b) collected their specimens.

Based on existing taxonomic evidence, distribution records and previously confirmed identifications from nearby geographical areas, the Indian specimens identified as *Cq. xanthogaster* by Goud *et al*. (2022b) are most certainly specimens of *Cq*. *crassipes*, a very widespread species in India.

Correction 4. Misidentification of a native Indian species of *Uranotaenia* as the American *Uranotaenia* (*Uranotaenia*) *lowii* Theobald, 1901b

Uranotaenia lowii is a species native to the Americas, widely distributed through North, Central and South America (Wilkerson *et al*. 2021). Goud *et al*. (2023) reported this species as a new country record for India based on 18 adult females collected in Odisha State. The identification was carried out using Christophers (1933) (irrelevant), Barraud (1934) and online keys of the Florida Medical Entomology Laboratory, University of Florida (https://fmel.ifas.ufl.edu/mosquito-guide/species- identification-table/species-identification-table- adult/#Uranotaenia). The description of *Ur*. *lowii* provided by Goud *et al*. was also obtained from online sources.

Goud *et al*. (2023) briefly described their purported females of *Ur. lowii* as follows: "A small mosquito that is dark greyish brownish in appearance. Palps are dark and approximately 1/5 the length of the proboscis. The proboscis is dark and fat at the tip. Dark greyish brown scutum. Thorax is pale in colour, with a black patch and a few pale blue scales. Dark abdomen with pale iridescent scale patterns on the sides. On the stem of the 5th vein, the wings have a short stripe of pale blue scales. White booties, dark hind legs, and pale knee patches." The mosquito shown in their figure 1 does not entirely fit the description. Most importantly, the "thorax" (meaning the thoracic pleura) is not "pale in colour" and the abdomen, except for tergum V, does not have distinctive pale scaling at the sides. Although the specimen shown in figure 1 bears some similarities with *Ur. lowii*, e.g. the lines of pale scales on the anteprontum and above the paratergite, and the hindlegs (although not clearly in focus) with tarsomeres 4 and 5 (and probably the distal part of 3) pale-scaled, it is not *Ur. lowii*. Comparison of the mosquito shown in figure 1 with the photograph of *Ur. lowii* available on the Florida Medical Entomology Laboratory website (https://fmel.ifas.ufl.edu/mosquito-guide/mosquito-genera-and-species/genus-uranotaenia/uranotaenia-lowii/) clearly reveals that the Indian mosquito differs (1) in having very dark thoracic pleura (mainly very light yellowish in *Ur. lowii*) and (2) in lacking distinct patches of pale scales on the lateral margins of abdominal terga II–VI (terga II, III, V and VI have prominent apicolateral patches of pale scales in *Ur. lowii*). Additionally, in the mosquito illustrated by Goud *et al*. (1) the scutum is uniformly dark-scaled (described as "dark greyish brown") whereas it bears a broad median longitudinal stripe of distinctly darker scales in *Ur. lowii* (see Carpenter & LaCasse 1955: plate 18) and (2) the tibiae of all legs are entirely dark-scaled whereas the tibiae of *Ur. lowii* have discrete dorsoapical white spots. It is important to note that the abdomen of the female shown in figure 1 of Goud *et al*. is distended, and the pale area along the margins of the terga is the exposed pleural membrane. Unfortunately, this makes it difficult to distinguish the individual terga, but one of the posterior terga, probably tergum V, has an apical pale band.

Because erect scales appear to be absent from the vertex of the head of the mosquito illustrated by Goud *et al*., its identification as a species of the subgenus *Uranotaenia* Lynch Arribálzaga, 1891 appears to be correct. The subgenus currently includes 123 known species with distributions in tropical, and to some extent in subtropical, areas of the Afrotropical, Australasian, Neotropical and Oriental Regions (Harbach 2026). Unfortunately, there are no recent keys or revisionary studies of the subgenus in the Oriental Region. In the keys to species of *Uranotaenia* in Barraud (1934), for species known at the time to occur in areas from Myanmar to Pakistan, and Darsie & Pradhan (1990), for species of Nepal, the female pictured in Goud *et al*. (2023) keys to *Ur. edwardsi* Barraud, 1926, but it cannot be that species because it lacks basal white marks on hindtarsomeres 2–4.

If the pale band noted above is indeed on the apical margin of tergum V, then the species would appear to be a member of the Campestris Series, which includes nine species in the Oriental Region: *Ur*. *arguellesi* Baisas, 1935, *Ur*. *campestris* Leicester, 1908, *Ur*. *christophersi* Barraud, 1926, *Ur*. *heiseri* Baisas, 1935, *Ur*. *macfarlanei* Edwards, 1914b, *Ur*. *mendiolai* Baisas, 1935, *Ur*. *metatarsata* Edwards, 1914a, *Ur*. *rampae* Peyton & Klein, 1970 and *Ur*. *subnormalis* Martini, 1920 (see Harbach 2024). Members of this group are small mosquitoes with (1) mostly dark brown to black integument; (2) lines of white scales along the margins of the eyes, between the scutal angle and the base of the wing, and across the postpronotum and the mesokatepisternum; (3) wing mostly dark-scaled with some pale scales at base of one or more veins; and (4) the abdominal terga variously marked, but tergum V has an apical band of pale scales. Without a doubt, the mosquito photographed by Goud *et al*. fits this description. Furthermore, if the mosquito is run through the key of Rattanarithikul *et al*. (2006), it traces to *Ur. rampae*, which is presently recorded from localities in Bangladesh, Cambodia, Malaysia, Thailand and Vietnam (Wilkerson *et al*. 2021). The coastal state of Odisha, where Goud *et al*. collected their specimens, lies southwest of West Bengal State, which borders Bangladesh. If the mosquito is indeed *Ur. rampae*, it is a plausible new country record for India. However, detailed study of adult females and males, preferably individually reared specimens with associated larval and pupal exuviae and dissected male genitalia, is needed to make a definitive identification.

Comments

It is undeniable that many individuals working with mosquitoes today, to borrow wording from Harbach (2018), "have limited knowledge of mosquito anatomy and morphological terminology, lack insights into the limitations of available identification keys, published illustrations and descriptions, and are unaware of the morphological diversity of mosquitoes." Goud and his co-authors mistakenly relied on keys for the identification of mosquitoes that occur in areas of the world far outside of the Oriental Region, without confirming their conclusions with relevant resources specific for their own country (Barraud 1926, 1928, 1934). Reliance on online keys and photographs rather than species descriptions can easily lead to erroneous records, as is clearly evident here.

Accurate identification of mosquitoes is crucial for understanding vector-pathogen interactions, disease transmission dynamics and their socio-economic implications. Seriously, misidentifications can lead to adverse consequences for biodiversity assessments and vector control strategies (Burkett-Cadena & Harbach 2025).

Despite advancements in molecular systematics, morphological identification remains the primary reference method due to its historical foundation, cost-effectiveness and accessibility (Jourdain *et al.* 2018). However, unlike traditional morphology-based revisionary studies of taxonomic groups, which revolve nomenclatural problems, institute formal taxonomic changes and refine classifications, DNA sequencing and sequence analyses have largely focused on phylogenetic assessments without translating the results into formal taxonomic changes and improved classifications. Ideally, molecular studies should be integrated with morphological studies to ensure that the results of DNA sequencing are consonant with formal taxonomy.

In the four publications evaluated above, the authors relied primarily on comparisons with images without consulting principal taxonomic resources, regional identification keys, taxonomic treatments and taxonomic expertise. They failed to compare salient morphological characters of their specimens with published descriptions and neglected to use associated males, larvae and pupae to aid the identification of their specimens. The integration of those methods with DNA sequencing would likely have increased their chances of correctly identifying their specimens to species.

In summary, the four cases of misidentification reveal the necessity to soundly base new country records on the results of rigorous taxonomic procedure – morphological examination of multiple life stages of link-reared specimens (adults, larvae, pupae, male genitalia) and sequencing of discriminating DNA loci (*COI*, ITS2, etc.). Ultimately, Goud *et al*. (2021, 2022a,b, 2023) are responsible for the erroneous identifications of the four species; however, it is concerning that the peer-review and editorial process failed to recognise the errors. As noted by Harbach & Burkett-Cadena (2025), "editors, reviewers and publishers must pay closer attention to the quality of science and subject matter to avoid the proliferation of erroneous and misleading information."

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