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Short Article

New record of of *Baetis* (*Tenuibaetis*) *panhai* Suttinun, Gattolliat & Boonsoong, 2022 (Ephemeroptera: Baetidae) from the Southern Western Ghats, India

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Abstract. *Baetis* (*Tenuibaetis*) *panhai* Suttinun, Gattolliat & Boonsoong, 2022, originally documented solely in Thailand, has now been identified for the first time in the Tamil Nadu region of the Southern Western Ghats, India. Prior discrepancies in the description of *Tenuibaetis frequentus* Müller-Liebenau & Hubbard, 1985 including larval features such as the presence of hindwing pads, tergalius I and IV ratio, and the number of marginal spines in the paraproct, resulted in misidentification, with the species erroneously categorized as *Tenuibaetis frequentus* in Tamil Nadu until 2023. This comprehensive study involved a re-examination of *Baetis* (*T.*) *panhai*, leading to the accurate determination of its population in Tamil Nadu. Detailed larval characters of *Baetis* (*T.*) *panhai* were provided together with discussion about its taxonomic status and related taxa.

Keywords: India, mayflies, new record, Tamil Nadu, *Tenuibaetis frequentus*

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Tenuibaetis was primitively considered as a subgenus by Kang *et al.* (1994) within the genus *Baetis* Leach, 1815 designating *Baetis pseudofrequentus* Müller-Liebenau, 1985. Describing two more species viz., *Baetis* (*Tenuibaetis*) *inornatus* Kang & Yang, 1994 and *Baetis* (*Tenuibaetis*) *arduus* Kang & Yang, 1994, the number of species within *Tenuibaetis* was originally three. The subgenus *Tenuibaetis* was established based on the following larval characters described by Kang *et al.* (1994): 1) mandible with smooth medial margin between prostheca and mola, without setae, spines, or serration; 2) conical segment III of labial palpus; 3) presence of femoral villopore and 4) paraproct with a patch of notched scales. Waltz & McCafferty (1997) synonymized *Tenuibaetis* with *Baetiella* based on the shape of the labial palps. Fujitani *et al.* (2003) disagreed with Waltz & McCafferty (1997) and separated *Tenuibaetis* from *Baetiella* and related genera based on the presence of robust setae with a median ridge on the dorsomedial surface of the larval femur and elevated *Tenuibaetis* to the generic rank. Nevertheless, Kluge *et al.* (2023) did not accept this generic rank, placing again *Tenuibaetis* under the subgenus of *Baetis* based on the combination of larval and imaginal characters. In south India, three species of *Tenuibaetis* were reported via., *Baetis* (*T.*) *frequentus* Müller-Liebenau & Hubbard, 1985, *Baetis* (*T.*) *kaltenbachi* Kluge, Srinivasan, Sivaruban, Barathy & Isack, 2023 and *Baetis* (*T.*) *bialatus* Kluge, Srinivasan, Sivaruban, Barathy & Isack, 2023 (Kluge *et al.*, 2023).

Kubendran *et al.* (2015) previously described the larvae and imagines from Tamil Nadu as '*Tenuibaetis frequentus*' but Kluge *et al.* (2023) found that this larva did not belong to *T. frequentus* as they lack pseudo-bifurcate setae in the tibia. In this contribution, the species which was earlier considered as *T. frequentus* by Kubendran *et al.* (2015) was redescribed and identified as *Baetis* (*T.*) *panhai* Suttinun, Gattolliat & Boonsoong, 2022 based on the larval characters.

The larvae of the new record were collected during January 2023 from the Kottakudi River of Tamil Nadu, India by handpicking and preserved in 80% ethanol. Dissection was carried out using 2-ethoxyethanol and slides were made in Canada balsam. Morphological characters were studied using Magnus MSZ-TR stereo zoom microscope and LABOMED Lx400 microscope. Photos were captured with an AR 6 Pro digital camera and

measurements were acquired using Capture 2.2.1 software and further processed in Adobe Photoshop 7.0. The species identification is based on the original descriptions of Kubendran *et al.* (2015) and Suttinun *et al.* (2022) respectively. Terminology is mostly based on Suttinun *et al.* (2022) and Kluge *et al.* (2023). The materials of the new record are deposited in The American College Museum, Madurai, Tamilnadu, India (AMC). Results are as follows:

Class Insecta Linnaeus, 1758

Order Ephemeroptera Hyatt & Arms, 1891

Family Baetidae Newman, 1853

Genus *Baetis* Leach, 1815

Subgenus *Tenuibaetis* Kang & Yang (in Kang, Chang & Yang), 1994

Baetis (*Tenuibaetis*) *panhai* Suttinun, Gattolliat & Boonsoong, 2022 (Figs. 1–19)

Material examined

1 male mature larva (AMC/ZN/283) and 12 larvae (AMC/ZN/284), India, Tamil Nadu, Theni district, Kurangani, Kottakudi River, 10°08′09″N, 77°25′52″E, ca. 632 m. a.s.l., 15.I.2023, leg. P. Srinivasan & R. Isack.

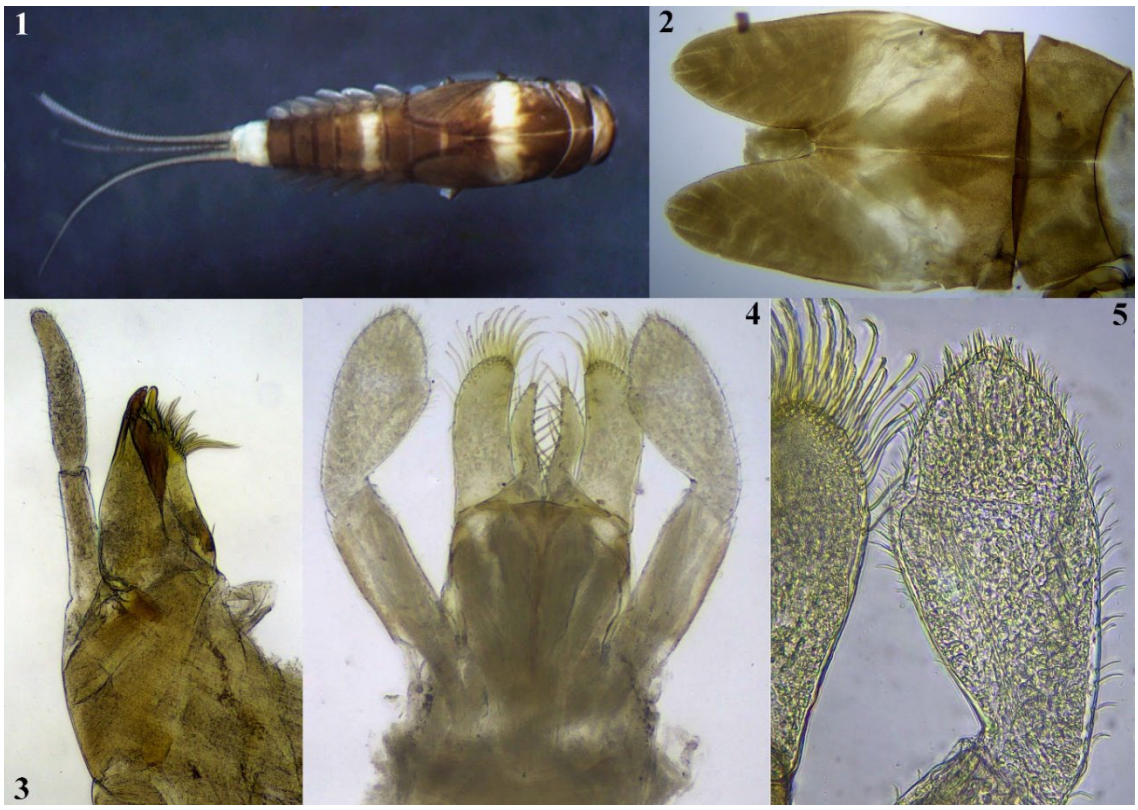
Distribution

India (new record) and Thailand (Suttinun *et al.,* 2022; Kluge *et al.,* 2023).

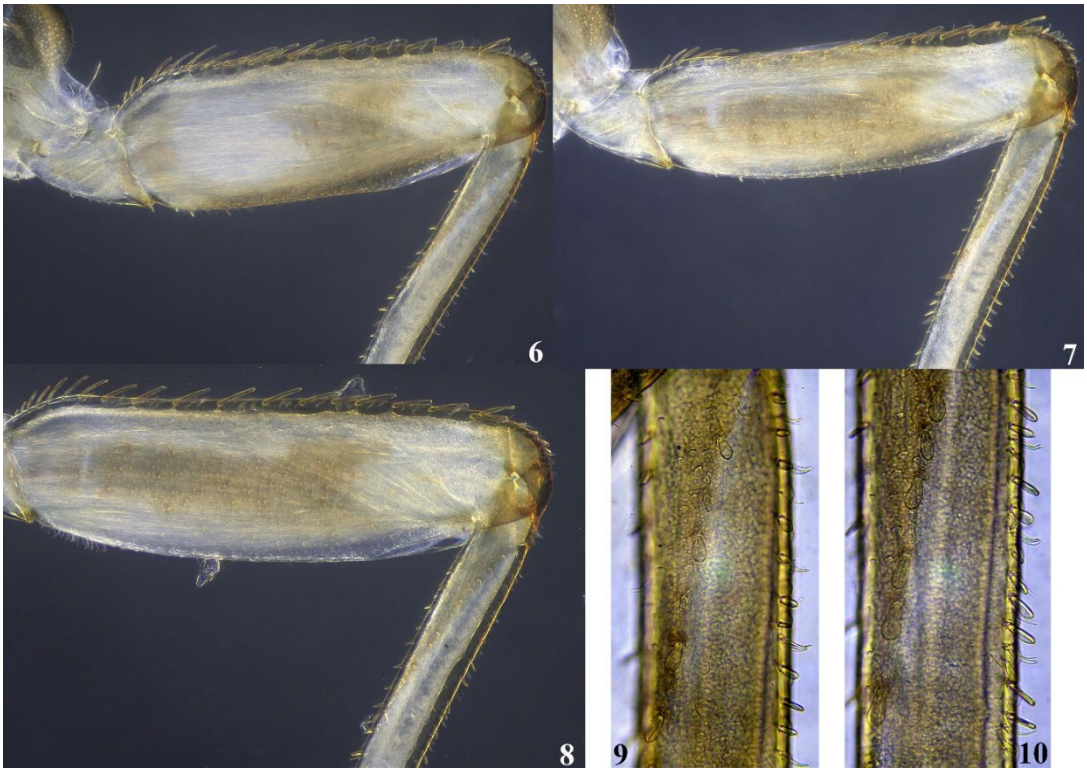
Diagnostic characters

Detailed larval characters of *Baetis* (*T.*) *panhai* were provided by Kubendran *et al.* (2015) (wrongly described as '*T. frequentus*'), Suttinun *et al.* (2022) and Kluge *et al.* (2023). Larva of *Baetis* (*T.*) *panhai* can be distinguished from all other known *Baetis* (*Tenuibaetis*) species by the following combination of characters: i) abdominal terga I–III and V–VIII dark brownish, tergum IV pale, terga IX–X colorless (Figs. 1); ii) mesonotum medially with a pale transverse band (Figs. 2); iii) maxillary palp two-segmented and about 1.4–1.5 times as long as the length of galea-lacinia (Fig. 3); iv) labial palp segment I slightly shorter than the length of the segments II and III combined (Fig. 4); v) labial palp segment II with a poorly developed distomedial protuberance and segment III slightly asymmetrical and conical (Fig. 5); vi) outer margin of femur of all legs with a row of stout, two-channel setae; dorsal surface with numerous stout, two-channel setae of various sizes, mostly elongate and distally widened and rounded (Figs. 6–8); vii) outer marginal stout, two-channel setae of fore tibia significantly small when compared with the mid and hind tibiae (Figs. 9–14); viii) outer margin of tarsus of all legs with row of few stout, two-channel setae only on the proximal half (Figs. 12–14); ix) hindwing pads absent (Fig. 15); x) Tergalius I about 2.5 times the size of the tergalius IV (Figs. 16, 17); xi) posterior margin of abdominal terga II–X bluntly triangular (Figs. 18, 19).

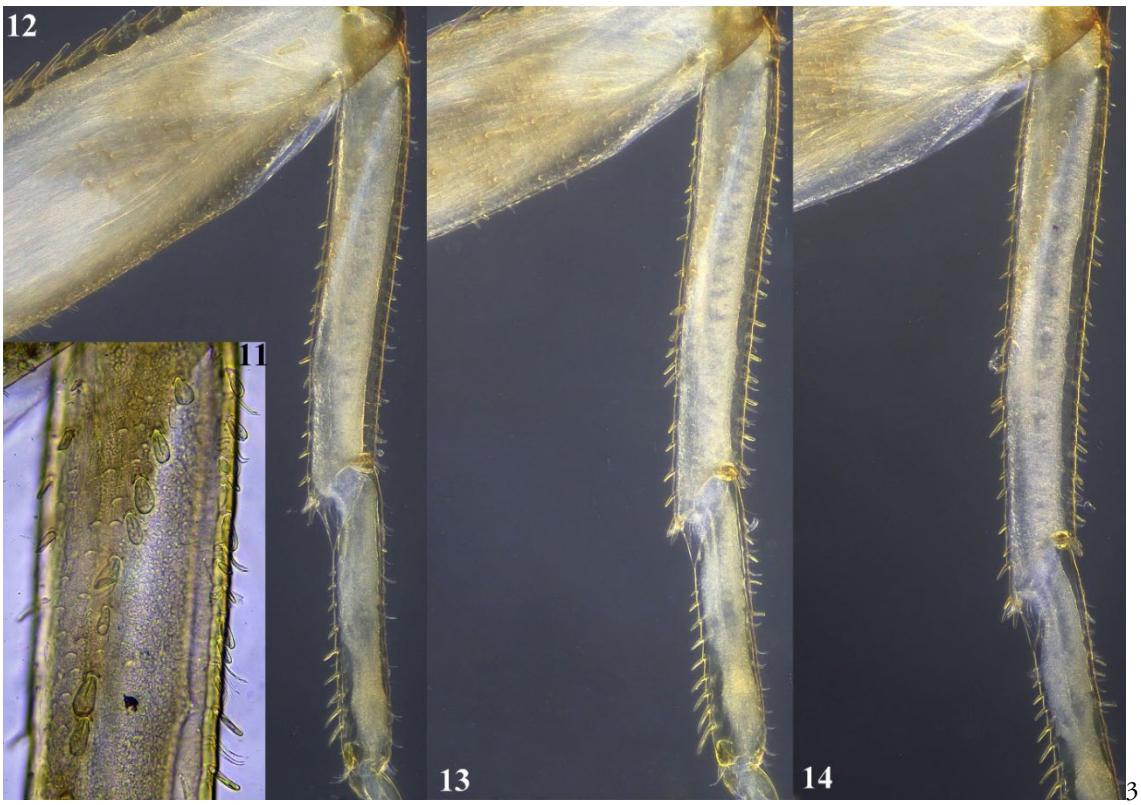
Baetis (*T.*) *panhai* was first described by Suttinun *et al.* (2022) from Thailand. Though Kubendran *et al.* (2015) identified the same species as *Tenuibaetis frequentus* in India. Discrepancies in the original description of Kubendran *et al.* (2015) such as the presence of hindwing pads (Kubendran *et al.,* 2015; Fig. 12), ratio of the tergalius I and IV (Kubendran *et al.,* 2015; Figs. 13, 14) and the number of marginal spines in the paraproct (Kubendran *et al.,* 2015; Fig. 15) leads to the misidentification. However, Kluge *et al.* (2023) stated that this species does not belong to *Tenuibaetis frequentus*, as they lack pesudo-bifurcate setae in the outer margin of the tibia and also questions about the validity of the male imaginal characters as the male imagines are not reared from the larva. The absence of hindwing pads in the larva has conclusively identified that the male imago reported by Kubendran *et al.* (2015) does not correspond to the larva they described, since the male imago they described had hindwings and it might be the male imago of *Nigrobaetis* sp. *Baetis* (*T.*) *bialatus* is another known *Tenuibaetis* species that lacks a hindwing pad in the larval stage. It differs from *Baetis* (*T.*) *panhai* by the structure of labium and labrum, setation of the femur, and coloration of mesonotum and terga (Kluge *et al.,* 2023). *Baetis* (*T.*) *panhai* didn't share an ecological niche with the *Baetis* (*T.*) *frequentus*. In fact, *Baetis* (*T.*) *frequentus* exhibited a restricted distribution, primarily occupying several sky islands in the Western Ghats of India and Sri Lanka (Selva-kumar *et al.,* 2012; Kluge *et al.,* 2023).



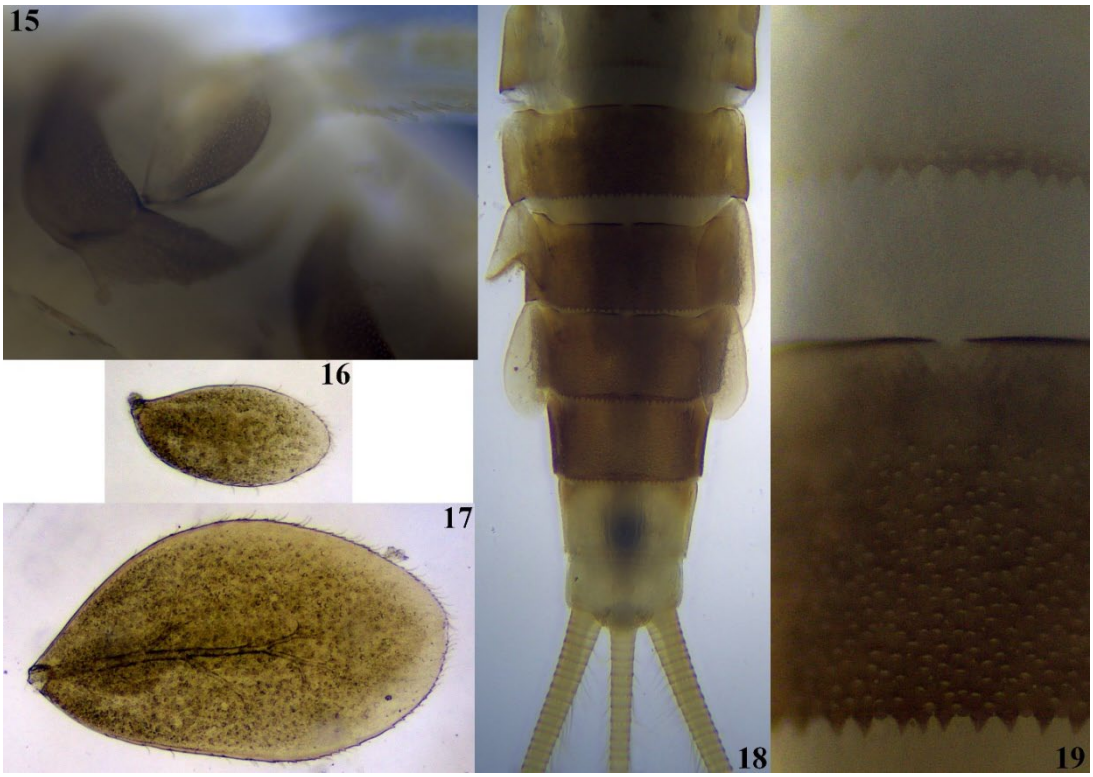
Figs. 1-5. *Baetis* (*Tenuibaetis*) *panhai* Suttinum, Gattolliat & Boonsoong, 2022: 1. Larva, dorsal view; 2. Pronotum and Mesonotum; 3. Maxilla: 4. Labium; 5. Labial palp segment II & III.



Figs. 6–10. *Baetis* (*Tenuibaetis*) *panhai* Suttinun, Gattolliat & Boonsoong, 2022: 6. Fore femur; 7. Mid femur; 8. Hind femur; 9. Fore tibia setation; 10. Mid tibia setation.



Figs. 11–14. *Baetis* (*Tenuibaetis*) *panhai* Suttinun, Gattolliat & Boonsoong, 2022: 11. Hind tibia setation; 12. Fore tibia and fore tarsus; 13. Mid tibia and mid tarsus; 14. Hind tibia and hind tarsus.



Figs. 15–19 *Baetis* (*Tenuibaetis*) *panhai* Suttinun, Gattolliat & Boonsoong, 2022: 15. Base of the hind leg clearly shows the absence of hindwing pad; 16. Tergalius I; 17. Tergalius IV; 18. Posterior margin of abdominal terga IV–X; 19. Closer view of denticles in posterior margin of abdominal terga IV & V.

Selvakumar *et al.* (2016) had already barcoded the COI gene of the Indian population of *Baetis* (*Tenuibaetis*) *panhai*, where it was misidentified as '*T. frequentus*' (GenBank Accession No. LC056074; Selvakumar *et al.,* 2016; Table 1). They also barcoded *Baetis michaelohubbardi* Selva-Kumar, Sundar, and Sivaramakrishnan, 2012 (GenBank Accession No. LC061856; Selvakumar *et al.,* 2016; Table 1), which is, in fact, the true '*T. frequentus*' (Kluge *et al.,* 2023). The results of Selvakumar *et al.* (2016) clearly shows that *Baetis* (*T.*) *panhai* forms a distinct monophyletic clade (Selvakumar *et al.,* 2016; Fig. 1). Selvakumar *et al.* (2016) collected *Baetis* (*T.*) *panhai* (# LC056074) from the same locality as our collections and their results should be extended to our specimens.

Suttinun *et al.* (2022) reported two more species that are morphologically identical to *Baetis* (*T.*) *panhai*, with genetic distances ranging from 15% to 20% (Suttinun *et al.,* 2022; Table 3). Similarly, the genetic distance of the Indian population of *Baetis* (*T.*) *panhai* (mentioned as '*T. frequentus*' (# LC056074) in Suttinun *et al.,* 2022) which is morphologically indistinct (Kubendran *et al.,* 2015; Kluge *et al.,* 2023), is around 16% to 19% (Suttinun *et al.,* 2022; Table 3). We remain considering the Indian population of *Baetis* (*T.*) *panhai* as a species hypothesis for now without further treatment in this paper because of the absence of nominal morphological differences despite the significant interspecific genetic distance between the Indian population of *Baetis* (*T.*) *panhai* and other cryptic complexes of *Baetis* (*T.*) *panhai*. We suspect that geographical isolation and environmental variables are the key drivers for these cryptic species and more studies have to be carried out in the molecular aspects to know the exact status of these cryptic *Tenuibaetis* species.

Author's Contributions

Thambiratnam Sivaruban: Visualization, conceptualization, supervision, review and edit, formal analysis; **Pandiarajan Srinivasan**: Investigation, methodology, draft preparation, review and edit; **Sivaruban Barathy**: Visualization, conceptualization, supervision, formal analysis; **Rajasekaran Isack**: Visualization, conceptualization, project administration, final review and edit.

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Data Availability Statement

All data supporting the findings of this study are available within the paper.

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Ethics Approval

Insects were used in this study. All applicable international, national, and institutional guidelines for the care and use of animals were followed. This article does not contain any studies with human participants performed by any of the authors.

Conflict of Interest

The authors declare no conflict of interest.

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گزارش جدید *Baetis* (Tenuibaetis) *panhai* Suttinun, Gattolliat & Boonsoong, 2022 (Ephemeroptera: Baetidae) از جنوب غربی گاتز، هند

تامبیراتنام سیواروبان[۱]، پاندیاراجان سرینیواسان[۱]، سیواروبان براتی[۲] و راجاسهکاران اسحاق[۱]

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۲- گروه جانورشناسی، کالج فاطمه، مادورای-۶۲۵۰۱۸، هند

چکیده: گونه *Baetis* (*Tenuibaetis*) *panhai* Suttinun, Gattolliat & Boonsoong, 2022، که تاکنون فقط در تایلند گزارش شده بود، اکنون برای اولین بار در منطقه تامیل نادو در جنوب غربی گات، هند شناسایی شده است. تناقضات قبلی در توصیف *Tenuibaetis frequentus* Müller-Liebenau & Hubbard, 1985 از جمله ویژگی های لاروی مانند وجود پدهای بال عقبی، نسبت ترگالیوس I و IV، و تعداد خارهای حاشیه ای در paraproct، منجر به شناسایی نادرست گونه *panhai*، به عنوان *Tenuibaetis frequentus* تا سال ۲۰۲۳ شد. این مطالعه جامع شامل بررسی مجدد *Baetis* (*T.*) *panhai* بود که منجر به شناسایی دقیق جمعیت آن در تامیل نادو شد. صفات دقیق لاروی *Baetis* (*T.*) *panhai* همراه با بحث در مورد وضعیت طبقه‌بندی آن و گونه‌های مرتبط ارائه شده است.

کلمات کلیدی: هند، یکروزه‌ها، گزارش جدید، تامیل نادو، *Tenuibaetis frequentus*

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