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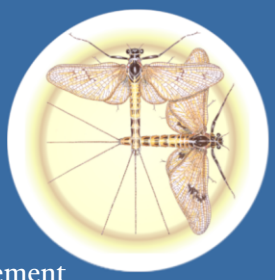

Article

On the genus *Einfeldia* Kieffer from France. Description of *E. aberlencii* sp. n. from French Guiana with emendation of four recently described species from continental France (Diptera, Chironomidae)

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ABSTRACT

Male adult of *Einfeldia aberlencii* sp. n. is described based on adults captured over the canopy and along the undergrowth of aquatic habitats in the primary rainforest of Petit-Saut in French Guiana. The distinguishing characters (antero-median part of frontal area with a characteristic concavity, frontal tubercles conical, well developed; antenna 11-segmented, 1235 µm long, terminal segment 850 µm long, AR 2.21; apex of femur and base of tibia of PI with dark spots, pulvilli bilobed; tergites II-VI with semicircular pigmentation medially; tergites VII-VIII fused; tergite IX with two median ridges located between the rows of dorsal setae and the anal bands; anal point slender, parallel-sided; basal portion of superior volsella densely covered with short setae, caudo-lateral side with 2 characteristic curved setae, 1 dorsal, 1 ventral; dorsal setae on inferior volsella short, located apically; gonostylus swollen medially, abruptly narrowing distally) easily separate the new species from all other congeners. In total, 6 *Einfeldia* species are reported from France, which include *E. pagana* (Meigen, 1838), *E. palaearctica* Ashe, 1990 and 4 recently described species, which were wrongly assigned to the genus *Polypedilum* subgenus *Uresipedilum*: *P. alixae* Moubayed & Langton, 2022; *P. bernardae* Moubayed-Breil, 2020; *P. claudei* Moubayed-Breil, 2020; *P. tissoti* Moubayed-Breil & Langton, 2020. At present, 4 new combinations are proposed to the 4 previously cited species, which are considered henceforth as belonging to the genus *Einfeldia*, namely: *E. alixae* (Moubayed & Langton, 2022); *E. bernardae* (Moubayed-Breil, 2020); *E. claudei* (Moubayed-Breil, 2020) and *E. tissoti* (Moubayed-Breil & Langton, 2020). Consequently, a total of 7 *Einfeldia* species are currently known from France, including 6 already reported from continental France and 1 (*E. aberlencii* sp. n.) from French Guiana. Remarks on the taxonomic position with comments on the ecology of the new species are given.

Keywords: Diptera, Chironomidae, *Einfeldia aberlencii* sp. n., French Guiana, new combinations of four species, France.

Sur le genre *Einfeldia* Kieffer en France. I. Description d'*E. aberlencii* sp. n. de Guyane française et nouvelle combinaison binominale pour quatre espèces récemment décrites de France continentale (Diptera, Chironomidae)

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RESUMÉ
L'adulte mâle d'*Einfeldia aberlencii* sp. n. est décrit à partir d'un matériel collecté au-dessus de la canopée et le long des habitats aquatiques du sous-bois de la forêt primaire de Petit-Saut en Guyane française. Les caractères distinctifs suivants: partie antéro-médiane de l'aire frontale avec une concavité caractéristique, tubercules frontaux bien développés, en forme de cône; antenne à 11 segments, 1235 μm de long, dernier segment 850 μm, AR 2.21; apex du fémur et base du tibia de PI tachetés ; partie médiane des tergites II-VI présentant des pigmentations semi-circulaires, tergites VII-VIII fusionnés ; tergite IX avec 2 carènes médianes situées entre les rangées de soies dorsales et les bandes anales ; pointe anale fine et effilée, côtés parallèles ; partie basale de la volselle supérieure munie de 2 soies postéro-latérales recourbées, 1 dorsale et 1 ventrale ; volselle inférieure avec des soies dorsales courtes apicales; gonostyle enflé dans sa partie médiane, effilé dans sa partie distale, permettent de séparer facilement la nouvelle espèce de tous ses congénères. Au total, 6 espèces d'*Einfeldia* sont connues de France. Elles incluent *E. pagana* (Meigen, 1838), *E. palaearctica* Ashe, 1990 et 4 espèces récemment décrites, assignées par erreur au genre *Polypedilum* sous-genre *Uresipedilum* : *P. alixae* Moubayed & Langton, 2022; *P. bernardae* Moubayed-Breil, 2020; *P. claudei* Moubayed-Breil, 2020; *P. tissoti* Moubayed-Breil & Langton, 2020 et pour lesquelles quatre nouvelles combinaisons sont proposées: *Einfeldia alixae* (Moubayed & Langton, 2022); *E. bernardae* (Moubayed-Breil, 2020); *E. claudei* (Moubayed-Breil, 2020) and *E. tissoti* (Moubayed-Breil & Langton, 2020). Par conséquent, 7 espèces d'*Einfeldia* sont actuellement connues de France, dont 6 de France continentale et 1 (*E. aberlencii* sp. n.) de Guyane française. Des commentaires sur la position taxonomique et l'écologie de la nouvelle espèce sont fournis.

Mots-clés : Diptera, Chironomidae, *Einfeldia aberlencii* sp. n., Guyane française, correction binominale pour 4 espèces, France.

1. Introduction

A large material composed of Diptera was collected using entomological net and Malaise traps over the canopy and aquatic habitats delimited by the undergrowth of the primary rainforest in French Guiana. Exploration of the primary forest all over the world was implemented by the project named Canopy Raft (Radeau des Cimes), which allowed prof. F. Hallé (Montpellier university) and his collaborators (botanists, entomologists, climbers) to collect a precious and valuable patrimonial material of both terrestrial and aquatic insects. Sampling methods and other various technics of capture are detailed in ABERLENC (2017).

Male adult of *Einfeldia aberlencii* sp. n. is diagnosed and described based on male adults collected over the canopy and along the aquatic habitats delimited by the undergrowth of the primary rainforest of French Guiana. Data on the taxonomy, key for identification, geographical distribution and ecology for known *Einfeldia* species worldwide (KIEFFER 1924, TOWNES 1945, FREEMAN 1957, 1961, SUBLETTE 1964, TOKUNAGA 1964, BECK & BECK 1970, DANKS 1971, OLIVER 1971, SASA 1979, 1985, 1989, 1998, SHILOVA 1980, PINDER & REISS 1983, HASHIMOTO 1985, CRANSTON et al. 1989, HUDSON et al. 1990, OLIVER et al. 1990; SUBLETTE & SASA 1994; SPIES & SÆTHER 2004; LANGTON & PINDER 2007; SÆTHER 2012; SÆTHER & SPIES 2013; EPLER 2017; CRANSTON et al. 2016; SINGH & RAWAL 2016; MOUBAYED-BREIL 2020; MOUBAYED-BREIL & TISSOT 2020; MOUBAYED & LANGTON 2022; LANGTON 2023), show that the genus is well represented and mostly reported as well from the Nearctic (North and Central America) and Palaearctic Regions but also from the Oriental, Afrotropical and Australasian Regions.

The genus *Einfeldia* Kieffer, 1912 still partly revised despite several attempts to clarify its status and its taxonomic position. The identification of male adults to both genus and species level, would be applied on the basis of some relevant generic and specific characters, as detailed and discussed in the differential diagnosis. Remarks with short comments on the ecology of the new species are given.

2. Material and methods

The described male adults were collected exclusively by sweeping net and by Malaise traps set over the canopy and along the undergrowth of the primary rainforest of French Guiana. Sampling methods and other various technics of capture are detailed in ABERLENC (2017). The col-

lected material was preserved in 80-85% ethanol for the taxonomic examination and description. Information on the methodology of mounting and conservation of the type-material is provided in MOUBAYED (2024). Morphological terminology and measurements follow those of SÆTHER (1980) and LANGTON & PINDER (2007).

3. Description

Einfeldia aberlencii sp. n.

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Material examined

Holotype. French Guiana. 1 male adult captured by sweeping net over the canopy at the primary rainforest of Petit-Saut (5° 9' 22.5504" N, 52° 53' 8.7144" W); leg. H.P. Aberlenc and G. Delvare. 25.X.1989.

Paratype (leg. H.P. Aberlenc and G. Delvare). One mounted male adult, captured by Malaise traps set around the undergrowth of the primary rainforest of Petit-Saut, same data as for holotype.

Holotype (mounted on one slide) is deposited in the collections of the 'Musée cantonal de Zoologie, Palais de Rumine, 6 place de la Riponne, CH-1014 Lausanne (MZL), Switzerland' (GBIFCH01217138). The paratype is deposited in the collection of the senior author.

Etymology: the new species is named *"aberlencii"* in honour of our colleague Henri-Pierre Aberlenc, who remains active as entomologist on terrestrial insects in preserving the biodiversity of habitats.

Diagnostic characters

The male adult of *E. aberlencii* sp. n. is easily distinguished from other members of the subgenus *Einfeldia* by the following distinguishing characters. Head with a distinct deep concavity on antero-median part of frontal margin, frontal tubercles distinctly conical; antenna 11 segmented, 1235 μm long, last flagellomere 850 μm long, AR 2.21; median part of tergites II-VI with dark pigmentation; foreleg with apex of femur and base of tibia spotted, pulvilli bilobed; brachiolum of wing with 3 setae, squama with 17 setae; median area of tergites II-VI with semicircular dark pigmentation, tergite VII with postero-lateral spots, tergites VII and VIII fused, base of tergite VIII rounded; tergite IX with 2 distinct ridges located between the dorsal setae and the anal tergite bands; anal point slender, parallel sides; superior volsella with 2 unusual characteristic setae on outer corner of basal portion (1 dorsal, 1 ventral); dorsal setae on inferior volsella short, all located apically; setiferous ventral lobe with 4 fine setae; gonostylus distinctly swollen in its mid-section, abruptly tapering distally.

Male imago

(n = 3; Figs 1A-P)

Medium to big sized species. Total length 4.90 mm. Wing length 3.15 mm, TL/WL = 1.56. General colouration brownish in general, with contrasting brown to dark brown thorax. Antenna brownish; mesonotal stripes dark brown; wing pale brown; legs brownish, foreleg with apex of femur and base of tibia spotted. Abdomen brown to dark brown; tergites II-VI with median pigmentation; anal segment contrasting brown to dark brown. Head (Fig. 1A). Eyes bare; antero-median margin of frontal area with a characteristic concavity; coronal triangle modified; temporals 11 including8 inner and 3 outer verticals; frontal tubercles (Figs 1A-B), conical, well-developed as in some *Einfeldia* species. Antenna is *Einfeldia*-type, 11-segmented, 1235 μm long, last flagellomere 850 μm long, weakly clubbed; antennal groove beginning on segments 2/3; AR 2.21. Clypeus (Fig. 1C) broadly rectangular to square shaped, with rounded lateral sides, 150 μm long, 190 μm maximum width, with 32 setae in 5 rows. Palpomere 1 about 60 μm long, segments 2-5 missing. Thorax. Lobes of antepronotum (Fig 1D) not gaping, uniformly thick from base to apex, lateral antepronotals 3; acrostichals 13, in 1-2 rows, located close to antepronotum;

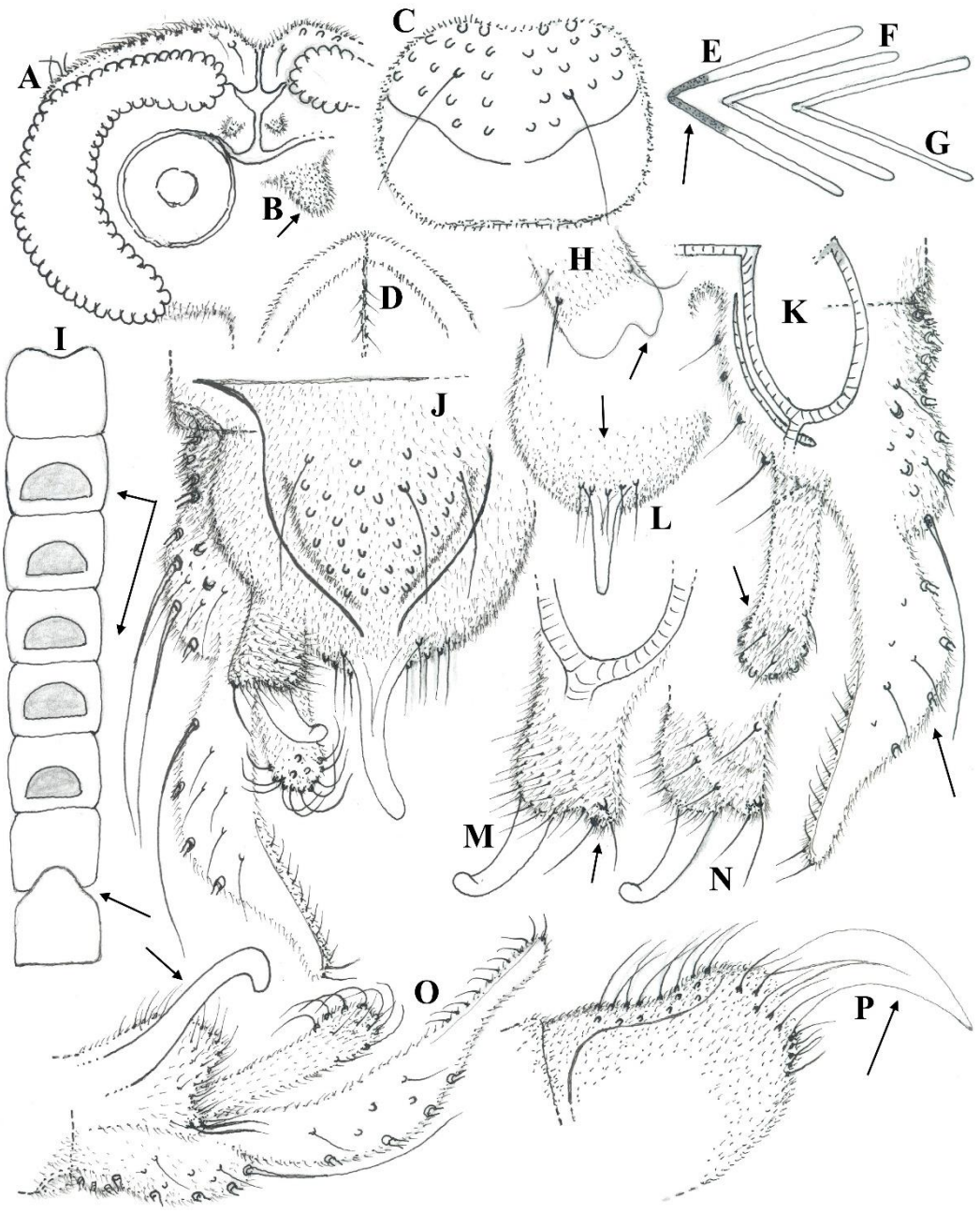

Figure 1. Male imago of Einfeldia aberlencii *sp. n. Head (left side, dorsal), frontal area, vertex and temporal setae (A); frontal tubercle (B); clypeus (C); lobes of antepronotum, basal part (D); femur and tibia of PI-PIII (E-G); tibial scale of PI (H); tergites I-VIII (I); hypopygium in dorsal (J) and ventral view (K); anal point, ventral (L); superior volsella, right side in dorsal (M) and ventral view (N); superior and inferior volsella, gonocoxite and gonostylus, lateral (O); tergite IX and anal point, lateral (P). The arrows indicate some distinctive characters.*

Figure 1. Imago mâle de Einfeldia aberlencii *sp. n. Tête (côté gauche, vue dorsale), aire frontale, vertex, et soies temporales (A) ; tubercule frontal (B) ; clypéus (C) ; (D) ; fémur et tibia de PI-PIII (E-G) ; éperon tibial de PI (H) ; tergites I-VIII (I) ; hypopyge en vue dorsale (J) et ventrale (K) ; pointe anale (L) ; volselle supérieure, côté droit, vue dorsale (M) et ventrale (N) ; volselle supérieure et inférieure, gonocoxite et gonostyle, vue latérale (O) ; tergite IX et pointe anale, vue latérale (P). Les flèches indiquent quelques caractères distinctifs.*

	fe	ti	ta_1	ta_2	ta_3	ta_4	ta_5	LR	BV	SV	BR
PI	1850	1630	1985	515	470	365	135	1.30	3.61	1.70	2.10
PII	1710	1460	1025	410	325	240	105	0.70	3.88	3.10	1.80
PIII	1790	2010	1260	585	415	315	120	0.63	3.53	3.00	2.00

Table 1. "LR = Length of tarsomere ta_1 divided by length of tibia (ti); BV = Combined length of femur (fe), tibia and ta_1 divided by combined length of tarsomeres ta_2-ta_5; SV = Ratio of femur plus tibia to tarsomere ta_1; BR = Ratio of longest seta of ta_1 divided by minimum width of ta_1, measured one third from apex."

dorsocentrals 13, not decumbent in one row; prealars 8 uniserial; scutellum with 32 setae, including 18-20 much longer located close to the posterior margin. Wing. Wide 875 μm; brachiolum with 3 setae; subcosta overreaching fork of radius; number of setae on veins: R, 46-48; R_1, 33-35; R_{4+5}, 43-45; remaining veins bare. Abdomen. Tergites I-VIII (Fig. 1I), tergites II-VI with characteristic semicircular dark pigmentation; tergites VII-VIII fused, basal part of tergite VIII not triangular. Legs. Femur and tibia of PI-PIII (Figs 1E-G); PI with dark spots on apex of femur and basal part of tibia; tibial scale of PI (Fig. 1H) short with rounded apex, tibial spurs on PII-III well-developed; ta_5 of PII (0.70 μm) much shorter than in PII and PIII (1.35, 1.20); sensilla chaetica present on tibia and tarsomeres of PI, only on tarsomeres of PII-PIII; pulvilli (*Einfeldia*-type), with 2 distinct lobes. Length (in μm) and proportions of legs (n = 1, paratype) as in the Table 1.

Abdomen. Hypopygium in dorsal and ventral view as in Figs 1J-K: dorsal (Fig. 1J), ventral view (Fig. 1K) with tergite IX and anal point omitted. Tergite IX (Fig. 1J, dorsal; Fig. 1P, lateral) 235 μm long, 265 μm maximum width, broadly semicircular in its distal half; dorsal side slightly concave medially when viewed laterally (Fig. 1P); anal tergite bands (ATB, Figs 1J, P) 210 μm long, 125 μm wide at median area, cup shaped, starting on caudal part of tergite VIII, narrowing distally, abruptly interrupted before base of anal point; dorsal side with 32-34 setae, located antero-medially between 2 characteristic dorsal ridges. Anal point (Figs 1J, L, P), dorsal (Fig. 1J), ventral (Fig. 1L), lateral (Fig. 1P), 125 μm long, 2-3 μm maximum width; slender, parallel-sided; basal part with 15 setae, 10 lateral (5 on each side), 5 ventral (Figs 1L, P). Laterosternite IX with 6 setae (3 on each side). Apodemes (Fig. 1K), sternapodeme orally projecting, transverse part straight, right angled basally, lateral expansion absent; phallapodeme finely elongate. Superior volsella as in Figs 1J, M-O, dorsal (Figs 1J, M), ventral (Fig. 1N), lateral (Fig. 1O); basal portion 130 μm long, 50 μm maximum width, rectangular, caudal side wider, densely covered with inwardly directed short setae, outer corner with 2 typical stout curved setae of 40 μm long (1 dorsal, 1 ventral); projection linearly elongate, bare, turned over and inwardly directed apically. Inferior volsella (Figs 1J, K, O), 175 μm long; cylindrical, apical margin rounded in dorsal (Fig. 1J), ventral (Fig. 1K) and lateral view (Fig. 1O), dorsal side with 13-14 short setae located apically, setiferous ventral lobe with 4 fine characteristic setae. Gonocoxite 150 μm long, 75 μm maximum width; dorsolateral part with 12 setae on each side (7 longer reaching half of gonostylus, 5 shorter); basal inner margin (Fig. 1K) with 5 stout setae of equal size. Gonostylus (Figs 1J, K, O) 250 μm long, maximum wide 50 μm medially, 3-5 μm distally; mid-section markedly swollen, abruptly tapering distally; inner margin with 9-11 thin setae located on distal half, apex with 2 stout setae. HR 0.86; HV 0.28.

Female adult, pupa and larva: unknown.

4. Remarks and discussion

Generic and specific differential diagnosis

The genus *Einfeldia* needs a deep and detailed worldwide revision, based on associated material

including male pharates, pupal exuviae and larvae. Though this genus remains partly revised, its taxonomical status is still insufficiently clarified as it has been mainly reorganized and confused over past decades, due to the high number of species being assigned to other related genera, namely: *Benthalia*, *Chironomus*, *Lobochironomus*, etc.

Moreover, in every examination of male adult, an accurate identification should take in consideration the following main distinctive generic characters: anterior margin of frontal area with or without concavity; frontal tubercles often present, vestigial, medium or large sized, conical, cylindrical, digitiform; antenna with 11 segments; femur and tibia of legs occasionally spotted, pulvilli distinctly bilobed; tergites often with dark pigmentation, tergites VII-VIII fused, base of tergite VIII rounded; anal point in both dorsal and lateral view with various distinctive shapes (slender, parallel-sided, spatulate apically, broadly enlarged medially, etc.); superior volsella with basal portion densely covered with short and median sized setae, longer setae always inwardly directed; inferior volsella cylindrical, mainly with short dorsal setae located apically, setiferous ventral lobe present; gonostylus strongly to moderately swollen in its mid-section, abruptly tapering distally.

The four recently described species from continental France by MOUBAYED-BREIL (2020), MOUBAYED & LANGTON (2022) and MOUBAYED-BREIL & TISSOT (2020), were not ranked in the right genus *Einfeldia* but wrongly assigned to the genus *Polypedilum* subgenus *Uresipedilum* as:

- *P.* (*Ur.*) *alixae* Moubayed & Langton, 2022

- *P.* (*Ur.*) *bernardae* Moubayed-Breil, 2020

- *P.* (*Ur.*) *claudei* Moubayed-Breil, 2020

- *P.* (*Ur.*) *tissoti* Moubayed-Breil & Langton, 2020.

These species are considered henceforth as belonging to the genus *Einfeldia*, after four new combinations:

- *Einfeldia alixae* (Moubayed & Langton, 2022) comb. n.

- *Einfeldia bernardae* (Moubayed-Breil, 2020) comb. n.

- *Einfeldia claudei* (Moubayed-Breil, 2020) comb. n.

- *Einfeldia tissoti* (Moubayed-Breil & Langton, 2020) comb. n.

At present, a total of 6 *Einfeldia* species are known from continental France including, besides *E. pagana* (Meigen, 1838) and *E. palaearctica* Ashe, 1990, the 4 above listed species. Consequently, the description of *E. aberlencii* sp. n. from the French Guiana (a French overseas territory) increases the total number of known *Einfeldia* species to 7 from France.

To date, several recent new combinations, synonymies and clarifications of the genus *Einfeldia*, based on the morphology of associated material (BECK & BECK 1970, SUBLETTE 1964, HASHIMOTO 1985, HUDSON et al. 1990, OLIVER et al. 1990, SUBLETTE & SASA 1994, SPIES et al. 2009, SÆTHER & SPIES 2013, SÆTHER 2012, EPLER 2017, CRANSTON et al. 2016, LANGTON 2023), show that some distinctive characters found in the male adult need to be clearly highlighted at both generic level and specific level. Accordingly, before any eventual reliable attempt of taxonomic recognition, the taxonomist must assemble a better key for identification to ensure a correct and definitive specific name.

However, on the basis of a specific differential diagnosis, *E. aberlencii* sp. n. appears to be more closer to species reported from the Nearctic and Neotropical Regions, namely: *E. atitlanensis* Sublette & Sasa, 1994; *E. austini* Beck & Beck 1970; *E. bruneipennis* (Johannsen, 1905); *E. chelonia* (Townes, 1945); *E. dorsalis* (Meigen, 1818); *E. natchitocheae* Sublette, 1964. In the other hand, less common characters are observed with the known species from France and the Palaearctic Region: *E. alixae*, *E. bernardae*, *E. claudei*, *E. pagana*, *E. palaearctica*, *E. tissoti*.

Consequently, the new species can be separated from other related congeners by some relevant distinguishing characters, which are summarized in the following differential diagnosis:

- Head (Figs 1A-B). Anterior margin of frontal area (Fig. 1A) with a characteristic concavity, frontal tubercles distinctly conical (Fig. 1B), while no concavity is observed on head of the latter 6 cited species, which have cylindrical, digitiform or occasionally vestigial frontal tubercles;

- Legs. Foreleg with dark spots on base of femur and apex of tibia (Figs 1E-F); pulvilli *Einfeldia*-type, with 2 distinct lobes. Pulvilli, in particular are differently figured in some other genera of Chironomini, particularly in the genus *Polypedilum* sensu lato;

- Abdomen (Fig. 1I). Tergites VII and VIII entirely fused; basal part of tergite VIII rounded (not triangular), consist of a relevant generic differentiating character. Tergites II-VI with semicircular pigmentation medially, which will often separate some closely related species;

- Hypopygium Figs 1J-L. Tergite IX broadly semicircular, with ridges located between the anal tergite bands; anal point slender, parallel-sided, laterally and ventrally sides with 15 setae (10 lateral, 5 on each side; 5 ventral);

- Superior volsella (Figs 1J, M-O). Basal portion rectangular, densely covered with inwardly directed setae, outer corner with 2 unusual long setae (1 dorsal, 1 ventral). Distribution pattern of setae is differently figured in the other known *Einfeldia* species;

- Inferior volsella (Figs 1J-K, O). Cylindrical, dorsal setae short, located apically; setiferous ventral lobe with 4 fine characteristic setae;

- Gonostylus (Figs 1J-K, O). Markedly swollen in its median part, abruptly tapering distally, nearly to entirely parallel-sided in some other closely related genera of Chironomini, namely: *Benthalia*, *Chironomus*, *Lobochironomus*.

5. Ecology and distribution

Larvae of *Einfeldia* are mainly found in lentic habitats (wet meadows, acidic and alkaline peat bogs, littoral zone of shallow lakes) but also in slow flowing water of large rivers (down basin, potamal). The ecology of the new species cannot be determined, as only adults were collected in two different habitats of the primary rainforest of French Guiana (the first, over the canopy at 30-40 m high; the second, along the undergrowth at different lower heights). Nevertheless, larval population of the captured adults over the canopy could be occurring in modified leaves of some phytotelmata or bromeliads, which predominate in density and number of species in the Neotropical, Afrotropical and Nearctic biogeographical Regions, as documented by LOPES FILHO et al. 2023.

Geographical distribution: At present, the new species is only known from its type-locality.

Acknowledgements

The authors are greatly indebted to H.P. Aberlenc and G. Delvare, who kindly untrusted the precious captured adults of chironomids, which currently includes the type-material of *E. aberlencii* sp. n. and many other yet undescribed species from French Guiana. We also express our gratitude to our colleague Martin Spies for his constructive suggestions about the genus *Einfeldia*.

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