



The Moth flies (Diptera, Psychodidae) of the 'tourbière du Machais' National Nature Reserve (France, Grand Est, Vosges): discovery of a new species for the French mainland fauna

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Résumé – Les Psychodidés (Diptera, Psychodidae) de la Réserve naturelle nationale de la tourbière de Machais (France, Grand Est, Vosges) : découverte d'une nouvelle espèce pour la faune continentale française.

Cette étude porte sur 152 spécimens de Psychodidae collectés dans la Réserve Naturelle Nationale de la tourbière de Machais à La Bresse (Vosges, France). Parmi ceux-ci, 132 spécimens ont été identifiés au niveau de l'espèce, englobant 6 genres et 14 espèces. Il est à noter que *Psychoda satchelli* Quate, 1955, est signalée pour la première fois en France continentale. Par conséquent, le nombre total d'espèces de Psychodidae recensées en France s'élève désormais à 171, dont 14 espèces recensées dans le département des Vosges.

Mots-clés – Espace protégé, inventaire généralisé, liste départementale, nouvelles données, Psychodinae, taxons méconnus.

Abstract – This study examines 152 Psychodidae specimens collected from the National Nature Reserve of the 'tourbière du Machais' in La Bresse (Vosges, France). Of these, 132 specimens were identified at the species level, encompassing 6 genera and 14 species. Notably, *Psychoda satchelli* Quate, 1955, is recorded for the first time in mainland France. Consequently, the total number of Psychodidae species documented in France now stands at 171, with 14 species recorded in the Vosges region.

Keywords – Protected area, global inventory, departmental species checklist, new data, Psychodinae, dark taxa.

INTRODUCTION

The family Psychodidae (Diptera: Nematocera), commonly known as moth flies or sand flies, includes nearly 3,500 globally described species in six extant subfamilies, namely Bruchomyiinae (74 spp), Horaiellinae (6 spp), Phlebotominae (1,060 spp), Psychodinae (2,050 spp), Sycoracinae (46 spp), and Trichomyiinae (215 spp), and one extinct subfamily, Datzinae (5 spp) (Cordeiro & Wagner 2018, Curler *et al.* 2019, Galati 2018, Galati & Rodrigues 2023, Wagner & Ibáñez-Bernal 2009). Adults typically range from 1 to 6 millimeters in size and are easily recognizable by their setose appearance. Many species hold their wings horizontally over their abdomen when at rest, making them resemble small moths, hence the common name of moth flies. All extant subfamilies are present in Europe except Horaiellinae (Wagner 2001, 2004), with over 500 species documented in the region (Wagner 2004). Despite Europe being extensively studied, there remains significant variation in taxonomic knowledge among countries, leading to the continual discovery of new geographic records and species descriptions (Wagner 2000, 2004, Kvitte & Andersen 2012, Kvitte & Menze 2016, Kvitte 2018, 2019, 2023, Jaume-Schinkel *et al.* 2023, Ježek *et al.* 2017, 2018, 2020, 2023). Of the 500 species recorded in Europe, 170 are found in France (Wagner 2004, Kvitte & Menzel 2016, Gibernau & Albre 2022). Found in the heart of the Vosges mountains within the 'Ballons des Vosges' Regional Nature Park, the 'tourbière du Machais' National Nature Reserve (RN) spans 145 hectares,

ranging in altitudes between 950 and 1,160 meters. The RN occupies a small glacial cirque with unique geomorphological features and hosts the last and largest intact floating peat bog in the entire massif. The site experiences a mountain climate, a transition between oceanic and degraded continental climates, characterized by abundant precipitation (2000 mm/year, mainly as snow, amounting to 1.5 to 2 meters over 4 to 6 months) and an average annual temperature of 5°C (Badré 2021a).

The purpose of this article is to present the results of the Psychodidae samples from the RN and enhance the understanding of the site, according to goals of the management plan for this protected area (Badré 2021b).

MATERIAL AND METHODS

Specimen collection

Nine Malaise tent-type interception traps (Malaise 1937) were placed from June to September between 2020 and 2021 (Figure 1B and also see Claude *et al.* 2025: table 1 and figure 2). Bottles were collected and replaced approximately every two weeks, and Psychodidae specimens were isolated during the sorting process. All examined material comes from the National Nature Reserve of

'tourbière de Machais', located in La Bresse, Vosges (88), France. Please refer to Claude *et al.* (2025) for more detailed information. To avoid redundancy, the country and locality details are omitted in the material examined section.

DNA barcoding and slide preparation

DNA extraction and slide preparation were conducted according to the protocol described by Jaume-Schinkel *et al.* (2024). PCR products were shipped to BGI Genomics (China) for sequencing. The cytochrome c oxidase subunit I (COI in the following text) DNA barcodes were assembled, aligned, and cleaned using Geneious version R7 (Biomatters, Auckland, New Zealand), with a sequence length set to 658 bp. Additionally, Geneious Prime ver. 2023 was used to perform a distance-based neighbor-joining (NJ in the following text) analysis using the Jukes-Cantor model. All the sequences generated for this study are available on the German Barcode of Life website (<https://data.bolgermany.de/gbol1/ergebnisse/results>) using the unique codes (ZFMK-TIS-XXXX) provided in the examined material section. Similarly, all specimen metadata can be accessed on BOLD Systems under the Dataset DS-PsBresse (available at: dx.doi.org/10.5883/DS-PSBRESSE).

The material examined is deposited at the Leibniz Institute for the Analysis of Biodiversity Change – Museum Koenig, Bonn, Germany (ZFMK).

Species distribution

The species distribution is primarily based on Wagner's (2004) work within the Fauna Europea project (de Jong *et al.* 2014). This foundation is further complemented, but not limited to, studies such as those by Ježek *et al.* (2018) Omelkova & Ježek (2012), Kvifte *et al.* (2011; 2013), Kvifte & Boumans (2014), Kroča & Ježek (2019), Morelli & Biscaccianti (2021) and Svensson (2009).

Abbreviations: AB: Alix GREUZAT BADRÉ; JC: Jocelyn CLAUDE; Leg.: collector; masl: meters above sea level; MT: Malaise trap; TL: Type locality.

RESULTS AND TAXONOMIC ACCOUNT

A total of 152 Psychodidae specimens were collected. Out of these, 132 were identified to species, belonging to 6 genera and 14 species (Table 1). The remaining 20 specimens were only identified to genus level (Table 1). All the unidentified species belong to the genera *Pericoma* Haliday, 1856 and *Psychoda* Latreille, 1797 (Table 1) and are listed as such (*Pericoma* sp. and *Psychoda* sp.) due to the uncertainty of their taxonomic identity.

We successfully barcoded 89.47% of the total specimens (136 out of 152) (Figure 1B). However, the sequence of specimen ZFMK-TIS-2632155 was contaminated. The COI barcode did not match the morphology, and after BLASTing the sequence in BOLD and Genbank, the closest sequence match was Culicidae (84%) and Chironomidae (87%) respectively. Therefore,

Table 1 – List of the 14 species of Psychodidae identified from the 'tourbière de Machais' National Nature Reserve between 2009 and 2021. Number (No.) of specimens by sex (F = female, M = male), and total number of specimens by species.

Species	No.		Total
	M	F	
<i>Berdeniella illiesi</i> (Wagner, 1973)	1		1
<i>Clytocerus ocellaris</i> (Meigen, 1804)	38	30	68
<i>Pericoma</i> sp.		2	2
<i>Pneumia gracilis</i> (Eaton, 1893)	2	3	5
<i>Pneumia mutua</i> (Eaton, 1893)	1	9	10
<i>Pneumia trivialis</i> Eaton, 1893	1	1	2
<i>Psychoda albipennis</i> Zetterstedt, 1850	1	2	3
<i>Psychoda gemina</i> (Eaton, 1904)		2	2
<i>Psychoda grisescens</i> Tonnoir, 1922		1	1
<i>Psychoda lobata</i> Tonnoir, 1940	4	14	18
<i>Psychoda minuta</i> Banks, 1894	1	9	10
<i>Psychoda phalaenoides</i> (Linnaeus, 1758)	3	5	8
<i>Psychoda satchelli</i> Quate, 1955	1	1	2
<i>Psychoda</i> sp.	5	13	18
<i>Psychoda trinodulosa</i> Tonnoir, 1922		1	1
<i>Saraiella auberti</i> (Sarà, 1954)		1	1
Total	58	94	152

sequence ZFMK-TIS-2632155 is not included in our COI NJ tree (Figure 1B).

■ *Berdeniella illiesi* (Wagner, 1973)

Pericoma illiesi Wagner, 1973: 517. TL: Germany. Hesse: Schlitz, Breitenbach.

Distribution in Europe: Bulgaria, Czech Republic, France, Germany, Slovakia.

Material examined: 1♂; 48.0061°N, 6.9648°E; 985 masl; 18 Jun. 2021; leg. JC, AB; MT; ZFMK-TIS-2638877.

Genetics: All examined material was successfully sequenced.

■ *Clytocerus ocellaris* (Meigen, 1830)

Trichoptera ocellaris Meigen, 1804: 44. TL: Not given [= Germany. Northwestern].

Distribution in Europe: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, Netherlands, Norway, Poland, Romania, Sardinia, Slovakia, Slovenia, Switzerland, United Kingdom.

Material examined: 2♂, 1♀; 48.0061°N, 6.9594°E; 6 Jun. 2020; leg. JC; MT [ZFMK-TIS-2632158 (♀), ZFMK-TIS-2632159 (♂), ZFMK-TIS-2632160 (♂)]. — 9♂, 5♀; same data as for preceding except: 19 Aug. 2020 [ZFMK-TIS-2632164 (♀), ZFMK-TIS-

2632165 (♀), ZFMK-TIS-2632166 (♀), ZFMK-TIS-2632167 (♀), ZFMK-TIS-2632168 (♀), ZFMK-TIS-2632169 (♂), ZFMK-TIS-2632170 (♂), ZFMK-TIS-2632171 (♂), ZFMK-TIS-2632172 (♂), ZFMK-TIS-2632173 (♂), ZFMK-TIS-2632174 (♂), ZFMK-TIS-2632175 (♂), ZFMK-TIS-2632176 (♂), ZFMK-TIS-2632177 (♂)]. — 4♂; same data as for preceding except: 27 Oct. 2020 [ZFMK-TIS-2632147 (♂), ZFMK-TIS-2632148 (♂), ZFMK-TIS-2632149 (♂), ZFMK-TIS-2632150 (♂)]. — 9♂, 10♀; 48.0074°N, 6.9631°E; 985 masl; 7 Jun. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638827 (♂), ZFMK-TIS-2638829 (♂), ZFMK-TIS-2638860 (♂), ZFMK-TIS-2638862 (♂), ZFMK-TIS-2638864 (♂), ZFMK-TIS-2638866 (♂), ZFMK-TIS-2638867 (♂), ZFMK-TIS-2638868 (♂), ZFMK-TIS-2638872 (♂), ZFMK-TIS-2638861 (♀), ZFMK-TIS-2638863 (♀), ZFMK-TIS-2638865 (♀), ZFMK-TIS-2638869 (♀), ZFMK-TIS-2638870 (♀), ZFMK-TIS-2638871 (♀), ZFMK-TIS-2638873 (♀), ZFMK-TIS-2638874 (♀), ZFMK-TIS-2638875 (♀), ZFMK-TIS-2638876 (♀)]. — 2♂, 5♀; 48.0074°N, 6.9648°E; 985 masl; 18 Jun. 2021; leg. JC, BA; MT 03 [ZFMK-TIS-2638879 (♂), ZFMK-TIS-2638881 (♂), ZFMK-TIS-2638883 (♀), ZFMK-TIS-2638886 (♀), ZFMK-TIS-2638887 (♀), ZFMK-TIS-2638888 (♀), ZFMK-TIS-2638889 (♀)]. — 1♂; 48.0074°N, 6.9631°E; 985 masl; 2 Jul. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638835]. — 2♂, 2♀; same data as for preceding except: 25 Aug. 2021 [ZFMK-TIS-2638842 (♂), ZFMK-TIS-2638845 (♂), ZFMK-TIS-2638843 (♀), ZFMK-TIS-2638844 (♀)]. — 2♀; 48.0021°N, 6.9495°E; 1048 masl; 25 Aug. 2021; leg. JC, AB; MT 01 [ZFMK-TIS-2638853, ZFMK-TIS-2638855]. — 1♂, 1♀; same data as for preceding except: 16 Sep. 2021 [ZFMK-TIS-2638820 (♂), ZFMK-TIS-2638825 (♀)]. — 8♂, 3♀; 48.0074°N, 6.9631°E; 985 masl; 16 Sep. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638809 (♂), ZFMK-TIS-2638814 (♂), ZFMK-TIS-2638816 (♂), ZFMK-TIS-2638818 (♂), ZFMK-TIS-2638837 (♂), ZFMK-TIS-2638838 (♂), ZFMK-TIS-2638839 (♂), ZFMK-TIS-2638841 (♂), ZFMK-TIS-2638810 (♀), ZFMK-TIS-2638812 (♀), ZFMK-TIS-2638840 (♀)]. — 1♀; 48.0074°N, 6.9648°E; 985 masl; 02 Nov. 2021; leg. JC, BA; MT 03 [ZFMK-TIS-2638807].

Genetics: All examined material was successfully sequenced. The maximum intraspecific uncorrected pairwise distance for COI sequences was 4.11 % or 27 bp.

■ *Pericoma* sp. (cf. *pseudoexquisita* Tonnoir, 1940)

Material examined: 1♀; 48.0074°N, 6.9631°E; 985 masl; 19 Aug. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638831]. — 1♀; 48.0074°N, 6.9648°E; 985 masl; 02 Nov. 2021; leg. JC, BA; MT 03 [ZFMK-TIS-2638806].

Genetics: All examined material was successfully sequenced. The maximum intraspecific uncorrected pairwise distance for COI sequences was 5.93 % or 39 bp.

Note: The closest match for both sequences within BOLD is *Pericoma pseudoexquisita* Tonnoir, 1940; however, they group into different Barcode Index Numbers (BINs), BOLD: ADE2215 and BOLD: ACU4724 (for more information, see: https://v3.boldsystems.org/index.php/resources/handbook?chapter=2_databases.html§ion=bins). Both BINs show a 5.28% genetic distance from their closest relative, which aligns with the uncorrected pairwise distance observed in this study. The differences between sequences, along with the inability to

achieve a definitive morphological identification, highlight the need for further refinement of online databases through morphological assessments. Additionally, they underscore that COI sequence variability within Psychodidae remains an area of ongoing research.

■ *Pneumia gracilis* (Eaton, 1893)

Pericoma gracilis Eaton, 1893: 123. TL: not given (likely, United Kingdom)

Distribution in Europe: Belgium, Bulgaria, Czech Republic, France, Germany, Greece, Norway, Slovakia, Slovenia, United Kingdom.

Material examined: 1♀; 48.0067°N, 6.9594°E; 27 May. 2020; leg. JC; MT [ZFMK-TIS-2636662]. — 1♂, 2♀; same data as for preceding except: 19 Aug. 2020 [ZFMK-TIS-2632161 (♂), ZFMK-TIS-2632162 (♀), ZFMK-TIS-2632163 (♀)]. — 1♂; 48.0021°N, 6.9495°E; 1048 masl; 16 Sep. 2021; leg. JC, AB; MT 01 [ZFMK-TIS-2638823].

Genetics: All examined material was successfully sequenced. The maximum intraspecific uncorrected pairwise distance for COI sequences was 1.52 % or 10 bp.

■ *Pneumia mutua* (Eaton, 1893)

Pericoma mutua Eaton, 1893: 121. TL: not given (likely, United Kingdom)

Distribution in Europe: Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Netherlands, Slovakia, Slovenia, and the United Kingdom.

Material examined: 5♀; 48.0074°N, 6.9648°E; 985 masl; 18 Jun. 2021; leg. JC, BA; MT 03 [ZFMK-TIS-2638878, ZFMK-TIS-2638880, ZFMK-TIS-2638882, ZFMK-TIS-2638884, ZFMK-TIS-2638885]. — 1♀; 48.0074°N, 6.9631°E; 985 masl; 02 Jul. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638836]. — 1♂, 3♀; 48.0074°N, 6.9648°E; 985 masl; 19 Aug. 2021; leg. JC, BA; MT 03 [ZFMK-TIS-2638798 (♂), ZFMK-TIS-2638796 (♀), ZFMK-TIS-2638799 (♀), ZFMK-TIS-2638800 (♀)].

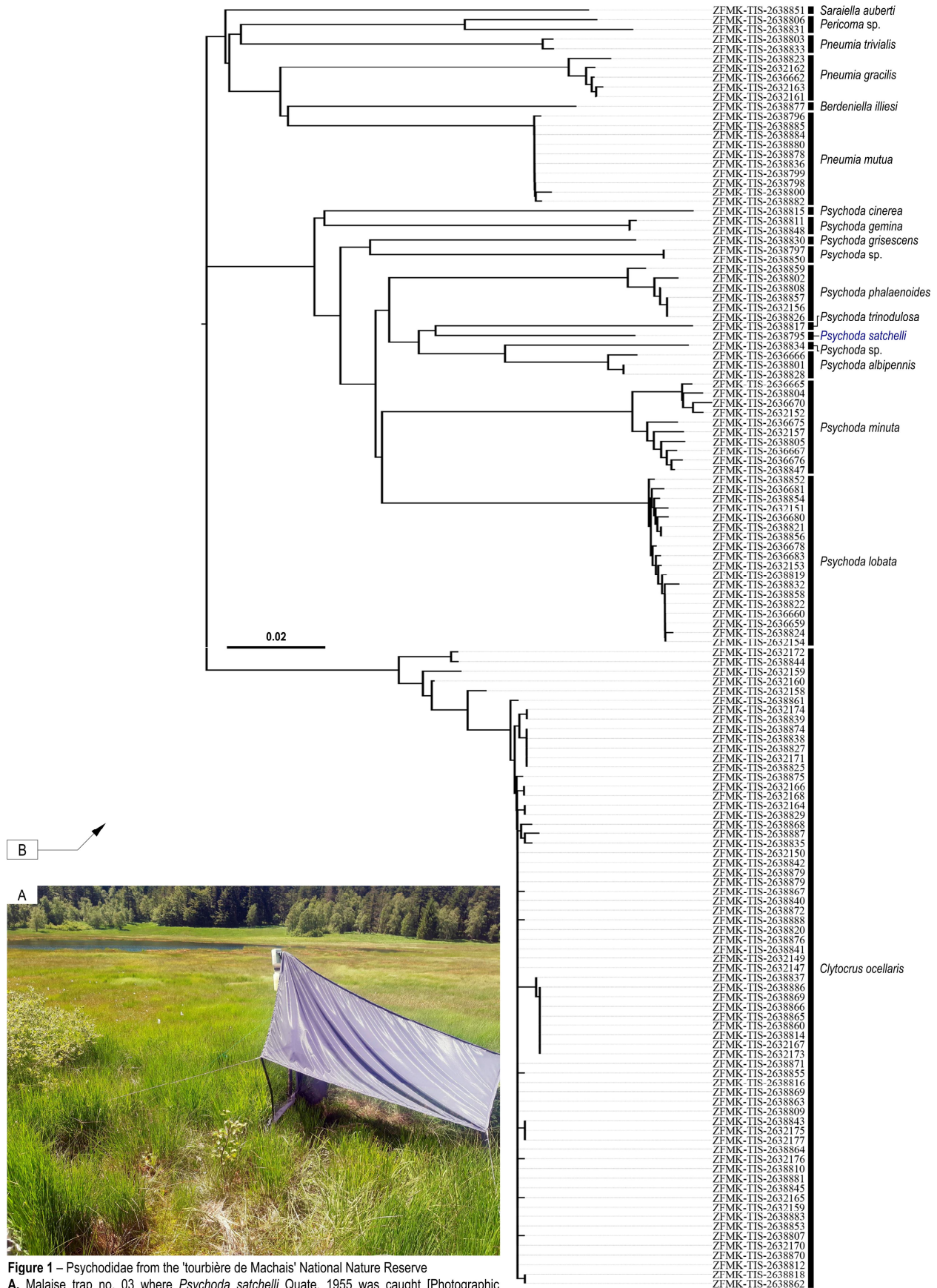
Genetics: All examined material was successfully sequenced. The maximum intraspecific uncorrected pairwise distance for COI sequences was 0.56 % or 3 bp.

■ *Pneumia trivialis* (Eaton, 1893)

Pericoma trivialis Eaton, 1893: 121. TL: not given (likely, United Kingdom).

Distribution in Europe: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom.

Material examined: 1♂; 48.0074°N, 6.9631°E; 985 masl; 05 Aug. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638833]. — 1♀; same data as for preceding except: 04 Nov. 2021 [ZFMK-TIS-2638803].



Genetics: All examined material was successfully sequenced. The maximum intraspecific uncorrected pairwise distance for COI sequences was 0.56 % or 3 bp.

■ ***Psychoda (Logima) albipennis* Zetterstedt, 1850**

Psychoda albipennis Zetterstedt, 1850: 3708. TL: Norway. "Toien" near Oslo.

Remarks: for a complete synonymy see Ježek (1983, 1984). Moreover, I follow Bravo *et al.* (2006) in their treatment of the genera and subgenera proposed by Ježek (1984) for *Psychoda*, applied to the remaining species within the genus found in this study.

Distribution in Europe: Austria, Azores Is, Belgium, Bulgaria, Corsica, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Slovakia, Spain, Sweden, Switzerland, United Kingdom.

Material examined: 1♀; 48.0061°N, 6.9594°E; 15 Jun. 2020; leg. JC; MT [ZFMK-TIS-2636666]. — 1♀; 48.0074°N, 6.9648°E; 985 masl; 07 Jun. 2021; leg. JC, BA; MT 03 [ZFMK-TIS-2638828]. — 1♀; 48.0074°N, 6.9631°E; 985 masl; 04 Nov. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638801].

Genetics: All examined material was successfully sequenced. The maximum intraspecific uncorrected pairwise distance for COI sequences was 0.92 % or 6 bp.

■ ***Psychoda (Psychodocha) cinerea* Banks, 1894**

Psychoda cinerea Banks, 1894: 331. TL: USA, New York.

Distribution in Europe: Austria, Belgium, Bulgaria, Corsica, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, UK.

Material examined: 1♀; 48.0074°N, 6.9631°E; 985 masl; 04 Nov. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638815]

Genetics: All examined material was successfully sequenced.

■ ***Psychoda (Psychodocha) gemina* (Eaton, 1904)**

Threticus gemina Eaton, 1904: 57 TL: United Kingdom, Seaton, Devon.

Remarks: I follow Bravo *et al.* (2006) regarding the treatment of the genera and subgenera for *Psychoda*.

Distribution in Europe: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Luxembourg, Netherlands, Norway, Portugal, Romania, Slovakia, Slovenia, Spain, Switzerland, United Kingdom.

Material examined: — 1♀; 48.0074°N, 6.9631°E; 985 masl; 16 Sep. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638811]. — 1♀; 48.0074°N, 6.9648°E; 985 masl; 18 Jun. 2021; leg. JC, BA; MT 03 [ZFMK-TIS-2638848].

Genetics: All examined material was successfully sequenced. The maximum intraspecific uncorrected pairwise distance for COI sequences was 0.02 % or 1 bp.

■ ***Psychoda (Psycha) grisescens* Tonnoir, 1922**

Psychoda grisescens Tonnoir, 1922: 87. TL: Belgium, Brussels.

Remarks: I follow Bravo *et al.* (2006) regarding the treatment of the genera and subgenera for *Psychoda*.

Distribution in Europe: Belgium, Bulgaria, Corsica, Czech Republic, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, United Kingdom.

Material examined: 1♀; 48.0074°N, 6.9631°E; 985 masl; 19 Aug. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638830].

Genetics: All examined material was successfully sequenced.

■ ***Psychoda (Chodopsycha) lobata* Tonnoir, 1940**

Psychoda lobata Tonnoir, 1940: 60. TL: United Kingdom, Parhyn, Shute, Devon.

Distribution in Europe: Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Hungary, Ireland, Italy, Luxembourg, Norway, Slovakia, Slovenia, United Kingdom.

Material examined: 1♂, 2♀; 48.0061°N, 6.9594°E; 6 Jun. 2020; leg. JC; MT [ZFMK-TIS-2632151 (♂), ZFMK-TIS-2632153 (♀), ZFMK-TIS-2632154 (♀)]. — 4♀; same data as for preceding except: 19 Jul. 2020 [ZFMK-TIS-2636678 (♀), ZFMK-TIS-2636680 (♀), ZFMK-TIS-2636681 (♀), ZFMK-TIS-2636683 (♀)]. — 2♀; same data as for preceding except: 21 Oct. 2020 [ZFMK-TIS-2636659 (♀), ZFMK-TIS-2636660 (♀)]. — 2♂, 3♀; 48.0021°N, 6.9495°E; 1048 masl; 25 Aug. 2021; leg. JC, AB; MT 01 [ZFMK-TIS-2638854 (♂), ZFMK-TIS-2638858 (♂), ZFMK-TIS-2638832 (♀), ZFMK-TIS-2638852 (♀), ZFMK-TIS-2638856 (♀)]. — 1♂, 3♀; same data as for preceding except: 16 Sep. 2021 [ZFMK-TIS-2638819 (♂), ZFMK-TIS-2638821 (♀), ZFMK-TIS-2638822 (♀), ZFMK-TIS-2638824 (♀)].

Genetics: All examined material was successfully sequenced. The maximum intraspecific uncorrected pairwise distance for COI sequences was 0.76 % or 5 bp.

■ ***Psychoda (Psychodula) minuta* Banks, 1894**

Psychoda minuta Banks, 1894: 331. TL: USA, New York.

Distribution in Europe: Austria, Belgium, Bulgaria, Corsica, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Madeira, Netherlands, Norway, Romania, Sardinia, Slovakia, Slovenia, Spain, Switzerland, United Kingdom.

Material examined: 1♂; 48.0061°N, 6.9594°E; 27 May. 2020; leg. JC; MT [ZFMK-TIS-2636665]. — 2♀; same data as for preceding except: 06 Jun. 2020 [ZFMK-TIS-2632152, ZFMK-TIS-2632157]. — 2♀; same data as for preceding except: 15 Jun. 2020 [ZFMK-TIS-2636667, ZFMK-TIS-2636670]. — 1♂, 1♀; same data as for preceding except: 10 Sep. 2020 [ZFMK-TIS-2636676 (♂), ZFMK-TIS-2636675 (♀)]. — 1♀; 48.0074°N, 6.9648°E; 985 masl; 16 Sep. 2021; leg. JC, BA; MT 03 [ZFMK-TIS-2638847]. — 2♀; same data as for preceding except: 02 Nov. 2021 [ZFMK-TIS-2638804, ZFMK-TIS-2638805].

Genetics: All examined material was successfully sequenced. The maximum intraspecific uncorrected pairwise distance for COI sequences was 2.60 % or 17 bp.

■ *Psychoda phalaenoides* (Linnaeus, 1758)

Tipula phalaenoides Linnaeus, 1758: 588. TL: Unknown.

Distribution in Europe: Austria, Belgium, Bulgaria, Corsica, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, Netherlands, Norway, Poland, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

Material examined: 1♀; 48.0061°N, 6.9594°E; 06 Jun. 2020; leg. JC; MT [ZFMK-TIS-2632156]. — 2♀; 48.0021°N, 6.9495°E; 1048 masl; 16 Sep. 2021; leg. JC, AB; MT 01 [ZFMK-TIS-2638857, ZFMK-TIS-2638859]. — 1♂; same data as for preceding [ZFMK-TIS-2638826]. — 2♂, 1♀; 48.0074°N, 6.9631°E; 985 masl; 7 Jun. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638808 (♂), ZFMK-TIS-2638813 (♂), ZFMK-TIS-2638815 (♀)]. — 1♀; same data as for preceding except: 04 Nov. 2021 [ZFMK-TIS-2638802].

Genetics: All examined material was successfully sequenced. The maximum intraspecific uncorrected pairwise distance for COI sequences was 1.52 % or 10 bp.

■ *Psychoda (Logima) satchelli* Quate, 1955

Psychoda satchelli Quate, 1955: 214. TL: USA, California, Berkeley, Strawberry Canyon.

Distribution in Europe: Austria, Belgium, Bulgaria, Corsica, Czech Republic, Finland, France*, Germany, Greece, Italy, Ireland, Netherlands, Norway, Russia, Slovakia, Slovenia, Sweden, Ukraine.

* This is the first record for continental France.

Material examined: 1♀; 48.0074°N, 6.9648°E; 985 masl; 19 Aug. 2021; leg. JC, BA; MT 03 (Figure 1A) [ZFMK-TIS-2638795]

Genetics: All examined material was successfully sequenced.

■ *Psychoda* sp.

Material examined: 2♀; 48.0061°N, 6.9594°E; 27 May. 2020; leg. JC; MT [ZFMK-TIS-2636663; ZFMK-TIS-2636664]. — 2♀; same data as preceding except: 15 Jun. 2020 [ZFMK-TIS-2636668; ZFMK-TIS-2636669]. — 3♀; same data as preceding except: 19 Jul. 2020 [ZFMK-TIS-2636677; ZFMK-TIS-2636679; ZFMK-TIS-2636682]. — 1♂, 1♀; same data as for preceding except: 25 Jul. 2020 [ZFMK-TIS-2636671 (♂); ZFMK-TIS-2636672 (♀)]. — 1♂, 1♀; same data as for preceding except: 10 Sep. 2020 [ZFMK-TIS-2636673 (♂); ZFMK-TIS-2636674 (♀)]. — 1♂, 1♀; same data as for preceding except: 21 Oct. 2020 [ZFMK-TIS-2636658 (♂); ZFMK-TIS-2636661 (♀)]. — 1♂; 48.0074°N, 6.9648°E; 985 masl; 19 Aug. 2021; leg. JC, BA; MT 03 [ZFMK-TIS-2638797]; 1♂; same data as for preceding except: 16 Sep. 2021 [ZFMK-TIS-2638850]. — 2♀; 48.0074°N, 6.9648°E; 985 masl; 16 Sep. 2021; leg. JC, BA; MT 03 [ZFMK-TIS-2638846, ZFMK-TIS-2638849].

Genetics: Specimens ZFMK-TIS-2638797; ZFMK-TIS-2638834; and ZFMK-TIS-2638850 were successfully sequenced.

Sequences ZFMK-TIS-2638797 and ZFMK-TIS-2638850 are identical, with an average distance of 14.3 % to *Psychoda minuta*, and 10.7% to *Psychoda grisea*. Sequence ZFMK-TIS-2638834 has an average distance of 6.68% to *Psychoda albipennis*, 8.82% to *Psychoda satchelli*, and 13.1 with sequences ZFMK-TIS-2638797 and ZFMK-TIS-2638850.

Note: the specimens are damaged, and/or the position in the slides is not good for identify. Moreover, the sequences vary quite a lot with each other. Likely, more than one species is present within these studied specimens. In the future, we may be able to identify these specimens, but not quite yet.

■ *Psychoda (Psychomora) trinodulosa* Tonnoir, 1922

Psychoda trinodulosa Tonnoir, 1922: 86. TL: Belgium.

Distribution in Europe: Austria, Belgium, Bulgaria, Corsica, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, Netherlands, Norway, Poland, Sardinia, Slovakia, Slovenia, Spain, United Kingdom.

Material examined: 1♀; 48.0074°N, 6.9631°E; 985 masl; 16 Sep. 2021; leg. JC, AB; MT 02 [ZFMK-TIS-2638817].

Genetics: All examined material was successfully sequenced.

■ *Saraiella auberti* (Sarà, 1954)

Pericoma auberti Sarà, 1954: 2. TL: Switzerland.

Distribution in Europe: Austria, France, Germany, Italy, Switzerland.

Material examined: 1♀; 48.0074°N, 6.9648°E; 985 masl; 16 Sep. 2021; leg. JC, BA; MT 03 [ZFMK-TIS-2638851].

Genetics: All examined material was successfully sequenced.

DISCUSSION

France, alongside other European countries such as Czech Republic (n=182 species), Germany (n=163 species), and Slovakia (n=119 species), stands out for its rich diversity of Psychodidae species, with now 171 recorded species. This highlights significant differences in taxonomic and faunistic knowledge of Psychodidae across countries. For instance, Ukraine had only 11 recorded species before 2017; currently, 43 species are documented (Ježek *et al.* 2017). Similarly, Albania previously recorded just 10 species; which recently increased to 27 (Ježek *et al.* 2023); Switzerland has a total of 79 species, compared with 61 in 1998 (Wagner & Schaffner 2024).

In a recent study involving the genus *Psychoda* within France and including Corsica (Gibernau & Albre 2022), *Psychoda satchelli* was recorded for Corsica, but not for mainland France. Despite France's relatively comprehensive taxonomical studies, our research has resulted in the first record of *Psychoda satchelli* in the french mainland. This discovery underscores the importance of faunistic studies in accurately mapping species distributions. It also demonstrates that even in well-studied countries, conducting research/sampling in different habitats can unveil previously unknown species. The 14 identified species,

along with the unidentified specimens discovered in this study, represent approximately 10% of the total species found in France. The newly recorded species suggest that the overall number of species in the country is likely to increase in the future.

Despite recent efforts, the application of COI barcodes and species molecular delimitation within Psychodidae remains limited (Kvifte & Andersen 2012, Cordeiro *et al.* 2023, Gibernau *et al.* 2021, Jaume-Schinkel *et al.* 2023). Enhanced and systematic molecular studies (using integrative taxonomy), are necessary to advance taxonomic knowledge within Psychodidae. Recent studies using COI DNA barcodes for the genus *Psychoda* in France and Corsica (Gibernau & Albre 2022) have shown that using only COI barcodes is insufficient to distinguish cryptic species within some *Psychoda* species complexes, including *P. alternata*, *P. cinerea*, and *P. satchelli*. COI barcoding gives the impression that works well for species delimitation and sex association, but we lack information to understand how the inter- and intraspecific distances vary among different genera within Psychodidae. Combining COI with other molecular markers (i.e. 18S, ITS2, or elongation factor 1-alpha) could improve the delimitation within species complexes.

According to the list of the National Natural Heritage Inventory (Inventaire National du Patrimoine Naturel, <https://inpn.mnhn.fr/>), some of the species found in this study are listed, but without data concerning the threatened status or known distribution, highlighting the need for further taxonomic studies. In contrast, in the red list of German monthlies (Wagner, 2016), the species *Berdeniella illiesi*, *Clytocerus ocellaris*, *Pneumia mutua*, *P. trivialis*, and *Saraiella auberti* are considered as not threatened; while *Pneumia gracilis* is data deficient; *Psychoda albipennis*, *P. gemina*, *P. grisea*, *P. lobata*, *P. minuta*, *P. phalaenoides*, *P. satchelli*, and *P. trinodulosa* are not evaluated; and *Pericoma pseudexquisita* was not considered in the list. Likewise, in the Norwegian red list (Gammelmo *et al.* 2021), *Pneumia gracilis*, and *P. satchelli* are data deficient, while the remaining species are under the Least Concern category or not assessed. In contrast, none of the species found in this study is considered in any threat category in the Czech red list (Ježek 2005).

Despite these considerations, virtually nothing is known about the populations of moth flies around Europe, even less is known for specific countries, including France. The lack of information makes conservation efforts difficult for Psychodidae, this is why works such as this (also see Grootaert & Drumont 2023, Claude *et al.* 2025) are crucial for understanding the insect communities in specific habitats, especially during the massive insect decline happening right now.

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