Checklist of mayflies (Insecta: Ephemeroptera) of Luxembourg

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Abstract. For this study, 11,399 records of mayfly species (Insecta: Ephemeroptera) have been accessed since 1990 for Luxembourg. The compiled checklist includes 52 species, however, three species have not been observed for more than 70 years: *Prosopistoma pennigerum* (Müller, 1785), *Ephoron virgo* (Olivier, 1791) and *Isonychia ignota* (Walker, 1853). Particularly noteworthy are the first record of *Arthroplea congener* Bengtsson, 1908 as well as the re-finding of *Caenis macrura* (Stephens, 1836).

Keywords. National checklist, biodiversity inventory, freshwater fauna, *Arthroplea congener*.

1. Introduction

Mayflies (Insecta: Ephemeroptera) are considered aquatic keystone species, and as such, their larvae are widely assessed as bioindicators in monitoring programs aimed at ensuring good ecological quality of water bodies (Bauernfeind & Moog 2000, Türkmen & Kazanci 2015). In the middle of the last century, Hoffmann (1950) was the first to systematically study the mayfly fauna of Luxembourg. In his survey, he identified 25 species along the country's watercourses. A later inventory by Dolisy (2000), studying the rhithral part of the watercourses, compiled a checklist comprising 39 species. More scattered surveys, coordinated by the National Museum of Natural History of Luxembourg (MNHNL), have been carried out since 2000 to investigate other aquatic environments, such as the potamal part of watercourses and the stagnant waters of ponds and small pools. Furthermore, recent community efforts have started to contribute valuable distribution data on mayflies via the Global Biodiversity Information Facility (GBIF) portal and the iNaturalist community. In addition to studies geographically focused on the territory of Luxembourg, mayfly inventories of neighboring regions can provide valuable data, if they have studied bordering rivers (e.g. Müller-Liebenau 1960, Jacquemin & Coppa 1996). The aim of this work is to compile available mayfly records for Luxembourg into an updated national checklist.

2. Material and methods

This update of the national checklist of mayflies by Dolisy (2000) is based on the results of several research projects carried out at the MNHNL in collaboration with the Luxembourg Institute of Science and Technology (LIST; formerly the Centre de Recherche Public - Gabriel Lippman). A first project entitled «Etude biocénotique de la partie rhithrale des cours d'eau luxembourgeois», carried out during the period 1994-1998 (included in Dolisy 2000), was followed by a second project entitled «Etude de la microflore et de la macrofaune aquatique des rivières luxembourgeoises en vue de la mise au point d'un Système d'Evaluation de la Qualité écologique globale» during the period 2000-2003. As ephemeropteran larvae colonise practically all freshwater environ-

ments, both flowing and stagnant, two other projects on the inventory of macroinvertebrates in stagnant waters, carried out by the MNNHL between 2005 and 2010, have enabled the existing fauna lists to be extended. The first project was a limnological study of the water bodies in the Remerschen area ("Etangs de Remerschen") and the second was a limnological inventory of the stagnant water bodies in all municipalities of Luxembourg ("Kleingewässer"). Another European Water Framework Directive (WFD) monitoring project, carried out at LIST in 2015-2018, contributed to the present work, although most of the discoveries were at the family or genus level. Furthermore, records from GBIF and, more recently, from the iNaturalist community (research-grade) were considered. For doing so, data was downloaded on 26-06-2023 from the mdata platform (https://mdata.mnhn.lu/), which collates observation and physical collection data managed by the MNNHL (MNNHL 2023), data retrieved from GBIF and research-grade data from iNaturalist (iNaturalist 2023). A polygon slightly larger than the country-boarders of Luxembourg was used to identify "Ephemeroptera" records from 01-01-1990 onwards. The polygon was used to also include observations made along bordering rivers (e.g. Sauer, Our, Eisch, Moselle). Mayfly nomenclature and taxonomy are used according to Buffagni et al. (2023), however, they have frequently changed during the last decades. For several genera, e.g. in the Baetidae and Ephemerellidae, taxonomic boundaries are still under discussion (see e.g. Bauernfeind & Soldán 2012).

Species were identified by Danielle Dolisy and confirmed if necessary by external specialists (Prof. Gilles Jacquemin and Dr A. Haybach).

3. Results

A total of 11,399 records of mayflies were retrieved, which can be accessed via the mdata portal of the MNHNL (MNHNL 2023; Figure 1). A record thereby can comprise a single individual of a given species, or multiple individuals. Mayflies in Luxembourg are represented by 49 species, grouped in 24 genera and 9 families (Table 1, online checklist available from Dolisy et al. 2024). The checklist further includes three species belonging to three different fami-

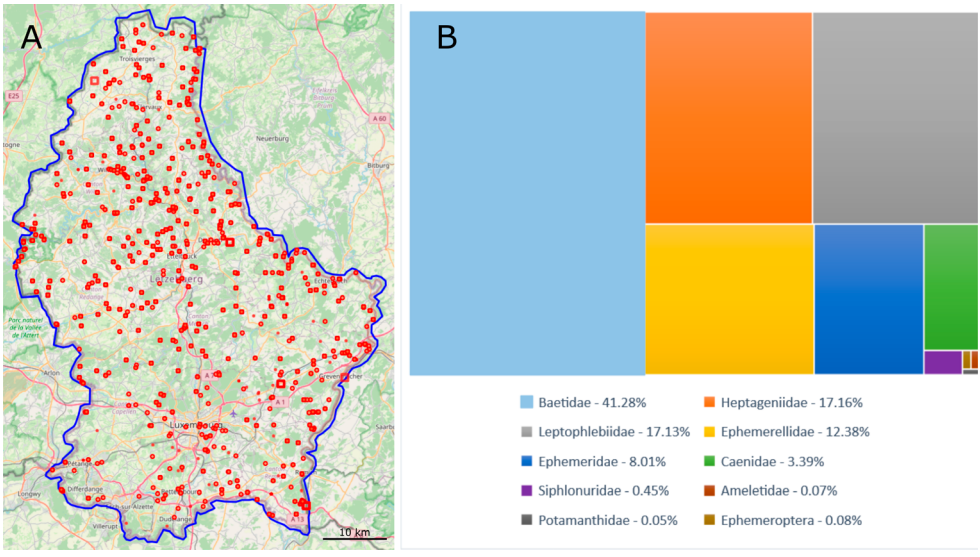


Fig. 1. Dataset of the mayfly records made in Luxembourg. **A:** Overview of the geographical origin of the records. The used polygon is depicted as a blue line. **B:** Treemap indicating the relative frequency of mayfly families. The dataset comprises 11,399 records made since 1990.

lies and genera that have not been observed since Hoffmann (1950): *Prosopistoma pennigerum* (Müller, 1785), *Ephoron virgo* (Olivier, 1791) and *Isonychia ignota* (Walker, 1853) (Table 1). Baetidae dominated the dataset (41% of records), followed by Heptageniidae and Leptophlebiidae (both 17%), and Ephemerellidae (12%) (Figure 1). The most frequently reported species were *Baetis rhodani* (Pictet, 1843) (14% of all records), *Ephemera danica* Müller, 1764 (8%), *Torleya major* (Klapálek, 1905) (7%) and *Habroleptoides confusa* Sartori & Jacob, 1986 (6%). Particularly noteworthy are the first record of *Arthroplea congener* Bengtsson, 1908 made by collecting two larvae on the 22nd of April 2010 from a pond near Grass and the Eisch River in the commune of Clémency (MNHNL93020a, b) (Figure 2), as well as the re-finding of *Caenis macrura* Stephens, 1835. The latter species was collected by a single larva in 2018 in the Sauer River at

Tab. 1. Checklist of mayflies (Ephemeroptera) of Luxembourg. Abundance of each species in the dataset retrieved from mdata.lu is classified as follows: A, >500 records; B, 101-500 records; C, 51-100 records; D, 21-50 records; E, 5-20 records; F, 1-4 records). A record can comprise a single or multiple individuals / observations of the given species at one locality. A machine-readable form of the checklist is available from Dolisy et al. (2024). *The species was identified by Peter Roos (1 larva found in the Sauer River in 2018). **The species was identified by Isabel Schrankel (found in the Eisch River in 1999). ***The species was identified by Jos Hoffmann in 1950.

Family	Species	Abundance class
Siphlonuridae	1. *Siphlonurus aestivalis* Eaton, 1903	D
	2. *Siphlonurus lacustris* Eaton, 1870)	E
Ameletidae	3. *Metreletus balcanicus* (Ulmer, 1920)	E
Baetidae	4. *Alainites muticus* (Linnaeus, 1758)	B
	5. *Baetis alpinus* (Pictet, 1843)	E
	6. *Baetis fuscatus* (Linné, 1761)	B
	7. *Baetis lutheri* Müller-Liebenau, 1967	E
	8. *Baetis melanonyx* (Pictet, 1843)	C
	9. *Baetis rhodani* (Pictet, 1843)	A
	10. *Baetis scambus* Eaton, 1870	B
	11. *Baetis vardarensis* Ikonomov, 1962	B
	12. *Baetis vernus* Curtis, 1834	B
	13. *Centroptilum luteolum* (Müller, 1776)	B
	14. *Cloeon dipterum* s.l. (Linnaeus, 1758)	B
	15. *Cloeon simile* Eaton, 1870	B
	16. *Nigrobaetis niger* (Linnaeus, 1761)	D
	17. *Procloeon bifidum* (Bengtsson, 1912)	E
	18. *Procloeon pennulatum* (Eaton, 1870)	E
Heptageniidae	19. *Epeorus assimilis* Eaton, 1885	B
	20. *Rhithrogena hercynia* Landa, 1969	F
	21. *Rhithrogena picteti* Sowa, 1971	F

Family	Species	Abundance class
	22. *Rhithrogena puytoraci* Sowa & Degrange, 1987	F
	23. *Rhithrogena semicolorata* (Curtis, 1834)	B
	24. *Ecdyonurus dispar* (Curtis, 1834)	E
	25. *Ecdyonurus insignis* (Eaton, 1870)	D
	26. *Ecdyonurus submontanus* Landa, 1969	F
	27. *Ecdyonurus torrentis* Klimmins, 1942	C
	28. *Ecdyonurus venosus* (Fabricius, 1775)	E
	29. *Electrogena lateralis* (Curtis, 1834)	E
	30. *Electrogena ujhelyii* (Sowa, 1981)	D
	31. *Heptagenia sulphurea* (Müller, 1776)	D
	32. *Arthroplea congener* Bengtsson, 1908	F
Ephemerellidae	33. *Ephemerella mucronata* (Bengtsson, 1909)	D
	34. *Serratella ignita* (Poda, 1761)	B
	35. *Torleya major* (Klapálek, 1905)	A
Caenidae	36. *Caenis beskidensis* Sowa, 1973	D
	37. *Caenis horaria* (Linnaeus, 1758)	B
	38. *Caenis luctuosa* (Burmeister, 1839)	C
	39. *Caenis macrura* (Stephens, 1836)*	F
	40. *Caenis rivulorum* Eaton, 1884**	F
	41. *Caenis robusta* Eaton, 1884	E
Leptophlebiidae	42. *Leptophlebia marginata* (Linné, 1767)	E
	43. *Paraleptophlebia submarginata* (Stephens, 1836)	B
	44. *Habroleptoides confusa* Sartori & Jacob, 1986	A
	45. *Habrophlebia fusca* (Curtis, 1834)	C
	46. *Habrophlebia lauta* Eaton, 1884	B
Ephemeridae	47. *Ephemera danica* Müller, 1764	A
	48. *Ephemera vulgata* Linnaeus, 1758	F
Potamanthidae	49. *Potamanthus luteus* (Linnaeus, 1767)	E
Prosopistomatidae	50. *Prosopistoma pennigerum* (Müller, 1785)***	n. a.
Polymitarcyiidae	51. *Ephoron virgo* (Olivier, 1791)***	n. a.
Isonychiidae	52. *Isonychia ignota* (Walker, 1853)***	n. a.

Echternach for the first time since Hoffmann (1950). Finally, and according to Thomas et al. (1999), *Epeorus assimilis* Eaton, 1885 is regarded as the Central European *Epeorus* species present in Luxembourg. This species was formerly treated as a synonym of *Epeorus sylvicola* (Pictet, 1865), which seems to be endemic to the Iberian Peninsula.

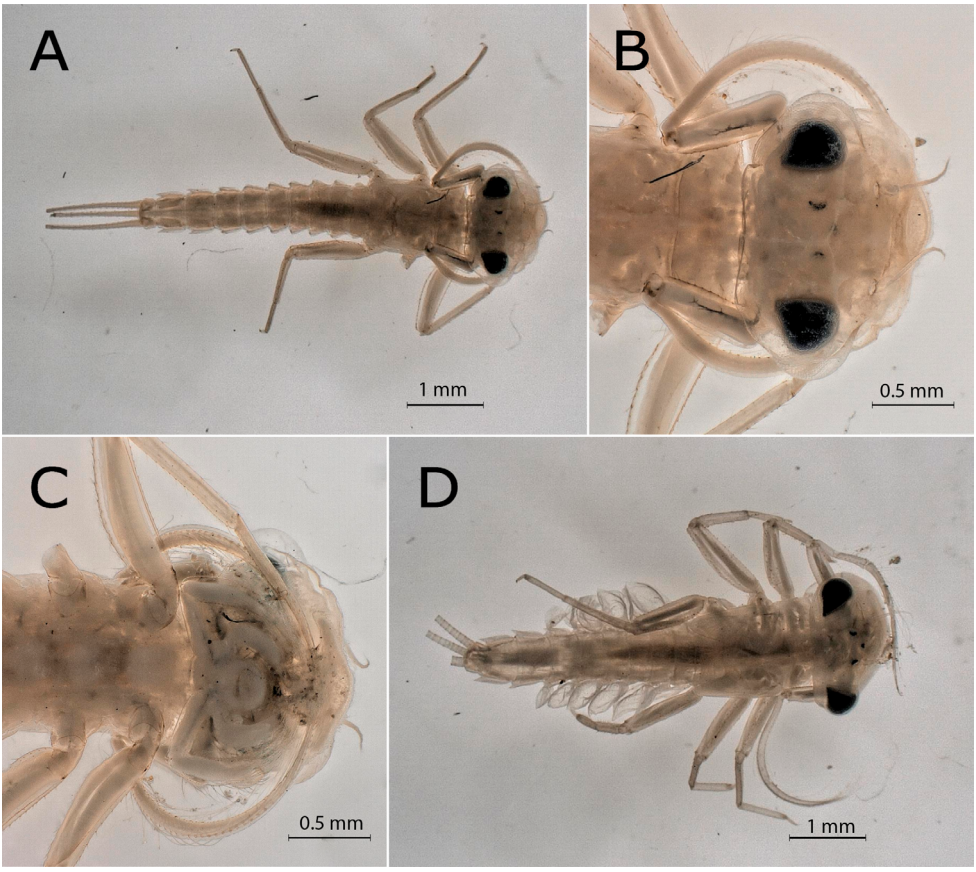


Figure 2. *Anthroplea congener* Bengtsson, 1908. **A:** dorsal view of specimen MNHNL93020a. **B:** head dorsal view of specimen MNHNL93020a. **C:** head ventral view of specimen MNHNL93020a. **D:** dorsal view of specimen MNHNL93020b. Both specimens were identified by Danielle Dolisy.

4. Discussion

The newly compiled national checklist of mayfly species for Luxembourg comprises 52 species, of which three species have not been found during the various surveys carried out since 1950: *Prosopistoma pennigerum* (Müller, 1785), *Ephoron virgo* (Olivier, 1791) and *Isonychia ignota* (Walker, 1853). The question arises whether these species have disappeared from Luxembourg in the meantime. This is probably the case for *Prosopistoma pennigerum* (Müller, 1785), which is considered extinct all over Europe except in Spain, Russia and south-eastern Europe (personal communication A. Wagner 2022). *Isonychia ignota* (Walker, 1853) is also threatened almost everywhere, except in France where it has been recently recorded (Morgillo & Michaut 2008). In 1950, Jos Hoffmann reported it as uncommon in the lower Sauer River. Finally, *Ephoron virgo* (Olivier, 1791) has disappeared from many countries, but is on the raise in France and locally in Germany (Kureck & Fontes 1996). In the past, this species, although not very common, was present in Luxembourg along the Moselle River, the lower and middle Sauer River, the lower Alzette River and the Attert River. It would be thus not surprising to see it return to colonise their riverbeds. The first discovery of *Arthroplea congener* Bengtsson, 1908 is a remarkable observation for Luxembourg. The rarity of the sites colonised and its very disjunct European range mean that this species has endangered status, according to the IUCN code, in

Germany (Malzacher et al. 1998) and in many European countries such as France (Julienne & Brulin 2005) and Switzerland (Wagner et al. 2014). In addition to the observations made by Studemann et al. (1987), who found it in the calm zones of rivers, and those of Wagner et al. (2014), who found it in a pond, we can add that the species also colonises other environments such as small ponds. In Luxembourg, it appears that habitats favourable to this species are extremely rare. So far, this single locality has enabled the species to survive, but for how long? In view of its particular ecological requirements, only protection of the habitats colonised would enable this species, a veritable glacial relic, to survive (Zimmermann 2009). This species deserves special protection status in Luxembourg.

Previous fieldwork carried out to survey the various aquatic environments, including specifically some mayfly inventories, indicates that Luxembourg's mayfly fauna is diverse. When referring to the Sartori & Landolt (1999) model for estimating the number of Ephemeroptera species present in Central European countries, we see that for Luxembourg (2,586 km^2), the regression line (r^2= 0.66; p<0. 001) provides a value of 50. This number corresponds perfectly to the 49 species we currently consider to be present in Luxembourg. However, more detailed studies would give us a better knowledge and understanding of the very specific ecological requirements of each species and its current distribution.

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References

Bauernfeind, E. & O. Moog, 2000. Mayflies (Insecta: Ephemeroptera) and the assessment of ecological integrity: a methodological approach. *Hydrobiologia* 422: 71–83. https://doi.org/10.1007/978-94-011-4164-2_6

Bauernfeind, E. & T. Soldán, 2012. The Mayflies of Europe (Ephemeroptera). Apollo Books, Ollerup, Denmark, 781 pp.

Buffagni, A., Armanini, D. G., Cazzola, M., Alba-Tercedor, J., Lopez-Rodriguez, M. J., Murphy, J., Sandin, L. & A. Schmidt-Kloiber, 2023. Dataset "Ephemeroptera". www.freshwaterecology.info - the taxa and autecology database for freshwater organisms, version 8.0 [accessed on 26.06.2023].

Dolisy, D., 2000. Les éphémères du Grand-Duché de Luxembourg: 1. Partie rhithrale des cours d'eau : Faunistique [Ephemeroptera]. *Ephemera* 2 (1): 7–14.

Dolisy, D., Weigand, A. & P. Braun, 2024. Ephemeroptera of Luxembourg checklist 2024. Version 1.9. Musée national d'histoire naturelle Luxembourg. Checklist dataset https://doi.org/10.21373/cbyaq5 [accessed on 13.02.2024].

Hoffmann, J., 1950. Essai d'un inventaire des Euplectoptères observés dans le Grand-Duché de Luxembourg. *Archives de l'Institut Grand-Ducal de Luxembourg, Section des Sciences naturelles* 19: 509–554.

iNaturalist, 2023. iNaturalist.org research-grade Observations from Luxembourg. Accessed through MNHNL-mdata at https://mdata.mnhn.lu [26-06-2023].

Jacquemin, G. & G. Coppa, 1996. Inventaire des Ephémères de Lorraine et de Champagne-Ardenne (N-E France): premiers résultats (Ephemeroptera). *Bulletin de la Société Entomologique Suisse* 69: 141–155.

Julienne, L. & M. Brulin, 2005. Additions à la faune des Ephémères de France (11) : *Arthroplea congener* Bengtsson, 1908 [Ephemeroptera, Arthropleidae]. *Ephemera* 7 (2): 89–94.

Kureck, A. & R. J. Fontes, 1996. The life cycle and emergence of *Ephoron virgo*, a large potamal mayfly that has returned to the River Rhine. *Large Rivers* 10: 319-323. https://doi.org/10.1127/lr/10/1996/319

MNHNL (2023). Recorder-Lux, database on the natural heritage of the Grand Duchy of Luxembourg. National Museum of Natural History, Luxembourg. Occurrence dataset accessed through MNHNL-mdata at https://mdata.mnhn.lu accessed [26-06-2023].

Morgillo, A. & E. Michaut, 2008. Nouvelle présence d'*Isonychia ignota* (Walker, 1853) dans le bassin de la Loire. [Ephemeroptera, Isonychiidae]. *Ephemera* 10 (1): 42.

Müller-Liebenau, I., 1960. Eintagsfliegen aus der Eifel (Insecta, Ephemeroptera). *Gewässer und Abwässer* 27: 55–79.

Sartori, M. & P. Landolt, 1999. Atlas de distribution des éphémères de Suisse (Insecta, Ephemeroptera). *Fauna helvetica* 3: 1–213.

Studemann, D., Landolt, P. & I. Tomka, 1987. Complément à la description de *Arthroplea congener* BENGTSSON, 1908 (Ephemeroptera) et son statut systématique. *Bulletin de la Société Fribourgeoise des Sciences Naturelles* 76: 144–167. https://doi.org/10.5169/seals-308667

Thomas, A., Marie, V. & M. Brulin, 1999. Corrections à la Faune des Ephémères d'Europe occidentale : 2. *Epeorus assimilis* Eaton, 1885 est une espèce valide, distincte d'*E. sylvicolus* (Pictet, 1865) [Ephemeroptera, Heptageniidae]. *Ephemera* 1 (2): 85–91.

Türkmen, G., & N. Kazanci, 2015. Determining the reference Ephemeroptera communities in the eastern part of the Black Sea region for the implementation of the Water Framework Directive in Turkey. *Transylvanian Review of Systematical and Ecological Research* 17 (1): 177–194. https://doi.org/10.1515/trser-2015-0058

Wagner, A., Stuck, P. & M. Sartori, 2014. *Arthroplea congener* BENGTSSON, 1908 (Ephemeroptera: Heptageniidae) un genre et une espèce nouveaux pour la faune de Suisse. *Bulletin de la Société Entomologique Suisse* 87: 61–69.

Zimmermann, W. 2009. Die Eintagsfliege *Arthroplea congener* - ein Insekt der Tundra mit eigenartiger Lebensweise und außergewöhnlicher Verbreitung. *Landschaftspflege und Naturschutz in Thüringen* 46 (2): 73–79.