



## Mayfly taxonomy (Arthropoda: Hexapoda: Ephemeroptera) during the first two decades of the twenty-first century and the concentration of taxonomic publishing

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### Introduction & Background

The twentieth anniversary of the first issue of *Zootaxa* (De Moraes & Freire, 2001) provides an appropriate opportunity to reflect on some trends in global Ephemeroptera taxonomy publishing over the last two decades, with a focus on the description of new species and the outsized role of the journals *Zootaxa* and *ZooKeys*, in particular. Detailed reviews of world Ephemeroptera knowledge up to about 2000 were collected in a series of nine papers from a symposium on the subject, published together in the proceedings of the ninth International Conference on Ephemeroptera (Domínguez 2001). Domínguez & Dos Santos (2014) provided updates and analysis for South America up to the year 2012. More recent detailed accounts of regional and taxonomic diversity, and other aspects of mayfly biology and ecology, were reviewed by Jacobus *et al.* (2019), while Ogden *et al.* (2019) discussed current issues involving higher classification.

### The Rise of *Zootaxa* and *ZooKeys*: Concentration of Taxonomic Publishing

Since the first Ephemeroptera paper was published in *Zootaxa* on 15 May 2002 (Salles & Lugo-Ortiz, 2002), over 40% of new mayfly species have been published in *Zootaxa*. A total of 289 papers with a primary focus on Ephemeroptera have been published in *Zootaxa* since its launch (Table 1). The Ephemeroptera editors have been among the most productive editors of the journal (*e.g.*, Zhang 2014, 2015). The two most-cited papers (according to Google Scholar) are by Kluge & Novikova (2014) and Sun & McCafferty (2008), each with about 40 citations.

**TABLE 1.** Annual tallies of papers, new species and new genera for Ephemeroptera in *Zootaxa* and *ZooKeys*; totals of new species and new genera of mayflies across all outlets also given. Fossil taxa excluded. Numbers before 2001 exclude junior synonyms, homonyms and invalid names.

| year          | number of<br><i>Zootaxa</i><br>papers | number of<br><i>Zookeys</i><br>papers | total number<br>of new species | new species<br>in <i>Zootaxa</i> | new species<br>in <i>Zookeys</i> | total number<br>of new genera | new<br>genera in<br><i>Zootaxa</i> | new<br>genera in<br><i>Zookeys</i> |
|---------------|---------------------------------------|---------------------------------------|--------------------------------|----------------------------------|----------------------------------|-------------------------------|------------------------------------|------------------------------------|
| before        |                                       |                                       | 2823                           |                                  |                                  | 389                           |                                    |                                    |
| 2001          | 0                                     |                                       | 41                             | 0                                |                                  | 3                             | 0                                  |                                    |
| 2002          | 1                                     |                                       | 26                             | 1                                |                                  | 1                             | 0                                  |                                    |
| 2003          | 3                                     |                                       | 30                             | 2                                |                                  | 5                             | 0                                  |                                    |
| 2004          | 5                                     |                                       | 57                             | 4                                |                                  | 4                             | 0                                  |                                    |
| 2005          | 5                                     |                                       | 29                             | 5                                |                                  | 5                             | 1                                  |                                    |
| 2006          | 8                                     |                                       | 49                             | 13                               |                                  | 5                             | 2                                  |                                    |
| 2007          | 13                                    |                                       | 20                             | 8                                |                                  | 3                             | 1                                  |                                    |
| 2008          | 8                                     | 0                                     | 62                             | 31                               |                                  | 16                            | 7                                  |                                    |
| 2009          | 12                                    | 0                                     | 39                             | 21                               |                                  | 5                             | 1                                  |                                    |
| 2010          | 20                                    | 0                                     | 44                             | 21                               |                                  | 5                             | 3                                  |                                    |
| 2011          | 17                                    | 1                                     | 69                             | 27                               | 0                                | 3                             | 1                                  | 0                                  |
| 2012          | 11                                    | 0                                     | 33                             | 10                               |                                  | 5                             | 0                                  |                                    |
| 2013          | 20                                    | 1                                     | 48                             | 24                               | 0                                | 2                             | 0                                  | 0                                  |
| 2014          | 21                                    | 4                                     | 40                             | 29                               | 0                                | 3                             | 1                                  | 0                                  |
| 2015          | 27                                    | 5                                     | 65                             | 43                               | 6                                | 4                             | 1                                  | 2                                  |
| 2016          | 19                                    | 7                                     | 46                             | 24                               | 0                                | 6                             | 3                                  | 0                                  |
| 2017          | 26                                    | 3                                     | 57                             | 46                               | 4                                | 2                             | 0                                  | 0                                  |
| 2018          | 18                                    | 5                                     | 57                             | 17                               | 34                               | 3                             | 1                                  | 0                                  |
| 2019          | 24                                    | 8                                     | 60                             | 25                               | 22                               | 2                             | 1                                  | 0                                  |
| 2020          | 31                                    | 13                                    | 83                             | 37                               | 35                               | 7                             | 3                                  | 0                                  |
| <b>Totals</b> | <b>289</b>                            | <b>47</b>                             | <b>3778</b>                    | <b>388</b>                       | <b>101</b>                       | <b>478</b>                    | <b>26</b>                          | <b>2</b>                           |

In 2008, another biodiversity journal with a focus on identification and taxonomy, *ZooKeys*, was launched by Pensoft. The two journals are contrasted by very different policies regarding publishing costs. *Zootaxa* is free of charge, unless you choose to pay for your paper to have open access (freely accessible online by all). By the end of 2020, 26 Ephemeroptera papers had been published as open access in *Zootaxa*. *ZooKeys*, on the other hand, fully follows the Creative Commons Attribution License 4.0, which means that all papers are open access; however, authors must pay for publication. A total of 47 papers about mayflies have been published in *ZooKeys* through the end of 2020 (Table 1). The first paper in *ZooKeys* dealing with mayflies involved a fossil identified to the family level (Prokop & Nel 2011). The first paper with a focus on recent mayflies appeared in 2013 (Boonsoong & Braasch, 2013), and the first new genera and new species described in *ZooKeys* appeared on the same day in 2015 (Molineri *et al.* 2015, Shi & Tong, 2015). The two most-cited papers (according to Google Scholar) are by Vilenica *et al.* (2015) and Salur *et al.* (2016), with about 20 citations each. Both of these papers are faunistic checklists. Such checklists usually are outside the scope of manuscripts considered by the *Zootaxa* Ephemeroptera editors.

From 2015–2020, nearly four out of every five new mayfly species have been described in *Zootaxa* or *ZooKeys*. This means that mayfly scholars just need to follow two journals to be aware of roughly 80% of advances in Ephemeroptera taxonomy. This reflects a steady trend of concentration and defragmentation of taxonomic publishing (Zhang 2006, 2015). Despite the apparent competition from *ZooKeys*, more than 50% of new mayfly species descriptions since the start of 2015 have continued to appear in *Zootaxa*. Notably, more than 60% of new mayfly species appearing in *ZooKeys* over the course of its history were included in just three publications about a single hyperdiverse genus, *Labiobaetis* Novikova & Kluge 1987 (Kaltenbach & Gattolliat 2018, 2019; Kaltenbach *et al.* 2020).

About one-third of all new genera during the time periods detailed above have been published in *Zootaxa* (Table 1). Just the two genera mentioned previously (Molineri *et al.* 2015) have been described in *ZooKeys*.

## 2020: A Remarkable Year

The year 2020 was notable in that 83 new mayfly species were described across all sources (*Zootaxa*, *ZooKeys* and others); this is the highest annual total since 2000 (Table 1), and it is one of the highest ever totals (we have not yet produced good annual global tallies for previous years). Thirty-seven new species were published in *Zootaxa* during 2020 (excluding one fossil species), the highest annual total for new mayfly species in this journal (Table 1). Three new mayfly genera were described in *Zootaxa* during the year. Thirty-five new species were described in *ZooKeys*, the highest annual total (barely exceeding 34 described in 2018) (Table 1). More than one in four species described during 2020 belong to the genus *Labiobaetis* (e.g., Kaltenbach & Gattolliat 2020, Kaltenbach *et al.* 2020). During 2020, nearly 87% of all new mayfly species were described in just *Zootaxa* and *ZooKeys*.

Human and non-human biological diversity interactions were highlighted in 2020 by the emergence of the coronavirus SARS-CoV-2 as a global threat. In spite of the COVID-19 disease pandemic and global response that followed, 31 Ephemeroptera papers appeared in *Zootaxa*, and 13 appeared in *ZooKeys*. Even though many authors were facing restricted access to collections and offices, this is the highest annual total ever for *Zootaxa*, exceeding the previous high of 27 during 2015. This also is the highest annual total for *ZooKeys*, exceeding the previous high of eight, set in 2019 (Table 1, Figure 1).

We tallied 3,778 named species of recent mayflies worldwide at the end of 2020 (Table 1). This total excludes junior synonyms and homonyms and any invalid names; due to the subjective nature of synonyms, and disagreement among taxonomic authorities, this number should be considered a precise estimate.

## Editorial Histories in Brief

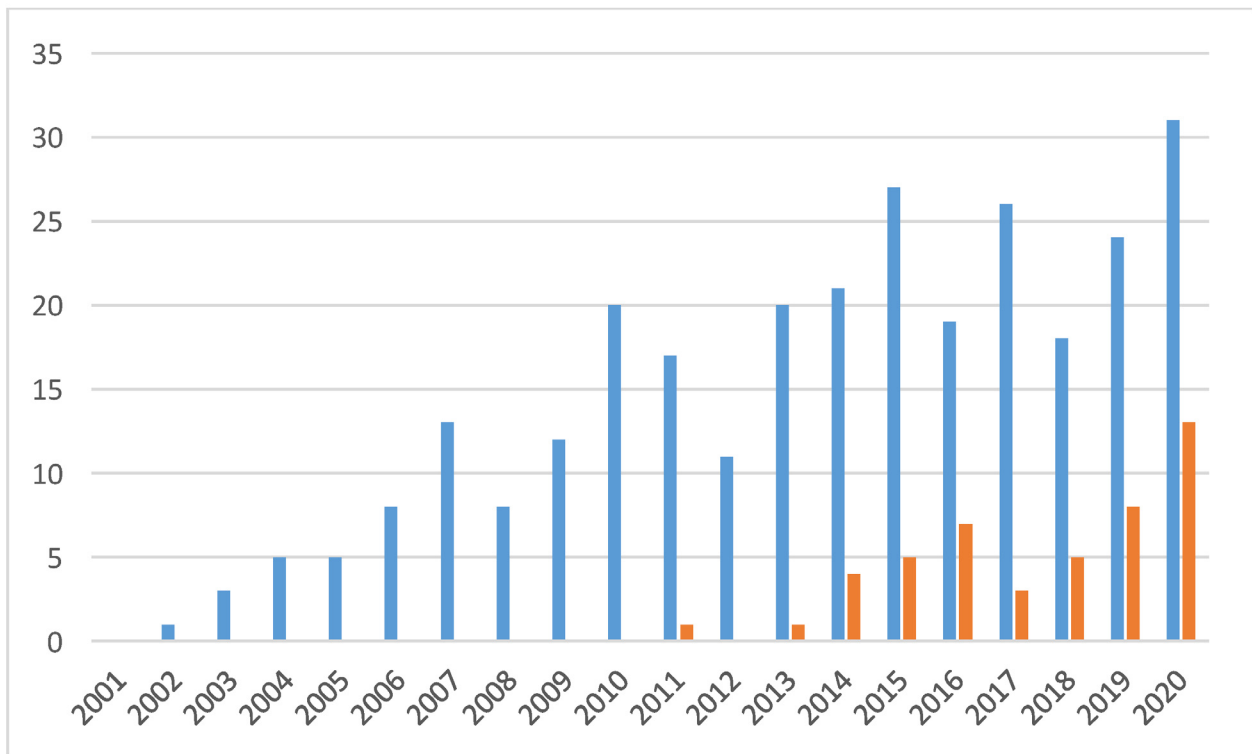
The monumental concentration of work represented within the pages of *Zootaxa* and *ZooKeys* would not be possible without dedicated teams of editors.

Seven individuals have served as nominal Ephemeroptera subject editors for *Zootaxa*. Michael D. Hubbard (Florida A&M University, USA) was the first Ephemeroptera editor for *Zootaxa* and served until his death in 2012. Fred Salles (currently Universidade Federal de Viçosa, Brazil) joined in 2009 (following a heavy work load by Hubbard in 2007–2008) and has served since then with intermittent hiatus. Luke Jacobus (Indiana University Purdue University Columbus, USA) joined in 2012 (upon losing Hubbard) and currently coordinates activity among the editors. Michel Sartori (Musée Cantonal de Zoologie, Lausanne, Switzerland) joined in 2014 during a hiatus by Salles. Phil Suter (La Trobe University, Australia) joined in 2016 (after three years of steady increase in manuscripts) and retired from service in 2019. Carlos Molineri (Neotropical Biodiversity Institute (IBN) CONICET and National University of Tucumán, Argentina) and Tatyana Tiunova (Russian Academy of Sciences, Vladivostok, Russia) began their service in late 2020. A few others served as guest editors, as needed, when potential conflicts of interest were present. Ernest Barnard (University of Tennessee, USA) served as editor for at least three manuscripts in this regard.

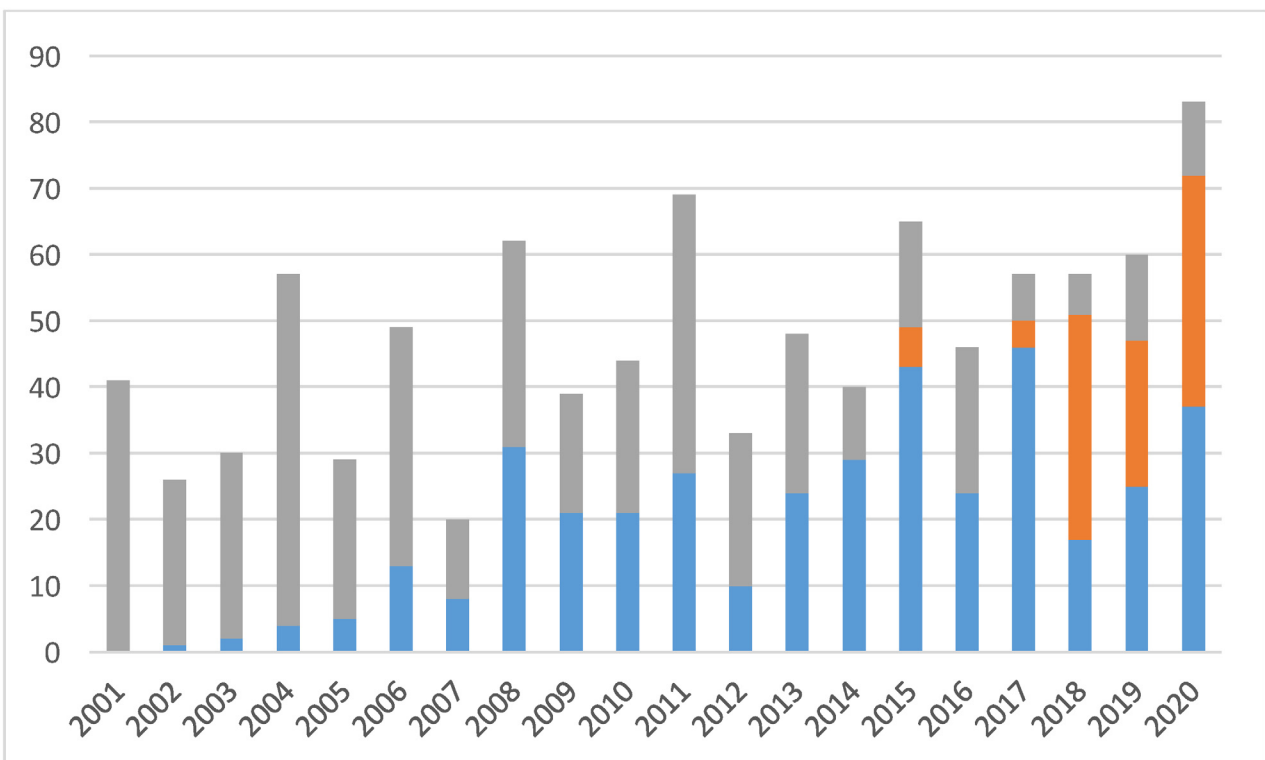
*ZooKeys* has a team of three editors: Eduardo Domínguez (Neotropical Biodiversity Institute (IBN) CONICET and National University of Tucumán, Argentina) has served since 2013; Ben Price (Natural History Museum London, UK) has served since 2015; and Lyndall Pereira-da-Conceicao (Wellcome Sanger Institute) has served since 2016.

## Rates of Rejection and Revision

More than half of the mayfly manuscripts handled by *Zootaxa* editors during 2020 required major revision before they were accepted for publication. About one out of seven manuscripts received by *Zootaxa* editors were rejected, and about an equal proportion that were submitted remain unpublished, pending major revisions by the authors. We do not have long-term data for *Zootaxa* mayfly manuscripts primarily due to the loss of the first editor and also due to subsequent turnover in more recent years.



**FIGURE 1.** Annual numbers of Ephemeroptera papers in *Zootaxa* (blue) and *ZooKeys* (orange), 2001–2020. *Zootaxa* launched in 2001, and *ZooKeys* launched in 2008.



**FIGURE 2.** Annual numbers of new Ephemeroptera species published in *Zootaxa* (blue), *ZooKeys* (orange), and all other sources (gray). *Zootaxa* launched in 2001, and *ZooKeys* launched in 2008.

Over the course of *ZooKeys* publishing, four mayfly manuscripts have been rejected (under 8% rejection rate); two manuscripts required major revision before being accepted; and one was withdrawn due to challenges with processing charges.

## Conclusions

For the time being, the dominance of *Zootaxa* as a source of mayfly taxonomic biodiversity information appears to be holding, and *ZooKeys* is growing. Both journals show a trend of increasing numbers of Ephemeroptera publications (Figure 1). The record numbers of manuscripts detailing new taxa during 2020 may have been due, at least in part, to time and effort diverted from other areas of work restricted by the global response to COVID-19. Also, more new taxa are being described from parts of Asia that have been long-neglected (e.g., India). Studies of the genus *Labiobaetis* have contributed to recent species totals and publishing trends in a major way.

The relatively low rejection and revision rates over time for both journals are due to a combination of factors, including strong collaborations between experienced and new researchers, extra efforts by editors and reviewers to improve manuscripts (sometimes over the course of years), and clearly stated expectations for manuscripts for both journals (e.g., Dubois *et al.* 2011). The higher rejection and major revision rates for *Zootaxa* are mostly due to less experienced specialists with local or regional expertise recently striving to become more independent. This probably is a natural byproduct of the transitional stage between pioneering and autonomous work for certain poorly studied areas (Dominguez & Dos Santos 2014).

The fact that nearly 87% of all new mayfly species described during 2020 appeared in just *Zootaxa* and *ZooKeys* (Table 1) provides clear illustration of the trend of centralization of taxonomic publishing (Zhang 2015). This trend is apparent in Figure 2. This brings up many considerations. Following the majority of taxonomic developments is now more convenient than ever. Also, centralization of biodiversity data would seem to amplify their power (Zaspel *et al.* 2020). On the other hand, a sardonic juxtaposition is to be found in the decreasing diversity of biodiversity publishing.

## Acknowledgments

We thank Zhi-Qiang Zhang (*Zootaxa* chief editor) for suggesting valuable improvements to this paper. Most importantly, we owe a debt of gratitude to the generous individuals who serve as reviewers of manuscripts, often several times per year. Annually since 2013, lists of the ca. 30–40 individuals who served as *Zootaxa* reviewers have been published in *The Mayfly Newsletter* (<https://dc.swosu.edu/mayfly/>), along with annual summaries and commentaries. All editors and reviewers of both journals serve on a voluntary basis, with no financial or other personal considerations provided for their work. Thus, these journals are built on the volunteer work of those who choose to serve their purposes.

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