Review

Eight years of BioInvasions Records: patterns and trends in alien and cryptogenic species records

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Abstract

“BioInvasions Records” (BIR) is an international journal founded in 2011, with its primary focus the publication of new records of non-native species. We analyzed all published articles in BIR between 2012 and 2019, aiming to: make all georeferenced records openly available; investigate spatio-temporal patterns in reported records, methodologies for species identification, and pathways of invasion; and identify possible biases in reporting alien species occurrences and distributions. In total, 10457 georeferenced records were retrieved from 467 published articles, reporting 628 different species. Terrestrial species were under-represented in the dataset. Chordata dominated in the list of reported species, followed by Arthropoda, Mollusca, and Tracheophyta. Europe was the continent with most recorded species, followed by North America. In terms of species reported by country, USA ranked on top. This geographic bias is in accordance with global patterns of research output, related to the fact that North America and Western Europe are leaders in funding research and development, and this is where the majority of highly ranked universities are situated. The country diversity of reported species exhibited an increasing trend from 28 countries in 2012 to 49 countries in 2019. Single-author papers represented only ~5% of all published papers, and the median number of authors has increased from 3 in 2012–2013, to 4 in 2015–2019, following global trends of increased collaborations. The frequency of conducting molecular analyses for species identification has increased from 4.5% of published articles in 2012 to 25.2% in 2019, and is expected to further increase with the continuing development of molecular tools, in particular rapid advances and cost reduction in eDNA, next-generation sequencing, barcoding and metabarcoding analyses. The most common pathway of introduction (based on the CBD classification) was “transport-stowaway”, followed by “escape from confinement” and “corridor”. However, the importance of pathways significantly differed by environment. “Transport-stowaway” was the most important pathway for marine and transitional species, whereas “escape from confinement” was the most important pathway for terrestrial and freshwater species. The most important CBD pathway subcategory was “ship/boat ballast water”, followed by “interconnected waterways/basins/seas”, “natural dispersal across borders”, “ship/boat hull fouling”, “aquaculture/mariculture”, and “pet/aquarium/terrarium species (including live food for such species)”. BIR has provided the means for publishing valuable information on the distribution of alien species, the dynamics of invasions, and pathways of introduction, therefore substantially supporting invasion science and management.

Key words: biodiversity, biological invasions, invasive alien species, non-indigenous, pathway of introduction, spatial distribution
Introduction

Humans have transported (intentionally or unintentionally) many thousands of species beyond their natural ranges, reshaping global biogeography (Turbelin et al. 2017) and breaking down biogeographic barriers (Capinha et al. 2015). The impacts of biological invasions are well documented in the scientific literature. Invasive species constitute one of the main drivers of global change and biodiversity loss (Simberloff et al. 2013; Pyšek et al. 2020), often compromise the flow of ecosystem services (Katsanevakis et al. 2014; Vilà and Hulme 2017; Castro-Díez et al. 2019), and can have substantial negative impacts on human health (Mazza et al. 2014; Pyšek et al. 2020). On the other hand, some alien species can be beneficial for biodiversity and ecosystem services (Katsanevakis et al. 2014; Vimercati et al. 2020) and can be even considered as important contributors in reaching conservation goals by securing ecosystem functioning (Mačić et al. 2018; Katsanevakis et al. 2020a).

Globalization and the intensification of trade and transport have accelerated biological invasions on all continents with no sign of saturation (Seebens et al. 2017). It is estimated that alien species will keep accumulating in the following decades (Seebens et al. 2021), and their future impacts are expected to increase in most socioecological contexts mostly driven by transport, climate change and socio-economic change (Essl et al. 2020). Hence, it is of utmost importance to support biological invasions science with relevant datasets of presence, distribution, pathways of introduction, and impacts of alien species. To gain a better understanding of ecosystem functioning, and for the effective management and conservation of ecosystems in an era of global change and cumulative anthropogenic pressures (Gissi et al. 2021), there is a need for adequate spatiotemporal knowledge of biota at relevant scales. In particular, such datasets are needed to support the achievement of global commitments of the signatories of the Convention on Biological Diversity (CBD 2010) and the United Nation’s Sustainable Development Goals (UN 2015) to prevent the introduction and significantly reduce the impacts of invasive alien species. Management of invasive species should be evidence-based (Sutherland et al. 2004), and thus access to high quality datasets is essential.

In recent years, a remarkable increase in the availability of biodiversity data has been observed (La Salle et al. 2016). In particular, global data on alien species and their distribution have greatly improved over the last couple of decades through a multitude of targeted projects, comprehensive accounts, citizen science initiatives, and online databases (e.g. Katsanevakis et al. 2015; Fuller and Neilson 2015; Pagad et al. 2018; Giovos et al. 2019; Ahyong et al. 2020). Nevertheless, comparisons of online databases has revealed low level of overlap, indicating that there is an amount of data not fully exploited (Gatto et al. 2013; Seebens et al. 2020). For many taxonomic groups, data on alien species distributions remain limited (Thakur et al.
2019), and regional biases in terms of data availability exist (Pyšek et al. 2008; McGeoch et al. 2010). Often information on alien species distribution remains buried in the personal files of researchers or in scattered repositories (Katsanevakis et al. 2020b). Such information is vital to assess the role of alien species in the ongoing changes of biodiversity patterns, their invasion progress, impacts and temporal dynamics, and to develop species distribution models to forecast their present and future distributions. Hence, publication of alien species records and distributions is vital to support invasion science and management.

Journals publishing first records of alien species, checklists, or extensive datasets of alien species records, often amended with information on native ranges, pathways of introduction, and impacts, have been invaluable in feeding large databases (e.g. Trombetti et al. 2013; Katsanevakis et al. 2020b), and thus substantially contribute in risk analyses and management of biological invasions (Lucy et al. 2016). “BioInvasions Records” (hereafter BIR) is a primary example of this journal type, with its focus on the “publication of accounts of new records of both aquatic and terrestrial non-native species and other applied papers in the area of biological invasions” (Lucy and Panov 2012). BIR has aimed to “provide solutions to the growing issues of (1) environmental and biodiversity-related data sharing (Costello 2009), and (2) the support of online databases of invasive alien species with geo-referenced species records data” (Lucy and Panov 2012).

We herein reviewed all published articles in BIR between 2012 and 2019, aiming to (1) compile all published georeferenced species records in BIR and make them openly available in a single database; (2) investigate spatial patterns and temporal trends in reported records, methodologies for species identification, reported pathways of invasion; and (3) identify possible geographical biases, methodological gaps, or other obstacles in the smooth flow of information of alien species occurrences and distributions.

**Materials and methods**

We reviewed all published articles in BIR between April 2012 (first issue) and December 2019. For each article, the following information was retrieved: (1) bibliographic information such as DOI, short reference (author, year), year of publication, volume, issue, pages, number of authors, number of countries in affiliations; (2) environment (terrestrial, freshwater, marine, transitional); (3) continent (Europe, Asia, Africa, North America, South America, Australia, Antarctica); (4) country; (5) marine biogeographic realm (only for marine species) according to Spalding et al. (2007) (Arctic, Temperate Northern Atlantic, Temperate Northern Pacific, Tropical Atlantic, Western Indo-Pacific, Central Indo-Pacific, Eastern Indo-Pacific, Tropical Eastern Pacific, Temperate South America, Temperate Southern Africa, Temperate Australasia, Southern Ocean); (6) terrestrial biogeographic realms (for terrestrial, freshwater, and transitional species) in line with
Olson et al. (2001) (Neartic, Neotropic, Palearctic, Afrotrropic, Indo-Malay, Australasia, Antarctic, Oceania); (7) number of alien species reported; (8) reported species; (9) Phylum; (10) approach for taxonomic identification (only morphological, only molecular analysis, combination of morphological and molecular analyses); (11) if an introduction pathway is suggested (yes/no); (12) main introduction pathway suggested, classified according to the CBD main categories, i.e. “release in nature” (“species intentionally transported and released in the (semi)natural environment with little to no dedicated anthropogenic assistance” post-release), “escape from confinement” (“species that have escaped from the confined or controlled environments where they were kept and cared for a number of purposes, e.g. provide food, resources, services or companionship”), “transport-contaminant” (“species introduced unintentionally or accidentally through the movement of other organisms or organic materials and products”), “transport-stowaway” (“species introduced into natural environments as accidental stowaways or hitchhikers on a variety of vectors”), “corridor” (“species spreading to new regions along artificially created infrastructure corridors such as bridges, tunnels, canals”), and “unaided” (“species that spread to new regions by natural dispersal, without action or assistance by humans, from regions in which they are alien and were introduced by one of the other introduction pathways”) (Harrower et al. 2017); (13) main introduction pathway suggested, classified according to the CBD subcategories (e.g. “ship/boat hull fouling”, “hitchhikers on ship/boat”, “contaminant on animals”, “parasites on animals”, “horticulture”, “food contaminant” etc; see Harrower et al. 2017, for a full account and detailed definitions); (14) first record in country (yes/no); (15) first record in continent (yes/no).

All georeferenced records reported in the articles were compiled in an additional database and were mapped with the GIS software ArcMap v10.7.1. In addition to descriptive statistics to present the review results, cross-tabulation analysis was conducted to quantify the degree of association between selected pairs of variables, using the software Statgraphics Centurion XVI. The hypothesis of independence between such pairs was tested with chi-square tests.

Results

Overall, data were retrieved from 467 published articles, reporting, in total, 10457 georeferenced records (Supplementary material Table S1) of 628 different species (854 species reports in total), of which 275 were freshwater, 268 marine, 66 terrestrial, and 19 were reported from transitional environments (estuaries, lagoons) (Figure 1A). There were no articles reporting terrestrial species in 2012 and 2013 but, subsequently, terrestrial submissions increased reaching 26 articles in 2019 (24.5% of published articles) (Figure 2). Chordata (including mainly vertebrates but also ascidians) dominated in the list of reported species, followed by Arthropoda, Mollusca,
Figure 1. Identity of the species records in the 467 reviewed BIR articles between 2012–2019. (A) Share of reported species by environment (N = 628). (B) Share of reported species by Phylum (N = 628). (C) Share of species reports by continent (N = 854). (D) Share of reported species by country (N = 891).

Figure 2. Trends in the share of published articles in BIR by environment (freshwater, marine, transitional, and terrestrial) between 2012–2019.

and Tracheophyta (Figure 1B). Europe was the continent with most reported species, followed by North America and Asia, whereas Australia was the least represented continent, excluding Antarctica, from which there were
no records (Figure 1C). Temperate Northern Atlantic was the marine biogeographic realm mostly represented in marine records, and Palearctic was the terrestrial biogeographic realm mostly represented in both freshwater and terrestrial records. The distribution of records was highly patchy, with vast areas lacking any record, in particular in Asia, Africa and Australia (Figure 3). Among the species reported, 28.8% were first country records, and 3.9% first continent records.

In terms of species reported in each country, USA ranked on top followed by Ukraine, Canada, and China (Figure 1D). Some countries ranked high due to a small number of papers reporting national or subnational checklists, e.g. Schofield and Akins (2019) for USA, Semenchenko et al. (2016) for Ukraine, and Xiong et al. (2018) for China, or large-scale studies, e.g. Gartner et al. (2016) for Canada. Reports of alien species from 105 different countries have been published in BIR between 2012 and 2019. Temporal differences in reporting were observed in certain countries, e.g. only one alien species was reported from Libya (which is considered a data-poor country) before 2017 by Milazzo et al. (2012) without the participation of any Libyan authors, while between 2017–2019 fifteen species were reported from that country in six different publications all led by Libyan scientists (Shakman et al. 2017; Rizgalla et al. 2018, 2019a, b, c, d), most published by a single research team. The country diversity of reported species exhibited an increasing trend from 28 countries in 2012 to 49 countries in 2019 (Figure 4). There was an increasing number of reported alien species from new countries (with no previous records in BIR) in the last years, with 11 new countries in 2019 (Figure 4), i.e. Botswana (Buxton et al. 2019), Curaçao (Behm et al. 2019), Guinea-Bissau (Catarino et al. 2019), Iran (Mohaddasi et al. 2019), Korea (Kang et al. 2019), Serbia (Živković et al. 2019), Slovenia...
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Figure 4. Annual trend of the total number of countries from which species were reported in BIR between 2012–2019 (bars, left axis). The temporal distribution of the number of countries that were represented only in one article each during the 2012–2019 period is also provided (red line, right axis).

(Sajna 2019), Tanzania (Kuguru et al. 2019), The Bahamas (Liebgold et al. 2019), Uganda (Vanderhaegen et al. 2019), and Venezuela (Lodeiros et al. 2019).

The median number of authors has increased from 3 in 2012–2013, to 4 in 2015–2019 (Figure 5A). Single-author papers represented only 5.4% of all published papers. In all years, most articles had 3 or 4 authors but gradually the relative number of multi-authored articles with 5 or more authors has substantially increased (Figure 5A). In 68.1% of the articles, author(s) were affiliated with organizations of a single country, in 22.3% of cases with organizations of two countries, and in much less cases with three (6.9%) or four countries (2.4%) (Figure 5B). There were only two articles with affiliations from 5 (Zhulidov et al. 2018) and 6 (Naser et al. 2012) countries.

In 81.5% of studies, species identification was based solely on morphological characters (Figure 6). In the rest of the studies molecular analyses were conducted either in combination with morphological identification (16.3%) or alone (2.1%). The frequency of conducting molecular analyses for species identification has increased from 4.5% in 2012 to 25.2% in 2019 (Figure 6). The identified species among all 14 published studies based solely on molecular analyses included species difficult to be identified morphologically or to be distinguished from similar congeneric species. Such species were fish parasites (Chiary et al. 2014; Hansen and Alarcón 2019), leeches (Soors et al. 2015), clams of the genus *Corbicula* (Okawa et al. 2016), fish of the genus *Pterois* (*miles/volitans*) (Guzmán-Méndez et al. 2017), amphipods (Lipinskaya et al. 2018), frogs of the genus *Pelophylax* (Bellati et al. 2019; Bisconti et al. 2019), slugs ( Hirano et al. 2019), and
mosquitofish (Chang et al. 2019). Among the 86 articles that applied molecular tools for identification, there was only one single-author paper (Colgan 2017), i.e. 1.2%, while the median number of authors was 4 for the entire 2012–2019 period and 5 for 2019.
The most reported species was the blue crab *Callinectes sapidus* from the Mediterranean Sea, due to the rapid expansion of its distribution in the last decade (see Shaiek et al. 2021 and references therein). The species has been reported in nine BIR articles, of which five were in 2019 (Fuentes et al. 2019; Benabdi et al. 2019; Morais et al. 2019; Piras et al. 2019; Labrune et al. 2019).

In the 467 reviewed articles, 854 species reports were made, and for 694 a specific pathway was linked to their introduction. The most common pathway (based on the CBD classification) was “transport-stowaway”, followed by “escape from confinement” and “corridor” (Figure 7A). However, the importance of pathways significantly differed by environment (chi-square test, $p < 0.001$; the same if transitional environment is excluded from the analysis due to low number of records) (Figure 7B). “Transport-stowaway” was the most important pathway for marine and transitional species, whereas “escape from confinement” was the most important pathway for
terrestrial and freshwater species. “Release in nature” was much more important for freshwater species than for the other environments, and “transport-contaminant” for terrestrial species than for marine and freshwater. “Corridor” was the second most important pathway for aquatic species but was not reported for any terrestrial species. The importance of pathways also significantly differed by taxonomic group (chi-square test, p < 0.001; the same if only Chordata, Arthropoda and Mollusca are kept in the analysis) (Figure 7C). “Escape from confinement” was the most important pathway for Tracheophyta and Chordata, whereas “transport-stowaway” was the most important pathway for Arthropoda, Mollusca, Cnidaria, Annelida and Bryozoa.

The most important CBD pathway subcategory was “ship/boat ballast water”, followed by “interconnected waterways/basins/seas”, “natural dispersal across borders”, “ship/boat hull fouling”, “aquaculture/mariculture”, and “pet/aquarium/terrarium species (including live food for such species)” (Figure 8). The importance of each pathway subcategory substantially varied by environment. “Shipping/ballast water” was the most frequent pathway for marine species, followed by “shipping/fouling” and “interconnected waterways/basins/seas”, whereas for freshwater species “natural dispersal across borders” was the most common pathway, followed by “interconnected waterways/basins/seas”, “ship/boat ballast water”, and “aquaculture/mariculture” (Figure 8). Terrestrial species were most frequently introduced through “ornamental purpose other than horticulture”, followed by “hitchhikers on ship/boat (excluding ballast water and hull fouling)”, “food contaminant (including of live food)”, “contaminant on plants (except parasites, species transported by host/vector)”, and “horticulture”.

Figure 8. Number of species reports in BIR between 2012–2019 by CBD pathway subcategories and by environment.
Discussion

Europe was the continent with most reported species, followed by North America, and the “Temperate Northern Atlantic” biogeographic realm had by far the most reported marine species. This geographic pattern is common in global reviews or systematic mapping of ecological studies, and has been highlighted by many recent articles (e.g. Mačić et al. 2018; Kytinou et al. 2020; Gissi et al. 2021), including reviews on biological invasions (Pyšek et al. 2008). Globally, the majority of research has been conducted in North America and Europe (e.g. Badenhorst et al. 2016), which can be partly explained by the fact that North America and Western Europe are leaders in funding research and development (UNESCO Institute for Statistics 2020), and this is where the majority of highly ranked universities are situated (Jöns and Hoyler 2013). National spending on research and development, the number of universities in a country, GDP, and English proficiency have been found by various studies to positively correlate with research output (Man et al. 2004; Meo et al. 2013; Jamjoom and Jamjoom 2016; Mueller 2016). Hence, the observed geographic pattern in the distribution of published species records in BIR, should not be perceived as representative of the actual distribution patterns of alien species but it is largely an artifact of global trends in research output. It has to be noted that a similar geographic pattern as the one observed herein, was reported by an analysis of the Global Invasive Species Database and the CABI Invasive Species Compendium (Fig. 1A in Turbelin et al. 2017), with the exception of Australia which had high numbers of invasive alien species according to the latter study but is under-represented in BIR.

Records of aquatic species dominated in BIR’s articles. This is contrary to global inventories of alien species, in which terrestrial species, in particular plants and arthropods, constitute the richest groups (Turbelin et al. 2017). For example, in the European Alien Species Information Network (EASIN; Katsanevakis et al. 2015; EASIN 2020), among the 13001 alien and cryptogenic species listed, 11048 (85%) are terrestrial, of which 5950 are Tracheophyta and 3361 are Arthropods. The dominance of terrestrial plants and arthropods has been observed since Elton (1958), who commented that invasive alien species are primarily attributed to the transport of plants and related insect hitchhikers. This low representation of terrestrial species in BIR is probably partly related to the history of the journal, which emerged as a continuation of the former “Aquatic Invasions Records”, an electronic supplement of the open access journal “Aquatic Invasions”, a journal with clearly aquatic scope. Moreover, there are many other international and national outlets traditionally used for publishing records of alien terrestrial plants (e.g. EPPO Bulletin, Preslia, Weed Research, Research Journal of Agricultural Science, Acta Biologica Slovenica, Bulletin de la Société Botanique de France, Botanica Lithuanica, Acta Societatis Botanicorum Poloniae, Botanica Serbica, Acta Botanica Croatica,
Pakistan Journal of Botany) and arthropods (e.g. Bulletin of Insectology, Insects, Journal of Pest Science, Journal of Insect Conservation, Atti Accademia Nazionale Italiana di Entomologia). Nevertheless, the increasing trend of terrestrial contributions to BIR will probably lead to a more balanced reporting of alien taxa in the future.

We observed an increasing trend in the number of authors per article. Single-author articles represented only 5% of the published articles, which is quite similar to the results of MacNeil (2019) who assessed the trends in the number of authors of published articles in the journals BioInvasions Records, Aquatic Invasions and Management of Biological Invasions over a range of years until September 2018, and led him to the conclusion that we are probably witnessing “the imminent extinction of that increasingly rare species, the single-author”. Similar were the conclusions by Barlow et al. (2018) who examined the trends in the number of authors in the Journal of Applied Ecology, and noted that single-author papers accounted for > 60% of the journal’s output in the 1960s but < 4% in the last decade. Such trends had been identified since 1963 by Price (1963) who stated that “the proportion of multi-author papers has accelerated steadily and powerfully, and it is now so large that if it continues at the present rate, by 1980 the single-author paper will be extinct”. The rise of research networks and collaborations is a potent aspect of globalization of science (Leydesdorff and Wagner 2008; Gui et al. 2019), and has been reflected in the increasing number of authors in scientific articles in most scientific disciplines (Adams 2012). Such trends observed in BIR, as in other journals and disciplines, are probably related to increasing considerations of larger spatial scales and larger datasets, the growing need of multiple skills (e.g. combining field work, ecological knowledge, taxonomic expertise, and the use of molecular tools), increased internationalization through multinational networks and projects, research funding considerations often encouraging collaborations among different institutes and countries (e.g. the funding schemes of the European Commission), broader contributor recognition and more inclusive author lists often including data collectors and citizen scientists (Barlow et al. 2018; MacNeil 2019).

We found an increasing use of molecular tools for species identification, in particular in cases of high morphological similarities and lack of unique diagnostic morphological characters among related species. It is expected that with the further development of molecular tools, their use in biodiversity studies will increase in the near future (Porter and Hajibabaei 2018). In particular, rapid advances and cost reduction in eDNA, next-generation sequencing, barcoding and metabarcoding analyses are promising for early detection of new invasions, overcoming difficulties in traditional morphological approaches for species identification, allowing identification when damaged specimens may not contain the characters needed for identification or when the life stages collected lack such characters, and
allowing fast and large-scale biomonitoring of multiple alien species as part of whole communities (metabarcoding), based on water, biofilm or soil samples (Jerde et al. 2011; Muha et al. 2017). In addition to species identification, molecular approaches allow invasion biologists to better understand the mechanisms and dynamics of an invasions by identifying the origin and invasion route, assessing effective population sizes, estimating levels of genetic differentiation, and assessing hybridization with native species (Pauls et al. 2014 and references therein).

Our analysis highlighted the differing importance of the various pathways of introduction amongst environments and taxonomic groups. We are aware that due to the geographic and environmental non-representativeness of the present dataset (as previously discussed) biases may be introduced in the assessment of the importance of pathways. Nevertheless, this is a large dataset (N = 694), which we believe is of high relevance. All global databases suffer to some extent from geographic biases due to country development status, varying funding and sampling effort (McGeoch et al. 2010), and global research trends (as previously discussed). The ranking of the main pathways herein reported agrees with many other studies based on different datasets. For example, for marine species “transport-stowaway” (i.e. shipping) has been highlighted as the most important pathway in both global (Molnar et al. 2008) and regional analyses (Katsanevakis et al. 2013; Pergl et al. 2020). “Corridor” was the second most important pathway, as also found for Europe (Katsanevakis et al. 2013) due to the impact of the Suez Canal, although in the global review by Molnar et al. (2008) it ranks third after aquaculture. For freshwater species, the European review by Nunes et al. (2015), based on the assessed pathways of 550 species, also concluded that “escape from confinement” was the most important pathway. For terrestrial species, “escape from confinement” and “transport-contaminant” were also the two most important pathways highlighted by Pergl et al. (2020) (for plants and terrestrial invertebrates respectively) based on a subset of the EASIN database (298 plants and 1345 terrestrial invertebrates). Nevertheless, it has to be highlighted that in most cases there was no direct evidence for a documented pathway (e.g. a species actually found in ballast waters) but the pathway was rather based upon speculation and correlation (e.g. a marine species initially found near a major port with no other potentially accountable human activities in the wider area). Apart from intentional introductions, in most other cases more than one possible pathway can be inferred based on the human activities in the locality of the first records (Katsanevakis and Moustakas 2018).

In conclusion, BIR substantially contributed in making open access important information on the distribution of alien species, the dynamics of invasions, and pathways of introduction. Such information can feed global databases and support invasions science and management. Nevertheless,
we identified geographic and taxonomic biases, similar to existing global databases, which affect global assessments of biological invasions. We also highlighted important trends in increased research collaborations and the use of molecular tools, which can further promote biomonitoring and allow large-scale and low-cost assessments and reporting of the distribution and dynamics of biological invasions in the future. The present global analysis of pathways, despite the low representation of terrestrial species, highlighted the main pathways and thus contributes to the global efforts to prioritize management efforts for reducing the rates of new species introductions.

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References

Adams J (2012) Collaborations: The rise of research networks. Nature 490: 335–336, https://doi.org/10.1038/490335a

Ahyong S, Costello MJ, Galil BS, Gollasch S, Hutchings P, Katsanevakis S, Lejeusne C, Marchini A, Ochitipinti A, Pagad S, Poore GCB, Rius M, Robinson TB, Sterrer W, Turon X, Willan RC, Zhan A (2020) World Register of Introduced Marine Species (WRIeMS), https://doi.org/10.14284/347 (accessed 29 October 2020)

Badenhorst A, Mansoori P, Chan KY (2016) Assessing global, regional, national and sub-national capacity for public health research: a bibliometric analysis of the Web of ScienceTM in 1996-2010. Journal of Global Health 6: 010504, https://doi.org/10.7189/jogh.06.010504

Barlow J, Stephens PA, Bode M, Cadotte MW, Lucas K, Newton E, Nuñez MA, Pettorelli N (2018) On the extinction of the single-authored paper: The causes and consequences of increasingly collaborative applied ecological research. Journal of Applied Ecology 55: 1–4, https://doi.org/10.1111/1365-2664.13040

Behm JE, van Buurt G, DiMarco BM, Ellers J, Irian CG, Langhans KE, McGrath K, Tran TJ, Helmus MR (2019) First records of the mourning gecko (Lepidodactylus lugubris Duméril and Bibron, 1836), common house gecko (Hemidactylus frenatus in Duménil, 1836), and Tokay gecko (Gekko gecko Linnaeus, 1758) on Curaçao, Dutch Antilles, and remarks on their Caribbean distributions. BioInvasions Records 8: 34–44, https://doi.org/10.3391/bir.2019.8.1.04

Bellati A, Bassu L, Nulchis V, Corti C (2019) Detection of alien Pelophylax species in Sardinia (western Mediterranean, Italy). BioInvasions Records 8: 8–25, https://doi.org/10.3391/bir.2019.8.1.02

Benabdi M, Belmahi AE, Grimes S (2019) First record of the Atlantic blue crab Callinectes sapidus Rathbun, 1896 (Decapoda: Brachyura: Portunidae) in Algerian coastal waters (southwestern Mediterranean). BioInvasions Records 8: 119–122, https://doi.org/10.3391/bir.2019.8.1.13

Bisconti R, Martino G, Chiozzi A, Siclari A, Canestrelli D (2019) Balkan marsh frogs Pelophylax kartmueleri (Gayda, 1940) introduced in the Aspromonte National Park, southern Italy. BioInvasions Records 8: 26–33, https://doi.org/10.3391/bir.2019.8.1.03

Buxton M, Lebani K, Nyamukondiwa C, Wasserman RJ (2019) First record of Aedes (Stegomyia) aegypti (Linnaeus, 1762) (Diptera: Culicidae) in Botswana. BioInvasions Records 8: 551–557, https://doi.org/10.3391/bir.2019.8.3.10

Capinha C, Essl F, Seebens H, Moser D, Pereira HM (2015) The dispersal of alien species redefines biogeography in the Anthropocene. Science 348: 1248–1251, https://doi.org/10.1126/science.aaa8913

Castro-Diez P, Vaz AS, Silva JS, van Loo M, Alonso Á, Aponte C, Bayón Á, Bellingham PJ, Chiufo MC, DiManno N, Julian K, Kandert S, La Porta N, Marchante H, Maule HG, Mayfield MM, Metcalfe D, Monteverdi MC, Nuñez MA, OsterTag R, Parker IM, Pelzer DA, Potgieter LJ, Raymond M, Raymond D, Reisman-Berman O, Richardson DM, Roos RE, Saldaña A, Shackleton RT, Torres A, Trudgen M, Urban J, Vicente JR, Vilà M, Yiojo T, Zenni RD, Godoy O (2019) Global effects of non-native tree species on multiple ecosystem services. Biological Reviews 94: 1477–1501, https://doi.org/10.1111/brv.12511

Catarino L, Indjai B, Duarte MC, Monteiro F (2019) Chromolaena odorata invasion in Guinea-Bissau (West Africa): first records and trends of expansion. BioInvasions Records 8: 190–198, https://doi.org/10.3391/bir.2019.8.1.20
CBD (2010) Convention on Biological Diversity. Quick guide to the Aichi biodiversity targets.
9. Invasive alien species prevented and controlled. https://www.cbd.int/doc/strategic-plan/targets/T9-quick-guide-en.pdf

Chang C-H, Wang Y-C, Lee D-C, Yang H-C, Liu S-H (2019) Mitochondrial DNA authenticates Gambusia affinis (Baird and Girard, 1853) as the invasive mosquitofish in Taiwan. BioInvasions Records 8: 933–941, https://doi.org/10.3391/bir.2019.8.4.22

Chiary HR, Chaudhary A, Singh HS, Goswami UC (2014) Molecular characterization of two non-native species of Dactylurus (Monogenea: Dactylogyridae) recovered from introduced hosts in India. BioInvasions Records 3: 297–301. https://doi.org/10.3391/bir.2014.3.4.12

Colgan DJ (2017) The invasive slug Deroceras invadens Reise, Hutchinson, Schunack and Schlitt, 2011 occurs on Norfolk Island. BioInvasions Records 6: 9–12. https://doi.org/10.3391/bir.2017.6.1.02

Costello MJ (2009) Motivating online publication of data. BioScience 59: 418–427, https://doi.org/10.1525/bio.2009.59.5.9

EASIN (2020) European Commission - Joint Research Centre - European Alien Species Information Network (EASIN). https://easin.jrc.ec.europa.eu/ (accessed 29 December 2020)

Elton CS (1958) The ecology of invasions by animals and plants. Methuen, London, England, 181 pp, https://doi.org/10.1007/978-1-4899-7214-9

Essl F, Lenzner B, Bacher S, Bailey S, Capinha C, Dullinger S, Genovesi P, Hui C, Hulme PE, Jeltsch KE, Katsanevakis S, Kühn I, Leung B, Liebhold A, Chunlong L, Ruiz GM, Russell JC, Sanders NJ, Sax DF, Sculthorpe L, Schinbrenn L, Silver S, Springborn M, Sæther BE, Somerfield P, Toft S, Toto R, van Strien A, Weakley S, Winter M, Zenni RD, Mattson BJ, Roura-Pascual N (2020) Drivers of future alien species impacts: an expert-based assessment. Global Change Biology 26: 4880–4893, https://doi.org/10.1111/gcb.15199

Fuentes MA, Torrent L, Barrera S, Boix D (2019) Rapid invasion of the American blue crab Callinectes sapidus Rathbun, 1896 in the North-East of the Iberian Peninsula. BioInvasions Records 8: 113–118. https://doi.org/10.3391/bir.2019.8.1.12

Fuller P, Neilson ME (2015) The U.S. Geological Survey’s nonindigenous aquatic species database: over thirty years of introduced aquatic species in the United States (and counting). Management of Biological Invasions 6: 159–170, https://doi.org/10.1007/s10530-015-0206-4

Gartner HN, Murray CC, Frey MA, Nelson JC, Larson KJ, Ruiz GM, Therriault TW (2016) Non-indigenous invertebrate species in the marine fouling communities of British Columbia, Canada. BioInvasions Records 5: 205–212, https://doi.org/10.3391/bir.2016.5.4.03

Gatto F, Katsanevakis S, Vandenkerkhove J, Zenetos A, Cardoso AC (2013) Evaluation of online information sources on alien species in Europe - the need of harmonization and integration. Environmental Management 51: 1137–1146, https://doi.org/10.1007/s00267-013-0042-8

Giovos I, Kleitou P, Poursanidis D, Batjakas I, Bernardi G, Crocetta F, Dourmpas N, Kalogirou S, Kampouris TE, Keramidas I, Langeneck J, Maximiadi M, Mitsou E, Stoilas VO, Tiralongo F, Romanidis-Kyriakidis G, Vasilidi NJ, Zenetos A, Katsanevakis S (2019) Citizen-science for monitoring marine invasions and stimulating public engagement: a case project from the eastern Mediterranean. Biological Invasions 21: 3707–3721, https://doi.org/10.1007/s10530-019-02083-w

Gissi E, Manea E, Mazaris AD, Fraschetti S, Almpanidou V, Bevilacqua S, Coll M, Guarnieri G, Lloret-Llort E, Pascual M, Petza D, Rilov G, Schonwald M, Stelzenmüller V, Katsanevakis S (2021) A review of the combined effects of climate change and other human stressors on the marine environment. Science of the Total Environment 755: 142564, https://doi.org/10.1016/j.scitotenv.2020.142564

Gui Q, Liu C, Du D (2019) Globalization of science and international scientific collaboration: A network perspective. Geoforum 105: 1–12, https://doi.org/10.1016/j.geoforum.2019.06.017

Guzmán-Méndez IA, Rivera-Madrid R, Díaz-Jiménez P, García-Rivas MC, Aguilar-Espinosa M, Arias-González JE (2017) First genetically confirmed record of the invasive devil firefish Bothriopeplus achenogathni (Yamaguti, 1934) in Scandinavia. BioInvasions Records 8: 437–441, https://doi.org/10.3391/bir.2019.8.2.26

Harrower CA, Scalera R, Pagad S, Schönrogge K, Roy HE (2017) Guidance for interpretation of CBD categories on introduction pathways. Technical note prepared by IUCN for the European Commission. https://www.cbd.int/doc/10.3391/bir.2017.6.2.02

Hansen H, Alarcón M (2017) First record of the Asian fish tapeworm Schyzocotyle (Bothriocephalus) achenogathni (Yamaguti, 1934) in Scandinavia. BioInvasions Records 8: 437–441, https://doi.org/10.3391/bir.2019.8.2.26

Harrower CA, Scalera R, Pagad S, Schönrogge K, Roy HE (2017) Guidance for interpretation of CBD categories on introduction pathways. Technical note prepared by IUCN for the European Commission. https://www.cbd.int/doc/10.3391/bir.2017.6.2.02

Hirano T, Yamazaki D, Uchida S, Saito T, Chiba S (2019) First record of the slug species Semperula wallacei (Issel, 1874) (Gastropoda: Eupulmonata: Veronicellidae) in Japan. BioInvasions Records 8: 258–265, https://doi.org/10.3391/bir.2019.8.2.07

Jamjoom BA, Jamjoom AB (2016) Impact of country-specific characteristics on scientific productivity in clinical neurology research. eNeurologicalSci 4: 1–3, https://doi.org/10.1016/j.ensci.2016.03.002

Stranga and Katsanevakis (2021), Management of Biological Invasions 12(2):221–239, https://doi.org/10.3391/mbi.2021.12.2.01
Jerde CL, Mahon AR, Chadderton WL, Lodge DM (2011) “Sight-unseen” detection of rare aquatic species using environmental DNA. *Conservation Letters* 4: 150–157, https://doi.org/10.1111/j.1755-263X.2010.00158.x

Jöns H, Hoyler M (2013) Global geographies of higher education: the perspective of world university rankings. *Geoforum* 46: 45–59, https://doi.org/10.1016/j.geoforum.2012.12.014

Kang H-J, Koo KS, Sung H-C (2019) Current distribution of American bullfrog *Rana catesbeiana* Shaw, 1802 in the Republic of Korea. *BioInvasions Records* 8: 942–946, https://doi.org/10.3391/bir.2019.8.4.23

Katsanevakis S, Moustakas A (2018) Uncertainty in marine invasion science. *Frontiers in Marine Science* 5: 38, https://doi.org/10.3389/fmars.2018.00038

Katsanevakis S, Zenetos A, Belchior C, Cardoso AC (2013) Invading European Seas: assessing pathways of introduction of marine aliens. *Ocean and Coastal Management* 76: 64–74, https://doi.org/10.1016/j.ocecoaman.2013.02.024

Katsanevakis S, Wallentinus I, Zenetos A, Leppäkoski E, Çınar ME, Öztürk B, Grabowski M, Golani D, Cardoso AC (2014) Impacts of marine invasive alien species on ecosystem services and biodiversity: a pan-European review. *Aquatic Invasions* 9: 391–423, https://doi.org/10.3391/ai.2014.9.4.01

Katsanevakis S, Deriu I, D’Amico F, Nunes AL, Pelaez Sanchez S, Crocetta F, Arianoutsou M, Bazos I, Christopoulou A, Curto G, Delipetrou P, Kokkoris Y, Panov V, Rabitsch W, Roques A, Scalera R, Shirley SM, Tricarico E, Vannini A, Zenetos A, Zervou S, Zikos A, Cardoso ACC (2015) European Alien Species Information Network (EASIN): supporting European policies and scientific research. *Management of Biological Invasions* 6: 147–157, https://doi.org/10.3391/mabi.2015.6.2.05

Katsanevakis S, Coll M, Fraschetti S, Giakouni S, Goldsborough D, Mačić V, Mackelworth P, Kuguru B, Groeneveld J, Singh S, Mchomvu B (2019) First record of giant freshwater prawn *Macrobrachium rosenbergii* (de Man, 1879) from small-scale fisheries in East Africa, confirmed with DNA barcoding. *BioInvasions Records* 8: 379–391, https://doi.org/10.3391/bir.2019.8.2.19

Kytinou E, Sini M, Issaris Y and Katsanevakis S (2020) First DNA barcoding based record of *Echinogammarus trichiatus* (Martynov, 1932) (Crustacea, Gammaridae) in Belarus. *BioInvasions Records* 9: 391–423, https://doi.org/10.3391/bir.2019.8.4.23

Kytinou E, Sini M, Issaris Y and Katsanevakis S (2020) Global systematic review of small-scale fisheries in East Africa, confirmed with DNA barcoding. *BioInvasions Records* 8: 379–391, https://doi.org/10.3391/bir.2019.8.2.19

Labrune C, Amlhat E, Amouroux J-M, Jabouin C, Gigou A, Noël P (2019) The arrival of the parthenogenetic mourning gecko, *Lepidodactylus lugubris* (Duméril and Bibron, 1836) to Paradise Island, The Bahamas, with comments on citizen science observations of non-native herpetofauna. *Conservation Letters* 12: 876–881, https://doi.org/10.1111/conl.12311

Leydesdorff L, Wagner CS (2008) International collaboration in science and the formation of a core group. *Journal of Infometrics* 2: 317–325, https://doi.org/10.1016/j.joi.2008.07.003

Liebgold EB, Liebgold HL, Ransom MJ, Ransom TS (2019) The spread of the parthenogenetic mourning gecko, *Lepidodactylus lugubris* (Duméril and Bibron, 1836) to Paradise Island, The Bahamas, with comments on citizen science observations of non-native herpetofauna. *BioInvasions Records* 8: 45–49, https://doi.org/10.3391/bir.2018.8.4.16

Lipinsksaya T, Radulović A, Makaranka A (2018) First DNA barcoding based record of *Echinogammarus trichiatus* (Martynov, 1932) (Crustacea, Gammaridae) in Belarus. *BioInvasions Records* 7: 55–60, https://doi.org/10.3391/bir.2018.7.1.08
Lodeiros C, González-Henríquez N, Cuéllar-Anjel J, Hernández-Reyes D, Medina-Alcaraz C, Quintero J, ReyMéndez M (2019) Invasion of the dark false mussel in shrimp farms in Venezuela: species identification and genetic analysis. Biollusions Records 8: 838–847, https://doi.org/10.3391/bir.2019.8.4.12

Lucy FE, Panov VE (2012) BioInvasions Records: A new international journal on biological invasions. BioInvasions Records 1: 1–4, https://doi.org/10.3391/bir.2012.1.1.01

Lucy FE, Roy H, Simpson A, Carlton JT, Hanson JM, Magellan K, Campbell ML, Costello MJ, Pagad S, Hewitt CL, McDonald J, Cassey P, Thomaz SM, Katsanevakis S, Zenetos A, Tricarico E, Boggero A, Groom QJ, Adriaens T, Vanderhoeven S, Torchin M, Hubraker R, Fuller P, Carman MR, Conn DB, Vitule JRS, Canning-Clode J, Galil BS, Ovaceh H, Bailey SA, Therriault TW, Claudi R, Gazda A, Dick JTA, Caffrey J, Witt A, Kenis M, Lehtiniemi M, Helmsaari H, Panov VE (2016) INVASIVESNET towards an International Association for Open Knowledge on Invasive Alien Species. Management of Biological Invasions 7: 131–139, https://doi.org/10.3391/mbi.2016.7.2.01

Maciel V, Albano PG, Almanquidou V, Claudet J, Corrales X, Esol F, Evagelopoulos A, Giovos I, Jimenez C, Kark S, Marković O, Mazaris AD, Ölabsfóditir GÁ, Panayotova M, Petövić S, Rabitsch W, Ramdani M, Rillo G, Tricarico E, Vega Fernández T, Simi N, Trygonis V, Katsanevakis S (2018) Biological invasions in conservation planning: A global systematic review. Frontiers in Marine Science 5: 178, https://doi.org/10.3389/fmars.2018.00178

MacNeil C (2019) “One is the loneliest number”; are we witnessing the death throes of the single-author research paper in the field of biological invasions? Management of Biological Invasions 10: 1–5, https://doi.org/10.3391/mbi.2019.10.1.01

Man JP, Weinkauf JG, Tsang M, Sin DD (2004) Why do some countries publish more than others? An international comparison of research funding, English proficiency and publication output in highly ranked general medical journals. European Journal of Epidemiology 19: 811–817, https://doi.org/10.1023/B:JEPI.0000036571.00320.b8

Mazza G, Tricarico E, Genovesi P, Gherardi F (2014) Biological invaders are threats to human health: an overview. Ethology, Ecology, and Evolution 26: 112–119, https://doi.org/10.1080/03949970.2013.863225

McGeoch MA, Butchart SHM, Spear D, Marais E, Kleynhans EJ, Symes A, Chanson J, Brian M, Helmisaari H, Panov VE (2016) INVASIVESNET towards an International Association for Open Knowledge on Invasive Alien Species. Management of Biological Invasions 7: 131–139, https://doi.org/10.3391/mbi.2016.7.2.01

Mee SA, Al Masri AA, Usmani AM, Memon AM, Zaidi SZ (2013) Impact of GDP, spending on R&D, number of universities and scientific journals on research publications among Asian countries. PLoS ONE 8: e66449, https://doi.org/10.1371/journal.pone.0066449

Milazzo M, Azzurro E, Badalamenti F (2012) On the occurrence of the silverstripe blaesop. Molnar JL, Gamboa RL, Revenga C, Spalding MD (2008) Assessing the global threat of marine biodiversity. Frontiers in Ecology and the Environment 6: 458–492, https://doi.org/10.1890/070064

Milazzo M, Azzurro E, Badalamenti F (2012) On the occurrence of the silverstripe blaesop. Molnar JL, Gamboa RL, Revenga C, Spalding MD (2008) Assessing the global threat of marine biodiversity. Frontiers in Ecology and the Environment 6: 458–492, https://doi.org/10.1890/070064

Milazzo M, Azzurro E, Badalamenti F (2012) On the occurrence of the silverstripe blaesop. Molnar JL, Gamboa RL, Revenga C, Spalding MD (2008) Assessing the global threat of marine biodiversity. Frontiers in Ecology and the Environment 6: 458–492, https://doi.org/10.1890/070064

Moaddabi M, Ali -abadi MAS, Abdi R, Momtazi F, Ranjbar MS, da Rocha RM (2019) First records, description and distribution of the colonial ascidian Didemnum psammatodes (Sluiter, 1895) in the Eastern Persian Gulf. BioInvasions Records 8: 582–589, https://doi.org/10.3391/bir.2019.8.3.14

Molnar JL, Gamboa RL, Revenga C, Spalding MD (2008) Assessing the global threat of invasive species to marine biodiversity. Frontiers in Ecology and the Environment 6: 458–492, https://doi.org/10.1890/070064

Morais P, Gaspar M, Garel E, Baptista V, Cruz J, Cerveira I, Leitão F, Teodósio MA (2019) The Atlantic blue crab Callinectes sapidus Rathbun, 1896 expands its non-native distribution into the Ria Formosa lagoon and the Guadiana estuary (SW -Iberian Peninsula, Europe). BioInvasions Records 8: 123–133, https://doi.org/10.3391/bir.2019.8.1.14

Mueller CE (2016) Accurate forecast of countries’ research output by macro-level indicators. Scientometrics 109: 1307–1328, https://doi.org/10.1007/s11192-016-2084-1

Muha TP, Rodríguez-Rey M, Rolla M, Tricarico E (2017) Using environmental DNA to improve species distribution models for freshwater invaders. Frontiers in Ecology and Evolution 5: 158, https://doi.org/10.3389/fevo.2017.00158

Naser MD, Page TJ, Ng NK, Apel M, Yasser AG, Bishop JM, Ng PKL, Clark PF (2012) Invasive records of Eriocheir henspan Dai, 1991 (Crustacea: Brachyura: Grapsoidea: Varunidae): Implications and taxonomic considerations. BioInvasions Records 1: 71–86, https://doi.org/10.3391/bir.2012.1.1.15

Nunes AL, Tricarico E, Panov V, Cardoso AC, Katsanevakis S (2015) Pathways and gateways of freshwater invasions in Europe. Aquatic Invasions 10: 359–370, https://doi.org/10.3391/ai.2015.10.4.01

Okawa T, Kurita Y, Kanno K, Koyama A, Onikura N (2016) Molecular analysis of the distributions of the invasive Asian clam, Corbicula fluminea (O.F. Müller, 1774), and threatened native clam, C. leana Prime, 1867, on Kyushu Island, Japan. BioInvasions Records 5: 25–29, https://doi.org/10.3391/bir.2016.5.1.05

Olson DM, Dinerstein E, Wikramanayake ED, Burgess ND, Powell GVN, Underwood EC, D’Amico JA, Itoua I, Strand HE, Morrison JC, Loucks CJ, Allnutt TF, Ricketts TH, Kura Y, Lamoreux JF, Wattegel WW, Hedao P, Kassem KR (2001) Terrestrial ecoregions of the world: A new map of life on earth. BioScience 51: 933–938, https://doi.org/10.1641/0006-3568(2001)051[0933:TEOTWA]2.0.CO;2

Stranga and Katsanevakis (2021), Management of Biological Invasions 12(2):221–239, https://doi.org/10.3391/mbi.2021.12.2.01
Shaiek M, El Zrelli R, Crocetta F, Mansour L, Rabbaoui L (2021) On the occurrence of three exotic decapods, Callinectes sapidus (Portunidae), Portunus segnis (Portunidae), and Trachysalambria palaestinensis (Penaeidae), in northern Tunisia, with updates on the distribution of the two invasive portunids in the Mediterranean Sea. *BioInvasions Records* 10: 158–169, [doi:10.3391/bir.2021.10.1.17](https://doi.org/10.3391/bir.2021.10.1.17)

Shakman EA, Ben Abdalha F, Talha F, Al-Faturi A, Bariche M (2017) First records of seven marine organisms of different origins from Libya (Mediterranean Sea). *BioInvasions Records* 6: 377–382, [doi:10.3391/bir.2017.6.4.13](https://doi.org/10.3391/bir.2017.6.4.13)

Simberloff D, Martin J, Genovesi P, Maris V, Wardle DA, Aronson J, Courchamp F, Gaile B, Garcia-Berthou E, Pascal M, Pyšek P, Sousa R, Tabacchi E, Vilà M (2013) Impacts of biological invasions: what’s what and the way forward. *Trends in Ecology & Evolution* 28: 58–66, [doi:10.1016/j.tree.2012.07.013](https://doi.org/10.1016/j.tree.2012.07.013)

Soors J, Mertens J, Moser WE, Richardson DJ, Hammond CI, Lazo-Wasem EA (2015) Molecular confirmation of the North American leech Placobdella ornata (Verrill, 1872) (Hirudinida: Glossiphiomidae) in Europe. *BioInvasions Records* 4: 185–188, [doi:10.3391/bir.2015.4.3.05](https://doi.org/10.3391/bir.2015.4.3.05)

Spalding MD, Fox HE, Allen GR, Davidson N, Ferdaña ZA, Finlayson M, Halpern BS, Jorge MA, Lombana A, Lourie SA, Martin KD, McManus E, Molnar J, Recchia CA, Robertson J (2007) Marine ecoregions of the world: A bioregionalization of coastal and shelf areas. *BioScience* 57: 573–583, [doi:10.1641/B570707](https://doi.org/10.1641/B570707)

Sutherland WJ, Pullin AS, Dolman PM, Knight TM (2004) The need for evidence-based conservation. *Trends in Ecology & Evolution* 19: 305–308, [doi:10.1016/j.tree.2004.03.018](https://doi.org/10.1016/j.tree.2004.03.018)

Thakur MP, van der Putten WH, Cobben MMP, van Kleunen M, Geisen S (2019) Microbial invasions in terrestrial ecosystems: from processes to impacts and implications. *Nature Reviews Microbiology* 17: 621–631, [doi:10.1038/s41579-019-0236-z](https://doi.org/10.1038/s41579-019-0236-z)

Trombetti M, Katsanevakis S, Deriu I, Cardoso AC (2013) EASIN-Lit: a geo-database of published alien species records. *Management of Biological Invasions* 4: 261–264, [doi:10.3391/mbi.2013.4.3.08](https://doi.org/10.3391/mbi.2013.4.3.08)

Turbelin AJ, Malamud BD, Francis RA (2017) Mapping the global state of invasive alien species: patterns of invasion and policy responses. *Global Ecology and Biogeography* 26: 78–92, [doi:10.1111/geb.12517](https://doi.org/10.1111/geb.12517)

UN (2015) Transforming our world: the 2030 agenda for sustainable development. In: Resolution adopted by the general assembly on 25 September 2015, A/RES/70/1. United Nations General Assembly

UNESCO Institute for Statistics (2020) How Much Does Your Country Invest in RandD? [http://uis.unesco.org/apps/visualisations/researchand-development-spending/](http://uis.unesco.org/apps/visualisations/researchand-development-spending/) (accessed 28 December 2020)

Vanderhaegen K, Naturinda Z, Kouakou LMM, Vanderheyden A, Dekoninck W (2019) First record of the invasive longhorn crazy ant, Paratrechina longicornis (Latreille, 1802) (Hymenoptera: Formicidae) from Mt. Elgon, eastern Uganda. *BioInvasions Records* 8: 505–514, [doi:10.3391/bir.2019.8.3.05](https://doi.org/10.3391/bir.2019.8.3.05)

Vilà M, Hulme PE (2017) Impact of biological invasions on ecosystem services. Springer, New York, 359 pp, [doi:10.1007/978-3-319-45121-3](https://doi.org/10.1007/978-3-319-45121-3)

Vimercati G, Kumschick S, Probert AF, Volery L, Bachr S (2020) The importance of assessing positive and beneficial impacts of alien species. *Neobiota* 62: 525–545, [doi:10.3897/neobiota.62.52793](https://doi.org/10.3897/neobiota.62.52793)

Xiong W, Wang H, Wang Q, Tang J, Bowler PA, Xie D, Pan L, Wang Z (2018) Non-native species in the Three Gorges Dam Reservoir: status and risks. *BioInvasions Records* 7: 153–158, [doi:10.3391/bir.2018.7.2.06](https://doi.org/10.3391/bir.2018.7.2.06)

Zhulidov AV, Kozhara AV, van der Velde G, Leuven RSEW, Son MO, Gurtovaya TY, Zhulidov DA, Nalepa TF, Santiago-Fandino VJR, Chuikov YS (2018) Status of the invasive brackish water bivalve Mytilopsis leucophaeata (Conrad, 1831) (Dreissenidae) in the Ponto-Caspian region. *BioInvasions Records* 7: 111–120, [doi:10.3391/bir.2018.7.2.02](https://doi.org/10.3391/bir.2018.7.2.02)

Živković MM, Andelković AA, Cevjanić DL, Novković MZ, Vukov DM, Šipoš SS, Ilić MM, Pankov NP, Miljanović BM, Pavlović DM, Radulović SB (2019) The beginnings of Pistia stratiotes L. invasion in the lower Danube delta: the first record for the Province of Vojvodina (Serbia). *BioInvasions Records* 8: 218–229, [doi:10.3391/bir.2019.8.2.03](https://doi.org/10.3391/bir.2019.8.2.03)

### Supplementary material

The following supplementary material is available for this article:

**Table S1.** Georeferenced records of alien and cryptogenic species in all *BioInvasions Records* articles between 2012–2019.

This material is available as part of online article from:

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