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[REVIEW]

Sinking Down or Floating Up? Current State of Taxonomic Studies on Marine Invertebrates in Japan Inferred From the Number of New Species Published Between the Years 2003 and 2020

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Taxonomic studies on marine invertebrates have been prominent in Japan since the 19th century. Globally, taxonomy was reported to have been in recession since the early 21st century, but it is not clear if it is still in hardship or is making a recovery in recent years in Japan. In order to comprehend the status quo of taxonomic studies on marine invertebrates in Japan, we compiled a list of marine invertebrate species newly described from the exclusive economic zone of this country during the period between 2003 and 2020 and investigated trends by making comparisons of higher taxa and academic journals in terms of the numbers of new species and taxonomic authors. We noticed that recruitment of new researchers into taxonomic studies is evident in some taxa. We also found that certain articles with descriptions of new species are now being published in journals aimed at general biology/zoology, not oriented principally to taxonomy. We consider from our analyses that taxonomic studies on marine invertebrates in Japan show signs of resurgence, but development of new taxonomists is awaited in certain taxa.

Key words: animal diversity, fauna, marine invertebrates, new species, systematics, taxonomy

INTRODUCTION

At the beginning of the 21st century, taxonomy and systematics faced a difficult situation worldwide with the decrease of taxonomists and lack of funding, and the extinction of the field was seriously being feared (Godfray, 2002; Hopkins and Freckleton, 2002; Wheeler, 2004; Bacher, 2012). But recently, there have been reports stating that taxonomy is making a resurgence (Guerra-Garcia et al., 2008; Gomez Daglio and Dawson, 2019), possibly due to three main factors. The first is the innovation of molecular techniques such as molecular phylogenetic analyses and DNA barcoding. These methods enable species identification independent of detailed morphological observations and lower the hurdle for non-taxonomists for describing new species and investigating phylogenetic relationships. The second factor is the establishment of multiple online databases such as the Biodiversity Heritage Library, Global Biodiversity Information Facility, Ocean Biodiversity Information System, World Register of Marine Species (WoRMS), Biological Information System of Marine Life, and Regionally Integrated Marine Database. Researchers can now obtain various kinds of information on marine organisms, such as their scientific names, habitats, and phylogenetic positions, just by searching on the internet. The third is the rising awareness concerning biodiversity among both scientists and the public. As global warming and ocean acidification drastically change the environment, countermeasures and Sustainable Development Goals to be achieved are being actively discussed. Taxonomic studies are crucial for correctly understanding the biodiversity and for preserving the environment on this planet.

Taxonomic studies on marine invertebrates are one of the traditional and active fields of biology in Japan (Kajihara and Kakui, 2017), with faunal surveys having been and continuing to be organized by university-affiliated marine stations, the National Museum of Nature and Science, Biological

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Laboratory of the Imperial Household, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japanese Association for Marine Biology (JAMBIO), and other organizations (Lindsay et al., 1998; National Science Museum, 2006a, b, c; The National Museum of Nature and Science, 2007; Namikawa, 2008; Fujikura et al., 2010; Nakano et al., 2015). However, taxonomic studies in Japan were also affected by the global decline of the field from the end of the 20th century until the beginning of the 21st century (Mawatari, 1994; Motokawa, 2000; Matsuura, 2011). Roughly 20 years later at present, it has not been well documented if marine invertebrate taxonomy in the country is still in a predicament or if it shows signs of resurgence due to the above three factors. It may not seem simple to evaluate the flow of a particular field in science, but, concerning taxonomy, we consider that this can be accomplished by investigating the yearly number of new species descriptions of marine invertebrates. Discovering and describing species new to science is one of, if not the, most important acts of taxonomy and we believe its abundance will represent the state of marine invertebrate taxonomy. In addition to the simple number of published papers, new species descriptions can be analyzed through several factors, such as the phylum of the new species and the authors of the papers. Caution should be taken with the fact that measuring the activity of taxonomic studies by the number of new species, as is implemented in this paper, is only a proxy. In reality, new species are abundant and 'easily' established in certain taxa, while undescribed species are quite rare in other taxa. In addition, taxonomy does not always consist of description of new species, but also involves examination of taxonomic characters in terms of morphology, ecology, and biogeography. Readers should be aware that such taxonomic contributions—i.e., those not directly involving description of new species—are not explicitly evaluated in this article.

One factor of special interest concerning new species descriptions is the academic journals in which they are published. With the rise of online and open access journals, new scientific journals are being launched at an unprecedentedly rapid pace in recent years (Caon, 2016; Bates, 2017). However, there have been no quantitative data regarding whether this increase also applies to taxonomy. By surveying journals publishing new species, we aim to investigate if there has been a recent rise in journals mainly focused on taxonomy. Furthermore, our analyses visualize recent trends of taxonomists' publications of new species descriptions. There are traditional taxonomy-oriented journals that have historically published large numbers of new species descriptions. National and local museums have published proceedings and other printed matter that have also contributed significantly to taxonomy. For taxa with a large researcher population such as Crustacea and Mollusca, taxon-specific journals exist. Our analyses of new species descriptions will clarify recent preferences, if any, of taxonomists, such as traditional journals or new ones, and taxon-specific journals or more general ones.

One issue we had to decide was the starting point of our investigation. As taxonomy has a long history, it would have been possible to begin our investigation from the 19th century. Since our main goal was to examine the recent state of marine invertebrate taxonomy in Japan, a survey spanning many decades might have been helpful, but was not necessary. One publication that came to our attention was the Japanese Biota Species Number Survey published in 2003 (JBSNS, Union of Japanese Societies for Systematic Biology, 2003). It summarized the number of species then known for each animal taxon, and also published a list of the estimated number of undescribed species in Japan at that time. Therefore, to recognize trends in taxonomic studies after JBSNS and to compare our results with the estimates made in JBSNS, we decided to perform our investigation from 2003 onwards.

METHODS

We compiled a list of species-group taxa (i.e., species and subspecies, hereafter simply "species" for convenience and brevity) of marine invertebrates newly established during the period 2003–2020 based on material derived from Japan's exclusive economic zone (EEZ). For each record, the author(s), the publication year, and the publication medium (journal/book title) in which the relevant species was originally described were included. The list compilation was largely based on online resources such as Google Scholar, WoRMS, and ZooBank. It was complemented by our personal knowledge and also by literature support from some of our colleagues. For a few records that were either incorrect or not listed on WoRMS, the editors of respective taxa were notified to add/rectify the entries. New replacement names (nom. nov.) to resolve homonymy were not included. Nominal species subsequently synonymized with senior names were excluded. Species/journal names were listed and enumerated for each phylum; for larger phyla, records were classified into lower ranks, viz., to class for Cnidaria, Mollusca, and Echinodermata, and variously down to infraorder for Arthropoda, following the classification scheme employed at WoRMS. Data were treated with Microsoft Excel for Microsoft 365 MSO and visualized with Adobe Illustrator CC 2018.

Comparison of the current data with the JBSNS results necessitated incorporation of taxonomic changes in higher taxa that have been made since 2003 up to present. These changes include: (1) Myxozoa turned out to form a subgroup within the phylum Cnidaria (Jímenez-Guri et al., 2007); (2) Stauromedusae was separated from the class Scyphozoa as another independent class, Staurozoa (Marques and Collins, 2004); (3) Echiura and Sipuncula were incorporated in Annelida (e.g., Weigert and Bleidorn, 2016); (4) Ingolfiellida was separated from Amphipoda (Lowry and Myers, 2017); (5) Thermosbaenacea (formerly in Pancarida) was transferred to Peracarida (Spears et al., 2005; Meland and Willassen, 2007); (6) Palinuridea was abandoned, and divided into Achelata and Polychelida (e.g., Palero et al., 2009; Tsang et al., 2009; Chan, 2010); (7) Thalassinidea was dismissed, separated into Gebiidea and Axiidea (e.g., Bracken et al., 2009, 2010; Robles et al., 2009; Dworshak et al., 2012); and (8) Xenacoelomorpha was established (Cannon et al., 2016).

RESULTS AND DISCUSSION

Of the species compiled, four—two anthozoans, *Halcurias japonicus* Uchida, 2004 and *Halcurias levis* Uchida, 2004; and two gebiids, *Upogebia neogenii* Saigusa et al., 2018 and *Upogebia semicircula* Saigusa et al., 2018—are claimed to be nomenclaturally unavailable. No repository for the name-bearing types was specified for *H. japonicus* or *H. levis*, violating Article 16.4.2 of the International Code of Zoological Nomenclature (ICZN, 1999); and no name-bearing type was fixed in the original description for *U. geogenii* or *U. semicircula*, violating Article 16.4.1 of the International Code of Zoological Nomenclature (ICZN, 1999). These names, however, are kept in our list (see Supplementary Table S1).

Taxon breakdown

During the period 2003–2020, a total of 1511 new species belonging to 24 phyla were described from Japanese waters (Fig. 1A; see Supplementary Table S1). The phylum Arthropoda had the most species reported with 806, representing more than half of the newly described species. Mollusca was second with 204 species and Annelida third with 170 species. These three were the only phyla to have over 100 species reported. On the other hand, nine phyla out of 24 had fewer than four species reported.

Figure 1B–E shows the status within selected phyla. In Cnidaria and Mollusca, more than 60% of the new species were occupied by a single class, Anthozoa and Gastropoda, respectively (Fig. 1B, C). Looking into Arthropoda, all but 15 of the new species were from Crustacea amounting to 98.1%, with all others from Chelicerata (Fig. 1D). Within Crustacea, the three constituent taxa Decapoda, Peracarida, and Copepoda each had over 150 species newly reported. Among the five classes of Echinodermata, wide differences were present (Fig. 1E). Holothuroidea and Ophiuroidea had over 10 species reported, whereas only a single species was reported for Echinoidea.

Trends in numbers of species, authors, and journals

No clear trends were observed in the number of yearly new species reports, with an average of about 84 species described each year (Fig. 2A). Most years had roughly 60 to 80 reports, with some years, such as 2012, showing a very high number. The reason for the abundant reports in some years will be discussed in subsequent sections.

We examined if the number of new species depends on taxon size. Figure 2B shows that these factors are indeed positively correlated, with a correlation coefficient of 0.778; for this analysis, taxa that are a mixture of terrestrial, freshwater, and marine species were excluded (e.g., Annelida, Gastropoda, Amphipoda, Isopoda). Remarkably, in the following four taxa, the number of new species established during the period 2003–2020 surpassed the number of spe-

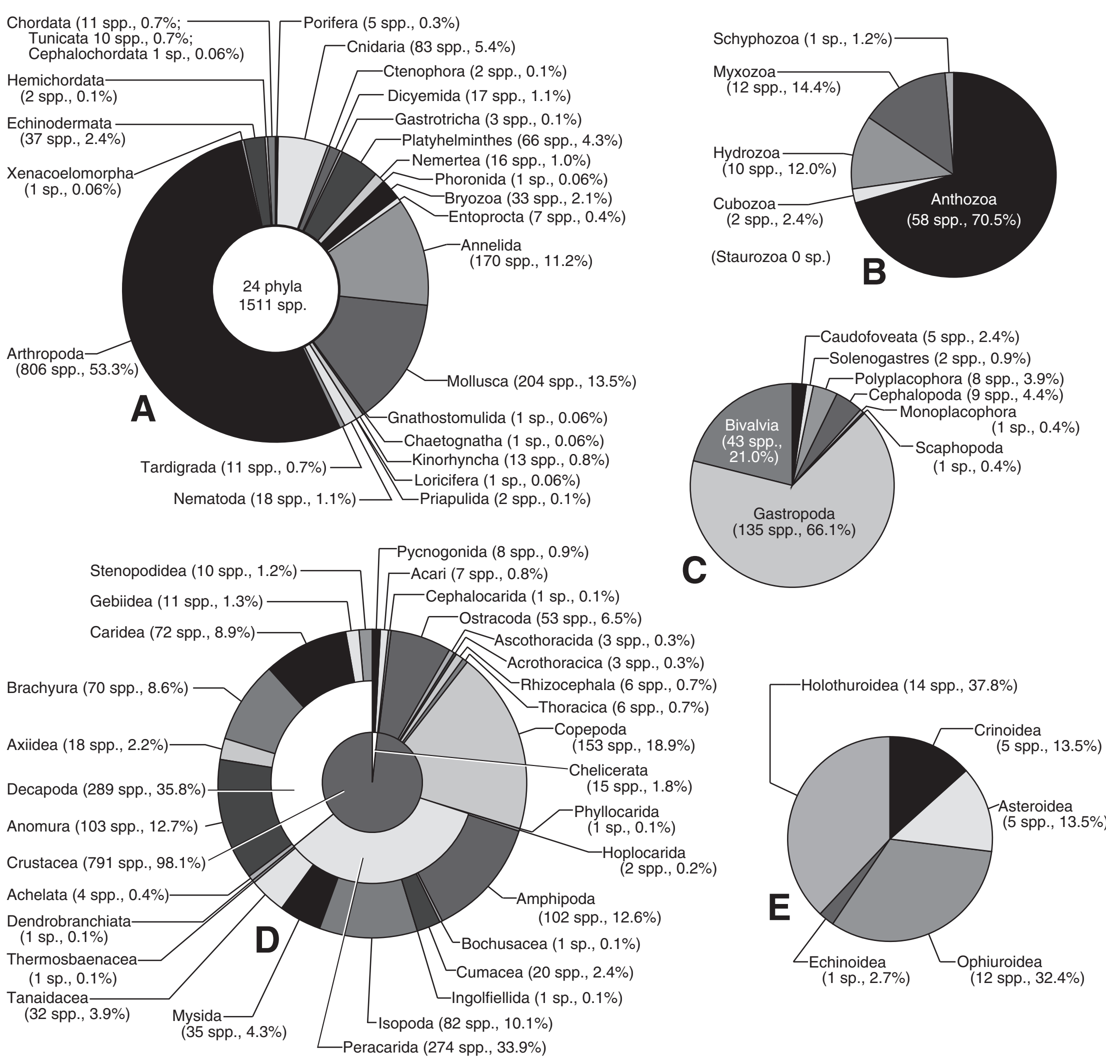

Fig. 1. **(A–E)** Pie charts showing the numbers and percentages of new species of marine invertebrates originally described during the period 2003–2020 based on material from Japan's EEZ; **(A)** entire data for each phylum; **(B)** cnidarian classes; **(C)** molluscan classes; **(D)** arthropod taxa, variously from subphylum to infraorder; **(E)** echinoderm classes.

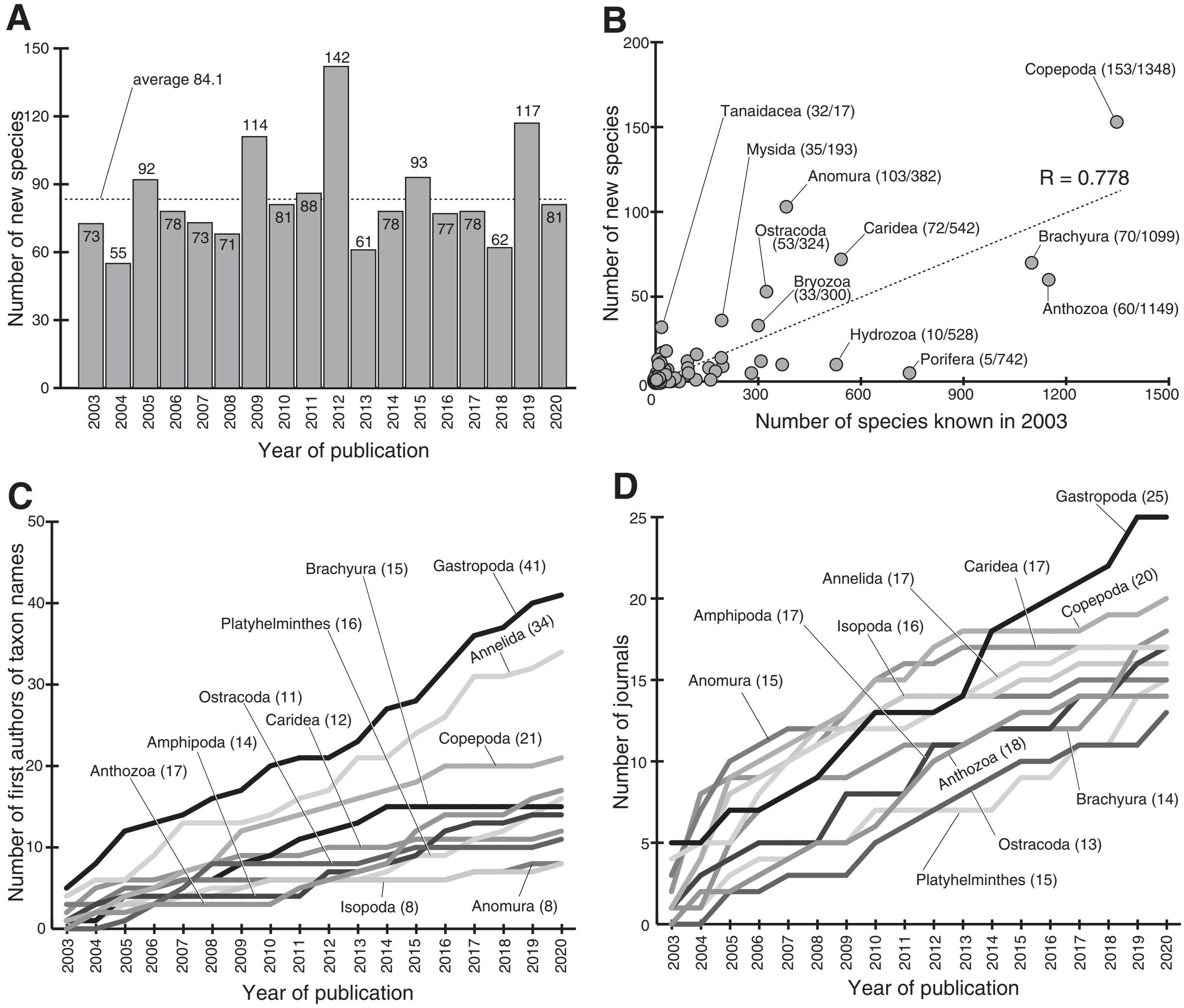

Fig. 2. (A) Bar graph showing the number of new species of marine invertebrates originally described based on material derived from Japan's EEZ in each year during the period 2003–2020. **(B)** Scatter plot showing the relation between the number of new species of marine invertebrates originally described based on material from Japan's EEZ during the period 2003–2020 (vertical axis) and the number of species known in 2003 as the results of the Japanese Biota Species Number Survey by the Union of Japanese Society for Systematic Biology (2003) (horizontal axis); dotted line represents the linear approximation; 11 notable taxa are indicated with the number of species in parentheses (new species in 2003–2020/species known in 2003); Platyhelminthes, Annelida, Bivalvia, Gastropoda, Rotifera, Nematoda, Nematomorpha, Tardigrada, Acari, Branchiopoda, Syncarida, Amphipoda, Isopoda were excluded because these taxa include not only marine species but also terrestrial/freshwater members; see also Supplementary Table S2. **(C, D)** Cumulative curves showing the numbers of **(C)** the first authors of new species of marine invertebrates and **(D)** journals in which the species were published based on material from Japan's EEZ during the period 2003–2020 for 11 taxa in which more than 50 species were described; the number in parentheses after each taxon name is the value in 2020.

cies known in 2003: Tanaidacea (32 species described in 2003–2020, whereas 17 species known in 2003), Kinorhyncha (13 spp. in 2003–2020, seven spp. in 2003), Stenopodidea (10 spp. in 2003–2020, nine spp. in 2003), and Caudofoveata (five spp. in 2003–2020, three spp. in 2003) (Fig. 2B; see Supplementary Table S2).

Figure 2C presents the cumulative number of different first authors who described new species for selected taxa with over 50 new species reported in 2003–2020, viz., Amphipoda, Annelida, Anomura, Anthozoa, Brachyura, Caridea, Copepoda, Gastropoda, Isopoda, Ostracoda, and Platyhelminthes. Gastropods lead the list with 41 first authors and annelids are second with 34 authors. They both show steady growth during 2003–2020, indicating that recruitment of new researchers into these fields is continuing at a healthy pace, although a certain fraction of these authors were graduate students who might not eventually become academic researchers. Another factor is the involvement of foreign researchers affiliated at institutes overseas working with Japanese samples, either by visiting Japan on collection trips or by being provided with samples from domestic collaborators (Aguado et al., 2008; Rouse et al., 2016). In contrast, several taxa were present in which all of the new species were described by a single author, such as Dicyemida with 17 species and Tardigrada with 11 species (see Supplementary Table S1). It will be essential to recruit new scientists, both domestic and foreign, into the taxonomic studies of these taxa with a small research population to continue the efforts in uncovering the still-hidden diversity within these groups.

Figure 2D shows the cumulative number of journals that published new species descriptions for the same taxa as in Fig. 2C. All of the taxa show substantial growth during the studied period. This probably reflects diverse needs of different authors, whether they prefer journals with a high impact factor, open access journals, or charge-less journals, and we predict that the number of journals publishing new species descriptions will continue to increase for the foreseeable future (see following section for more discussion on this subject).

Journal analyses

Concerning journal breakdown, 321 new species were described in *Zootaxa*, followed by *Species Diversity* with 131 species, and *ZooKeys* at third with 99 species (Fig. 3A). These three journals account for more than one-third of the new species descriptions published between 2003 and 2020, indicating that they were popular choices for Japanese marine-invertebrate taxonomists. Looking at the yearly changes in new species descriptions in these journals, there were no obvious trends in any of the three, showing an uneven pattern with very high peaks in some years (Fig. 3B). This was owing to the results of major surveys and expeditions with numerous new species descriptions being published. This was evident in 2012, when the results of the Kumejima Marine Biodiversity Expedition were reported in a special issue of *Zootaxa* (Naruse et al., 2012), and 23 new species of commensal Leucothoidae (Crustacea, Amphipoda) from the Ryukyu Archipelago, Japan were described in a series of papers in *ZooKeys* (White and Reimer, 2012a, b, c).

These three journals present different factors to authors as possible choices when submitting a new species description. *Zootaxa*, published by Magnolia Press, is included in the Journal Citation Reports, resulting in the journal having an impact factor. The journal requires no page charge; color figures in the online edition are also free of charge, but fees are needed to make published papers open access. *Species Diversity* is published by The Japanese Society of Systematic Zoology, and at least one of the authors needs to be a member of the society for submission. All papers in the journal are open access, with the author paying no fees. The journal is not included in the Journal Citation Reports at the moment, and therefore does not have an official impact factor. *ZooKeys*, published by Pensoft Publishers, is an open-access journal possessing an impact factor, but the author is required to pay article processing charges when a manuscript is accepted. The three journals each have their pros and cons, and the author can choose among them (or other journals) depending on the needs at the time of submission. Since the needs of each author should be different, and the needs of a single author may change over time, it is likely that these journals will coexist.

New biological journals are increasing rapidly, but this was not evident in the field of marine invertebrate taxonomy. Out of the 109 journals that published new species descriptions, 13 were journals that were launched after 2003 (see Supplementary Table S3). However, there were only four journals mainly focused on taxonomy, with others acknowledging a broader aim. Looking at individual species, 124 species out of 1511 were described in the 13 new journals. However, this is slightly misleading as 99 species were published in *ZooKeys*. Therefore, with *ZooKeys* as an exception, newly launched journals do not seem to have played a significant role in recent marine invertebrate taxonomy.

One conspicuous trend was that many descriptions were not being published in taxonomy-oriented journals, but in journals with broader biological objectives, including those that were established before 2003 (see Supplementary Table S3). In these cases, authors often performed additional experiments such as molecular phylogeny (Montenegro et al., 2015; Nakano et al., 2017, 2018; Kise et al., 2019;

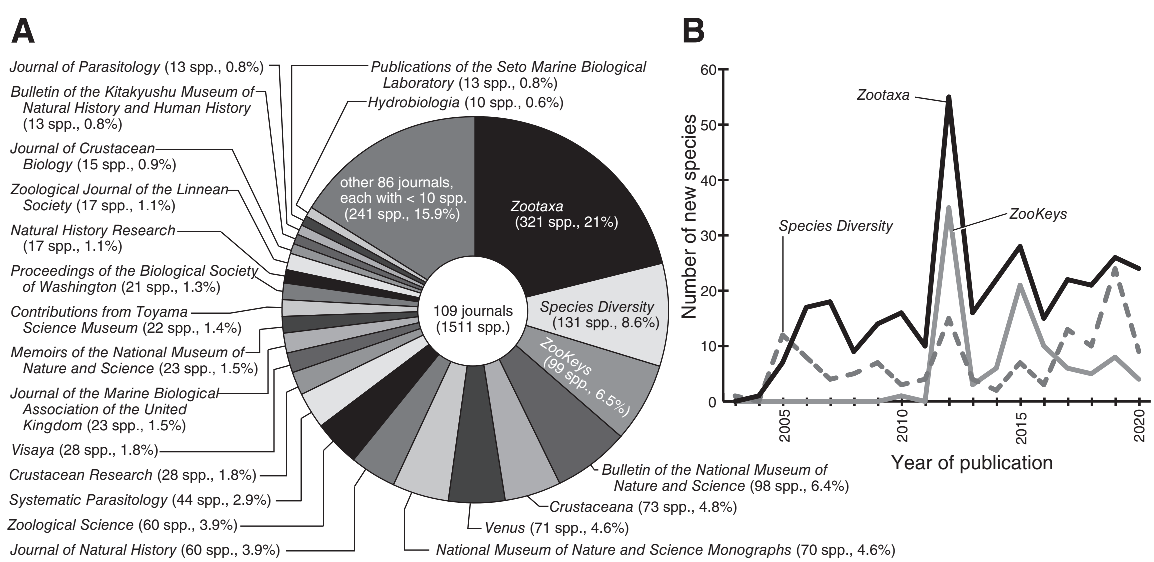

Fig. 3. **(A)** Pie chart showing the numbers and percentages of marine invertebrate species newly established based on material from Japan's EEZ during the period 2003–2020 for each journal; journals that contained fewer than 10 new species were merged. **(B)** Line graph showing the number of marine invertebrate species newly established based on material from Japan's EEZ during the period 2003–2020 in *Zootaxa* (solid black line), *Species Diversity* (broken gray line), and *ZooKeys* (solid gray line).

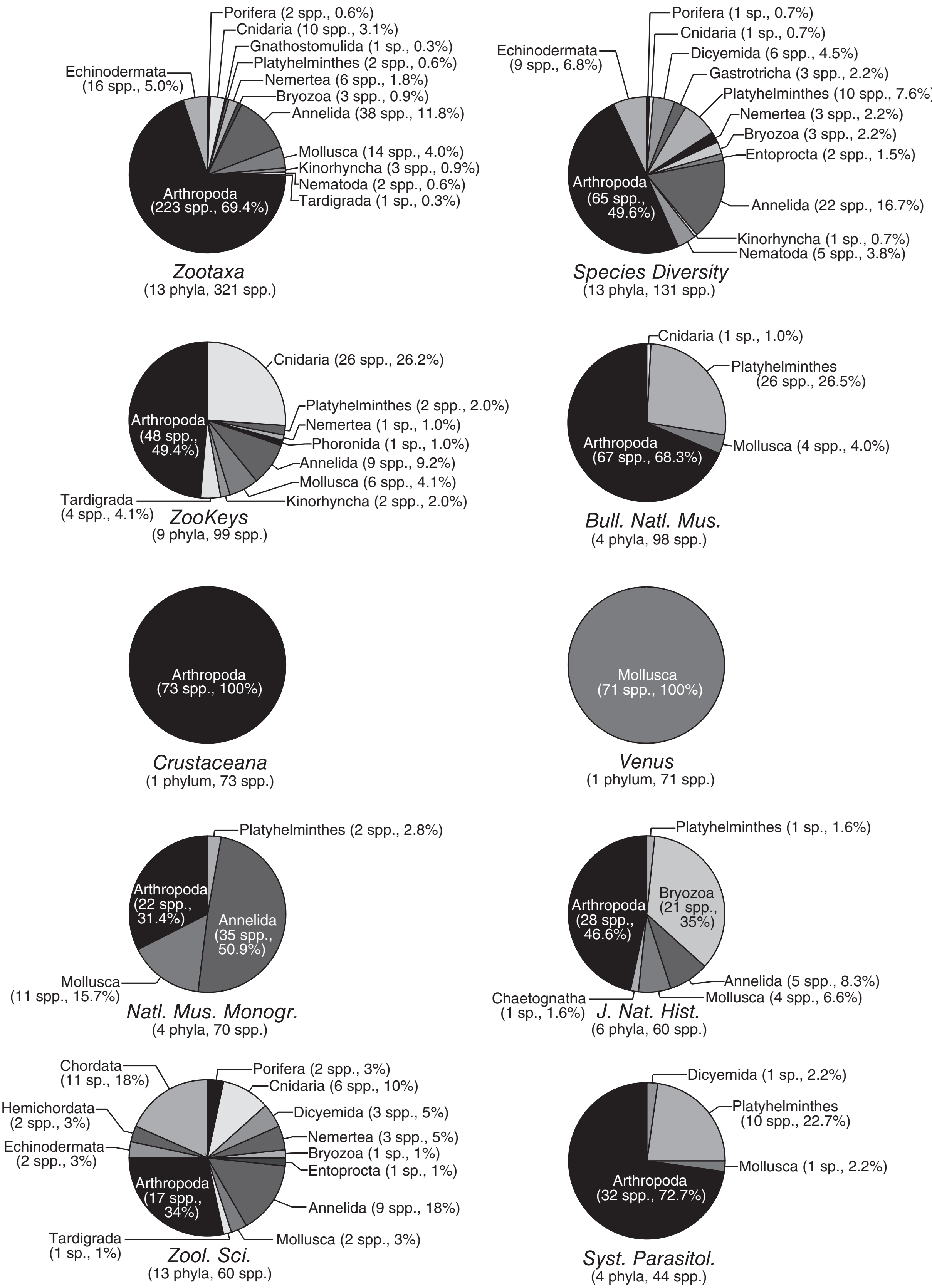

Fig. 4. Pie charts show the numbers and percentages of marine invertebrate species newly established based on material from Japan's EEZ during the period 2003–2020 for each phylum in the 'top 10 journals' (see Fig. 3). Abbreviations: *Bull. Natl. Mus.*, *Bulletin of the National Museum of Nature and Science*; *J. Nat. Hist.*, *Journal of Natural History*; *Natl. Mus. Monogr.*, *National Museum of Nature and Science Monographs*; *Syst. Parasitol.*, *Systematic Parasitology*; *Zool. Sci.*, *Zoological Science*.

Pfingstl et al., 2019) or behavioral observations (Igawa and Kato, 2017), to make the report not as just a taxonomic description, but as a scientific paper dealing with other areas of biology such as evolution, ecology, and phylogeography. We assume that taxonomists perform these additional experiments and submit new species descriptions to general journals mainly for two reasons. First, as these journals have a broader audience than taxonomy-oriented journals, these journals are being chosen so that the new species gains wider attention. This is supported by the fact that many new species descriptions are being published in open access journals (Igawa and Kato, 2017; Pfingstl et al., 2019). Second, as these general journals tend to have higher citation metrics such as impact factors than taxonomy-oriented journals, taxonomists wishing to have good metrics may likely choose these journals.

Three scientific publications of the National Museum of Nature and Science each reported over 10 new species: *Bulletin of the National Science Museum* 98 species, *National Museum of Nature and Science Monographs* 70 species, and *Memoirs of the National Museum of Nature and Science* 23 species (Fig. 3A). This indicates that the National Museum of Nature and Science plays a critical role in taxonomic and systematic studies in Japan. Other journals published by local museums also reported over 10 new species descriptions, such as *Contributions from Toyama Science Museum*, *Natural History Research* (published by Natural History Museum and Institute, Chiba), and *Bulletin of the Kitakyushu Museum of Natural History and Human History*, suggesting the importance of museums, not only major central national museums but also local museums, for taxonomic research.

Top 10 journals

Figure 4 shows phylum breakdown for journals with over 40 new species reported in 2003–2020. Here, we can see the importance of taxon-specific journals, such as *Crustaceana* (Brill Publishers) and *Venus* (The Malacological Society of Japan); 73 and 71 new species all belonging to a single phylum were reported, respectively, in these two journals (Arthropoda in the former and Mollusca in the latter). Although not included in Fig. 4, over 25 species were reported in *Crustacean Research* and in *Visaya* (Fig. 3A), further showing the importance of taxon-specific journals. A unique journal is *Systematic Parasitology* (Springer Science+Business Media), which is not a taxon-specific journal, but a journal specific to parasitic organisms, as its title suggests. It published descriptions of a number of phyla, such as Arthropoda and Platyhelminthes. Together with *Journal of Parasitology* (Allen Press) with 13 new species descriptions (Fig. 3A), these life-style-specific journals are also important for taxonomic studies.

The three major journals, *Zootaxa*, *Species Diversity*, and *ZooKeys*, not only report large numbers of new species but also publish descriptions of new species from a wide range of phyla, with 13, 13, and nine phyla reported, respectively. A

Table 1. Comparison with the Japanese Biota Species Number Survey.

Phylum	Known species in JBSNS 2003	Undescribed species estimated in JBSNS 2003	Marine species described between 2003 and 2020
Porifera	742	ca. 540	5
Placozoa	1	—	0
Cnidaria	ca. 1714+93 (Myxozoa)	?	83
Ctenophora	28	—	2
Dicyemida	19	42	17
Gastrotricha	?	?	3
Platyhelminthes	ca. 269	ca. 300	66
Nemertea	120	58	16
Brachiopoda	69	27	0
Phoronida	2	?	1
Bryozoa	ca. 300	900	33
Entoprocta	35	35	7
Cycliophora	0	—	0
Orthonectida	1	0	0
Annelida	ca. 1000	ca. 300	170
Mollusca	ca. 8045 (incl. terrestrial spp.)	1412	204
Gnathostomulida	0	?	1
Rotifera	397	ca. 3000	0
Micrognathozoa	—	—	0
Chaetognatha	24	4	1
Kinorhyncha	7	100	13
Loricifera	1	10	1
Priapulida	2	?	2
Nematoda	ca. 300	10000–100000	18
Nematomorpha	?	?	0
Onychophora	0	0	0
Tardigrada	115 (incl. terrestrial spp.)	28	11
Arthropoda	40223 (incl. terrestrial spp.)	>10140	806
Xenacoelomorpha	ca. 10	ca. 100	1
Hemichordata	11	>10	2
Echinoidea	ca. 1051	—	37
Chordata			
Tunicata	ca. 370	—	10
Cephalochordata	3	—	1

journal worth mentioning is *Zoological Science*, published by the Zoological Society of Japan, which covers broad fields of zoology, such as behavioral biology, biochemistry, cell biology, developmental biology, diversity and evolution, ecology, endocrinology, genetics, immunology, molecular biology, morphology, neurobiology, phylogeny, physiology, reproductive biology, and taxonomy. There were 60 new species descriptions in the journal, about 60% of the number in *ZooKeys*, but the former were represented by 13 phyla, surpassing the number of phyla represented by species described in *ZooKeys* and identical to the numbers of phyla of species reported in *Zootaxa* and in *Species Diversity* (Fig. 4). Despite not being a taxonomy or systematics specific journal, *Zoological Science* plays a significant role for taxonomic studies of a wide range of animals in Japan.

Comparison with the JBSNS

The Union of the Japanese Societies for Systematic Biology published the JBSNS in 2003 (Table 1). In the survey results, estimated numbers of undescribed species in Japan for metazoan phyla were listed (note that these numbers include terrestrial and fresh-water species). For example, about 300 undescribed species were estimated for Annelida. In this review, we revealed that 170 annelid species were newly reported in 2003–2020. Moreover, the estimate for Mollusca was 1412, with 204 marine species being reported in the same span. Does that mean there are fewer than roughly 130 and 1200 undescribed species for these phyla in Japan, respectively? We regard this as highly unlikely and propose that reconsideration of the estimates is necessary for certain phyla. On the other hand, although about 3000 undescribed species were estimated for Rotifera, no new marine species was reported in the studied years. It is essential to encourage new researchers to work on the taxonomy of groups such as rotifers that lack recent taxonomic studies but hide numerous undescribed species.

CONCLUSIONS

Our analyses showed that 1511 new species belonging to 24 phyla were described from Japanese waters between the years 2003 and 2020. Recruitment of new researchers into taxonomic studies is continuing at a steady pace, at least in some taxa such as Annelida and Gastropoda. The presence of various journals, including those not specific to taxonomy such as *Zoological Science*, has a positive effect on the field, providing taxonomists with a wide variety of journals for submitting their works, depending on their specific needs. Compared with predictions made nearly 20 years ago, abundant numbers of new species have been reported for some taxa, and estimations of undescribed biodiversity need to be reconsidered. To conclude, we deduce from our analyses that taxonomic studies on marine invertebrates in Japan show signs of rejuvenating, but recruitment and development of new taxonomists are awaited in certain taxa.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

HN and HK conceived the review, NJ, TS, and HK analyzed data, HK prepared the figures, HN and HK wrote the text, and all authors approved the manuscript.

SUPPLEMENTARY MATERIALS

Supplementary materials for this article are available online. (URL: https://doi.org/10.2108/zs210076)

Supplementary Table S1. New species of marine invertebrates originally described during the period of 2003–2020 based on material from Japan's EEZ.

Supplementary Table S2. Numbers of marine invertebrate species known from Japanese EEZ in 2003 as the results of the Japanese Biota Species Number Survey by the Union of Japanese Society for Systematic Biology (2003) and newly described in 2003–2020. Taxa indicated with an asterisk (*) include freshwater and terrestrial members, and thus were excluded in Fig. 2B.

Supplementary Table S3. New species descriptions by journals. Journals launched after 2003 are indicated by a single asterisk (*); taxonomy-oriented journals launched after 2003 are indicated by double asterisks (**).

REFERENCES

Aguado MT, San Martín G, Nishi E (2008) Contribution to the knowledge of Syllidae (Annelida, Phyllodocida) from Japan with descriptions of three new species. Syst Biodivers 6: 521–550

Bacher S (2012) Still not enough taxonomists: reply to Joppa et al. Trends Ecol Evol 27: 65–66

Bates SE (2017) Too many journals. The Oncologist 22: 126–128

Bracken HD, Toon A, Felder DL, Martin JW, Finley M, Rasmussen J, et al. (2009) The decapod tree of life: compiling the data and moving toward a consensus of decapod evolution. Arthropod Syst Phylogeny 67: 99–116

Bracken HD, De Grave S, Toon A, Felder DL, Crandall KA (2010) Phylogenetic position, systematic status, and divergence time of the Procarididea (Crustacea: Decapoda). Zool Scr 39: 198–212

Cannon JT, Vellutini BC, Smith J, Ronquist F, Jondelius U, Hejnol A (2016) Xenacoelomorpha is the sister group to Nephrozoa. Nature 530: 89–93

Caon M (2016) There are too many medical physics journals! Australas Phys Eng Sci Med 39: 813–816

Chan TY (2010) Annotated checklist of the world's marine lobsters (Crustacea: Decapoda: Astacidea, Glypheidea, Achelata, Polychelida). Raffles Bull Zool 23 (Suppl): 153–181

Dworschak PC, Felder DL, Tudge CC (2012) Infraorders Axiidea de Saint Laurent, 1979 and Gebiidea de Saint Laurent, 1979 (formerly known collectively as Thalassinidea). In "Treatise on Zoology-Anatomy, Taxonomy, Biology. The Crustacea, Volume 9 Part B" Ed by F Schram, JC von Vaupel Klein, Brill, Leiden,

pp 109–219
Fujikura K, Lindsay D, Kitazato H, Nishida S, Shirayama Y (2010) Marine biodiversity in Japanese waters. PLOS ONE 5: e11836
Godfray HCJ (2002) Challenges for taxonomy. Nature 417: 17–19
Gomez Daglio L, Dawson MN (2019) Integrative taxonomy: ghosts of past, present and future. J Mar Biol Assoc UK 99: 1237–1246
Guerra-Garcia JM, Espinosa F, Garcia-Gomez JC (2008) Trends in taxonomy today: an overview about the main topics in taxonomy. Zool Baetica 19: 15–49
Hopkins GW, Freckleton RP (2002) Declines in the numbers of amateur and professional taxonomists: implications for conservation. Anim Conserv 5: 245–249
ICZN (1999) International Code of Zoological Nomenclature. 4th ed, International Trust for Zoological Nomenclature, London
Igawa M, Kato M (2017) A new species of hermit crab, *Diogenes heteropsammicola* (Crustacea, Decapoda, Anomura, Diogenidae), replaces a mutualistic sipunculan in a walking coral symbiosis. PLOS ONE 12: e0184311
Jiménez-Guri E, Okamura B, Holland PW (2007) Origin and evolution of a myxozoan worm. Integr Comp Biol 47: 752–758
Lowry JK, Myers AA (2017) A phylogeny and classification of the Amphipoda with the establishment of the new order Ingolfiellida (Crustacea: Peracarida). Zootaxa 4265: 1–89
Kajihara H, Kakui K (2017) An overview of recent marine biodiversity research in Japan. In “Species Diversity of Animals in Japan” Ed by M Motokawa, H Kajihara, Springer Japan, Tokyo, pp 25–45
Kise H, Maeda T, Reimer JD (2019) A phylogeny and the evolution of epizoism within the family Hydrozoanthidae with description of a new genus and two new species. Mol Phylogenet Evol 130: 304–314
Lindsay D, Hunt JC, Hashimoto J, Fujikura K, Fujiwara Y, Tsuchida S, et al. (1998) The benthopelagic community of Sagami Bay. JAMSTEC J Deep Sea Res 14: 493–499.
Marques AC, Collins AG (2004) Cladistic analysis of Medusozoa and cnidarian evolution. Inverteb Biol 123: 23–42
Matsuura K (2011) How animal taxonomists survive from extinction: a role of animal taxonomy in biodiversity studies. TAXA 31: 5–11 (in Japanese)
Mawatari SF (1994) The Logic of Animal Taxonomy: Methods of Recognizing Biodiversity. University of Tokyo Press, Tokyo (in Japanese)
Meland K, Willassen E (2007) The disunity of “Mysidacea” (Crustacea). Mol Phylogenet Evol 44: 1083–1104
Montenegro J, Sinniger F, Reimer JD (2015) Unexpected diversity and new species in the sponge-Parazoanthidae association in southern Japan. Mol Phylogenet Evol 89: 73–90
Motokawa M (2000) Can university museums train taxonomists? Mamm Sci 40: 61–68 (in Japanese)
Nakano H, Kakui K, Kajihara K, Shimomura M, Jimi N, Tomioka S, et al. (2015) JAMBIO Coastal Organism Joint Surveys reveals undiscovered biodiversity around Sagami Bay. Reg Stud Mar Sci 2: 77–81
Nakano H, Miyazawa H, Maeno A, Shiroishi T, Kakui K, Koyanagi R, et al. (2017) A new species of *Xenoturbella* from the western Pacific Ocean and the evolution of *Xenoturbella*. BMC Evol Biol 17: 245
Nakano H, Miyazawa H, Maeno A, Shiroishi T, Kakui K, Koyanagi R, et al. (2018) Correction to: A new species of *Xenoturbella* from the western Pacific Ocean and the evolution of *Xenoturbella*. BMC Evol Biol 18: 83
Namikawa H (2008) Recent developments in the faunal surveys of Sagami Bay. In “Origin and Evolution of Natural Diversity, 21st Century COE for Neo-Science of Natural History” Ed by H Okada, SF Mawatari, N Suzuki, P Gautam, Hokkaido University, Sapporo, pp 125–127
Naruse T, Chan T-Y, Tan HH, Ahyong ST, Reimer JD (2012) Scientific results of the Kumejima Marine Biodiversity Expedition—KUMEJIMA 2009. Zootaxa 3367: 5–7
National Science Museum (ed) (2006a) Study on environmental changes in the Sagami Sea and adjacent coastal area with time serial comparison of fauna and flora. I. Marine organisms (brown algae and animals (sponges–annelids)). Mem Natl Sci Mus Tokyo 40: 1–408
National Science Museum (ed) (2006b) Study on environmental changes in the Sagami Sea and adjacent coastal area with time serial comparison of fauna and flora. II. Marine organisms (animals (arthropods–chordates)). Mem Natl Sci Mus Tokyo 41: 1–575
National Science Museum (ed) (2006c) Study on environmental changes in the Sagami Sea and adjacent coastal area with time serial comparison of fauna and flora. III. Living organisms and soil of coastal areas. Mem Natl Sci Mus Tokyo 42: 1–310
Palero F, Crandall KA, Abelló P, Macpherson E, Pascual M (2009) Phylogenetic relationships between spiny, slipper and coral lobsters (Crustacea, Decapoda, Achelata). Mol Phylogenet Evol 50: 152–162
Pfingstl T, Wagner M, Hiruta SF, Koblmüller S, Hagino W, Shimano S (2019) Phylogeographic patterns of intertidal arthropods (Acari, Oribatida) from southern Japanese islands reflect paleoclimatic events. Sci Rep 9: 1–20
Robles R, Tudge CC, Dworschak PC, Poore GCB, Felder DL, Martin JW, et al. (2009) Molecular phylogeny of the Thalassinidea based on nuclear and mitochondrial genes. In “Decapod Crustacean Phylogenetics” Ed by JW Martin, KA Crandall, DL Felder, CRC Press, Boca Raton, pp 309–326
Rouse GW, Lanterbecq D, Summers MM, Eeckhaut I (2016) Four new species of *Mesomyzostoma* (Myzostomida: Annelida). J Nat Hist 50: 1–23
Saigusa M, Hirano Y, Kan BJ, Sekiné K, Hatakeyama M, Nanri T, et al. (2018) Classification of the intertidal and estuarine upogebiid shrimps (Crustacea: Thalassinidea), and their settlement in the Ryukyu Islands, Japan. J Mar Biol Oceanogr 7: 2
Spears T, DeBry RW, Abele LG, Chodyla K (2005) Peracarid monophyly and interordinal phylogeny inferred from nuclear small-subunit ribosomal DNA sequences (Crustacea: Malacostraca: Peracarida). Proc Biol Soc Wash 118: 117–157
The National Museum of Nature and Science (2007) Fauna Sagamiana. Tokai University Press, Hadano (in Japanese)
Tsang LM, Chan TY, Cheung MK, Chu KH (2009) Molecular evidence for the Southern Hemisphere origin and deep-sea diversification of spiny lobsters (Crustacea: Decapoda: Palinuridae). Mol Phylogenet Evol 51: 304–311
Uchida H (2004) Actinologia japonica (1) On the actiniarian family Halcuriidae from Japan. Kuroshio Biosphere 1: 7–26
Union of Japanese Societies for Systematic Biology (2003) Japanese Biota Species Number Survey, 1st ed. URL: http://ujssb.org/biospnum/search.php
Weigert A, Bleidorn C (2016) Current status of annelid phylogeny. Org Divers Evol 16: 345–362
Wheeler QD (2004) Taxonomic triage and the poverty of phylogeny. Philos Trans R Soc B 359: 571–583
White K, Reimer J (2012a) Commensal Leucothoidae (Crustacea, Amphipoda) of the Ryukyu Archipelago, Japan. Part I: ascidian-dwellers. ZooKeys 163: 13–55
White K, Reimer J (2012b) Commensal Leucothoidae (Crustacea, Amphipoda) of the Ryukyu Archipelago, Japan. Part II: sponge-dwellers. ZooKeys 166: 1–58
White K, Reimer J (2012c) Commensal Leucothoidae (Crustacea, Amphipoda) of the Ryukyu Archipelago, Japan. Part III: coral rubble-dwellers ZooKeys 173: 11–50

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