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The new Checklist of the Italian Fauna: Cladocera (Branchiopoda: Ctenopoda, Anomopoda, Onychopoda, and Haplopoda)

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Keywords: Biogeography, limnology, marine biology, species distribution, species list.

SUMMARY

The new Checklist of the Italian Fauna provides an updated inventory of Cladocera species in Italy, encompassing the orders Ctenopoda, Anomopoda, Onychopoda, and Haplopoda. The checklist contains 121 species belonging to 13 families, with Chydoridae and Daphniidae being the most abundant. Seven freshwater species have been added since the previous checklist, while the number of marine species remained unchanged at six. Following recent taxonomic revisions, changes in the nomenclature have been introduced, primarily within the subfamily Aloninae. None of the species is endemic to Italy, but six are considered alien. The presence of species in each macroregion and administrative region is reported, with the number of species per region ranging from 10 in Molise to 77 in Lombardy administrative regions. A total of 165 new regional citations are recorded, with southern regions showing increases exceeding 40% of their total records with respect to the previously reported ones in the CKmap database published in 2005. Although the total number of Italian cladoceran species is well known, their taxonomy is still evolving, particularly within Aloninae and Daphniinae. Molecular studies are expected to reveal cryptic species and refine biogeographic patterns.

INTRODUCTION

Approximately three decades ago, Italy became the pioneering nation in completing a comprehensive checklist of its fauna documented across 110 issues (Minelli et al. 1993–1995). Approximately a decade later, a significant initiative, the “Checklist and distribution of the Italian fauna” (CKmap), was concluded, revising and mapping distribution data for approximately 10,000 terrestrial and inland water species (Ruffo & Stoch, 2005). An updated “Checklist of the Italian Fauna” commenced in 2020 and remains ongoing (Bologna et al. 2022). This data paper aimed to provide information and details on the updated checklist concerning Italian species of Cladocera.

Cladocera, or water fleas, are crustaceans inhabiting freshwater habitats, such as lakes, ponds, rivers, bogs, pools, and swamps, with few marine species. These planktonic, phytophilic, and benthic species form plankton communities as grazers and predators or live on bottom sediments or macrophytes, consuming bacteria, detritus, or algae. As a major zooplankton group, Cladocera plays a central role in pelagic food webs. The position between primary producers and higher trophic levels makes them suitable for tracking environmental changes (Davidson et al., 2011). Moreover, paleolimnologists have used Cladocera remains to reconstruct lake changes (Bennion et al., 2011) and past zooplankton communities.

The class Branchiopoda consists of four extinct orders and nine living orders. Among these, Cladocera is the most speciose taxon and is currently regarded as a monophyletic superorder (Castellucci et al., 2022). This superorder encompasses the extinct orders Cryptopoda and Proanomopoda and the extant orders Anomopoda, Ctenopoda, Haplopoda, and Onychopoda (Van Damme et al., 2022).

Kotov et al. (2013), in their global checklist of cladocerans, estimated the presence

of approximately 720 species. However, only 50% of cladoceran species have been properly described, many of which are species complexes (Forró et al., 2008). Furthermore, DNA research has indicated higher species diversity than morphological studies (Sacherova & Hebert, 2003). Bledzki & Rybak (2016) reported 199 cladoceran species in Europe as of July 2015. Unfortunately, Cladocera are difficult to identify at the species level based only on morphology, and there are no molecular revisions for Italian species. Several species groups harbor cryptic taxa, some of which cannot be distinguished without molecular data (e.g., the *Chydorus sphaericus* group: Kotov et al., 2016). In such cases, Bledzki & Rybak (2016) indicated a species group as a single unit, and this criterion is adopted in this paper.

The first monograph on Italian Cladocera dates to Parenzan (1932); it was not until Margaritora's (1985) volume in the series "Fauna d'Italia" that a modern taxonomic treatment was published, bringing order to the nomenclature and distribution of Italian species. More recently, Cottarelli et al. (1995) compiled a checklist for Italian Branchiopoda. Several updates were made within the “CKmap” project cited above (Margaritora, 2005), where a list of all known Italian localities where cladocerans were found up to 2000, together with the complete literature and data on unpublished records stored in collections, was reported. Since 2005, the taxonomy of several families has changed dramatically, particularly that of Daphniidae and Chydoridae. This contribution aims to provide and illustrate the checklist of Italian Cladocera, first published online on the LifeWatch platform (Margaritora et al., 2021). Considering that four years have passed between the online publication of the checklist and this data paper, some nomenclatural changes have occurred, and some new regional records have been published. To present the most up-to-date overview of Italian cladoceran fauna and its distribution, these changes are indicated in the Supplementary file.

MATERIAL AND METHODS

Study area

The new Checklist of Italian Fauna follows the subdivision of Italy into four macroregions: northern continental Italy (N), southern peninsular Italy (S), Sicily (Si), and Sardinia (Sa) (Bologna et al., 2022; Fig. 1). Northern Italy includes eight administrative regions (Aosta Valley, Piedmont, Lombardy, Trentino – South Tyrol, Veneto, Friuli Venezia Giulia, Liguria, Emilia Romagna), while southern Italy includes ten regions (Tuscany, Umbria, Marche, Lazio, Abruzzo, Molise, Campania, Basilicata, Apulia, Calabria). For marine species, presence was reported for each of the nine areas used in the checklist of marine flora and fauna (Relini 2008, 2010), including only records from the Italian Economic Exclusive Zone (Fig. 1).

Literature data

This update is based exclusively on data published until December 2025. Distribution records or nomenclatural changes were directly verified by examining and evaluating the information within each paper or source.

Data set organization

Fifty-three fields of the new Checklist of the Italian Fauna (Bologna et al., 2022) were compiled in the cladoceran dataset. The first columns were dedicated to the systematic classification of each species (phylum, class, order, family/subfamily, genus/subgenus, species, and subspecies). Besides the taxonomic information, the following data were given: (a) endemic or alien status; (b) for the marine and freshwater species, the Aphia ID identifier of the WoRMS database (Horton et al., 2025), when available; (c) for freshwater species, the presence in each of the macroregions (continental, peninsular, and insular Italy) and in the Italian administrative regions; (d) for marine species, presence in the nine marine areas; finally, (e) taxonomic and distribution notes

were added, including reference to relevant literature for taxa recently reported in Italy or in one of its region/marine areas after the publication of the checklist by Margaritora (2005). The dataset is available as a simplified online version on the LifeWatch website (see below).

The Supplementary file of the present paper reports with updates of all the above-mentioned information, reorganized in two tables for practical purposes.

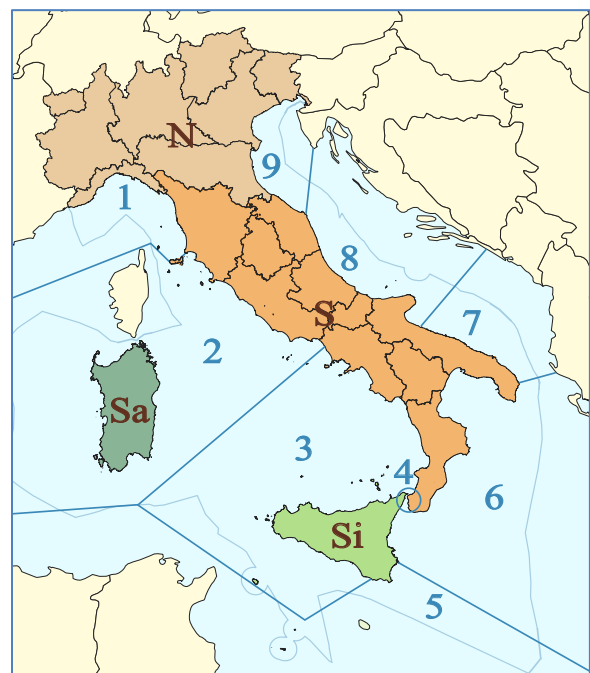


Figure 1. Study area: Italy is divided into four macroregions and nine marine geographical units following the general framework of the project for a new Checklist of the Italian Fauna. Terrestrial and inland water sectors: N - Continental Italy; S - Peninsular Italy; Si - Sicily; Sa - Sardinia. Marine sectors, with the Italian Economic Exclusive Zone border in light blue: 1 - Ligurian Sea; 2 - Northern Tyrrhenian Sea; 3 - Southern Tyrrhenian Sea; 4 - Messina Strait; 5 - Eastern Mediterranean Basin; 6 - Ionian Sea; 7 - Southern Adriatic Sea; 8 - Middle Adriatic Sea; 9 - Northern Adriatic Sea.

Data set information

Object name: Checklist of the Italian Fauna: Cladocera

Characters encoding: Unicode (UTF-8).

Data set citation: Margaritora F.G., Vagaggini D., Stoch F., 2021. Arthropoda Branchiopoda Cladocera. In: Bologna M.A., Zapparoli M., Oliverio M., Minelli A., Bonato L., Cianferoni F., Stoch F. (eds), Checklist of the Italian fauna. Version 1.0. Last update: 2021-03-31.

Format name: xml, Extensible Markup Language, for the online version at LifeWatch, Italy.

Format version: 1.0

Distribution: <https://www.lifewatchitaly.eu/en/initiatives/checklist-fauna-italia-en/checklist/>

Date of creation: November 2, 2020.

Date of publication: July 23, 2021.

Language: English.

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Metadata language: English.

Metadata managers: Marco Bologna, Lucio Bonato, Fabio Cianferoni, Alessandro Minelli, Marco Oliverio, Fabio Stoch, Marzio Zapparoli & LifeWatch Italy.

Management details

Project title: The new Checklist of the Italian Fauna: Cladocera.

Database managers: Fabio Stoch, Daria Vagaggini; Marco Bologna, Lucio Bonato, Fabio Cianferoni, Alessandro Minelli, Marco Oliverio, Marzio Zapparoli & LifeWatch Italy.

Temporal coverage: Anything published until November 2020.

Record basis: Published records in the scientific literature and database collection Margaritora (Museum of Natural History La Specola, University of Florence, Italy).

Funding grants: No funding was specifically available for the Cladocera Project.

Geographic information

General description: The dataset includes records from Italy within its internationally recognized political borders.

Geographic units: The geographical units within Italy refer to the three macroregions and all administrative regions. The geographical units of marine and coastal waters refer to nine biogeographical sectors, as indicated in the study area.

Bounding box: All areas falling under the Italian administration from 35° 25' to 47° 06' N and from 6° 35' to 19° 20' E (WGS84 reference system) were included.

Sampling design: Distribution data were derived from published data, as well as from museum and natural history collection databases, provided they were verified by the authors.

Biogeographic region: Within the Palearctic realm, according to the definitions of the European Environmental Agency (2017), the dataset covers three European biogeographical regions: Alpine, Continental, and Mediterranean.

Countries: Italy.

Quality control for geographic data: We checked whether the published localities matched the geographical units used in the checklist at the administrative region level.

Literature records

General description: All records published since Margaritora (2005) were considered. Records for Italian regions stored in the database of the Margaritora collection (Museum of Natural History, La Specola, University of Florence, Italy) were considered. Only a few records overlooked by Margaritora et al. (2021) were added. The source of the data stored in the new checklist is reported in the Supplementary files.

Literature list: The papers published after the previous checklist by Margaritora (2005) that provided new records for Italian regions are as

follows: Alfonso (2007), Alfonso et al. (2012), Alfonso et al. (2016), Alonso et al. (2021), Bagella et al. (2016), Beccarisi et al. (2024), Benzie (2005), Bledzki & Rybak (2016), Fadda et al. (2011), Leoni et al. (2021), Margaritora et al. (2021), Marková et al. (2013), Marrone et al. (2007), Marrone & Vecchioni (2020), Piscia et al. (2006), Rossetti et al. (2009), Rossi et al. (2014), Tiberti (2011), Troia et al. (2016). The papers that provided new records for Italian regions, published before Margaritora (2005) and overlooked in the previous checklist, are Bonacina & Pasteris (2001), Cioglia et al. (1969), Faranda (1977), Ferrari et al. (1982), Leoni & Cotta-Ramusino (1996), Margaritora (1972), Marrone (2003), Moniez (1889), Monti & Stella (1934), Moroni & Bellavere (2001), Salmaso & Naselli-Flores (1999), Taticchi (1968), and Taticchi (1979).

Quality control for literature data: Only original references and material deposited in the Margaritora collection were considered. After careful checking, the records reported in the supplementary material by Beccarisi et al. (2024) were not stored in our database. In addition to the outdated nomenclature and misspellings in species names, the paper reported the presence of some species in Apulian pools that were unexpected for biogeographical and/or ecological reasons. These records were reported without any comments or supporting information and must be regarded as pending verification.

Taxonomic information

General description: Only records reporting species or subspecies were included, and those identified only at higher taxonomic levels were disregarded.

Taxonomic coverage: Class Branchiopoda, orders Ctenopoda, Anomopoda, Onychopoda, and Haplopoda.

Taxonomic rank: All taxa of the class Branchiopoda (phylum Arthropoda, subphylum Crustacea) are reported in the files of this paper.

The taxon Cladocera Latreille, 1829, which is of common use, is unaccepted following WoRMS (Horton et al., 2025), although, according to recent genomic studies, it is a monophyletic group (Castellucci et al., 2022).

Taxon specialists: Fiorenza G. Margaritora, Federico Marrone, Fabio Stoch, Daria Vagaggini.

Nomenclature: The nomenclature followed Margaritora (2005) and Horton et al. (2025), amended by the recent revisions reported below.

Taxonomic remarks: Any taxonomic change that occurred since the publication of the previous checklist (Margaritora, 2005) is cited in the Supplementary file and includes: Kotov et al. (2013), Marková et al. (2013), Marková et al. (2017), Orlova-Bienkowskaja (1998), Petrussek et al. (2008), Sinev (2015, 2020a, 2020b), Sinev & Dumont (2016), Sinev et al. (2005, 2023), Van Damme et al. (2009).

Quality control for taxonomic data: Taxonomic data were checked and updated to include the revision of names, synonyms, delimitation of genera, and higher taxa.

RESULTS

Summary statistics

The checklist contains 121 species belonging to four orders and 13 families. The most abundant families were Chydoridae and Daphniidae (Fig. 2). The number of species in the families is as follows: Order Ctenopoda: Sididae (6), Holopediidae (1); order Anomopoda: Bosminidae (3), Daphniidae (36), Moinidae (6), Ilyocryptidae (4), Macrothricidae (7), Eurycercidae (1), Chydoridae (49); order Onychopoda: Polyphemidae (1), Cercopagidae (1), Podonidae (5); order Haplopoda: Leptodoridae (1).

The total number of freshwater cladoceran species included six species in addition to the previous CKmap checklist: *Daphnia bolivari*, *Daphnia similis*, *Ceriodaphnia smirnovi*,

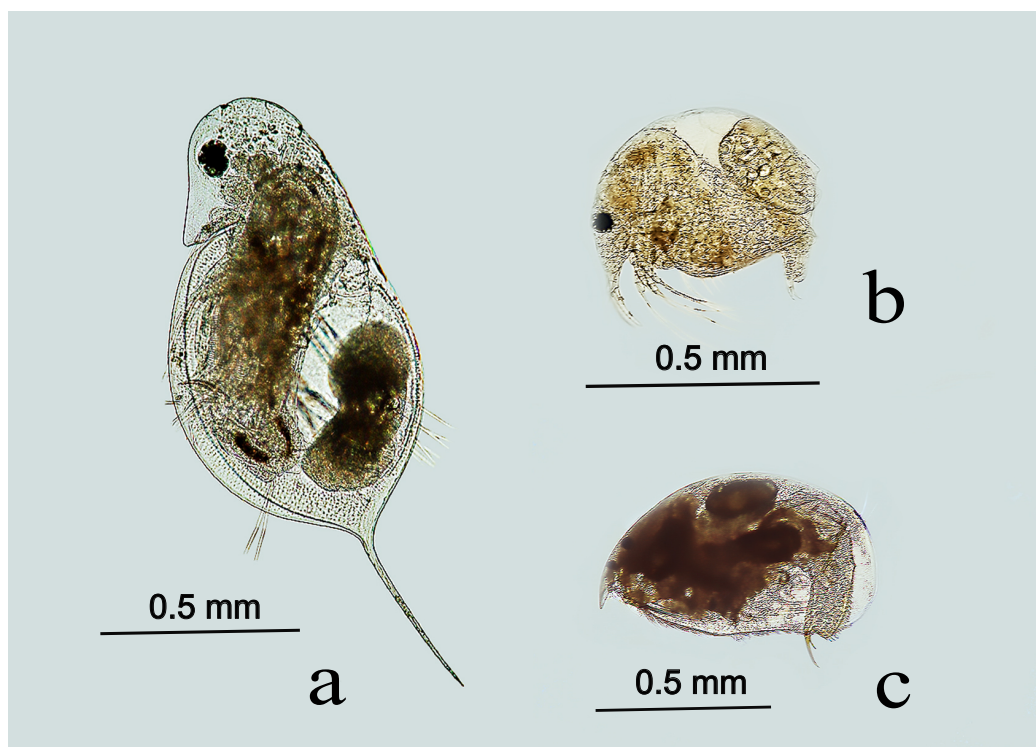
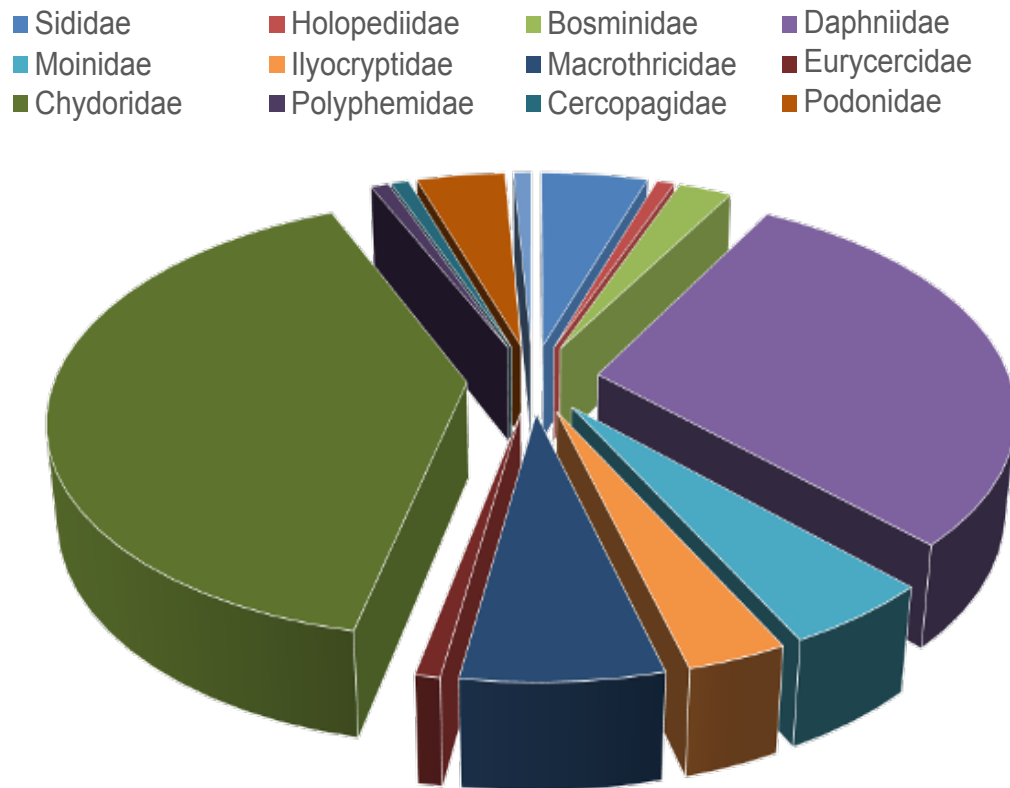


Figure 2. Up: Composition of the Italian cladoceran fauna illustrating the percentage of species included in every family. Bottom: Some examples of the habitus of representatives of the most species-rich families (a - *Daphnia longispina*; b - *Bosmina longirostris*; c - *Biapertura affinis*).

Ilyocryptus cuneatus, *Disparalona leei*, and *Leydigia korovchinskyi*. A further addition (*Ceriodaphnia affinis*, waiting confirmation) is due to the fact that, in the previous checklist, the species was considered a junior synonym of *C. dubia*, and the Italian material must be revised. The number of marine species (six) has remained unchanged since the first checklist (1995).

Some species lack the AlphaID identifier, because the WoRMS database has not yet been updated for Cladocera.

Nomenclatural changes are reported in the notes in the Supplementary file and deal mainly with the subfamily Aloninae, after the erection of the genera *Prendalona*, *Coronatella* (with the two new subgenera *Coronatella* s. str. and *Ephemerallona*), *Flavalona*, *Ovalona*, and *Phreatalona*, and the re-evaluation of the genera *Leberis* and *Biapertura*. The nomenclature was left unchanged in the subgenus *Daphnia*, where the proposed synonyms of *Daphnia longispina* require further confirmation.

No species is endemic to Italy, while six species included in the checklist are alien: *Latonopsis australis* (originating in Southeast Asia, Australia, or neighboring regions), *Daphnia ambigua* (North America), *D. parvula* (North and South America), *Simocephalus heilongjiangensis* (China), *Moina affinis* (North America), *M. weismanni* (Japan), and *Disparalona leei* (North America). Another alien species reported only in the online checklist, *Simocephalus punctatus* Orlova-Bienkowskaja, 1998, was not confirmed during our review, and the species was deleted from the list. Moreover, molecular studies have shown that several populations of *Daphnia pulex* belong to North American strains in continental Italy and Sardinia.

The Supplementary file reports: (i) the presence of freshwater or brackish water species in each of the four macroregions, that is, continental Italy (104 species), peninsular Italy (88), Sicily (60), and Sardinia (56); (ii) the presence of marine species in each of the nine

sectors (only *Evadne nordmanni* is present only in sectors 1, 8, and 9, whereas the other five species are present in all sectors); (iii) the presence of freshwater or brackish water species in each Italian administrative region. The number of species in each administrative region is summarized in Figure 3, ranging from 10 in Molise to 77 in Lombardy. The same figure shows both the number of species already reported in the previous checklist and the novel regional records stored in the new checklist.

The total number of new regional citations for Italy is 165, distributed across the following macroregions: continental Italy (31), peninsular Italy (117), Sicily (10), and Sardinia (8). The percentage of species added to the fauna of each Italian administrative region is shown on the map (Fig. 3). In continental Italy this percentage varied between 3 to 14%, while some regions of peninsular Italy (such as Molise, Apulia, Basilicata, and Campania) showed an increase in comparison to Margaritora (2005) exceeding 40% of the total records (100% in Molise, where no species have been previously reported). In insular Italy, Sicily increased by 17%, while Sardinia increased by 14%.

DISCUSSION

Comparing the data of the new checklist reported in the Supplementary file with older ones (Margaritora, 2005), it can be noticed that the increase in the number of species was small (seven species out of 121, two of which have been introduced to Italy), all reported from freshwater, whereas the marine species remained unchanged since the first checklist (Cottarelli et al., 1995). Moreover, a putative new species reported in the online checklist by Margaritora et al. (2021), *Macrothrix* sp., from Ustica Island (Sicily, cited by Marrone, 2003), has not been reported herein, pending description, while one of the added species (*Ceriodaphnia dubia*) is waiting for confirmation. Notwithstanding some uncertainty regarding the total number of species, we can state that the cladoceran fauna in Italy is relatively well known.

In contrast, the increase in species records is quite important, especially in southern Italy. While northern Italian regions showed an increase in a few records (3-14%), as already stated for the whole cladoceran fauna of Italian Alpine lakes recently assessed (Stoch et al., 2019), the situation is different for the southernmost peninsular regions. Margaritora (2005) remarked that ‘research on the inland water environments of the central Apennines and the most southern regions is very poor and

discontinuous’. After 20 years, we demonstrated that due to recent field research (Marrone et al., 2007; Alfonso, 2007; Alfonso et al., 2016, 2021), some regions of peninsular Italy showed an increase that may exceed 40% of their total records. In insular Italy, the situation showed more moderate increases (17% in Sicily, 14% in Sardinia), due to field research by Marrone (2003), Marrone & Vecchioni (2020), and Troia et al. (2016) for Sicily, and Bagella et al. (2016) for Sardinia.

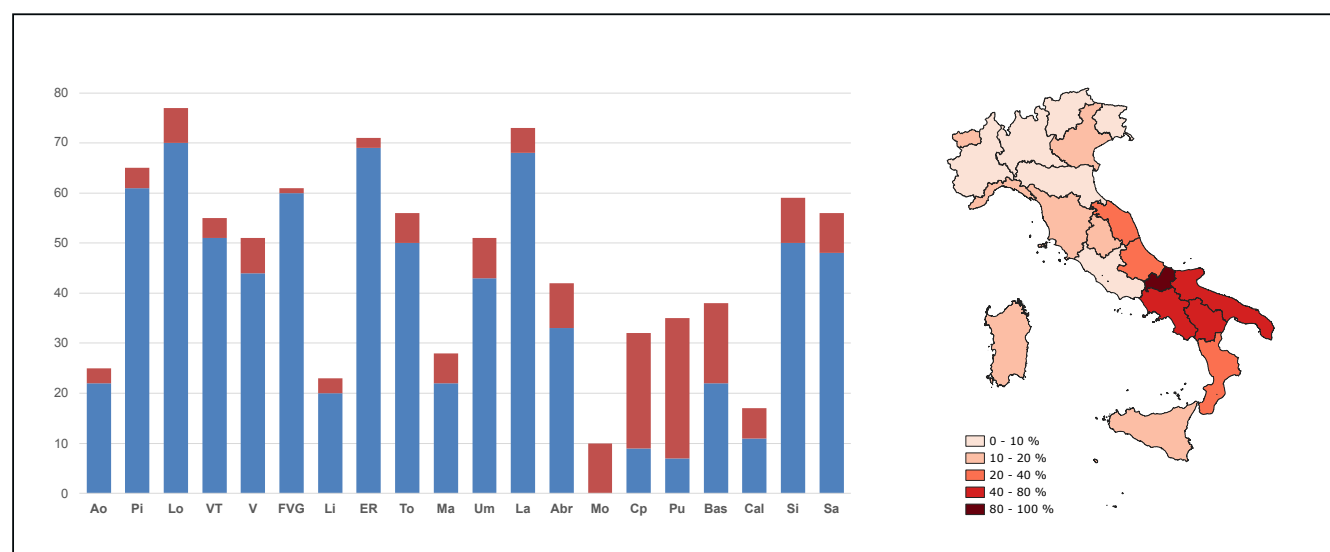


Figure 3. Left: Number of species added to the fauna of each Italian administrative region in the new checklist (in red) with respect to the previous CKmap checklist (Margaritora, 2005, in blue). Right: Map showing the percentage of species added to the fauna of each Italian administrative region in the new checklist.

Although the total number of Italian cladoceran species is quite well known, their taxonomy is still in a phase of change, especially within the subfamily Aloninae, due to the work by Sinev (2015, 2020a, 2020b) and Sinev et al. (2016, 2023). Several problems have been observed in *Daphnia* (Petrusek et al., 2008; Marková et al. (2013, 2017), and although molecular techniques have been applied, the number of species remains uncertain. Finally, it must be remarked that papers dealing with molecular taxonomy and genomics are still in their infancy in cladocerans, and further studies could reveal the presence of cryptic species, as already reported by Kotov et al. (2016) for *Chydorus sphaericus* 10 years ago.

In recent years, even after the publication of the online checklist (Margaritora et al., 2021), updates in nomenclature and new distribution data have been released, highlighting the highly dynamic nature of the current checklist. It is hoped that a clearer and more stable understanding will soon emerge, which will facilitate the refinement of biogeographic patterns and the establishment of conservation priorities.

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