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Peer reviewed

The new Checklist of the Italian Fauna: Formicidae

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SUMMARY

I present the updated version of the ‘Checklist of the Italian Fauna’ for what concerns ants (Insecta: Hymenoptera: Formicidae), which is part of the broader effort to produce an updated comprehensive checklist of the Italian fauna about 25 years after the first edition. The present list is the fourth Italian checklist of ants to be published since 1916, and refers to the state of art on November 2020. A simplified version of the data set is available as a supplementary file to this paper, while the full data set will be accessible in a regularly updated form from the LifeWatch Italy Data Portal (<https://dataportal.lifewatchitaly.eu/data>). Compared to the previous list by Poldi and others, published in 1995, the new one contains changes retrieved from 86 literature sources, including 17 published between 1921 and 1995 (which were missed in the previous checklist) and 69 published from 1996 to 2020. These references add 50 new species, including 9 new endemic species, as well as 68 nomenclatural changes and 88 distribution novelties at the regional level to the previous checklist. A total of 267 species and subspecies belonging to 7 ant subfamilies and 42 genera are part of the new list. The knowledge of the Italian ant fauna is rapidly improving on several fronts, and such dynamism is well-testified by the several novelties from 10 articles published after this dataset was compiled, to be included in the first future update of the on-line checklist. A further new list with extensive comments, detailed species distribution and biogeographic consideration will be desirable as soon as the situation stabilizes.

INTRODUCTION

About 25 years ago, a complete list of all the species of animals known to occur in the Italian territory was compiled thanks to the involvement of several specialists within the project ‘Checklist of the Italian Fauna’ (Minelli et al. 1993-1995), probably making

Italy the first country to have a list of this kind. Starting from 2020, an important effort is now being conducted in the attempt to update this list, making a new data set available in a new form that allows continuous updates to be made thanks to the LifeWatch Italy Data Portal (<https://dataportal.lifewatchitaly.eu/da>

ta; see Bologna et al. 2022). The newly produced data sets of each systematic group will be accompanied by data papers published by the journal *Biogeographia*, explaining the work behind the checklists and commenting their results (Bologna et al. 2022).

Ants are a large family of aculeate hymenopterans comprising around 14,000 species (Bolton 2021). Their monophyly is well-demonstrated and their taxonomic treatment as a single family appears solid (Ward 2014, Borowiec et al. 2019). Thanks to their widespread success in terrestrial ecosystems of the globe, ants play important ecological roles, often interacting directly with human activities, and are considered a model for biodiversity monitoring (Hölldobler & Wilson 1990, Lach et al. 2010, Parker & Kronauer 2021).

During the last few decades, ant taxonomy has made important advancements at the global and European level (Ward 2007, Seifert 2018). For instance, it has largely improved its methodologies in order to uncover cryptic species (i.e. species only diagnosable by quantitative morphology or genetics, and not by qualitative morphology) and find stable and objective criteria for their delimitation through integrative approaches (e.g. Csösz et al. 2015, Seifert et al. 2017, Wagner et al. 2017, Steiner et al. 2018, Schifani et al. 2021a). Moreover, phylogenetics and phylogenomics have allowed to clarify evolutionary relationships between taxa at an unprecedented level (e.g. Ward et al. 2015, 2016). New online resources have greatly facilitated taxonomic and faunistic investigations (see AntCat, AntMaps and AntWebl, see Janicki et al. 2016, Guénard et al. 2017, Bolton et al. 2022). Nonetheless, the Mediterranean ant fauna, which is especially rich and diverse due to a highly complex paleogeographic history and generally favourable climatic conditions, still needs significant efforts to become well-described.

The first Italian checklist of ants, published in a monograph by Emery (1916), included 186 taxa (including ‘varieties’) illustrated through dichotomic keys. A second checklist was then published by Baroni Urba-

ni (1971), who listed 225 taxa and provided a meticulous compendium of all published literature and of all distribution data available at that time. Both Emery (1916) and Baroni Urbani (1971) based their checklist on a territory extending beyond the political borders of Italy, adducing biogeographical reasons. At last, a third checklist of 252 taxa was published by Poldi et al. (1995) within the ‘Checklist della Fauna d’Italia’ framework, this time considering only the Italian territory. As part of the project for a new ‘Checklist of the Italian Fauna’ (Bologna et al. 2022), I present in this paper a new checklist of the Italian ants, containing significant updates to the previous work by Poldi et al. (1995). The data presented in this paper refer to the state of art at November 2020, while data on the online version of the checklist (LifeWatch) will witness regular updates.

MATERIALS AND METHODS

Study area

Like the previous one (Poldi et al. 1995), the new checklist is based on the Italian territory with the only addition of the microstates of San Marino and Vatican City. The study area is divided into four regions to illustrate species distribution (Fig. 1): ‘N’ corresponds to continental Italy and is the sum of eight administrative regions of northern Italy (Aosta Valley, Emilia-Romagna, Friuli-Venezia Giulia, Liguria, Lombardy, Piedmont, Veneto, Trentino-Alto Adige); ‘S’ corresponds to peninsular Italy and contains the remaining ten peninsular regions from central and southern Italy (Abruzzo, Apulia, Calabria, Campania, Basilicata, Marche, Molise, Lazio, Tuscany, Umbria) plus San Marino and the Vatican City; ‘Sa’ corresponds to the region of Sardinia; ‘Si’ corresponds to the region of Sicily. It is worth noting that the administrative regions of Sardinia and Sicily include not only the two homonymous very large islands, but also all the small islands that surround them. This subdivision mostly overlaps with the biogeographic patterns of the Italian ants (Wang et al. 2022).

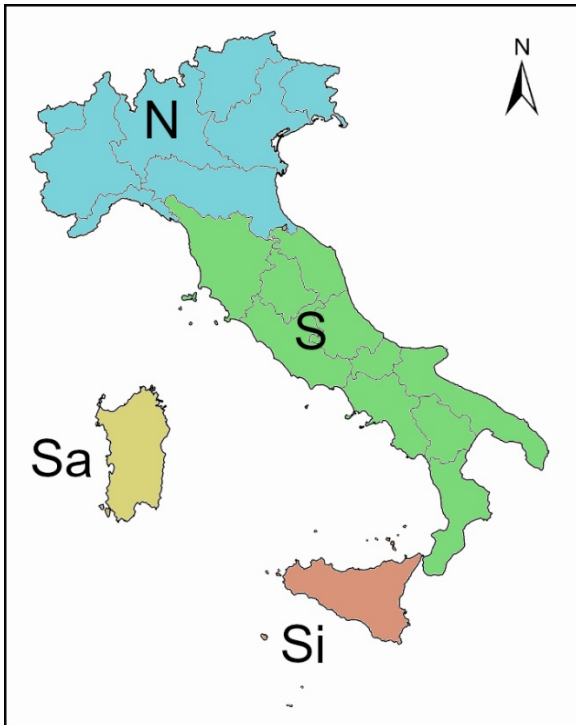


Figure 1. Study area: The Italian territory is divided into four sub-regions following Poldi et al. (1995) and the general framework of the project for a new Checklist of the Italian Fauna: N (Continental Italy), S (Peninsular Italy), Si (Sicily), Sa (Sardinia).

Literature data

The current version is based on data published until November 2020. Literature was searched through the search engines Google Scholar and Scopus, as well as through the AntMaps database on geographic distribution (www.antmaps.org; see Janicki et al. 2016, Guénard et al. 2017) and on the AntCat taxonomic catalogue (www.antcat.org; see Bolton 2021). Distribution records or nomenclatural changes were verified directly by examining and evaluating the information within each paper. Novel species records originally published by Radchenko et al. (2004) within the Fauna Europaea framework (and sometimes reported by following authors, e.g. Borowiec 2014) were not considered: they are clearly the result of an error, since they introduce several distribution novelties, some of which are rather incredible, in a checklist context in which distribution novelties were not expected in the first place (e.g. Schifani & Alicata 2018).

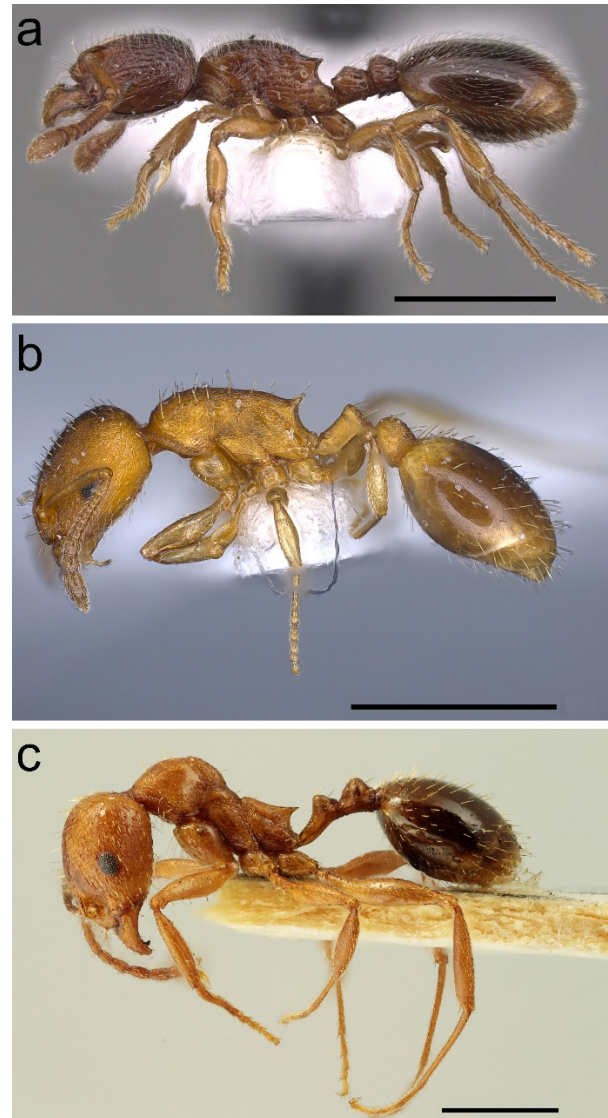


Figure 2. Worker specimens of three Italian endemic ant species described after the checklist published by Poldi et al. (1995); images from AntWeb (www.antweb.org): a) *Myrmecina melonii* Rigato, 1999 from Sardinia (CASENT0904563), b) *Temnothorax alienus* Schulz, Heinze & Pusch, 2007 from the Italian peninsula (ANTWEB1041296), c) *Aphaenogaster trinacriae* Alicata & Schifani, 2019 from Sicily (ANTWEB1041230). Photos by Will Ericson, Roland Schultz and Enrico Schifani. Scale: 1 mm.

Data set organization

The data set is available on-line version from the LifeWatch website. A simplified version is given in the Supplementary file S1.

The ant checklist contains 22 of the 46 columns that are common to all animal groups. The first columns are dedicated to the systematic classification of each species, from phylum rank to family, genus, species and

subspecies, including the descriptors of the former three. They are followed by an additional column presenting the name of the species/subspecies in the Fauna Europaea database (www.faunaeur.com) whenever possible, and two columns describing its status as either endemic (e), subendemic (s), introduced (a) or possibly introduced (?). Finally, two columns contain references for the nomenclatural or distribution changes compared to the checklist by Poldi et al. (1995).

The Supplementary file S2 contains a list of taxa that were present in the previous edition (Poldi et al. 1995) but were excluded from the update checklist for one of the following three reasons according to the relevant literature: *i*) they were considered dubious names; *ii*) they were considered absent from Italy; *iii*) after careful examination, their inclusion by Poldi et al. (1995) was found to be unsupported by any published paper.

Data set information

Object name: Checklist of the Italian Fauna: Formicidae

Characters encoding: Unicode (UTF-8)

Data set citation:

Schifani E., 2021. Formicidae. 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: 2021-05-31.

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

Format version: 1.0

Distribution: <https://dataportal.lifewatchitaly.eu/view/urn%3Auuid%3Ac1f2ab37-61e4-48e9-b3a9-15bdbf002f9d>

Date of creation: November 2nd, 2020

Date of last revision: November 28th, 2021

Date of publication: July 23rd, 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: Formicidae

Database manager: Enrico Schifani; Marco Bologna, Lucio Bonato, Fabio Cianferoni, Alessandro Minelli, Marco Oliverio, Fabio Stoch, Marzio Zapparoli & LifeWatch

Temporal coverage: Anything published until November 2020.

Record basis: Published records in the scientific and grey literature.

Funding grants: funding for the general project of the checklist of the Italian fauna was obtained from LifeWatch Italy; no funding was specifically available for the update of Formicidae.

Geographic information

General description: The dataset includes records from the national territory of Italy, including the two major islands Sardinia and Sicily, together with archipelagos and minor islands politically under the Italian legislation.

Geographic units: The geographical units within the Italian national territory for terrestrial records refer to the administrative boundaries of the Italian regions, in addition to San Marino Republic and Vatican City. Continental Italy was also divided in only two units, namely North (Friuli - Venezia Giulia, Veneto, Trentino - Alto Adige, Lombardia, Valle d'Aosta, Piemonte, Liguria, Emilia Romagna) and South (Toscana, Marche, Umbria, Lazio, Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria).

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

Sampling design: We did not perform any additional sampling to collect records, but we used only published data.

Habitat type: NA.

Biogeographic region: Palearctic.

Countries: Italy, San Marino, Vatican City.

Quality control for geographic data: We checked that the published localities matched the geographical units used for the checklist at the level of administrative regions.

Literature records

General description: Only published records are included.

Literature search methods: Google Scholar, Scopus.

Literature list: Müller (1921), Finzi (1924), Menozzi (1925), Bernard (1967), Baroni Urbani (1971, 1977), Kutter (1977), Süß (1979), Agosti & Collingwood (1987), Ortiz & Tinaut (1987), Buschinger et al. (1988), Casevitz-Weulersse (1990), Seifert (1992a, b, 1994), Bolton (1995), Mei (1995), Cagniant (1996), Carniel (1998), Buschinger et al. (1999), Rigato (1999, 2011), Sanetra et al. (1999), Seifert (2000, 2002, 2005, 2012a, b, 2018, 2020), Bolton (2003), Csösz & Seifert (2003), Glaser (2003, 2004), Limonta & Colombo (2003), Radchenko & Elmes (2003, 2010), Bonelli et al. (2004), Bernasconi et al. (2006), Radchenko et al. (2006), Scupola (2006, 2017), Csösz et al. (2007, 2014, 2015), Baroni Urbani & De Andrade (2007), Schultz et al. (2007), Verdinelli et al. (2007), Wetterer et al. (2007), Boer (2008, 2013), Elmes et al. (2008), Jucker et al. (2008), Seifert et al. (2009, 2014, 2017), Glaser et al. (2011, 2012), Steiner et al. (2010, 2018), Bolton & Fisher (2011), Rigato & Toni (2011), Yoshimura & Fisher (2012), Loi (2013), Bračko et al. (2014), Borowiec et al. (2015), Salata & Borowiec (2015, 2018a), Sarnat et al. (2015), Seifert & Csösz (2015), Ward et al. (2015), Bračko (2017), Centorame et al. (2017), Galkowski & Cagniant (2017), Schifani (2017), Wagner et al. (2017), Salata et al. (2018, 2021), Schifani & Alicata (2018, 2019), Ali-

cata & Schifani (2019), Galkowski et al. (2019), Giannetti et al. (2019), Masoni et al. (2019), Schär et al. (2020). Quality control for literature data: Additional references were searched through the literature, scanning the cited references of each paper.

Taxonomic information

General description: Only records reporting species or subspecies were included, disregarding records identified only at higher levels like genus, family, etc.

Taxonomic coverage: family Formicidae

Taxonomic rank: Only species and subspecies are reported; the dataset reports higher taxa for each species, including Phylum, Class, Order, Family, Genus.

Taxon specialists: Enrico Schifani.

Nomenclature: The nomenclature followed the most recently updated taxonomic framework.

Taxonomic remarks: All taxonomic changes that occurred since the publication of the previous checklists (1995) until November 2020. Species that were included in the previous checklist and are now considered not valid or not present in Italian waters, are excluded from the dataset.

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

RESULTS

Summary statistics

The checklist contains 267 species and subspecies belonging to 42 genera and 7 subfamilies: Amblyoponinae (2), Dolichoderinae (13), Formicinae (80), Leptanillinae (3), Myrmicinae (156), Ponerinae (8), and Proceratiinae (4). The distribution of these taxa in the four sub-regions is the following: N: 191; S: 160; Sa: 74; Si: 132.

A total of 33 taxa is currently considered endemic to the Italian territory, while 12 are considered subendemic (Figure 2). Endemic taxa are concentrated in the S (58%) and Si (45%), while only a few occur in N (12%) and Sa (9%). Most of the endemic taxa belong to the subfamily Myrmicinae (78%). On the other hand, there are 13 alien species and the status of 2 species as either native or introduced is dubious. Most introduced species are known to inhabit N (70%) or Si (60%), followed by S (40%) and Sa (20%).

The global IUCN red list includes 24 species occurring in Italy: 5 *Formica* species from the *rufa* group are considered Near Threatened (NT), and 19 inquiline social parasites are considered Vulnerable (VU) (they belong to the genera *Camponotus*, *Formicoxenus*, *Harpagoxenus*, *Lasius*, *Leptothorax*, *Myrmica*, *Plagiolepis*, *Strongylognathus*, *Temnothorax*, and *Tetramorium*) (Social Insect Specialists group 1996).

Changes in comparison to the previous checklist by Poldi et al. (1995) resulted from information published in 86 literature sources (articles or books). Some of them were actually published earlier than the last checklist, and were either missed by Poldi et al. (1995) or published at a stage when their work was already in the process of being published. They are 17 references in total: Müller (1921), Finzi (1924), Menozzi (1925), Bernard (1967), Baroni Urbani (1971, 1977), Kutter (1977), Süss (1979), Agosti & Collingwood (1987), Ortiz & Tinaut (1987), Buschinger et al. (1988), Casevitz-Weulersse (1990), Seifert (1992a-b, 1994), Bolton (1995), Mei (1995). In addition, novelties came from the following 69 references (summarized in Table 1) that were published after 1995: Cagniant (1996), Carniel (1998), Buschinger et al. (1999), Rigato (1999, 2011), Sanetra et al. (1999), Seifert (2000, 2002, 2005, 2012a, b, 2018, 2020), Bolton (2003), Csösz & Seifert (2003), Glaser (2003, 2004), Limonta & Colombo (2003), Radchenko & Elmes (2003, 2010), Bonelli et al. (2004), Bernasconi et al. (2006), Radchenko et al. (2006), Scupola (2006, 2017), Csösz et al. (2007, 2014, 2015), Baroni Urbani & De Andrade (2007), Schultz

et al. (2007), Verdinelli et al. (2007), Wetterer et al. (2007), Boer (2008, 2013), Elmes et al. (2008), Jucker et al. (2008), Seifert et al. (2009, 2014, 2017), Glaser et al. (2011, 2012), Steiner et al. (2010, 2018), Bolton & Fisher (2011), Rigato & Toni (2011), Yoshimura & Fisher (2012), Loi (2013), Bračko et al. (2014), Borowiec et al. (2015), Salata & Borowiec (2015, 2018a), Sarnat et al. (2015), Seifert & Csösz (2015), Ward et al. (2015), Bračko (2017), Centorame et al. (2017), Galkowski & Cagniant (2017), Schifani (2017), Wagner et al. (2017), Salata et al. (2018, 2021), Schifani & Alicata (2018, 2019), Alicata & Schifani (2019), Galkowski et al. (2019), Giannetti et al. (2019), Masoni et al. (2019), Schär et al. (2020).

Recent changes to be included in future updates

A total of 10 papers were published after this dataset was uploaded on the LifeWatch platform (2021-2022), and will be included the first update of the checklist in the near future.

They imply the addition of 8 species and 1 genus new to Italy, including 4 species of new description and 3 new endemics, the removal of 1 species, 6 nomenclatural changes and 47 distribution novelties. Boudinot et al. (2021) demonstrated the inconsistency of the subgeneric classification of *Lasius* and synonymized five subgenera including Italian species. *Aphaenogaster strioloides* Forel, 1890 was recorded in Italy for the first time and discovered to replace *A. crocea* André, 1881 in Si, implying the absence of *A. crocea* in Italy (Schifani et al. 2021a). The presence of further 9 species in Si was confirmed or recorded for the first time while other 19 were considered absent (Schifani et al. 2021b). *Solenopsis lusitanica* Emery, 1915 was recorded in Italy for the first time, in both Sa and S regions, while other 4 species were added to Sa and 2 were removed (Schifani et al. 2021c,d). *Aphaenogaster ovaticeps* (Emery, 1898), previously considered an Italian endemic, was synonymized with *A. muelleriana* Wolf, 1915 (Salata et al. 2021). Another two new distribution records were published for S and Si (Schifani et al. 2022a). The alien *Brachypon-*

era chinensis (Emery, 1895) was added to the Italian fauna based on a discovery in S (Menchetti et al. 2022). The newly described *Colobopsis imitans* Schifani et al. 2021 was discovered to replace *C. truncata* (Spinola, 1808) in Si (Schifani et al. 2022b). *Acropyga palearctica* Menozzi, 1936 was recorded in

Italy for the first time, in the S region (Scupola et al. 2022). Three new *Temnothorax* species endemic or subendemic to Si were described, while *T. lagrecai* (Baroni Urbani, 1964) was discovered to be subendemic and not endemic due to its presence the Maltese islands (Schifani et al. 2022c).

Table 1. Temporal distribution of novelties produced since the checklist by Poldi et al. (1995) was published. The ‘new species described’ column refers to descriptions of entirely new taxa, while redescrptions and resurrections also had an important role. The ‘nomenclatural changes’ are intended as the number of new synonymies, changes in taxonomic rank or taxonomic recombinations occurred. The ‘distribution novelties’ column only refers to novelties changing species distribution in relation to the subdivision of Italy in four sub-regions used in this and in the previous checklist.

Years	New papers	New species added	New endemic species described	Nomenclatural changes	All distribution novelties
1994-2000	9	5	3	33	11
2001-2005	8	5	0	9	5
2006-2010	16	12	4	9	17
2011-2015	17	7	1	17	20
2016-2020	19	17	1	0	35
Total	69	50	9	68	88

DISCUSSION

Our understanding of the Italian ant fauna has made very important steps forward since the first list was published more than a century ago (Emery 1916), and changes were also significant during the last 25 years (Poldi et al. 1995). Recently, even a first regional handbook was published (Scupola 2018). At present, Italy appears to be the third most species-rich country in Europe, right after Greece and Spain (Salata & Borowiec 2018b, Tinaut & Ruano 2021), and significantly distances all the other countries from the continent (Csösz et al. 2021). In the Mediterranean region, it falls to the fourth place, as it is preceded by Turkey as well (Kiran & Karaman 2020).

Despite significant improvements during the last decades, there are still many open questions and unsolved issues. For instance, the actual figure of endemic taxa has to be revised as

there are still many taxa whose current valid status is unsupported by any evidence, with at least a few which are most-likely synonyms of species with a broader distribution. This has already happened for subspecific taxa such as *Tetramorium semilaeve siciliense* Santschi, 1927 and *T. s. liparaeum* Santschi, 1927 (see Sanetra et al. 1999). More in general, all subspecific taxa reported in the list need to be taxonomically revised. Furthermore, knowledge over the geographic distribution of several species is extensively (sometimes almost exclusively) based on records that were produced before their taxonomic boundaries were significantly reworked by modern revisions. Obvious examples are those of *Lasius alienus* (Foerster, 1850), *Solenopsis fugax* (Latreille, 1798), or *Tapinoma erraticum* (Latreille, 1798): these species were considered extremely widespread in Europe and Italy due to confusion with a variety of morphologically similar taxa, and their presence in most

or even all the Italian territory is currently uncertain (e.g. Seifert 2012, 2020, Seifert et al. 2017, Schifani et al. 2021b,c). On the other hand, distribution data on those species with cryptic habits, either inquiline social parasites (some Formicinae and Myrmicinae) or endogenous taxa (mostly Amblyoponinae, Leptanillinae, Proceratiinae and some Ponerinae), are often scarce. In particular, the ancestral genus *Leptanilla* suffers from a combination of both insufficient taxonomic understanding and very limited distribution knowledge (Scupola & Ballarin 2009, Pérez-González et al. 2020).

No conservation priorities have yet been defined specifically for the Italian ant fauna, while the conservation status of ants in Europe is also rarely well assessed. Among the ‘Vulnerable’ social parasite species of Italy, some appear to be truly localized (Schifani et al. 2021e), while others are probably widespread (Schifani et al. 2021b). All are certainly difficult to sample (Espadaler & López-Soria 1991, Schifani 2017), making it difficult to have a clear understanding of their status. In the IUCN list, the status of these species is usually accompanied by a “needs updates” note (Social Insect Specialists group 1996). The conservation status of narrowly-distributed Italian endemics is rarely documented (Schifani et al. 2020, 2022c). On the other hand, new exotic species becoming established are increasing across the Mediterranean, especially in urban areas (Schifani 2019, Menchetti et al. 2022). The establishment of part of the species most recently recorded from Italy and provisionally included in the list is still uncertain and requires further investigation (see *Camponotus atriceps* (Smith, 1858), *Technomyrmex pallipes* (Smith, 1876), and *Tetramorium lucayanum* Wheeler, 1905 reported by Jucker et al. 2008).

A significant number of nomenclatural changes, distribution novelties and species descriptions, were already published during 2021-2022, outdating the version of the checklist currently available on LifeWatch (and in the supplementary file of this paper) and testifying a very dynamic state of art. A significantly more accurate and stable picture will hopefully be achieved in the near future, allowing to better-

define biogeographic patterns and conservation priorities.

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