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Journal

Biogeographia - The Journal of Integrative Biogeography, 37(1)

ISSN

1594-7629

Authors

Mastrototaro, Francesco

Montesanto, Federica

Publication Date

2022

DOI

10.21426/B637156606

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The new Checklist of the Italian Fauna: Ascidiacea

FRANCESCO MASTROTOTARO ^{1,2}, FEDERICA MONTESANTO ^{1,2} *

¹ *Department of Biology, University of Bari, Via E. Orabona, 4, I-70125, Bari (Italy)*

² *CoNISMa, Piazzale Flaminio 9, I-00197, Roma (Italy)*

* *corresponding author, email: montesantofederica90@gmail.com*

Keywords: Ascidiacea, ascidian, Aplousobranchia, Phlebobranchia, Stolidobranchia, marine, species list

SUMMARY

We present a data set reporting the checklist of the species belonging to the class Ascidiacea for the 9 Italian marine biogeographical units, updating the one previously published by Mastrototaro & Tursi in 2010. In detail, the updated checklist includes 138 taxa at species level (66 Aplousobranchia, 30 Phlebobranchia and 42 Stolidobranchia). Records refer to various marine habitats, including lagoons, harbours and semi-enclosed environments as well as deep habitats. The previous checklist reported 129 taxa (66 Aplousobranchia, 27 Phlebobranchia and 36 Stolidobranchia): in detail, 12 species were added, of which four newly described species, seven non-indigenous species and a new record for the Italian waters. On the other hand, three species reported in the previous checklist were removed: two because currently considered dubious, and one because its occurrence in the Mediterranean Sea is not actually confirmed. Finally, two species were renamed because they are considered synonyms of older ones and five species are currently accepted with new combinations. In addition, five species expanded their biogeographic distribution. The checklist data set will be dynamically updated with new records, and it will be freely available from Lifewatch Italy at <https://www.lifewatchitaly.eu/en/initiatives/checklist-fauna-italia-en/checklist>. This note describes the state of the art of the Ascidian checklist data set until February 2022.

INTRODUCTION

The project ‘Checklist delle Specie della Fauna d'Italia’ (Minelli et al. 1993-1995) represents one of the first attempts to carry out an almost

complete list of the animal species known for terrestrial and marine habitat of the Italian country. The goal of the present data paper is to provide information on the updated checklist,

limited to the class Ascidiacea, with the description of the state of the art of the updated data set as it currently stands in February 2022.

The project for an updated ‘Checklist of the Italian Fauna’ started in 2020 (Bologna et al. 2022) and the process is now complete for the data on the class Ascidiacea. The database will be continuously updated on the online platform of LifeWatch Italy (www.lifewatchitaly.eu/en/initiatives/checklist-fauna-italia-en/checklist) allowing a dynamically updated knowledge on the occurrence of the Italian fauna (Bologna et al. 2022).

Ascidiacea, comprising approximately 3,000 described species found in all marine habitats, is the largest and most diverse class of the subphylum Tunicata or Urochordata (Shenkar & Swalla 2011) (from the Greek word “ουροσ”, tail and the Latin word “chorda”, cord, Fig. 1). The current classification of the class was developed by Perrier (1898) and later by Garstang (1928) and is based on the position of the gonads. Two orders are recognised: Enterogona (gonads under/in the gut loop), and Pleurogona (gonads in the body wall) (Brunetti & Mastrototaro 2017) (Fig. 2). Moreover, a classification, based on the structure of adult branchial sac, was proposed by Lahille (1886, 1888, 1890), who recognized three taxa: Aplousobranchia (without folds and without internal longitudinal vessels), Phlebobranchia (without folds but with internal longitudinal vessels) and Stolidobranchia (with folds and internal longitudinal vessels) (Fig. 3). The Enterogona order includes the suborders Aplousobranchia and Phlebobranchia, while the order Pleurogona includes the suborder Stolidobranchia.

Ascidiacea are benthic organisms present at all latitudes, from shallow to deep waters, living attached to biotic and abiotic substrata and colonizing several different habitats from rocky bottoms, coral reefs and sandy or muddy sediments (Brunetti & Mastrototaro 2017). They constitute a faunistic group with significant presence in benthic communities, indeed they

represent one of the main animal taxa among the biofouling species (Brunetti & Mastrototaro 2017).

Apart from their important phylogenetic position as a key taxon to study vertebrate evolution, ascidians provide extensive opportunities for research in many fields such as embryo development, tissue regeneration, stem cells, animal evolution, aging, ecology and research of new bioactive natural products.

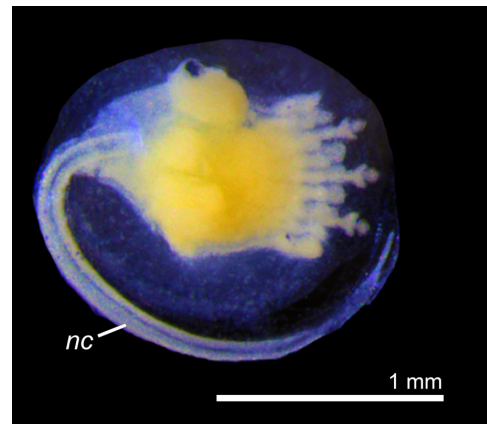


Figure 1. Larva of the ascidian species *Polyclinum constellatum* showing the notochord in the tail (nc).

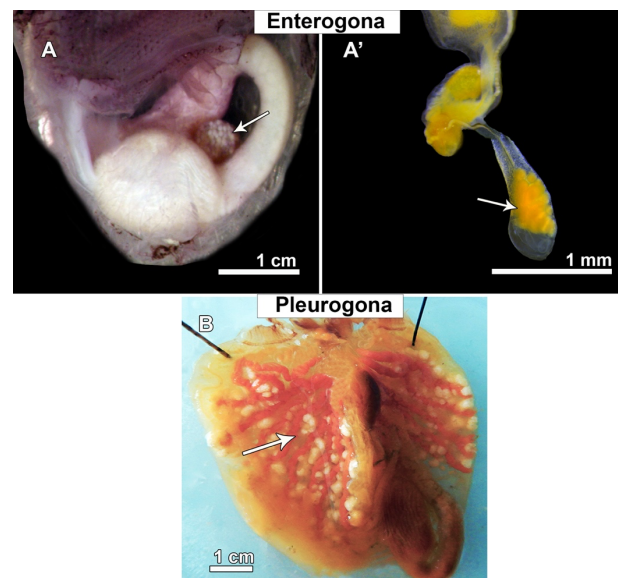


Figure 2. Order Enterogona: A) species with gonads in the gut loop (arrow) (i.e., *Ciona*) or (A') with gonads under the gut loop (arrow) (i.e., *Polyclinum*), B) Order Pleurogona: species with gonads in the body wall (arrow) (i.e., *Styela*).

Data set description

The ascidian data set includes information on 25 out of 51 columns of the total Italian Fauna data set (Table 1). The first columns refer to the hierarchical taxa from Phylum to Family, followed by Genus, genus-authorship, Species and species-authorship.

The binomen of the species is mentioned as in WoRMS (World Register of Marine Species) (Horton et al. 2021), with the relative AphiaID code.

Considering the definition of the Secretariat of the Convention on Biological Diversity (2002) and in view of the current knowledge, two columns report whether the species is endemic (End) or not, and whether it is a recent alien introduction (Alien) for the Italian waters or not.

According to the biogeographical divisions of the Italian Seas (Bianchi 2004, Relini 2008, 2010) the known occurrence of the species in the nine Italian marine geographical units (Fig. 4) are reported. Finally, two columns of the data set report nomenclatorial changes occurred since the publication of the previous checklist by Mastrototaro & Tursi (2010) and the literature reference used to expand the species list and/or the distribution of the species since Mastrototaro & Tursi (2010).

A simplified version of the checklist is given in the Supplementary file S1.

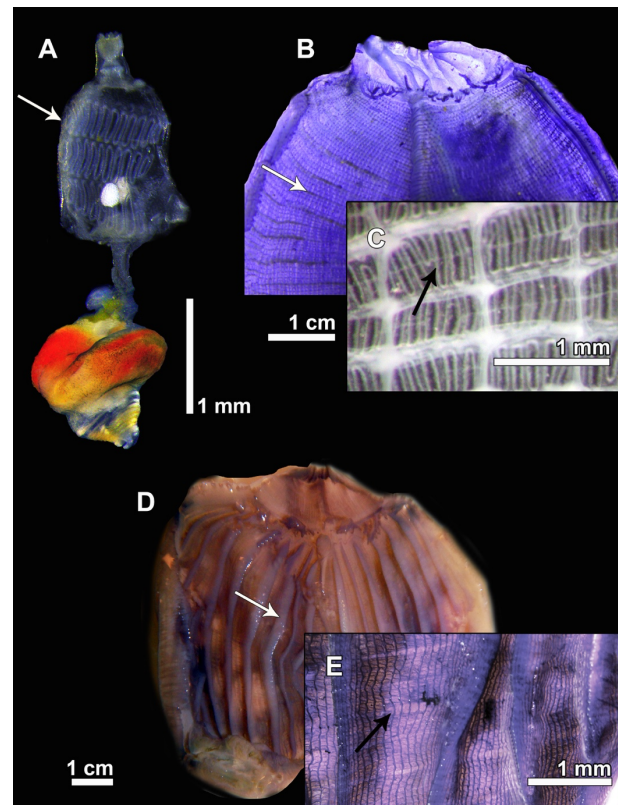


Figure 3. A) Pharynx of a *Trididemnum* species (order Aplousobranchia) (the arrow points to the stigmatal rows without internal longitudinal vessels and folds). B) Pharynx of a *Ciona* species (order Phlebobranchia), showing no folds (white arrow) but (C) with internal longitudinal vessels (black arrow). D) Pharynx of a *Microcosmus* species (order Stolidobranchia), showing the presence of folds (white arrow) and (E) with internal longitudinal vessels (black arrow).

Table 1. Description of the data set with specific information relative to definitions and storage type for each of the 51 columns of the total data set. The variables (25) used for the Ascidiacea are reported in bold.

Variable (column)	Description	Storage type
Phylum	Phylum name, Tunicata for all records	string
Class	Class name, Ascidiacea for all records	string
Order	Order name	string
Suborder	Suborder name	string
Family	Family name, according to WoRMS	string
Subfamily	Subfamily name, according to WoRMS	string
Genus	Valid genus name, according to WoRMS	string
Genus authorship	Genus author	string

Variable (column)	Description	Storage type
Species	Valid species name, according to WoRMS	string
Species authorship	Species author	string
Subspecies	Valid subspecies name, according to WoRMS	string
Subspecies authorship	Subspecies author	string
Fauna Europaea (name)	Species name as reported in FaunaEuropaea	string
WoRMS (AphiaID)	Species AphiaID as reported in WoRMS	string
Endemic	Species known as endemic	binary
Alien	Species known as alien	binary
N	Occurrence of the taxon in Northern continental Italy (grouping: Friuli - Venezia Giulia, Veneto, Trentino - Alto Adige, Lombardia, Valle d'Aosta, Piemonte, Liguria, Emilia Romagna)	binary
S	Occurrence of the taxon in Southern continental Italy (grouping: Toscana, Marche, Umbria, Lazio, Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria)	binary
Si	Occurrence of the taxon in Sicily	binary
Sa	Occurrence of the taxon in Sardinia	binary
Ao	Occurrence of the taxon in Valle d'Aosta	binary
Pi	Occurrence of the taxon in Piemonte	binary
Lo	Occurrence of the taxon in Lombardia	binary
VT	Occurrence of the taxon in Trentino - Alto Adige	binary
V	Occurrence of the taxon in Veneto	binary
FVG	Occurrence of the taxon in Friuli - Venezia Giulia	binary
Li	Occurrence of the taxon in Liguria	binary
ER	Occurrence of the taxon in Emilia Romagna	binary
To	Occurrence of the taxon in Toscana	binary
Ma	Occurrence of the taxon in Marche	binary
Um	Occurrence of the taxon in Umbria	binary
La	Occurrence of the taxon in Lazio	binary
Abr	Occurrence of the taxon in Abruzzo	binary
Mo	Occurrence of the taxon in Molise	binary
Cp	Occurrence of the taxon in Campania	binary
Pu	Occurrence of the taxon in Puglia	binary
Bas	Occurrence of the taxon in Basilicata	binary
Cal	Occurrence of the taxon in Calabria	binary
RSM	Occurrence of the taxon in Repubblica di San Marino	binary
CV	Occurrence of the taxon in Città del Vaticano	binary
1	Marine area number 1 according to SIBM: Ligurian Sea North of Piombino and Capo Corso	binary
2	Marine area number 2 according to SIBM: Coasts of Sardegna (and Corsica), with North Tyrrhenian Sea from Piombino to Gaeta	binary
3	Marine area number 3 according to SIBM: Coasts of Campania, Tyrrhenian coasts of Basilica, Calabria and Sicilia	binary
4	Marine area number 4 according to SIBM: Messina Strait between Sicilia and Calabria	binary
5	Marine area number 5 according to SIBM: South-Eastern coasts of Sicilia, Pelagic Islands, Maltese archipelago	binary

Variable (column)	Description	Storage type
6	Marine area number 6 according to SIBM: Eastern coast of Sicilia (without Messina Strait), Ionian coasts of Calabria and Basilicata and Southern part of Puglia up to Otranto	binary
7	Marine area number 7 according to SIBM: Lower Adriatic Sea, Coasts of Puglia between Otranto and Manfredonia	binary
8	Marine area number 8 according to SIBM: Mid Adriatic Sea, coasts between Manfredonia (Puglia) and Conero (Marche)	binary
9	Marine area number 9 according to SIBM: High Adriatic Sea, coasts from Conero (Marche) to Istria (Friuli - Venezia Giulia)	binary
Taxonomic notes	Nomenclatorial changes from the previous checklist of Mastrototaro & Tursi (2010)	string
Distribution notes	Literature reference for new distribution records not included in Mastrototaro & Tursi (2010)	string

Data set information

Object name: Checklist of the Italian Fauna: Ascidiacea

Characters encoding: Unicode (UTF-8)

Data set citation: Mastrototaro F., Montesanto F., 2021. Ascidiacea. 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: June 15th, 2020

Date of last revision: February 15th, 2022

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: Ascidiacea

Database manager: Francesco Mastrototaro, Federica Montesanto; Marco Bologna, Lucio Bonato, Fabio Cianferoni, Alessandro Minelli, Marco Oliverio, Fabio Stoch, Marzio Zapparoli & LifeWatch Italy

Temporal coverage: We checked all the available scientific articles and grey literature published by February 2022.

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

Funding grants: No funding was specifically available for the project on Ascidiacea; funding for the update of the Checklist of the Italian fauna was obtained from LifeWatch Italy.

Geographic information

General description: The data set includes records from the national waters of Italy, including the two major islands Sardinia and Sicily, archipelagos and minor islands within Italian administrative boundaries.

Geographic units: The geographical units for marine and coastal waters refer to the nine biogeographical units identified by the Società Italiana di Biologia Marina, SIBM (Bianchi 2004).

Bounding box: All sea waters falling under Italian administrative boundaries were included.

Sampling design: We did not perform any additional sampling to collect records of ascidians; only published data were taken into account.

Habitat type: Any type of marine habitat where ascidian can be found was considered (Brunetti & Mastrototaro 2017). These include all natural and anthropic marine habitats, such as open sea, estuaries, lagoons, semi-enclosed environments, harbours marinas and as well as deep habitats.

Countries: Italy.

Quality control for geographic data: We checked that the georeferenced records and the published localities in the papers matched the geographical units accepted for the checklist at the level of marine units.

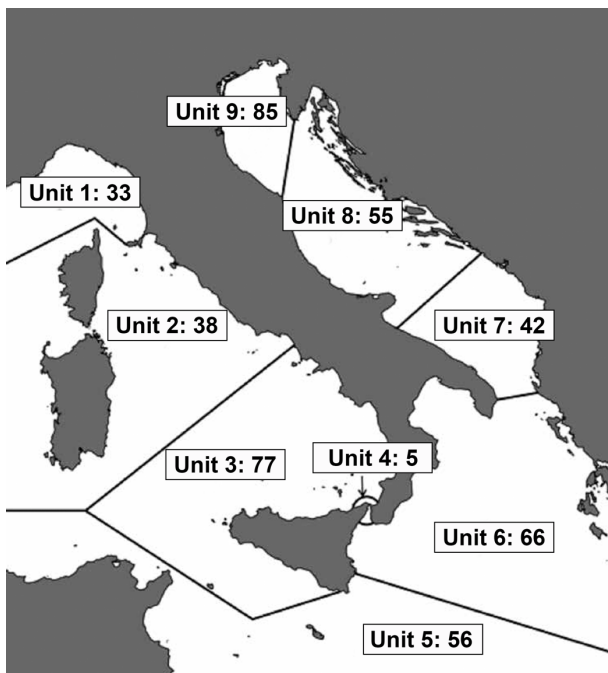


Figure 4. Marine geographical units recognized in the checklist, with number of species of Ascidiacea found in each of them.

Literature records

General description: Only published records are included in the data set. A search through the literature was performed by 15th February 2022.

Literature search methods: We searched through Web of Science, Scopus, and Google Scholar for keywords ('ascidian' or 'Ascidiacea') and ('Italy' or 'Italian').

Literature list: The 16 papers or books published after the previous checklist by Mastrototaro & Tursi (2010) that reported new ascidian records are: Bay-Nouailhat et al. 2020, Brunetti 2009, Brunetti & Mastrototaro 2017, Lezzi et al. 2018, Mastrototaro et al. 2019a, b, 2020a, b, Monniot 2016, Montesanto et al. 2021, 2022, Ordóñez et al. 2016, Orfanidis et al. 2021, Ponti & Mastrototaro 2006, Santin et al. 2021, and Tagliapietra et al. 2012.

Quality control for literature data: We checked all the available scientific articles and grey literature published by February 2022. The dynamic nature of the online data set at Lifewatch Italy will allow including potentially overlooked records.

Taxonomic information

General description: Only records identified at the species level were included.

Taxonomic coverage: Phylum Ascidiacea.

Taxonomic rank: The data set includes species and mentions higher taxa for each species, including Phylum, Class, Order, Family, and Genus.

Taxon specialists: Francesco Mastrototaro, Federica Montesanto.

Nomenclature: The adopted nomenclature followed the species names in WoRMS (or from the original descriptions for species newly described). Species authorships follow the rules of art. 51.3 of the 4th edition of the International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature 1999) for the use of parentheses.

Taxonomic remarks: Any taxonomic change that occurred since the publication of the previous checklist (Mastrototaro & Tursi 2010) is mentioned, according to the nomenclature reported

in WoRMS and considering the recent scientific literature. Species that were included in the previous checklist and currently considered not valid by WoRMS are excluded from the data set.

Quality control for taxonomic data: Taxonomic data were checked and updated to include revision of names, synonyms, delimitation of genera and higher taxa, all conducted through a comparison according to WoRMS and with the original descriptions for all species described after year 2000.

RESULTS

Summary statistics

The species list includes 138 taxa at the species level, with 66 taxa of Aplousobranchia, 30 of Phlebobranchia, and 42 of Stolidobranchia. The previous checklist (Mastrototaro & Tursi 2010) reported 129 taxa: 66 Aplousobranchia, 27 Phlebobranchia and 36 Stolidobranchia. In the current checklist 12 species were added and three were removed. Moreover, two species were synonymized and five are currently accepted with new combinations.

In particular, the updated checklist reports four newly described species: *Pseudodistoma valeriae* Brunetti, 2009 (Brunetti 2009), *Ciona intermedia* Mastrototaro, 2020 (Mastrototaro et al. 2020a), *Botrylloides crystallinus* Bay-Nouailhat, Bay-Nouailhat, Gasparini & Brunetti 2020 (Bay-Nouailhat et al. 2020), and *Botryllus gaiiae* Brunetti, 2020 (Brunetti et al. 2020). Furthermore, five species were recorded for the first time in marine units where they were not present before, thus expanding their geographical distribution: *Aplidium tabarquensis* Ramos-Esplá, 1991 (Ponti & Mastrototaro 2006, Petović et al. 2018), *Ecteinascidia turbinata* Herdman, 1880 (Lezzi et al. 2018, Ragkousis et al. 2020), *Diazona violacea* Savigny, 1816 (Mastrototaro et al. 2020b), *Distaplia bermudensis* Van Name, 1902 (Orfanidis et al. 2021) and *Ciona edwardsi* Roule, 1884 (Santin et al. 2021). Seven new non-indigenous species were recorded along the Italian coasts: *Didemnum vexillum* Kott, 2002

(Tagliapietra et al. 2012), *Botrylloides giganteus* (Pères, 1949) (Brunetti & Mastrototaro 2017, Rocha et al. 2019, Salonna et al. 2021), *Microcosmus anchylodeirus* Traustedt, 1883 (Monniot 2016), *Symplegma brakenhielmi* (Michaelsen, 1904) (Mastrototaro et al. 2019a), *Aplidium accarensense* Millar, 1953 (Montesanto et al. 2021), *Polyclinum constellatum* Savigny, 1816 (Montesanto et al. 2022), *Styela clava* Herdman, 1881 (Mastrototaro et al. 2022). A peculiar deep species *Dicopia antirrhinum* Monniot, 1972 recorded off Aeolian Islands (Mastrototaro et al. 2019b) was added. Two species were synonymized: *Clavelina phlaegrea* Salfi, 1929 with *C. oblonga* Herdman 1880 (Ordóñez et al. 2016), *Aplidium coeruleum* Lahille, 1890 with *A. asperum* Drasche, 1883. Furthermore, the sequent species are actually accepted as new combinations: *Molgula impura (occidentalis)* Heller, 1877 with *M. occidentalis* Traustedt, 1883, *Aplidium fuscum* Herdman, 1881 with *A. undulatum* Monniot & Gaill, 1978, *Polycarpa sabulosa* Heller, 1877 with *P. gracilis* Heller, 1877, *Archiascidia neapolitana* Julin, 1904 with *Pycnoclavella neapolitana* (Julin, 1904) and *Aplidium (Morchellium) argus* (Milne-Edwards, 1841) with *Morchellium argus* (Milne-Edwards, 1841) (Brunetti & Mastrototaro 2017).

Of the three removed species two are considered dubious species: *Distaplia styliifera* (Kowalewsky, 1874) and *Polyclinella azemai* Harant, 1930, while the occurrence of the third deleted species, *Aplidium pellucidum* Drasche, 1883, is not confirmed in the Mediterranean basin (Brunetti & Mastrototaro 2017).

A special case is represented by the iconic species *Ciona intestinalis* (Linnaeus, 1767) used as model animal in many biological studies (i.e., Satoh & Jeffery 1995, Corbo et al. 2001, Satoh et al. 2003). In the early 2000s, molecular studies indicated the existence of a surprisingly high genetic divergence among specimens assigned to this binomen but distributed in distant geographical localities (Caputi et al. 2007, Zhan et al. 2010, Sato et al. 2012). These genetic divergences lead to consider *C. intestinalis sensu lato* as a complex of four cryptic

species, named A to D types. Subsequently, in-depth morphological analyses of specimens of the different types belonging to the *C. intestinalis* species complex revealed that type A could be correctly assigned to the species *Ciona robusta* Hoshino & Tokioka, 1967 (for many years considered a synonym of *C. intestinalis*), whereas the type B to *C. intestinalis* (Linnaeus, 1767) *sensu stricto* (Brunetti et al. 2015, Mastrototaro et al. 2020a). These last studies reported that the two species, although sympatric in some areas of the Atlantic, have a disjoint distribution. In particular, type A (namely *C. robusta*) has been found primarily in the Mediterranean Sea, the Pacific Ocean (Australia, Japan, New Zealand, South Korea, and West coast of North America), and the Atlantic coasts of South Africa (Caputi et al. 2007, Zhan et al. 2010), while type B (namely *C. intestinalis*) has been found on the coasts of both the NE and NW North Atlantic Ocean, as well as in the Bohai and Yellow Seas (China) (Brunetti et al. 2015, Zhan et al. 2010). These studies lead to the conclusion that all the records assigned to *C. intestinalis* in the Mediterranean Sea before 2000s should be considered as *C. robusta* although it should be verified. Therefore, in the present checklist we maintain both binomina with the same distribution, although only *C. robusta* should be considered as currently present in the Mediterranean basin.

Concerning the geographic distribution of the species, the marine biogeographical unit 9 (North Adriatic Sea) showed the highest number of taxa (85), followed by the unit 3 (South Tyrrhenian Sea) (77) and the unit 6 (Italian Ionian Sea) (66), no marine areas is without known records of ascidians (Fig. 2).

ACKNOWLEDGEMENTS

We thank the ‘Comitato Scientifico per la Fauna d’Italia’ for promoting and editing updates for the checklist of the Italian Fauna.

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Submitted: 02 March 2022

First decision: 20 April 2022

Accepted: 24 April 2022

the Guest editors for the special section
“The new Checklist of the Italian Fauna”:

Marco A. Bologna, Lucio Bonato,
Fabio Cianferoni, Alessandro Minelli,
Marco Oliverio, Fabio Stoch, Marzio Zapparoli