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The new Checklist of the Italian Fauna: Odonata

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Keywords: Odonata; biodiversity; biogeography; species distribution; checklist

SUMMARY

Seventeen years after the publication of the last checklist of the damselflies and dragonflies found in Italy, an updated list has been compiled. This list reports 95 species belonging to 10 families and 38 genera and includes 2 national endemic and 1 sub-endemic species. Compared to the previous checklist, three species were removed, two subspecies were granted species status, and 10 species were added as new taxa for Italy. The checklist summarizes the current state of the knowledge on the geographical distribution of the Italian species with a regional detail. After the online publication of this dataset on the LifeWatch Italy website in 2021, some minor updates will be included in future releases. The newly discovered species are the result of increased exploration of the national territory combined with some possible range shifts, especially of Libellulidae species of Afro-Asiatic origin. This increased coverage of the country is the result of the efforts of many contributors. It stems from the rapidly growing interest in this zoological group, also enhanced by the activation of a nationwide citizen science project promoted by the Italian Society for the Study and Conservation of Dragonflies (Odonata.it).

INTRODUCTION

Odonata is an insect order composed of approximately 6370 species (Paulson et al. 2022). Dragonflies and damselflies are recognised as valuable ecological indicators in a variety of hydroecosystems and are thus successfully used for: i) the assessment and monitoring of aquatic and terrestrial habitat integrity and ii) the detection and prediction of the biological impact of climate warming (Hassall 2015, Rocha-Ortega et al. 2019) (Fig. 1).

In Europe, 145 species of dragonflies and damselflies are known to occur so far (Boudot and Kalkman 2015, Viganò et al. 2017, López-Estrada et al. 2020). Italy is among the best-known country of Europe with respect to the fauna of Odonata (Boudot and Kalkman 2015). It has been extensively studied from a faunistic point of view since the end of the XIX century (e.g., Ausserer, 1869; Pirota, 1879; Garbini, 1897), although several authors wrote about the Italian dragonflies even earlier (e.g., Vandelli, 1763, Allioni, 1766; Cirillo, 1787).

Checklists and related faunistic occurrence data are key elements in biogeographical and ecological investigations, as they contribute to the identification of priority areas, organization and planning of projects dealing with mapping, inference, and modelling of current or potential species distributions (Gaston and Rodrigues, 2003; Phillips et al. 2006; Possingham et al., 2007; Sandal et al., 2022). Italy has a long history of odonatological checklists. The first ‘modern’ effort was the first volume of the ‘Fauna d’Italia’ series (Conci and Nielsen, 1956), which reported the occurrence of all the Odonata species known at that time for each Italian region, for a total of 80 species for Italy as a whole. Subsequently, other authors provided periodical updates, in particular: Carchini et al. (1985), Carchini and Rota (1986), Utzeri (1994), Utzeri and D’Antonio (2005). The last two checklists were published in the framework of the huge collaborative project of

the ‘Checklist of the Italian Fauna’ (Minelli et al. 1993-1995; Ruffo and Stoch, 2005).

Since the publication of the last Italian Odonata checklist 17 years ago (Utzeri and D’Antonio, 2005), there has been a remarkable increase in the number of valuable faunistic papers on odonates in Italy, even in the traditionally less explored regions of central and southern Italy. This increase, concomitantly reported in other parts of Europe, has been likely triggered by the improved availability of tools for species identification and the presence of internet platforms that allow data, photographs, and observations to be shared, reflecting a rapidly growing interest for this group of insects (Kalkman et al. 2018).

The new checklist (available on the LifeWatch Italy web site, and in a synthetic version in the Supplementary file S1) presents an updated checklist of the damselflies and dragonflies occurring in Italy with a regional geographical detail. New species have been reported in the last 17 years and some taxa have been recently taxonomically revised, making it necessary to update the list of the country to reflect the current state of the knowledge for this order of insects (Supplementary file S2). Thanks to all the researchers and volunteers who have dedicated their time and energy to building an understanding of dragonfly distribution patterns in Italy, the present checklist is based on materials from private and institutional collections and scientific literature, as well as digital biodiversity repositories fed by citizen science projects.

RESULTS

Summary statistics

A total of 95 species belonging to 10 families and 38 genera are listed: Calopterygidae (1 genus, 4 species); Lestidae (3 genera, 9 species); Platycnemididae (1 genus, 1 species); Coenagrionidae (7 genera, 18 species); Aeshnidae (4 genera, 13 species); Gomphidae (6

genera, 8 species); Cordulegastridae (1 genus, 4 species); Corduliidae (2 genera, 6 species); Synthemistidae (1 genus, 1 species); Libellulidae (12 genera, 31 species). 52 species occur in all three Italian biogeographical regions: 68 species live in the Alpine region, 70 in the Continental region and 76 in the Mediterranean region. The Mediterranean region also has the largest number of exclusive species (15 species), followed by the Alpine region (9 exclusive species) and the Continental region (3 exclusive species).

From a chorological point of view, 39% of the species consists of Mediterranean taxa (including species more or less widely spread in the Mediterranean countries), 16% are Asiatic-European species, 12% Sibero-European species, 14% European species, and the remaining 19% belong to other 7 chorotypes. Altogether the 95 species represent about 66% of

the European odonatological fauna. Two species, namely the damselfly *Coenagrion castellani* (formerly known as *C. mercuriale castellanii*) and the dragonfly *Cordulegaster trinacriae*, are endemic of Italy, while *Ischnura genei* is a subendemic species due to its presence in the French island of Corsica. Compared to the previous checklist (Utzeri and D'Antonio, 2005), 3 species (*Ischnura graeelsi*, *Cordulegaster picta*, *Epithea bimaculata*) should not be considered part of the national fauna anymore. Further occurrences of the species in national territory not included in the Supplementary file S2 will be included in future updates of the checklist. It is the case of *Aeshna subarctica* in Veneto, *Cordulegaster bidentata* in Molise, *Somatochlora flavomaculata* in Puglia, and *Trithemis annulata* in Piemonte, just to name a few of the cases of which the authors are currently aware.



Figure 1. Representative Odonata: a) *Coenagrion castellani* – Trevi (PG), 03/06/2022 (foto G. La Porta); b) *Aeshna subarctica* – Altavalle (TN), 09/08/2019 (foto G. Assandri); c) *Oxygastra curtisii* – Calcio (BG), 11/06/2018 (foto F. Leandri); d) *Zygonyx torridus* –S. Caterina Menfi (AG), 14/08/2014 (foto F. Landi).

Data set information

Object name: Checklist of the Italian Fauna: Odonata

Characters encoding: Unicode (UTF-8)

Data set citation: La Porta G., Landi F., Leandri F., Assandri G., 2022. Odonata. 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.

Format version: 1.0

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

Date of creation: June 15th, 2020

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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: Odonata

Database manager: Odonata.it; Marco Bologna, Lucio Bonato, Fabio Cianferoni, Alessandro Minelli, Marco Oliverio, Fabio Stoch, Marzio Zapparoli & LifeWatch Italy

Temporal coverage: Anything published until May 2021.

Record basis: Published records in scientific and grey literature and records stored and validated in digital biodiversity repositories fed by citizen science projects.

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

Geographic information

General description: The dataset includes records from the national territories 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 territories for terrestrial records refer to the administrative boundaries of the 20 Italian regions, in addition to San Marino Republic and Vatican City (Table 1). 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), while islands of Sardinia and Sicily were left as independent units. Furthermore, the national territory was also analyzed by considering three European biogeographical regions, as defined for Italy by the European Environment Agency (2017): Alpine, Continental, and Mediterranean.

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 and validated sightings coming from georeferenced archives of Odonata.it.

Habitat type: Odonata are amphibiotic hemimetabolous insects, whose nymphs generally live in shallow and slow-flowing waters, whereas adults are good flyers, specialized for dispersal and reproduction. Some species are highly mobile and/or migrant and may disperse over hundreds or even thousands of kilometers. This data paper provides information on dragonflies and damselflies that have been recorded in Italy at fresh flowing or standing waters, as in any terrestrial habitat. Different species inhabit different habitats, such as permanent or temporary waters, unvegetated or with submerged, floating, emergent and waterside plants. Surveys have been conducted across a wide range of habitats such as springs, brooks, streams, rivers, ponds, lakes, ditches, canals, quarries and reservoirs, swamps, peat bogs, marshes, fens, and coastal brackish wetlands. Furthermore, flying adults, dispersing, hunting or maturing, may be encountered in any terrestrial habitat, especially open woods, edges, bushes, meadows and grasslands even far from freshwater sites.

Countries: Italy, without including Corsica, Canton Ticino, and Maltese Archipelago, politically belonging respectively to the French Republic, Swiss Confederation and the Republic of Malta, which have been properly investigated in detail by other authors (Wildermuth et al., 2005, Ebejer, et al., 2008, Roché et al., 2008, Berquier C. 2013, Degabriele 2013, UICN France, 2016, Boudot et al., 2017, Monnerat et al., 2021). San Marino and Vatican City were included even though no odonatological studies were ever carried out due to a lack of relevant sites of odonatological interest.

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

Literature records

General description: Only published records and publicly available records are included in the dataset. A search through the literature was performed on 15th June 2020.

Literature search methods: We searched through Web of Science, Scopus, and Google Scholar for keywords ('odonata', 'dragonflies', 'damselflies') and ('Italy' or 'Italian'), and individual species by their names.

Literature list: (i) Papers reporting the nine new species found in Italy after checklist of 2005: Bedjanič and Šalamun, (2003); Kunz et al. (2006); Holusa (2008); Festi (2011); Corso et al. (2012a); Corso et al. (2012b); Rattu et al. (2014); Viganò et al. (2017); Corso and Penna (2020); (ii) Papers reporting significant information inserted in species distribution notes: Conci et al. (1944); Capra (1945; 1964); Conci (1948); Roberts (1948); Consiglio (1950; 1953); Nielsen and Conci (1951); Minelli (1966); Bucciarelli (1972; 1978); Bordoni et al. (1980); Mancini et al. (1993); D'Antonio (1995, 1997); Bedjanic and Salamun (1999); Kunz (2006); Boano et al. (2007); Olias et al. (2007); Dijkstra and Matushkina (2009); Fiorenza et al. (2009); Festi (2011); Giugliano and Terzani (2011); Dijkstra et al. (2012, 2013, 2021); Ottonello and Oneto (2013); Terzani et al. (2013); Corso et al. (2014); Riservato et al. (2014); Schneider and Utzeri (2014); Zandigiacomo (2014); Mastropasqua and Liuzzi (2016); Aguzzi et al. (2017); Assandri (2019); Corso (2019); Piretta and Assandri (2019); Bonometto (2020); Assandri et al. (2022); (iii) Other selected papers of local, regional, or national interest published after 2005 (Supplementary file S1).

Taxonomic information

General description: Only records reporting species were included, disregarding records at higher level like genus, family, etc.

Taxonomic coverage: Any species of the order Odonata Fabricius, 1793 of the class Insecta.

Although in the previous checklist (Utzeri and D'Antonio, 2005) 26 taxa were treated at a subspecific level, in the present work subspecies were not included as they require further genetic investigation for a taxonomic resolution (Galimberti et al. 2020) and present doubtful geographic delimitations.

Taxonomic rank: Only species, without subspecies, are reported.

Taxon specialists: Giacomo Assandri, Federico Landi, Fausto Leandri, Gianandrea La Porta

Nomenclature: The adopted nomenclature follows the World Odonata List (Paulson et al. 2022).

Taxonomic remarks: All taxonomic changes that occurred since the publication of the previous checklists (Utzeri and D'Antonio, 2005). Species that were included in the previous checklist and are now considered not valid or for which there is new evidence that they do not occur in Italy were 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, all conducted through a comparison with the World Odonata List (Paulson et al. 2022) and other published catalogues (Bridges 1994; Banki et al., 2022).

Table 2 - Description of the dataset with specific information relative to definitions and storage type for each field.

| Field | Description | Storage type |
|-----------------------|---|--------------|
| Phylum | Phylum name, Arthropoda for all records | string |
| Class | Class name, Insecta for all records | string |
| Order | Order name, according to Paulson et al. 2022 | string |
| Family | Family name, according to Paulson et al. 2022 | string |
| Subfamily | Subfamily name, according to Bridges (1994) | string |
| Genus | Valid genus name, according to Paulson et al. 2022 | string |
| Genus authorship | Genus descriptor | string |
| Species | Valid species name, according to Paulson et al. 2022 | string |
| Species authorship | Species descriptor | string |
| Fauna Europaea (name) | Species name as reported in FaunaEuropaea | string |
| Endemic | Species known as endemic for Italy | string |
| Alien | Species known as alien for Italy (all the Italian species should be considered native) | string |
| 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 |
| Chorotype | Chorotype according to Vigna Taglianti et al., 1999 | string |
| Taxonomic notes | Relevant taxonomic and systemic notes | string |
| Distribution notes | Significant notes referring to the regional distribution of each taxon and the relative references | string |

DISCUSSION

Taxonomic revisions, evaluations of historical documentary sources and reappraisal of specimens in collections have had little effect on the changes occurred from the previous checklist to the present inventory. Only two species previously considered subspecies have been granted species status (*Calopteryx xanthostoma* and more recently *Coenagrion castellani*, still

listed in Supplementary file S2 as *C. mercuriale*), two species have been reassigned to a different taxonomic position (*Orthetrum anceps* and *Brachythemis leucosticta*), and three species, namely *Ischnura graeelsi*, *Cordulegaster picta*, and *Epitheca bimaculata*, have been removed from the list due to misidentifications of the specimens and lack of clear evidence of past presence in Italy.

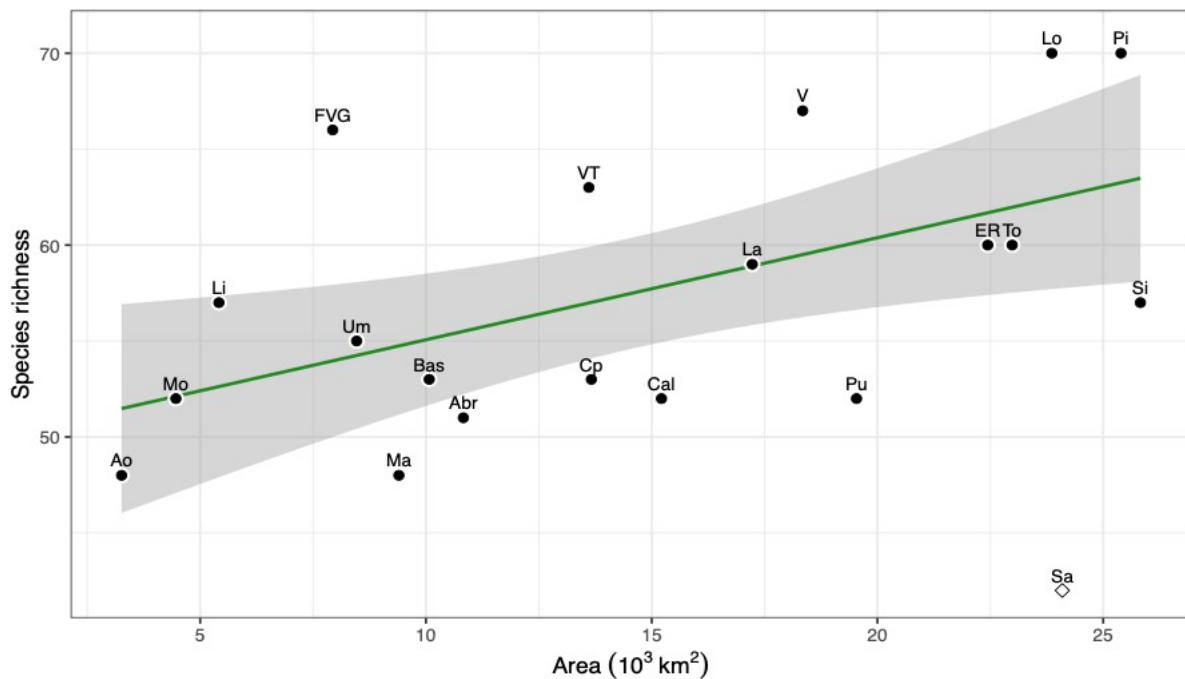


Figure 2. The relationship between the species richness and the area of the Italian regions. Linear regression model: Species richness = 50 + 0.53 Area.

Much more impactful have been the changes resulting from the newly discovered species, which are related to: i) the increased exploration of the national territory, ii) the rediscovery of one species thought to be extinct from the country (*Coenagrion ornatum*), iii) the possible recolonization or extension of range from the near-east (*Cordulegaster heros*), iv) the northward shift of the range margins of some species. In fact, seven of the ten new species on the checklist, namely *Orthetrum chrysostigma*, *Sympetrum sinaiticum*, *Diplacodes lefebvrei*, *Pantala flavescens*, *Tramea basilaris*, *Trithemis*

kirby, *Zygonyx torridus* belong to the family of Libellulidae and are thermophilic Afro-Asiatic taxa rapidly expanding northward in most of their range (Polette et al. 2017; Günther 2019; Cerini et al. 2020).

These recent colonizations are likely linked to the dispersal abilities of some species and the climatic suitability of central and southern Italy. However, in some cases, these species are currently known from few or single localities and the long-term persistence of their populations over time should be monitored. These range shifts are also the main reason for

the remarkable increase in diversity of the Mediterranean area, currently the richest of the three Italian bioregions and also the least known and investigated. Fifty-two species are widespread throughout the country, although three of them are currently rare and very localized in the Mediterranean context (*Erythromma najas*, *Sympetrum flaveolum* and *Sympetrum depressiusculum*) and two are found only on the edges of the Alpine area (*Gomphus vulgatissimus* and *Somatochlora meridionalis*).

Considering the individual Italian administrative regions, a statistically significant linear correlation arises between the species richness (S) and the area of the mainland and the Sicily insular system ($R=0.56$; $p<0.05$) (Fig. 2). Sardinia, which is biogeographically distinct because of its geological history, was not considered in the regression and is indicated with a different symbol. The overall rate of increase in species richness per unit area is estimated at 0.53 species/1000 km² (Fig. 2), while the northern regions show a more pronounced increase, as these combine alpine and lowland habitats, and thus have a higher environmental heterogeneity. In contrast, the southern regions are characterized by an increased species turnover and a lower than the expected richness. The situation differs particularly for the island of Sardinia, which is faunistically impoverished compared to the continental regions. The causes for this low species richness can be traced back to its long isolation and its origins from a microplate detached from the Iberian Peninsula (Schmitt et al., 2021). These factors have probably resulted in a low colonization rate of the territory, especially by damselflies. In addition, the current climatic conditions of this region result in a lower availability of wetlands and suitable areas for odonates. Furthermore, it needs to be considered that the odonates of Sardinia, together with the other southern regions, has been less investigated, compared to the northern regions, and thus the rate of false absences is likely to be higher.

The information compiled for country-level checklists - and the present one is no exception - inevitably contains a certain degree of spatial and environmental biases and survey incompleteness. Indeed, the efficiency of biodiversity studies is related to various aspects of survey design and the observer or taxonomist distribution across the territory (Engel, 2021). Effective survey designs are required when the patchiness in the distribution of species richness is high, while some key elements lead to a concentration in species occurrence (e.g., sites accessibility, survey frequency, distance from observer or taxonomist residences). Besides, the availability of information and odonatalogical lists for the localities formerly surveyed can direct field activities towards species-rich sites, but also promote more efficient use of previous efforts. This is the case for northern regions and a few provinces in the rest of Italy for which there is a more consolidated natural history tradition. On the other hand, lack of information and unavailability of collected specimens are factors that lead to the uncoordinated and repeated investigation of a smaller group of localities. Extensive and systematic surveys are indeed expensive and time-consuming. Consequently, better results can be achieved combining the efforts of many contributors. In this perspective, the Italian Society for the Study and Conservation of Dragonflies (Odonata.it) in 2014 launched a nationwide data collection project based on a citizen science (CS) approach. Collecting data through CS activities raises some issues, such as those related to the lack of formal protocols, uneven spatial coverage, erratic fluctuation in the number of volunteers, but also those related to detectability and identifiability of species, population densities, and accessibility of sites. In addition, besides the quantity of collected sightings, the associated quality is an important concern in data reliability. The experience of this project, whose description is beyond the scope of this data-paper, shows that some of these issues can be mitigated. Especially, when activities are conducted through a combination of expert surveys, accurate data validation, and the

creation of a network of active odonatologists. From the start-up phase to the present, the degree of coverage of the national territory on a grid of 10 × 10 km has increased from 72% to 87% and a data set of more than 200,000 field records has been collected. Despite the unevenness in survey effort and research infrastructure, the data collected so far have allowed the reduction of the national Wallacean shortfall (Cardoso et al., 2011), improving the knowledge on the distribution of dragonfly in Italy. On the other hand, no significant progress has been achieved in filling or containing instead the Prestonian shortfall (Cardoso et al., 2011). This impediment, which outlines the limited knowledge on the abundance of species and their changes in space and time, is nowadays one of the most critical challenges in insect conservation and the present checklist hopes to be a trigger for action by the Italian odonatological community.

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