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How many endemic species? Species richness assessment and conservation priorities in Italy

Fabio STOCH

Associate Researcher at the Museum of Natural History, Verona, Italy. Current address: v.le XXV Aprile 24 , I-34015 Muggia (Trieste), Italy (e-mail: fabiocop@tin.it).

Abstract

The "Checklist of the species of the Italian fauna", recently published and transformed in a database, allows for the first time the assessment of the number of species in Italy; the aims and the first results obtained by a new project, based on the checklist, are described herein. The preliminary results from the analysis of the data set include: (a) the checklist of the Italian fauna includes more than 58000 species, 95% being invertebrates; (b) the number of species decreases from North to South in the Italian peninsula, and is rather high on the main islands in comparison with their area; (c) from the steepness of Steyskal's curves for endemic species I suggest that more than 10% of Italian species are endemic. The existing network of protected areas in Italy (Bioitaly project) includes 2288 small or very small reserves: I suggest that this high number of sites, probably due to the highly fragmented Italian landscape, may be inadequate to conserve invertebrate biodiversity and endemism, being based on a "red-list" of species severely criticized; moreover, the percentage of invertebrates included in these areas is nearly unknown. The aim of the project is to study the Italian fauna by establishing a database of species distribution and to use this information in the future to study patterns of endemism, rarity and species richness in Italy for the identification of priority areas for invertebrate biodiversity conservation.

Keywords : biodiversity, endemism, checklist, invertebrates.

Introduction

The checklist of the species of the Italian fauna (MINELLI *et al.*, 1993-95) represents the first overall inventory of the animal species of a whole country to be completed (see KLOET & HINCKS, 1964-78; RAZOWSKI, 1990-91 and the other references cited in MINELLI, 1996, for examples of partial checklists, dealing mainly with insects). The checklist reports endemic as well as threa-

tened species and subspecies, allowing a first, rough estimate of their number in Italy (MINELLI, 1996).

Accelerating extinction rates have cast a new spotlight on the study of endemism as an aid in the identification of priority areas for conservation (see GASTON, 1994; VANE-WRIGHT, 1996; WILLIAMS, VANE-WRIGHT & HUMPHRIES, 1993 among several others). Moreover, the extraordinary biodiversity of Italian fauna, probably one the most species-rich countries in Europe (MINELLI, 1996), calls for a complete inventory of biodiversity and species distribution in Italy. For this reasons, a new project based on the checklist started at the end of 1998. The project includes the following topics:

a) conversion of the checklist into a hierarchical database allowing patterns to be explored using statistical techniques

b) production of a quantitative mapping software to explore patterns of species richness, rarity and endemism using the distributional data collected by a team of specialists on indicator taxa (over 6000 species in a 3-year project) selected following the rigorous guidelines given by PEARSON (1995)

c) correction and enrichment of the species lists published in the Habitat Directive and evaluation of their effectiveness as tools for protecting biodiversity and endemism

d) identification of priority areas for biodiversity conservation in Italy using species richness and endemism, taking in account the critiques to the usage of the hotspots of narrow endemism and to the "umbrella species concept" (KERR, 1997; WILLIAMS *et al.*, 1996).

The goal of this paper is to illustrate the first results of the project analyzing the structure of the checklist and discussing the following topics: a) the number of endemic species in Italy and their large-scale distribution along the peninsula and the main islands; b) the effectiveness of the "species of communitary interest" listed in the Habitat Directive as tools for the conservation of biodiversity and endemism.

Species richness of the Italian fauna

The total number of species and subspecies included in the checklist of the Italian fauna up to 1993 amounts to 58145; 1742 "protozoans", 55107 invertebrates and 1296 vertebrates are listed. I will restrict the analysis to the distributional pattern of the invertebrates, which make up 95% of the total species richness; this pattern is summarized in Table 1. The numbers reported for northern Italy, central and southern Italy, Sicily and Sardinia are inclusive of terrestrial and freshwater species (47536 species, 86.3% of the total fauna), the remaining species being exclusively marine or brackish water inhabitants.

The regions listed in Table 1 have different areas; however, considering species density (species / km^2), terrestrial and freshwater biodiversity shows a dramatical decrease from North to South. This "faunistic gradient" (MASSA, 1982), already pointed out by other researchers (CONTOLI & PENKO, 1996) as

regards vertebrates, may be explained considering a "peninsular effect" (MASSA, 1982; CONTOLI & PENKO, 1996; see also MARTIN & GURREA, 1990), which reflects the increasing difficulty of colonizing isolated areas. Sicily is richer than Sardinia, even if the extension of the two islands is similar (Table 1); the difference may be explained taking in account the colonization of Sicily from northern Africa (Tertiary "bridges": STOCH *et al.*, 1996) as well as from peninsular Italy (up to the last glaciation), while Sardinia was rather isolated from the mainland (see LA GRECA, 1984, for an exhaustive discussion of the origin of Italian fauna). Nevertheless, the high species density of the two islands in comparison to peninsular Italy contradicts the "insular effect" as well as other hypotheses based on colonization. Allopatric speciation increases biodiversity of islands; however the number of endemics (Table 1) is too small to account for the high species richness of Sicily and Sardinia. Apart from history, the relative importance of further variables, like habitat diversity and disturbance, in the explanation of biodiversity patterns in Italy is virtually unexplored and deserves further investigation.

Table 1. Species numbers of total (Nt) and endemic (Ne) invertebrates compared with area of: northern Italy, Emilia Romagna excluded (N); central and southern Italy (S); Sicily (Si); Sardinia (Sa); western Thyrrenian sea (3); northern and central Adriatic sea (4); southern Adriatic, Jonic sea and other seas (5). A map of the sectors is reported in MINELLI, RUFFO & LA POSTA (1993-95).

	Nt	Ne	% Ne/Nt	Area (km²)	sp/km²
N	35658	1562	4.4%	97741	0.37
S	25988	1482	5.7%	153710	0.17
Si	14000	595	4.3%	25708	0.55
Sa	10598	686	6.5%	24090	0.44
3	6633	102	1.5%	-	-
4	4004	30	0.7%	-	-
5	3789	14	0.4%	-	-

How many endemic species?

The number of endemic invertebrates listed in the database is 5336 (9.7% of the whole invertebrate fauna), 4960 being terrestrial or freshwater species; the endemic vertebrates are 67 (5.2% of the overall vertebrate species).

A first, rough estimation of the distributional pattern of endemics is Italy is given in Table 1 (the numbers are referred to the endemics of the different regions, not to the number of Italian endemics in that region). The percentages, higher in southern Italy and Sardinia, reflect the isolation of these areas and the historical explanations already advocated for species richness patterns. On the contrary, the percentage of marine endemic species is very low (< 1.5%).

The number of endemic species reported in the checklist should be taken with caution (MINELLI, 1996). In this author's opinion, several species may be considered endemic just because of our lack of knowledge on their real distri-

bution, and for this reason the real numbers could be overestimated. On the other hand MINELLI (1996) correctly stated that this effect may be partially offset by the fact that the word "endemic" was used as "endemic to Italy"; this fact lead to the exclusion of several endemics which are present in restricted areas of neighbour countries as well. For example, most of the troglobiont and stygobiont species of northeastern Italy (STOCH, 1995) are endemic, but excluded from the calculations being distributed also in a small karstic area in Slovenia.

After a thorough analysis of the checklist, I suppose that the total number of endemic species in Italy may be severely underestimated: many endemic species are being discovered at a high rate (STOCH, 1995), are hidden in species-complexes or may be sibling species (KNOWLTON, 1993).

To test the importance of this hypothesis, I performed an analysis using Steyskal's curves (STEYSKAL, 1965; see STOCH, 1995, for other examples); the curves for invertebrates and vertebrates are illustrated in Figs 1-2. This kind of curves may underestimate the total number of species; they become steeper when new taxonomists begin to work, new taxonomic criteria are used by specialists or new kinds of habitats are explored using novel sampling techniques (STOCH, 1995; see also the curve in Fig. 2). Notwithstanding this fact, the cumulative number of Italian endemic invertebrates plotted against the year of description (Fig. 1) shows that the curve is very steep. This fact suggests that the total number of Italian endemic species will increase in the future. I didn't compare this rate of increase with that of the whole fauna, because the year of the first observation of the non-endemic species in Italy is as yet unknown; however, it is reasonable to suppose that the percentage of endemic invertebrates in Italy may be higher than 10% of the fauna.

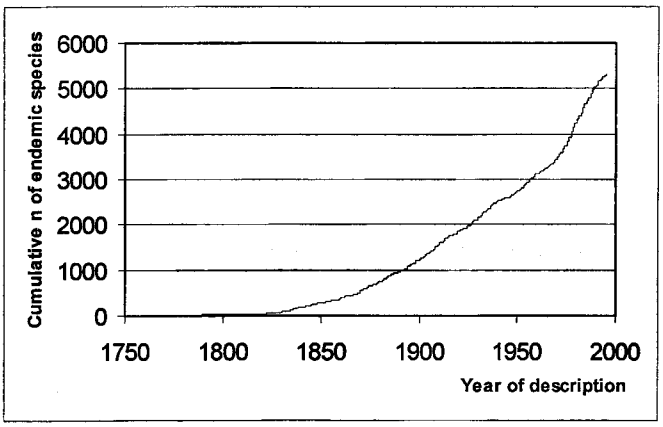

Fig. 1. Steyskal's curve of the number of endemic species of invertebrates of the Italian fauna.

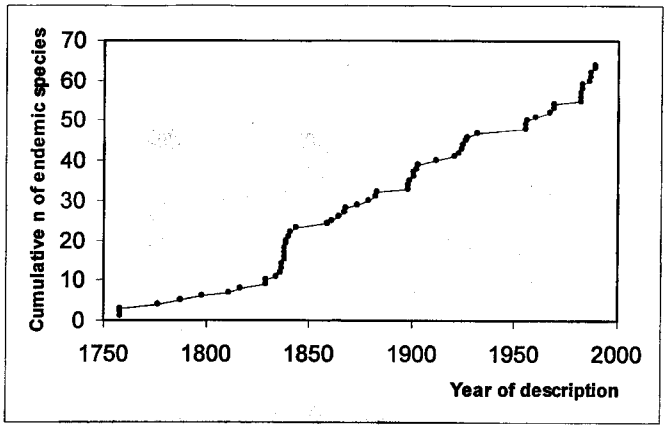

Fig. 2. Steyskal's curve of the number of endemic species of vertebrates of the Italian fauna.

Endemism, red-lists and the Habitat Directive

Endemism is one of the key concepts (together with rarity and vulnerability) used for choosing the species of interest to European Community (Habitat Directive 92/43, 21 May 1992, Article 1). The invertebrate list II attached to the Habitat Directive includes 31 species occurring in Italy, only 3 of them being endemic. The beetle family Carabidae, which includes 230 endemic species in Italy, is represented by a single species (*Carabus olympiae* Sella); the family Curculionidae, which includes 427 endemic species, is excluded from the list. Moreover, whole orders with high percentages of endemic species in Italy (MINELLI, 1996) like Plecoptera (41 species representing 28.5% of the total species of the order), Ephemeroptera (20 species, 21.3%) and Orthoptera (84 species, 26%), used as indicator species in freshwater or terrestrial ecosystem studies, are completely ignored.

In a recent analysis of the subject carried out by RUFFO & STOCH (1998) and STOCH (1998), the list of species included in the Habitat Directive was severely criticized. The list is not representative of the different taxonomic groups of invertebrates of the Italian fauna (Fig. 3), nor inclusive of endemic or rare taxa. The selection of Nature 2000 and Bioitaly sites using this small number of species may be severely biased toward single vertebrate species protection. This fact may lead to unreliable criteria for habitat conservation (KERR, 1997).

The solution has to be found in a novel approach starting from the checklist and from a screening of the most useful groups of indicator species (PEARSON, 1995). The choice of indicator species must rely on objective approaches; a subjective selection of a small species list (as the Habitat Directive list) is probably nonsense (RUFFO & STOCH, 1998). Moreover, STOCH (1998) shows that 23 out of 31 species listed in the Habitat Directive are not rare, vulnerable or endemic; their areal in Italy was not decreasing during this century (Fig. 4),

and their conservation status may be defined "satisfactory". For this reasons, 23 out of 31 species should not have been included in the Habitat Directive.

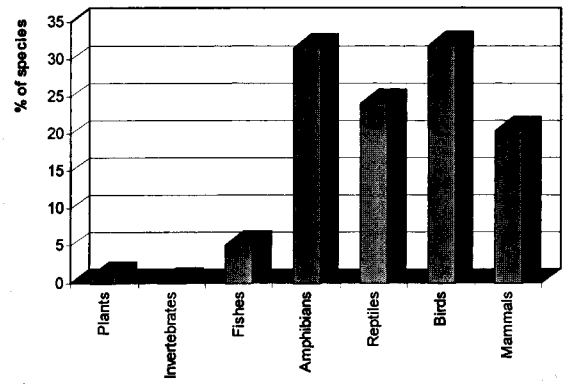

Fig. 3. Percentage of Italian species of different taxonomic groups included in the EC directives (Habitat Directive and Bird Directive).

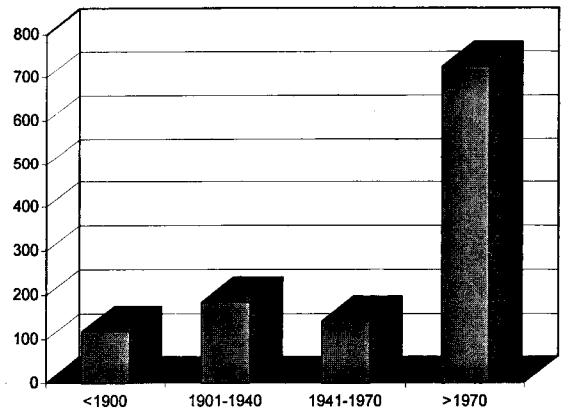

Fig. 4. Number of new citations of the 31 species of the Habitat Directive in the Italian territory (STOCH, 1998).

Another interesting source of "red-lists" is the checklist itself. Every endangered or vulnerable species was marked by the specialists using "M" (= "minacciata", threatened in Italian). This approach is probably largely subjective, and the choice biased toward certain taxa (butterflies, carabid beetles, snails) extensively sampled by specialists as well as by simple collectors. However, a rough analysis of the data reported in the checklist may be informative: 531 species of invertebrates (less then 1% of the fauna) are listed, 131 of them being endemic. The role of endemic species in this choice is evident as well as

the discrepancy with the few species listed in the Habitat Directive.

Finally, an analysis (STOCH, 1998) of the IUCN Red List - 79 species - and of PAVAN (1992) - 2893 species - indicates the overwhelming importance given to endemism as a criterion for selecting vulnerable species. For example, most of the 458 troglobiont or stygobiont threatened species listed by PAVAN (1992) are endemic (and none of them is included in the Habitat Directive). Moreover, 1130 non-troglobiont endemic species are considered as vulnerable or endangered in Italy: only 3 of them are reported in the Habitat Directive.

The discrepancy between the red-list of PAVAN (1992), including 2893 species, and the red-list obtained from the checklist, including 531 species, is difficult to explain and demonstrates the subjectivity of the approaches. One can speculate that in Pavan's opinion narrow endemic is sometimes synonymous with vulnerable or endangered, considering that approximately one third of the total number of endemic species is included in his red-list.

Invertebrate biodiversity, endemism and conservation priorities in Italy

Notwithstanding the fact that few species were listed in the Habitat Directive, 2288 small or very small sites were selected in Italy during the Bioitaly project (CASTORINA *et al.*, 1997). The criteria of choice are largely based on the work of botanists even though the main goal is probably the protection of individual vertebrate species, especially birds and mammals (STOCH, 1998). The fragmented landscape and the geographical complexity of Italy may explain the high number of selected sites. Are these sites adequate for the protection of invertebrate biodiversity and hotspots of endemism? The data needed to give a satisfactory answer to this complex question are lacking; the ongoing research on this subject will try to find an answer. Moreover, it will allow the identification of priority areas for conservation.

As a matter of fact, to protect effectively more than two thousand sites is a very difficult task; apart from the old SLOSS (Single Large Or Several Small reserves) controversy (see ROSENZWEIG, 1995, for an update), the most urgent questions are: which sites must we protect first? are there some hotspots of biodiversity and endemism in Italy excluded from the list? Considering the richness of the Italian fauna and the high percentage of endemic species, we can speculate that some of the most important hotspots of invertebrate biodiversity and endemism of the European Communities are located in Italy; but we do not know where they are. The compilation of the checklist was the first step towards their discovery.

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