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From the Apennines to the Alps: recent range expansion of the crested porcupine *Hystrix cristata* L., 1758 (Mammalia: Rodentia: Hystricidae) in Italy

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Abstract

In the last few decades, the crested porcupine (*Hystrix cristata* L., 1758) showed a marked range expansion in Italy. Published and unpublished material was collected to reconstruct this phenomenon. Data were gathered by means of: (i) specific papers on crested porcupine distribution and more generic books and articles, (ii) expert collaboration in various Italian regions and (iii) information from the national Vertebrates mailing list. Until the 1970s, *H. cristata* was only present in Central and Southern Italy, mostly in the western part. Since 1978, the porcupine has been protected by Italian national law. The species first crossed the Apennines from the Tyrrhenian coast to the Marche, where the expansion to the north may have begun, and then reached the northernmost regions. An analysis of the potential distribution of the species was performed in a species distribution modeling framework (Maxent). The model suggested a high suitability of most of the Central and Southern Italian Peninsula for *H. cristata*, including the two major islands. Northern Italy proved suitable for the species' establishment only in some central and western areas of the Po Valley. The core areas of the Apennines and of the Alps, as well as some areas characterized by low annual rainfall, were predicted as unsuitable. Historical and social factors related to the progressive urbanization and the consequent abandonment of the traditional land use in mountain landscapes probably helped the re-expansion of forests and uncultivated fields. Three introduced populations have been detected in Sardinia, Liguria and the province of Varese. In order to make the data collected easily consultable and to give people the opportunity to contribute to a continuous updating of the distributional map of the species, a web page dedicated to *H. cristata* was set up, in the framework of an open-source wildlife mapping project.

Keywords: Crested porcupine, range expansion, wildlife mapping

Introduction

Subgenus *Hystrix* Linnaeus, 1758 includes three species of large rodents (body weight: 10–15 kg) distributed in the Old World. Their range is almost completely allopatric, with the exception of an area of overlap between *H. cristata* Linnaeus, 1758 and *H. africae australis* Peters, 1852, in Central Tanzania (Kingdon 1997).

Crested porcupine (*H. cristata*) is classified as “lower risk-near threatened” by the International Union for Conservation of Nature (IUCN), listed in Berne Convention (all. II) and Habitat Directive (all. IV). It has been protected by Italian law since

1978 (national law no. 968/1977). The species is distributed, with some discontinuities, in a portion of Southern Europe, Northern Africa – from Morocco to Northern Libya (Mohamed 2011) – and sub-Saharan Africa – from Senegal to Central Tanzania (Amori et al. 2008). Italy is the only European country hosting viable populations of *H. cristata* (Figure 1). The presence of the species in the Balcanic peninsula (Nowak 1999) has never been confirmed.

Some free-ranging individuals have been recently observed in Alentejo (Portugal). They probably escaped from captivity and cannot be considered as

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Figure 1. Current distribution of the crested porcupine (*Hystrix cristata* L., 1758) (<http://maps.iucnredlist.org>. Accessed on 1st June 2013, updated).

a population, since no reproduction event has been recorded yet (see: http://portal.icnb.pt/NR/rdonlyres/3C2F574C-0F4B-4066-94C9-B999618B719A/6509/08_Mamiferos1.pdf, last accessed 15 October 2012).

The current status of the crested porcupine in Egypt is unclear, and the hypothesis that it went extinct cannot be rejected (O. Shalaby, personal communication 2011). It is still unclear if Northern Sinai records might be attributable to *H. indica* Kerr, 1872 or *H. cristata* (Saleh & Basuony 1998; Hoath 2003).

Amori et al. (2008) reported that crested porcupine is distributed throughout Central and Western Italy, with the exception of Campania and Basilicata, and, on the Eastern coast, only in Gargano (Apulia) and in Emilia Romagna. According to those authors, the northern limit is represented by the province of Verona (Veneto) to the east, and by the province of Piacenza (Emilia Romagna) to the west.

In recent decades, a relevant increase in the historical range of *H. cristata* was recorded in Italy, showing a marked northward expansion of the species. This paper aims to describe this phenomenon and to update the current distribution range of the crested porcupine in Italy.

Historical background

The origin of the Italian population of the crested porcupine has been controversial and debated for a

long time (Scalera 2001; Amori et al. 2008). Some authors supported the hypothesis of an indigenous origin. They asserted that some populations could have survived in coastal southern refuges during the Ice Age, showing a subsequent northward expansion (Amori & Angelici 1992). Morphometric analysis on the skulls of crested porcupine (Angelici et al. 2003) showed some differences between Italian and African samples. Nevertheless, such morphological differences are not sufficient to support an autochthonous origin, since they could be the result of isolation subsequent to an ancient introduction.

As far as it is known, no data seems to confirm the presence of the genus *Hystrix* in Europe during the Holocene (Riquelme Cantal & Moralez Muñiz 1997), supporting the hypothesis of a non-native origin of the Italian population. Genetic, archeozoological and paleontological data (Trucchi & Sbordoni 2009; Masseti et al. 2010) seem to document a non-native North African origin, although the historical period(s) of introduction of the species in Italy is debated.

The most common hypothesis assumes that *H. cristata* was imported from Barbary in Roman times as a game species (Minà Palumbo 1868; Niethammer 1963; Corbet & Jones 1965; Pigozzi 1993). This supposition, though, presents several discrepancies: Orsomando and Pedrotti (1976) pointed out that there is no document supporting the Ancient Roman introduction hypothesis (already postulated also by Bonaparte 1841). Masseti et al.

(2010) emphasize that *H. cristata* is not represented in the iconography and archaeology of Pompeii, which includes many other wild species. Moreover, in his *Naturalis historia* (VIII, 25), Pliny the Elder declared that porcupines are common in India and Africa, without any reference to Italy. This is not in contrast with the supposed time window of 1500–2500 years ago, postulated by Trucchi and Sbordoni (2009); Riquelme Cantal and Moralez Muñoz (1997) and Masseti et al. (2010) hypothesized that the introduction might have occurred after late Antique or early Medieval times (the most ancient record dates back to 560–720 AD; S. Giovanni di Ruoti, Potenza, Basilicata), when trades between North Africa, the Italian Peninsula and Sicily increased. This seems to be currently the most plausible reconstruction of facts.

Materials and methods

Published and unpublished material on the presence and distribution of *H. cristata* in Italy were collected. The main sources of information were: (i) scientific papers on crested porcupine distribution, (ii) generic books and articles reporting data on the presence and distribution of this species, (iii) data coming from a sectorial national mailing list dedicated to Vertebrates (vertebrati@liste.cilea.it: VML) and (iv) direct observations and other data collected by different experts in various Italian regions.

Our research did not involve any sampling sessions in the field, since the aim was not to collect information on crested porcupine distribution in Italy, but to describe the historical, recent and current distribution, with particular attention to the range expansion phenomenon. Our screening did not take into account unconfirmed records. Conversely, data provided by qualified experts in the field or corroborated by photographs were considered reliable and included. On the other hand, the risk of misidentification is very low, since the body shape/structure and some signs of presence (such as the quills) make *H. cristata* clearly identifiable.

Sightings and other types of data assessing the presence of the species were organized in a database. Records were then ordered on the basis of latitude. The source of first occurrence and the most recent confirmation of presence for any parallel were then identified. Spearman coefficient was used to assess the correlation between latitudinal coordinates and time.

The dataset was divided in two sections: historical (before 1970) and recent data (from 1971 to 2012). The 1970 threshold was chosen as a starting point for the recent colonization process of the species,

following the first records reported north of the Arno river and on the northeastern slopes of the Apennines (Orsomando & Pedrotti 1976; Tomei & Cavalli 1976, respectively). In some cases it was possible to ascertain a recent anthropochorous origin of some local populations. Those data were labeled as “introduced” to distinguish them from the natural expansion of the range.

An analysis of the potential distribution of the species using the current points of presence was performed in a species distribution modeling framework.

Climate data and digital elevation model (DEM) were obtained from the Worldclim database (Hijmans et al. 2005), which contains interpolated surfaces for 19 climatic variables, available at different spatial resolutions. For the purpose of the present analyses, we used data with a 30 arc-seconds resolution. We chose a subset of the climatic variables retaining only those not strongly correlated with each other (Pearson correlation coefficient, $r^2 < 0.70$). Included layers are the following: Altitude; BIO1, annual mean temperature; BIO2, mean diurnal range in temperature; BIO4, temperature seasonality; BIO8, mean temperature of the wettest quarter of the year; BIO9, mean temperature of the driest quarter of the year; BIO12, annual precipitation; and BIO19, precipitation of the coldest quarter of the year. The model was calibrated using Maxent (Phillips et al. 2006; Phillips & Dudik 2008), which estimates species distributions using environmental predictors together with species occurrences. This algorithm is based on an application of the maximum entropy principle in an ecological context (Jaynes 1957). It is used to estimate the distribution probability, so as to satisfy a set of constraints derived from environmental conditions at species' presence sites. These constraints require that the expected value of each environmental predictor falls as close as possible to the empirical mean of that predictor measured over the presence records. Among all the possible distributions that satisfy constraints, the algorithm chooses the closest to the uniform, maximizing the entropy. Maxent has generally been shown to perform better than other similar techniques, especially in predicting species distributions over past climatic conditions (Elith et al. 2006).

We kept default settings of the Maxent algorithm, with the exception of the number of replicates and default prevalence. In particular, to obtain a reliable evaluation of the model, we randomly split the occurrence data into two subsets, using 70% of records to calibrate the model and the remaining 30% to evaluate the model. This procedure was

replicated 10 times, each time randomly selecting different 70%–30% portions of occurrence data. The final model was obtained averaging the 10 runs. For each replicate, we evaluated the predictive performance of the models using the area under the curve (AUC) calculated by Maxent. Moreover, to account for the fact that the species is quite common and easy to observe across most of its geographical range, we set the default prevalence to 0.8 (Elith et al. 2006).

Results

Current distribution range

A total of 1674 (1131 historical and 543 recent) records of crested porcupine were recorded. All the Italian regions but two – Aosta Valley and Friuli Venezia Giulia – include at least one record. Figure 2 shows the current distribution of *H. cristata* in Italy.

The southern range of the species includes the whole of Sicily (even though no recent records are available for the easternmost areas: Seminara &

Ragni 1991; Amori et al. 2008; Di Vittorio & Falcone 2008), Basilicata (Aloise et al. 2003; L. Giacomino and G. Riccarducci, personal communication, 2011) and Calabria (Amori et al. 2008), whereas it seems to be absent south to the Isthmus of Marcellinara (Cosenza (CZ), Bevilacqua 2003; C. Gerace, personal communication, 2011). In Apulia, with the exception of the Gargano promontory (where the last records date back to 1985), the presence of crested porcupine is scarce and irregular (for Taranto and Brindisi provinces: M. Marrese, personal communication, 2011; for Foggia province: M. Caldarella, personal communication, 2013). The situation in Campania is poorly known: in both Salerno and Naples provinces, the species is currently considered extinct (S. Capasso, personal communication, 2012), whereas some individuals are surely present in Caserta province (A. Croce, personal communication, 2012). In Southern Latium, near the boundaries with Campania, the species is well distributed, both in the Latina (G. Forcina & E. Mancuso, personal communication, 2012) and

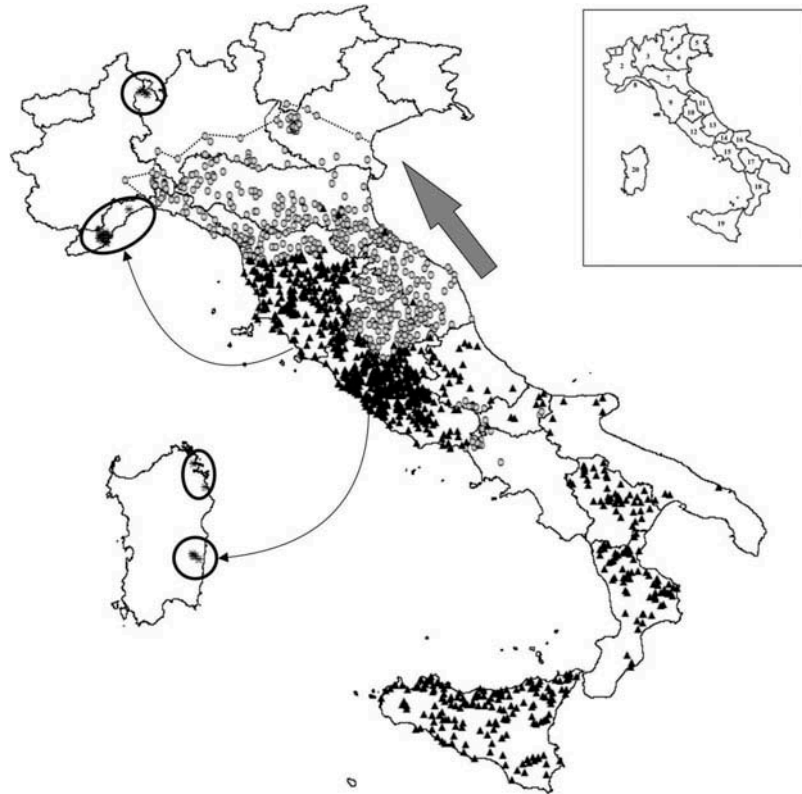


Figure 2. Distribution of crested porcupine (*Hystrix cristata* L., 1758) in Italy. Black triangles represent the historical range (before 1970), white circles the recent expansion (since 1970). Asterisks are the introduced nuclei. Box shows the Italian Regions: 1. Valle d'Aosta; 2. Piedmont; 3. Lombardy; 4. Trentino Alto Adige; 5. Friuli Venezia Giulia; 6. Veneto; 7. Emilia Romagna; 8. Liguria; 9. Tuscany; 10. Umbria; 11. Marche; 12. Latium; 13. Abruzzi; 14. Molise; 15. Campania; 16. Apulia; 17. Basilicata; 18. Calabria; 19. Sicily; 20. Sardinia. Introduced nuclei are circled: arrows represent the link with the source population, where known. Dotted line shows the current northern borderline of *H. cristata* in Italy.

Frosinone provinces (Corsetti & D'Orsi 2007; Mori 2010). The current presence of crested porcupine in Sardinia is quite recent, as the result of one or more introduction events (see below).

The species occurs in the inland of L'Aquila and Teramo provinces (Pellegrini et al. 1992; Febbo & Pellegrini 1994; Morini 2011), the hilly areas of Majella (Santoleri & Cerceo 2007) and lower Biferno valley. No data are currently available for the Gran Sasso-Monti della Laga National Park (I. Marini, personal communication, 2011). Records from Molise on the boundary with Apulia are few and concentrated in the surroundings of S. Croce di Magliano (Norante & Nappi 2003). Some signs of presence and road kills were recently found in the Isernia Province (Colle al Volturmo), near the boundaries with Latium and Campania (M. di Febbraro, personal observations, 2012). The species is currently present throughout the whole of Latium, Tuscany, Umbria, Marche and Emilia Romagna. In Liguria, *H. cristata* is present in La Spezia, Genoa (W. Pieretti & M. Calvini, personal communication, 2012) and Savona provinces. In the latter, the population originated from an introduction event (see below). Some records reveal the start of the colonization of Southern Piedmont (province of Alessandria: Silvano 2010). In Lombardy, crested porcupines are increasingly recorded in the provinces of Cremona (G. Vicini and B. Riboni VML 2010), Pavia (G. Bogliani VML 2003 and 2010), Mantova (Bon et al. 2004; L. Rossetti, personal communication, 2012), Brescia (R. Bontempi, personal communication, 2012) and Lodi (R. Levert VML 2010). An isolated nucleus has been introduced in the province of Varese (see below). Some records were recorded in northwestern Veneto between 2003 and 2007, allowing some authors to declare the presence of the species as stable (Spada et al. 2007; Amori et al. 2008).

The colonization process

Until the beginning of the last century, *H. cristata* was present in Southern and Central Italy (Marmocchi 1844; Cornalia 1871–1872; Doderlein 1872, 1881; Lucifero 1909; Ghigi 1917; Altobello 1920). The species lived in Sicily and west to the Apennines ridge, from Aspromonte to the mouth of the Arno River, including Basilicata, Southern Campania inland and part of the territories currently included in the Abruzzi-Latium-Molise National Park (PNALM; Altobello 1920). Since 1997, a range expansion of crested porcupine from the lower portions of the PNALM to more elevated areas was recorded (R. Latini, personal communication,

2012). East to the Apennines ridge, crested porcupines were reported only in the area between Gargano and Salento (Toschi 1965; Tassi 1971; Santini 1980). The last records from the province of Lecce date back to 1944–1945 (Amori & Angelici 1992). In Campania, the species was present and probably evenly distributed in the nineteenth century (Costa 1839; Caputo 1989; Carpino & Capasso 2008) and, at least until the 1950s, in the area of Cilento and Vallo di Diano National Park (Picariello et al. 1999). Records from Northern Campania (Caserta province) were documented since 2002, when the species probably crossed the Garigliano River and started to expand its range southwards and eastwards (A. Argenio, G. Capobianco & A. Croce, personal communication, 2011).

The first records of crested porcupine populations from Umbria and Marche are reported by Orsomando and Pedrotti (1976). In the Marche, the population started to become consistent and stable after 1976, colonizing the provinces of Ancona, Macerata, Ascoli Piceno and, since 1980s, Pesaro (Orsomando & Pedrotti 1976; Pandolfi 1986; Furlani 1987; Rossi Brunori 1987; Pandolfi 1992; Biondi & Baldoni 1996). More recently, sightings of crested porcupines from this region were reported from the coast around S. Benedetto del Tronto (A. Sperduti VML 2011) and the Conero promontory (Morici et al. 2008; D. Fiacchini, personal communication, 2012).

Tomei and Cavalli (1976) reported for the first time the presence of this rodent north to the Arno river (later confirmed by Romè 1980 and Ferri & Sala 1990) in the provinces of Prato, Pistoia and Lucca: just a few records are reported from Massa Carrara province. At end of the 1970s, some individuals (probably coming from Tuscany) naturally colonized the provinces of La Spezia and Genoa (Vigna Taglianti & Bologna 1981; Amori & Capizzi 2002).

Road kills and quills have provided occupancy evidence of crested porcupines in Emilia since the 1980s (Modena, Bologna and Reggio Emilia provinces: Sala 1987; Ferri & Sala 1990; Toso et al. 1998). Despite the fact that the first record reported for Romagna dates back to the second half of the eighteenth century (Ginanni 1774) and some sightings were recorded before 1970 (Zangheri 1946, 1957; Zangheri 1969; Silvestri 1970, 1971), the presence of viable populations in this area was not proven until the end of the 1980s (Zavalloni & Castellucci 1989; Zavalloni et al. 1991; Toso et al. 1998), in the provinces of Forlì-Cesena (Tedaldi & Semeraro 1992), Ravenna (Scaravelli et al. 2001) and Rimini (Casini & Gellini 2008). In the 1990s,

crested porcupine established in the province of Parma (Lavezzi 1999). In the same period and in more recent times, some sightings were also recorded in the Trebbia and Po valleys, in the provinces of Piacenza (Lavezzi 1999) and Ferrara (Vannini et al. 2000). First records for Lombardy were reported in 1999, followed by other observations collected in 2004 (Lavezzi 1999; Ghezzi & Lavezzi 2004). Despite the fact that a single individual was recorded in Veneto in 1818 (Naccari 1818), no other data are available for this area until 1986. In both cases, however, they were probably single crested porcupines escaped from captivity (Bon et al. 1993; De Franceschi 2002). The colonization of this region started most probably later, at the end of the 1990s (Bon 2001; Bon et al. 2006). Since 1997, the presence of *H. cristata* has been regularly documented in the hilly areas of the provinces of Verona and Vicenza (De Franceschi 2002; Fontana & Fanton 2002; Spada et al. 2007) and in the plains of the provinces of Rovigo and Venice (Verza 2005). Since the end of the 1990s, crested porcupine sightings have been recorded for the provinces of La Spezia and Genoa (C. Aristarchi and W. Pieretti, personal communication, 2012). Since 2003, data from Piedmont has been collected, in the province of Alessandria (Silvano 2004; Sindaco 2006; Sindaco & Seglie 2009; Silvano 2010): a quill was recently found on the boundary with the province of Asti.

In March 2011, some quills were collected near Saccone in Trentino Alto Adige [about 780 m above sea level (a.s.l.)] in a mixed deciduous woodland, at the edge of a grassland area. It represents the first presence sign of *H. cristata* for this region: no other sign of presence was found in the surroundings and no more quills were collected in the same area in the subsequent months. From a formal point of view, data are too poor to consider the species to be present in this region and further information is needed. Quills are stored in the Maremma Natural History Museum, in Grosseto.

The increase of latitudinal coordinates of the collected data ($N = 1674$) is significantly correlated with time (Spearman coefficient = 0.90, $P < 0.01$: Figure 3).

Introduced populations

As previously stated, some crested porcupine populations in Italy have a recent anthropochorous origin. Collected information proves that at least four areas have been affected by introduction events. Crested porcupine was historically absent from Sardinia. Around 2005, a few individuals were illegally

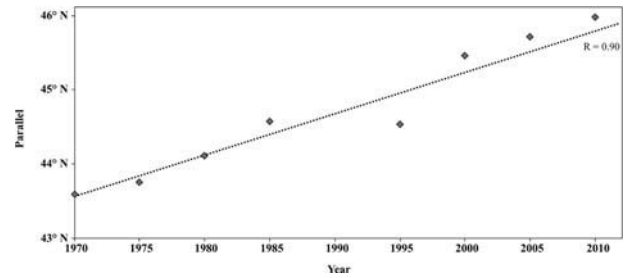


Figure 3. Spearman rank correlation between the increase of latitude (parallel) of coordinates of crested porcupine (*Hystrix cristata* L., 1758) presence data and the increase of the time variable (year).

introduced in the Ogliastra Province, possibly from Latium, according to genetic data (Angelici et al. 2009; P.A. Cabras, personal communication, 2011; Figure 2). More recently (2010), crested porcupine quill injury in a dog was documented by a veterinarian from Northern Sardinia (S. Amadori, personal communication, 2011; Figure 2) and some other quills were collected around Budoni (N. Gibanu, personal communication, 2011; Figure 2).

In the first half of the nineteenth century, an introduction in the Island of Elba was documented by Thiebaut de Bernaud (1808); De Marinis et al. (1996) report that a further introduction event of a few individuals occurred in the 1980s. In spite of these introductions, the species is thought to be currently absent from this island (F. Giannini, personal communication, 2011).

In the 1950s–1960s, five specimens from Tuscany were brought to Stampino hunting reserve, near Andora (Savona Province, Liguria: Balletto 1977), from which they escaped. At the end of the 1990s, a road-killed crested porcupine was found near Conna (Savona, SV), confirming the presence of the species in this area (P. Gavagnin, personal communication, 2012). A group of individuals was illegally introduced in the northern part of the province of Varese, possibly around 2007. The population of this area is thought to be in expansion (Gagliardi et al. 2012).

Species distribution modeling

The model showed excellent predictive abilities (AUC > 0.9, sd = 0.002), according to Swets (1988), suggesting a high suitability of most of the Central and Southern Italian Peninsula for *H. cristata*, including the two major islands: Sicily and Sardinia. Northern Italy proved fairly suitable for the species only in some central and western areas of the Po Valley. The core areas of the Apennines ridge and

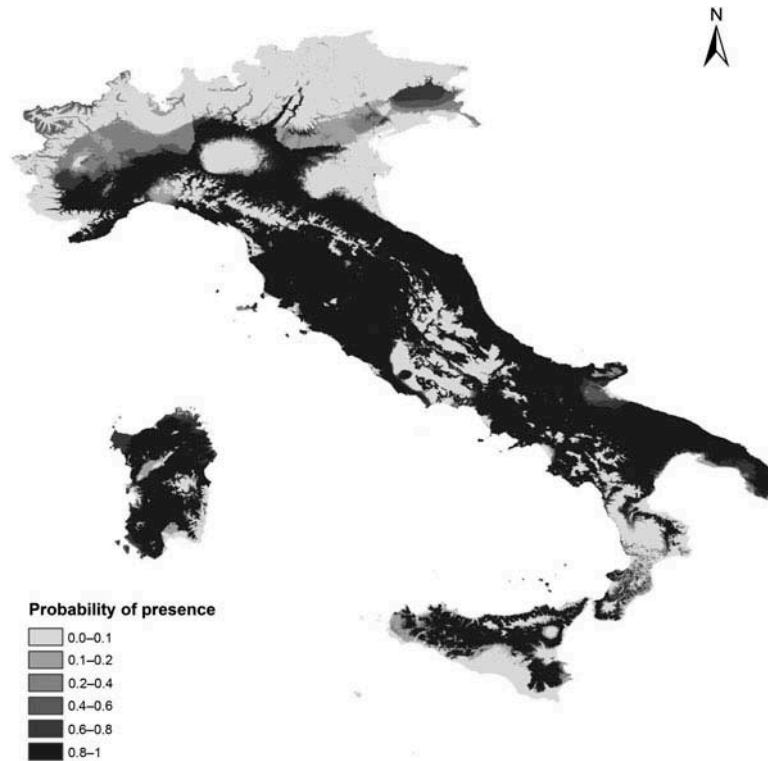


Figure 4. Maxent prediction of potential geographic distribution of crested porcupine *Hystrix cristata* L., 1758) in Italy, made with all the occurrence records. The predictive probability values ranging from 0 to 1 are depicted by greyscale.

some lands characterized by very low annual rainfall (e.g. Southern Calabria and Sicily) were predicted as sub-optimal or unsuitable habitats for the species (Figure 4).

Discussion

Geographical distribution limits of living species are influenced by both physical phenomena and physiological tolerance levels (Parmesan 2006), in terms of biotic and abiotic interactions (Sexton et al. 2009). In particular, climatic oscillations represent a significant factor in shaping biogeographical patterns of species distribution. Ranges are hence highly mobile over time, in response to changes in environmental conditions (Svenning et al. 2008; Sexton et al. 2009). Dispersal behavior implies the ability of a species to positively respond to changes in habitat quality and extension, climate parameters and availability of suitable areas (Gaston 2009). Since the end of World War II, historical and social factors related to progressive urbanization and the consequent abandonment of the traditional land use in mountain landscapes brought about the re-expansion of forests and uncultivated fields. This allowed many mammal species such as ungulates (Riga et al. 2011) and wolf

(Boitani et al. 2010) to increase their populations and distribution.

Until around 1970s, crested porcupine in Europe was present just in Central and Southern Italy, mostly in the Western Apennine slope. It was legally hunted until 1977, when the national law no. 968/77 listed it among the protected species. However, in the core of its historical range, crested porcupine is still subjected to a strong local poaching pressure. This potential threat, though, did not prevent *H. cristata* from colonizing, in the last few decades, most of the northern regions of Italy and some southern regions, where it was possibly absent or rare in the past and poaching on this species was not traditionally practiced.

Since the beginning of the 1990s, the establishment of new protected areas in Italy (following the 394/1991 National Law) created new favourable conditions for the colonization process of this species, as happened elsewhere for other taxa (e.g. Wilson et al. 2004; Romanowski 2006). *H. cristata* crossed the Apennines from the Tyrrhenian coast to the Marche and Umbria regions, from where the expansion to the northeastern territories began (Pandolfi 1986, 1992). The reconstruction of the distribution of crested porcupine in Italy is quite

complicated, and we cannot exclude that local introduction events could have occurred in the past, as proved for the Island of Elba. In this paper, some strong evidence of recent introduction events are reported for at least three different areas of the current distributional range (Sardinia, Liguria and Varese Province). Due to the location, timing and concentration of sightings, we cannot exclude that the population around Verona could have had an anthropochorous origin.

Latitude-correlated factors (sun angle, photoperiod, seasonality, mean temperatures and thermal peaks, rainfall amount and timing) also influence the distribution of a species (Barnosky 2004). In the case of crested porcupine, taking into consideration its behavior and habitat requirements (Corsini et al. 1995; Monetti et al. 2005), a future trend of expansion in Italy can be hypothesized. Furthermore, the predictions of the species distribution model suggested that the range expansion of *H. cristata* towards the northern regions of Italy appeared most likely to occur following the northern limit of the Apennines to the western and central Po Valley (Piedmont, Liguria and Lombardy).

In Sardinia, a population establishment and a subsequent expansion of the area of distribution is quite probable. Our model confirms this hypothesis and identifies large portions of the island as highly suitable for the crested porcupine. As far as a northward expansion of the species in peninsular Italy is concerned, a full colonization of the northern Italian regions (considering the winter snow cover, mean winter temperature and mean altitude) is thought to be difficult (Figure 4). Though it reduces its activity during the colder season, *H. cristata* does not hibernate, so it depends on food resources during the whole year. Hence, mountains (more than 2000 m a.s.l.) seem to be unsuitable for crested porcupine establishment. The congeneric *H. indica* is considered to be unable to colonize areas characterized by high snow cover (such as Caucasus slopes), because it spends too much time and energy in foraging and this could result in a population reduction (Alkon & Saltz 1988). *H. cristata* has been recorded in areas more than 1500 m a.s.l. in the Apennines (Amori & Angelici 1992) and more than 1400 m a.s.l. in winter time on the Amiata Mountain (Southern Tuscany, Andrea Sforzi, personal observation, 2012), thus showing the ability to locally exploit (presumably at low population density) even less suitable areas covered by snow in some periods of the year (Bon et al. 2006).

H. indica and *H. cristata* are active on average 7 hours per night (Alkon & Saltz 1988; Corsini et al. 1995). According to the minimum night duration

hypothesis (Alkon & Saltz 1988), crested porcupines wouldn't successfully colonize areas located north of the 46°N parallel where, in summer, nights last less than 7 hours. This northern limit was confirmed for the Indian crested porcupine (Alkon & Saltz 1988). If the Italian population would overpass the Alps, the minimum night duration hypothesis (Alkon & Saltz 1988) would represent a geographical limit for the species in Central Europe. The individuals escaped from captivity and established in Great Britain in the 1970s (now completely eradicated: Gosling 1980; Genovesi et al. 2009), belonged to a northern porcupine species, adapted to live in lower temperature conditions: the Himalayan porcupine (*H. brachyura*).

This paper collected a relevant amount of information on the distribution of *H. cristata* in Italy. Given the rapid evolution of this phenomenon, there is the need to regularly insert new records in the national database. To constantly improve the collection of new observations and to give the opportunity to update in real time the distributional map of this species, we set up a web page dedicated to the crested porcupine: www.naturaesocialmapping.it/istrice.

The map associated with the given URL represents a graphical and zoomable output of all the data collected during the writing of this paper. Moreover, its inclusion in the "Naturae Social Mapping" project gives to any potential observer the opportunity to register and send in his/her record that, once validated, will actively contribute to update in real time the national map of distribution of the species. We strongly recommend taking part in the implementation process of this map.

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