
The “Bollettino del Museo Civico di Storia Naturale di Verona” is the Museum’s journal. Founded in 1948 as “Memorie del Museo Civico di Storia Naturale”, it became “Bollettino” in 1974. Since 2000 it is issued annually in two distinct parts: 1. Botany and Zoology; 2. Geology, Paleontology and Prehistory; both extended contributions and brief notes regarding the naturalistic aspects of these disciplines are published.

Founding editor: Sandro Ruffo †
Editor in chief: Leonardo Latella
Editors: Alessandra Aspes, Angelo Brugnoli, Roberto Zorzin
Editorial assistant: Cristina Cristante

EDITORIAL BOARD: - Botanica - C. Blasi (Roma), Carmela Cortini-Pedrotti (Camerino), Giovanni Cristofolini (Bologna), Riclef Grole (Jena), David L. Hawksworth (London), Guido Moggi (Firenze), Pier Luigi Nims (Trieste), Franco Pedrotti (Camerino), Sandro Pignatti (Roma), Livio Poldini (Trieste), Herbert Reisigl (Innsbruck), Harald Riedl (Wien), Giovanni Sburlino (Venezia) - ZOOLOGIA - Roberto Argano (Roma), Paolo Audisio (Roma), Sebastiano Barbagallo (Catania), Denise Bellan-Santini (Marseille), Marco Bologna (Roma), Dan Danielopol (Mondsee), Folco Giusti (Siena), Franz Krapp (Bonn), Alessandro Minelli (Padova), Giuseppe Osella (L’Aquila), Bruno Sabelli (Bologna), Valerio Sbordoni (Roma), Wim Vader (Tromsø), Augusto Vigna Taglianti (Roma), Aldo Zullini (Milano) - GEOLOGIA E PALEONTOLOGIA - Alexandre Bannikov (Moskva), Alberto Castellarin (Bologna), Maria Bianca Cita (Milano), Mauro Cremaschi (Milano), Carlo Doglioni (Roma), Derek Ford (Hamilton), Paolo Forti (Bologna), Alexander Klimchouk (Kiev), Walter Landini (Pisa), Nevio Pugliese (Trieste), Domenico Rio (Padova), Benedetto Sala (Ferrara), Ugo Sauro (Padova), Enrico Serpagli (Modena), Andrea Tintori (Milano), James C. Tyler (Washington D. C.) - PREISTORIA - Giancarlo Alciati (Padova), Laurence Barfield (Birmingham), Carlo Baroni (Pisa), Alberto Broglio (Ferrara), Leone Fasani (Verona), Maria Antonietta Fugazzola (Roma), Giacomo Giacobini (Torino), Jean Guilaine (Paris), Janusz K. Kozlowski (Krakow), Venceslas Kruta (Paris), Carlo Peretto (Ferrara), Luciano Salzani (Verona), Christian Strahm (Freiburg).
BOLLETTINO DEL MUSEO CIVICO DI STORIA NATURALE DI VERONA

Volume 42

Botanica Zoologia
A new subspecies of grey wolf (Carnivora, Canidae),
recently extinct, from Sicily, Italy

FRANCESCO MARIA ANGELICI & LORENZO ROSSI
(* FIZV, Via Marco Aurelio 2, I-00184 Roma, Italy; email: francescomariaangelici@gmail.com; Corresponding author.
** Associazione Orango, Via San Cristoforo 196, I-47522 Cesena, Italy; e.mail: info@associazioneorango.com)

Abstract

A new endemic subspecies of grey wolf from the island of Sicily (Italy) is described. While usually considered extinct before 1940, there’s some evidence it may have survived up to 1970. This wolf was widespread throughout the island and characterized by a smaller size and a paler coloration than the Apennine wolf (Canis lupus italicus) from Central-Southern Italy. This subspecies is described from a mounted specimen (the holotype) including also a separate skull stored at the Museo di Storia Naturale ‘La Specola’, Università di Firenze, Italy. The three paratypes are: a) a mounted specimen stored at the ‘Museo Regionale Interdisciplinare di Terrasini’ in Terrasini (Palermo), Italy, b) a mounted specimen stored at the Museo di Zoologia ‘Pietro Doderlein’, Università di Palermo, Palermo, Italy, c) a mounted specimen stored at the Museo Civico Baldassarre Romano in Termini Imerese (Palermo), Italy.

This new subspecies is described as Canis lupus cristaldii subsp. nov. We suggest ‘Sicilian wolf’ as common name for this new taxon.

Key words: Canis lupus cristaldii subsp. nov. Angelici and Rossi, 2018, Sicilian wolf, extinction, Sicily.

The grey wolf (Canis lupus) is a widely distributed species native to many Eurasian and American regions (Mech and Boitani 2010). Currently there are at least forty-four subspecies described (see Wozencraft 2005) several of which are however disputed. Among these is the Apennine wolf Canis lupus italicus Altobello, 1921, widespread in the Italian peninsula and morphologically and genetically distinct from all other European populations (Nowak and Federoff 2002; Montana et al. 2017).

Canis lupus has been present since the Pleistocene until recent times also in Sicily (e.g. Bonfglio et al. 2003), the largest island of the Mediterranean Sea, located south of the Italian Peninsula (about 37°45’0 N; 14°15’0 E). It was especially common in the mountains around Palermo, the woods around Mt Etna, the Peloritani, Nebrodi, Madonie and Sicani Mountains and Ficuzza Wood; the species was also present further south on the Erei and Iblei Mountains, where it has been recorded until 1928 (La Mantia and Cannella 2008).

The Sicilian wolf is usually considered extinct in the early decades of the twentieth century, but there is no unanimity on the exact date. The last confirmed specimens were shot near Bellolampo (Palermo) in 1924, but there are several reports of wolves killed between 1935 and 1938 near Palermo. Furthermore, there are several sightings of wolves in Sicily between 1960 and 1970 and some of them seem convincing (Angelici et al. 2016a).

The main cause of extinction of the Sicilian wolf appears to have been human persecution, due to alleged damage to livestock (eg. Minà Palumbo 1858a; 1858b; Chicoli 1870). This may have been due the extinction of the wild ungulates on which the predator fed due to an environmental crisis that starting on the island at the end of the Norman Period (ca 1198 CE) (Bresc 1983).

To date, remains of Sicilian wolves are extremely scarce: no more than 7 specimens (represented by skins, stuffed individuals, skulls, etc.) are known. All of them are stored in Italy, in the ‘Museo Storia Naturale ‘La Specola’, Università di Firenze, in the Museo di Zoologia ‘P. Doderlein’, Università di Palermo, in the Museo di Storia Naturale ‘La Specola’, Università di Firenze, and in the Museo Civico ‘Baldassarre Romano’, Termini Imerese (Palermo). Moreover, there exists only a single picture of a live Sicilian wolf (Fig. 1).

The complete specimens available had some peculiarities compared to the Apennine wolf. Among these the smaller size and the paler coat colour, which have already been noticed by some authors of the past (eg. Minà Palumbo 1868; Migneco 1897).

Materials and methods

A total of four adult specimens were studied: the holotype, a mounted male specimen plus its separate complete skull, and three paratypes, three mounted
specimens (all males). Although Sicilian wolf disappeared only recently there are very few specimens available and some of them are in poor conditions. We were also able to find three other specimens: another skin and two juveniles. However we chose not to use these in our description.

Repositories of described or cited specimens are: Museo di Storia Naturale 'La Specola', Università di Firenze, Florence, Italy; 'Museo Regionale Interdisciplinare di Terrasini', Terrasini (Palermo), Italy; Museo di Zoologia 'Pietro Doderlein', Università di Palermo, Palermo, Italy; Museo Civico ‘Baldassarre Romano’, Termini Imerese (Palermo), Italy.

Body measurements (n= 4) were taken using a tape measure to allow flexibility on mounted specimens, with an accuracy of 0.1 cm

A total of 10 measurements were taken on the skull of the holotype: 7 measures from the skull, and 3 from the mandible. The skull measurements were taken using a Vernier gauge with accuracy of 0.1 mm

The skull belongs to an elderly individual and several teeth are missing, while those still present are visibly worn and blunt. Only measurements that can be obtained with the highest precision allowed by our instruments were thus taken.

We compared skull and body measurements of the Sicilian wolf with the respective measurements of C. l. italicus using data available in literature (Siracusa and Lo Valvo 2004; Berté 2013; Altobello 1921; Ciucci and Boitani 2003). We have excluded from the comparative skulls the specimens with deciduous teeth or teeth not yet completely erupted (cf. Siracusa and Lo Valvo 2004; Berté 2013). We used only average measurements for sexually mature, adult individuals. (Altobello 1921; Ciucci and Boitani 2003).

In order to sort the multidimensional data, we developed a Principal Component Analysis (PCA) of body measurements from a sample of twenty Apennine wolves (9 MM, 11 FF) and a sample of four males Sicilian wolves using the software ‘R’. Then a cluster based
A NEW SUBSPECIES OF GREY WOLF (CARNIVORA, CANIDAE), RECENTLY EXTINCT, FROM SICILY, ITALY

on Euclidean distances between the points of the PCA to reconstruct the phenetics relationship was made using the Ward Method (1963). This method was chosen because it recognizes groups that minimize intra-group variance (more morphologically homogeneous).

**Systematic taxonomy**

*Carnivora* Bowditch, 1821

*Caniformia* Kretzoi, 1938

*Canidae* Fischer, 1817

*Canis* Linnaeus, 1758

*Canis lupus* Linnaeus, 1758

*Canis lupus cristaldi* subsp. nov. (Sicilian wolf)

**Holotype.** Mounted specimen of an old adult male, labeled MZUF-1891-Coll.652-1884 (Fig. 2). Skull MZUF-C 11875 (Fig. 3). The wolf was killed on 17th July 1883, at Vicari (Palermo). Collected by Mr Costantino Ciotti. Museo di Storia Naturale, Sezione di Zoologia, ‘La Specola’, University of Florence, Florence, Italy.

**Paratypes.** N. 1 Mounted specimen of an adult male, inventory number 9263 (Fig. 4). This individual was caught in Sicily (unknown location), date unknown. Donated by ‘Centro Studi e Ricerche’, C.S.I.’, Trapani, Italy. Museo Regionale Interdisciplinare di Terrasini (Palermo), Italy.

N. 2 Mounted specimen of an adult male, labeled M/18 (Fig. 5). This individual was killed in Sicily (unknown location), date unknown. Museum of Zoology ‘Pietro Doderlein’, Università di Palermo, Palermo, Italy.

N. 3 Mounted specimen of an adult male, labeled 3 (Fig. 6). This individual was most likely shot on Monte San Calogero near Termini Imerese (Palermo), date unknown but most likely in the last years of nineteenth century. The specimen was acquired by the Museum in 1969. Museo Civico ‘Baldassarre Romano’, Termini Imerese (Palermo), Italy.
**Etymology.** This taxon is dedicated to Professor Mauro Cristaldi (1947-2016), an Italian mammalogist and professor of Comparative Anatomy, born in Rome from a family of Sicilian origins. He was very attached to Sicily and he devoted his life to the study of Italian mammals, mostly rodents. He died suddenly in the summer of 2016.

**Type locality.** Vicari (Palermo Province), 640 m a.s.l., near ‘Bosco della Ficuzza’, NW Sicily (37°51’0.36” N, 13°34’0.72” E).

**Distribution.** In the past the species was widespread all over the island, especially around Palermo, woods surrounding Mt Etna, Peloritani, Nebrodi, Madonna and Sicani Mountains, and the Ficuzza Wood. It was also present further south, on the Erei and Iblei Mountains.

**Diagnosis.** The body is slender and sturdy, but overall proportionate. The legs are short. The small size of the Sicilian wolf place it among the smallest subspecies of *Canis lupus*, together with the endangered Arab wolf *Canis lupus arabs* Pocock 1934, and the extinct Japanese wolf *Canis lupus hodophilax* Temminck 1839 (see Pocock 1935).

To our knowledge there are only two works in literature containing measurements of Sicilian wolves (Galvagni 1837; Minà Palumbo 1868, see table I) but use of these sources is problematic. Galvagni (1837) uses inches as units of length, which we have considered pouces or Paris inches (1 Paris inch = 2.70 cm) for conversion in International System. Moreover, Galvagni (1837) does not specify if the height measurement is to ‘shoulder height’ or ‘withers height’ and we believe he may have included the head.

Minà Palumbo is also not clear in indicating the height, and he also does not specify if the ‘body length’ includes the tail or not. Considering the sizes reported it is probable he included tail measurements as well.

The body measurements of four *C. l. cristaldii* subsp. nov. specimens studied are in Table II.

The overall colour of the coat varies slightly from individual to individual and is generally paler than those displayed by other European wolf populations, particularly *C. l. italicus*. We believe the mounted specimens we used for this study did not suffer a significant discoloration. First, in XIX century sources, the colour
7A NEW SUBSPECIES OF GREY WOLF (CARNIVORA, CANIDAE), RECENTLY EXTINCT, FROM SICILY, ITALY

Fig. 4 – *Canis lupus cristaldii* subsp. nov. Paratype n.1. Mounted specimen of an adult male, inventory number 9263. Museo Regionale Interdisciplinare di Terrasini (Palermo), Italy.

Fig. 5 – *Canis lupus cristaldii* subsp. nov. Paratype n.2. Mounted specimen of an adult male, labeled M/18. Museum of Zoology ‘Pietro Doderlein’, University of Palermo, Palermo, Italy.
of the Sicilian wolf is described as very similar to that of the studied specimens for both living and recently dead adult individuals (eg Minà Palumbo 1869). Furthermore at least three of the four studied individuals (including the holotype) have been stored away from direct sunlight for many decades. It should also be stressed that in 1891 famous Italian naturalist Enrico Hillyer Giglioli, then director of the Museum of Florence, examined the specimen designated in this work as the holotype, describing it in a not dissimilar way from what it is like today ‘Is very remarkable for its small size, the light yellow color of the fur, and to miss the black band along the forearm” (see Ghigi, 1911).

The background colour is very pale tawny, in some way reminiscent of the lion’s coat (‘lionato’ according to Minà Palumbo 1868). A good match in commonly

---

**Table I – Historic measurements of the Sicilian wolf**

<table>
<thead>
<tr>
<th>Measurements by Galvagini (1837) (n=?)</th>
<th>Measurements (mean) by Minà Palumbo (1868) (n = 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head-body length</td>
<td>3 feet 3 inches (105.3 cm)</td>
</tr>
<tr>
<td>Tail length</td>
<td>9.5 inches (25.65 cm)</td>
</tr>
<tr>
<td>Height (including head ?)</td>
<td>“more than 2 feet” (more than 64.8 cm)</td>
</tr>
<tr>
<td></td>
<td>125 (cm) (including tail ?)</td>
</tr>
<tr>
<td></td>
<td>21 (cm)</td>
</tr>
<tr>
<td></td>
<td>63 (cm)</td>
</tr>
</tbody>
</table>

**Table II – *Canis lupus cristaldii* subsp. nov. body measurements**

<table>
<thead>
<tr>
<th>Measurements taken on available specimens (n = 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head-body length (cm)</td>
</tr>
<tr>
<td>Tail length (cm)</td>
</tr>
<tr>
<td>Shoulder height (cm)</td>
</tr>
<tr>
<td>Ear length (cm)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Head-body length (cm)</th>
<th>108; 110; 101; 102.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tail length (cm)</td>
<td>30.5; 43.5; 32; 33.5</td>
</tr>
<tr>
<td>Shoulder height (cm)</td>
<td>52.5; 53; 56.5; 56.5</td>
</tr>
<tr>
<td>Ear length (cm)</td>
<td>9; 8; 9.5; 7</td>
</tr>
</tbody>
</table>

**Table III. Comparison between body measurements (mean) of *Canis lupus cristaldii* subsp. nov., and *Canis lupus italicus*.**

<table>
<thead>
<tr>
<th>Mean measures taken on <em>Canis lupus cristaldii</em> subsp. nov. (n= 4)</th>
<th>Mean measures taken on <em>Canis lupus italicus</em> (Altobello, 1921) (n &gt;1)</th>
<th>Mean measures taken on <em>Canis lupus italicus</em> (processed from Ciucci and Boitani, 2003)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head-body length (cm)</td>
<td>105.4 (±4.3)</td>
<td>105.8 (±5.12, FF, n= 21)</td>
</tr>
<tr>
<td>Tail length (cm)</td>
<td>34.9 (±5.9)</td>
<td>34.3 (±3.58, n=27)</td>
</tr>
<tr>
<td>Shoulder height (cm)</td>
<td>54.6 (±2.2)</td>
<td>66.9 (±7.66, MM, n=12)</td>
</tr>
<tr>
<td>Ear length (cm)</td>
<td>8.4 (±1.1)</td>
<td>11.0 (±0.62, n=24)</td>
</tr>
</tbody>
</table>
Fig. 6 – *Canis lupus cristalidii* subsp. nov. Paratype n.3. Mounted specimen of an adult male, labeled 3. Museo Civico ‘Baldassarre Romano’, Termini Imerese (Palermo), Italy.

Fig. 7 – Forearms of Sicilian wolf have not, or just slightly hinted, line typical of Apennine wolf. A holotype, B paratype N.1, C paratype N. 2, D paratype N. 3.
Available literature is Lion tawny, Dictionary of Color #C19A6B. Older individuals are ashen in colour, almost dirty white (see also Minà Palumbo 1868). Dorsally and on the sides the coat is overall darker, with predominance of light tawny, dark grey, and lighter grey tones. The colour of the chest and the belly is light and varies from dirty white to pale yellowish cream. The throat, cheeks and inner parts of the limbs are also paler than the dorsal parts. The ears are light beige-tawny with some darker grey dorsally hairs and very light, almost white, internally hairs.

The base of tail is narrow, then widens and the hair becomes thicker, ending progressively in a pointed shape. The colour of the tail is usually darker at the base, sometimes tending to black at the end.

The legs are rather pale, between light beige and grey. The dark line on the forearms, typical of Apennine wolf (Altobello 1921), is absent or very slightly hinted (see Fig. 7). However, there is a very slight difference

---

Table IV – Measurements (cm) of the skull of the holotype of *Canis lupus cristaldii* subsp. nov. compared with *C. l. italicus* (Siracusa and Lo Valvo 2004; Berté 2013).

<table>
<thead>
<tr>
<th>Measurements taken on the skull of the holotype of <em>Canis lupus cristaldii</em> subsp. nov.</th>
<th>Mean measurements taken on <em>C. l. italicus</em> (Siracusa and Lo Valvo, 2004) n=20 (MM n=10; FF N=10)</th>
<th>Mean measurements taken on <em>C. l. italicus</em> (Berté, 2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranium total length (Akrokranium-Prosthion)</td>
<td>21.80</td>
<td>24.17 (±5.8) MM 22.72 (±6.5) FF</td>
</tr>
<tr>
<td>Condylobasal length</td>
<td>20.95</td>
<td>22.38 (±6.4) MM 21.27 (±5.7) FF</td>
</tr>
<tr>
<td>Lenght of the nasals (Nasion-Rhinion)</td>
<td>8.29</td>
<td></td>
</tr>
<tr>
<td>Skull height (including Sagittal crest)</td>
<td>6.75</td>
<td></td>
</tr>
<tr>
<td>Zygomatic breadth (Zygion-Zygion)</td>
<td>12.43</td>
<td>13.68 (±4.7) MM 12.70 (±4.5) FF</td>
</tr>
<tr>
<td>Greatest neurocranium breadth (Euryon-Euryon)</td>
<td>6.20</td>
<td></td>
</tr>
<tr>
<td>Frontal breadth (Ectorbitale-Ectorbitale)</td>
<td>5.85</td>
<td></td>
</tr>
<tr>
<td>Mandible total length (Condyle process-Infradentale)</td>
<td>16.35</td>
<td>17.43 (±4.6) MM 16.54 (±5.7) FF</td>
</tr>
<tr>
<td>Lenght angular process-Infradentale</td>
<td>16.21</td>
<td></td>
</tr>
<tr>
<td>Height of the vertical ramus (Basal point of the angular process-Coronion)</td>
<td>6.48</td>
<td></td>
</tr>
</tbody>
</table>

---

Fig. 8 – Size comparison between skulls of *Canis lupus cristaldii* subsp. nov. Holotype (right), and *Canis lupus italicus* (male) (left). For details see text.

Fig. 9 – Size comparison between skulls and mandibles of *Canis lupus cristaldii* subsp. nov. Holotype (right), and *Canis lupus italicus* (male) (left). For details see text.
between the external and the internal colour of the legs: the latter is lighter. Intermediate hairs of the toes tend to ochraceous-tawny.

The skull of the adult is smaller than the nominate subspecies and also significantly smaller than the Apennine subspecies *C. l. italicus*.

**Comparison with Apennine wolf**

(*Canis lupus italicus* Altobello, 1921)

Table III shows the mean measurements of *Canis lupus cristaldii* subsp. nov., compared with those of *Canis lupus italicus* by Altobello (1921), and Ciucci and Boitani (2003).

The size of the Sicilian wolf is smaller than the average size of the Apennine wolf, in particular shoulder height, ear length, and head-to-body length.

The skull is also appreciably smaller than the skull of the Apennine wolf (Table IV) and the rising frontal region seems scarcely steeply at all. In the comparisons of Figs. 8-9 we used the skull of an adult almost coeval (1892) male of Apennine wolf from Capalbio (GR), Central Italy (Museo di Storia Naturale, Sezione di Zoologia, ‘La Specola’, Università di Firenze, Florence, Italy, labeled MZUF-12415).

Fig. 10 shows the PCA of the body measurements of *C. l. italicus* (Ciucci & Boitani 2003) compared with four individuals of *C. l. cristaldii* susp. nov. In Fig. 11 is the correlation circle as explanation of Fig. 10 where is indicated how much they vary between the two comparative samples and how much they affect, the four linear measures collected. While in Fig. 12 is the dendrogram showing the phenetic relationship of the same samples of Fig. 10.

**Discussion**

Data show that both holotype, and paratypes of *C.l.
A NEW SUBSPECIES OF GREY WOLF (CARNIVORA, CANIDAE), RECENTLY EXTINCT, FROM SICILY, ITALY

cristaldii subsp. nov. have distinct phenotypic features from the Apennine wolf.

Fig. 10 shows the body measurements of four specimens of *C.l. cristaldii* subsp. nov. compared with the same body measurements of the sample of *C.l. italicus* in a two-dimensional space. The figure shows body measurements of the Sicilian wolf are clearly different from the Apennine wolf. Shoulder height is the trait that most differentiates Sicilian wolf from Apennine wolf (see Fig. 11). Ear length is also a notable trait, and also the head-body length, albeit less so. Tail length, however, appears to be exactly the same for both subspecies.

Fig. 12 shows the Sicilian wolf to be readily separated from a phenetics point of view (ordinates) from the Apennine wolf because of its small size. In fact only one individual of *C.l. italicus* appears stochastically partially associated with *C.l. cristaldii*.

The morphological distinction is supported by preliminary analysis of mitochondrial DNA (mtDNA) which was conducted using genetic material extracted from the teeth of two specimens: the holotype skull, and an immature wolf skull preserved at the Museo di Zoologia 'P. Doderlein', Università di Palermo. The result indicates that both specimens do not belong to the Apennines population from mainland Italy because they present a unique and clearly differentiated haplotype which differs from the typical haplotype of the Apennine wolf (W14) by two substitutions (Angelici et al. 2016b). Further and more detailed analysis of mtDNA and genome sequencing are currently underway.

At the present state of knowledge we believe that the most likely explanation for these differences is the isolation from the Italian population from which the Sicilian wolf originated. The last known land bridge between Italy and Sicily is estimated between 21.5 and 20 kiloyears BP (Antonioli et al. 2012). Although the Sicilian mammal fauna is still not as well studied taxonomically, small mammals are increasingly recognized as discreetly endemic (cf. Bezerra et al. 2016).

The present work is a further evidence of the criti-
cal relevance of museum collections for a complete understanding of former and present biodiversity, even of apparently well-known large mammals (cf. Gippoliti et al., 2014).

Acknowledgments

This work would not have been possible without the heartfelt collaboration and generous help of many people. Paolo Agnelli of the Museo di Storia Naturale ‘La Specola’, Firenze, helped us obtain continuous access to the holotype. Saulo Bambi, of the same Museum, took the photographs of the holotype published in this paper.

Ferdinando Maurici and Fabio Lo Valvo of the Museo Regionale Interdisciplinare ‘D’Aumale’ of Terrasini were just as generous and indispensable, as well as Sabrina Lo Brutto, Enrico Bellia, Maurizio Sarà of the Museo Zoologico ‘P. Doderlein’ of Palermo, and Fabio Lo Bono of the Museo Civico ‘B. Romano’ of Termini Imerese. A huge thank you goes to all of them.

We thank Agatino M. Siracusa, Elisabetta Cilli, Marta M. Ciucani, Davide Palumbo, Riccardo Castiglia, Flavia Annesi from the Sicilian wolf biomolecular working group for the advice and collaboration; E. Cilli was indispensable in pointing out the existence of the stuffed specimen of the museum of Termini Imerese. A.M. Siracusa has also collected some valuable historical bibliographic data. Davide F. Berté have made available to us many of his unpublished data on *C. l. italicus*, from his Ph.D thesis. A particular thank to Paolo Colangelo for the indispensable help in the statistical analysis, and his advice in compiling the present work. Luigi Boitani and Paolo Ciucci have provided us with the database of the body size of the Apennine wolf. We are very grateful to Ronald H. Pine because his suggestions have been fundamental to increase the quality of the manuscript. We express our gratitude to Mauro Cella for improving the English of this manuscript and to Fabrizio Antonioli and Aldo Piombino for their clarifications regarding the land bridge between mainland Italy and Sicily. Last but not least, a special thanks to Spartaco Gippoliti and Raffaele Sardella for improving this paper with their suggestions.

References


Breeding birds in a morenic peatbog (Castellaro Lagusello, Mantua, Northern Italy): A preliminary survey

GIUSEPPE DODARO*, CORRADO BATTISTI**
(* Sustainable Development Foundation, via Garigliano 61a - 00198 Rome (Italy)
** Corresponding Author: c.battisti@cittametropolitanaroma.gov.it, via dei Carafa 274 - 00148 Rome (Italy)

Abstract

We reported data on a preliminary survey (point count method) on the breeding bird community of a small peatbog located in the morenic hills of Garda lake (“Complesso morenico di Castellaro Lagusello”; SAC IT20B0012; Mantua; Northern Italy). We sampled 34 species (23 breeding; 26.06 species as calculated with the parametric estimator $S_{\text{Chao}}$). Eight species were dominant. The study area host a relatively rich and heterogeneous species assemblage (with water-related species mixed to common mosaic, forest and synanthropic ones) and with a high number of non Passeriformes (about 39%). Among the species of conservation concern, Ardea purpurea has not been reported in the SAC Management Plan. Although extremely preliminary because obtained in a short time span, our data may contribute to the knowledge of bird assemblages occurring in these peculiar ecosystems since that research for subalpine peatbogs are yet scanty.

Key words: Point count method, Margalef index, Chao 2 richness estimator, diversity, evenness.

Introduction

Peatbogs are wet habitats characterized by their unique ability to accumulate and store dead plants as peat. Other than play an important role in the biosphere, these ecosystems provide habitats of conservation concern for many peculiar plants and animals (European Commission, 2007). Among birds, peatbogs may host many water-related and mosaic species since they are wet habitats often surrounded by shrub and arboreal vegetation (van der Valk, 2011). Many studies on this topic are available from Northern Europe (e.g. Boström and Nilsson, 1983; Stroud et al., 1988; Stastny and Bejcek, 2002).

Although a number of surveys, reviews or general ornithological reports have been carried out in peatbogs and peatlands of Northern Italy, research focused on the bird assemblages for subalpine sites are yet scanty, often descriptive or only limited to water-related species (e.g. Brichetti, 1976; Brambilla, 2003; Brambilla, 2005; Assandri and Papini, 2005; Maffezzoli, 2005; Brichetti and Grattini, 2008; Bertocchi et al., 2009).

In this preliminary note we would contribute to knowledge to the breeding bird community of a small peatbog and their immediately surrounding landscape mosaic located in the morenic hills of Garda lake (province of Mantua; Northern Italy), within a Site of Community Importance (SCI) at European level.

Material and methods

The “Torbierina” (45°22’47” N, 10°38’01” E; size area: 4.14 ha) is a small wetland located in an area once used for the extraction of peat. This peatbog belong to the Special Area of Conservation (SAC) IT20B0012 named “Complesso morenico di Castellaro Lagusello” (92/43/EU Directive; continental biogeographic region; size area: 271 ha; alt. 97 - 156 m a.s.l.; municipalities of Monzambano and Cavriana; province of Mantua; Rossi, 2010), a complex ecological system including the Castellaro Lagusello Lake, which occupies an intermorenic hollow, and the surrounding mosaic of agricultural areas, woodland patches and grasslands. Currently the whole “Torbierina” area contains a wide variety of vegetation types, with some elements of relevant interest. Inside the pond and tributary channels an important phytocenosis occur, characterized by radiant rhizophytes, typical of stagnant or weakly running waters with high content of nutrients (Bolpagni, 2013). This vegetation, with strong dominance of Nuphar lutea, accompanied by Nymphaea alba, Lemna minor, Polygonum amphibium (Persico, 1988), can be referred to the EU Habitat 3150 “Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation” (Rigoni, 2011). Throughout the area helophytes communities are also present, referred to Phragmiti-Magnocariceta class, with characteristic species such as Typha latifolia,
Carex elata, C. humilis, C. flava, Juncus effusus with a cover dominance of Phragmites australis reed beds. The tree vegetation is characterized by an hygrophilous cover dominance of Alnus glutinosa (belonging tree vegetation is characterized by an hygrophilous cover dominance of Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) (Biondi and Blasi, 2009). Other tree vegetation include a hygrophilous wood with prevalence of Salix alba, and presence of Populus nigra, Cornus sanguinea, Frangula alnus, that can be ascribed to the association Salici-Populetum nigrae (Tüxen 1931) Meyer-Drees 1936 and a mixed sub hygrophilous wood characterized by the prevalence of Quercus robur and Carpinus betulus, accompanied by Fraxinus angustifolia and Robinia pseudoacacia, that can be referred to the EU Habitat 91L0 “Ilyrtian oak-hornbeam forests” (Erythronio-Carpinion).

The local avifauna has been yet partially studied at landscape and site level (e.g. Manzi et al., 1988; Martignoni, 1988; Rossi, 2010), and wintering bird surveys have been carried out from GMO (Gruppo Mantovano di Ornitologia; e.g. Rubolini et al., 2005; Longoni and Fasola, 2011; area code INFN MN0102). We carried out a rapid survey using the individual-based point count method (IPA; Bibby et al., 2000; Sutherland, 2006). Along the “Torbiera” lake-shore, we located nine point counts (fixed radium: 25 m; minimum distance: > 75 m), each one of 5 min. in the early morning (05.00-10.00; 12 June 2014). To detect crepuscular and nocturnal species, further not standardized rapid surveys have been carried out in the June, 11, during the afternoon (2 hours) and the night (23.00-24.00) (total research effort: about 300 min.). During these surveys we sampled all the species individuals, including vagrants probably breeders in the surrounding (* in Tab. 1). Total area detected by these surveys was about 10.10 ha.

We analyzed data obtaining the following community parameters: i) total number of breeding bird recorded (at level of single species, n, and totally, N); ii) total mean abundance (Mean Abb: i.e., the averaged total number of individuals in each point count); iii) dominance (pi; i.e., the ratio between the number of individuals of the ith-species and the total number of individuals in the community; we considered dominant a species with a pi ≥ 0.05); iv) Margalef index (Dm; calculated as Dm=S-1/logN; this represents a value of species richness normalized to the sample, where S is the total species richness and N the total number of breeding records); v) Shannon-Wiener diversity index (H’, calculated as H’ = - S pi ln pi); vi) evenness (J, calculated as J = H’/lnStot; see Magurran, 2004, for details); vi) percentage of non Passeriformes.

To predict the breeding species richness effectively occurring we used a simple non parametric estimator (Chao 2; Magurran, 2004) as SChao2 = S + Q1/2Q2, where S is the species richness, Q1, the number of singletons, i.e. the species occurring in only one point count, Q2, the number of doubletons, i.e. the number of species occurring in only two point counts.

As possible, we checked for data reliability following Battisti and Dodaro (2010).

Results

Totally, we sampled 34 species (including Columba livia forma domestica). Among them, 23 species were detected with the point count method (N = 112 ind. detected; total mean abundance: 12.94±3.97 ind./point count; Tab. 1). Eight species were dominant (pi>0.05): two water-related (Gallinula chloropus, Fulica atra; with 24 ind. as maximum number contemporarily detected), five forest mosaic (Streptopelia turtur, Sylvia atricapilla, Aegithalos caudatus, Oriolus oriolus, Fringilla coelebs) and one hole-nesting synanthropic species (Sturnus vulgaris; Tab. 1). Margalef index was 16.59, Shannon diversity H’ index was 2.744, evenness was 0.875. The 39.13% of the species were Non Passeriformes. We estimated 26.06 species with the parametric estimator SChao2.

In the immediately surrounding landscape (about a radium of 1 km; excluding the Castellaro-Lagusello lake) we also detected (outside the point counts): Merops apiaster, Garrulus glandarius, Muscicapa striata. Some species recorded in not standardized surveys probably breed in the surrounding (e.g. herons and Falco peregrinus). We also observed Phalacrocorax carbo as vagrant (not included in Tab. 1).

Discussion

This peatbog host a relatively rich and heterogeneous bird assemblage with many non Passeriformes mainly belonging to water-related taxa and other common forest, shrubby and synanthropic species, typical of the hilly mosaic landscapes of Garda lake (Vigorita and Cucé, 2008). The fragmented patches of riparian forests located on the lake-shore (with many mature tree plants) allow the occurrences of some hole-nesting
Table 1 – Check-list of breeding bird species detected in “Torbrierina” (SAC IT20B0012; Monzambano and Cavriana; province of Mantua; Northern Italy). Euring code, species, number of individuals (n), relative frequency or dominance (pi; in bold, the dominant species with pi > 0.05; N = 112) and mean abundance (Mean Abb: n. ind./point count and standard deviation, s.d.) are reported. (*) = species recorded outside the standard method (vagrants and/or probably breeding in the surrounding).

<table>
<thead>
<tr>
<th>Euring</th>
<th>Species</th>
<th>pi</th>
<th>Mean Abb (and s.d.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00070</td>
<td>Tachybaptus ruficollis</td>
<td>0.009</td>
<td>0.111 (±0.33)</td>
</tr>
<tr>
<td>00090</td>
<td>Podiceps cristatus</td>
<td>(*)</td>
<td></td>
</tr>
<tr>
<td>01040</td>
<td>Nycticorax nycticorax</td>
<td>(*)</td>
<td></td>
</tr>
<tr>
<td>01220</td>
<td>Ardea cinerea</td>
<td>(*)</td>
<td></td>
</tr>
<tr>
<td>01240</td>
<td>Ardea purpurea</td>
<td>(*)</td>
<td></td>
</tr>
<tr>
<td>01860</td>
<td>Anas platyrhynchos</td>
<td>(*)</td>
<td></td>
</tr>
<tr>
<td>03200</td>
<td>Falco peregrinus</td>
<td>(*)</td>
<td></td>
</tr>
<tr>
<td>03940</td>
<td>Phasianus colchicus</td>
<td>(*)</td>
<td></td>
</tr>
<tr>
<td>04240</td>
<td>Gallinula chloropus</td>
<td><strong>0.063</strong></td>
<td>0.778 (±0.87)</td>
</tr>
<tr>
<td>04290</td>
<td>Fulica atra</td>
<td><strong>0.125</strong></td>
<td>1.556 (±1.51)</td>
</tr>
<tr>
<td>-</td>
<td>Columba livia forma domestica</td>
<td>0.027</td>
<td>0.333 (±0.71)</td>
</tr>
<tr>
<td>06700</td>
<td>Columba palumbus</td>
<td>0.009</td>
<td>0.111 (±0.33)</td>
</tr>
<tr>
<td>06840</td>
<td>Streptopelia decaocto</td>
<td>(*)</td>
<td></td>
</tr>
<tr>
<td>06870</td>
<td>Streptopelia turtur</td>
<td><strong>0.063</strong></td>
<td>0.778 (±0.83)</td>
</tr>
<tr>
<td>07240</td>
<td>Cuculus canorus</td>
<td>(*)</td>
<td></td>
</tr>
<tr>
<td>07950</td>
<td>Apus apus</td>
<td>(*)</td>
<td></td>
</tr>
<tr>
<td>08310</td>
<td>Alcedo atthis</td>
<td>0.009</td>
<td>0.111 (±0.33)</td>
</tr>
<tr>
<td>08560</td>
<td>Picus viridis</td>
<td>0.027</td>
<td>0.333 (±0.71)</td>
</tr>
<tr>
<td>08760</td>
<td>Dendrocopos major</td>
<td>0.045</td>
<td>0.556 (±0.53)</td>
</tr>
<tr>
<td>09920</td>
<td>Hirundo rustica</td>
<td>0.027</td>
<td>0.333 (±0.71)</td>
</tr>
<tr>
<td>10010</td>
<td>Delichon urbicum</td>
<td>0.018</td>
<td>0.222 (±0.67)</td>
</tr>
<tr>
<td>11040</td>
<td>Luscinia megarhynchos</td>
<td>0.018</td>
<td>0.222 (±0.44)</td>
</tr>
<tr>
<td>11870</td>
<td>Turdus merula</td>
<td>0.036</td>
<td>0.444 (±0.73)</td>
</tr>
<tr>
<td>12770</td>
<td>Sylvia atricapilla</td>
<td><strong>0.107</strong></td>
<td>1.333 (±0.87)</td>
</tr>
<tr>
<td>14370</td>
<td>Aegithalos caudatus</td>
<td><strong>0.161</strong></td>
<td>2 (±2.5)</td>
</tr>
<tr>
<td>14620</td>
<td>Cyanistes caerulesus</td>
<td>0.009</td>
<td>0.111 (±0.33)</td>
</tr>
<tr>
<td>14640</td>
<td>Parus major</td>
<td>0.018</td>
<td>0.222 (±0.44)</td>
</tr>
<tr>
<td>15080</td>
<td>Oriolus oriolus</td>
<td><strong>0.054</strong></td>
<td>0.667 (±0.5)</td>
</tr>
<tr>
<td>15490</td>
<td>Pica pica</td>
<td>0.009</td>
<td>0.111 (±0.33)</td>
</tr>
<tr>
<td>15670</td>
<td>Corvus cornix</td>
<td>(*)</td>
<td></td>
</tr>
<tr>
<td>15820</td>
<td>Sturnus vulgaris</td>
<td><strong>0.107</strong></td>
<td>1.333 (±1.66)</td>
</tr>
<tr>
<td>16360</td>
<td>Fringilla coelebs</td>
<td><strong>0.018</strong></td>
<td>0.222 (±0.44)</td>
</tr>
<tr>
<td>16400</td>
<td>Serinus serinus</td>
<td>0.009</td>
<td>0.111 (±0.33)</td>
</tr>
<tr>
<td>16490</td>
<td>Carduelis chloris</td>
<td>0.036</td>
<td>0.444 (±1.01)</td>
</tr>
</tbody>
</table>
species (e.g., woodpeckers, tits and *Sturnus vulgaris*) and other relatively common forest birds (e.g. *Oriolus oriolus*). Among the species of conservation concern, *Ardea purpurea* has not been reported in the SCI Management Plan (Rigoni, 2011).

Since that we carried out a rapid survey in a short time span oriented to detect mainly diurnal common species occurring in spring (by point counts), some more rare and less detectable breeding, wintering or migrant species known for this area have not been sampled (e.g. *Botaurus stellaris, Isopychus minutus, Egridia garzetta, Casmerodius albus, Pernis apivorus, Buteo buteo, Accipiter nisus, Milvus migrans, Circus aeruginosus, C. cyaneus, Otus scops, Asio otus, Lanius collurio, Acrocephalus spp.*, *Emberiza schoeniclus, Remiz pendulinus, Cettia cetti*; Manzi et al., 1988; Rossi, 2008; Rigoni, 2011). Although this limitation, the Chao 2 richness estimator evidenced as this sampling may be considered representative at least for breeding birds, since that only a few limited number of them was not detected (23 sampled vs. about 26 estimated as occurring).

Although further quantitative research, especially focused on more elusive species, need to be carried out, our preliminary data may be useful for future monitoring and comparisons carried out locally in this site and, generally, in other peatbogs of Northern Italy.

Acknowledgments

This study has been carried out inside the Project “Corridoi ecologici in provincia di Mantova – Il ruolo dell’agricoltura nella realizzazione e valorizzazione della Rete Ecologica Regionale” - conducted by Ambiente Italia srl, Studio Eureco and dr. Agr. For. Marco Goldoni on behalf of ERSAF – Regione Lombardia and Provincia of Mantua. We would like to thank Anna Bombonato, Daniele Cuizzi, Marco Goldoni, Nunzio Grattini (GMO) and Mario Vannuccini.

References


RIGONI P., 2011. Piano di gestione del SIC IT20B0012 “Complesso morenico di Castellaro Lagusello”. Relazione di Piano; Quadro conoscitivo; Allegato I - Elenco floristico; Tavola 5 – Carta degli habitat Studio di incidenza. Studio Silva s.r.l. disponibile on-line.

ROSSI S., 2010. Atlante dei SIC della Provincia di Man-
tova. Milano: Regione Lombardia e Fondazione Lombardia per l’Ambiente.


INDICE

Francesco Maria Angelici, Lorenzo Rossi
A new subspecies of grey wolf (Carnivora, Canidae), recently extinct, from Sicily, Italy....................... pag 3

Giuseppe Dodaro, Corrado Battisti
Breeding birds in a morenic peatbog (Castellaro Lagusello, Mantua, Northern Italy): A preliminary survey........................................................................................................ pag 17

Presentazione dei lavori

I lavori devono essere indirizzati alla Redazione Editoriale - Museo Civico di Sto- ria Naturale di Verona Lungadige Porta Vittoria, 9 37129 Verona, accompagnati- ti da indirizzo, recapito telefonico ed eventuali fax e casella di posta elettronica dell’autore. Lo stesso è richiesto ai tre autori, di un autorizzazione riferimento. I contributi richiedi- ti dalla Redazione saranno inviati per una valutazione a revisori scientifici e quin- di, se accettati, verranno rinvianti agli autori con richiesta di eventuali modifiche. L’accettazione o il rifiuto dei lavori è in ogni caso di competenza della Redazione. Il costo della stampa di eventuali figure a colori (es. 18 x 24, 11.75). Nella copia stampata inviata alla Redazione dovrà essere indicato a matita a margine della copia stampata inviata alla Redazione. Per il simbolo di femmina utilizzare #. Per il simbolo di maschio utilizzare $, per il simbolo di sesso indefinito utilizzare %.


Guidelines for authors

The Bollettino del Museo Civico di Storia Naturale di Verona is issued annually in two distinct parts: Botany and Zoology; 2. Geology, Paleontology and Archaeology. Both extended contributions and brief notes regarding the naturalis- tic aspects of these disciplines are welcome. Submission of manuscripts

Manuscripts should be addressed to: Redazione Editoriale - Museo Civico di Storia Naturale di Verona, Lungadige Porta Vittoria, 9 37129 Verona, and should be accompanied by the address, telephone number and, if possible, the fax number and email address of the author or in the case of multiple authors, of the corresponding author. The manuscripts received by the editors will be sent for evaluation to scientific referees and, if accepted, will then be returned to the authors for eventual requested modifications. The final decision for acceptance or refusal of manuscripts is always taken by the editors. Instructions for manuscript preparation

The contributions must be presented on computer disc and in two printed copies with photocopies also of the plates and illustrations. The work should be accom- panied by an Abstract in English (including the title and the Key Words which should not be less than three in number) and by an Abstract (Riassunto) in Italian (including the Key Words which should not be less than three in number). Both the Abstract and Riassunto should consist of at least three lines of text. Headings: Title of the article in bold, name and surname (in full) of the author or authors in capitals, institution or city of residence of the authors in italics and between brackets, for example: Indagini idrogeologi- che nell’area del Corno d’Aquilio (Monti Lessini nordoccidentali - Verona) ROBERTO ZORZIN (Museo Civico di Storia Naturale di Verona)


Indirizzo dell’autore o degli autori

Deve essere indicato dopo la bibliografia come nel seguente esempio: SANDRO RUFI - Museo Civico di Storia Naturale di Verona, Lungadige Porta Vittoria, 9 - 37129 Verona; e-mail: sandro.rufo@comune.verona.it.

Bozza

L’autore riceverà una sola bozza in formato pdf. Per i lavori a più nomi la bozza verrà inviata all’autore di riferimento. La bozza, corretta con indicazioni chiare e leggibili, deve essere inviata per e-mail alla Redazione entro 10 giorni dalla data di ricevimento. La ritarda restituzione potrà comportare il passaggio del lavoro al volume successivo. Nella correzione non sono ammesse aggiunte, riduzioni o modifiche al testo, se non a spese dell’autore.

Estratti

A ogni autore o gruppo di autori verrà inviata una copia elettronica dell’articolo in formato pdf ad alta risoluzione. Eventuali estratti stampati potranno essere richiesti, a spese degli autori, direttamente alla tipografia.
FRANCESCO MARIA ANGELICI, LORENZO ROSSI
A new subspecies of grey wolf (Carnivora, Canidae), recently extinct, from Sicily, Italy

GIUSEPPE DODARO, CORRADO BATTISTI
Breeding birds in a morenic peatbog (Castellaro Lagusello, Mantua, Northern Italy): A preliminary survey