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Observations on the historical distribution of the red deer, *Cervus elaphus* L., 1758, in the wood of Mesola (Ferrara), and in the Po delta (north-eastern Italy)

Dati sulla diffusione storica del cervo, *Cervus elaphus* L., 1758. della Mesola nel delta padano (Italia nord-orientale)

Summary – Several authors currently regard the red deer of the Mesola wood (Gran Bosco della Mesola o Boscone della Mesola) of the abbey of Pomposa, as the only endemic deer of the Italian peninsula. However, certain evidence on the historic distribution of the species points to a different situation. In reality, the Mesola dunes, where the deer park was established by the d'Este princes in the late Middle Ages, originated from the geological settlement of the mouth of the river Po not prior to the 13th century AD. Thus, the red deer may not have been autochthonous but introduced after this event from abroad. However, an eastwards diffusion of the species, progressively colonizing the new coastlines from the hinterland of the Ferrara plain, just a few meters westwards of the dune spits, cannot be ruled out. Few osteological remains and literary data on the diffusion of this species are available in the territory of the Po delta from prehistoric times to the Middle Ages.

*Riassunto – Osservazioni sulla diffusione storica del cervo della Mesola, *Cervus elaphus* L., 1758 (Ferrara), e nel delta padano (Italia nord-orientale). Vari autori considerano il cervo del Gran Bosco della Mesola o Boscone della Mesola della Prepositura Pomposana, nel delta del Po ferrarese, come l'ultima popolazione endemica della specie dell'intera penisola italiana. Dati sulla distribuzione storica dell'animale farebbero invece propendere per una diversa situazione. In realtà le dune dove, nel basso Medioevo, fu creato un parco per cervi dai duchi di casa d'Este, sono state originate dall'assessamento della foce del Po non prima dell'XIII secolo d.C. Come conseguenza di ciò, i cervi vi potrebbero non essere autoctoni ma esservi stati introdotti in seguito. Anche se non si può escludere una diffusione verso est della specie che avrebbe progressivamente colonizzato le nuove linee di costa, dall'interno della pianura ferrarese, pochi metri più a ovest dei cordoni dunali. Rari reperti osteologici e dati di letteratura sulla diffusione della specie sono disponibili per il delta padano dalla preistoria al Medioevo*

Key words: Red deer, *Cervus elaphus*, Mesola Wood, Po delta, North-eastern Italy

*Parole chiave: Cervo nobile, *Cervus elaphus*, Bosco della Mesola, Delta del Po, Italia nord-orientale*

INTRODUCTION

The natural reserve of the Mesola wood, officially called as Gran Bosco della Mesola and/or Boscone della Mesola is located in the Po delta, in the namesake municipality of the province of Ferrara, in north-eastern Italy. The castle of Mesola, one of the medieval delizie of the Este family, is instead at a certain distance from this reserve. Its construction commenced in the year 1578 at the wish of Alfonso II, the last descendant of the house of Este. The delizia comprises the castle and the adjacent enclosed wood, but it has nothing to do with the present-day Gran Bosco, which is the surviving remnant of the forest of the abbey of Pomposa. The red

deer, *Cervus elaphus* L., 1758, which live in the Mesola reserve derive their name from the locality in which they have survived up to the present. In the Italian peninsula this is, possibly, the only population of the cervid to have survived deforestation and persecution by man, living in the small forest of the Po delta (Mattioli et al. 2003) (Fig. 1). Mesola deer are regarded as a population of great relevance for zoogeography, ecology, conservation and local cultural perspectives (Lovari, Nobili 2010). Several authors, such as Castelli (1941), Mattioli (1990), Mattioli *et al.* (2001), Ferretti and Mattioli (2012), currently consider them as the only endemic deer of the Italian peninsula, thus regarding them as the sole survivors of the autochthonous Italian deer



Figure 1. Several authors currently regard the red deer of the Mesola wood (Ferrara, north-eastern Italy) as the only endemic deer of the Italian peninsula, but certain evidence on the historic distribution of the species points to a different situation. These deer display a summer spotted coat throughout their lives (photo by Paolo Cortesi).

(Ghigi 1911, 1950; Castelli 1941; Riedel 1991; Mattioli 1990, 2003, 2010; Lovari 1993; Hmwe et al. 2006; Hajji et al. 2007; Zachos et al. 2009; Ferretti, Mattioli 2012). These ungulates show certain morphological peculiarities: small body size, and reduced sexual dimorphism (Mattioli 1990, 1993; Mattioli et al. 2003; Mattioli, Mauri 2010). The mean weight of adult males is 110 kg and of adult hinds 74 kg as compared with the central European mean of 160-200 kg and 90-110 kg respectively. Moreover, the height at the withers of the deer of Mesola is proportionately inferior to that of other conspecific populations: a slight phenomenon of shortening of the limbs means that the height at the withers is equivalent on average to 58% of the head-trunk length, as against a norm of 63% (Mattioli et al. 2003; Mattioli 2010). All these morphological features are typical of deer populations that have adapted to live in poor habitats. Another prevailing phenotypic character can be identified in the persistent spotting of the summer coat, still visible in the adult individuals.

RED DEER FROM AREAS OF LOW TROPIC PRODUCTION

In the genus *Cervus* L., 1758, the reduction in size and the simplified antler architecture have often been interpreted as a consequence of prolonged isolation in restricted areas of low trophic production, combined with the effects of genetic bottlenecks (founder effect), and of a serious and

continuous consanguinity (cf. Feldhamer et al. 1985; Kaji et al. 1988; Mattioli 1993). According to Stefano Mattioli (1990, 1991a, 1991b, 2003, 2010), possibly the greatest current expert on the deer of Mesola, this population has been isolated for centuries in a restricted area of low trophic production, where it has probably been present at length with animals of reduced stature and a very simplified architecture of the stag antlers (Mattioli 1993). Deer can in fact develop extremes in phenotype depending on the availability of material resources for ontogenetic development. As explained by Geist (1987), environmental paedomorphic dwarfs are one extreme, that is efficiency phenotypes characterised by slow growth, small adult body size, low reproductive output, low behavioural vigour, and so on. These are indeed known as “maintenance phenotypes”. Mesola red deer have been defined as “maintenance dwarfs with paedomorphic antlers” (Geist 1999) and their small body size, their low sexual dimorphism and their simple antlers are thought to be related to the limited production of the coastal sub-Mediterranean woodland on sandy soil (Mattioli 1993; Mattioli et al. 2003; Ferretti, Mattioli 2012). Furthermore, Lovari and Nobili (2010) observe that, not surprisingly, this population shows an extremely reduced genetic variability, a high level of inbreeding and a very low productivity. The existence of a mitochondrial DNA genotype has been shown with a sequence significantly different from those of all other populations of red deer (Hmwe et al. 2006; Lorenzini et al. 2005), suggesting that it represents an independent unit of conservation (Moritz 1994), which merits conservation measures (Zachos, Hartl 2011; Ferretti, Mattioli 2012). Detailed analyses showed that the Mesola red deer had 35-40 calves per 100 hinds per year on average (as opposed to a usual figure of 50-70 calves), in addition to revealing slow body growth and delayed antler development, with some antlerless yearlings and subadults and with adult antlers often lacking the bez tine and the crown (Mattioli 1990, 1993; Mattioli et al. 2003; Zachos et al. 2009).

The Mesola red deer antlers are even more simplified than those of red deer from other poor habitats, such as the Sardinian maquis scrub or the highlands of Scotland (Mattioli 1993; Zachos et al. 2009). Considering only adult stags of 10

years and older, their trophy scarcely exceeds 8 tines (Mattioli 1990, 1991b, 1993). Often the bez tine and the crown are missing (Mattioli 1991b, 1993; Mattioli *et al.* 2003). Similar antler phenotypes have been observed in other deer populations which lived in poor trophic conditions, such as that which survived on the small island of Lampedusa, in the Sicilian channel (Italy), between the last years of the 18th and the first half of the 19th century (Masseti, Zava 2002a, 2002b). Analogous phenotypic patterns were also observed in the relic population of red deer that possibly still survives in the peninsula of Sithonia (Chalkidiki, Greece) (cf. Poirazidis 1987). The modest antlers of the extant Sardinian stags, *C. elaphus corsicanus* Erxleben, 1777, again rarely reach the typical structural development of the species and reveal a reduced total length, with the bez tine generally developed in a very low percentage (Cetti 1774; Dolan 1988; Vigne, Marinval-Vigne 1988; Beccu 1989; Caboni *et al.* 2006). The antlers of this subspecies are not always characterised by the absence of the crown, often displaying a tendency to produce palmation below the fork (Vigne, Marinval-Vigne 1988; Beccu 1989; Caboni *et al.* 2006). Similar morphological patterns are also characteristic of another Mediterranean population of red deer, that of the Barbary stag, *C. e. barbarus* Bennett, 1833, which is at present confined to a very restricted geographical range, in the forested area comprised within the geographical triangle bordered by the urban centers of Bone, in Algeria, and Tabarka-Ghardimaou, in Tunisia (Salez 1959; Schomber, Kock 1960; Van Dijk 1972; Dhoub 1998; Oumani *et al.* 2004; Zava, Masseti 2007). The cranial appendices of this form characteristically lack the bez tine too (Gervais 1854; Joleaud 1913, 1925; Lavauden 1924; Salez 1959). In Tunisia, studies carried out on antlers indicate that only about five per cent of the population develops a bez tine, and this may often appear only as a bump or slight projection on the beam of the antler (Meyer 1972; Dolan 1988; Oumani *et al.* 2004). The similarity of African red deer to the representatives of the species from Sardinia is shared by various authors, such as Gervais (1848), Lataste (1885), Corbet (1978), Kowalski and Rzebik-Kowalska (1991), Pitra *et al.* (2004), Groves and Grubb (2011). As observed by Lorenzini *et al.* (1998), the

Mesola red deer have undergone several severe bottlenecks, and their level of genetic diversity is even lower than that of *C. e. corsicanus* and among the lowest found in this species (Zachos, Hartl 2011). Together with the Tyrrhenian and Barbary red deer, the Mesola population boasts a unique genetic lineage, although it is not acknowledged taxonomically (Zachos, Hartl 2011).

THE RED DEER IN THE PO DELTA REGION IN HISTORIC TIMES: OSTEOLOGICAL EVIDENCE AND LITERARY REFERENCES

Acknowledgement of the survival up to today of wild game of large dimensions, such as the red deer in the Mesola wood, raises serious questions about the origins of the present-day mammalian fauna of this area and of the entire Po delta.

Indeed, not many osteological remains and literary data on the diffusion of red deer are available in the territory of this part of north-eastern Italy, from prehistoric times to the Middle Ages. The occurrence of the cervid has, nevertheless, been reported from the Neolithic levels of the modern town of Riccione (Emilia Romagna) (Riedel 1991). For later chronologies, it was also possible to record the presence of the species in the territory of Ferrara during the Bronze Age (Farello 1995), at Spina (Ferrara) in the Etruscan period (Riedel 1978), in the southern Po delta at Ravenna in the course of the 3rd century AD (Lorenzini *et al.* 2005), at Venice between the 6th and the 9th century (Riedel, 1991), and on the island of Torcello, in the Venice lagoon, in the middle to late Middle Ages (Riedel, 1979). Referred, instead, to earlier chronologies is an antler on display at the Museo Civico di Storia Naturale (Municipal Museum of Natural History) of Ferrara, which was yielded by the archaeological exploration of the site of Valle Trebba, near the town of Comacchio (Ferrara) (Fig. 2). This is a very old specimen and the museum label indicates it as “Corno di cervus antiquus (elaphus) trovato scavando il terreno della Valle Trebba (Comacchio) dove si rinvennero anche numerosi ceppi di roveri, e nei pressi, il sepolcreto di Spina – Pleistocene superiore” (= “Antler of cervus antiquus (elaphus) found together with numerous oak stumps, and in the vicinity of the necropolis of Spina - Upper Pleistocene”) (Fig. 3). In the case of this antler too, one can note the extreme

simplification of the architecture, lacking the bez tine and, in its distal portion, the crown. Moreover, the total length is slightly inferior to the largest antler recorded for the Mesola deer (cf. Mattioli 1990, 1991b, 2003). The length of the Valle Trebba beam is 91 cm, whereas the longest Mesola beam is about cm 95 (Tab. 1). The length of the Valle Trebba trez tine is 34 cm, and the circumference of the coronet 25 cm. The circumference of the beam at the thinnest point between the brow tine and the trez tine is 16 cm, and that of thinnest point between the trez tine and its distal portion 14 cm.

The lower half of another antler was on display in a cooperative company of the Ferrara Po delta, which managed a coffee shop in a building dating to the Este period, which had been restored shortly before (Stefano Mattioli, in verbis). This was Torre Abbà, a

construction built at the end of one of the drainage channels during the reclamations carried out in the 16th century. The antler was found in the 1950s by a carriolante, that is a wheelbarrow man, during the works for clearance of an area located to the west of the assumed coastline Roman times. The beam was of medium size, slightly larger in comparison to the best extant Mesola antlers, with a coronet of 21 cm in circumference. This did not appear exceptional, since in the inland plains of the Po valley the environmental conditions must have been similar to those in modern-day Slavonia, between Croatia and Hungary, where red deer end to flourish (Stefano Mattioli, in litteris). We know that later the Torre Abba specimen was painted using boat paint before, unfortunately, being definitively lost.

In any case, at the end of the 16th century red deer has almost completely disappeared from the entire inner Po valley, surviving in only four forested areas along the north-western Adriatic coast, from the Po delta southwards to the environs of the present-day town of Cervia: the pine woods of Ravenna; the “Bosco Eliceo”, near the present settlement of San Giuseppe; the forest of the abbey of Pomposa; and the wood of the Este castle of Mesola (Alfieri 1970; Cencini 1979; Mattioli 1990, 2010; Lorenzini et al. 2005; Mattioli, Mauri 2010).

In the course of 150 years, three of these areas were partially or completely deforested and all their deer were eliminated. Only part of the forest of the abbey of Pomposa, later known as the “Mesola wood”, succeeded in saving itself, together with its deer, from the attacks of mankind, thanks to the protection offered by the extensive malarial wetland which surrounded it. A number of impressive hydraulic works carried out by the neighbouring Republic of Venice to save the Venetian lagoon from progressive silting undermined the entire Este reclamation system, leading to the formation of vast flooded areas, known as *valli*, throughout the area of the delta (Mattioli, Mauri 2010). It was indeed these malarial swamps and the sea that in the end came to represent a band of partial protection for deer of the ancient forest, while in the rest of the peninsula deer became increasingly rare, taking refuge in just a few mountainous areas. From 1758 to 1784, the Mesola wood belonged to the House of Hapsburg and then passed into the hands of the Papal State, which in 1815 transferred it to the Istituto di Santo Spirito of Rome. In 1919, it was purchased by the Società delle Bonifiche Ferraresi and managed as a game reserve



Figure 2. Red deer antler on display at the Museo Civico di Storia Naturale (Municipal Museum of Natural History) of Ferrara, provided by the archaeological exploration of the site of Valle Trebba, near the town of Comacchio (Ferrara) (photo by Stefano Mazzotti, courtesy Museo di Storia Naturale di Ferrara).

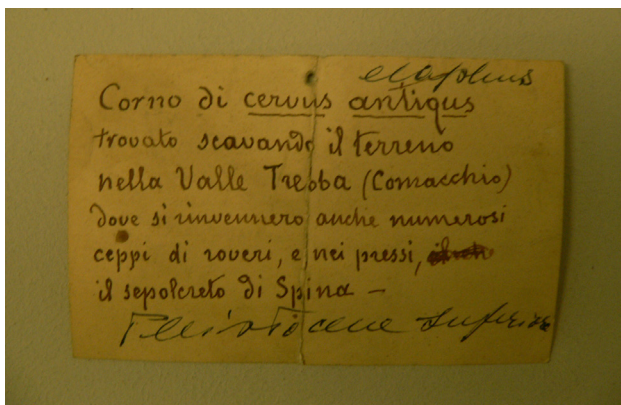


Figure 3. The antler of the Museo Civico di Storia Naturale of Ferrara is a very old specimen and its label indicates it as “Antler of *cervus antiquus* (elaphus) found along with numerous oak stumps, and in the vicinity of the necropolis of Spina - Upper Pleistocene” (photo by Stefano Mazzotti, courtesy Museo di Storia Naturale di Ferrara).

	Antler length	Number of tines	References
West European red deer	80-105 cm	10-14 per antler pair	Whitehead 1993; Mazzarone, Mattioli 1996; Geist 1999; Mattioli 2003
Mesola red deer	65-70 cm	4-6 per antler pair	Mattioli 1990, 1991b, 1993, 2003
Valle Trebba antler	90 cm	5 per beam	present work

Table 1. Comparison between the antler lengths and the number of tines of the Valle Trebba specimen, the Mesola red deer and the mean of the West European populations of *C. elaphus*. Only adult stags (5 years and older) have been considered.

up to the Second World War (Mattioli, Mauri 2010). The last years of the conflict and the immediate post-war years, came close to being fatal for the Mesola red deer, which were apparently reduced to around a dozen individuals (Mattioli 1990). In the year 1954, the Mesola wood was purchased by the Corpo Forestale dello Stato (Italian State Forestry Department), which undertook a vast operation of environmental reconstruction (Mattioli, Mauri 2010).

In the light of all this, the population of Mesola is regarded as the only surviving stock of the autochthonous red deer in the entire Italian peninsula. Nevertheless, there are some problems in this regard. Indeed, certain evidence on the historic distribution of the species points to a different situation. There is some doubt regarding the fact that the local deer is an element native to the area, since the Mesola wood developed between the 13th and 17th century AD, confirming its origin not prior this time above the sand dunes which developed parallel to the Adriatic coast (Costantini 1907; Alfieri 1970; Bondesan 1990; Mantovani 1993; Barberini 2006). The red deer might have been introduced from outside after the formation of the dunes, even in recent historical times. It is also possible that a natural distributional expansion eastwards of the species took place, progressively colonizing the new coastlines from the inland areas of the Ferrara plain. As already mentioned, when the project was abandoned, Mesola fell into decline and the famous curtain walls were pulled down from on 1598, the material being used to build other structures (Costantini 1907; Longhi 1968) In the *Annali manoscritti di Ferrara* (Biblioteca Comunale Ariostea, BCAFÉ), Filippo Rodi (16th - 17th century) makes an explicit connection between the extinction of the red deer in the wood of the Mesola castle and the death of Alfonso II Este (Ferrara, October 27th, 1597). Subsequently, other authors, such as the geographer Alberto Penna (1658), described the abundance of wild boars and roe deer in the bush of several parts of the Polesine of Ferrara, albeit without making any mention of red deer.

CONCLUDING REMARKS

In actual fact, among all the red deer populations studied by Hajji *et al.* (2008), the one of Mesola reveals values least distant from that of the other historic Italian stock, the Corsican red deer, yielding allele frequencies that are more similar to those of *C. e. corsicanus* than are those of the red deer of North Africa. In effect, the genetic diversity of the Mesola deer is very low compared to the rest of Europe (observed and expected heterozygosity 0.50 and 0.61, respectively), and an overall excess of homozygosity is indicative of inbreeding (Zachos *et al.* 2009). Nevertheless, in view of the historic vicissitudes suffered, even recently, by the district of Mesola, it should be noted that the local population of red deer suffered a severe bottleneck in the recent past (Hmwe *et al.* 2006). Furthermore, Valerius Geist (1999) is of the opinion that these deer are "... despite their current uniqueness, classical west European deer in social characteristics". Moreover, as observed by Lorenzini *et al.* (2005), the exclusive haplotype found in this population appears to be an offshoot of one of the two main Alpine lineages, although their mean genetic distance is only slightly lower than those between the Mesola haplotype and the second Alpine lineage or the Sardinian lineage. Furthermore, according to Zachos and Hartl (2011), nuclear DNA links the Mesola deer to the Tyrrhenian red deer, *C. elaphus corsicanus*. It seems most probable that Italian mainland red deer were introduced to Sardinia and Corsica from where, later, red deer were introduced to North Africa (Hmwe *et al.* 2006; Hajji *et al.* 2008).

The red deer of both Mesola and Sardinia have been regarded at length as the only surviving populations in Italy, and among the few in Europe (Adrian M. Lister, pers. comm., in Lorenzini *et al.* 2005), which were never subjected to "blood-stock" improving procedures or restocked with foreign individuals. Nevertheless, we have to bear in mind the possibility that restocking may have occurred, even in very recent times and that the population ran a strong

risk of losing its purity, although fortunately this does not appear to have happened. To take an emblematic example, we can mention the notice of the transfer, on 20th June 1890, of seven wapitis, *Cervus canadensis* Erxleben, 1777 (two males and five hinds), from the then Royal Estate of Castelporziano (Rome) to the Società della Bandita della Mesola, as indicated in a document still conserved at the Archivio Centrale di Stato in Rome (ASR, 4-4 1924), and cited by Masseti (2003). In this document, entitled “*Regie caccie. Notizie sulle antilopi ed altri animali - provenienti dalla R. Mandria [a hunting preserve in the vicinity of Turin, nda] e dal soppresso Giardino Zoologico di Monza. Sulle Antilopi di Castelporziano*”, dated September 8th, 1924, mention is made of the transfer of these wapitis, while another individual in the group had to be killed because it had broken its leg. This is, nevertheless, purely a reference to the shipment to Mesola of a contingent of deer. Whether the animals actually arrived has yet to be demonstrated. Indeed this event is not confirmed in the monograph by Costantini (1907) dealing with this game reserve of the Po delta. Moreover, we might also note that American wapitis have been recognised as principally responsible for the diffusion in Italy of the liver parasite *Fascioloides magna* (Bassi 1875), which arrived at the royal game reserve of La Mandria, near Torino, together with some representatives of this subspecies of *C. elaphus*, and caused considerable health problems there (see Comba 1872). It would therefore seem rather strange that the literature available does not document any evidence of endoparasitism of this type in the Mesola area. The local deer have been the subject of numerous health analyses carried out by the Istituto Zooprofilattico di Teramo especially between 1994 and 1999, but no blood parasite was ever found (Masetti, 2003). Furthermore, no trace of wapiti DNA has ever been found in the genetics of the Mesola deer.

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