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On the coloration of the wild rabbit, *Oryctolagus cuniculus* (Linnaeus, 1758) (Mammalia Leporidae), in the Maltese Archipelago

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ABSTRACT Although most non-scientific literature listing wild rabbit, *Oryctolagus cuniculus* (Linnaeus, 1758) (Mammalia Leporidae), in the Maltese islands mentions the occurrence of two colour morphs in the Maltese islands, an attempt at describing in scientific detail such coloration has never been made. Wild rabbits in the Maltese islands occur in two dominant morphs; the grey agouti and the yellow morph. In this article, a detailed description of each variation was given with regards to 'dorsum', 'flanks', 'nape', and 'ventrum', as well as the specific descriptions of 'head', 'tail', and 'ear tip'. Hair colour bands for both morphs are also given. Predation and camouflage are explored as the major driving force behind the high level of occurrence of the wild rabbit *Oryctolagus cuniculus* sporting the yellow morph. This when compared to other countries.

KEY WORDS *Oryctolagus cuniculus*; Malta; colouration; lagomorph; morphology.

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INTRODUCTION

The European wild rabbit *Oryctolagus cuniculus* (Linnaeus, 1758) (Mammalia Leporidae) is described as an animal with a coat of greyish-brown agouti coloration.

Toschi (1965) gives a detailed description of the coloration and coat of the European wild rabbit and he states that the typical greyish-brown coloration is due to a series of bands of colour found on every single hair. He identifies 5 such colour bands on hairs taken from the dorsal part of the coat. The colours described are as follows, starting from the base; light grey, reddish-brown, greyish-black, creamy-yellow and black.

A similar description is given by Schilling & Singer (1986) and Sarà (1998).

Haltenorth & Diller (1988) describe *O. cuniculus* as having "*thick and woolly pelage*". They describe the colour as greyish-brown on the upperside with the flanks being lighter, a rusty-red nape patch, underside (throat to tail) pale grey to white, ear upper edge and upper side of tail, black.

Furthermore, they present (Haltenorth & Diller, 1988) a list of noted variations. Colour variations listed are; white, yellowish, foxy red, bluish-grey, black. Sarà (1998) notes that some of the southern populations from the Mediterranean area tend to have a lighter coat.

Coat coloration in lagomorphs was very specifically also discussed and analysed by Stoner et al. (2003). In their study regarding the adaptive significance of coloration in lagomorphs, they analysed pelage coloration in relation to habitat type,

geographical region, altitude, and behaviour. Apart from the overall coloration, they investigated the significance of tail and ear tip coloration.

Stoner et al. (2003) presented a very detailed table listing variables for the Leporidae and Ochotonidae species. Each species was described with regards to particular variables. The physiological traits described were; dark/light overall coloration, red/grey overall coloration, and white in winter, white ventral coloration, dark/white ear tips, dark/white tail. They also included ecological traits (habitats: woodland, grassland/scrubland, rocky, swamp, desert, tundra) and habitual traits (diurnal, crepuscular, nocturnal, burrow use, and social). Information about the coloration and behavioural ecology of each species was collected from an extensive range of literature.

After condensing the data collected, Stoner et al. (2003) described *O. cuniculus* as having grey overall coloration, a white ventrum, dark ear tips, and a dark and white tail. As for the habitat, they described it as an inhabitant of grassland, scrubland and rocky environments. Also, it was found to occur in arctic, subarctic, subtropic and tropic climates. Behaviour-wise, the European rabbit was found to have crepuscular and nocturnal tendencies, to live in burrows and to be a social animal.

A mention of a variation in colour in Maltese *O. cuniculus* was presented by Adams (1870), that listed the rabbit as one of the few indigenous quadrupeds living on these Islands. He states (Adams, 1870) that "[*the rabbit*] i*s seemingly a variety with a sparser fur, and lighter brown shades on the upper parts than the rabbit of Northern Europe*". However this description is very broad and leaves a lot of room for discussion.

It is unclear when the *O. cuniculus* first occurred in Malta. Remains identified as appertaining to *O. cuniculus* were excavated in only one site on the island of Malta, at Ghar Dalam (Despott, 1923). These remains were found in superficial sediments associated with bones of domestic animals such as sheep, pigs, and goats (Pleistocene period) (Boessneck & Kuver, 1970). Remains found could not be identified as coming from wild or domesticated, however this indicates that rabbits have inhabited Malta, at least, since Malta was inhabited by the first people (circa 5000 BC).

The hypothesis presented in most literature is that *O. cuniculus* is not native to the Maltese islands and it was brought here by man in ancient times, with the present wild rabbit being the descendant of the domesticated rabbits which have been released or which managed to escape (Baldacchino et al., 1990.)

Although the wild rabbit is the largest land mammal in the Maltese islands, practically no studies on the Maltese *O. cuniculus* have been conducted, except for a study which was aimed at establishing the average craniometric data for the islands of Malta and Comino (Falzon, personal data).

Reference to the Maltese wild rabbit has been made in many local publications (French Angas, 1842; Baldacchino & Schembri, 2002). Morphological data present in such literature was always adopted from European references (Miller, 1912; Van Den Brink, 1967; Harrison Matthews, 1968; Savona Ventura, 1982; Biju-Duval et al., 1991; Macdonald, & Barrett, 1993; Sarà, 1998; Branco et al., 2000; Smith & Boyer, 2008).

One feature which stands out prominently when studying the Maltese *O. cuniculus* population is that although the local population of rabbits consists of the grey agouti morph commonly described in literature, in Malta one can observe quite frequently the occurrence of yellowish rabbits, or "*fenek ahmar/isfar*" as called by the locals.

The aim of this study is to give a detailed description of the two common colour varieties of *O. cuniculus* occurring on the Maltese islands.

MATERIAL AND METHODS

Data collection

Data concerning coloration, distribution and occurrence has been directly collected by the author, and also through various cited sources. All the analysed samples were collected under license.

Coloration description

Specimens of *Oryctolagus cuniculus* was described as grey agouti or yellow based on their general appearance. Description of each variation was then given with regards to 'dorsum', 'flanks', 'nape', and 'ventrum'. Specific descriptions of 'head', 'tail', and 'ear tip' was also given. Ear tip

coloration was categorised as either dark or white. Dark includes black tips, dark brown tips, and tips which are darker than the rest of the ears, while white tips includes tips which are not pure white, but evidently lighter than the ears. Tails description was given for the upper part as the lower part was included with the ventrum.

An attempt was also made to describe the colour bands on hairs taken from the dorsal part of the coat for both morphs.

RESULTS

The Tables 1 and 2 describe the overall appearance, in terms of coloration, of the grey agouti and yellow morph respectively. Unfortunately, there is no standardised methodology for defining colouration in mammals.

Grey Agouti Morph (Figure 1) hair colour bands are as follows starting from the base: Light Grey, Fawn, Brown Black, Creamy Yellow, Black Tip.

Yellow Morph (Figure 2) hair colour bands are as follows starting from the base: Pale Fawn, Fawn, Sandy, Sandy Brown, Fawn Tip.

DISCUSSION AND CONCLUSIONS

Records of yellow morph rabbits have been recorded in most places around Malta, as well as on the neighbouring island of Gozo. The colony on Comino consists entirely of yellow morph rabbits.

From field observations, one can deduce that it's possible to find rabbits of both colours originating from the same rabbit colonies.

We have observed both yellow and grey colour morphs living in the same colony of rabbits, and informants have reported finding nests of kits comprised of different colours. In March 2012 (at Wardija) and June 2014 (at Mosta), specimens of both colours where observed feeding together in close proximity and interacting; nuzzling and grooming. During observations of March 2012, a colony of *O. cuniculus* of the grey morph, a kit of the much lighter yellow morph, appeared in the field with the other rabbits. It is very probable that all rabbits observed co-habit the same burrow. The rabbits observed in June 2014 were mature adults. The observations mentioned were made in two very distinct locations in Malta. Sometimes, Maltese hunters, especially with regards to coloration, say (vernacular speech), "*dik il-bejta taghmel sofor/homor*" which literally translates to: "*that nest produces yellow/red rabbits*".

The prime factor which could be responsible for the light colour adaptation is predation, and the deriving need for concealment.

Oryctolagus cuniculus has a very important role in the ecosystem, as it is one of the main prey animals. Predatorial pressure in the Maltese islands comes from the Least Weasel *Mustela nivalis* (Linnaeus, 1766), Cat Snake *Telescopus fallax fallax* (Fleischmann, 1831), Leopard Snake *Elaphe situla*

PART OF BODY	COLOURATION
DORSUM	REDDISH-GREY GRIZZLED WITH BLACK
FLANKS	PALE REDDISH GREY TO GREY
NAPE	RUSTY RED
VENTRUM - THROAT TO TAIL	PALE GREY TO WHITE
HEAD	PALE REDDISH GREY WITH PALE/WHITE EYE CIRCLES AND REDDISH NOSE
UPPER PART OF TAIL	BLACK
EAR TIP	DARK

Table 1. Overall Coloration in the grey morph of *Oryctolagus cuniculus*.

PART OF BODY	COLOURATION
DORSUM	SANDY
FLANKS	FAWN
NAPE	DARK SANDY
VENTRUM - THROAT TO TAIL	PALE GREY TO WHITE
HEAD	SANDY WITH FAWN MARKINGS WITH PALE/WHITE EYE CIRCLES AND DARK SANDY NOSE
UPPER PART OF TAIL	FAWN
EAR TIP	WHITE

Table 2. Overall Coloration in the yellow morph of *Oryctolagus cuniculus*.

Figure 1. Grey agouti morph of *Oryctolagus cuniculus*.

Figure 2. Yellow agouti morph of *Oryctolagus cuniculus*.

leopardina (Linnaeus, 1758), Black Whip Snake *Coluber viridiflavus carbonarius* (Lacépède, 1789), Algerian Whip Snake *Coluber florulentus algirus* (Jan, 1863) as well as the Black Rat *Rattus rattus* (Linnaeus, 1758) and the Brown Rat *Rattus norvegicus* (Berkenhout, 1769).

Populations of feral cats and dogs, as we observed, may also have an impact on the Maltese population of *O. cuniculus*, and human activity should also be taken too into consideration (Baldacchino et al., 1990), especially for hunting with nets, ferrets and dogs. In his book about the traditional Maltese rabbit dish, il-Fenkata, Cassar (1994) makes a reference to a report given by Mgr. Visconti's secretary (1582) on the fertility of Gozo, who states that the land is "*fertile abbondante e copiosa, non solo delle cose necessarie al vitto, ma di molte delizie ancora, perche abbonda di conigli, di lepri, di uccelli e di miele*".

French Angas (1842) recounts how maltese rabbits offered sport to the Governor and his officers. Also Luke (1963), quotes a seventeenth century Frenchman who appreciatively notes that rabbits and other game caught in Malta is fatter than their counterparts in Europe.

The previously quoted Leith Adams (1870) notes that; "*although there is every facility for rabbits to increase, especially among the rocky parts along the southern coasts, they are not plentiful, perhaps for the reason that they have formidable enemies in man and the weasel*".

All this reiterates why predation can be considered as one of the factors, if not the only, for the paler morph to emerge and thrive as a concealment technique (adaptive crypsis)

Stoner et al. (2003) confirmed that there is a correlation between lagomorphs living in open habitats, such as deserts and barren lands, and pale body coloration. Evidence also suggested that there is an association between red and grey coloration with rocky habitats.

Adaptation of colour morphs and variation of coat colour on the basis of habitat coloration was observed in different species, see, for example, Majerus & Mundy (2003) for the adaptive coloration in *Chaetodipus intermedius* (Merriam, 1889) from Valley of Fire, New Mexico, and also cited references (Cott, 1940; Foster, 1964; Lockley, 1980; Jaksic & Scoriguer, 1981; Monnerot et al., 1994; Caro, 2005; Millien, 2006; Van der Geer et al., 2010).

Perhaps the small size of the Maltese islands and the lack of habitat boundaries prevented total adaptation from occurring. On the other hand, this interbreeding amongst colonies could possibly be an advantage, as it keeps the rabbit always ready for change and adaptation, if need arises. Or perhaps, the selective pressure is not enough to totally phase out the disadvantaged coloured rabbits.

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