UNIVERSITY OF CRETE

BIOLOGY DEPARTMENT

POSTGRADUATE PROGRAMME

"MANAGEMENT OF MARINE AND LAND-LIVING RESOURCES"

DISTRIBUTION, ACTIVITY, MORPHOLOGICAL AND MORPHOMETRICAL CHARACTERS OF *Erinaceus concolor nesiotes*, *Mustela nivalis galinthias*, *Martes foina bunites*, *Meles meles arcalus*, *Felis silvestris cretensis* IN CRETE

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M.Sc.Thesis

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Examining Committee

Assoc. Professor Mylonas M.

Professor Eleftheriou A.

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ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ

ΤΜΗΜΑ ΒΙΟΛΟΓΙΑΣ

ΠΡΟΓΡΑΜΜΑ ΜΕΤΑΠΤΥΧΙΑΚΩΝ ΣΠΟΥΔΩΝ
"ΔΙΑΧΕΙΡΙΣΗ ΘΑΛΑΣΣΙΩΝ ΚΑΙ ΧΕΡΣΑΙΩΝ ΒΙΟΛΟΓΙΚΩΝ ΠΟΡΩΝ"

ΚΑΤΑΝΟΜΗ, ΔΡΑΣΤΗΡΙΟΤΗΤΑ, ΜΟΡΦΟΛΟΓΙΚΟΙ ΚΑΙ ΜΟΡΦΟΜΕΤΡΙΚΟΙ ΧΑΡΑΚΤΗΡΕΣ ΤΩΝ ΘΗΛΑΣΤΙΚΩΝ *Erinaceus concolor nesiotes*, *Mustela nivalis galinthias*, *Martes foina bunites*, *Meles meles arcalus*, *Felis silvestris cretensis* ΣΤΗΝ ΚΡΗΤΗ

Alessandra Belardinelli
Μεταπτυχιακή Διατριβή

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ΗΡΑΚΛΕΙΟ

2001

CONTENTS

PREFACE

The present research is included in the postgraduate programme "ΔΙΑΧΕΙΡΙΣΗ ΘΑΛΑΣΣΙΩΝ ΚΑΙ ΧΕΡΣΑΙΩΝ ΒΙΟΛΟΓΙΚΩΝ ΠΟΡΩΝ" (Management of marine and land-living resources), financed by Ε.Π.Ε.Α.Ε.Κ. of the Biology Department of the University of Crete. The research has been carried out at the Natural History Museum of Crete, under the supervision of Assoc. Professor M. Mylonas. The second examiner of this study is Professor A. Eleftheriou.

This research project began in October 1999 with the aim to investigate the presence, distribution, systematic status and ecology of the Cretan carnivores (the weasel, beech marten, badger and the wildcat) and the Cretan hedgehog. Since a relatively new method of research, the phototrap, is used, a trial period for testing the traps was necessary and many modifications to the first model were made during the course of the survey. The species measurements taken from dead animals were possible thanks to the Natural History Museum's extensive collection and all the addition animals analysed have been deposited there. The literature referenced throughout the presented thesis was obtained from the Museum's library.

This research would not have been possible if it were not for considerable help from all the members of the Natural History Museum of Crete and many of the staff at the University of Crete. First and foremost is Professor M. Mylonas, whose experience and knowledge was a constant source of assistance and inspiration, and whose valuable comments helped shape this work. Many thanks are also owed to Professor A. Eleftheriou as the second supervisor for reading and assessing this master thesis. I am especially grateful to the Institute of Zoology of the University of Perugia, and particularly to the Professor B. Ragni who first introduced me to Crete and as a world expert of wild cats also provided a great deal of help.

During the course of this project I have been very fortunate in having had the help and the support of friends and colleagues of the Natural History Museum of Crete. Special thanks are due to Mr. P. Lymberakis for his scientific support, his useful ideas and continuous assistance throughout my entire master project. Thanks to Mr. M. Papadimitrakis who was invaluable in the field and for his help in the lab. The technical assistance of Mr. I. Nikoloudakis, without his knowledge of electronics and cameras this project would not have taken place. To Mr. S. Roberts for his support, ideas, help in the field and English corrections. To Mr. M. Nikolakakis, Mr. N. Poulakakis and Mr. G. Gonianakis for their help in assessing some of the maps present in this work. Dr. A. Trichas should also be thanked for photographic advice and tuition. I would also like to thank E. Sarropoulou and Mr. V. Paravas for translating articles from German. Many thanks to Miss A. Kaliontzopoulou and Mr. A. Parmakelis for their help in statistical analyses. Last but in no way least are the other co-workers in the vertebrate lab, Miss M. Ivovic who also helped measure some of the animals, Miss G. Mantziou, who also translated the summary in greek, Miss G. Manthalou, Mr. G. Theologidis and Mr. P. Giorgiakakis for their stimulating scientific discussion.

Finally thanks to my friends and colleagues P. Cicconi, who first worked with me on the Cretan Wildcat in 1996 and A. Sforzi, director of the Natural History Museum of Grosseto. Obviously many thanks to my mother and father for their continuous and fundamental presence.

INTRODUCTION

The Cretan species studied in this research (*Mustela nivalis galinthias, Martes foina bunites, Meles meles arcalus, Felis silvestris cretensis, Erinaceus concolor nesiotes*) are considered as subspecies by various authors who classified and described them at the beginning of the 19^{th} century, often only using a few specimens, and occasionally of uncertain origin. Raulin (1869) published the first list of the mammals of Crete and he was also the first to report the presence of the wildcat in Crete. The second list of the Cretan mammals was presented by Bate (1905). Many studies carried out in Crete regarding these species are outdated and partial so one of the main aims of this research is to discuss and reassess the presence, distribution and taxonomical status of these animals in light of recent information and new data obtained. The hedgehog was included in this study because there were limited data on its distribution and having a niche comparable to that of the small carnivores, the methods used provided data for this species as well.

Understanding the distribution, population status, and habits of these animals is more important today than it has ever been, mostly due to ever-increasing land usage that encroaches on their natural habitats. A study about the carnivore's status in an area assumes a very important ecological and conservational role because carnivores, as keystone species, influence the environmental structure of an ecosystem and reflect the strength of the trophic levels on which they depend. The integrity of an ecosystem may be measured by the health of its vertebrate carnivore populations (Kucera *et al.*, 1996).

Moreover, Crete has an important biogeographical role in the eastern Mediterranean basin because it is at a crucial point juxtaposition with Europe, Africa and Asia. The relationships between the Cretan populations and others on continental Greece and other Mediterranean countries is another extensive topic like how, when and from where did these animals arrive in Crete. Finally Crete, as most islands, presents peculiar forms that are different from the corresponding continental species.

In these contexts, the importance of extensive further research becomes only too apparent. With the appropriate facilities and within a timescale beyond the confines of this research a much more complete picture could be developed, as is discussed in the following sections.

CHAPTER 1

INTRODUCTION

1.1. THE ISLAND OF CRETE

Crete lies on the southern edge of the Aegean Sea and with a surface area of 8,261 km^2 it is Greece's largest island. It is 250 km in length from east to west and 60 km at its widest point from north to south. The island lies between 23^0 30′ and 26^0 20′ longitude east and 34^0 51′ and 35^0 41′ latitude north. Crete's geographical position is in the centre of the oriental Mediterranean basin, only 300 km away from the north coast of Africa, 275 km from Athens and 200 km from Asia Minor (FIG. 1.1.1.).

Fig. 1.1.1. Mediterranean basin

There are three large mountain ranges on the island: Lefka Ori (the White Mountains) to the west, Dikti to the east and Psiloritis in the centre. All of them surpass 2000m above sea-level (a.s.l.) in particular Psiloritis, which is the highest, reaches an altitude of 2456 m, whereas Lefka Ori and Dikti reach 2452m and 2141m respectively.

Crete is geomorphologically characterised by the predominance of mountain elements, 65% of the land is at a height of between 100 and 800 m and 25% exceeds the altitude of 800 m, whereas only 10% is below 100 m (Zaffran, 1982).

The climate is typically Mediterranean with long, hot, dry summers and winter rain that often falls as snow in the mountains.

The Cretan vegetation is mostly characterised by Mediterranean maquis and phrygana, with scant forests in the mountains. Nowadays a smaller portion of the island is occupied by forest, due to the long human influence (agriculture, clearance for grazing, tourism, and fires).

The presence of forest with *Pinus brutia* can be observed from sea level up to 1100 m a.s.l., whereas cypress forests (*Cupressus sempervirens*) are limited to mountains at an altitude of 1000-1800 m. Oak groves of *Quercus coccifera* are found all over the island except for coastal areas while *Quercus ilex* has mostly been observed in western and central Crete (Vardinoyiannis, 1994).

Crete has a wide variety of biotopes and a long history of human influence, starting from the Neolithic period, which has had a strong impact on its environment (Sondaar *et al.*, 1998; Hamilakis, 1996; Jarman, 1996). Since then, the exploitation of the island's natural resources has continued.

Regarding the paleogeography of Crete, during the Miocene, the island was connected to mainland Greece and to Asia Minor. In the Middle of the Miocene and in the very early Pliocene, Crete was divided into several smaller islands still connected to Asia Minor (Creutzburg, 1963; Dermitzakis & Papanikolaou, 1981). From five million years ago (Pliocene), Crete, still consisted of several islands, but was no longer connected to the mainland having become isolated. It is in the Pleistocene that the island attained its present shape (Creutzburg, 1963; Dermitzakis & Papanikolaou, 1981; Sondaar *et al.*, 1996; Fassoulas, 2000). (FIG. 1.1.2.)

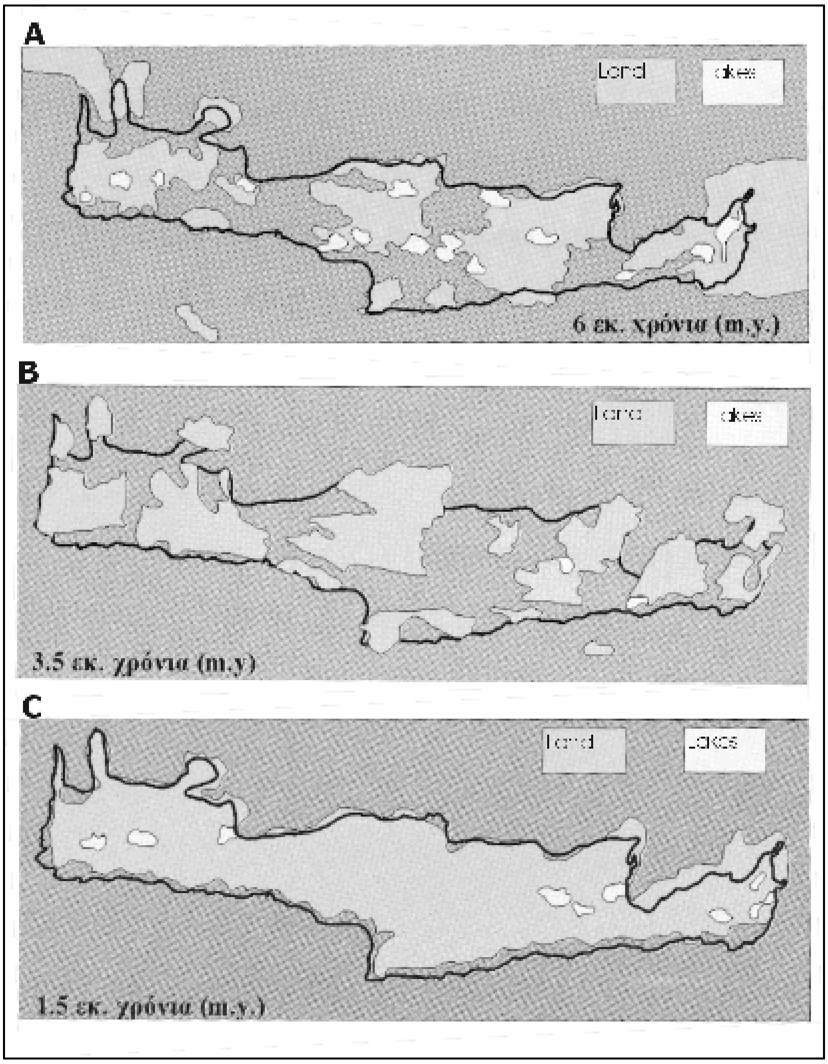


Fig. 1.1.2. Crete during (A) the Miocene (6 mya), (B) Pliocene (3.5 mya) and (C) Pleistocene (1.5 mya) (Modified from Fassoulas, 2000).

1.2. GENERAL OVERVIEW OF THE STUDIED SPECIES

Mustela nivalis (the weasel), *Martes foina* (the beech marten) and *Meles meles* (the badger) all belong to the Mustelidae, which is a large and widely distributed family present on all continents except Antarctica, Australia, Indonesia and other indo-pacific islands (Macdonald & Barrett, 1993). The representatives of this family are of medium dimensions with a slender body and relatively short legs. They have five toes per foot and are usually good climbers and diggers.

Felis silvestris (the wildcat) belongs to the Felidae family, whose wild members are found on all continents except for Australia and Antarctica (Nowell & Jackson, 1996). Cats are very good hunters and agile climbers. They are mostly solitary and nocturnal, with well-developed sense organs. According to Wozencraft (1993) felids include 36 species divided into 18 genera.

The Mustelidae and Felidae families both belong to the order Carnivora, which arose about 58 million years ago (Macdonald & Barrett, 1993). These animals distinguishing feature is the possession of carnassial teeth that are specialised to slice meat like scissors, even if not all members of this order have a totally carnivorous diet.

Erinaceous concolor (the hedgehog) belongs to the Erinaceinae subfamily in the Erinaceidae family, which is included in the order Insectivora. Insectivores originate from the mid-Cretaceous (135 mya) and are considered among the oldest surviving mammalian lineages (Savage, 1986; Macdonald & Barrett, 1993). The members of the Erinaceidae family are widespread throughout the world except for Antarctica and Australia (Macdonald & Barrett, 1993). All insectivores are small and feed mainly on invertebrates, especially insects. Hedgehogs are highly specialised having erectable spines for defence.

Of the five studied species only *Felis silvestris cretensis* and *Meles meles arcalus* are considered endangered (E) and vulnerable (V) respectively by the Greek red data book. These two species are protected by the Bern Convention.

1.2.1. The Hedgehog

CLASS **Mammalia**

ORDER **Insectivora**

FAMILY **Erinaceidae**

SUBFAMILY Erinaceinae

GENUS *Erinaceus*

SPECIES *Erinaceus concolor* Martin, 1838.

SUBSPECIES *Erinaceus concolor nesiotes* Bate, 1905

1.2.1.1. Genus *Erinaceus*

According to Hutterer (1993), the genus *Erinaceus* Linnaeus, 1758, includes three species:

- *Erinaceus amurensis* Schrenk, 1859
- *Erinaceus concolor* Martin, 1838
- *Erinaceus europaeus* Linnaeus, 1758

1.2.1.2. General distribution

According to Hutterer (1993), *Erinaceus concolor* is distributed in Eastern Europe, Southern Russia and West Siberia as far as the River Ob; Asia Minor to Israel and Iran; Greek and Adriatic islands including Crete, Corfu and Rhodes. In Asia it occurs in Israel, northern-west Iraq and northern Iran (Corbet, 1988, Mitchell-Jones *et al*., 1999).

In Europe there are two species of the Genus *Erinaceus*: the western hedgehog *Erinaceus europaeus,* which is distributed in western, central and northern Europe and the eastern hedgehog *Erinaceus concolor* which is distributed in East and Southeast Europe. The distribution ranges of *Erinaceus europaeus* and *Erinaceus concolor* overlap in central Europe (Suchentrunk *et al.,* 1998; Mitchell-Jones *et al*., 1999).

Erinaceus concolor is distributed in Europe as reported above and in particularly it occurs in Poland, the Czech Republic, Slovakia, Austria, north-eastern Italy, the Balkan Peninsula, Turkey, Southern Russia, the western side of the Caspian sea and western Siberia to the River Ob (Corbet, 1988; Giagia & Markakis, 1996; Mitchell-Jones *et al.*, 1999). It is widely distributed on Adriatic and Greek islands. (FIG. 1.2.1.).

Another species of African origin is distributed in Europe (Canary Islands, Balearic Islands, Malta and Mediterranean France and Spain). This species was variously allocated to separate genera and it is now classified as *Atelerix algirus* (Lereboullet, 1842), commonly called the Algerian hedgehog (Mitchell-Jones *et al.*, 1999).

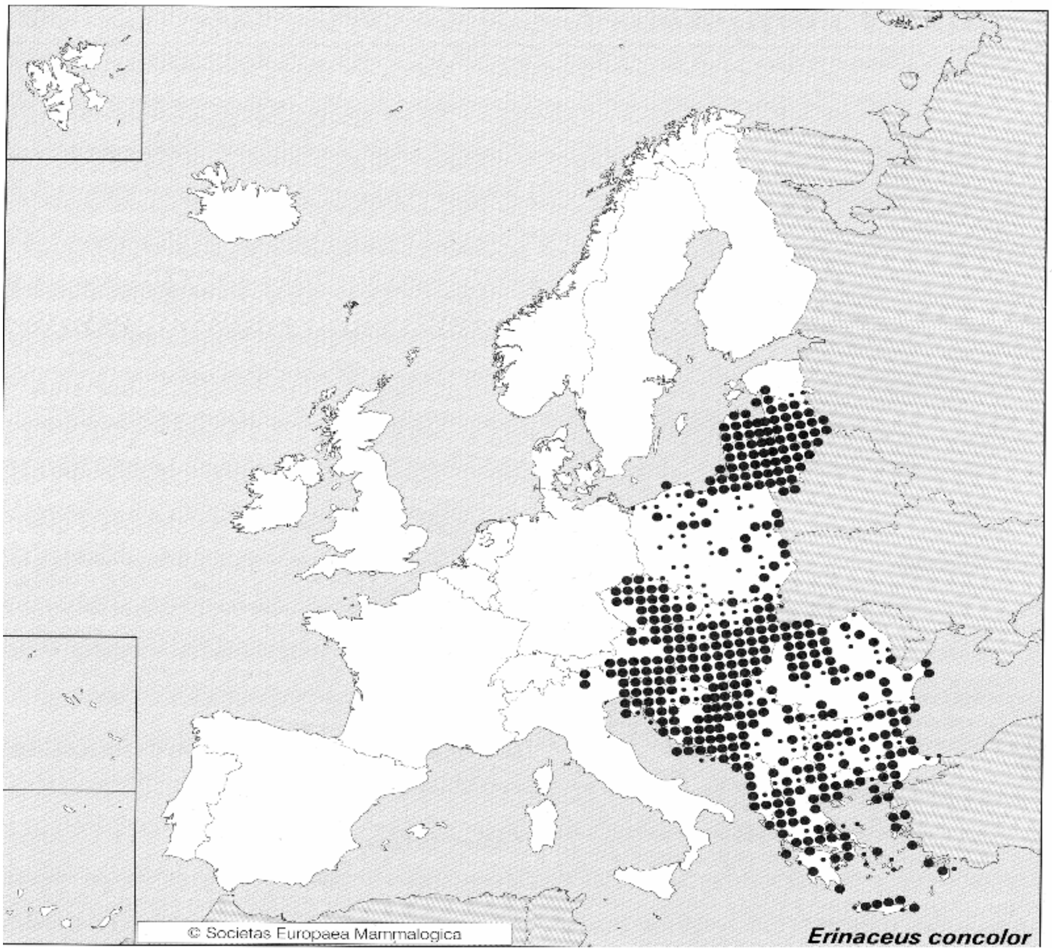
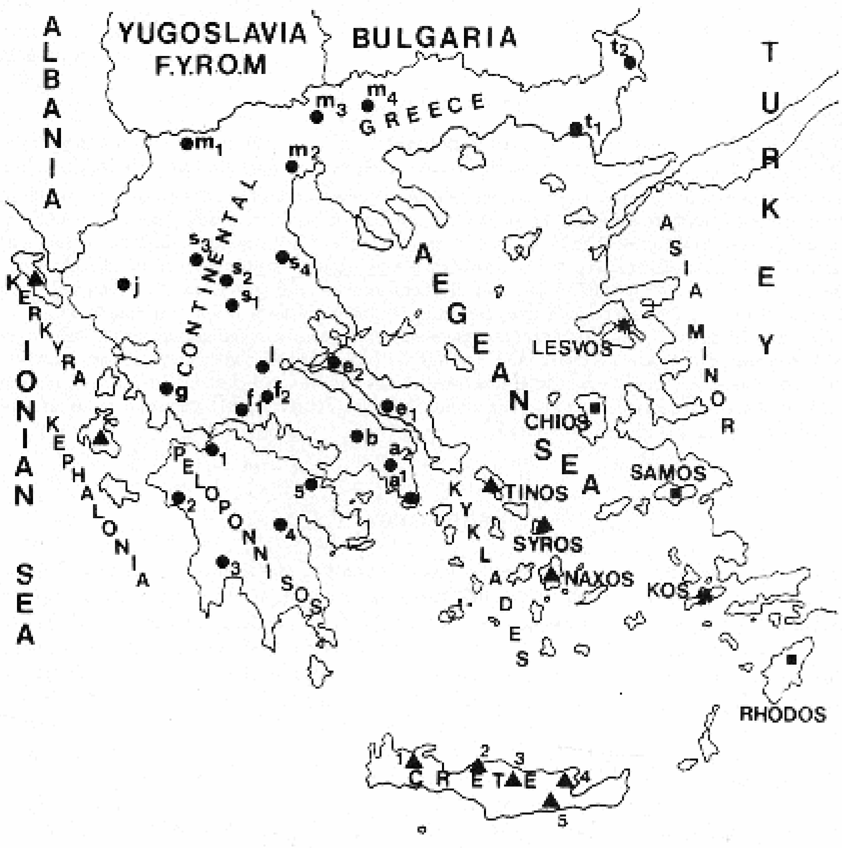


Fig.1.2.1. European distribution of *Erinaceus concolor* (Modified from Mitchell-Jones *et al.*, 1999)

1.2.1.3. Distribution in Greece

According to Giagia and Markakis (1996) four subspecies of *Erinaceus concolor* live in Greece. In the mainland *Erinaceus concolor bolkayi*, which was firstly classified as *E. c. drozdovskii*, whereas two insular subspecies of smaller body size are distributed in the Greek islands. *E. c. nesiotes* was found in Crete, Kyklades islands such as Syros, Tinos and Naxos and Ionian Islands such as Kerkyra and Kephalonia. *E. c. rhodious* (Festa, 1914) is distributed in the islands of Rhodos, Samos and Chios (FIG. 1.2.2.). The subspecies *E. c. transcaucasicus* seems to occur only in the islands of Lesvos and Kos.



• = *E. c. bolkayi*.
▲ = *E. c. nesiotes*, ■ = *E. c. rhodius*, * = *E. c. transcaucasicus*. Continental Greece: a = Attica (a_1 = Koropi, a_2 = Parnitha), b = Boiotia (Thebes), e = Evoia (e_1 = Aliveri, e_2 = Edipsos), l = Fthiotida (Lamia), f = Fokida (f_1 = Lidoriki, f_2 = Tichio), g = Aetoloakarnania (Agrinio), i = Epiros (Ioannina), s = Thessalia (s_1 = Karditsa, s_2 = Trikala, s_3 = Kalambaka, s_4 = Elassona), m = Makedonia (m_1 = Florina, m_2 = Alexandria, m_3 = Kilkis, m_4 = Serrae), t = Thrace (t_1 = Alexandroupolis, t_2 = Soufli). Peloponnisos: 1 = Kastritsi (Patra), 2 = Pyrgos, 3 = Kiparissia, 4 = Astros (Kinouria), 5 = Korinthos. Crete: 1 = Chania, 2 = Rethymno, 3 = Iraklio, 4 = Agios Nikolaos, 5 = Ierapetra.

Fig.1.2.2. Greek distribution of *Erinaceus concolor* (From Giagia & Markakis, 1996).

1.2.1.4.Taxonomic review of the Cretan Hedgehog

The species *Erinaceus concolor* includes many subspecies one of them is *Erinaceus concolor nesiotes*, the Cretan form, which was classified by Bate in 1905. The species *E. concolor* and *E. europaeus* were considered the same till karyological analyses and body and skull measurements were carried out (Giagia & Ondrias, 1980; Hutterer, 1993). This is the reason why the Cretan hedgehog was first classified as *Erinaceus europaeus nesiotes*.

Bate (1905) describes the hedgehog of Crete as *Erinaceus europaeus nesiotes*, on the basis of three specimens collected in Crete. For Bate Cretan hedgehogs are small forms, peculiar to the island. The Cretan form was found to be different from all forms of *Erinaceus europaeus* represented in the British Museum Collection (Bate, 1905), especially for its smaller size. For this reason, Bate classified the Cretan hedgehog as a subspecies. The same author also found that *Erinaceus europaeus nesiotes* seems to be more closely related to *Erinaceus europaeus italicus*, from which it can be distinguished by its smaller size, the lighter colour of its fur and for the shorter and more slender spines. Some characteristics of the skull seem to be more similar to *Erinaceus europaeus roumanicus* (Bate, 1905 & 1913).

Wettstein (1953) pointed out that the Cretan hedgehog does not have a lighter colour than *E. italicus*, and they are differentiated by only the lateral part that is paler in the Cretan form. He also stated that the ventral colour is always white.

1.2.2. The Weasel

CLASS **Mammalia**

ORDER **Carnivora**

FAMILY **Mustelidae**

SUBFAMILY **Mustelinae**

GENUS ***Mustela***

SPECIES *Mustela nivalis* Linnaeus, 1766

SUBSPECIES *Mustela nivalis galinthias* (Bate, 1905)

1.2.2.1. Genus *Mustela*

According to Wozencraft (1993), the genus *Mustela* Linnaeus, 1758, includes 16 species:

- *Mustela africana*
- *Mustela altaica*
- *Mustela erminea*
- *Mustela eversmannii*
- *Mustela felipei*
- *Mustela frenata*
- *Mustela kathiah*
- *Mustela lutreola*
- *Mustela lutreolina*
- *Mustela nigripes*
- *Mustela nivalis*
- *Mustela nudipes*
- *Mustela putorious*
- *Mustela sibirica*
- *Mustela strigidorsa*
- *Mustela vison*

1.2.2.2. General distribution

According to Wozencraft (1993), *Mustela nivalis* is distributed in the Palearctic region (except for Ireland, the Arabian Peninsula and Arctic Isles); Japan; Alaska, Canada, USA (south to Wyoming and north Carolina); and introduced to New Zeland.

In Africa *Mustela nivalis* occurs today in northern Maghreb (Morocco, Algeria and Tunisia, Kowalski & Rzebik-Kowalska, 1991). It is also present in Europe and Anatolia (Corbet, 1978; Harrison & Bates, 1991, Mcdonald & Barret, 1993). In the Levant its distribution is restricted to the northern part, including Lebanon and northern Syria (Harrison & Bates, 1991). In Israel the species does not exist, but is present in northern Egypt along the Nile delta and valley with a population characterised by large body size (Qumsiyeh, 1996). *Mustela nivalis* is distributed over the whole of Anatolia and in Turkey where they are found from the sea level to 2500 m of altitude (Kasparck, 1989).

In Europe there are two subspecies of *Mustela nivalis.* In northern Europe, the pigmy weasel (*M. n. nivalis*) is distributed in Scandinavia and Russia while in central, western and Mediterranean Europe the common weasel (*M. n. vulgaris*) is found (Macdonald & Barrett, 1993; Mitchell-Jones *et al*., 1999). The species of the Mediterranean area may constitute a third subspecies named *M. n. boccamela (*Mitchell-Jones *et al*., 1999).

The weasel is widely distributed in mainland Europe. Great Britain, many Mediterranean islands and the Azores also have weasel populations. The species is absent from Ireland and Iceland (Corbett, 1978). Within the Mediterranean basin, *Mustela nivalis* occurs in many islands: the Balearic, Corsica, Sardinia, Sicily, Malta and some Greek islands (Mitchell-Jones *et al*., 1999) (FIG. 1.2.3.).

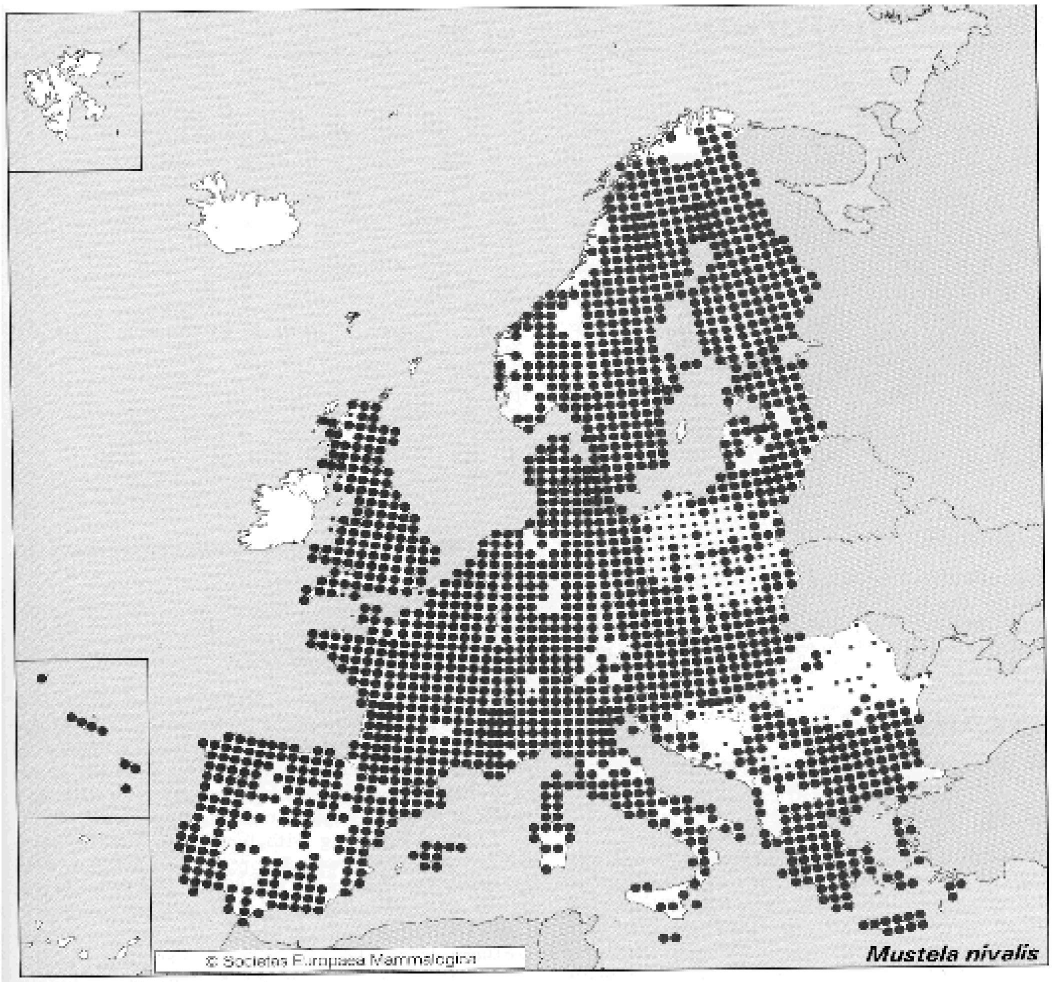


Fig.1.2.3. European distribution of *Mustela nivalis* (Modified from Mitchell-Jones *et al.*, 1999).

1.2.2.3. Distribution in Greece

Mustela nivalis is widespread throughout Greece (Ontria, 1967) and it also occurs on some islands. The species is reported to be present by Masseti (1995) on the islands of Thera, Skopelos and Crete and in the Ionian island of Corfu.

1.2.2.4. Taxonomic review of the Cretan Weasel

Mustela nivalis includes many subspecies, one of them is the Cretan weasel, which was classified by Bate in 1905. The Cretan subspecies was firstly described by Bate as *Putorius nivalis galinthias* and successively as *Mustela galinthias*, using two skins from Crete. On these two specimens no skull or body measurements were taken. Bate described an animal of larger size and with a sharp colour demarcation between the upper and lower surfaces. This distinct line of demarcation differentiates the Cretan form from *M. africana,* which is otherwise very similar (Bate, 1913). Bate also pointed out a strong similarity between the Cretan weasel and *P. n. atlas*, which is a large size weasel distributed in the Atlas Mountains of Morocco. For Bate, they share similar characters that have been independently acquired, but have different coat colours. The pale lower surface was found by Bate to be dirty white in one case and yellowish in the other.

Zimmermann (1953) describes an animal larger in size with a bigger tail and completely white on the ventral part.

1.2.3. The Beech Marten

CLASS **Mammalia**
ORDER Carnivora
FAMILY Mustelidae
SUBFAMILY **Mustelinae**
GENUS *Martes*
SPECIES *Martes foina* (Erxleben, 1777)
SUBSPECIES *Martes foina bunites* (Bate, 1905)

1.2.3.1. Genus *Martes*

According to Wozencraft (1993), the genus *Martes* Pinel, 1792, includes 8 species:

- *Martes americana*
- *Martes flavigula*

- *Martes foina*
- *Martes gwatkinsii*
- *Martes martes*
- *Martes melampus*
- *Martes pennanti*
- *Martes zibellina*

1.2.3.2. General distribution

According to Wozencraft (1993), *Martes foina* is distributed in Southern and Central Europe, through the Caucasus Mountains, to the Altai (Russia, Kazakhistan), Mongolia, and Himalayas; adjacent China. The species occurs from Europe to the south Asian steppe zone through the north side of the Caucasus, the Elburz Mountains south of the Caspian sea and the Mountains of Afghanistan to the Mountains of Tien Shan and to the Altai Mountains in the north and probably the mountains of the Chinese provinces of Shensi and Shansi to the south (Mitchell-Jones *et al*, 1999).

At present, the species is distributed throughout most of Southern Europe missing from Norway, Sweden, Finland, Great Britain and Northern Russia. The species is also absent from many Mediterranean islands such as Mallorca, Corsica, Sardinia, Sicily, Cyprus and some small Aegean islands while it is present in the islands of Corfu, Crete and Rhodes (Mitchell-Jones *et al.*, 1999) (FIG. 1.2.4.). In the Near East, its range includes in Anatolia and in the Levant region till the Dead Sea. The beech Marten is absent from southern Iran, the Arabian Peninsula and North Africa (Harrison & Bates, 1991).

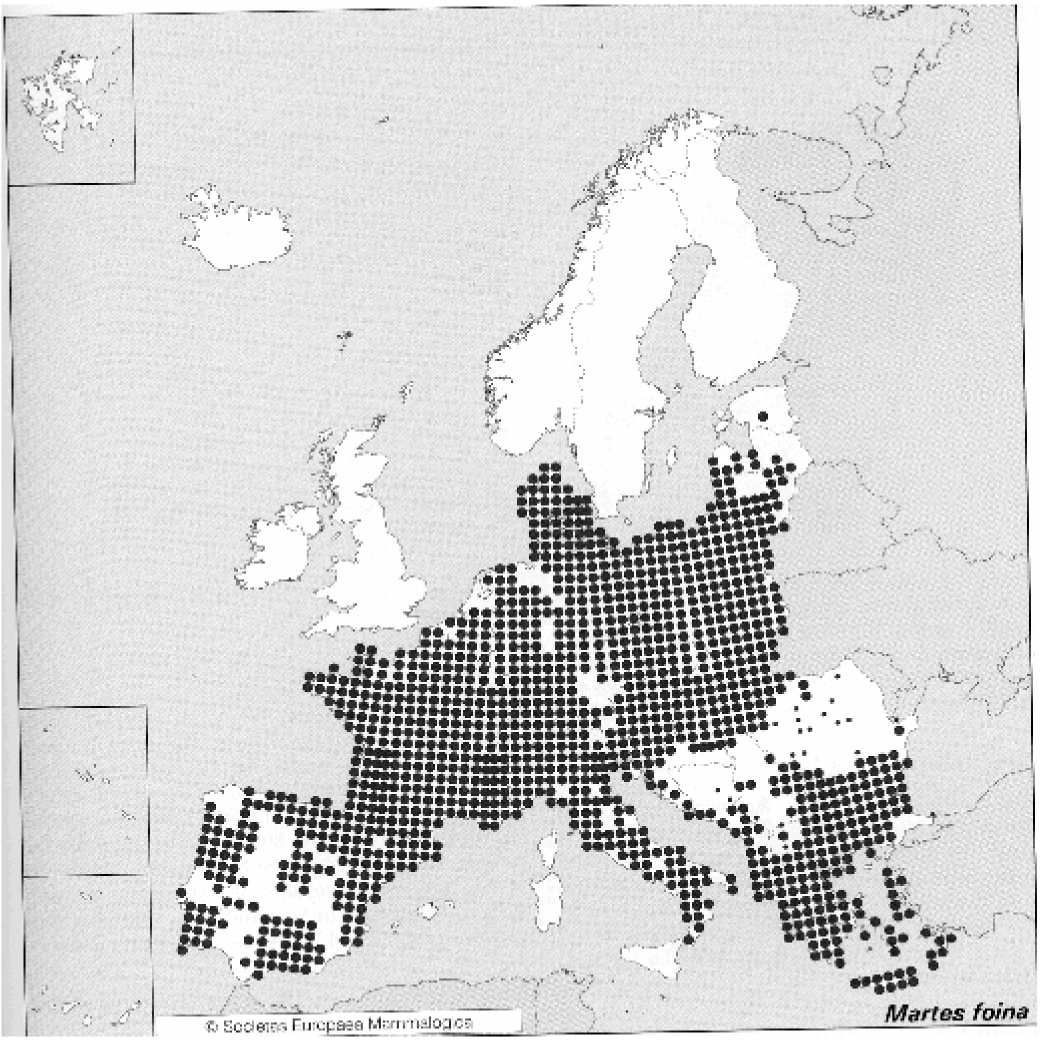


Fig.1.2.4. European distribution of *Martes foina* (Modified from Mitchell-Jones *et al.*, 1999)

1.2.3.3. Distribution in Greece

Three subspecies are reported from the eastern Mediterranean islands:

- *M.f.foina* Erxleben, 1777, recorded from the Ionian Islands as Corfu, Lefkas, Zakynthos, Ithaca and Kephalonia (Miller, 1912; Niethammer, 1962, Douma-Petridou, 1984: In Masseti, 1995/b).
- *M.f.milleri* Festa, 1914, probably confined in the island of Rhodos (Festa, 1914).
- *M.f.bunites* Bate, 1905, distributed in the island of Crete and in other Aegean islands (Barrett-Hamilton, 1899; Bate, 1905; Zimmermann, 1953; Ondrias, 1965; Corbet, 1978; Masseti, 1995/b)

In the Aegean Islands the species occurs in Evoia, Thassos, Samos, Lesvos, Chios, Ikaria, Thera, Kos, Skopelos, Alonissos, Naxos, Karphatos, Serifos and Kytnos (De Beaux, 1929; Douma-Petridou, 1984: In Masseti, 1995/a). *Martes foina* is widespread in mainland Greece.

1.2.3.4. Taxonomic review of the Cretan Beech Marten

The species *Martes foina* includes the Cretan subspecies, *Martes foina bunites* classified by Bate in 1905.

Bate (1905) initially describes the animal as a subspecies named *Mustela foina bunites*, on the basis of five skins obtained in Crete and another two already present in the collection of the British Museum. For Bate the Cretan subspecies especially differs in length, colour and also in the size and shape of the throat pattern (Bate, 1905; Bate, 1913). Successively the same author describes the Cretan marten as *Martes bunites*, smaller in size, rather light in the colour of the coat and with a small white throat pattern than those of the nominal form. In a previous study, Barrett-Hamilton (1899) described the Cretan marten as a local and peculiar form, which is indistinguishable from *Mustela foina leucolachmea*, distributed from Turkistan and Afghanistan. This great similarity was rejected by Bate, who said that the Cretan form resembles *M.f. leucolachmea* only for some characters.

The throat patch is generally indicated as greatly reduced. MacDonald & Barrett (1993) talking about the Cretan population, report the presence of a small greyish throat patch, whereas Corbet & Oveden (1985) described a reduced or even absent pattern.

Zimmermann (1953) described the Cretan beech marten as an animal smaller in size, lighter in colour and with a bushy tail. Regarding the throat patch, Zimmermann reports the presence of a small patch that can even be completely absent.

1.2.4. THE BADGER

CLASS **Mammalia**

ORDER Carnivora

FAMILY Mustelidae

SUBFAMILY **Melinae**

GENUS *Meles*

SPECIES *Meles meles* Linnaeus, 1758

SUBSPECIES *Meles meles arcalus* Miller, 1907

1.2.4.1. Genus *Meles*

According to Wozencraft (1993), the genus *Meles* Boddaert, 1785, includes one species:

- *Meles meles*

1.2.4.2. General distribution

According to Wozencraft (1993), *Meles meles* is distributed in the palearctic region from Scandinavia to south Siberia and south to Israel; Iraq; China, Korea and Japan; Ireland, Britain, Crete and Rhodes. *Meles meles* is widespread and common throughout mainland Europe, while it is absent from some large Mediterranean islands such as Sardinia, Sicily, Corsica, Cyprus and the Balearic (Mitchell-Jones, 1999) (FIG. 1.2.5.). Badgers also occur in Anatolia and Levant (Corbet, 1978; Harrison & Bates, 1991; Mcdonald & Barret, 1993).

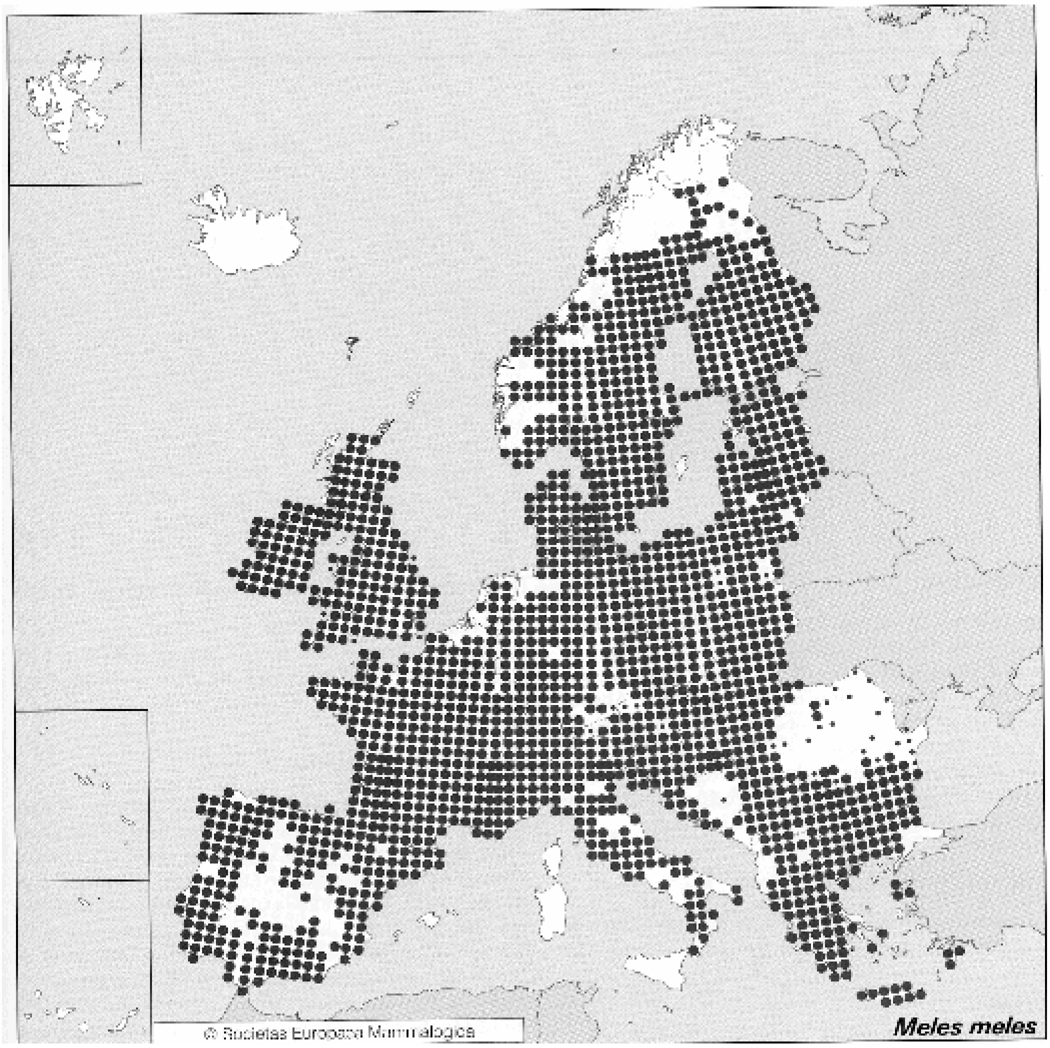


Fig.1.2.5. European distribution of *Meles meles* (Modified from Mitchell-Jones *et al.*, 1999).

1.2.4.3. Distribution in Greece

In the Greek Islands the species has been reported from Tinos, Siphnos, and Andros (Adamakopoulos *et al.*, 1991). Badgers are also reported from the island of Rhodes (Festa, 1914; Ondrias, 1965; Adamakopoulos *et al.*, 1991) and Crete (Barrett-Hamilton, 1899; Bate, 1905; Miller, 1912; Zimmermann, 1953; Ondrias, 1965; Adamakopoulos *et al.*, 1991). In continental Greece the species seems to be widespread (Ondrias, 1965).

1.2.4.4. Taxonomic review of the Cretan Badger

Meles meles has many different subspecies and one of them consists of the Cretan form, which was classified by Miller (1907).

The Cretan badger was first classified as *Meles meles mediterraneus* by Barrett-Hamilton in 1899 and the same name is used by Bate (1905) in the list of mammals. Barrett-Hamilton (1899) analysed two immature specimens coming from the area of Lassithi. In the identification, Cretan badgers are described as lighter Mediterranean forms, which are generally intermediates between those of Persia and of Europe.

Bate (1905) described the local form as *Meles arcalus*, which is pale in colour and smaller in size than the nominal form. Miller (1907), using four specimens from Crete, described the island's subspecies as *Meles meles arcalus*, characterised by small size and pale colour.

Zimmermann (1953) describes the Cretan form as an animal of smaller dimension and pale in colour. Some specimens found by the author were of a darker form.

1.2.5. THE WILDCAT

CLASS **Mammalia**

ORDER Carnivora

FAMILY Felidae

SUBFAMILY **Felinae**

GENUS *Felis*

SPECIES *Felis silvestris* Schreber, 1777

SUBSPECIES *Felis silvestris cretensis* Haltenorth, 1953

1.2.5.1. Genus *Felis*

According to Wozencraft (1993), the genus *Felis* Linnaeus, 1758, includes five species:

- *Felis bieti*
- *Felis chaus*
- *Felis margarita*
- *Felis nigripes*
- *Felis silvestris*

According to Ragni & Randi (1986) *Felis silvestris* is a single polytypical species that includes three wild phenotypes, *Felis silvestris silvestris* (European wildcat), *Felis silvestris libyca* or *ocreata* (African wildcat) and *Felis silvestris ornata* (Asian wildcat) and the domestic subspecies *Felis silvestris catus*. The systematic relationships between these phenotypes are controversial and there is a persistent dispute about the taxonomic identification and correct systematic definition of *Felis silvestris*. Some authors considered the four phenotypes as separate species (Pocock, 1951; Smithers, 1983), whereas others regard them as subspecies of the same polytypical species (Haltenorth, 1953; Kingdon, 1977; Randi & Ragni, 1991; Essop *et al.*, 1997). A multivariate analysis of skull characters and biochimical studies on allozymes variability carried out on Italian populations of *silvestris*, *libyca* and *catus* showed phenotypic continuity among them, sustaining the hypothesis of conspecificity (Ragni & Randi, 1986). More over the phylogenetic situation in the wildcat groups was reviewed by Hemmer (1978): one geographical radiation seems to be responsible for the species *chaus*, *bieti*, *margarita* and another for the *silvestris* line which ultimately radiated into three form groups, *silvestris*, *libyca* and *ornata*. The slight genetic gap that exists between *silvestris* and *libyca* (Ragni & Randi, 1986; Randi & Ragni, 1991), the phylogenetic relationships between them (Hemmer, 1978) and their morphometric continuity (Ragni & Randi, 1986) are important arguments in support to the theory that *silvestris* and *libyca* are conspecific.

Catus and *libyca* phenotypes are more closely related to one another than to the *silvestris* phenotype (Ragni and Randi, 1986). So that phenotypic distinctions between them become a morphometric continuity via the African wildcat (uninterrupted continuity in character variation). This fact seems to confirm the theory concerning the African origins of domestic cats. Randi & Ragni (1991) pointed out that the European and African wildcats diverged approximately 20,000 years ago.

1.2.5.2. General distribution

According to Wozencraft (1993), *Felis silvestris* is distributed in Europe, in the greater part of the African continent (from Morocco to Egypt till South Africa) and in Afghanistan, Arabia, China, India, Iran, Iraq, Israel, Kazakistan, Pakistan, Syria, Turkistan. It has also been introduced into Australia, Brazil, Canada and Madagascar.

Felis silvestris has an extensive distribution area in Eurasia and throughout the African continent, from Scotland to South Africa and from Morocco to central and southern China (Corbet, 1978; Haltenorth, 1953). It lives in forests, savannah and steppe from Western Europe to western China and central India (Corbet, 1978). The species also occurs in Egypt and Libya (Hufnagl, 1972) and in the northern part of Algeria, from the coast to the northern belt of the Sahara (Kowalski & Rzebik-Kowalska, 1991).

According to the Convention on wildlife and natural habitat conservancy in Europe, carried out in Strasburg in 1991, *Felis silvestris* occurs in: France, Italy, Germany, Hungary, Romania, Scotland, Portugal, Bulgaria, Czechoslovakia, Greece, Poland, Yugoslavia, Switzerland and Spain. The species is extinct from the Netherlands. In Belgium and Austria the wildcat seems to have recolonized these areas in the middle of the 19th century (Stahl & Artois, 1991) (FIG. 1.2.6.).

The three phenotypes of *Felis silvestris* are differently distributed (Ragni, 1981):

- *Felis silvestris silvestris* includes the population of Europe (except some Mediterranean islands), Asia Minor and Caucasus.
- *Felis silvestris libyca* includes the population of Africa, eastern Mediterranean areas, Mesopotamia, Palestine, northern Arabia, Crete, Sardinia, Corsica and Balearic Islands.
- *Felis silvesris ornata* includes the population of oriental distribution (from Iran to India and western China).

The three subspecies are probably found together in the territories of Armenia, Azerbaijan and northern Persia. There is not a demarcation line between them but it seems possible that Mesopotamia, the Persian deserts and the Caspian Sea represent natural separation barriers.

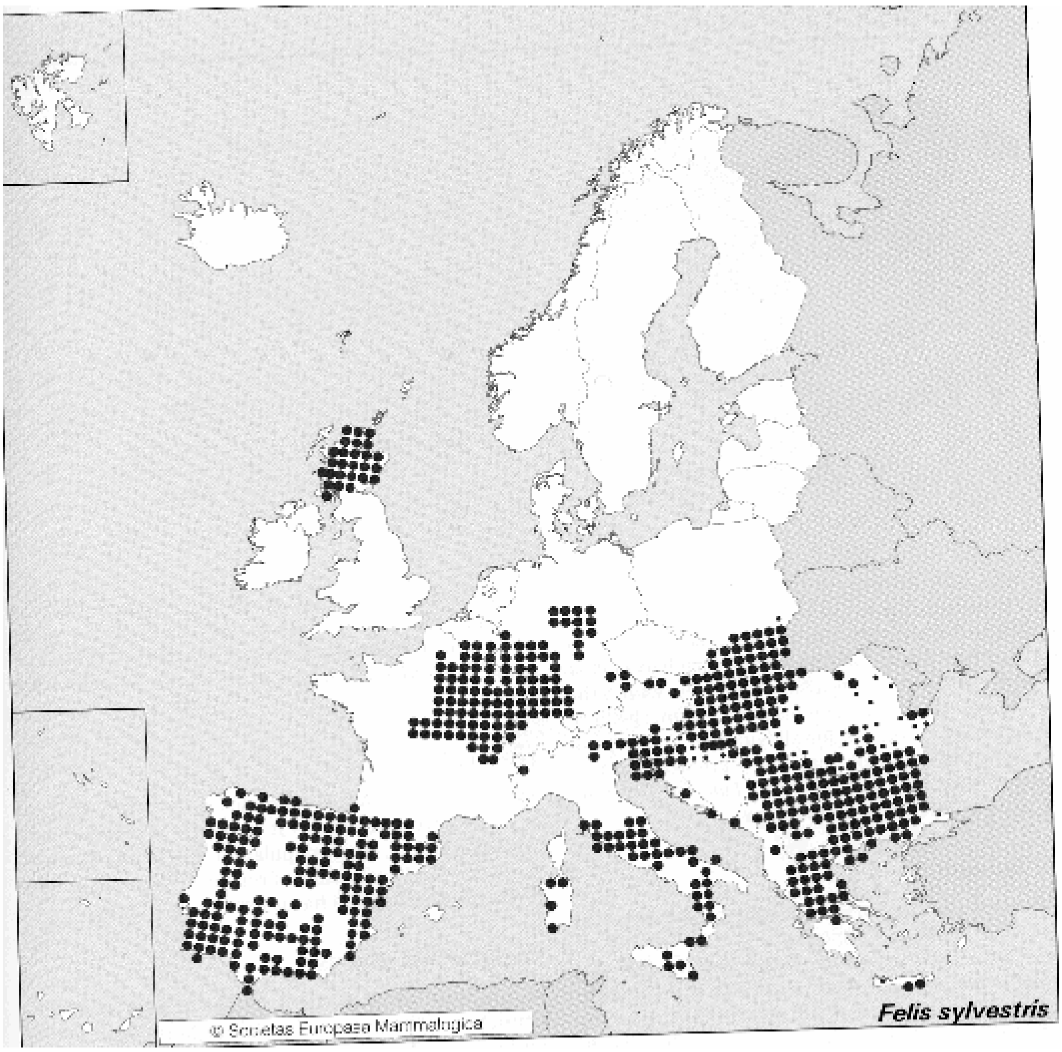


Fig.1.2.6. European distribution of *Felis silvestris* (Modified from Mitchell-Jones *et al.*, 1999).

1.2.5.3. Distribution in Greece

Adamakopoulos-Matsoukas, 1991, reports the presence of the wildcat by direct observations in the following areas of northern and central Greece (FIG. 1.2.7.):

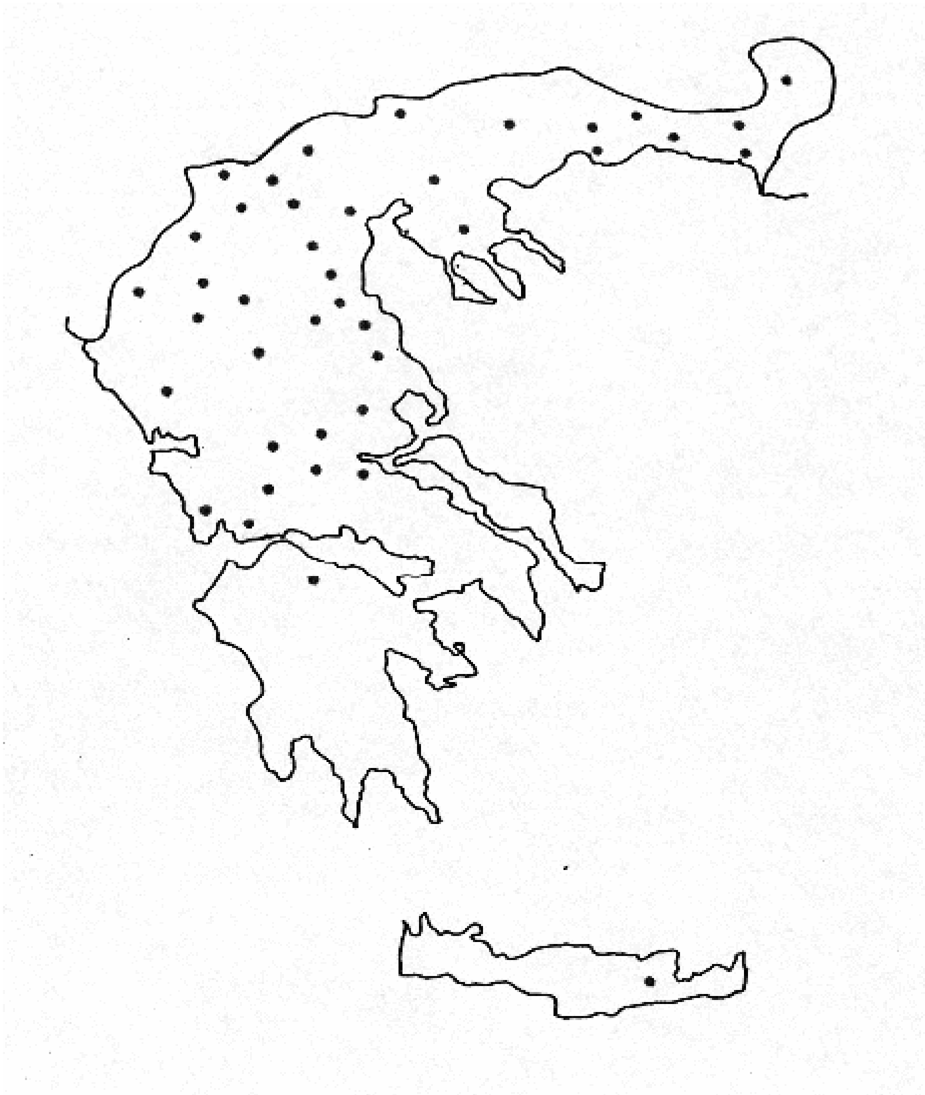


Fig.1.2.7. Distribution of *Felis silvestris* in Greece (Modified from Adamakopoulos-Matsoukas, 1991).

Evros Mountains/Thrace (by Hallmann in CORINE 1988)
Evros Region/Thrace (by Hallmann in CORINE 1988)
Filiouri River/Thrace (by Hallmann in CORINE 1988)
Nestos Gorge/Macedonia (by Hallmann in CORINE 1988)
Delta of Nestos/Macedonia (by Hallmann in CORINE 1988)
Kerkini Lake/Macedonia (by Hallmann in CORINE 1988)

Kato Olympos/Thessaly (by Hallmann in CORINE 1988)
Rodia Gorge/Thessaly (by Hallmann in CORINE 1988)
Domokos Plateau/Thessaly (by Adamakopoulos-Matsoukas 1991)
Olympos Mount/Thessaly (by Adamakopoulos-Matsoukas 1991)
Chassia Mount/Thessaly (by Adamakopoulos-Matsoukas 1991)

Traces of wildcats were found in:
Papikio Mount/Ipiros (by Adamakopoulos-Matsoukas 1991)
Ligos Mount/Ipiros (by Adamakopoulos-Matsoukas 1991)
Zigos Mount/Ipiros (by Adamakopoulos-Matsoukas 1991)
Vermio Mount/Macedonia (by Adamakopoulos-Matsoukas 1991)
Pieria Mount/Macedonia (by Adamakopoulos-Matsoukas 1991)
Ziria Mount/Peloponniso (by Hadzirvassanis 1987)
Gramos Mount/Ipiros (by Bosbouras)
Vikos-Aoos National Park/Ipiros (by Catsadorakis 1985)

Dead specimens of wildcat are reported from:
Drama Region/Macedonia (by Tsoukaris 1989)
Serres Region/ Macedonia (by Tsoukaris 1989)
Prespa National Park/Macedonia (by Catsadorakis)
Pertouli Forest/Thessalia (by Ioannidis)
Saloniki Region/Thessalia (by Tsoukaris 1989)
Ossa Mount/ Macedonia (by Hallmann in CORINE 1988)
Volos Region/Thessalia (by Tsoukaris 1989)
Velouchi Mount/Thessalia (by Ioannidis)
Sperchios Delta/Sterea Ellada (by Vourinakis)
Nafpaktia Mountains/Sterea Ellada (by Ioannidis)
Arakinthos Mount. /Sterea Ellada (by Ioannidis)
Aetolikon Region/Sterea Ellada (by Ioannidis)
Dikti Mount/Crete (by Schwaab et al.)
Vitsi Mount/Macedonia (by Bosbouras)

Souli Mountains/Ipiros (by Hallmann in CORINE 1988)
Iti Mount/Sterea Ellada (by Hallmann in CORINE 1988)
Mavrovouni Mont/Thessalia (by Hallmann in CORINE 1988)
Arnea Region/ Macedonia (by Hallmann in CORINE 1988)
Alexandroupoli (7 km north)/Thrace (by Bosbouras)

Festa (1914) reported the presence of a skin of a wildcat sold in a shop in Koskino (Rhodes). The same author wrote that local hunters rarely see wildcats in the forests of Alaerma and Elias, on the island of Rhodes.

1.2.5.4. Taxonomic review of the Cretan Wildcat

Raulin (1869) reported the wildcat of Crete for the first time as *Felis catus* and successively Bate (1905) described it as *Felis ocreata agrius*. Bate's identification was based on the pelts of two specimens bought in a bazaar at Chania, at different times. These two specimens were not accompanied by any measurements taken in flesh, even if Bate described an animal that seems to be large and robust. The Cretan form appears to be more closed related to the African type and for this reason Bate classified it in the *Felis ocreata* group. In Bate's description, the local form appears to have more distinctly marked stripes, a greater number of rings on the tail, that is also quite short and of a more intense colour.

Miller (1912) described the wildcat of Crete as *Felis agrius* and Zimmermann (1953) as *Felis silvestris agrius*. Zimmermann had only one skin and he noticed similarity between the Cretan and Sarda forms, even if the colour of the Cretan wild cat is paler than the Sardinian felid, and the coat pattern is clearer in the Sarda form. Similarity between the Cretan and the Sardinian wildcats has been noticed by many authors (Bate, 1905; Zimmerman, 1953; Haltenorth, 1953). Zimmermann describes the Cretan form as a cat with a long tail that ends with a black top and two or three rings normally present. The two skins examined by Bate were recognised as belonging to domestic cats by Haltenorth (1953), who therefore described the local wild form, *F. silvestris cretensis*, by the analysis of one specimen of uncertain origin obtained from the Chania area in 1942.

1.3. FOSSIL RECORDS

Remains of *Martes* sp. and *Meles* sp. have been found in Simonelli cave, near Rethimno, Gerani cave II, Liko cave and Mavromouri caves I and VII (Caloi, 1980; Lax, 1996) (FIG. 1.3.1.). In Mavromouri cave I only *Meles* remains have been found, while in Mavromouri VII only *Martes* remains. All these caves revealed Pleistocene faunal elements, in some cases associated with Neolithic archaeological material and Holocene animals (Steensma & Reese, 1996). The mustelins found in Simonelli cave must be considered as subfossils due to the conditions of their preservation (Kotsakis, 1990) and their presence in early stratigraphic levels (Pleistocene) is probably related to their digging abilities (Masseti, 1995). According to Steensma & Reese (1996) the badger and the beech marten have never been attested in any secure Pleistocene stratigraphic level in Crete.

The only secure endemic and native carnivore of the Cretan Pleistocene is probably *Lutrogale cretensis* (Symeonidis & Sondaar, 1975), which belongs to the *Lutrinae* subfamily. This otter was better adapted to a terrestrial way of life, than the extant *Lutra lutra*, which is present today in the Greek mainland. An ancestor of *Lutrogale cretensis* probably migrated from Asia Minor and Greece, where it was present during the Pleistocene, to Crete where it then evolved into an endemic species (Willemsen, 1996).

The Quaternary fauna of Crete has been defined as unbalanced, as indicated by the general lack of carnivores, which is a direct result of insularity (Sondaar, 1971; Dermitzakis & Sondaar, 1978). In fact Crete was not attached to continents by landbridges during the Quaternary, otherwise a more balanced continental fauna might be expected (Dermitzakis & Soondar, 1978; Sondaar *et al.*, 1986; Lax & Strasser, 1992). In view of this, the only non-volant terrestrial species that can reach and colonize an island are good

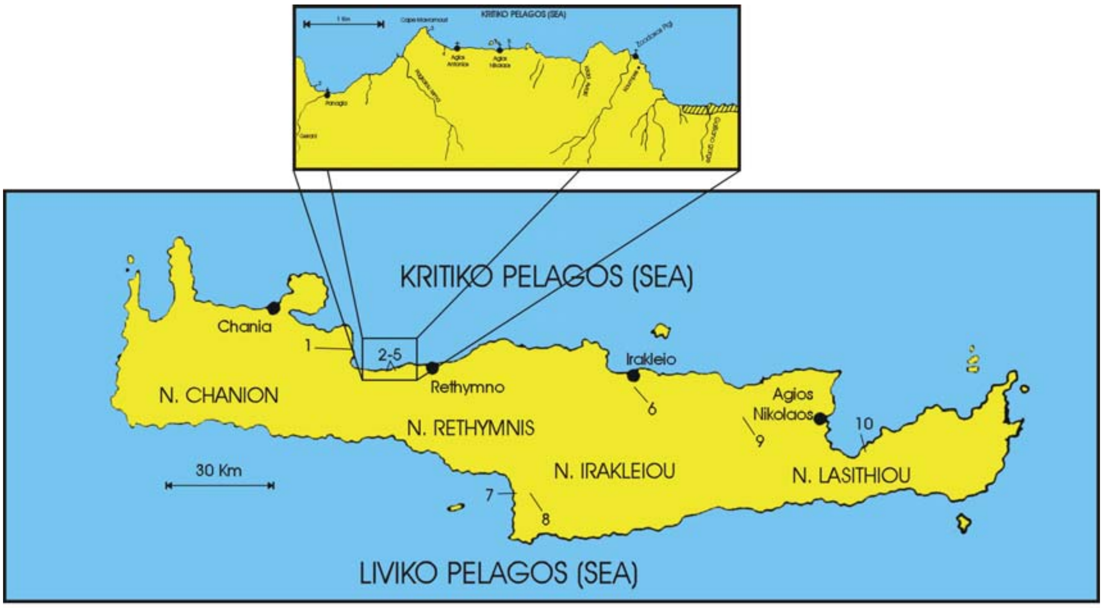


Fig.1.3.1.: Map of caves and archaeological sites

1. Liko cave
2. Gerani cave Ii
3. Mavromouri cave I
4. Mavromouri cave VII
5. Siomelli cave
6. Knossos (archaeological site)
7. Agia Triada (archaeological site)
8. Phestos (archaeological site)
9. Krasi Pediados (archaeological site)
10. Kavousi Kastro (archaeological site)

swimmers such as deer, elephants, hippopotami and otters or drifters such as rodents (Dermitzakis & Soondar, 1978; Lax & Strasser, 1992), all of which have been found in the Quaternary caves of Crete.

It is possible that small mammals were conveyed passively to Crete in the water during a sea regression period that reduced the distance between Crete and the island of Kythira, but it is unlikely that this hypothesis is applicable to larger forms such as *Meles meles* or *Felis silvestris* (Kotsakis *et al.*, 1979).

Remains from badgers and martens have also been collected from early Neolithic Knossos (Jarman, 1996) and from several Minoan sites such as Kavousi-Kastro (Snyder & Klippel, 1996) and Agia Triada (Wilkens, 1996). Considering that until today no evidence of humans in Crete has been found before the Aceramic Neolithic period (Hamilakis, 1996; Jarman, 1996; Sondaar *et al.*, 1998;) these remains must be considered associated with the human presence. Steensma & Reese (1996) stated that it is highly improbable that the mustelids and small carnivore in general reached Crete by swimming or rafting, in fact it is more likely that man brought them to the island.

Examination of the 35 elements (cranial and post cranial remains) of *Meles meles* found at the site of Kavousi-Kastro in east Crete, from the Late Minoan period, revealed cut marks on many of these bones, which are considered evidence of the human utilisation of badgers as a food resource or for pelts (Snyder & Klippel, 1996). Jarman (1996) comments that badgers have been used for their skins from the Early Neolithic until now and this mustelid must be considered as neither a domestic animal nor a completely wild type. Regarding the beech marten, Jarman (1996) remarks that martens were, until recently, also exploited regularly for fur and they could have been exploited in the past for this purpose. Furthermore at the archeological site of Knossos, *Meles meles* remains have been found from the earliest settlements (Aceramic Neolithic) and continue throughout the sequence until the Post Minoan period (Jarman, 1996). Jarman assumes that man introduced badgers into Crete and he presumes that the original *Meles* sp. population was the same species as was in Greece and Turkey at the time.

In Knossos archaeological site other species of domestic and wild animals were found such as the beech marten, the cat and the weasel (Snyder & Klippel, 1996). *Martes foina* and *Felis* sp. are present in the site but they occur sporadically. The beech marten has been only found in the Early Neolithic and Minoan levels and Jarman's explanation is that the species was introduced on few occasions becoming locally extinct between injections from the mainland. *Felis* sp. is known from one deposit, a mix of Roman and Minoan remains, from the Knossos site (Jarman, 1996). There is no evidence to say if the species is wild or domestic, but the cat is most likely domestic because at that time Minoans were in contact with Egyptians, who had already domesticated cats. *Felis* sp. is also known from a number of Minoan representations. The relationship between humans and cats and the reasons for its domestication still remain in doubt. Jarman's hypothesis is that man imported cats as pets and the modern wild population is a feral derivative. A terracotta model of a weasel is also known from the Minoan period (Steensma & Reese, 1996).

According to Vigne (1998), all the native mammal species of Crete became extinct during the Pleistocene, except for *Crocidura* sp., and humans introduced all the species living today on the island during the Holocene. Some of the species now found in Crete could exist as a result of feralization of early-domesticated species. Some species were, in fact, probably kept in semi-domestic conditions.

Remains of beech martens and badgers were examined by Steensma & Reese (1996) from four caves (Gerani II, Liko, Mavromouri I and VII). They discovered that the archaeological material belong to individuals intermediate with the current endemic Cretan form and the ancestral forms, were more similar to relatives found to the east, therefore confirming the idea of an eastern origin of the first human settlers. For Vigne (1998) however, all the modern Cretan taxa could have originated from the Balkan fauna.

In an archaeological site called Krasi Pediados, hedgehog remains were found in a tomb, as well as in some Phaestos representations (Jarman, 1996). For Jarman (1996) it is difficult to suggest a practical or economic purpose for the hedgehog importation or an accidental arrival of the animal. The species might probably have been imported as a casual interest for semi domestic pets, as many animals, like tortoise are kept nowadays in Western Europe. Considering that hedgehogs are used today as food resource in some European countries, it is probable that they were also consumed in ancient times for the same purpose. Moreover, in some Italian regions, hedgehogs were used in popular medicine surely till the middle of 19th century and the origin of this traditional treatment could have a very long history.

CHAPTER 2

MATERIALS AND METHODS

2.1. BIBLIOGRAPHICAL REVIEW

Literature has been collected concerning the biology, distribution and ecology of the studied animals, as well as on the palaeontology of Crete. Data from adjacent regions were also collected for comparative purposes.

Bibliographic information has also been collected about the systematics of the Cretan subspecies, as carried out by different authors.

Papers from the bibliographic database of the Natural History Museum of Crete have been used.

2.2. INDIRECT INDICES OF PRESENCE

This research includes the collection of different types of signs of an animal's presence. These signs are tracks, faeces, digging, food remains and nests. Sign counting is particularly useful in a situation where animals are very difficult to see, either because of their habits or the complexity of the study area. Cryptic, secretive or nocturnal mammals always leave some records of their presence in the environment. Counts of signs are often used as an index of occurrence of species and they can also used as a source of information about animal abundance.

During this phase of the research faeces and other indices of presence have been collected and tracks have been observed in the Psiloritis M., in the areas of Rouvas forest, Anogia and Agios Mamas. They were recognised as a census of the studied species in different places on the island of Crete.

2.3. DIRECT INDICES OF PRESENCE

This research includes the collection of direct indices of presence of the studied species such as carcasses or dead animals *in carne* and also direct observation of specimens.

The scope of the research did not include a census of the studied species but a study of their geographical and altitudinal distribution, activity and morphological and morphometrical characters. Two approaches, collection of dead animals and phototrapping, were chosen for these purposes.

The collection of dead animals represents direct proof of the presence of an animal in an area. Dead specimens were mostly found as road kill in a good state. Only a few hedgehogs were found very crushed and they were not used for measurements, while for the other specimens of the studied species, their conservation state was considered adequate for measurements. Dead wildcats analysed were found killed by guns, because shots from bullets were in the bodies. The specimens definite as hybrids were victims of road accidents or drowned in reservoirs. One alive specimen of wildcat, trapped in April 1996, was also measured. The specimens, whose state did not permit morphological observations, were used for morphometrical analysis of the skull. Measurements taken on dead animals and observations on their coat colour pattern are very important sources of systematic information.

A second source of direct indices is the phototrapping method, which was also used to investigate altitudinal differences in distribution and annual activity of the studied species.

Furthermore an advantage in using these methods is the reduced human disturbance since live animals have not been captured or directly manipulated, except for one specimen, which was captured in a previous trapping research.

2.3.1. Collection of animals- Morphology and morphometrics Measurements and remarks from dead animals have been taken from species that have been collected during the course of the research in the island or those already present in NHMC collections. All the vouchers are deposited at the Natural History Museum of Crete and they are conserved in the freezer of the Museum.

From each specimen of the five studied species, the following measurements were taken (FIG. 2.3.1):

- Head and body length (B) in mm.
- Tail length (T) in mm.
- Hind foot length (HF) in mm.
- Height of ear (E) in mm.
- Weight (W) in gr.
- Age
- Sex

and for the wildcat, these three additional measurements:

- Right superior canine height in mm.
- Right superior canine length (base diameters) in mm.
- Ear's tuft height in mm.

Morphological and metrical traits of the coat colour pattern and marking system of the five studied species were taken and observed. Measurements on body and skull of the cats made possible the identification and the descriptions of the specimens.

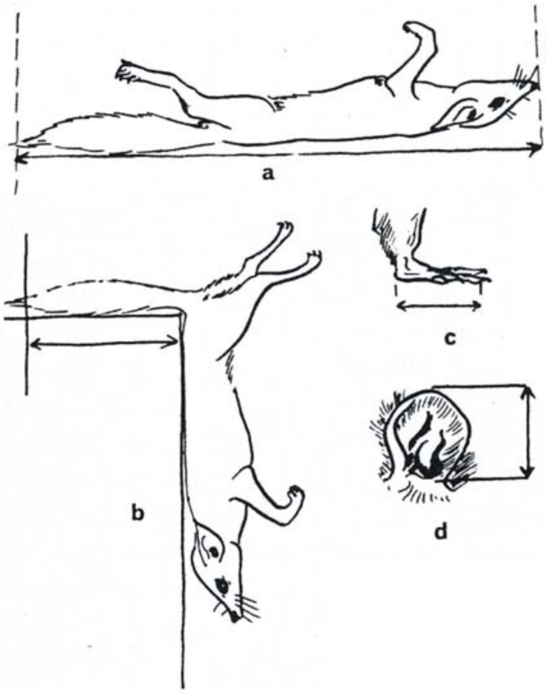


Fig. 2.3.1.: Body measurements (modified from Hufnagl, 1972). (a) Head-Tail length; (b) Tail length; (c) Hind foot; (d) Ear length. (Head-Body length = a-b).

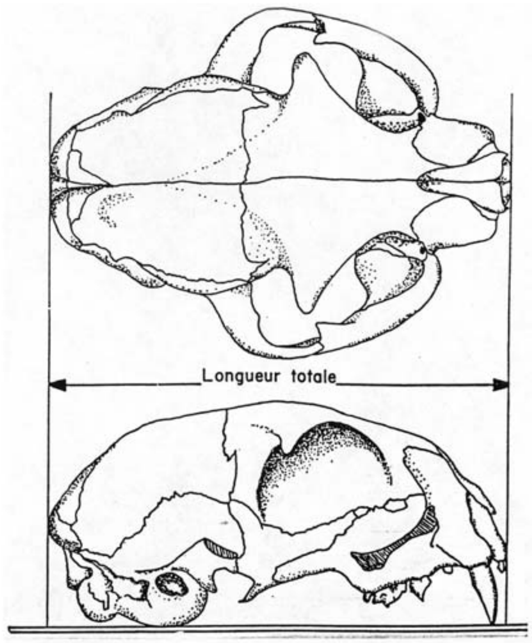


Fig. 2.3.4.: Total length of the cranium (from Shauenberg, 1969).

Differentiation between the European subspecies of wildcats (*F.s.silvestris*, *F.s.libyca* and *F.s.catus*) is based on morphological characters of the coat, on craniological and craniometric values and on behaviour patterns. Enzymatic analysis and studies on mithocondrial DNA have confirmed this differentiation (Ragni & Randi, 1986; Randi & Ragni, 1991; Ragni & Possenti, 1996; Randi *et al.*, in prep.). Pocock (1907 & 1951) used skin colour, coat pattern, morphology and osteology to classify felids from the beginning of the 19th century, whereas the use of ethological characters began in 1950 with the first study of Leyhausen (Leyhausen, 1950: in Hemmer, 1978; Leyhausen, 1979).

Morphological variations exist in the coat-colour and marking system of the wild and domestic cats, felids are, in fact, remarkable in possessing typical coat patterns as stripes or spots. These variations as well as metric characters can be used for discriminating between the three European phenotypes. Distances between subspecies that have been calculated through frequencies of coat patterns, seems to be fully consistent with those measured genetically (Randi & Ragni, 1991).

Felis silvestris populations are characterised by a variable coat-colour and marking system, which are visible in eight somatic regions (*Rhinarium, Pinnae, Gularis, Occipitalis-cervicalis, Scapularis, Dorsalis, Lateralis* and *Caudalis*) as is shown in FIG.2.3.2. (Ragni & Possenti, 1996; Ragni *et al.*, in prep.). There are 28 patterns that are variable and expressed in the afore-mentioned somatic regions.

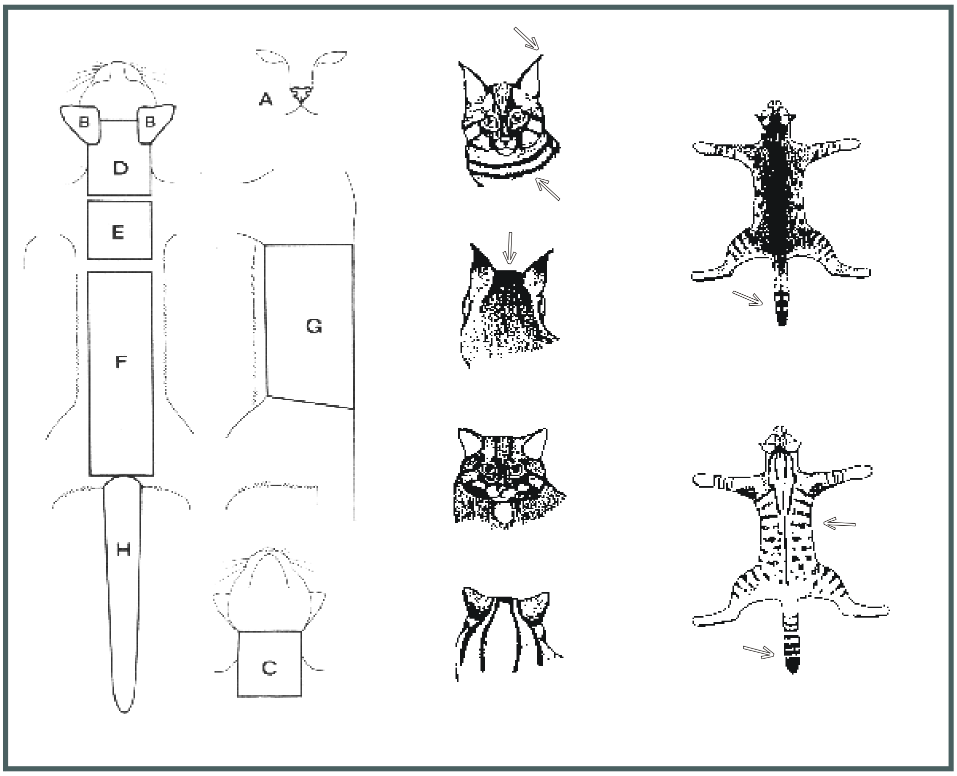
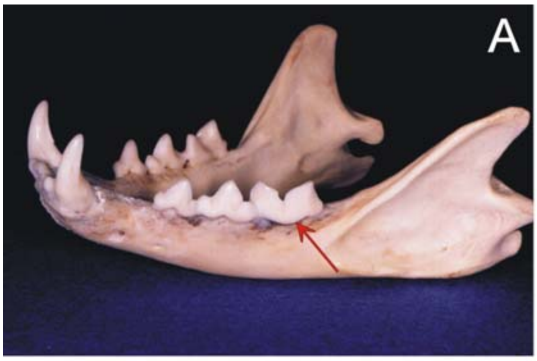


Fig.2.3.2. Morphological features of the coat. A: Rhinarium B: Pinnae C: Gularis D: Occipitalis E: Scapularis F: Dorsalis G: Lateralis H: Caudalis; 1a-1c and 2a-2c: coat patterns of F.s.libyca and F.s.silvestris respectively. (Modified from Ragni and Possenti, 1996 and Ragni, 1981).

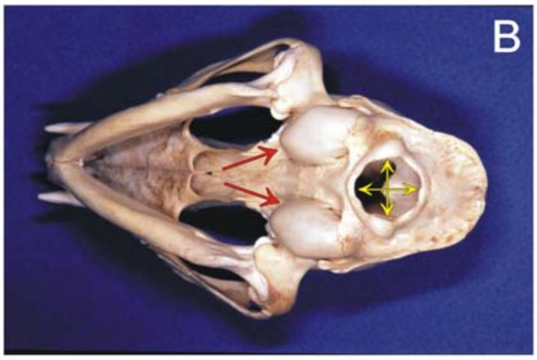
Identifications of dead cats were conducted according to Ragni (1981), Ragni & Possenti (1996), and Ragni *et al*. (in prep.).

Cranial measurements were only taken only for the wildcat, using the following characters that have been shown to be important for identification: (FIG.2.3.3.).

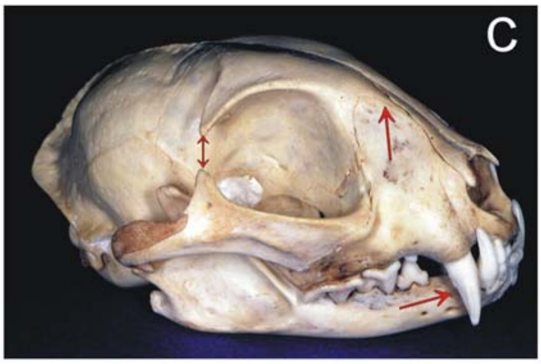
- Molar
- Area of the occipital foramen
- Auditory bullae shape
- Surface of the nasal-frontal juncture
- Distance between orbitary processes
- Canine size



A: Molar



B: Area of the occipital foramen
Auditory bullae shape



C: Surface of the nasal-frontal juncture
Distance between orbitary processes
Canine size

Fig.2.3.3. A, B, C: Characteristics of the cranium

The cranial index (I. C.) value was also taken.

According to Shauenberg (1969), I. C. is the total length of the skull (in mm.) divided by the neurocranium capacity (in cm^3). The total cranial length is taken as is reported in FIG. 2.3.4. The neurocranium capacity is measured after obturation of the orifices of the cranium, which is then filled with lead shots (1mm in diameter) from the occipital foramen. During this operation the cranium must be shaken in such a way that the shots can occupy all cavities. After that the shots must be poured into a volumetric tube, graduated in cm^3.

The area of the occipital foramen (A) is the maximum length (L) multiplied by the maximum height (H) of the foramen, multiplied by π (3.14) then subsequently divided by four, as shown below:

$$A = \frac{L \times H \times 3.14}{4}$$

According to Ragni *et al.* (in prep.), it is possible to distinguish between diagnostic characters and less diagnostic ones. The first group includes the distance between orbitary processes, area of the occipital foramen, surface of the nasal-frontal juncture and the cranial index. Less diagnostic characters are considered the teeth dimension and the auditory bullae shape.

In the TABLE 2.3.1., the ranges of the cranial characters for *Felis silvestris catus* (domestic cat), *Felis silvestris silvestris* (European wildcat) and *Felis silvestris libyca* (African wildcat) are reported.

More over, according to Schauenberg (1969) when the neurocranium capacity is larger than 35cm^3, the cranium belongs to wildcats, whereas when the neurocranium capacity is less than 35cm^3 the cranium belongs to domestic cats.

	F.s.catus	*F.s.silvestris*	*F.s.libyca*
Teeth dimension	Normal	Large	Large
Auditory bullae shape	Circular	Oval	Oval
Distance between orbitary processes	> 3mm	< 3mm	Usually > 3mm
Area of the occipital foramen	< 141,3mm^2	>141,3 mm^2	Usually < 141,3 mm^2
Surface of the nasal-frontal juncture	On a depression	On a plane	On a depression
Cranial index	>2,75 cm^3	<2,75 cm^3	<2,75 cm^3

TABLE 2.3.1. Cranial characters

2.3.2. Phototrapping

2.3.2.1. Introduction

The phototrapping method is a relatively new system for animal research. It has been used since the early 1900s (Wemmer *et al.*, 1996). However the technological improvements have largely increased the application and the efficiency of the method.

Phototraps are used for different purposes. The most common aims in these projects are the monitoring of activity of wild fauna, the study of the behaviour of animals in their natural habitat or, quite simply, a census and an identification of individuals of each single species occurring in an area. In some specific cases a phototrap method was also useful to apply a capture-recapture program on a tiger population (*Panthera tigris*) which are well individually distinguished by the stripes on the body (Karanth, 1995), or to identify predators of bird's nests (Goetz, 1981).

Camera traps are also useful for monitoring relative and absolute abundance of species. This technique of investigation has many management implications and could give important information about specific ecosystem, such as the dense vegetation in the rain forest habitat studied by Seydack (1984).

The phototrapping system could be one of the methods used to index changes in population size. Hiby & Jeffrey (1987) talk about photographic techniques for small population studies, and Mace *et al.* (1994) have carried out an estimation of the size of a grizzly bear population using camera sightings. Karanth (1995), using the phototrapping system with the capture-recapture program, was able to estimate the population size and density of tigers in India. Phototraps are also useful in counting changes in population abundance over time (Zielinski *et al.*, 1996). If detection surveys are carried out systematically, it is possible to compare the local distribution maps of each species over time, to monitor changes in species distribution.

Camera systems are especially useful to detect nocturnal and cryptic animals, which are more difficult to observe in nature (Carthew *et al.*, 1991).

The phototrap method includes a variety of systems in use to improve the capability of the method, relating to the requests of different researches and areas. The most commonly used systems can be divided into two major categories, according to the type of camera used: automatic 35-mm cameras and manual 110-mm cameras. The first system can be divided into two types, depending on the mechanism that triggers the camera (single sensor or dual sensor), whereas the second system is always a line-triggered mechanism (Kucera *et al.*, 1996). The single sensor system consists of an infrared transmitter and receiver connected to a 35mm camera and a dual sensor consists of a microwave motion sensor and a passive infrared sensor, which detects changes in ambient temperature, also connected to a 35-mm camera (Kucera *et al.*, 1996). The line-trigged mechanism requires a wood stake on top of which the camera is positioned and a wire connected both to the bait and to the shutter mechanism inside the camera. This is the most inexpensive method.

According to Wemmer *et al.* (1996), there are three types of trigger mechanism: mechanical, electronic and light-sensitive trip mechanisms. The mechanical trips work with baits attached to strings, positioned and connected to the camera in such a way as to be able to activate the shutter. The electric trip works with trip-plates, consisting of two pieces hinged together in a way that pressure completes an electric circuit. This method, just described, is the one applied in this study.

Concerning light-sensitive trip mechanisms, Wemmer (1996) talks about photic cells and infrared beams. Photic cells are used to activate the camera unit when animals pass through a beam, which must be properly aligned. Using pulsed infrared beam, the problems arising from the activation of the system by falling leaves or insects can be overcome. These beams can be set to select animals to be photographed on the basis of their size. Infrared beams can be active or passive. The active one consists of a unit that generates a wide beam and a receiver that detects a small segment of that beam, which could be set in relation to the size of the animal we want to detect. One major problem of this mechanism is that sunlight affects the sensor. The passive one is not selective and records any warm-blooded animal (Wemmer *et al.*, 1996). This mechanism is unsuitable to detect animals in warm climate regions.

In some cases the use of a polaroid camera (Goetz, 1981) or a video camera was found to be useful. Video cameras are especially useful in highly frequented sites and they can be used with an intervalometer, which take only single frame exposure at specified interval (Wemmer *et al.*, 1996).

One of the benefits of using the line-trigged mechanism is the low cost of the equipment, but one of the disadvantages comes from exposure to the elements, especially snow. In general camera systems have the problem of being limited to specific seasons, especially in areas with very harsh winter conditions. For this reason is always necessary to adapt the system in relation to the specific study area. An important advantage of using cameras is their non-intrusiveness. During the period of study, it has been noticed that there was no evidence of camera avoidance. Animals do not seem to mind the presence of the recording unit or even the flash. Many of them have been recorded more than once, even if after few minutes. In this way an area can be monitored with minimal human disturbance, and the animals do not have to be captured.

Regarding baits, it must be appropriate for the desired animal and it is sometimes recommended to use lures and visual attractants like pieces of aluminium (Kucera *et al.*, 1993).

There are some general sampling schemes that have been used in the application of the phototrap method. Zielinski *et al.* (1996) points out the importance of minimizing the possibility of overlooking an area within a region, taking care of the distance between sample units. The same author suggests using sample units as the smallest division of the study area, scaled to the size of the home range of the required animals. The cameras must be positioned in relation to the type of research that is being carried out. If the research is focused on a specific target animal, it is better to set the camera where one knows there is a frequently used path. The distance between the camera and the trigger must be such that it provides a full-body shot of the largest animal to be detected in an area.

2.3.2.2. Current application

The method used in this study is very similar to the one described above (line-trigged mechanism), but a 35mm camera and a different system to activate the camera were used. A plexiglas disc, positioned under the suspended bait, covers three trigger buttons connected to the camera. A Cannon 32-mm Prima BF-8 date, self-winding, time-date recording camera with an incorporated flash was set and housed in a removable plastic bottle, partially cut to be open in front, to protect it from the elements. The camera and the housing were raised about one meter from the ground and two meters from the trigger and the bait. The bait consisted mainly of pieces of meat and some small fish in a wire mesh suspended 30 cm from the plexiglas disc (FIG. 2.3.5.).

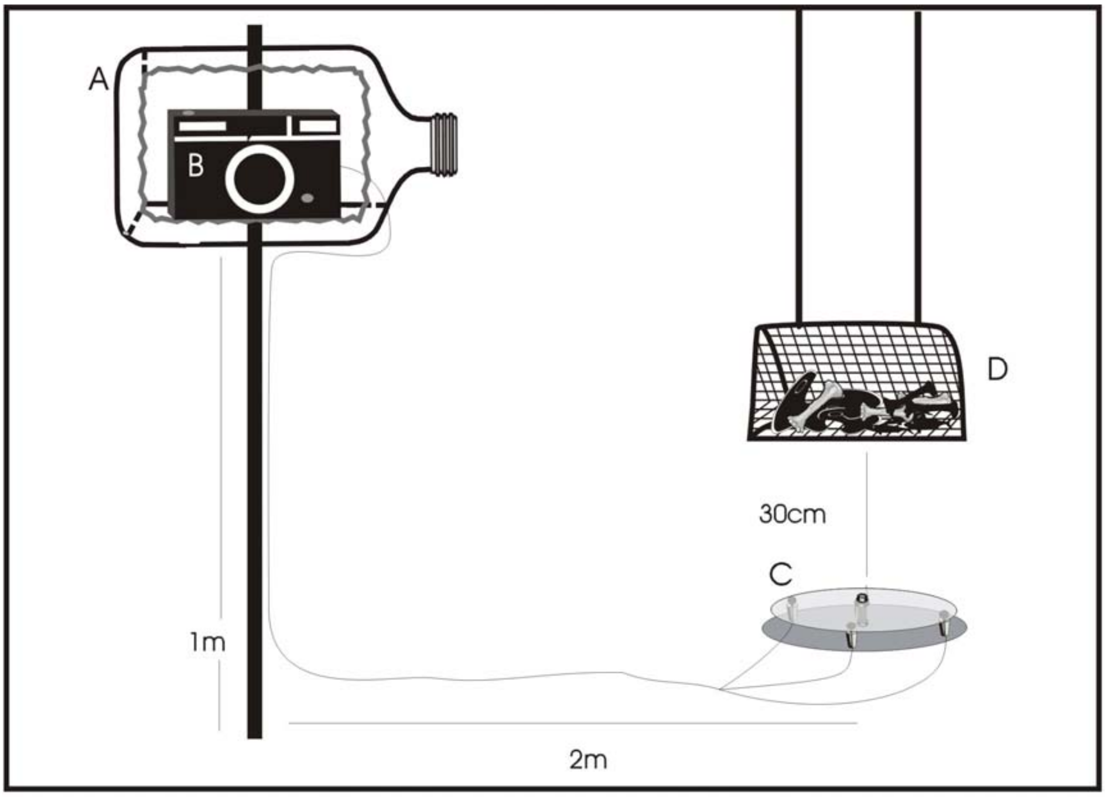


Fig.2.3.5.: The phototrapping system

A. The camera is housed in a common plastic jar with an appropriate opening. B. The camera (Cannon 32-mm Prima B-8 date). Both camera and housing are fixed on a metal pole which is hammered into the ground. This camera has two electronic switches: the normal shutter on top and a second, connected to the sliding cover of the lens. The connection with the trigger mechnism is done on the second switch by a small hole made on the camera's body and attaching of the wire on the two connections of the switch.This way the sliding cover of the lens becomes useless and care must be taken to keep it always open. Once the trap set, care must also be taken to jam the shutter. We did this by means of a plastic strap around the camera.C The trigger mechanism consists of two plexiglass disks 5mm thick with a diameter of 30cm. Three small electric switches are fixed on the lower one and connected to the camera. The top disk is held on the lower one by a simple screw and a nut. If it is too heavy or the switches too soft, it may be held at a distance from the lower one by means of a small cylinder around the screw. D The bait in a wire mesh is hung from a branch or a rock at approximately 30cm from the ground and 2m from the camera and the double plexiglass disk is positioned below it. The connecting wire must be camouflaged with dirt and stones as to avoid accidental triping.

During the last period of the phototrapping research, dry catnip (*Nepeta cataria*) that seems to be an attractant for cats was added to the bait. When the animal attempts to eat the bait, it applies pressure to the upper part of the plexiglas disc under which are located the buttons connected to the camera, that is then activated. Three trigger buttons were used to ensure activation as preliminary studies showed it was possible for an animal to press the disc without setting the camera or for one of the triggers to malfunction. A 100 ASA film, with 24 exposures, was used. Each week all stations were checked to monitor film, bait and batteries and in the later phase of the research the stations were checked each fifteen days, which was found to be an adequate time. In fact the control of the cameras once every two weeks allows enough time to change the baits and to resolve problems in the system, with a minimum degree of human disturbance. A 100 ASA film was used because this is the most adaptable film in different light situations and the most useful with a flash unit. The 24-exposure film is a suitable number when cameras are checked once a week, whereas it is better to use a 36-exposure film if the cameras are checked once every two weeks.

A test period was carried out for one month to check the effective functionality of the method. During this period some changes were made to the system. For example the plexiglas disc was chosen instead of the hardboard initially employed in the phototrap, as this material absorbs water, increasing the weigh of the upper part, which then applies pressure to the buttons connected with the camera.

According to Mace *et al*. (1994) in order to be counted as different specimens, photographs of the same individual at the same camera station had to be separated by an interval of more than 24 hours, when morphological traits are not enough to diagnostically differentiate individuals. The time-date recording function of the cameras allowed the distinction of individuals at the same station.

2.3.2.3. Survey area

The phototrap method was carried out during two different phases. The first one, from 2nd of March till the 7th of April 2000, was a survey research in three altitudinal gradients on Idi Mt. (Agios Mamas, Rouvas forest, Anogia) (FIG. 2.3.6.). Nine camera traps were placed along three transects, each of them consisted of one station in the following altitudinal categories: 0-500m, 500-1000m and over 1000m. The first station in Agios Mamas (350m) was characterised by the presence of *Quecus coccifera, Pistacia lentiscus, Salvia fruticosa, Olea europea* and near by cultivation of olives and carobs. *Phlomis frutticosa, Pyrus spinosa*, *Euphorbia acanthoclada* and *Thymus capitatus* mostly occupied the second station, at 780m*.* This station was a degraded maquis, exploited by humans for grazing. The third station on the Agios Mamas transect, at 1150m a.s.l., was a wooded area characterised by the presence of *Quercus coccifera, Euphorbia sp., Phlomis lanata, Acer sempervirens* and *Cupressus sempervirens.* On the Rouvas transect, the first station, at 400m, was characterized by the presence of *Quercus coccifera, Ceratonia siliqua* and olive cultivation. The second station, at 950m, was a wooded area with *Quercus coccifera* and *Acer sempervirens,* while the third station, at 1250m, was characterised by *Acer sempervirens* and bushes of *Quercus coccifera,* due to the presence of goats. Regarding Anogia, the first station, at 325m, was mostly characterised by *Quercus coccifera* and *Thymus capitatus,* while the second, at 770m, was a degraded maquis on a rocky area with *Salvia fruticosa, Cistus creticus* and *Thymus capitatus.* The third station, at 1100m, was a wooded area predominated by *Quercus coccifera.*

The second phase, from May 2000 to May 2001, was a specific survey on the wildcat's population, focused in the area where pictures of the felid were taken during the first phase of the research. At the same time a census research about the other studied animals was carried out in the same territory.

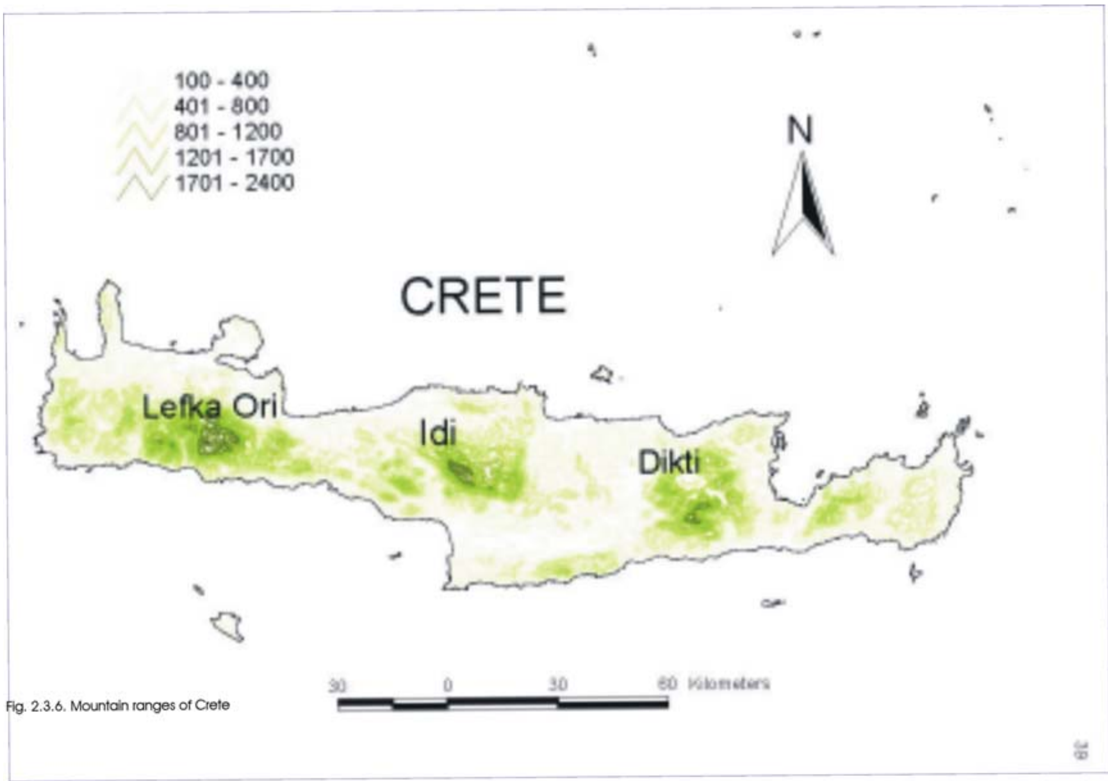


Fig. 2.3.6. Mountain ranges of Crete

The area was on the mountains over Agios Mamas which is the closest village. This area, at 1300m altitude, is characterised by the presence of *Quercus coccifera, Euphorbia sp., Phlomis lanata, Acer sempervirens* and *Cupressus sempervirens*. The area was divided into a grid of 156 ha squares. A camera was placed at the centre of each of the ten squares, named A2, B-1, B0, B1, B2, C-1, C0, C1, C2 and C3 (FIG. 2.3.7.). The total number of the cameras was ten. Considering that the average home range of a wildcat is of 100-200 hectares (Ragni *et al.*, in prep.), the area was covered in such a way as to collect more precise data on the animal's activity and on the population of the Psiloritis Mountain range of Crete. In radiotelemetry research carried out in 1996 on *Felis silvestris cretensis*, the home range of the animal was found to be very large of approximately 421 ha (Cicconi, 1997). In this way the grids chosen may encompass the home ranges of more than one cat.

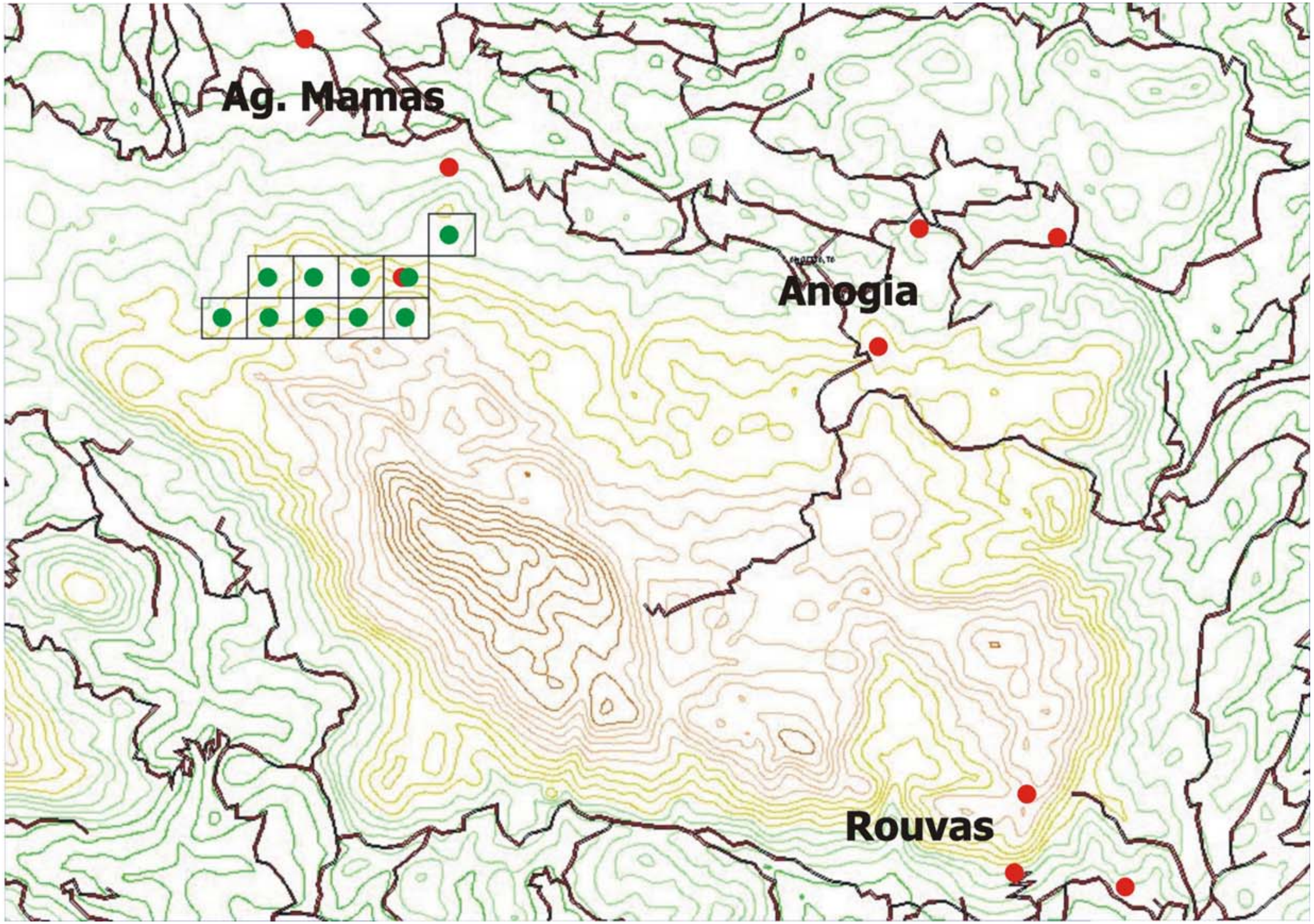
The climate of the area where the phototraps were set was calculated with data from the Prefecture of Crete for Psiloritis (Idi) Mt., at 1350 m a.s.l. and the temperatures taken in Anogia which is at 740 m a.s.l.. Considering that temperature decreases at a rate of 0.6 degrees per 100m, it is possible to extrapolate approximate average values for the study area as follows: 3.9

(Jan.), 4.6 (Feb.), 6 (Mar.), 9.8 (Apr.), 14.3 (May), 18.6 (Jun.), 20.2 (Jul.), 20 (Aug.), 16.6 (Sep.), 12.7 (Oct.), 9.6 (Nov.), 11.6 (Dec.).

The average precipitation at 1350 m a.s.l. on Mt. Psiloritis (Idi Meterological Station) over 30 years is given as 1,609 mm (Prefecture of Crete).

Fig.2.3.7.: Stations

- Stations of phase 1
- Stations and grid of phase 2



2.3.2.4. Site selection

Once it had been established that a grid system would be used, and the number of cameras was known, the next stage was the locating of the grid. In ideal circumstances, a square grid might have been used, however, considering the distances involved, it was seen to be impractical, as there was no vehicle access to large parts of the survey area. After close examination of the landscape considering, access, vegetation pattern of the area and other factors stated below, the final grid was settled as it is shown in FIG. 2.3.7.. To reach the survey area it takes two hours in a 4x4 vehicle that is capable of ascending the difficult dirt tracks and over five hours walking to visit all the cameras. A more standard grid pattern was not possible as there was neither the manpower nor the funding to facilitate it.

Over the course of this project several important criteria were developed to standardise the locating of phototraps, these are shown as bullet points below. A model 12XL GARMIN® G.P.S. (Global Positioning System) was used throughout, and proved most useful not only to accurately pinpoint all phototraps and transects, but also when combined with Geographical Information System (GIS) computer software. GIS, together with the downloaded GPS data allowed specific points and selected "routes" to be plotted onto electronic maps. With these maps the 156 hectare grid was plotted for the second phototrapping phase of the project, and the location of each phototrap within its cell, its distance from all other traps, and the exact altitude were all recorded automatically. The criteria for site selection on a large scale (100s of meters) are as follows:

- Inclusion in correct height zone, and grid cell.
- Inconspicuous
- Sheltered
- Location in relation to animal pathways

Then, on a much smaller scale (meters) the phototrap is located using the following criteria:

- lat surface for the disc
- anging point for bait
- Enough soil for ‘planting’ the camera
- hade

During the research a prior survey of the area was carried out to increase knowledge of the geomorphology and the vegetation of the territory, thus allowing the location of the most suitable sites.

2.3.3. Data analysis

All the measurements taken on dead specimens were reported on Excel programme. Average values of each measurement per species and Standard Errors (SE) were calculated using this programme. Statistical analyses were carried out on measurements taken on the Cretan forms and those of European species using t-test with one tailed distribution. It was not possible to check the normality data regarding species measurements in other European countries given in the literature because only average values and number of individuals were available, without single measurements. However the t-test analysis comparing data from measurements on Cretan forms and those found in the literature has been performed assuming that the normality criteria were satisfied.

Distribution maps in Crete were obtained from bibliography, direct and indirect indices of presence, using Access 2000 for the data and ArcView G.I.S. 3.1. to make and to shape the maps. The bibliographical and new records are reported in the same map with different symbols for each studied species in Crete and they are shown in Chapter 3. Each map has U.T.M. 10X10 grid.

CHAPTER 3

RESULTS

3.1. INDIRECT INDICES

Faeces of *Martes foina* are very common throughout the island from sea level up to the high mountains (1200m a.s.l.). For *Mustela nivalis* faeces are common as well. These numerous signs of presence could be also due to these animals habits. In fact they generally leave faeces in visible and predictable zones. The vast majority of searches for scats have taken place in the Psiloritis Mts.

Badger's latrines, which are depressed places where the animal normally defecates, were found in two places: Almiros (Irakleio) and Agios Mamas (site C3 and site B2). Tracks were recorded on the snow at the altitudinal range of 500-1000 m in the Agios Mamas area.

During this research wildcat's scat have never been found but tracks have been observed on the snow at the Agios Mamas area, close to the site C1.

3.2. DIRECT INDICES

3.2.1. Morphometrical and morphological data on body and skull

Erinaceus concolor nesiotes: A total of 15 Cretan hedgehogs were measured. Of those, three were female, six were male and two were juvenile males. For four hedgehogs the sex is indeterminable because they were found after road accidents, in a crushed state. All the measurements taken are reported (TABLE 3.2.1.).

NHMC number	**B**	**T**	**HF**	**E**	**W**	**Sex**	**Locality** I= Irakleio L= Lasithi H= Hania R= Rethimnon	Date	**Note**
NHMC 80.5.26.1.			40,66		300		Thrapsano Pediados (I)	19/9/00	Crushed
NHMC 80.5.26.2.	220	20,76	38,11	23,50	250	M	Messeleri (L)	25/8/00	
NHMC 80.5.26.3.	238		40,67	23	550	M	Epanosifi (I)	5/9/00	
NHMC 80.5.26.4.	207	18,27	32,52	14,59	300	M	Xalebi (R)	30/7/96	
NHMC 80.5.26.5.	172	19,3	31,19	15,07	200	F	Patzides (I)	12/7/99	
NHMC 80.5.26.8.	220	13,47	35,51	16,26					
NHMC 80.5.26.11.	210	20,59	39,36	19,25	400	M	Irakleio	13/10/00	
NHMC 80.5.26.13.	240	19,2	40,17	26,15	400	F	Moni Vidianis (L)	2/11/00	
NHMC 80.5.26.14.			41,47		250		Gourves (I)	7/11/00	Crushed
NHMC 80.5.26.15.	159	22,28	26,81	19,61	170	M	Skalani (I)	12/11/00	Juvenile
NHMC 80.5.26.16.	204		32,74	14,91	250		Koloudiana (H)	1/12/00	
NHMC 80.5.26.17.	202	21,51	33,08	20,82	200	M		2/97	
NHMC 80.5.26.18.	204	22,23	35,56	20,96	200	M			Crushed
NHMC 80.5.26.19.	170	20,62	32,15	16,2	196	M	Knossos (I)	10/1/01	Juvenile
NHMC 80.5.26.20.	167	23,17	32,68	15,46	330	F	Kokini Hani	18/1/2001	

TABLE 3.2.1. Mesuraments on *Erinaceus concolor*.

The average values for each character have been calculated. These values are reported for males and females separately, using only measurements taken on specimens whose sex was diagnosable, except for the two juveniles. The average values for the males have been calculated for only the six adult specimens (TABLE 3.2.2.).

	MALES n = 6	**FEMALES** n = 3
Head-body length (B)	**x= 213,5** SE= 5,53	**X = 193** SE= 23,54
Tail length (T)	**x= 20,6** SE= 0,66	**X = 20,5** SE= 1,30
Hind foot length (HF)	**x= 36,5** SE= 1,37	**X = 34,6** SE= 2,77
Ear height (E)	**x= 20,3** SE= 1,31	**X = 18,8** SE= 3,63
Body weight (W)	**x = 316,6** SE= 55,77	**X = 310** SE= 58,59

TABLE 3.2.2. Average values (**x**) and Standard Errors (SE) of measurements from *Erinaceus concolor*.

The t-test analysis with one tailed distribution was applied to compare the average values of the Cretan specimens (males and females separately) to the average values of *Erinaceus concolor* of Rumania, calculated by Simionescu (1977) (In: Niethammer & Krapp, 1990) (Table 3.2.3. & Table 3.2.4.).

Males	**μ**	**x**	**SE**	**Sx**	**T**	
B	268,000	213,500	5,530	2,258	-24,141	df=5
T	28,000	20,600	0,660	0,269	-27,464	a=0,05
HF	42,000	36,500	1,370	0,559	-9,834	**Tc = 2,015049**
E	24,500	20,300	1,310	0,535	-7,853	

TABLE 3.2.3. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Erinaceus concolor nesiotes* , Average values of Rumanian specimens (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

Females	**μ**	**x**	**SE**	**Sx**	**T**	
B	255,000	193,000	23,540	13,591	-4,562	df=2
T	27,000	20,500	1,300	0,751	-8,660	a-0,05
HF	42,000	34,600	2,770	1,599	-4,627	**Tc = 2,919987**
E	25,700	18,800	3,630	2,096	-3,292	

TABLE 3.2.4. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Erinaceus concolor nesiotes* , Average values of Rumanian specimens (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

The T < - Tc for both males and females of *Erinaceus concolor nesiotes*, so that the average values found in the Cretan specimens are statistical inferiors to those of the Rumanian specimens. These values will be discussed in chapter 4.

The hedgehogs examined have very slender spines, whilst both the short and long hair of the abdomen is quite scant.

Mustela nivalis galinthias: A total of nine specimens were measured. Of these, seven were male, one was female and for one specimen the sex was undetermined. All the measurements taken are reported in TABLE 3.2.5.. For the males only (7), the average value for each character was calculated (TABLE 3.2.6.).

	B	**T**	**HF**	**E**	**W**	**Sex**	**Locality** I= Irakleio L= Lasithi H= Hania R= Rethimnon	Date	Notes
NHMC 80.5.62.2	242	96	35,69	14,97	20,5	M	Akrotiri (H)	13/3/00	
NHMC 80.5.62.3	275	107	35,24	11,48			Vrises (H)	15/5/00	Skin
NHMC 80.5.62.4	257	104	42,39	13,77	26,0	M	Gergeri (I)	4/5/99	
NHMC 80.5.62.5	253	99	39,14	12,6	24,0	M	Prina Messaleri (L)	5/7/00	
NHMC 80.5.62.6	245	100	39,27	10,32	23,0	M	Ano Archanes (I)	3/8/95	
NHMC 80.5.62.7	190	87	30,6	9,45	9,5	F	Stavrakia (I)	9/10/98	
NHMC 80.5.62.8	252	110	38,79	13,84	26,0	M	Voutes (I)	9/4/00	
NHMC 80.5.62.9	252	103	40,84	14,79	23,7	M	Pachiamos (L)	23/2/98	
NHMC 80.5.62.16	215	90	40,59	15,03	18,0	M	Rodopou (H)	20/6/00	

TABLE 3.2.5. Mesuraments of *Mustela nivalis*.

	MALE n = 7
Head-body length (B)	**x = 245,1** SE= 5,37
Tail length (T)	**x = 100,2** SE= 2,39
Hind foot length (HF)	**x = 39,5** SE= 0,79
Ear height (E)	**x =13,6** SE= 0,63
Body weight (W)	**x = 23,0** SE= 1,09

TABLE 3.2.6. Average values (**x**) and Standard Errors (SE) of measurements from *Mustela nivalis*.

The t-test analysis with one tailed distribution was applied to compare the average values of the Cretan specimens (males only) to the average values of *Mustela nivalis* of Germany (In: Niethammer & Krapp, 1990) (Table 3.2.7.)

Males	**μ**	**x**	**SE**	**Sx**	**T**	
B	173,800	245,100	5,370	2,030	35,129	df=6
T	40,600	100,200	2,390	0,903	65,978	a=0,05
HF	23,600	39,500	0,790	0,299	53,250	**Tc = 1,943181**
E	12,200	13,600	0,630	0,238	5,879	

TABLE 3.2.7. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Mustela nivalis galinthias*, Average values of German specimens (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

T > Tc for males of *Mustela nivalis galinthias*, so that the average values found in the Cretan specimens are statistical larger than those of the German specimens. These values will be discussed in chapter 4.

All the individuals examined show a very distinct line of demarcation between the colours of the dorsal and ventral surfaces until the throat. The ventral part is white or yellowish and the colour may reach either the anterior or posterior feet or both of them.

Martes foina bunites: A total of 24 beech martens were measured. Of those, 11 were male, 12 were female and for one specimen the sex was impossible to determine. All the measurements taken are reported in TABLE 3.2.8..

	B	**T**	**HF**	**E**	**W**	**Sex**	**Locality**	**Date**	**Notes**
NHMC 80.5.61.4	407	205	70,61	29,54	1100	MM	Bali (R)	17/4/96	
NHMC 80.5.61.5	387	213	67,00	24,55	650	F	Bali (R)	17/4/96	
NHMC 80.5.61.6	406	197	67,72	30,86	730	F	Gonies (I)	11/7/97	
NHMC 80.5.61.7	377	186	68,68	26,73	710	F	Platanos (R)	2/4/00	
NHMC 80.5.61.9	420	228	73,62	30,45	1000	M	Asites (I)	14/10/99	
NHMC 80.5.61.10	445	235	77,14	22,42	1300	M	Pantanasa (I)	4/99	
NHMC 80.5.61.11	454	242	82,00	30,24	1500	MM	Spilia (I)	29/5/95	
NHMC 80.5.61.12	402	215	76,00	32,55	1100	M	Sises (I)	1/4/99	
NHMC 80.5.61.13	410	230	76,07	29,43	1200	MM	Agia Pelagia (I)	20/6/00	
NHMC 80.5.61.14	375	222	66,48	32,19	820	F	Perama (R)	9/3/00	
NHMC 80.5.61.15	397	207	67,79	27,25	800	F	K. Archanes (I)	29/4/99	
NHMC 80.5.61.16	395		63,32	30,53	810	F	Archanes (I)	30/12/99	
NHMC 80.5.61.17	415	224	71,07	30,40	1100	F	Agia Irini (I)	4/11/99	
NHMC 80.5.61.18	432	227	76,66	33,60	1500	MM	Xoumeri (R)	7/4/00	
NHMC 80.5.61.22	425	225	77,00	33,00	1130	FF	Stavromenos (R)	20/6/98	
NHMC 80.5.61.23	420	220	83,00	38,00	780	FF	Hersonissos (I)	11/98	
NHMC 80.5.61.24	415	228	80,00	38,00	1284	MM	Gouves (I)	11/98	
NHMC 80.5.61.25	420	230	56,00		1025	FF	Voutes (I)	25/9/98	
NHMC 80.5.61.30	380	213	70,60	28,12	500	F	Rouvas (R)	5/10/98	
NHMC 80.5.61.31	410	210	80,00	28,56	700	M		31/10/96	
NHMC 80.5.61.32	425	239	65,85	30,22	900	F		5/7/99	
NHMC	400	202	70,54	32,67	650				

80.5.61.33									
NHMC 80.5.61.34	427	244	86,00	28,72	1600	M			
NHMC 80.5.61.35	423	219	77,10	27,68	1400	M	Aghios Miron (I)		

TABLE 3.2.8. Measurements of *Martes foina*. I= Irakleio L= Lasithi H= Hania R= Rethimnon. MM= Mature male, FF= Mature female

The average values for each character have been calculated for the eleven males and the twelve females separately (TABLE 3.2.9.).

	MALES n= 11	**FEMALE** n= 12
Head-body length (B)	**x = 422,2** SE= 4,90	**x = 401,8** SE= 5,52
Tail length (T)	**x = 225,7** SE= 3,75	**x = 216** SE= 4,55
Hind foot length (HF)	**x = 77,7** SE= 1,25	**x = 68,7** SE= 1,92
Ear height (E)	**x = 30,1** SE= 1,17	**x = 30,1** SE= 1,08
Body weight (W)	**x = 1244** SE= 78,95	**x = 829,5** SE= 53,33

TABLE 3.2.9. Average values (**x**) and Standard Errors (SE) of measurements from *Martes foina*.

The t-test analysis with one tailed distribution was applied to compare the average values of the Cretan specimens (males and females separately) to the average values of *Martes foina* of East Germany (Table 3.2.10. & 3.2.11.) and Peloponnise (Table 3.2.12. & 3.2.13.) (In: Niethammer & Krapp, 1990).

Males	**μ**	**x**	**SE**	**Sx**	**T**	
B	455,600	422,200	4,900	1,477	-22,607	df=10
T	248,800	225,700	3,750	1,131	-20,430	a=0,05
HF	86,900	77,700	1,250	0,377	-24,410	**Tc = 1,812462**
E	38,800	30,100	1,170	0,353	-24,662	

TABLE 3.2.10. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Martes foina bunites;* Average values of German specimens (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

Females	μ	x	SE	Sx	T	
B	427,600	401,800	5,520	1,593	-16,191	df=11
T	236,900	216,000	4,550	1,313	-15,912	a=0,05
HF	80,400	68,700	1,920	0,554	-21,109	**Tc = 1,795884**
E	36,300	30,100	1,080	0,312	-19,887	

TABLE 3.2.11. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Martes foina bunites;* Average values of German specimens (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

Males	μ	x	SE	Sx	T	
B	428,300	422,200	4,900	1,477	-4,129	df=10
T	241,600	225,700	3,750	1,131	-14,062	a=0,05
HF	86,000	77,700	1,250	0,377	-22,022	**Tc = 1,812462**
E	39,500	30,100	1,170	0,353	-26,646	

TABLE 3.2.12. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Martes foina bunites;* Average values of Peloponnesian specimens (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

Females	μ	x	SE	Sx	T	
B	370,700	401,800	5,520	1,593	19,517	df=11
T	273,300	216,000	4,550	1,313	-43,625	a=0,05
HF	79,400	68,700	1,920	0,554	-19,305	**Tc = 1,795884**
E	37,500	30,100	1,080	0,312	-23,736	

TABLE 3.2.13. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Martes foina bunites;* Average values of Peloponnesian specimens (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

T < -Tc for both males and females of *Martes foina bunites*, so that the average values found in the Cretan specimens are statistical inferiors to those of the German specimens. The same result was found in respect to the males of Peloponnese. For females the average of body length of the Cretan forms is larger than those found in *Martes foina* from Peloponnese. These values will be discussed in chapter 4.

All the beech martens examined during this research have a white or greyish throat patch, which is always present and evident. The characteristic throat bib marking shows high levels of variability between individuals.

Meles meles arcalus: A total of 14 badgers were examined. Of those seven are males, including a juvenile, and six are females. One of the females was lactating and for one specimen the sex is unknown because it is just a skin. All the measurements taken are reported in TABLE 3.2.14.. The average values for each character have been calculated for the six adult males and the six females separately (TABLE 3.2.15).

	B	**T**	**HF**	**E**	**W**	**Sex**	**Locality**	**Date**	**Notes**
NHMC 80.5.63.2	678	102	100	42,2	9120	MM	Kedros (R)	27/1/99	
NHMC 80.5.63.3	630	101	96	42,6	7300	FF	Garazo (R)	21/3/98	Lactating
NHMC 80.5.63.4	640	150	98	32,9	6800	F	Giuchtas (I)	21/9/95	
NHMC 80.5.63.5	545	121	87	36,63	5000	M	Kounavos (I)	7/3/96	
NHMC 80.5.63.6	750	134	95	31,59			Apostoli Pediados (I)	23/12/97	Skin
NHMC 80.5.63.7	650	143	100	36,7	9200	MM	Agia Pelagia (I)	15/4/97	
NHMC 80.5.63.8	400	130	73	33,5	1200	M	Agia Pelagia (I)	15/4/97	Juvenile
NHMC 80.5.63.9	570	122	81	37,4	5750	F	Koutsouras (L)	20/1/99	
NHMC 80.5.63.10	710	101	94	29,1	8400	F	Gergeri (I)	9/2/00	
NHMC 80.5.63.11	572	132	95	41,66	6700	M	Lastros (L)	24/1/99	
NHMC 80.5.63.14	660	135	95	30,00	8350	MM	Agia Paraskevi (I)	17/1/99	
NHMC 80.5.63.18	579	130	97	35,9	6100	F	Honos (R)	23/11/99	
NHMC 80.5.63.19	573	145	84	39,04	5900	F	Platanias (H)	25/11/00	
NHMC 80.5.63.21	677	120	90	38,81	6750	MM		12/00	

TABLE 3.2.14.: Measurements of *Meles meles*. MM= Mature male, FF= Mature female.

	MALE n= 6	**FEMALE** n= 6
Head-body length (B)	ξ**= 630,3** SE= 23,38	ξ**= 617** SE= 22,31
Tail length (T)	ξ**= 125,5** SE= 5,89	ξ**= 124,8** SE= 8,58
Hind foot length (HF)	ξ**= 94,5** SE= 2,14	ξ**= 91,66** SE= 3,48
Ear height (E)	ξ**= 37,6** SE= 1,81	ξ**= 36,1** SE= 1,93
Body weight (W)	ξ**= 7520** SE= 675,45	ξ**= 6708** SE= 414,81

TABLE 3.2.15. Average values (**x**) and Standard Errors (SE) of measurements from *Meles meles*.

The t-test analysis with one tailed distribution was applied to compare the average values of the Cretan specimens (males and females separately) to the average values of *Meles meles* of Germany (Table 3.2.16. & 3.2.17.), England (Table 3.2.18. & 3.2.19.) and Switzerland (Table 3.2.20. & 3.2.21.) (In: Niethammer & Krapp, 1990).

Males	**μ**	**x**	**SE**	**Sx**	**T**	
B	813,000	630,300	23,380	9,545	-19,141	df=5
T	135,000	125,500	5,890	2,405	-3,951	a=0,05
HF	109,000	94,500	2,140	0,874	-16,597	**Tc = 2,015049**

TABLE 3.2.16. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Meles meles arcalus;* Average values of German specimens (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

Females	**μ**	**x**	**SE**	**Sx**	**T**	
B	785,000	617,000	22,310	9,108	-18,445	df= 5
T	140,000	124,800	8,580	3,503	-4,339	a-0,05
HF	107,000	91,660	3,480	1,421	-10,797	**Tc = 2,015049**

TABLE 3.2.17. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Meles meles arcalus;* Average values of German specimens (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

Males	μ	x	SE	Sx	T	
B	685,000	630,300	23,380	9,545	-5,731	df=5
T	155,000	125,500	5,890	2,405	-12,268	a=0,05
HF	105,000	94,500	2,140	0,874	-12,019	**Tc = 2,015049**

TABLE 3.2.18. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Meles meles arcalus;* Average values of English specimens (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

Females	μ	x	SE	Sx	T	
B	660,000	617,000	22,310	9,108	-4,721	df=5
T	155,000	124,800	8,580	3,503	-8,622	a=0,05
HF	105,000	91,660	3,480	1,421	-9,390	**Tc = 2,015049**

TABLE 3.2.19. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Meles meles arcalus;* Average values of English specimens (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

Males	μ	x	SE	Sx	T	
B	778,000	630,300	23,380	9,545	-15,474	df=5
T	163,000	125,500	5,890	2,405	-15,595	a=0,05
HF	114,000	94,500	2,140	0,874	-22,320	**Tc = 2,015049**

TABLE 3.2.20. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Meles meles arcalus;* Average values of specimens from Switzerland (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

Females	μ	x	SE	Sx	T	
B	732,000	617,000	22,310	9,108	-12,626	df=5
T	163,000	124,800	8,580	3,503	-10,906	a=0,05
HF	108,000	91,660	3,480	1,421	-11,501	**Tc = 2,015049**

TABLE 3.2.21. t-test analysis, Average values (**x**) and Standard Errors (**SE**) of *Meles meles arcalus;* Average values of specimens from Switzerland (**μ**), **Sx**= SE/√ n, **df**= degrees of freedom, **Tc**= T critical.

The T < - Tc for both males and females of *Meles meles arcalus*, so that the average values found in the Cretan specimens are statistical inferiors to those of the specimens from Germany, England and Switzerland. These values will be discussed in chapter 4.

Felis silvestris cretensis: Eight Cretan cats have been studied, of those four (NHMC 80.5.65.1, NHMC 80.5.65.3, NHMC 80.5.65.7. and NHMC 80.5.65.9) have been recognised as *Felis silvestris cretensis* and four have been described as hybrids (*Felis silvestris cretensis* x *Felis silvestris catus*) (TABLE 3.2.22.).

	Museum number	**Locality**	**Date**	**Leg.**	**Identified by**	**Probable determination**
Live sp.	**NHMC 80.5.65.1.**	Psiloritis	April 1996	Belardinelli-Cicconi	External morphology & morphometrics	F.s.cretensis
Live sp.	**NHMC 80.5.65.2.**	Lasithi plateau	October 1996	Lymberakis	External morphology & morphometrics	*F.s.cretensis* x *F.s.catus*
Dead sp.	**NHMC 80.5.65.3.**	Lasithi plateau	October 1996	Lymberakis	External morphology & morphometrics	***F.s.cretensis***
Dead sp	**NHMC 80.5.65.4.**	Lasithi plateau	January 1997	Mylonas	External morphology & morphometrics	*F.s.cretensis* x *F.s.catus*
Dead sp	**NHMC 80.5.65.7.**	Lefka Ori	November 1997	Lymberakis	Skull morphometrics	***F.s.cretensis***
Dead sp	**NHMC 80.5.65.9.**	Psiloritis	July 1998	Belardinelli-Lymberakis	Skull morphometrics	***F.s.cretensis***
Dead sp	**NHMC 80.5.65.10.**	Lasithi plateau	December 1998	Afordakos	Skull and external morphology & morphometrics	*F.s.cretensis* x *F.s.catus*
Dead sp	**NHMC 80.5.65.11.**	Psiloritis	September 2000	Belardinelli-Papadimitrakis	Skull morphometric	*F.s.cretensis* x *F.s.catus*

TABLE 3.2.22. Determination on *Felis silvestris*.

Of three specimens recognised as *Felis silvestris cretensis* (NHMC 80.5.65.1, NHMC 80.5.65.3 and NHMC 80.5.65.9) body measurements were taken (TABLE 3.2.23.) and on two of them (NHMC 80.5.65.1. and NHMC 80.5.65.3), coat colour and marking system were analysed according to Ragni & Possenti (1996). The specimen NHMC 80.5.65.9 was found in an advanced state of decomposition thus only body measurement could be taken and no coat-colour or markings observations were done. From a secure hybrid individual (NHMC 80.5.65.4) body measurements were also taken and are showed in the table 3.2.23..

	NHMC 80.5.65.1.	**NHMC 80.5.65.3.**	**NHMC 80.5.65.9.**	NHMC 80.5.65.4.
Head-body length	576	440	570	600
Tail length	325	275	285	265
Hind foot length	121	115	126	125
Ear height	55	34	50	55
Ear's tuft height	7		5	4
Canine height	9,7	9,5	10,5	8,8
Canine length	6,5	3,9	5,20	4,7
Body weight	5,5 Kg	3 Kg		5 kg
Sex	Male	Female	Female	Male
Age	> 5 years	< 3 years	<3 years	<5 years

TABLE 3.2.23. Measurements on *Felis silvestris*.

From the three specimens of *Felis silvestris cretensis* whose body measurements were taken, two were females and one was a male. In the table below (TABLE 3.2.24.) the average values for each character have been calculated for females. In the same table the correspondent values for the single male have been reported.

The t-test analysis with one tailed distribution is not applicable to the low number of measurements on the Cretan wildcat. These values are compared to those of *Felis silvestris silvestris* and *Felis silvestris libyca* var. Sarda of Italian population (Ragni, 1981) and discussed in chapter 4.

	FEMALE (n= 2)	**MALE (n=1)**
Head-tail length	**x = 505** SE= 65	**576**
Tail length	**x = 280** SE= 5	**325**
Hind foot length	**x = 120.5** SE= 5,5	**121**
Ear height	**x = 42** SE=8	**55**

Ear's tuft height	**5**	**7**
Sup. canine length	**x = 4.55** SE= 0,65	**6.5**
Sup. canine height	**x = 10** SE=0,5	**9.7**
Weight	**3000**	**5500**

TABLE 3.2.24. Average values (**x**) and Standard Errors (SE) of measurements from *Felis silvestris*.

The coat colour pattern and marking system of two individuals (NHMC 80.5.65.1 and NHMC 80.5.65.3) were examined in the eight somatic regions used for the identification. The colour and marking system of the coat of specimen NHMC 80.5.65.1 falls in the middle of the ranges of *F. s. silvetris* and *F. s. libyca* (var. *Sarda)* phenotypes, perhaps more closely related with the latter one. The specimen NHMC 80.5.65.3 generally has typical *F.s.libyca* characters, except for the caudal region. In Table 3.2.25. each morphological character examined in the two Cretan specimens is compared to the percentage of frequencies of the same character in the two phenotypes *F.s.silvestris* and *F.s.libyca*. The *Rhinarium* was found to be without upper black margin for both Cretan wildcats. This character has been found 2% in *F.s.silvestris* and 100% in *F.s.libyca* (Table 3.2.25.). The somatic regions of *Pinnae* were found to be with brown-black hair formations in the top for both Cretan specimens. This character is found 100% in *F.s.libyca* (Table 3.2.25.). The specimen NHMC 80.5.65.1 has permanent collars in the *Gularis* region (100% *F.s.libyca* character), while the wildcat NHMC 80.5.65.3 does not have any marking in this somatic region. This character was found to be rare for cats. In fact it was present only 4% in *F.s.silvestris*, 0% in *F.s.libyca* (Table 3.2.25.) and 3% in domestic cats. The somatic region *Occipitalis-Cervicalis* was found to be with four longitudinal stripes and one median evanescent in the specimen NHMC 80.5.65.1. This character is quite common in *F.s.silvestris* (96%) and completely absent in *F.s.libyca* (0%) (Table 3.2.25.). The opposite result was found in the same somatic region for the specimen NHMC 80.5.65.3. The disorderly patterns found in this specimen are typical of *F.s.libyca* (100%) and absent in *F.s.silvestris* (0%) (Table 3.2.25.). The *Scapularis* was found to be a 100% *F.s.silvestris* character for the specimen

NHMC 80.5.65.1 (two parallel longitudinal stripes plus one intermediate) and 100% *F.s.libyca* character for the specimen NHMC 80.5.65.3 (disorderly pattern) (Table 3.2.25.). The *Dorsalis* region with longitudinal median band was found to be the same for both individuals. This character has never been found in *F.s.silvestris* and is found just 7% of time in *F.s.libyca* (Table 3.2.25.). The disorderly pattern in the *Lateralis* region is common character for both specimens, found 95% in *F.s.libyca* (Table 3.2.25.). The *Caudalis*, for both individuals, had a dorsal longitudinal median evanescent bar, which was found 100% in *F.s.silvestris* (Table 3.2.25.).

The specimen NHMC 80.5.65.3 is definitely more displaced to characters that are typically *F.s.libyca*, while NHMC 80.5.65.1 seems to fall in the middle of the range of the two phenotypes. The same method of analysis was applied to another specimen (NHMC 80.5.65.4) identified as hybrid because the coat colour pattern and marking system were found to be in the middle ranges between the three European phenotypes (European, African and domestic).

	FREQUENCIES %			
	NHMC 80.5.65.1.		NHMC 80.5.65.3.	
	silvestris	*libyca*	*silvestris*	*libyca*
RHINARIUM	2	100	2	100
PINNAE	4	100	4	100
GULARIS	0	100	4	0
OCCIPITALIS-CERVICALIS	96	0	0	100
SCAPULARIS	100	0	0	100
DORSALIS	0	7	0	7
LATERALIS	7	95	7	95
CAUDALIS	100	54	100	54

TABLE 3.2.25. Frequencies of characters. The percentages of frequencies of each character in the two different phenotypes (*F.s.silvestris* and *F.s.libyca*) were analysed in a study carried out by Ragni & Possenti (1996) on 113 specimens of wildcat (African and European) collected in different part of Italy, comprise Sardinia in which the African wildcat occurs.

Morphometrical traits and parameters were observed and measured on the cranium of four specimens (NHMC 80.5.65.7, NHMC 80.5.65.9, NHMC 80.5.65.10 and NHMC 80.5.65.11), using Schauenberg's method (Schauenberg, 1969) (TABLE 3.2.26.). For two of them (NHMC 80.5.65.7 and NHMC 80.5.65.9) the characters observed and measured on the cranium show a very interesting mix between *F.s.silvestris* (European wildcat) and *F.s.libyca* (African wildcat). The specimen NHMC 80.5.65.7 has the frontal and nasal nose juncture on a plane that is a typical *F.s.silvestris* character while the area of the occipital foramen and the distance between orbitary process are *F.s.libyca* characters. The cranial index calculated for the specimen has a value that is conforms for both wild phenotypes while the carnassial teeth dimension is more a *F.s.silvestris* character than *F.s.libyca*. The specimen NHMC 80.5.65.9 has the area of the occipital foramen and the distance between orbitary processes values that are typical of the *F.s.silvestris* range while the frontal and nasal nose juncture is a *F.s.libyca* character. As in the specimen described above the cranial index is shared in both phenotypes while the robustness of the teeth is more *F.s.silvestris* character. The cranial measurements of the specimen NHMC 80.5.65.10 seems to fall in between the wild and domestic phenotypes thus it has been recognised as hybrid. In fact the cranial index calculated for this specimen was found to be comprised in the *F.s.catus* range, while all the other characters are shared by *F.s.libyca* and *F.s.catus* phenotypes.

The specimen NHMC 80.5.65.11. has been recognised as hybrid as well because the cranial index was found to be comprise in the *F.s.catus* range. The frontal and nasal nose juncture is on a plane as it is in *F.s.silvestris* and the other characters are shared by the domestic cat (*F.s.catus*) and the African wildcat (*F.s.libyca*).

	Range	**NHMC 80.5.65.7.**	**NHMC 80.5.65.9.**	**NHMC 80.5.65.10.**	**NHMC 80.5.65.11.**
Cranial index	*F.s.silvestris* & *F.s.libyca* <2.75 *F.s.catus* >2.75	2.6	2.5	3.4	3.5
Frontal	*F.s.silvestris* on a plane	On a plane	On a	On a	On a plane

and nasal nose juncture	*F.s.libyca* on a depression		depression	depression	
Carnassial teeth	*F.s.silvestris*> *F.s.libyca*	Significantly greater	Significantly greater	Greater	
Occipital foramen	*F.s.silvestris* >141 *F.s.catus* <141 *F.s.libyca* usually<141	138.07	150.3	97.026	108.6
Distance between Orbitary Processes	*F.s.silvestris* < 3mm *F.s.catus* > 3mm *F.s.libyca* usually> 3mm	5.5	2	6	6.7

TABLE 3.2.26.: Morphometrical parameters of the cranium of *Felis silvestris*.

3.2.2. Phototrapping

1st phase

During the first phase of the research, from the 2nd of March till the 7th of April 2000, a total of 144 photographs were obtained. Of these, 78 pictures were taken showing the presence of all four carnivores (TABLE 3.2.27., 3.2.28. and 3.2.29.).

Species	**Agios Mamas Site 1 (0-500m)**	**Agios Mamas Site 2 (500-1000m)**	**Agios Mamas Site 3 (over 1000m)**
	Photos	Photos	Photos
Meles meles	0	0	0
Martes foina	6	0	0
Erinaceus concolor	1	6	0
Felis silvestris	0	0	2
Mustela nivalis	0	6	0

TABLE 3.2.27. Number of photos in Agios Mamas transect

Species	**Anogia Site 1 (0-500m)**	**Anogia Site 2 (500-1000m)**	**Anogia Site 3 (over 1000m)**
	Photos	Photos	Photos
Meles meles	5	0	0
Martes foina	4	0	17
Erinaceus concolor	0	0	0
Felis silvestris	0	0	0
Mustela nivalis	24	0	0

TABLE 3.2.28. Number of photos in Anogia transect

Species	Rouvas Site 1 (0-500m)	Rouvas Site 2 (500-1000m)	Rouvas Site 3 (over 1000m)
	Photos	Photos	Photos
Meles meles	0	0	0
Martes foina	0	1	0
Erinaceus concolor	11	2	0
Felis silvestris	0	0	0
Mustela nivalis	5	8	0

TABLE 3.2.29. Number of photos in Rouvas transect

The most common visitor was the weasel (43), followed by the beech marten (28), the badger (5) and the wild cat (2) (FIG. 3.2.1., 3.2.2., 3.2.3. & 3.2.4.). A total of 20 photos were taken of the hedgehog (FIG.3.2.5.). Other animals including rodents, birds, dogs, pigs, and goats were also photographed during the investigation (46 in total) (FIG.3.2.6. & 3.2.7.).

The total trap-nights for each camera were of 36. On the GRAPHS 3.2.1. (Agios Mamas), 3.2.2. (Anogia) and 3.2.3. (Rouvas), the number of the photos and the corresponding numbers of individuals for each site are reported.

Fig.3.2.1. The Weasel (*Mustela nivalis galinthias)*

Fig.3.2.2.The Beech Marten (*Martes foina bunites*)

Fig.3.2.3. The Badger (*Meles meles arcalus*)

Fig. 3.2.4. The Wildcat (Felis silvestris cretensis) (A pregnant female, Ragni personal comunication)

Fig.3.2.4. The Wildcat (*Felis silvestris cretensis*)

Fig. 3.2.5. The Hedgehog (*Erinaceus concolor nesiotes*)

Fig. 3.2.6. The Jay (*Garrulus glandarius*).

Fig. 3.2.7. The Buzzard (*Buteo buteo*).

A total of 7 individuals of *Martes foina*, 8 of *Mustela nivalis*, 9 of *Erinaceous concolor*, 1 *Meles meles* and 1 *Felis silvestris* were photographed (TABLES 3.2.30. 3.2.31. & 3.2.32.).

Species	**Agios Mamas Site 1 (0-500m)**	**Agios Mamas Site 2 (500-1000m)**	**Agios Mamas Site 3 (over 1000m)**
	Individuals	Individuals	Individuals
Meles meles	0	0	0
Martes foina	2	0	0
Erinaceus concolor	1	2	0
Felis silvestris	0	0	1
Mustela nivalis	0	3	0

TABLE 3.2.30. Number of individuals in Agios Mamas transect

Species	**Anogia Site 1 (0-500m)**	**Anogia Site 2 (500-1000m)**	**Anogia Site 3 (over 1000m)**
	Individuals	Individuals	Individuals
Meles meles	0	0	0
Martes foina	2	0	2
Erinaceus concolor	0	0	0
Felis silvestris	0	0	0
Mustela nivalis	2	0	0

TABLE 3.2.31. Number of individuals in Anogia transect

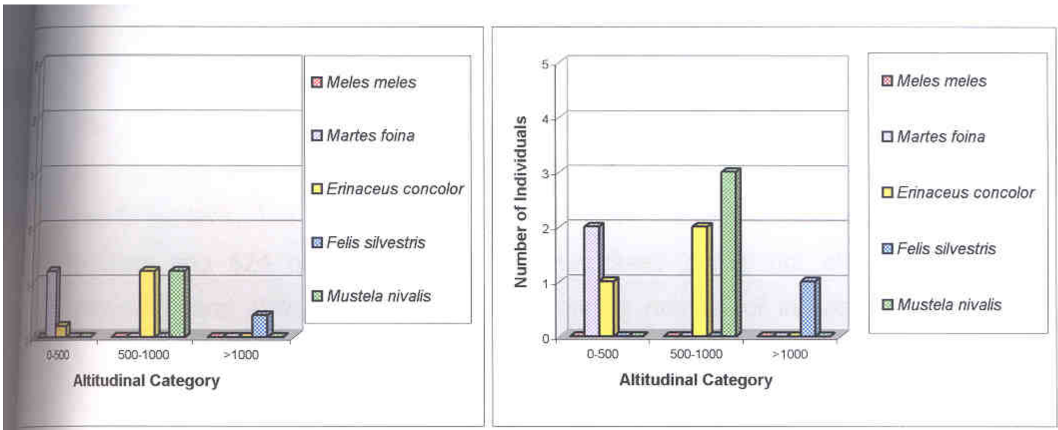
Species	**Rouvas Site 1 (0-500m)**	**Rouvas Site 2 (500-1000m)**	**Rouvas Site 3 (over 1000m)**
	Individuals	Individuals	Individuals
Meles meles	0	0	0
Martes foina	0	1	0
Erinaceus concolor	5	1	0
Felis silvestris	0	0	0
Mustela nivalis	2	1	0

TABLE 3.2.32. Number of individuals in Rouvas transect

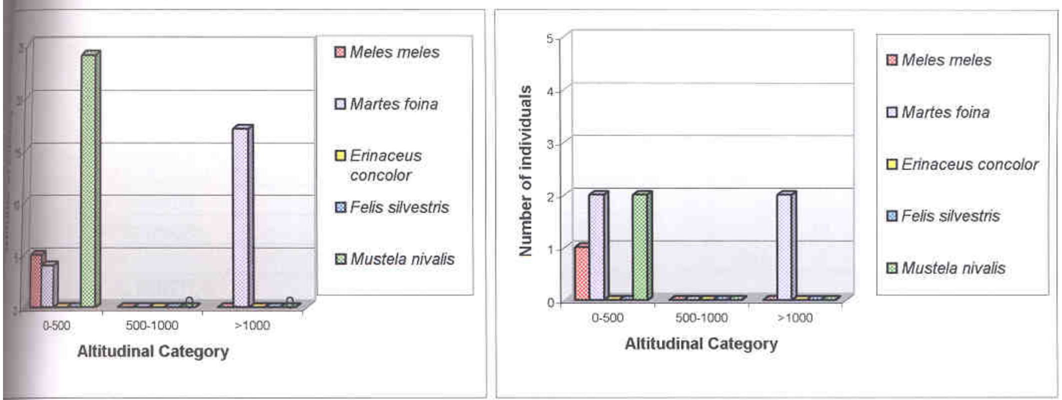
There are many differences regarding the altitude where the species were found and the time of the day when they were "caught" in the phototrap. The hedgehog has been photographed at the two altitudinal zones of 0-500 and 500-1000 m, as well as the weasel and they were not found at an altitude above 1000m. The beech marten has been photographed in all the three altitudinal ranges from 0 to over 1000m, whereas the wildcat was only found over 1000m of altitude and the badger from 0 to 500m.

The weasel seems to be a prevalent diurnal predator because it was photographed during daylight.

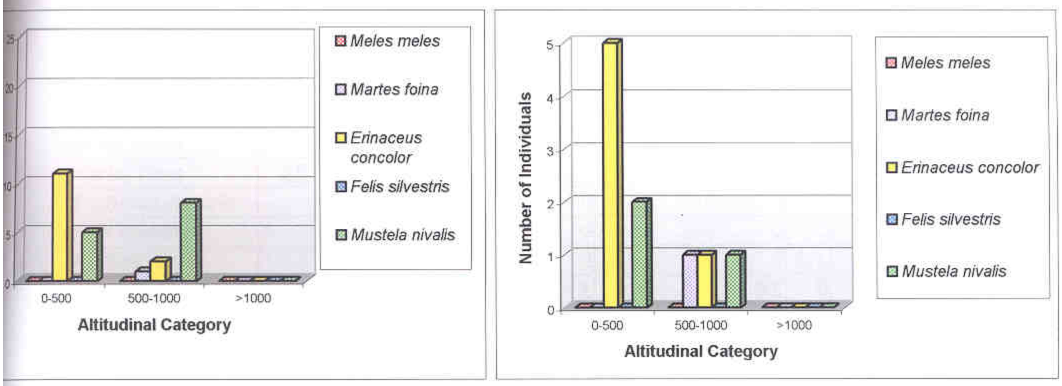
On the 15th of March at 22:12 for the first photo and 22:16 for the second, during the second week of the research, the wildcat was photographed at the highest station at Agios Mamas, called B2 in the second phase of the research. During the two consecutive visits (7 and 14 days after the first photos) the area was found covered by snow. This fact may have deprived other possible photos of the cat. The pictures of the wildcat were taken after 12 trap-nights. From the analysis of the photograph it was possible to identify the specimen as a probably pregnant female (Ragni, personal communication).



3.2.1. Graphs of Agios Mamas transect



3.2.2. Graphs of Anogia transect



3.2.3. Graphs of Rouvas transect

2nd phase

During the second phase of the research from 1st of May 2000 to the end of May 2001, the area of Agios Mamas was investigated. The total trap-nights for each camera were of 396. A total of 1873 photos were taken: 1059 photos of beech martens, 162 of hedgehogs, 21 photos of weasels, 2 of badgers, 5 of wildcats and 624 of other animals (mainly *Buteo buteo*, but also *Garrulus glandarius* and *Rattus rattus*). The corresponding number of individuals of the studied species are written in each table (TABLES 3.2.33., 3.2.34., 3.2.35., 3.2.36., 3.2.37., 3.2.38., 3.2.39.,.3.2.40.,.3.2.41., 3.2.42., 3.2.43., 3.2.44.) .

Species Present MAY 2000	**A2**	**B -1**	**B0**	**B1**	**B2**	**C -1**	**C0**	**C1**	**C2**	**C3**	**TOTAL**
Meles meles	0	0	0	0	0	0	0	**2/**1	0	0	**2**
Martes foina	**2**/2	0	0	0	**17/**2	0	0	**1/**1	0	0	**20**
Erinaceus concolor	0	0	**29/**2	0	0	0	0	**2/**1	0	0	**31**
Felis silvestris	0	0	0	0	0	0	0	0	0	0	**0**
Mustela nivalis	0	0	0	0	0	0	0	0	0	0	**0**
Others	0	0	**6**	**10**	0	0	0	**40**	0	0	**56**
TOTAL PHOTOS											**109**

TABLE 3.2.33. Number of photos in May (**photos**/ individuals).

Species Present JUNE 2000	**A2**	**B -1**	**B0**	**B1**	**B2**	**C -1**	**C0**	**C1**	**C2**	**C3**	**TOTAL**
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	**25**/2	0	0	0	**78**/6	0	**2**/1	0	0	0	**105**
Erinaceus concolor	0	0	**13**/5	0	0	0	0	0	0	0	**13**
Felis silvestris	0	0	0	0	0	0	0	0	0	0	**0**
Mustela nivalis	0	0	0	0	0	0	0	0	**1**/1	0	**1**
Others	0	**27**	**1**	**12**	**1**	0	0	**51**	0	0	**92**
TOTAL PHOTOS											**211**

TABLE 3.2.34. Number of photos in June (**photos**/ individuals).

Species Present JULY 2000	**A2**	**B -1**	**B0**	**B1**	**B2**	**C -1**	**C0**	**C1**	**C2**	**C3**	**TOTAL**
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	0	**30**/7	0	0	**41**/9	**1**/1	0	**5**/5	**1**/1	0	**78**
Erinaceus concolor	0	0	0	0	0	**13**/4	0	**3**/2	**1**/1	0	**17**
Felis silvestris	0	0	0	0	0	0	0	0	0	0	**0**
Mustela nivalis	0	0	0	0	0	0	0	0	0	0	**0**
Others	0	**17**	0	0	**4**	0	0	**46**	0	0	**67**
TOTAL PHOTOS											**162**

TABLE 3.2.35. Number of photos in July (**photos**/ individuals).

Species Present AUGUST 2000	**A2**	**B -1**	**B0**	**B1**	**B2**	**C -1**	**C0**	**C1**	**C2**	**C3**	**TOTAL**
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	0	**2**/1	0	0	**18**/4	0	**3**/2	**3**/1	**12**/4	0	**38**
Erinaceus concolor	0	0	**20**/8	0	0	0	**11**/5	**1**/1	0	0	**32**
Felis silvestris	0	0	0	0	0	0	0	0	0	0	**0**
Mustela nivalis	0	0	0	0	0	**2**/1	0	0	0	0	**2**
Others	0	**22**	**31**	0	**2**	**18**	**7**	**22**	**1**	0	**103**
TOTAL PHOTOS											**175**

TABLE 3.2.36. Number of photos in August (**photos**/ individuals).

Species Present SEPTEMBER 2000	**A2**	**B -1**	**B0**	**B1**	**B2**	**C -1**	**C0**	**C1**	**C2**	**C3**	**TOTAL**
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	0	**59**/7	0	0	**36**/3	0	**10**/3	**58**/5	0	**18**/6	**181**
Erinaceus concolor	0	0	0	0	0	**33**/4	**14**/4	0	0	0	**47**
Felis silvestris	0	0	0	0	0	0	0	0	0	0	**0**
Mustela nivalis	**5**/2	0	0	0	0	0	0	0	0	0	**5**
Others	0	0	0	0	**1**	**24**	0	**5**	0	**11**	**41**
TOTAL PHOTOS											**274**

TABLE 3.2.37. Number of photos in September (**photos**/ individuals).

Species Present OCTOBER 2000	**A2**	**B -1**	**B0**	**B1**	**B2**	**C -1**	**C0**	**C1**	**C2**	**C3**	**TOTAL**
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	0	**27**/5	0	**73**/3	**38**/4	0	**15**/2	0	**12**/7	0	**165**
Erinaceus concolor	0	0	0	0	0	0	**13**/5	0	0	0	**13**
Felis silvestris	0	0	0	0	0	0	0	0	0	0	**0**
Mustela nivalis	0	0	0	0	0	0	0	0	0	0	**0**
Others	0	0	0	**4**	0	**27**	**14**	0	0	0	**45**
TOTAL PHOTOS											**223**

TABLE 3.2.38. Number of photos in October (**photos**/ individuals).

Species Present NOVEMBER 2000	**A2**	**B -1**	**B0**	**B1**	**B2**	**C -1**	**C0**	**C1**	**C2**	**C3**	**TOTAL**
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	0	0	0	0	0	0	0	**36**/3	**8**/4	0	**44**
Erinaceus concolor	0	0	0	0	0	0	0	0	0	0	**0**
Felis silvestris	0	0	0	0	0	0	0	0	0	0	**0**
Mustela nivalis	0	0	0	0	0	0	0	0	0	0	**0**
Others	0	0	0	0	0	**30**	**24**	0	0	0	**54**
TOTAL PHOTOS											**98**

TABLE 3.2.39. Number of photos in November (**photos**/ individuals).

Species Present DECEMBER 2000	**A2**	**B -1**	**B0**	**B1**	**B2**	**C -1**	**C0**	**C1**	**C2**	**C3**	**TOTAL**
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	0	0	0	**4**/2	**28**/5	0	0	0	0	0	**32**
Erinaceus concolor	0	0	0	0	0	0	0	0	0	0	**0**
Felis silvestris	0	0	0	0	0	0	0	0	0	0	**0**
Mustela nivalis	0	0	0	0	0	0	0	0	0	0	**0**
Others	0	0	0	0	0	0	**35**	0	0	0	**35**
TOTAL PHOTOS											**67**

TABLE 3.2.40. Number of photos in December (**photos**/ individuals).

Species Present JANUARY 2001	A2	B -1	B0	B1	B2	C -1	C0	C1	C2	C3	TOTAL
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	0	**12**/9	0	0	**1**/1	0	**1**/1	0	**33**/1	0	**47**
Erinaceus concolor	0	0	0	0	0	0	**1**/1	0	0	0	**1**
Felis silvestris	0	0	0	0	0	0	0	0	0	0	**0**
Mustela nivalis	0	0	0	0	0	0	0	0	0	0	**0**
Others	0	0	0	0	0	**36**	**33**	0	0	0	**69**
TOTAL PHOTOS											**117**

TABLE 3.2.41. Number of photos in January (**photos**/ individuals).

Species Present FEBRUARY 2001	A2	B -1	B0	B1	B2	C -1	C0	C1	C2	C3	TOTAL
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	0	0	0	0	0	**27/**4	**19**/4	**35**/1	**25**/5	0	**106**
Erinaceus concolor	0	0	0	0	0	0	0	0	0	0	**0**
Felis silvestris	0	0	0	0	0	0	0	0	0	0	**0**
Mustela nivalis	0	0	0	0	0	0	0	0	0	0	**0**
Others	0	0	0	0	0	0	0	0	0	0	**0**
TOTAL PHOTOS											**106**

TABLE 3.2.42. Number of photos in February (**photos**/ individuals).

Species Present MARCH 2001	A2	B -1	B0	B1	B2	C -1	C0	C1	C2	C3	TOTAL
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	**2**/2	**8**/1	0	0	0	0	**35**/3	0	0	0	**45**
Erinaceus concolor	0	0	0	0	0	0	0	0	0	0	**0**
Felis silvestris	0	0	0	0	0	0	0	0	0	0	**0**
Mustela nivalis	**2**/2	0	0	**9**/4	0	0	0	0	0	0	**11**
Others	0	0	0	0	0	0	0	0	0	0	**0**
TOTAL PHOTOS											**56**

TABLE 3.2.43. Number of photos in March (**photos**/ individuals).

Species Present	A2	B -1	B0	B1	B2	C -1	C0	C1	C2	C3	TOTAL

APRIL 2001											
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	**4**/1	**5**/2	**32**/2	0	0	**2**/1	0	**71**/3	**8**/4	0	**122**
Erinaceus concolor	0	0	0	0	0	0	**8/**3	0	0	0	**8**
Felis silvestris	0	0	0	0	0	0	**3**/1	0	0	0	**3**
Mustela nivalis	0	0	0	0	0	0	0	0	0	0	**0**
Others	0	0	0	**27**	0	**35**	0	0	0	0	**62**
TOTAL PHOTOS											**195**

TABLE 3.2.44. Number of photos in April (**photos**/ individuals).

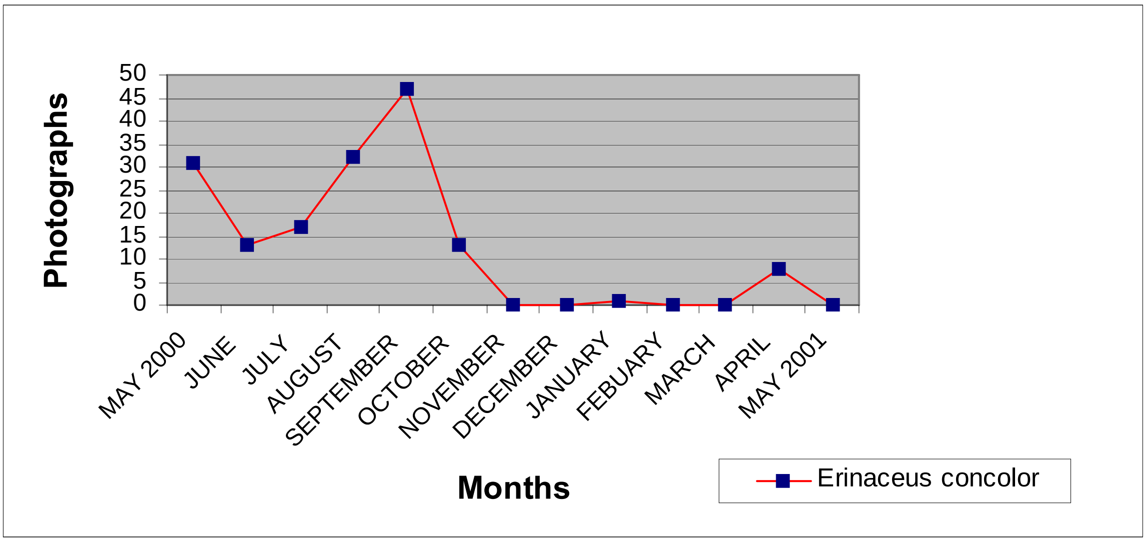
Species Present MAY 2001	**A2**	**B -1**	**B0**	**B1**	**B2**	**C -1**	**C0**	**C1**	**C2**	**C3**	**TOTAL**
Meles meles	0	0	0	0	0	0	0	0	0	0	**0**
Martes foina	**16**/1	0	**35**/2	0	0	0	0	0	**25**/7	0	**76**
Erinaceus concolor	0	0	0	0	0	0	0	0	0	0	**0**
Felis silvestris	0	0	0	**1**/1	0	0	0	0	**1**/1	0	**2**
Mustela nivalis	**2**/1	0	0	0	0	0	0	0	0	0	**2**
Others	0	0	0	0	0	0	0	0	0	0	**0**
TOTAL PHOTOS											**80**

TABLE 3.2.45. Number of photos in May (**photos**/ individuals).

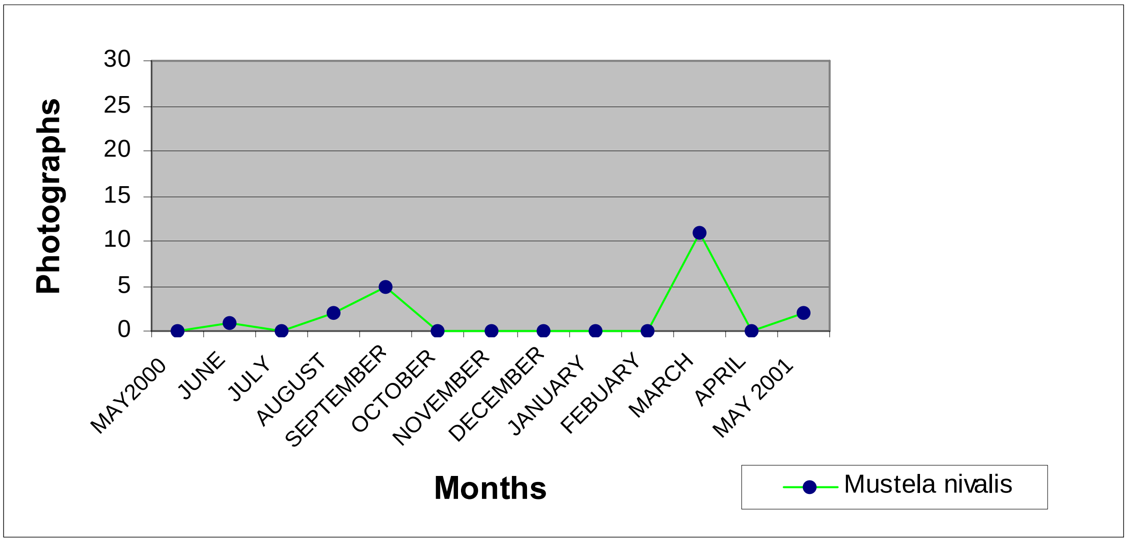
The beech marten’s pictures correspond to 163 individuals of which 4 animals are in 9 photographs seen in couples. The 162 pictures of hedgehogs correspond to 46 individuals whereas the pictures of weasels are considered as 11 specimens, the badger is only one individual and the wildcats are three specimens. The weasels as well as the only badger photographed were caught during daylight.

3.2.2.1 Total activity

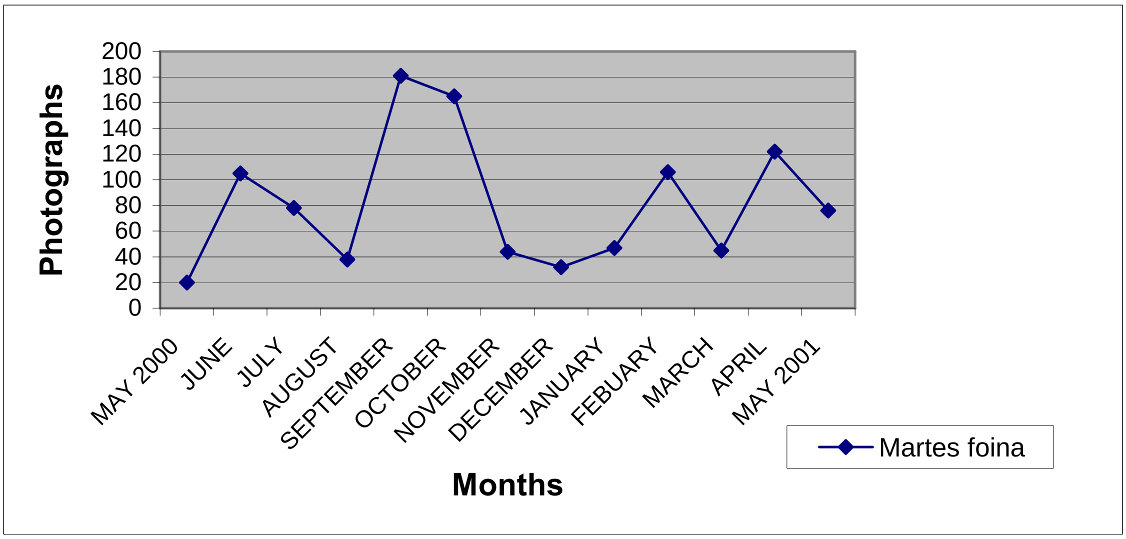
In GRAPHS 3.2.4 – 3.2.8 the total activities of the studied animals are shown. The graphs show the number of photographs taken per mounth and will be more fully discussed and analysed in Chapter 4.



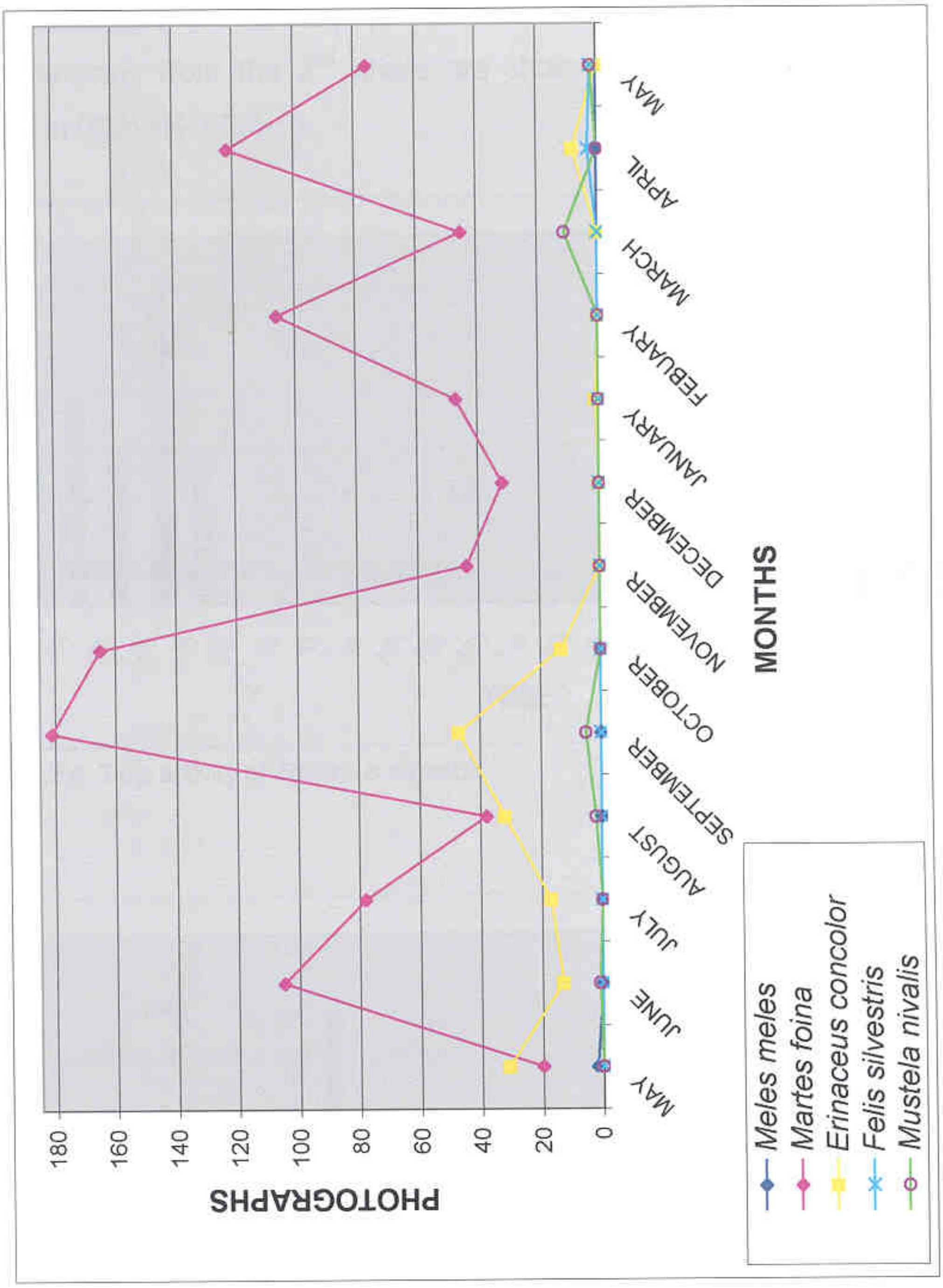
GRAPH 3.2.4. Total activity of *Erinaceus concolor*.



GRAPH 3.2.5. Total activity of *Mustela nivalis*.



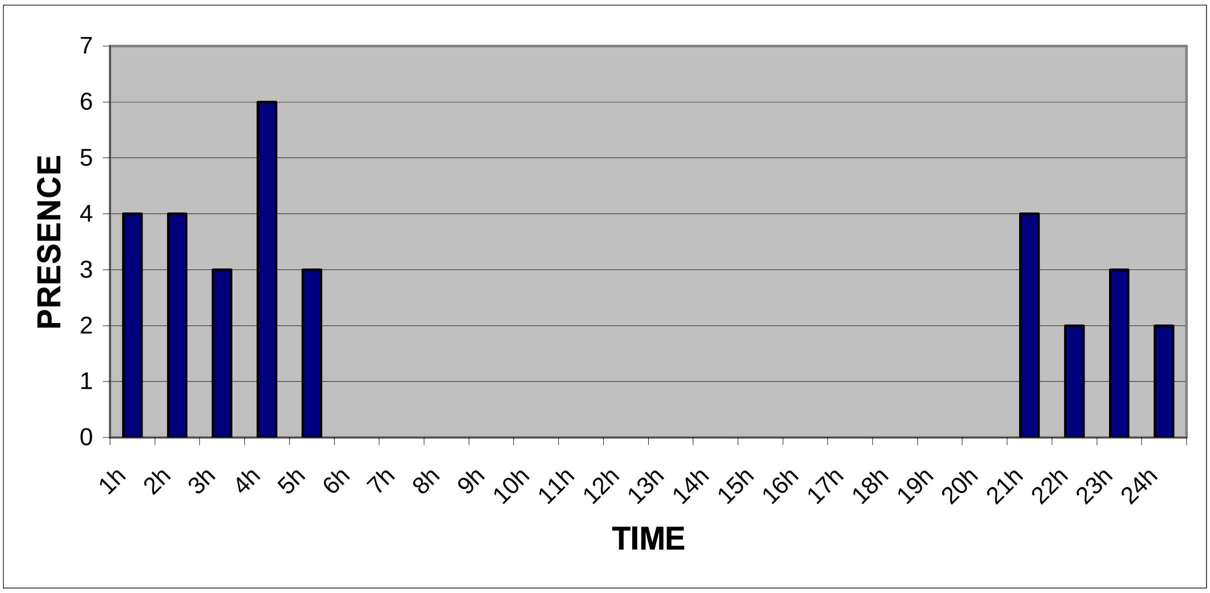
GRAPH 3.2.6. Total activity of *Martes foina*.



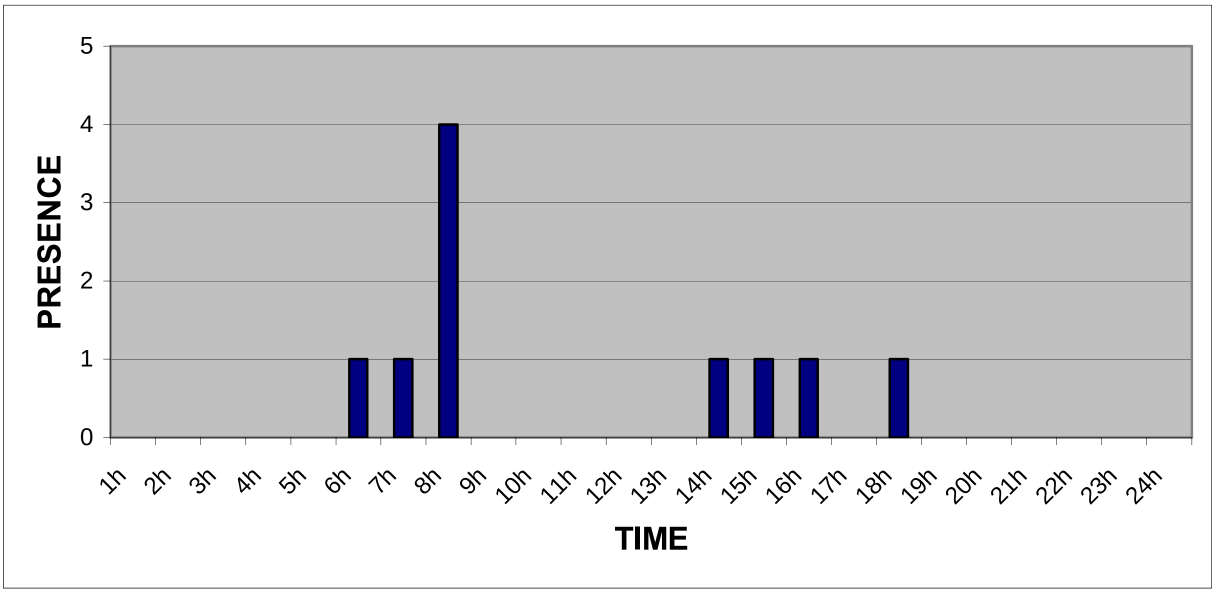
Graph 3.2.7. Total Activity of all five studied species over one year

3.2.2.2. Time activity

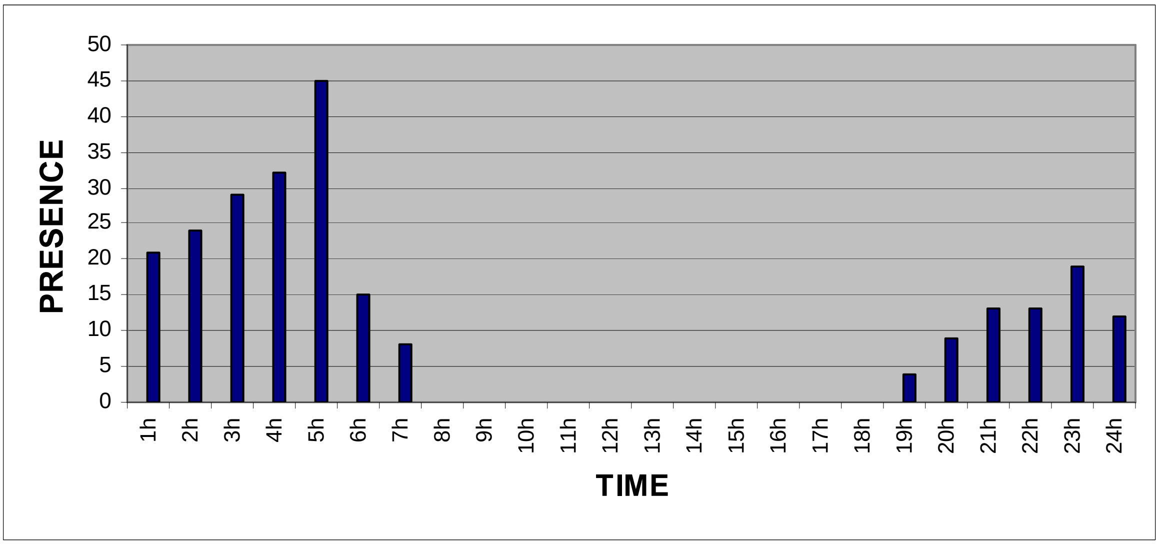
One of the key benefits of using a time-date recording unit is knowing at exactly what time each photograph was taken. The results of the time analysis of the photograps from the 2nd phase are shown for each animal with all sites merged in GRAPHS 3.2.8-10.



GRAPH 3.2.8. Time activity of *Erinaceus concolor*.



GRAPH.3.2.9. Time activity of *Mustela nivalis*.



GRAPH. 3.2.10.: Time activity of *Martes foina*.

3.3. DISTRIBUTION DATA

3.3.1. The Hedgehog in Crete

Bibliography

Original records: Three specimens analysed and collected in the island of Crete by Bate (1905). The author also pointed out that the Cretan hedgehog is commonly found in the low regions of the island.

Other records: 1. Wettstein (1953): hedgehogs are not very common in Crete except for the Messara region; 2. Ondrias (1965): the hedgehog is present in coastal zones near to cultivated areas; 3. Catsadorakis (1994): *Erinaceus concolor* occurs in the Samaria National Park, in particular in the areas of Omalos plateau, Samaria and Agia Roumeli; 4. Giagia and Markakis (1996): the hedgehog is present in Crete.

Direct-Indirect indices of presence

New records: During the course of the present research, dead specimens were found in the following localities: Thrapsano Pediados (Irakleio), Messeleri (Lasithi), Epanosifi (Irakleio), Xalebi (Rethymnon), Patzides (Irakleio), Moni Vidianis (Lasithi), Gouves (Irakleio), Skalani (Irakleio), Koloudiana (Irakeilo), Knossos (Irakleio), Kokini Chani (Irakleio) and around the surroundings of the town of Irakleio.

In the phototrapping survey, hedgehogs were phototrapped on the Agios Mamas and Rouvas transects. In the area of Agios Mamas the hedgehog was found from the sea level till up to 1000 m altitude, while in the area of Rouvas it was prevalently phototrapped in the altitudinal range between 0 and 500 meters.

In FIG. 3.3.1., results from bibliography, indirect and direct indices of presence are plotted with different symbols in the map of Crete. When bibliographical data are not accurate, the presence is recorded into a U.T.M. grid 10X10.

3.3.2. The Weasel in Crete

Bibliography

Original records: Bate (1905), two skins from Crete were observed. The author also pointed out that the animal is very common on the island.

Other records: 1. Zimmermann (1953): the weasel is spread throughout the island and especially frequent in Nida; 2. Ondrias (1965): the weasel is distributed all over Crete; 3. Catsadorakis (1994): *Mustela nivalis* is present in the Samaria National Park in alpine and subalpine habitats, in Coniferous woodland, in the gorge, in Omalos plateau, in Samaria and Agia Roumeli; 4. Ragni *et al.* (1996): the weasel is distributed over most of the island's surface. It occurs from sea level such as the coastal palm grove of Vai to mountain ranges. The author reports direct observations of the species or signs of its presence from Xiloskalo (1300m a.s.l.), Tripiti gorge (800m), the area of the Mount Juctas, the palmgrove of Vai and the surrounding area of Irakleio; 5. Belardinelli (1996): faeces of the weasel were found in the surroundings of Asomatos, Petsiliana, Castro-Vathiako, Adelphy Mount, Lochria, Zaros, Kourutes, Vistagi, Platania, Platanos, Kamares, Voria and Pano Assites;

Direct-Indirect indices of presence

New records: During the course of this survey, dead specimens of *Mustela nivalis* were found in the following areas: Akrotiri (Chania), Vrises (Chania), Gergeri (Irakleio), Prina Messaleri (Lassithi), Ano Archanes (Irakleio), Stavrakia (Chania), Voutes (Irakleio), Pachiamos (Lassithi) and Rodopou (Irakleio).

Faeces of the species are commonly found throughout the island. They were observed especially in the Psiloritis area and in the surroundings of Irakleio. During the survey carried out using the phototrap method, *Mustela nivalis* was photographed in the area of Agios Mamas in the altitudinal range of 500-1000m, in the Anogia transect in the altitudinal range of 0-500 m and in the Rouvas area from 0 to 1000 m of altitude. During the second phase of the research the weasel was also phototrapped in the Agios Mamas area at an altitude over 1000m.

In FIG. 3.3.2., results from bibliography, indirect and direct indices of presence are plotted with different symbols in the map of Crete. When bibliographical data are not accurate, the presence is recorded into a U.T.M. grid 10X10.

3.3.3. The Beech Marten in Crete

Bibliography

Original records: Bate (1905), five skins from Crete were analysed. The author also pointed out that the species is widespread all over the island.

Other records: 1. Zimmermann (1953): the beech marten is very common in Crete and it is found all over the island; 2. Catsadorakis (1994): the *Martes foina* is abundant and widespread in the Samaria National Park. It occurs in alpine and subalpine habitats, in the Coniferous woodland, in Omalos plateau, in the Gorge, in Samaria and Agia Roumeli; 3. Ragni *et al.* (1996): *Martes foina* seems to be widespread throughout the island from the sea level to the highest mountains. The same author pointed out the occurrence of the species from Cape Sideros on the easternmost point of the island to Lefka Ori mountain range, on western Crete. The presence of the species has also been reported from Lassithi, Chania and Ag. Nikolaos surroundings. The beech marten has been found to inhabit regions that are close to human settlements. Records of the animal have been reported from the area of Mount Juctas, Skalani, Myres, Orino', Ierapetra, Mount Adelphy, Vai, Agios Nikolaos, Kritza, Irakleio, Hania, Zaros, Panagia Pediados and Armeni; 4. Belardinelli (1996): faeces of the animal were also found in Asomatos, Petsiliana, Castro-Vathiano', Lochria, Kourutes, Vistagi-Platania, Kamares, Voritia and Pano assites.

Direct-Indirect indices of presence

New records: during the course of this survey, *Martes foina* has been found in the following areas: Bali (Rethymno), Gonies (Irakleio), Platanos (Rethymno), Asites (Irakleio), Pantanassa (Irakleio), Spilia (Irakleio), Sises (Irakleio), Agia Pelagia (Irakleio), Perama (Rethymno), Kato Archanes (Irakleio), Archanes (Irakleio), Agia Irini (Irakleio), Xoumeri (Rethymno), Stavromenos (Rethymno), Hersonossos (Irakleio), Gouves (Irakleio), Voutes (Irakleio), Rouvas (Irakleio), Agios Miron (Irakleio). Beech martens were often observed in the centre of the town of Irakleio.

Faeces of the animal are widespread throughout the island from sea level to the mountain ranges. During the phototrapping survey, *Martes foina* has been found in all transects (Agios Mamas, Rouvas and Anogia). It seems to be widespread in the three altitudinal ranges (0-500m; 500-1000m; over

1000m), except for Rouvas area where it was never photographed at an altitude over 1000m.

In FIG. 3.3.3.., results from bibliography, indirect and direct indices of presence are plotted with different symbols in the map of Crete. When bibliographical data are not accurate, the presence is recorded into a U.T.M. grid 10X10.

3.3.4. The Badger in Crete

Bibliography

Original records: Barrett-Hamilton (1895)

Other records: 1. Bate (1905): badgers are common in Crete; 2. Miller (1907): four specimens from Crete were described; 3. Zimmermann (1953): the badger is often present in the Cretan mountains; 4. Ondrias (1965): badgers are very common to be found throughout the island; 5. Catsadorakis (1994): the species it reported to be generally rare in the Samaria National park, even if it seems to occur in Omalos plateau, in the Coniferous woodland, in Samaria and Agia Roumeli; 6. Ragni *et al*. (1996): records of the presence of the species are reported from the areas of Petsiliana, Mount Juctas, Vai, Agios Nikolaos, Valtes, Athanathi (Irakleio), Spili and Chania; 7. Belardinelli (1996): faeces of the animals were found also in Asomatos, Petsiliana, Adelphy Mount., Lochria, Zaros, Platanos, Kourutes, Vistagi, Platania, Platanos, Kamares, Voritia and Pano Assites.

Direct-Indirect indices of presence

New records: During this survey, dead badgers were found in the following areas: Kedros (Rethymno), Garazo (Rethymno), Juctas (Irakleio), Kounavos (Irakleio), Apostoli Pediados (Irakleio), Agia Pelagia (Irakleio), Koutsouras (Lassithi), Gergeri (Irakleio), Lastros (Lassithi), Agia Paraskevi (Irakleio), Honos (Rethymno), Platanias (Irakleio).

Latrines of the animal were observed in the area of Almyros where the animal was also photographed in the altitudinal range within 0 and 500 m above sea level and in the area of Agios Mamas in the site called C3. A badger was also photographed at an altitude of over 1000m in the same area of Agios Mamas.

In FIG. 3.3.4., results from bibliography, indirect and direct indices of presence are plotted with different symbols in the map of Crete. When bibliographical data are not accurate, the presence is recorded into a U.T.M. grid 10X10.

3.3.5. The Wildcat in Crete

Bibliography

Original records: Raulin (1869)

Other records: 1. Bate (1905): the species is not uncommon in the island 2. Miller (1912): presence; 3. Zimmermann (1952): the wildcat lives in mountains and in gorges, far from villages. The author outlined two places particularly important for the presence of the wildcat, Akrotiri and the Lefka Ori range 4. Haltenorth (1953): the wildcat occurs in Crete in Lefka Ori mountains, in the Akrotiri region and in general in the Northwestern mountain range; 5. Ondrias (1965): presence of the wild cat in the Lefka Ori range during 1960; 6. Graf (1989): footprints of supposed wildcat in the gorge of Kalocambos (Lefka Ori) and others indexes of presence in the Dikti Mountains (Lassithi) (Schwaab-Vincent, 1988; Adamakopoulos-Matsoukas, 1991); 7. Catsadorakis (1994): the wildcat might be extinct nowadays in the Samaria National Park, although local people confirmed its presence few years ago in the Coniferous woodland of the park; 8. Adamakopoulos-Matsoukas (1991): Dikti Mount; 9. Belardinelli (1996): a wildcat was captured in April 1996 above the village of Kourutes; 10. Ragni *et al*. (1996): presence.

Direct-Indirect indices of presence

New records: during this study, the wildcat of Crete was found to be present in the three main mountain ranges of the island: Psiloritis, Lefka Ori and Lassithi. Dead specimens were found in Kritza (Lassithi), Agios Ioannis (Lefka Ori) and western Psiloritis. All the wildcats were found at an altitude over 1000 m from sea level. Individuals of *Felis silvestris cretensis* were photographed in the Area of Agios Mamas at about 1350m of altitude.

In FIG. 3.3.5., results from bibliography, indirect and direct indices of presence are plotted with different symbols in the map of Crete. When bibliographical data are not accurate, the presence is recorded into a U.T.M. grid 10X10.

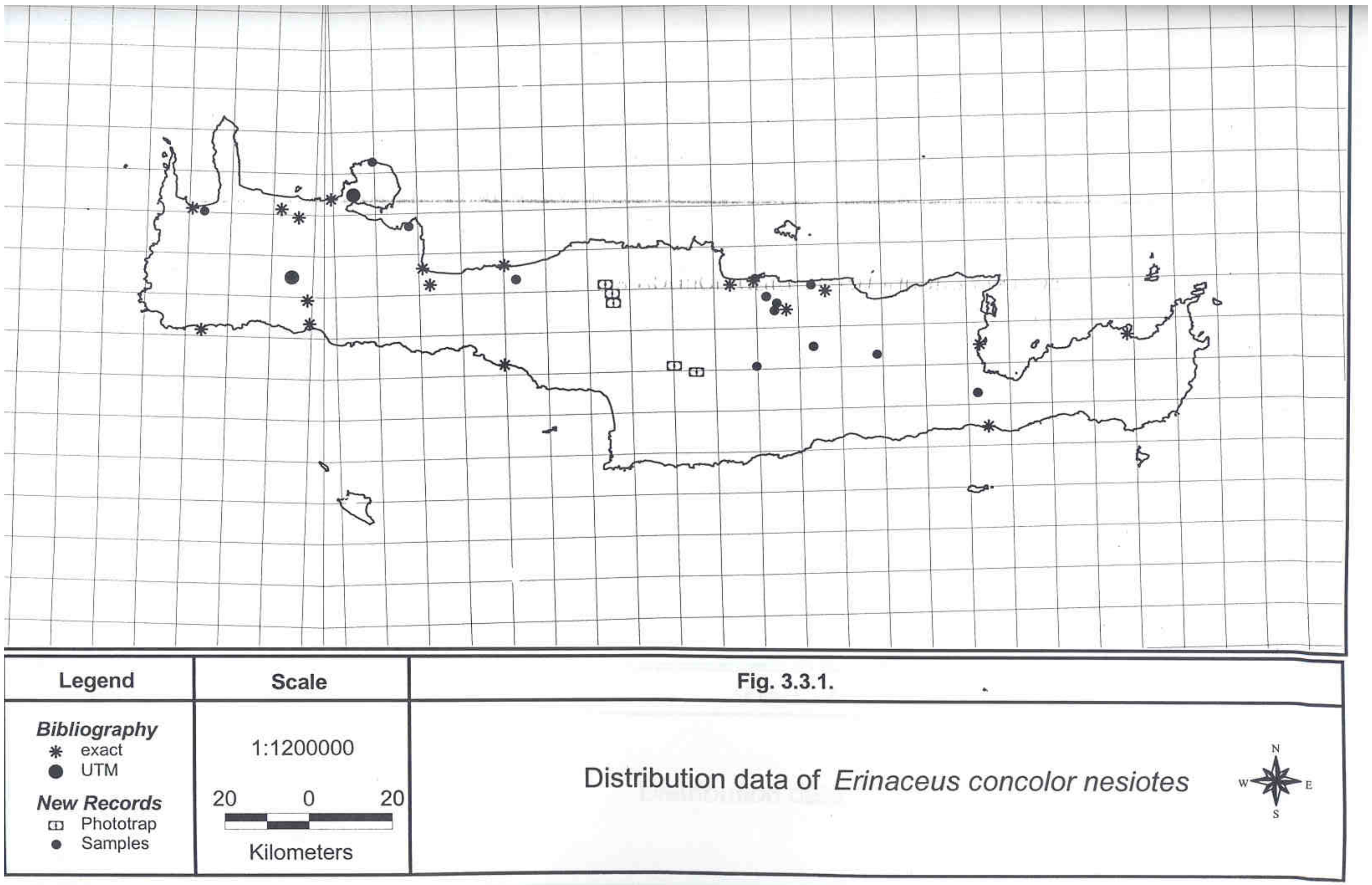


Fig. 3.3.1.

Distribution data of *Erinaceus concolor nesiotes*

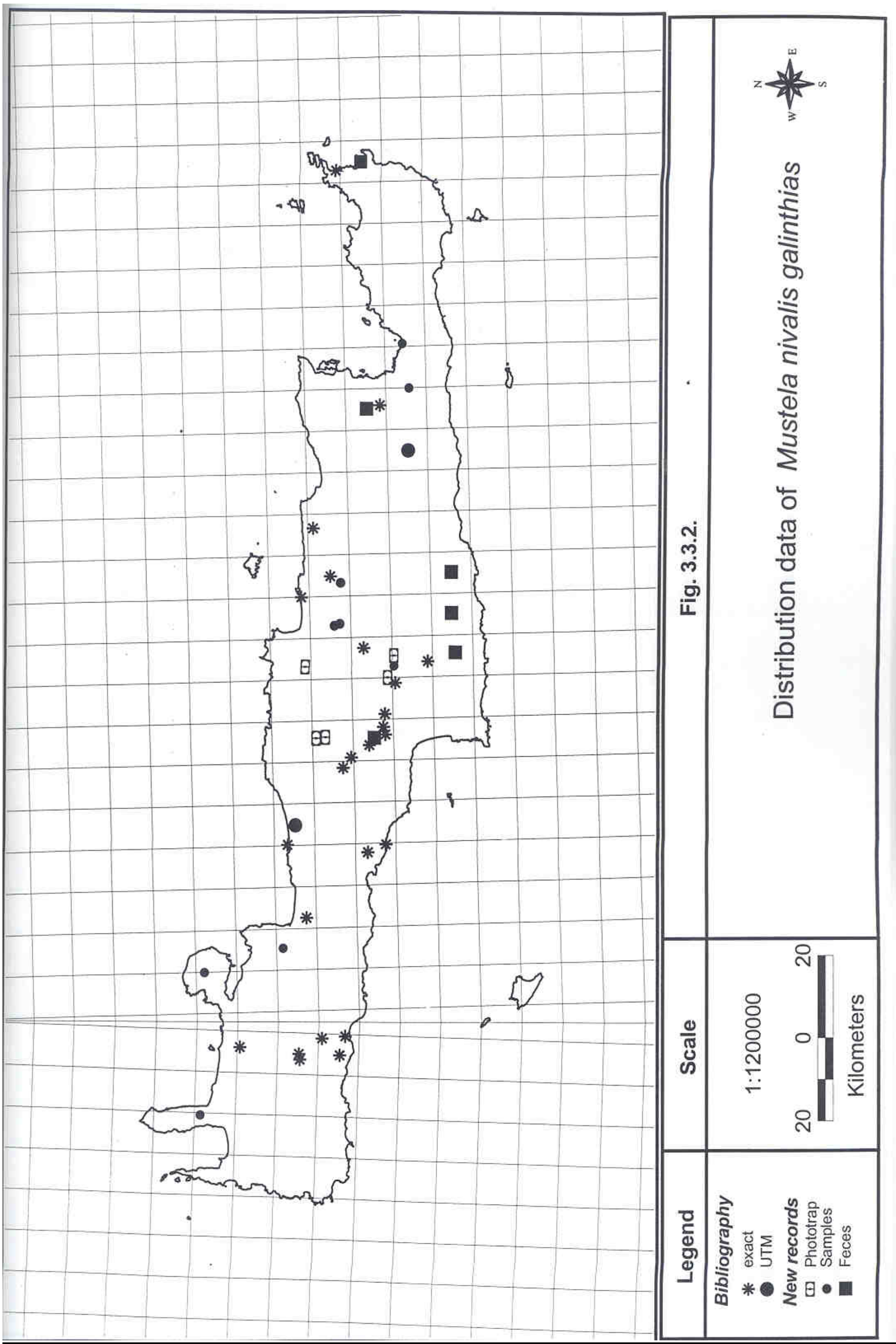


Fig. 3.3.2.

Distribution data of *Mustela nivalis galinthias*

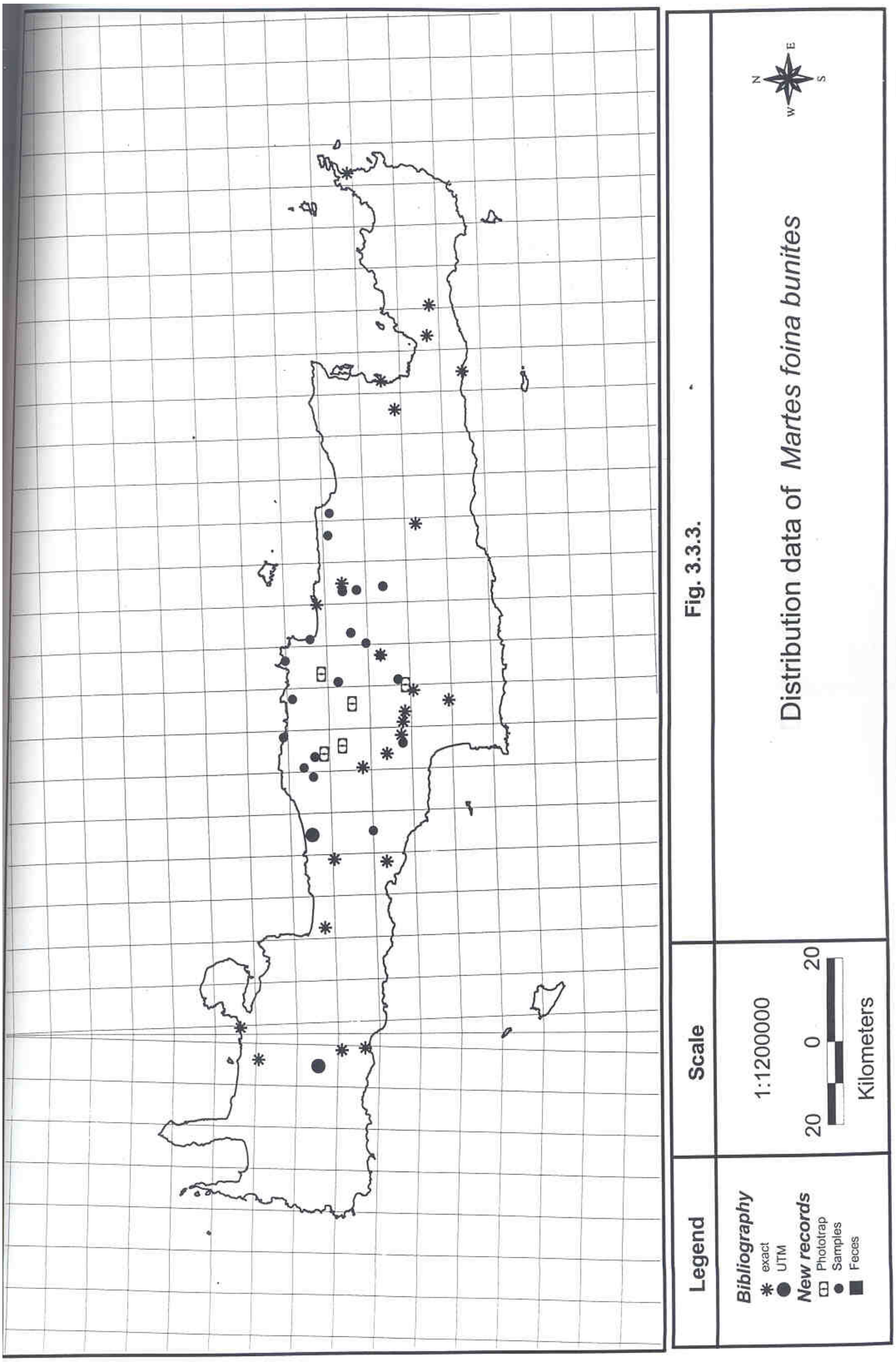


Fig. 3.3.3.
Distribution data of *Martes foina bunites*

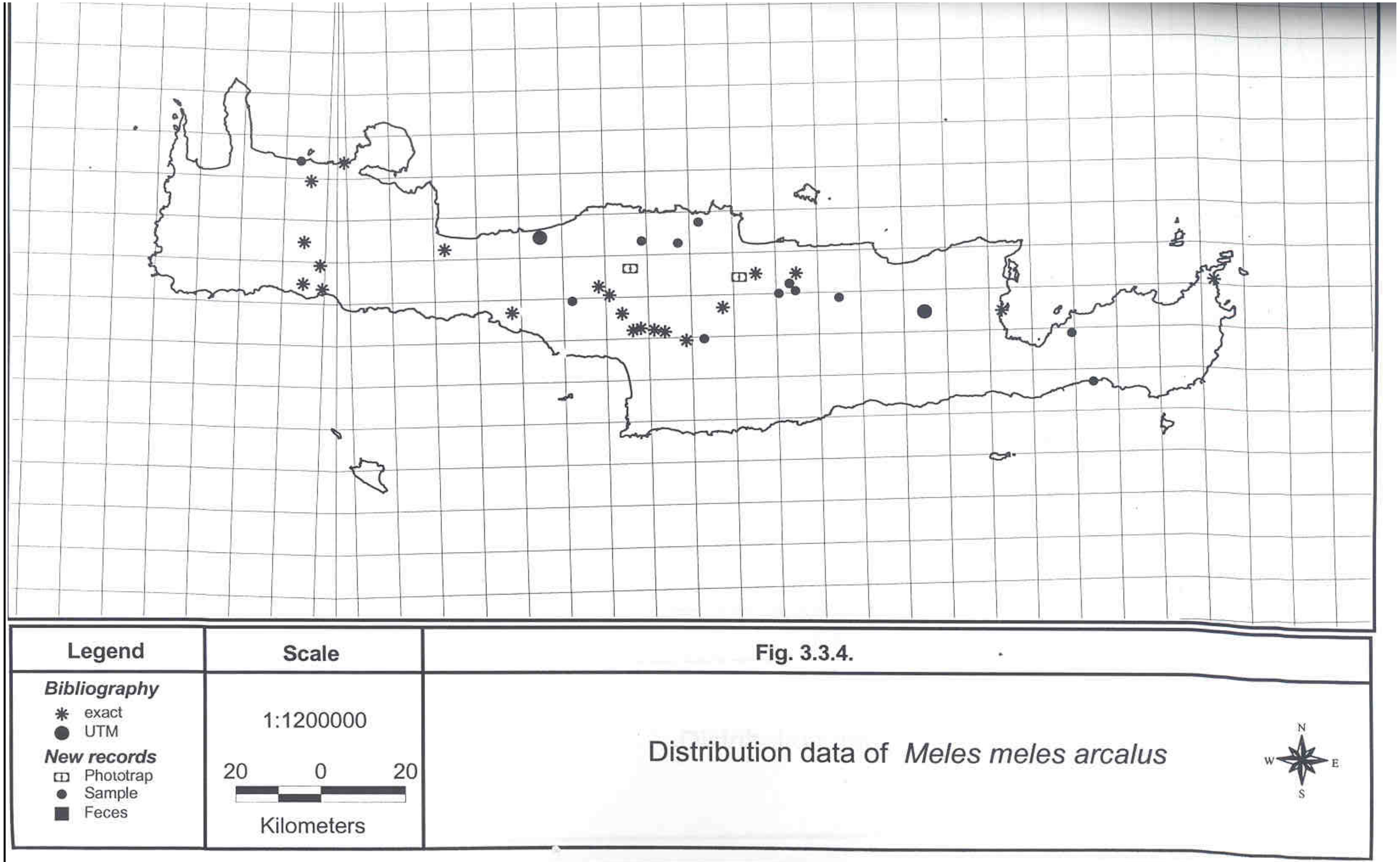


Fig. 3.3.4.

Distribution data of *Meles meles arcalus*

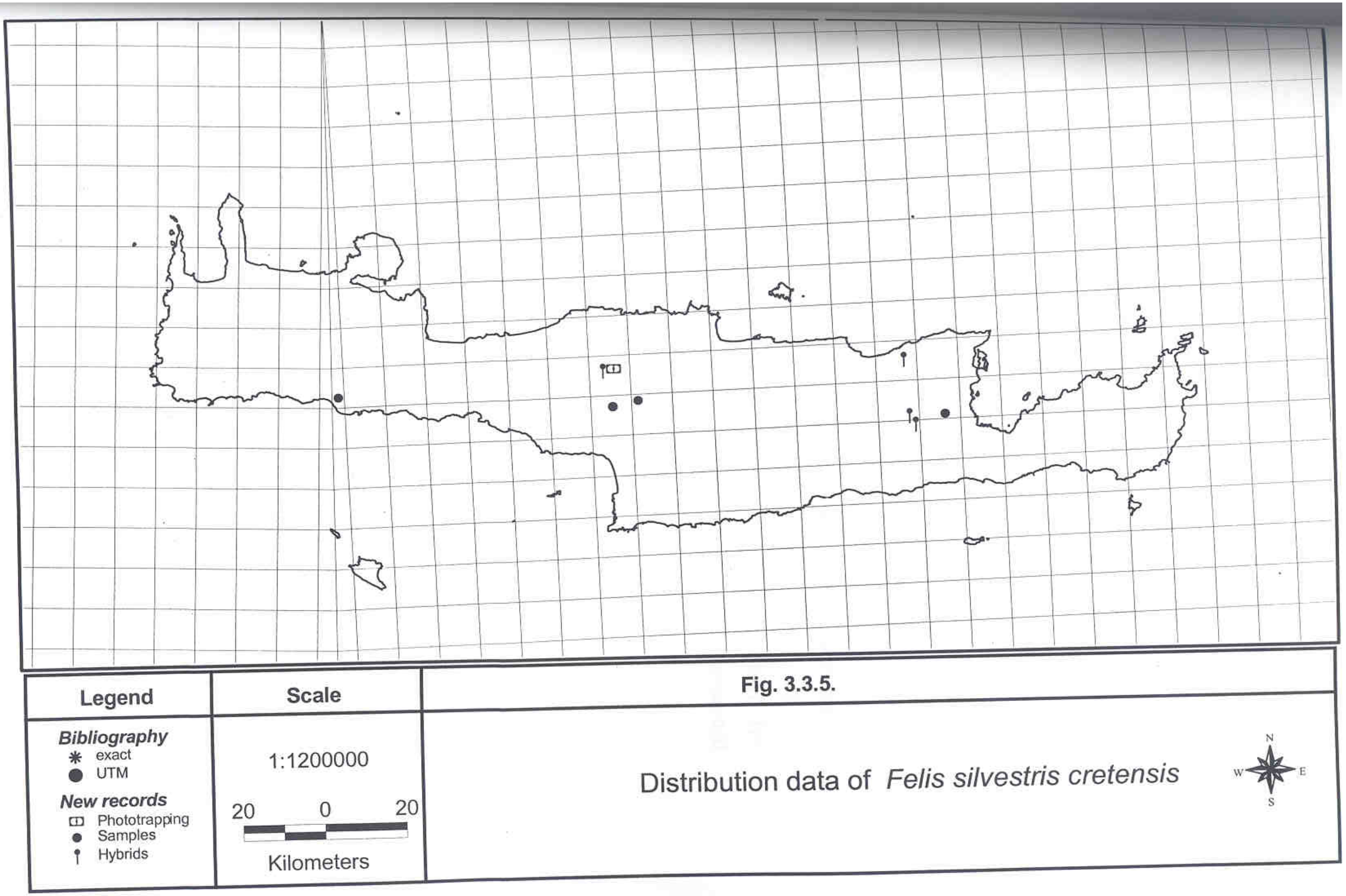


Fig. 3.3.5.

Distribution data of *Felis silvestris cretensis*

CHAPTER 4

DISCUSSION AND CONCLUSION

4.1. INTRODUCTION

The species studied in this research have been found to be of a different body size compared to those of continental Europe. Until more samples are acquired, it is only possible to speak about probable trends. Morphological traits and cranial measurements on the wildcats have shown another peculiar trend that must be confirmed by further research. The Cretan form seems in fact to fall in the middle of the range of European and African phenotypes, even if more related to the latter.

4.2. THE HEDGEHOG

4.2.1. Morphometrical and morphological analysis

In the table below (TABLE 4.2.1.) the average values of the Cretan hedgehogs measured during the course of this research, the average values of *Erinaceus concolor* from Rumania measured by Simionescu (1977) (In: Niethammer & Krapp, 1990) and the minimum (m) and maximum (M) values from European specimens reported by Macdonald & Barrett (1993) are compared.

	MEASUREMENTS ON NHMC SPECIMENS		**MEASUREMENTS by Simeonescu (1977)**		**MEASUREMENTS by Macdonald & Barrett (1993)**
	MALE n = 6	FEMALE **n = 3**	MALE n = 19	FEMALE **n = 26**	**Male & Female**
W	**X = 308,3** SE= 59,74	**X = 310** SE= 58,59			**m= 400** **M=1200**
B	**X = 213.5** SE= 5,53	**X = 193** SE= 23,54	**X = 268**	**X = 255**	**m= 225** **M= 275**
HF	**X = 36.5** SE= 1,37	**X = 34.6** SE= 2,77	**X = 42**	**X = 42**	**m= 40** **M=45**
T	**X = 20.6** SE= 0.66	**X = 20.5** SE= 1.30	**X = 28**	**X = 27**	**m=15** **M=30**

TABLE 4.2.1. Average values of measurements on *Erinaceus concolor*

The t-test analysis with one tailed distribution carried out on the measurements between hedgehogs from Crete and from Rumania has shown that the differences found are statistically significant. The values found in Rumanian specimens fall into the minimum and maximum values reported by Macdonald & Barrett (1993) for European animals.

Comparing the values of the Cretan hedgehogs with those of *E. concolor* in Rumania, the Cretan forms seem to be smaller in size. The head-body length average for both males and females of the Cretan hedgehog is far below the averages found in *Erinaceus concolor* from Rumania and it is far below the minimum value reported by Macdonald & Barrett (1993), as well as the hind foot length. While the tail length appears to be within the upper and lower values reported by Macdonald & Barrett (1993) but greatly reduced in respect to the Rumanian specimens.

The Cretan hedgehog seems in fact to be a form of small size, as has been described by Bate in 1905. Morphological observations have showed that *E. c. nesiotes* has slender spines and scant short and long hair on the abdomen and the white ventral part is quite extensive.

Measurements taken from eastern hedgehogs (*Erinaceus concolor*) of the Holy Land (Qumsiyed, 1996) have values that are more similar to the Cretan form than those occurring in Europe. The head and body length ranges from 200 to 260 mm, being more similar to *Erinaceus concolor nesiotes* size, while the weight is about 550-700 g that is greater than the weight found in Cretan populations. Small sized hedgehogs were also found in other Mediterranean islands. *E. e. italicus,* which occurs in Sardinia and Corsica, has head-tail length included between 200 and 250 mm. Of the same size is the Sicilian subspecies, *E. e. consolei*, which is differentiated by the darker colour of its body (Toschi, 1965). On the other hand, the subspecies of Rhodes reported by Festa (1914) has a body size (240-270mm) that is greater than the Cretan form and it is within the average of European values. However the subspecies of Crete was found to be karyotypically identical to the mainland form while the subspecies of Rhodes differs from the other two (Giagia & Markakis, 1996). Extensive studies of hedgehogs from Asia Minor (*E. c. transcaucasicus*) might help in clarifying the relationships between *E. concolor* in the southeaster Mediterranean.

4.2.2. Ecology

During this study hedgehogs were found from sea level up to over 1000m altitude, in contrast to that affirmed by Bate (1905) and Wettestein (1953). They stated in fact that *Erinaceus concolor* doesn't occur in Crete on the mountain ranges. Ondrias (1965) also reported its presence to be near cultivated areas in coastal zones. The phototrapping method has shown that hedgehogs appear to be prevalent foragers, and are abundant, even at high altitude.

This method has also shown that *Erinaceus concolor nesiotes* has a nocturnal activity as it was only photographed from seven o'clock in the evening till five o'clock in the morning, as would be expected. During the second phase of the phototrapping research carried on at an altitude over 1000m, the hedgehog was found from nine o'clock in the evening to five o’clock in the morning showing a time preference around four o’clock (GRAPH 3.2.8.).

The total activity of the animal, during the second phase of the phototrapping research in the area of Agios Mamas (from May 2000 to May 2001), is shown in GRAPH 3.2.4.. There are noticeable peaks of activity in September and May, whereas the animal is absent throughout November and December and it is present again, with just one picture after several particularly warm days in January.

It would seem that the hedgehog either becomes desensitised to bait, and consequently shows little interest in it or more possibly, with the lower temperatures after October, it greatly reduces its activity for the winter months. Hedgehogs are known to hibernate in more temperate climates; it is though that they do not at the southern limit of its range (Corbet, 1988). It cannot be taken for granted that they are actually hibernating during the months when not photographed, and until there is more evidence further speculation should be avoided.

Of the hedgehogs found as road kill; most were mature males, which could indicate that males have greater ranges in order to search for mates, or generally display more activity. It should also be observed that roads and passing cars pose a significant threat to hedgehogs, that otherwise have few natural predators on Crete. A possible predator is the badger against which the spines of the hedgehog don’t constitute any protection (Macdonald, 1995).

Despite this, it is not thought that the prolific road building throughout the mountains of Crete pose as much of a threat to hedgehogs as they may to other more sensitive animals.

4.3. THE WEASEL

4.3.1. Morphometrical and morphological analysis

On the table below (TABLE 4.3.1.) the average values measured on males of the Cretan weasel are compared to the average values found in specimens from Germany (In: Niethammer & Krapp, 1990) and the minimum (m) and maximum (M) values found in European specimens reported by Macdonald & Barrett (1993). The measurements taken on the only female found in Crete are also reported.

	MEASUREMENTS ON NHMC SPECIMENS		**MEASUREMENTS (In: Niethammer & Krapp, 1990) Germany**		**MEASUREMENTS by (In: Macdonald & Barrett, 1993)**	
	MALE n= 7	**FEMALE** n= 1	**MALE** n= 207	**FEMALE** n=57	**MALE**	**FEMALE**
W	**X = 23.0** SE= 1,09	**9,5**			**X= 73**	**X = 30**
B	**X = 245.1** SE= 5,37	**190**	**X= 173,8**	**X= 147.1**	**m=166 M= 214**	**X = 154**
HF	**X = 39.5** SE= 0,79	**30,6**	**X= 23,6**	**X=19.0**	**m=30 M= 35**	**m= 25 M= 30**
T	**X = 100.2** SE= 2,39	**87**	**X= 40,6**	**X= 32.4**	**m= 60 M= 125**	**m= 30 M= 88**

TABLE 4.3.1. Average values on measurements from *Mustela nivalis*

The t-test analysis with one tail distribution carried out on the measurements between male weasels from Crete and from Germany has shown that the values are significantly different. The values reported by Macdonald & Barrett (1993) are extremely variable depending on the different European countries. German specimens seem to be even smaller than the values reported by Macdonald & Barrett (1993), except for the head-body length of males and the tail length of females. The Cretan specimens seem to be larger than both those of Germany for each measurement and, comparing the values reported by Macdonald & Barrett (1993), to those found for *Mustela nivalis* in Europe. In fact the values of head-body length for both males and females (*Mustela nivalis galinthias*) surpass the average value found in European animals. The hind foot length of Cretan males barely surpasses the maximum value found in European values, as well as for the female. The tail length values, both for males and females of Cretan specimens, fit those reported for European animals. Although the Cretan weasel has a large body size compared to European populations its weight appears to be very low.

The weasel of Crete seems to be a form of large size, with a particularly long narrow shape. In fact the weight of the animal is very low compare to its body length so that the shape of the Cretan weasel appears to be extremely long and slender. An analogous situation has been found in other Mediterranean islands such as Sicily, Sardinia and Corsica where the subspecies *M. n. boccamela* presents a very large size (Toschi & Lanza, 1965). Larger weasels have also been found on some islands off British Columbia (Case, 1978) and Malta (Miller, 1912). Turkish weasels compared with Central European ones, are extremely large animals (Kaspark, 1989). In general the Mediterranean weasels are characterised by a very large body size (King, 1989). According to Qumsiyeh (1996) weasels of the Holy Land have head and body length values comprised between 250-300 mm with a relatively short tail length, less than one third of the entire body. These measurements show a weasel (*Mustela nivalis subpalmata*) that is even larger than the Cretan form.

The morphological observations carried out during the course of this research have showed that *M. n. galinthias* has a very distinct line of demarcation between the dorsal and ventral body surfaces. The lower part may be white or yellowish and this colour reaches the throat of the animal. In some cases the colour of the under part may also reach either the forelimbs or to the hind limbs or even both.

4.3.2. Ecology

During the present survey, *Mustela nivalis* has been found mostly at altitudes between 0-500m and secondly in the range of 500-1000m. The numbers of photos taken of this animal in the altitude over 1000m are extremely reduced. In particular, during the first phase of the phototrap research, the weasel never occurred at the altitude over 1000m whereas in the second phase, concentrated on highest zone, a few photos of the animal (7) were obtained during August – September, again in March (11) and in May (2). The results from the second phase of phototrapping tie in nicely with the results from the first phase. The records taken in August and September may reflect a summer migration to greener pastures because of the presence of more suitable food items and generally more favourable conditions (GRAPH. 3.2.5.).

In view of the success of the phototraps in capturing images of *Mustela nivalis* at lower altitudes it seems most unlikely that there are many individuals circulating above 1100 m. *Mustela nivalis* and *Martes foina* that coexist from 0 to 1000m, do not display excessive competition for prey items, so that the limiting factor for the upward spread of the weasel may in fact be purely related to altitude and prey availability.

As has been reported by several other authors it can be confirmed that there is a healthy population of *Mustela nivalis* throughout the lowlands of Crete, though there would not seem to be the mountain populations as they suggest (Bate, 1906; Zimmermann, 1953; Ondrias, 1965). As mentioned above, it seems most unlikely that a method that is highly successful at lower altitudes should be unsuccessful above 1000 m.

Furthermore, as seen from the time-date recording facility of the phototraps, *Mustela nivalis* is almost certainly a diurnal species. It could prove to be important that the Cretan form, that is especially slender, prefers to hunt during daylight while its rodent prey are sheltering in easily accessed burrows, rather than at night when its prey is active. The time of its activity is mostly concentrated from eight o'clock in the morning to seven o'clock in the afternoon, even if it has been found at midnight in only one picture. During the second phase of the phototrapping method (over 1000m a.s.l.), the weasel has been found between six o'clock in the morning till eight o'clock in the evening. In summer time the pictures shown its presence from six o'clock in the morning to six o'clock in the afternoon, while in march the time seems more reduced, being comprised of eight o'clock in the morning till three in the afternoon.

GRAPH 3.2.9. shows the total activity of the weasel in one year, related to the time of presence. It could be noticed that eight o'clock is the time when most pictures were found.

As in the case of the hedgehog, of the specimens examined from road kill, the majority were mature males. It has been reported that females of *Mustela nivalis* show reduced activity during the spring, in preparation for pregnancy (Macdonald & Barrett, 1993). This, combined with increased activity in males to locate mates, could account for the discrepancy in numbers.

4.4. THE BEECH MARTEN

4.4.1. Morphometrical and morphological analysis

On the table below (TABLE 4.4.1.) the average values of the specimens measured during this research are compared to the average values of specimens from East Germany and Peloponnese (In: Niethammer & Krepp, 1990) and maximum (M) and minimum (m) vales reported by Macdonald & Barrett (1993) for European animals.

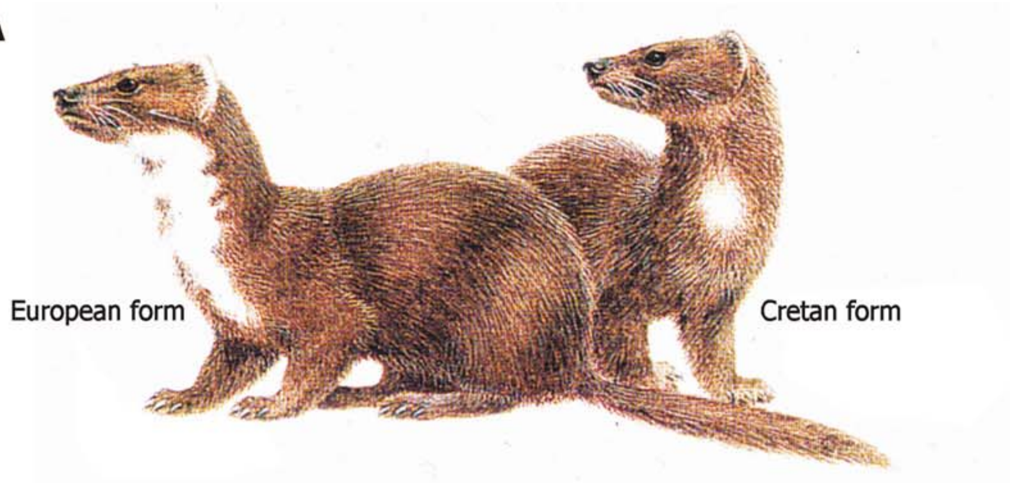
	MEASUREMENTS ON NHMC SPECIMENS		**MEASUREMENTS (In: Niethammer & Krapp, 1990)**				**MEASUREMENTS (In: Macdonald & Barrett, 1993)**
			East Germany		**Peloponnese**		
	MALE n= 11	**FEMALE** n= 12	MALE n= 159	FEMALE N=160	MALE n=34	FEMALE n=29	MALES & FEMALES
W	**X = 1244** SE= 78,95	**X = 829,5** SE= 53,33					**m=1300 M=2300**
B	**X =422,2** SE= 4,90	**X = 401,8** SE= 5,52	**X= 455.6**	**X= 427.6**	**X= 428.3**	**X= 370.7**	**m=420 M= 480**
HF	**X = 77.7** SE= 1,25	**X = 68,7** SE= 1,92	**X= 86.9**	**X= 80.4**	**X= 86**	**X= 79.4**	**m=80 M=90**
T	**X = 225,7** SE= 3,75	**X = 216** SE= 4,55	**X= 248.8**	**X= 236.9**	**X= 241.6**	**X= 273.3**	**x= 260**

TABLE 4.4.1. Average values of measurements from *Martes foina*

The t-test analysis with one tailed distribution carried out on the average values found in Cretan forms and those from East Germany and Peloponnese has shown that the differences found are statistically significant. The head-body and the hind-foot lengths found in German and Peloponnesian specimens seems to fall in the values reported by Macdonald & Barrett (1993), except for females from Peloponnise which are smaller than the minimum values reported. Measurements reported for specimens from Peloponnise seem to be smaller than those from East Germany, except for the tail length of the females. Comparing the measurements taken during this research with those of Peloponnise, the Cretan beech marten seems to be a smaller form except for the head-body length of the females. The head-body length value of Cretan males is very close to the minimum value found in European animals reported by Macdonald & Barrett (1993) while for females this value appear to be very low. For the hind foot and tail length in both sexes of the Cretan form, the values are found to be lower when compared to those of the European animals. Moreover the weight of the Cretan beech marten does not reach the minimum value found in European forms. According to Steensma and Reese, 1996, *Martes foina bunites* is also different from the mainland form by the total length of the M1 (molar) that is relatively larger and more slender.

The beech marten of Crete seems to be a form of small size, as has been described by Bate in 1905. Morphological observations have showed that the animal is characterised by a pale colour of the coat. In all the animals analysed the throat patch is always present and evident, in contrary to that affirmed by many authors such as Bate (1906), Zimmermann (1953), Corbet & Oveden (1985) and MacDonald & Barrett (1993). They all described an extremely reduced patch peculiar to the Cretan form that is characterized by a circular shape or that could be even completely absent. During the course of this study the throat patch was always found in all the specimens and it was found to be large and characterised by a horseshoe shape. This patch may be white or greyish and its shape has a high degree of variability between individuals. Generally the throat bib extends from as far up as the middle of the lower jaw to as far down as the upper foreleg. In most cases the marking is divided into two lobes by a rich brown stripe. The lobes may not join at all, may converge at the throat or may be entirely isolated spots but there is almost always a certain amount of symmetry (FIG. 4.4.1.).

A



B

Fig. 4.4.1.: Beech marten throat patch, (**A**) as discribed by Corbet & Oveden (modified from Corbet & Oveden, 1986), and (**B**) as photographed from a Cretan specimen.

The throat patch of the beech martens of the Levant (Syria and Palestine) is characterised by an irregular horseshoe shaped mark (Harrison & Bates, 1991). In this regard the Cretan beech marten falls into the phenotypical patterns of the Near-Eastern animals.

Beech martens of the Holy Land seem to have body sizes that are more similar to the Cretan form. According to Qumsiyeh (1996) the head and body length of these Asian specimens is 340-500 mm, the tail length is 170-260 mm and the weight is comprised between 700 and 1600gr. All the measurements taken on the Cretan forms are within the range of the Holy Land beech martens (*Martes foina syriaca*). For Steensma & Reese (1996) the cave fossil remains found in Crete could represent different intermediate stages between the mainland forms and the endemic types, so that influences from mainland Greece or from Near east could have played an important role.

Small sized beech martens have been also found in the island of Rhodes. From the measurements taken by Festa (1914) on three specimens, this form seems to be even smaller than the Cretan subspecies. In other large Mediterranean islands instead of *Martes foina*, which does not exist, there is a very closed related species that is *Martes martes*. The stone marten occurs in Sardinia and the Balearic Islands and it is a subspecies of normal size, while the subspecies of Sicily is characterised by a small size.

4.4.2. Ecology

During the present survey, *Martes foina* has been photographed in all three altitudinal ranges from sea level to over 1000m. The total activity of the animal for the second phase of the research in Agios Mamas (from May 2000 to May 2001) is shown in GRAPH. 3.2.6.. The graph may infer a drop in foraging activity in July and August and important peaks in September and October followed by a sharp decline in activity in November and December.

The most prominent peak, prior to the onset of winter, and after the first rains, is the September-October peak, this is probably increased foraging activity to lay down fat deposits for the oncoming winter, though there are several other possible explanations such as the mating period. The first rains normally fall around the beginning of September and result in an increase of primary production, and after an appropriate lag time, this may be passed along the food chain to prey items of *M. foina*, resulting a greater benefit from foraging, and therefore increased foraging.

It would appear that there is also a reduction of activity in July and August; this could be a result of reduced activity during the hottest summer months. Alternatively, animals, having reduced supplies at lower altitudes, may advance up the mountain in search of prey items that have become active following the snowmelt at high altitude. Though whether this might be the case for an animal like *M. foina* is yet to be seen. The costs of 'migration' to higher altitudes may outweigh any benefits from increased activity of prey items as a result of the post snowmelt spring 'bloom'.

However, these are perhaps more classical viewpoints, without a full understanding of the ecological role that the phototrap bait plays, further inferences along these lines may be dangerous. It is possible that the animals actually go to the bait as a result of a lack of other suitable food in the area. However, the concept of the bait is to offer animals a relatively easy way to obtain food, at a lower energy cost than hunting. So, on the other hand, photos may be a direct reflection of the general activity of the animal and their foraging habits. That is to say that, when an animal is devoting more time to foraging, it has an increased likelihood of locating and investigating the bait, therefore setting off the phototrap. Perhaps the firmest observation is that there is a reduction in activity in the winter months, possibly conservation of energy through reduced activity. It may also be a reflection of a reduction of an animals foraging range.

Confirming the views of other authors (Bate, 1906; Zimmermann, 1953; Masseti, 1995), the phototraps and the collected scats show that there is an abundant population of *M. foina* in Crete. Another confirmation from the phototraps is that *M. foina* is a nocturnal animal, preferring to move under the cover of darkness, as seen in 100% of the photographs. The time of activity seems to be comprised between seven o'clock in the afternoon to seven o'clock in the morning, showing a time preference from two to five in the morning. During winter time (from November to March), the activity starts at seven o'clock in the evening till seven o'clock in the morning, while during summer time the activity starts at nine o'clock in the evening till six o'clock in the morning, as it is shown in the TABLE 4.4.1..

	1h	**2h**	**3h**	**4h**	**5h**	**6h**	**7h**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19h**	**20h**	**21h**	**22h**	**23h**	**24h**
May		1		1																				
June	2	2	4	3	3																	2		2
Julay	5		4	4	2																2	1	1	2
August	3	3	1	2	5																	1	4	1
September	4	4	4	9	13	1															3	5	3	1
October		3	2	3	3	2														1			1	
November	1	4	1		1	1	1												2		1		1	
December	1		1	1	2	2														1			2	1
January	1	1	2	1	3	1	3												2	1			2	
February	2	2	4	4	3	3	2													3			3	1
March		3	1	1	1	1	2													1	1	2		
April	1	1	3	3	6	3														2	3	2	1	2
May	1		2		3	1															3		1	2

TABLE 4.4.1. Time table of *Martes foina* activity

This fact is probably directly correlated to the hours of light and darkness in winter and summer time or to the necessity of more food items during the cold period. GRAPH.3.2.10. shows the time of activity with a peack around five am.

It has been said that martens are solitary animals, and only in urban environments do groups of four or five animals congregate (Macdonald & Barrett 1993) to hunt together. It seems to be the case that in Crete, occasionally, pairs of animals are photographed together (FIG.3.2.2.). This may be mother/offspring couples, or it may be that several animals were attracted to the bait, arriving separately.

Perhaps as a reflection of their abundance in Crete, 24 specimens of *M. foina* were collected as road kill, with roughly equal numbers of males and females, possibly implying equal levels of activity between the sexes. April was the month when dead specimens of both sexes were mostly found probably due to the breeding season. As is seen there is a large population that is not particularly threatened by accidental road kills or by being killed by farmers as vermin as has been seen. *M. foina* were hunted for their pelts until recently, and the cessating of this activity could well be partly responsible for their current abundance.

4.5. THE BADGER

4.5.1. Morphometrical and morphological analysis

On the table below (TABLE 4.5.1.) the average values measured on the Cretan badger and the average values of *Meles meles* from Germany, England and Switzerland (In: Niethammer & Krapp, 1990) are compared. Maximum and minimum values for European Badgers found in Macdonald & Barrett (1993) are also reported (TABLE 4.5.2.).

	MEASUREMENTS NHMC SPECIMENS		**MEASUREMENTS (In: Niethammer & Krapp, 1990)**					
			GERMANY		**ENGLAND**		**SWITZERLAND**	
	MALE N= 7	**FEMALE** N= 6	**MALE**	**FEMALE**	**MALE**	**FEMALE**	**MALE**	**FEMALE**
W	**X = 7520** SE= 675,45	**X = 6708** SE= 414,81						
B	**X = 630,3** SE= 23,38	**X = 617** SE= 22,31	**X=813**	**X= 785**	**X= 685**	**X= 660**	**X= 778**	**X= 732**
HF	**X = 94.5** SE= 2,14	**X = 90,8** SE= 3,48	**X= 109**	**X= 107**	**X= 105**	**X= 105**	**X= 114**	**X= 108**
T	**X = 125,5** SE= 5,89	**X = 124,8** SE= 8,58	**X=135**	**X= 140**	**X= 155**	**X= 155**	**X= 163**	**X= 163**

TABLE 4.5.1. Average values on measurements from *Meles meles*

MEASUREMENTS (In: Macdonald & Barrett, 1993)		
	MALE	**FEMALE**
W	**X =12300**	**X =10900**
B	**m=686 M= 803**	**m= 673 M= 787**
HF	**m=90 M=110**	
T	**m=127 M= 178**	**m= 114 M= 190**

TABLE 4.5.2. Maximum (M) and minimum (m) values on European specimens

The t-test analysis with one tailed distribution carried out on the measurements taken on the Cretan badgers and those from Germany, England and Switzerland, has shown that the differences in size are statistically significant. Badgers from England seem to be smaller than those of Continental Europe even if they seem to be bigger than the specimens from Crete. Comparing the measurements taken during this research with those reported by Macdonald & Barrett (1993) referring to European specimens, the Cretan badger seems to be a smaller form. The head-body length value of Cretan males and females is situated far below the minimum value found in European specimens and below the values found in England. Moreover the male's head-body length in Crete is even below the same value for females in Europe. Regarding the tail length, values found in Cretan specimens are more compatible with those taken in European specimens. In particular the tail length in Cretan males is very close to the minimum value found in European males, while the same value for females falls into the ranges found in European female population. The weight of the Cretan population is almost half the value reported by Macdonald & Barrett (1993).

The Cretan badger seems to be a form of small size, as has been described in literature. Morphological observations have showed that the animal is characterised by a paler colour of the coat compared with continental forms.

According to Qumsiyeh (1996), adult female badgers from the Holy Land weigh 5000-10000 g while adult males weigh 7000-14000 g. The head and body lengths taken on badgers of the same region have values comprised between 550-850mm and the tail is short and stubby, measuring from 100 to 150mm. Measurements taken on the Cretan badgers fit well the parameters reported for the badger of the Holy Land (*Meles meles canescens).* Similitude was also found with badgers of the Near East. For Steensma and Reese (1996) an Anatolian origin of *Meles* is highly probable due to some anatomical similarities between them and the identical shape of the auditory bullae. According to the authors the Cretan form differs from the ordinary European badger for the auditory bullae which are strongly inflated, a character found in the Near Eastern forms as well. The size of the fossil *Meles* remains that were found in Crete in Pleistocene stratigraphic levels seems to be intermediate between the Near Eastern and the Cretan specimens. The Cretan forms found in fossil cave deposits can represent intermediate stages between the livings form and the ones on which *Meles meles arcalus* originated. J. Evans (1968) suggests an Anatolian origin for the first colonists of Crete and consequently of their pets.

Badgers from Rhodes (Festa, 1914) seem to be of a small size as well. Two badgers were measured and they appear to be even smaller than the Cretan subspecies. There are no data to compare the Cretan form with other Mediterranean islands except Rhodes since Crete is the only island population of the animal.

4.5.2. Ecology

A few photos of the badger at two different altitudes: 0-500 (Almyros) and over 1000 (Agios Mamas) were taken by the phototraps and tracks were recorded in the snow at the 500-1000 site on the Agios Mamas transect, though no photos were taken. The low numbers of photos may be a result of the fact that badgers do not have a strictly carnivorous diet so they might not be particularly interested in the baits which consists in meat. Tuyttens *et al.* (1999) used peanuts to trap badgers in England, having successfull trapping results. The tracks that were seen in snow at the second station at Agios Mamas were first seen exactly beside the Plexiglas disc of the phototrap, almost exactly below the bait. This could imply that after a cursory investigation, the bait was ignored. On the other hand the lack of photographs could be due to the fact that they are not as numerous in Crete as reported. For Bate (1905), Zimmermann (1953) and Ondrias (1965) the species was thought to be common throughout the island.

Other information that can be inferred from the phototrapping results is that two of the photographs were taken at 16:50 on the 24th of May, some four hours before darkness. According to Macdonald & Barrett (1993), badgers emerge before dusk in the months of May-August, and after dark for the rest of the year. In Crete, at the end of May, temperatures are high, even in the late afternoon, this observation of the animal may show that the habit of emerging before dusk as seen in the better studied animals in West and Central Europe may also apply in Crete.

It is possible that there has been a decline in the badger population since Bate and other authors reported the highly abundant badgers in Crete. Hundreds of kilometres of paved and dirt roads have been laid down, even in what would have been some of the most remote parts of Crete at the end of the last century. In this study alone, 14 individuals were collected as road kill, perhaps giving an indication of the effect that roads have besides destroying habitat. There has also been a huge increase in the amount of land given over or cleared for pasture and agriculture in general, which is not the ideal habitat for badgers that prefer wooded areas. Although the badger is no longer hunted for its fur as it was for many years until recently, there are many other more discrete, but no less dangerous, pressures on the Cretan population. The use of agrochemicals in agriculture may represent a threat for the badger due to its habit to eat vegetables and a possible contamination of another food source that consist of earthworms.

4.6. THE WILDCAT

4.6.1. Morphometrical and morphological analysis

The specimens identified as *Felis silvestris cretensis* presented body and skull dimension greater than the known average of the European and Sardinian wild populations. In TABLE 4.6.1. the average values for three morphometric characters of *cretensis*, *silvestris* and *libyca* are reported, together with the maximum values found for *silvetris* and *libyca* phenotypes (Ragni, 1981).

	F. s. cretensis		***F. s. silvestris***		***F. s. libyca var.Sarda***	
	Female	Male	Female	Male	Female	Male
W	X= 3000	5500	X= 2828	X= 3824 5000 (M)	X= 2100	X= 3050 6300 (M)
B	X= 505	576	X= 510	X= 559 630 (M)	X= 465	X= 545 655 (M)
HF	X= 120	121	X= 119	X= 128 140 (M)	X= 110	X= 127 140 (M)

TABLE 4.6.1.: Average values on measurements from *Felis silvestris*.

Statistical analysis on measurements has not been done due to the few number of Cretan wildcats. It is possible, however, to make some observations.

The weight of *Felis silvestris cretensis* surpasses the average values of *silvestris* and is very close to the maximum values for *libyca*. The head-body length, although perhaps rather above average when comparing males to *silvestris* and *libyca* and females to *libyca*, is within the given values for both of the other species. While the hind foot length for males is found to be inferior to the average values of the two other phenotypes.

Regarding the cranial measurements, the total length of the *cretensis* cranium was found to be greater than the average and maximum values for *silvestris* and *libyca*. The cranial index of the Cretan wildcat presents values that are more typical in *silvestris* than in *libyca*. The set of teeth are very robust and in one case larger than the average values found in *libyca* and *silvestris*.

The coat colour patterns and marking systems for the specimen NHMC 80.5.65.1 fall in the middle of the ranges *silvestris* and *libyca*, whereas for the specimen NHMC 80.5.65.3 the characters are more similar to the range *libyca*. The coat down colour of the two specimens is dominated by a reddish and fulvous colour which is completely absent or extremely rare in *silvestris* whereas is typical in *libyca*.

The Cretan wildcats examined till now seem to be a robust and large subspecies. The data from the coat colour patterns and the skull parameters of the studied specimens suggest that the taxon is situated in between the ranges *silvestris* and *libyca*, even if more related with the latter. This dual similarity could be due to the transport of the two subspecies to the island by humans: *F.s.libyca* form from the Mediterranean Afro-Asiatic coast and *F.s.silvestris* form from the Balkan Peninsula. Haltenorth (1953) described forms of wildcats that are morphologically intermediate between the three wild phenotypes of *silvestris*. These transitional forms were found to exist in some Mediterranean islands (*silvestris-libyca*) and in the North of the Arabian Peninsula (*libyca-ornata*).

Domestic cats have had their origin from African wildcats' populations of North Africa and the Middle East, from the 7th century B.C. onwards (Ragni and Randi, 1986, Ragni and Randi, 1991, Cicconi, 1997). From these areas pre-domesticated *libyca* have been carried by Neolithic navigators into many Mediterranean islands such as the Sardinian wildcat (Ragni, 1981) and the Corsican ones (Salotti, 1992) that both belong to the *libyca* phenotype. This transportation was carried out about 8000-6000 years ago at an early stage of domestication, before Egyptians completed the domestication process about 4000 years ago (Randi *et al*, in press). The Sardinian wildcat belongs in fact to the *libyca* group. Remains of a cat identified from the pre-pottery Neolithic level (7000 years ago) were found in Cyprus. These finds further confirm the transportation of this animal around the Mediterranean islands because there is no fossil record for the presence of cats before the first human immigration in this island (Clutton-Brock, 1994). The same types of cats such as the Sardinian ones could have been found in Cyprus where nowadays wildcats are absent (Davis, 1987). On the other hand the hypothesis of a pre-domesticated European wildcat brought to the island seems to be improbable because this phenotype has never shown an ethological tendency to domestication in experimental conditions, not even on hybrids of the first generation (Ragni *et al.,* in press; Cicconi, 1998). The hypothesis of a feral derivative of the Cretan wildcat populations seems to be improbable as well, because the specimens analysed till now have morphological and metrical characters of coat and skull, which are far from the *catus* range, except those which are shared with *libyca* forms.

The correct explanation about the Cretan wildcat represents a biogeographic rebus, which is still far from being understood. Concerning systematics, until more samples are acquired, one can only speak about probable trends. Ongoing molecular work on systematics and morphological features will add new elements. The main questions concerning the relation of the Cretan population to others in continental Greece and in other Mediterranean countries as well as how, when and from where the cat arrived in Crete, are still open questions.

4.6.2. Ecology

During the course of this survey, only two pictures of the same specimen (a pregnant female) and five pictures probable corresponding to another three specimens (two males and one female) were obtained. The four specimens phototrapped in Agios Mamas seem to present phenotiphical uniformity of the coat pattern and they seem to be in a very good physical condition (Ragni, personal communication). The Cretan population appear not to suffer from interbreeding with domestic cat. However risk of inbreeding was demonstrated by the hybrids found in Crete and by the capture and observation of domestic cats at the same locations at which wildcats were found. Interbreeding between wild and domestic cats are not only possible but they constitute one of the main threatens of the survival of the species. In Crete the magnitude of this risk remains to be studied.

All the photographs were taken over 1000 m a.s.l. as well as all the dead wildcats found during the course of this research. This evidence, together with the living wildcat captured in 1996 and the tracks found close to site C1, seems to confirm the presence of the species at quite high altitudes on the mountain ranges. Moreover, the wildcat appears to be well adapted to harsh climatic conditions, being photographed in an area which is normally covered by snow during winter times.

Little is still known about the Cretan population of wildcat and ongoing studies will give a much more complete picture of the abundance of this felid in the island. However Bate's assertion (1905) about the common presence of the wildcat in Crete seems to be far from the reality, also due to the great changes that the Cretan environment has suffered by the human presence, especially in the last 10 years. The increasing degree of road constructions and pasture, especially in mountain areas, has the consequence to physically change the environment against the wildcat's important need to have uninterrupted habitats and wooded areas. Another factor that may influence the low number of wildcats found and studied in this research is the fact that this felid is a very shy and cryptic animal, which completely avoid human contact.

The existence of a "pure" carnivore, situated on the top of the ecological pyramid is important both as an indicator of health of the ecosystem and for the conservation policy which should be applied. Concerning the conservation of the species in Crete, two key elements were revealed: the importance of wooded areas and the danger coming from the potential hybridism with domestic cats.

From the radiotelemetry study carried on in 1996, it was observed that the specimen used selectively the wooded area (Ragni *et al.*, 1996). Of the seven vegetational categories present in the area where the wildcat was studied by radiotelemetry, the specimen was mostly found in the wooded area with *Quercus coccifera* and in the degraded woods (91% of times). It should be noted that this area is more exposed to human exploitation (pasture, fire, lumber). Preliminary data suggest that the wildcat needs a large (ca.420 ha for the time studied), undisturbed area. Continuous roads construction which takes place in the mountain of Crete, is potentially a severe treat to the existence of the animal.

Comparing the home range of the Cretan wildcat with those calculated in other Mediterranean islands (Sicily, *F.s.silvestris*, 180-220 ha, Di Vittorio *et* *al.,* 1998 and Sardinia, *F.s.libyca*, 120-470 ha, Romeo & Murgia, 1998), it is the largest range of these values.

4.7. ELEMENTS OF BIOGEOGRAPHY

The species studied in this research were found to be of different body sizes compared to those of continental Europe. This fact must be considered a trend until more samples are acquired. The animals with more strictly carnivorous habits, such as the weasel and the wildcat, have increased their body size, probably due to the absence in Crete of medium and large carnivores, whose trophic niches could overlap with those of *Mustela nivalis galinthias* and *Felis silvestris cretensis*. This phenomenon is most evident for the weasel that has assumed in Crete a particularly elongated shape. The other three studied species (*Meles meles arcalus, Martes foina bunites* and *Erinaceus concolor nesiotes*) have been found to be of a smaller size compared to European standard, probably due to the absence of large predators on the island, to food supply and to instances of saving energy. A smaller size is an important ecological element for the amount of energy that the animal might secure from the environment. The food requirement is lower to sustain their body mass so that more time could be dedicated to other activities such as reproduction. More over a bigger size could be an advantageous character in case of large predators, which are absent from Crete. Risk of being predated, for example, may be a further factor that influences body size in insectivore's mammals (Dickman, 1988). Changing in body size could have been possible due to the absence of same size competitors.

These opposite evolutionary tendencies of increasing or decreasing body size could be explained not only in terms of ecological elements but also as a combination of different factors, coming from insularity and human influence. Tendencies to evolve larger or smaller body sizes have been recorded on islands. Many factors may play a role in size determination such as food supply or avaibility of resources, prey size, competition and lack of large carnivores, amount of energy and genetic isolation (Case, 1978; Mcnab, 1980; Shoener, 1983; Gittleman, 1986). Insularity plays a role in morphological changes as has been seen on many occasions on islands. To better understand the crucial elements for size determination in Cretan forms, further research and deeper knowledge are required on ecological and historical factors, especially related to species characters and island peculiarities. Since it has been reported that no carnivores living today on the island belong in any secure Pleistocene stratigraphic level (Kotsakis, 1990; Masseti, 1995; Steensma & Reese, 1996), these animals must have been brought by humans when Crete was already an island. As has been stated by many authors some of the species now found in Crete are the result of feralization of early-domesticated species (Schule, 1993; Vigne, 1996; Masseti 1998). The importation of these animals by humans was mostly due to their utilization as food resource, medicine or other purposes.

A great degree of morphological and morphometric similarities have been noted between some Cretan forms and those of the Holy Land. This fact suggests that animals from these areas might have influenced those of Crete, being transported by humans in the island or that the ecological factors in these places are very similar.

Differences in body size were found in other large Mediterranean islands, as it is reported in the TABLE 4.7. 1..

	CRETE	**CYPRUS**	**SICILY**	**SARDINIA**	**BALEARIC**	**CORSICA**
Vulpes vulpes		+	+	+<		+<
Mustela nivalis	+>>		+>	+>	+	+>
Martes foina	+<					
Martes martes			+<	+	+	+
Meles meles	+<					
Felis silvestris silvestris			+			
Felis silvestris libyca	+>			+	+?	+
Hemiechinus		+				

auritus						
Atelerix algirus					+	
Erinaceus concolor	+<					
Erinaceus europaeus			+>	+<		+

TABLE 4.7.1. Presence (+) and size (>: larger; < smaller) compare to European standard of the carnivores and the hedgehog in six large Mediterranean islands.

Mustela nivalis (the weasel) seems to be a large form in all the islands where the species is present even if this phenomenon is most evident in Crete. *Martes foina* (the beech marten) occurs only in Crete, while in the other islands a closely related species is present, the pine marten (*Martes martes),* which is of a smaller size in Sicily. *Meles meles* (the badger) is only present in Crete, as well as *Erinaceus concolor* (the hedgehog). *Erinaceus europaeus* occurs in Corsica, Sardinia and Sicily where the species was found to be of larger size while in Sardinia the species is found to be smaller, as the hedgehog of Crete. Another hedgehog, the Algerian one (*Atelerix algirus*), is present in Balearic Islands. The fox (*Vulpes vulpes*) occurs in all the islands mentioned below except for Crete and Balearic Islands. The species was found to be of smaller size in Sardinia and Corsica. The systematic situation of the Cretan wildcat (*Felis silvestris cretensis*) has showed a peculiar trend that must be confirmed by further studies. The morphological and morphometric characters of body and skull of the Cretan form seems to fall in between of the European wildcat (*Felis silvestris silvestris*) and the African wildcat (*Felis silvestris libyca*) even if more closely related to the latter one. *Felis silvestris libyca* occurs also in Sardinia, Corsica and probably in the Balearic Islands, while *Felis silvestris silvestris* is present in Sicily (Cheylan, 1984; Cheylan, 1991; Toschi & Lanza, 19xx (716); Ragni, in prep.).

It must be noted that Crete is the only large Mediterranean island where *Martes foina* and *Meles meles* occur. Most of the islands reported are characterized by the presence of four species of carnivores except for Balearic Is. with two or maybe three species and Cyprus, which is extremely poor in carnivores, because only *Vulpes vulpes* occurs in the island.

4.8. THE METHOD

During the course of this study bibliography together with the collection of direct and indirect indices of presence were used. Indirect indices of presence, such as the collection of feces have allowed the construction of a more complete picture about the animals' presence in Crete. Dead specimens which constitute a direct indices of presence has given information about sexual activity and distribution of the species. Moreover, from dead animals it was possible to observe morphological and morphometrical traits, important for systematic determination. The phototrapping system, which consists of a direct source of information about an animals' presence, it is a method that was redesigned for the purposes of the research. For this reason more emphasis is given to this method, which was greatly modified from Zielinsky & Kucera (1996) and it is showed in Fig.2.3.6., on chapter two. Some important advantages of this method are the low cost of the equipment, the recording of presence, seasonal and daily activity and the non-intrusiveness of the system. In fact differences of few seconds between pictures demonstrate that animals are not scared of the camera, especially of the flash unit. Some disadvantages of the method are the poor ability to distinguish between individuals if they are not morphologically differentiated and the exposure to the elements. According to Mace *et al.* (1994) to be counted as different specimens, pictures of the some species must be separated by an interval of more than 24 hours. During the course of this phototrapping survey, Mace's observation was applied in counting individuals even if its applicability in territorial species appears to be doubtful.

Elements were effectively a problem for the method, especially snow, rain and direct solar radiations. During the research in Crete, snow represented, only for few weeks in wintertime, the main problem of this method because of the weight of the snow tending to set off the camera and finishing the film (Fig. 4.7.1.). This system must be used when the risk of snow accumulation is low. Humidity, coming from the rain, may create problems in the electric circuit. The camera is always protected from water and sun by a removable plastic bottle that is partially cut to be open in front. In case of direct solar radiation on the system, pictures were taken in absence of animals (Fig. 4.7.2.). It seems to be important then, especially in areas like Crete where the sun's radiation is very intense, to locate the system under trees or in shadow places. Another problem of the phototrapping system come from vandalism. Two times on the same camera, the connection between the plexiglass disc with the trigger bottoms and the camera was found to be cut off by humans. For this reason the camera was moved to another place.

One of the most important advantages in using phototrapping system is the possibility to detect altitudinal presences, seasonal and daily activity and the possibility to detect cryptic and nocturnal animals. The phototrapping system has allowed the possibility to find differences depending on altitudinal range, seasonal variation and time of activity between the five studied species.

Care must be given to the bait depending on the target species that must be detected. In fact it seems that the low number of photos of *Meles meles arcalus* may be a result of the fact that badgers have not a strictly carnivorous diet. For this species the use of additional baits, such as peanut butter that gave good results in trapping research, it is very important. Another example of the importance of the bait is the fact that after using dry catnip (*Nepeta cataria)*, which is a plant that seems to attract felids, mixed with meat the number of pictures of the wildcat increased.

Fig. 4.7.1. Photograph induced by snowfall

Fig. 4.7.2. Photograph possibly induced by intense heat

SUMMARY

Distribution as well as preliminary elements of ecology and population status, in particular activity, altitudinal range and relative abundance of all the small carnivores (*Mustela nivalis galinthias, Martes foina bunites, Meles meles arcalus, Felis silvestris cretensis*) and the hedgehog (*Erinaceus concolor nesiotes*) were investigated in Crete.

This study is presented in four chapters. The first is a general introduction about carnivores and insectivores. It also includes a short introduction of the systematics, actual taxonomy of each studied species and a brief review of the taxonomic history of the Cretan forms. In this chapter the presence of the studied species in the fossil record on the island and a brief overview of Crete' natural environment are also included.

Chapter two regards the materials and methods used. The study was carried out using data from bibliography and new data from direct and indirect methods of sampling. The direct methods include phototrapping and the collection of dead specimens while indirect indices of presence consisted of collection of feces, tracks and other signs. More emphasis is given to the phototrap method because this is a relatively new method, used for the first time in Crete, after being redesigned for our purposes.

In third chapter the results from the different methods applied are considered separately, as they will be viewed individually in the chapter dedicated to the discussion on each studied species. Where relevant, or possible, statistical analyses are used to confirm the validity and significance of results.

In chapter four the results are discussed, especially those relating to the body and cranial measurements and coat-colour patterns observed on the animals. The species studied in this research seem to have different body sizes when compared to those of continental Europe. Until more samples are acquired, it is only possible to speak

about probable trends. The hedgehog, the beech marten and the badger were found to be smaller than the average size found in continental European specimens, while the weasel and the wildcat of Crete, which have a more strictly carnivorous diet, seem to be larger forms. These evolutionary tendencies are discussed and compared with those found on other islands and in other nearby regions. These trends could have several explanations relating to insularity, ecological factors and human transportation.

Morphological patterns are also pointed out, such as the evident and always present throat patch of the beech marten, in contrast to that affirmed by many authors. During the course of this study, the wildcats specimens analysed suggest that the taxon is situated in between the ranges of European and African phenotypes. The systematics of the Cretan wildcat still remain unclear. The distribution in Crete is analysed on the basis of the results from fieldwork, phototrapping and the bibliography for both past and current presence.

During the phototrap period all five species investigated were phototrapped. Differences were found in the number of pictures of each species depending on the altitudinal range, seasonal variation and time. Weasels were the most common visitors at low altitudes and they were always trapped during daylight, while beach martens were present in all the altitudinal categories and as well as the hedgehog also show nocturnal activity. The presence of the hedgehog at an altitude over 1000 m was reported for the first time, in contrast to that affirmed in previous reports from Crete. Badgers were phototrapped in two altitudinal ranges, though there were only a few photographs, possibly as a result of the unsuitability of bait which was aimed at carnivores. The wildcat was only found over 1000m. Activity graphs are also presented for each species showing differences depending on the season, especially winter and summer time.

All the information collected during this research is accompanied by comparisons with other large Mediterranean islands, both on the morphology of the species and the synthesis of the fauna. Finally a critical review of the method is included in the final section of the discussion.

ΠΕΡΙΛΗΨΗ

Στην παρούσα διατριβή μελετάται η κατανομή και προκαταρκτικά στοιχεία οικολογίας και πληθυσμιακής κατάστασης των μικρών σαρκοφάγων (*Mustela nivalis galinthias, Martes foina bunites, Meles meles arcalus, Felis silvestris cretensis*) και του σκαντζόχοιρου (*Erinaceus concolor nesiotes*). Συγκεκριμένα μελετώνται η δραστηριότητα, υψομετρική κατανομή και η σχετική αφθονία των προαναφερόμενων ειδών.

Η μελέτη περιλαμβάνει τέσσερα κεφάλαια. Το πρώτο κεφάλαιο αποτελεί μια γενική εισαγωγή για τα σαρκοφάγα και εντομοφάγα. Περιλαμβάνει μια εισαγωγή στη συστηματική, στην σύγχρονη ταξινόμηση του κάθε μελετούμενου είδους και μια σύντομη αναφορά της ταξινομικής ιστορίας των κρητικών μορφών. Τέλος στο κεφάλαιο αναφέρεται η παρουσία απολιθωμάτων των μελετούμενων ειδών στην Κρήτη καθώς επίσης και μια σύντομη αναφορά στα κλιματικά, γεωγραφικά και γεωλογικά στοιχεία της Κρήτης.

Το δεύτερο κεφάλαιο περιλαμβάνει τη μεθοδολογία που ακολουθήθηκε για τη διεξαγωγή της παρούσας διατριβής. Η μελέτη διεξήχθη με χρήση βιβλιογραφικών δεδομένων αλλά και νέων δεδομένων από άμεσες ή έμμεσες μεθόδους δειγματοληψίας. Οι άμεσες μεθόδοι δειγματοληψίας περιλαμβάνουν τις φωτοπαγίδες και τη συλλογή νεκρών δειγμάτων, ενώ οι έμμεσες τη συλλογή βιοδηλωτικών ιχνών όπως τα περιττώματα ίχνη ή και άλλες ενδείξεις. Μεγαλύτερη έμφαση δόθηκε στη μέθοδο των φωτοπαγίδων γιατί είναι μία σχετικά νέα μέθοδος που χρησιμοποιείται για πρώτη φορά στην Κρήτη και η οποία ξανασχεδιάστηκε για τους σκοπούς της παρούσας μελέτης.

Στο τρίτο κεφάλαιο αναφέρονται χωριστά τα αποτελέσματα από κάθε μέθοδο που χρησιμοποιήθηκε, ενώ αναλύονται χωριστά στο κεφάλαιο της συζήτησης για κάθε μελετούμενο είδος. Όπου ήταν απαραίτητο ή δυνατό, χρησιμοποιήθηκε στατιστική ανάλυση για την επικύρωση της αξιοπιστίας και σημαντικότητας των αποτελεσμάτων.

Στο τέταρτο κεφάλαιο συζητώνται τα αποτελέσματα και ιδιαίτερα εκείνα που αφορούν στις μετρήσεις σώματος και κρανίου και στα χρωματικά πρότυπα του τριχώματος που παρατηρήθηκε στα ζώα. Τα μελετούμενα είδη φαίνεται να έχουν διαφορετικό μέγεθος σώματος αν συγκριθούν με αυτά της ηπειρωτικής Ευρώπης. Μέχρι να έχουμε στη διάθεσή μας περισσότερα δείγματα μπορούμε ουσιαστικά να μιλήσουμε μόνο για πιθανές τάσεις. Ο σκαντζόχοιρος, το κουνάβι και ο ασβός φάνηκε να έχουν μικρότερο μέσο μέγεθος από τα αντίστοιχα ζώα που κατανέμονται στην ηπειρωτική Ευρώπη, ενώ η νυφίτσα και ο αγριόγατος της Κρήτης, τα οποία είναι αποκλειστικά σαρκοφάγα, φαίνεται να είναι μεγαλύτερα από τα αντίστοιχα ζώα της

ηπειρωτικής Ευρώπης. Αυτές οι εξελικτικές τάσεις συζητώνται και συγκρίνονται με αυτές που ισχύουν για άλλα νησιά και σε άλλες κοντινές περιοχές. Οι τάσεις αυτές έχουν πολλές δυνητικές εξηγήσεις που σχετίζονται με το νησιωτισμό, με οικολογικούς παράγοντες και με την μεταφορά από τον άνθρωπο. Επισημαίνονται εξάλλου μορφολογικά πρότυπα, όπως το πολύ εμφανές και πάντα παρόν λευκό σχέδιο του λαιμού του κουναβιού, σε αντίθεση με ότι μέχρι σήμερα υποστηριζόταν. Τα δείγματα του αγριόγατου που μελετήθηκαν δείχνουν ότι το τάξο έχει ενδιάμεσους φαινοτυπικούς χαρακτήρες μεταξύ των συγγενικών του της Ευρώπης και της βόρειας Αφρικής. Η συστηματική του είδους πάντως δεν είναι επαρκώς διευκρινισμένη. Η κατανομή στην Κρήτη αναλύεται από τα δεδομένα των αποτελεσμάτων των εργασιών πεδίου, και της βιβλιογραφίας, τόσο για την προγενέστερη όσο και για την παρούσα εξάπλωση του ζώου.

Κατά τη διάρκεια των φωτο - παγιδεύσεων εντοπίστηκαν και τα πέντε υπό μελέτη είδη. Βρέθηκαν διαφορές στον αριθμό των φωτογραφιών κάθε είδους αναλόγως με το υψόμετρο, την εποχή και την ώρα της ημέρας. Οι νυφίτσες ήταν οι κοινότεροι επισκέπτες στα χαμηλό υψόμετρα και φωτογραφίζονταν μόνο κατά τη διάρκεια της ημέρας. Τα κουνάβια και οι σκαντζόχοιροι ήταν παρόντα σε όλα τα υψόμετρα παρουσιάζοντας νυχτερινή δραστηριότητα. Μάλιστα η παρουσία του σκαντζόχοιρου καταγράφεται για πρώτη φορά σε υψόμετρο μεγαλύτερο των 1000m στην Κρήτη σε αντίθεση με ότι υποστηρίζονταν μέχρι σήμερα. Ο ασβός φωτογραφήθηκε σε δυο υψόμετρα. Εμφανίζεται όμως σε ελάχιστες φωτογραφίες λόγω της ακαταλληλότητας του δολώματος που προοριζόταν για ζώα με «περισσότερο» σαρκοφάγες συνήθειες. Ο αγριόγατος εντοπίστηκε μόνο σε υψόμετρα μεγαλύτερα από 1000m. Παρουσιάζονται εξάλλου διαγράμματα δραστηριότητας για όλα τα είδη. Στα διαγράμματα αυτά γίνονται εμφανείς οι προτιμήσεις κάθε είδους για την ώρα και την εποχή που προτιμούν να δραστηριοποιούνται με εντονότερες τις διακυμάνσεις μεταξύ καλοκαιριού και χειμώνα.

Γίνεται σύγκριση των συλλεχθέντων και των υπαρχόντων δεδομένων για τα ζώα της Κρήτης με αυτά από άλλα μεγάλα νησιά της Μεσογείου τόσο σε ότι αφορά τη μορφολογία αλλά και τη σύνθεση της πανίδας.

Τέλος γίνεται μια εκτίμηση και αξιολόγηση της μεθόδου των φωτο – παγιδεύσεων.

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