

The introduction of wild boar *Sus scrofa* in Cyprus: an alien species in a highly endemic area

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Key words: wild boar, Cyprus, Cyprus mouflon, reintroduction, alien species.

SUMMARY

In 1990, five wild boars (*Sus scrofa*) were imported from Greece to the island of Cyprus for game farming. The presence of wild boar on the island was seen by hunters as a great opportunity for Cyprus to acquire a large game mammal. Together with some officials of the Department of Forestry, they claimed that this species was present on Cyprus in the past, and that this was the opportunity to reintroduce it to the wild, thus fulfilling an obligation under international treaties and conventions. Other researchers, maintained that wild boar was never present on Cyprus, and should therefore never be allowed free on the island. In 1994 wild boar were illegally released in Limassol Forest and in 1996 in the Troodos National Forest Park, an area known for its very large number of endemic plant species. In this paper I examine whether wild boar should be treated as reintroduced or as an alien species by reviewing the literature and the archaeological finds to see if it was ever present on the island. In addition I analyze the effect which it might have on the environment. I conclude that this species should be treated as an alien species, which has the potential to cause considerable, maybe irreversible, damage to the local fauna and flora, and that it should be controlled.

1. INTRODUCTION

The introduction of exotic plants and animals to new regions has generated much concern among biologists because exotics can disrupt ecosystems and directly or indirectly lead to the extinction of native species (Schofield, 1989; Vitousek, 1990; Hobbs and Huenneke, 1992; Waithman et al., 1999). A few well known examples include rabbits (*Oryctogalus cuniculus*) in Australia (Lange and Graham, 1983), red fire ants (*Solenopsis invitta*) in North America (Killion and Grant, 1995) and Guams's ground dwelling bird fauna preyed on and almost eliminated by the brown tree snakes (*Boiga irregularis*) (McNeely and Strahm, 1997; Savidge, 1987). According to experts, harmful invasions are now the second most serious threat to biodiversity after habitat loss (Glowka et al., 1994; McNeely and Strahm, 1997). The most heavily affected areas include the world's oceanic islands, coastal estuaries, and large lakes. Native species on islands have been shown to be particularly vulnerable to extinction from

competition or predation from invasive exotic species (Schofield, 1989; Savidge, 1987; Hadjisterkotis and Masala, 1995).

Cyprus is an island of oceanic origin which has been isolated from the nearby mainland for the last 5 million years. Because of this isolation it developed a large number of endemic species of plants and animals (Hadjisterkotis and Masala, 1995; Christodoulou, 1996; Anonymous, 1992a; Hadjisterkotis et al., 2000). For many centuries no large wild mammals were introduced to the island. This has changed during the last two decades with the introduction of two new species. About 20 years ago the Department of Forestry introduced fallow deer (*Dama dama*). Although it was brought for reintroduction they were never released in the wild. In 1990, Nicolas Fournaris from Pareklisia, imported five wild boar (*Sus scrofa*) from Greece for game farming. The presence of wild boar on the island was seen by hunters and the owner of the farm as a great opportunity for Cyprus to acquire a large game mammal (Constantinou, 1991). The Cyprus Federation of Hunting, requested the Game Fund (Game and Fauna Service) to buy the animals and to release them in the wild. They claimed that this species was present on Cyprus in the past, and that this was the opportunity to reintroduce it.

The introduction of wild boar was also supported by some officials of the Department of Forestry, who also believed that this species was formerly present on Cyprus as far as the Troodos National Park (Iezekil et al., 1998: 32) (Fig. 1 and 2). Some of these officials suggested that the government must reintroduce wild boar because of its obligations to the international treaties and conventions (V. Pantelas, pers. commun.). According to Article 11.2(a), of the convention on the Conservation of European Wildlife and Natural Habitats, "each Contracting Party undertakes: a) to encourage the reintroduction of native species of wild flora and fauna when this would contribute to the conservation of an endangered species, provided that a study is first made in the light of experiences of other Contracting Parties to establish that such reintroduction would be effective and acceptable." (Commission of the European communities, 1992: 82).

In addition, the Convention on Biological Diversity which was signed on June 15, 1992 at the Rio de Janeiro conference on Environment and Development, was ratified by the government of Cyprus (Official Gazette of the Republic, 1996). Article 9c of the ratified law stipulates that "each Contracting Party shall... c) adopt measures for the recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions."

To inform the public about wild boar the Department of Forestry presented a mounted large male at the Agricultural Fair of Nicosia from 8 to 12 of October 1997. During this presentation they gave a questionnaire to the visitors, asking whether they were in favor of the reintroduction of wild boar on Cyprus. After this event the Pancyprian Union of Agriculturists wrote to the Director General of the Ministry of Agriculture, Natural Resources and Environment on 13 October

1997, protesting for the “advertising” of this exotic species by a governmental Department. The Union requested the Ministry not to take into consideration the results of this gallop, because the common citizen is not able to know the long term destruction which wild boar can cause to ecosystems and to agriculture.

Other researchers, including Professor of wildlife management at McGill University Dr. R. Bider, were against the “reintroduction” of wild boar on Cyprus, because “(a) they will not stay in the forest, (b) they will definitely invade agricultural lands (c) they will certainly compete with the Cyprus mouflon (*Ovis gmelini ophion*).” (Personal correspondence 13 Dec. 1994). Other Cypriot researchers (including the author) noted that wild boar was never present on Cyprus, therefore should never be allowed free on the island. According to Article 11.2(b) on the Conservation of European wildlife and Natural Habitats, we have the obligation to strictly control the introduction of non-native species (Commission of the European communities 1992: 82).

In this paper I report on the recent introduction of wild boar on Cyprus, how and where it was introduced. I examine whether wild boar should be treated as reintroduced or as an alien species by reviewing the literature and the archaeological finds to see if it was ever present on the island. Finally, I analyze the effect which this species might have on the environment and I suggest measures to control it.

2. HISTORICAL EVIDENCE FOR THE PRESENCE OF WILD BOAR IN CYPRUS

The first archaeological remains of wild boar on Cyprus are from Akrotiri-*Aetokremnos* (Fig. 1), dating about 8000 B.C. These remains were nine phalanges and three metapodials, which indicates that they were bones left in a piece of fur or skin which was used as clothing, bedding, etc. They were probably wild boar since domestic pig is not present at this time in the Levant. These remains must have brought from the mainland by the people living at *Aetokremnos* (D. Reese in preparation).

The first presence of boar/pigs in Cyprus comes from the Neolithic village of Khirokitia (Fig. 1) about 6000 BC (Davis, 1984). Davis suggested that those animals represent an early or “primitive” breed of domestic pig. According to Davis the feralization of pigs on Cyprus might have led to the extinction of the endemic species of the pygmy elephant and pygmy hippo (Davis, 1989: 124). However, it is possible that the first Cypriots eliminated these pygmy animals long before the arrival or the establishment of domestic pigs (Hadjisterkotis et al., 2000; Reese, 1992, 1995, 1996; Simmons, 1988a,b, 1989, 1991a,b,c, 1992, 1996).

Wild pig or boar has been reported from Khirokitia-*Vounoi Erimi-Pamboula* (King, 1953) and Dhali -*Agriidi* (Schwartz, 1973: 216; 1974: 105ff.; Lehavey, 1974: 96) (Fig. 1). Recent work, however suggests that these pigs were in fact a “primitive” breed of domestic pig (Davis, 1984: 156, 1989: 207; Croft, 1991: 66-67). Boar was not reported in any other faunal collection.

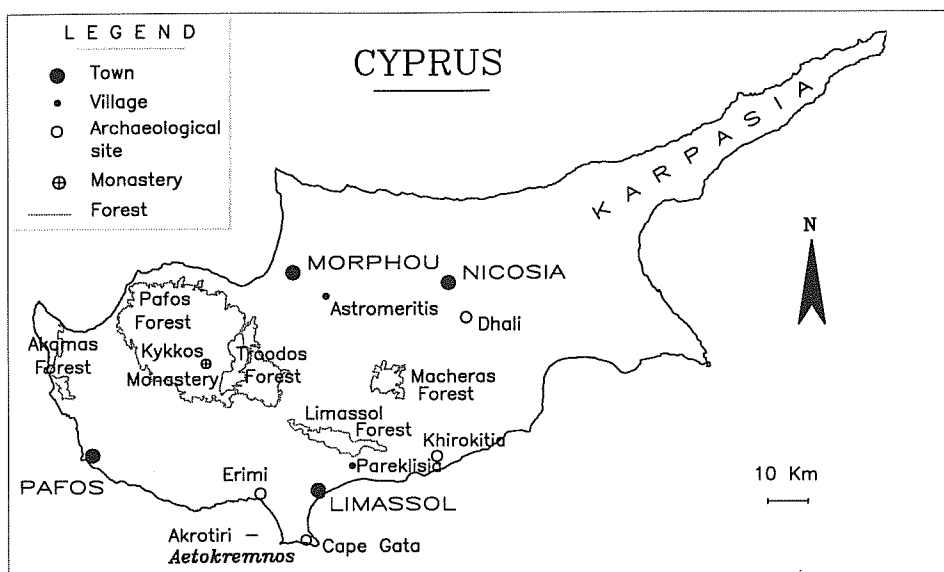


Fig. 1 - The map of Cyprus.

Bucknill (1930: 283) noted that “Mythology gives Cyprus the Idalion boar: early vases show hunting scenes, and a Ptolemaic inscription found at Salamis mentions an archicynegeus.”

Sibthorp, the editor of the *Flora Graeca* and founder of a professorship of Rural Economy at Oxford, visited Cyprus in 1787 and made notes and lists concerning the natural history of the island (Cobham, 1908: 332). In his notes on the mammals of Cyprus he mentioned that: “The wild boar inhabits Cape Gatto (Cape Gata, Fig. 1), and the Gazelle the higher parts of Troodos. Hares are scarce, and seem to confine themselves to the mountainous tracts of the island. The hedgehog, I was also informed, was an inhabitant. [...] Asses, I heard on good authority, were found in a wild state at Carpasso (Carpasia, Fig. 2) and that it was permitted to any person to hunt them.” The statement of Sibthorp concerning wild boar, and also the hedgehog and ass, are based upon verbal information. His identification of some species such as the Cyprus mouflon, was not correct, probably because he had never seen one. He refers to mouflon as “Gazelle (*Capra gazella*)” although it is wild sheep of the genus *Ovis*. It is questionable whether the “wild boar” of Cape Gatto, were not feral domesticates or free ranging domestic pigs. The traditional method of keeping pigs in some parts of Cyprus was to have them roaming free on their owners’ property, or near their sheep or goat pen in the woods.

According to the researcher and glossologist Menelaos Christodoulou (Personal communication, November 30, 1998) when Cypriots describe a free ranging domestic pig in the local Greek dialect they use the word *αγριόχοιρος* or

αρκόσιουρος = wild boar. According to local legends, the only animals on Cape Gata were feral domestic cats, introduced by St. Helena during the 3rd century A.D. to control the large numbers of snakes. Sibthorp may have mistaken the word wild cat *αγιόγατος* or *αρκόκαττος* for wild boar. In Cypriot legends, wild boar is associated with evil, probably deriving from the biblical story in which evil spirits went out of a man and entered the pigs. The whole herd - about two thousand pigs in all - rushed down the side of the cliff into the lake and drowned (Mark, 5.13). Such wild boar with evil spirits in them were thought to have lived in some parts of Cyprus, and their presence was always associated with certain bridges. Such a legend could also be taken by Sibthorp as reality.

In 1788, Archimandrite Kyprianos (Kyprianos, 1971: 41), says that Akamas peninsula was covered by thick forests, where at that time were foraging a variety of wild animals, horses, donkeys, cattle, wild goat, agrimia (most probably the Cyprus mouflon) and a large number of wild pigs. This was interpreted by some Cypriots to mean that Akamas was inhabited by wild boar. As I noted earlier, Cypriots refer to free ranging pigs as wild boar. The wild animals noted by Kyprianos, except for the Cyprus mouflon, are all free ranging domesticates. Today Akamas forest is surrounded with villages and the people keep free ranging goats all over the peninsula. It is possible that in the past they also kept horses, donkeys, cattle and pigs. The reason for not keeping free ranging large domestic mammals today is that cars and tractors eliminated the need for keeping horses, donkeys and cattle. The availability of cheap pork on the market, also eliminated the need for each family to keep its own pigs. Such free ranging animals would compete for the scarce forage with the goats, therefore they were eliminated.

Recently Sfikas (1991: 17), noted that there are testimonies that in the past on Akamas Peninsula there were wild boar (Pigs?), wild goats, deer, wild horses, wild donkeys and wild sheep. It seems that this information is based on Kyprianos (1971: 41) and with the exception of deer, refers to the domestic livestock noted earlier.

In 1992, the news media reported that there were wild boar in Pafos Forest (=Paphos Forest) until 1953 (Anonymous, 1992b). These wild pigs were shot by the Forestry Department of the British colonial government, because they were considered to be the cause of soil erosion. The report was based on information from people who hunted them. One of the foresters who participated in the extermination and processing of the meat was Mr. Stylianos Christodoulou. He told me that, from what he remembered from his childhood and what he was told by his father, in 1938, after the decision of the colonial government to remove all goat herders from Pafos Forest, a number of domestic pigs were left behind in the forest. The color of those pigs he said, was black, reddish or black and white. Similar free ranging domestic pigs can sometimes be seen today in some villages of Pafos.

Mrs. Esmé Scott-Stevenson (1880: 243), in her description of her explorations of Cyprus with her husband, ascended all the way to the top of mount Olympos

in search of mouflon. Although they never saw a mouflon, she noted that tracks were innumerable. She was shown at Morphou the skin of one of them, which a man had just shot, but she never mentions anything about wild boar being present anywhere on the island. In the appendices she provides a list of 16 game species (page 325) but she did not mention wild boar, which indicates that there were no such animals on the island at that time.

Löher, a German visitor to Cyprus in 1877, “while journeying through the length and breadth of that country” (Joyner, 1878), did not note the presence of wild boar on the island. Scott-Stevenson’s (1880) and Joyner’s accounts, support Christodoulou’s opinion that there were no wild boar in the Forests.

Sakelarios (1991: 257-262) in his book *Τα Κυπριακά (About Cyprus)* provides a list of the tame and wild animals of Cyprus. The book was first written in the 19th century and according to Th. Papadopoulos (Sakelarios, 1991: VII), was considered as the greatest contribution to the modern Greek sciences. In the list of the domestic animals he includes domestic pigs. In his list of wild animals he does not include wild boar or feral pigs. He notes that: “Many pigs are raised in Cyprus, in flocks, or each Christian in his house feeds a pig to feed himself and his family [...] in the old times [...] this animal in Cyprus was protected by Aphrodite” (Sakelarios, 1991: 257). The habit of Cypriots raising single pigs in their backyards or in flocks continued until the early sixties. In many cases in some villages these pigs were allowed to roam free (Pers. observ. in Famagusta district). The habit of raising pigs in the villages was stopped by new health laws in the sixties, which forbade the raising of livestock inside the villages.

Based on the above information, although probably there were free ranging feral domestic pigs in some parts of Cyprus, there is no evidence that wild boar was ever present on the island. Even if we accept that there were feral pigs at Cape Gata as Sibthorp noted, there is no indication that there were ever such animals in the Troodos mountains, with the exception of the feral pigs of Pafos Forest from 1938 until 1953. This indicates that the large number of endemic plant species of Troodos (72) evolved without the presence of pigs and wild boar. Therefore, the release of this species should be considered not as a reintroduction but as the introduction of an alien species.

The IUCN/Species Survival Commission (SSC) Invasive Specialist Group set out recommendations for reducing the risk of biodiversity loss caused by alien species. These guidelines are designed to assist governments to meet their obligations under the Convention on Biological diversity (Clout and Lowe, 1997), According to the guidelines, “...in general, no alien species should be deliberately introduced into any natural habitat, island, lake, sea, ocean or center of endemism, whether within or beyond the limits of national jurisdiction”.

Cyprus, besides being an island, according to Bibby et al. (1992), is the only endemic bird area in Europe and the Middle East. In addition, it is a center of

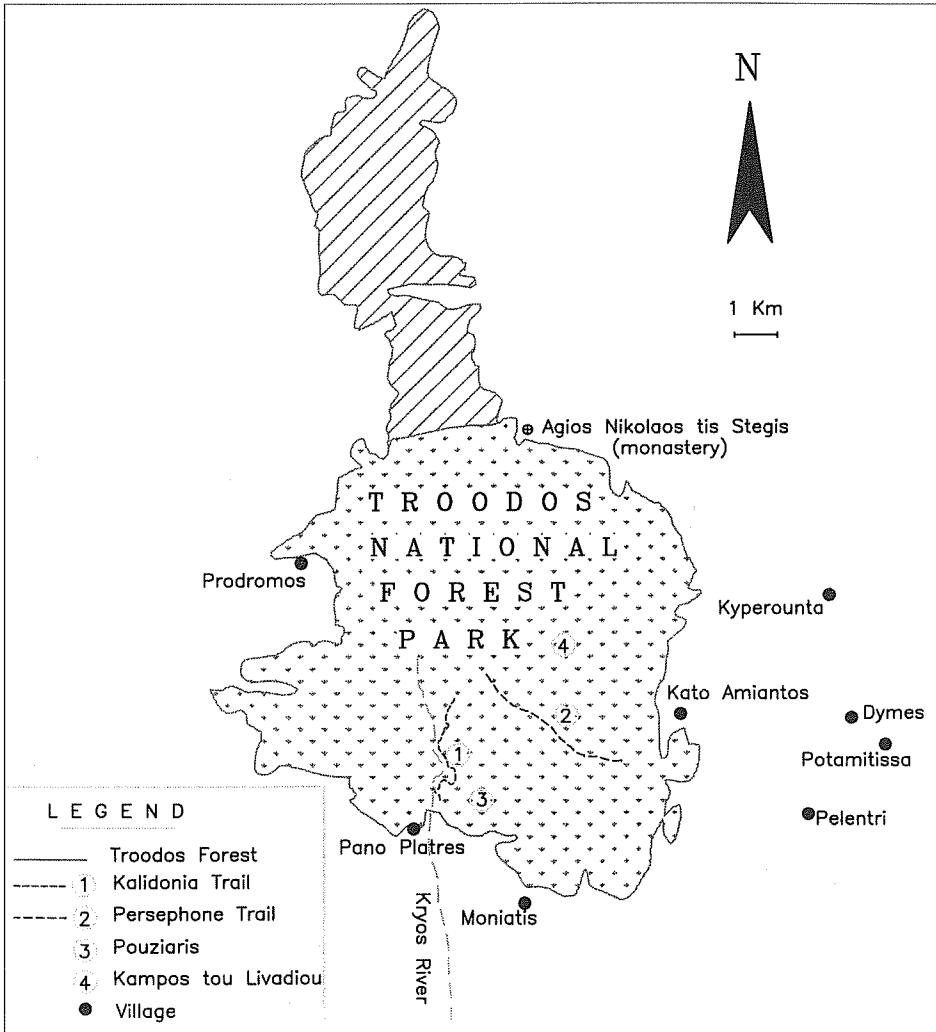


Fig. 2 - Troodos Forest.

plant diversity (WCMC, 1992), and half of its 11 terrestrial mammals are considered endemic subspecies (Hadjisterkotis and Masala, 1995).

3. THE MODERN INTRODUCTION OF WILD BOAR ON CYPRUS

Unfortunately the guidelines for reducing the risk of biodiversity loss mentioned in the foregoing section were completely ignored. Without consideration of the effect on the environment, wild boar were released in Limassol Forest (Fig. 1) and the Troodos Forest National Park (Fig. 2). The

latter area has the highest percentage of endemic plant species on the island (Christodoulou, 1996; Anonymous, 1992a). Also, they were possibly in Pafos Forest, which is the habitat of the endemic Cyprus mouflon.

The first attempt to introduce “wild boar” on Cyprus was attempted by father Makarios, a monk from the monastery of Saint Mary of Kykkos (Fig. 1) in 1986 (pers. observation). Father Makarios released a pair of domestic pigs on the property of the monastery located inside Pafos Forest. He was visiting his pigs daily to feed them. He hoped that gradually they would begin to feed on acorns which were plentiful in the area and other plant food. However, a few months later the pigs kept waiting for their daily bread from the monastery, running after father Makarios for food. The attempt to create wild boar from domestic pigs was a failure and the pigs ended up on the monastery’s dining table.

The recent importation on Cyprus by a game farm near Pareklisia village of 5 females and a male wild boar from Greece was seen by the Cypriot hunters as a great opportunity for the introduction of a new large game species. As a first place of introduction they suggested the Limassol Forest, which was near the game farm.

In the summer of 1990, a female wild boar escaped from the farm (Prastitis, 1990). It was recaptured by its owner 8 months later. For the farmer and the hunters this was the proof that these animals could survive in Limassol Forest. On the 6th of September 1991, the first four piglets were born in captivity (Constantinou, 1991), and since then began to multiply.

On the fifth of July 1993, the Officer of the Game and Fauna Service for Limassol District Savvas Savva presented a “study” to the Director General of the Ministry of Interior suggesting the introduction of this species in Limassol Forest (Savva was the Director from November 1997 to March 1999, when he was assassinated). The study summarized the description of wild boar, its distribution, breeding ecology, feeding habits and hunting. He suggested the release of 3 males and 7 females aged from 6 to 12 months. He concluded by noting that: “the success of this introduction would be a great event for the hunting of this country. The future expansion in other habitats e.g. Akamas, Machera, Pafos Forest etc. will result in the decrease of the great pressure which is inflicted on the endemic game, particularly the hare”.

On 6th of October 1993, the Director of the Game Fund of the Ministry of Interior requested my opinion and that of the Ministry of Agriculture, Natural Resources and Environment, on the release of wild boar in Limassol Forest (file no. 97/93, Ministry of Interior).

The Ministry of Agriculture responded that by releasing wild boar there would be a danger of transmission of diseases to domestic pigs, wild boar might attack farmers and people, and might cause unwanted damage to crops.

In my report I noted that there will be problems if wild boar are released in Pafos Forest (as S. Savva suggested) since they will compete with the endemic

Cyprus mouflon, and that wild boar should therefore never be allowed to enter Pafos Forest. I further noted that if the government decides to release them, the process should begin with a small number of animals in Limassol Forest marked with radiotransmitters. If they are found to be harmful to the environment, they should be eliminated.

In addition I suggested the following measures:

1. A detailed study of the microarthropods before and after the release. Microarthropods are important in soil formation processes and can be depleted by wild boar (Vtovov 1993).

2. The monitoring of the survival of the endemic species *Alyssum chondrogynum* with the construction of at least two exclosures of 20 X 20 m in areas covered with this rare species. (At that time it was the only endemic plant known in the area. Since then 6 more were discovered, Christodoulou, pers. comm.).

3. Two exclosures of 20 X 20 m should be constructed in the area of release above 800 m asl altitude, two exclosures at about 200-300 m asl and two at the bottom of the valleys. Exclosures should be constructed as strongly as possible since the European boar is known to overcome the best fencing barriers.

4. The plant species in the area should be recorded before the release and the percentage cover of each species estimated seasonally. After the release, the coverage of each plant species should be estimated twice a year in order to monitor the survival of each species. The feeding habits of the wild boar and its effect on vegetation should be studied. As was noted earlier, the opinion of Prof. Roger Bider from McGill University regarding the introduction of wild boar was also requested in 1994 and was negative.

On the 7th of February 1994 the Ministry of the Interior wrote to Mr. Fournaris that it was not going to allow the introduction of wild boar in Cyprus. On 11th of February 1994 Mr. Fournaris sent letter to the president of the republic requesting his intervention for the release of the animals. In December 1994, 5 pregnant females and one male were released from the farm in the Limassol Forest. The owner claimed that these animals were released during the night by someone who opened the door and allowed them to escape. (Anonymous, 1994). Although the owner claimed that this was done without his permission, he demanded from the government the cost of these animals (\$1600US each), since now they could be used for hunting. In November 1995 it was estimated that there were 60 -90 animals in Limassol Forest and in August the first 5 animals were shot by hunters (Anonymous, 1995).

In 1996 a new release took place at the edge of the Troodos National Forest Park, near Kato Amiantos village. These animals were brought and released by hunters (Papachristoforou, pers. commun.) without official permission. In the beginning of 1997 small groups of wild boar were present simultaneously in three parts of the forest. According to a letter of the Director of the Department of

Forestry Mr. S. Theophanous to the Director General of the Ministry of Interior Mr. T. Michael, on the 30th of May 1997, a group of wild boar were seen at Persefone Hiking Trail in Troodos National Forest Park (Fig. 2.), which is considered one of the most important areas on the island for endemic species. The animals were seen by two different groups of hikers who reported the matter to the police and to the Forestry Department. The group of animals consisted of 2 adults and two young. Mr. Theophanous requested the Ministry of Interior to eliminate these animals because they are alien to the habitat of the Troodos Mountains, and could cause the distraction of the National Park. Persefone Trail is about 3 km long and commences 150 m from the Troodos resort area.

At the same time, a group of animals was present in the Amiantos area, invading crops. Another group was near Kyperounta damaging orchards, potato fields and vegetables. This brought many complaints from farmers and the three unions of farmers, P.F.U "Agrotiki", the Union of Cypriot Farmers, and the P.E.K. In September 1997, all unions wrote letters to the Minister of Agriculture, Natural resources and Environment and the Minister of the Interior complaining of much damage to vegetable fields and orchards in the Troodos region.

One of the farmers from Amiantos used poisoned bait in his apple orchard to eliminate the animals. According to Dr. Papachristophorou, from the Agricultural Institute of Cyprus, the bait was discovered by the Game wardens of Limassol. The Game wardens removed the bait, and warned the farmers that if they did it again they would report them (Papachristophorou pers. commun.). In areas with considerable damages the Game Fund gave equipment for the production of blasting noises to scare the animals away from the area (Savva, pers. commun.).

Finally wild boar were seen near the Kalidonia Hiking Trail within the National Park, which is near the river Kryos (Fig. 2).

On February 9, 1998, the Director of the Veterinary Service in a letter to the Director of the Game Fund noted that all wild boar ranging free on the island must be eliminated because of the danger of transmitting diseases to livestock, particularly pigs.

On 6th of November 1997, in a meeting at the Ministry of Agriculture, Natural Resources and Environment, under the Direction of the Director General of the Ministry, the problem of free ranging wild boar was discussed. It was decided that the game wardens of the Game Fund must eliminate the free ranging animals. In addition it was suggested to the owner that the animals on the farm be used only for meat production. The same month the director of the Game Fund said that he had the opportunity to shoot ten of them near Kato Amiantos, but he avoided to do so (Anonymous, 1997).

In a letter to the Director of the Ministry of Agriculture Natural Resources and Environment - which was also published in the magazine "The Hunter" as confidential (Anonymous, 1998) - dated 30/3/1998, the Director of the Game

fund wrote that “during the hunting season 5 to 6 animals were shot by hunters near the villages Kato Amiantos, Pelentri, Dymes and Potamitissa (Fig. 2). Two or three animals were killed by a farmer in October 1997. Four animals were found dead by hunters, probably from poisoning. Presently, he noted, there were no information about wild boar being present in the wild.” From this letter it is evident that none of the animals were killed or captured by game wardens, and it is unknown if they even tried to do so.

In June 1998, during an international meeting on *Turdidae* in Athens, Savva said that wild boar had been eliminated from the wild. I asked him how that had happened, and he replied that they were shot during hunting.

In November 1998 a whitish pig (wild boar?) was seen inside Pafos Forest in a remote area near Kykkos monastery. The person who saw the pig was not sure if it was a wild boar (Pytharides pers. comun.). If that animal was a wild boar it is possible that the animals on Troodos dispersed towards Pafos Forest due to being chased by hunters, or maybe more animals were released, as was first suggested by Savvas Savva on the 5th of July 1993.

In November 1998 during small game hunting, hunters shot four young animals in the Troodos National Forest Park and were shown on the television news. On November 29, 1998 a hunter shot an adult animal about 250-300 kg in weight. The same day another hunter was seen with a wild boar of about 50 kg at Astromeritis. He said that he shot it on Troodos (Tsindidis pers. communic. 7.12.1998). Mr. Tsindidis also told me that few days ago while searching for edible wild mushrooms he noticed fresh diggings from wild boar in the vicinities of Kalidonia Hiking Trail, Persephone Trail, near the cliffs Pouziaris, on Kampos tou Livadiou camping ground, and at the monastery Agios Nikolaos tis Stegis (Fig. 2).

According to Birmingham (1983) in most areas with feral hogs it is unlikely that every hog can be exterminated. Theoretically it is possible, but the cost of doing so would be prohibitive. Unsuccessful hunting will make hogs keep to cover and a change in feeding habits will occur. According to Elman (1986), the average hunter should probably use nothing lighter than 180-grain loads in a .30-06 rifle, which are not allowed on Cyprus. A dogless hunter does not often come on a boar because this species will usually smell a man before he comes into view, and a wild boar's erect ears detect slight sounds far off. In Cyprus only 12-gauge two barrel shotguns are allowed, and the hunters are using lead shots for chukar partridge and hare. Most of the hunters are without dogs. Therefore it seems that it is impossible for the Cypriot hunters to exterminate wild boar. According to Dr. Papachristophorou, no agricultural damages were observed recently in the area of Troodos. Most probably a change in feeding habits took place as Birmingham noted. Wild boar have learned to avoid the gardens and are searching for wild plants, thus exerting heavier pressure on the local endemics and indigenous species.

Hunting and chasing of wild boar the way that it is done today on the island is expected to force them to find refuge in remote areas, to disperse them over wider range, and to teach them to avoid humans, particularly hunters. This would make their extermination in the long run more difficult, and more expensive, and is going to prolong the problem.

Moreover, the problem cannot be solved by shooting a few animals and allowing the release of additional animals whenever a hunter decides to do so. On the 7th of May 1998, I was informed that hunters are planing to release wild boar in Pafos Forest. In this way, they hope that when the wild boar increase and become problematic, the government will allow them to hunt in Pafos Forest, which has been a game reserve since 1938.

On the seventh of December 1998, the Director of the Veterinary Department Mr. Economides, in a letter to the Director of Agriculture noted that 1) it is risky to keep wild boar because no matter what measures are taken there is always the danger of escape, with destructive consequences to domestic pig farming from diseases and 2) the raising of wild boar in closed livestock units is not acceptable because their health and welfare are not guaranteed. Based on their nature these animals have biological and ethological needs which it is impossible to meet in closed locations. Therefore, keeping wild boar in this way is illegal and it is against the basic articles 4(1), 4(2), 4(3), 6(1), and 6(2) of Animal Protection and Welfare law no. 46(1)/94, as well as the articles 3 and 4 of the law of the European convention on the protection of animals kept for agricultural purpose of law no. 13 of 1977. Mr. Economides, based on information from professors of veterinary medicine, concludes that the safest solution is the slaughter of the captive pigs.

4. LOCALITIES ON CYPRUS WITH WILD BOAR

4.1 Limassol Forest

Limassol Forest is situated roughly 10 km from the city of Limassol on the southernmost foothills of Troodos range (Fig. 1). The forest is a mountainous area dominated by steep slopes and numerous gullies and tributaries. It rises in altitude from 300 to 1000 m with an average height of 500 m. The forest is 25 km long and ranging from a little less than 1 km up to 6 km in width. Despite the low annual precipitation which is about 562 mm, a considerable number of streams and springs with continuous water flow exists within the Forest area.

The vegetation seems to belong into two altitudinal zones. The first extends to 700 m above sea level and covers the largest part of the forest with the second zone extending over 700 m up to about 1000 m (Pantelas, 1985).

The lower zone is characterized by the abundance of olive trees *Olea europaea*, terebinth *Pistacia terebinthus*, carob trees *Ceratonia siliqua* and thorny broom

Calycotome villosa. The higher zone lies mainly between Kyparishia ridge and Kakomallis fire look-out station and is dominated by golden oak *Quercus alnifolia* and strawberry trees *Arbutus andrachne*, which are not present at altitudes lower than 600-700 m. Asphodel *Asphodelus microcarpus* seem to be common in both zones as well as brutia pine *Pinus brutia* (Pantelas, 1985).

Two endemics were found to grow in the area. The first is *Quercus alnifolia* which grows in most Cyprus Forests. The second is *Alyssum chondrogynum* which is according to Meikle (1985) "restricted to small isolated outcrops of serpentine in Limassol Forest". However, according to P. Christodoulou (pers. commun., 1999), recently 6 additional endemics were identified in this area.

4.2. Troodos National Forest Park

A large part of the Troodos Forest area was declared as a National Forest Park in 1991, in accordance with provisions of the Forest Legislation, following a decision by the Council of Ministers (Fig. 1 and 2). The Troodos National Forest Park has the highest biodiversity in Cyprus and the highest number of endemic species on the island. It is located at the center of Troodos massif and is 9 337 hectares.

At lower elevations from 700 to 1400 m., brutia pine is the dominant tree, found on higher elevations on the warm south slopes, and lower on the north slopes. The understory is mainly strawberry trees, sumach *Rhus coriaria*, the endemic golden oak and terebinth. At 1220-1500 m there is a mixture of brutia pine and black pine *Pinus nigra* ssp. *pallasiana* with understory golden oak, strawberry trees, terebinth, juniper *Juniperus oxycedrus*, barberry *Berberis cretica* and wild rose *Rosa* spp. At an altitude of 1400 m to 1800 there is black pine mixed with juniper, barberry, wild service tree *Sorbus aria cretica*, *Rosa* spp, etc. Black pine and juniper *Juniperus foetidissima* with forest floor cover *Sorbus aria cretica*, Barberry, Cotoneaster *Cotoneaster racemiflorus* var. *nummularius*, wild rose etc. are found from 1800 m up to the highest point 1952 m.

The riparian vegetation is made up of oriental plane *Platanus orientalis*, oriental alder *Alnus orientalis*, laurel *Laurus nobilis*, bramble *Rubus suncetus*, myrtle *Myrtus communis*, mint *Menta longifolia*, and ivy *Hedera helix*.

According to Christodoulou (1996), the number of species in the National Park in 1996 was 755. Today the number of taxa are estimated to be 780 (Christodoulou pers. Commun., 1999). Of the 139 endemic plants of Cyprus, 72 are found in the park, and 16 of them are local endemic. In addition, 58 non-endemic species are restricted within the range of the National Park. From the 19 species strictly protected by the Bern convention (Council of Europe, 1992), 6 are found in this National Park, as well as 19 taxa which are threatened according to the Red List of Threatened Species of the IUCN.

4.3. Pafos Forest

The dominant upland tree species of the Pafos Forest are brutia pine and golden oak along with occasional strawberry trees, turpentine tree and sumach. The understory brush consists of Rock roses *Cistus monspeliensis* and *C. villosus creticus*, *Asphodelus aestivus*, *Astragalus lusitanicus*, *Teucrium kotschyianum*, *Smilax aspera*, *Lathyrus aphaca*, *Bromus* sp., *Dactylis glomerata* and *Echinops spinosissimus*. The riparian vegetation consists of plane trees, with a dense understory of storax *Styrax officinalis*, bramble, myrtle, laurel, oleander *Nerium oleander*, green-brier and bracken fern *Pteridium aquilinum*. The number of endemic species is 50.

5. PROBLEMS EXPECTED FROM THE INTRODUCTION OF WILD BOAR

To what extent the boar might be expected to affect Limassol and Troodos Forests is not certain, but based on other studies the effect can be considerable. Although domestic pigs have provided a source of meat since Neolithic times, and some societies have formed pig cultures, feral pigs cause much destruction to habitats, and many species, particularly plant species, have become extinct or endangered because of habitat degradation caused by wild pigs. In areas where population densities are high or predators are absent as in most islands, wild pigs can be a significant conservation problem because they may serve as reservoirs of disease, or are host to disease - carrying insects, such as the blood sucking tsetse fly that causes sleeping sickness in people, and others that infect domestic livestock (Beacham and Beetz, 1998; Pavlov et al., 1992). Wild boar in Europe is the carrier of the classical swine fever (CSF) (Kaden, 1999). The CSF virus is transmitted within the wild boar population and from wild boar to domestic pigs. Susceptible young boar and wild sows infected during pregnancy play an important role in the perpetuation of CSF.

Wild pigs can threaten endemic plant populations (Kastdalen, 1982), alter soil processes (Lacki and Lancia, 1983) and enhance the spread of exotic grasses (Aplet et al., 1991). Wild pigs also may compete with native species for limited food resources (Ilse and Hellgren, 1995; Laurance, 1997) and consume the eggs of ground-nesting birds and reptiles (McFarland et al., 1974; Challies, 1975; Cruz and Cruz, 1987).

Vtorov (1993) found that in a Hawaiian rain forest wild pigs were responsible for the depletion of species, numbers, and biomass of microarthropods. Because soil microarthropods are important components of the soil formation process, he suggested that the impact of feral pigs (which are close relatives of wild boar) is harmful to forest ecosystems.

Onipchenko and Golikov (1996), in a 15 year study of the revegetation of alpine lichen heath after one-time wild boar digging in the alpine belt of the Mount Malaya Khatipara in the Teberda Reserve, the NW Caucasus (2,800 m a.s.l.),

found that the floristic richness had increased and had exceeded that of the control undisturbed plots. In addition the cover of vascular plants and lichens had increased but had not reached that of the control plots. Wild boar dug up the turf horizon of soil extracting apparently large roots of *Carum caucasicum*, *Campanula tridentata* and *Trifolium plophyllum*. Most of the soil surface was deprived of plants and led to the surface frost activity damaging seedlings and young plants.

Markov (1997) estimated the effect of rooting activity of wild boar on the plant communities in open landscape (holm and bench meadows) in the Middle Urals. He noted that the main impact of rooting activity on the plant communities was to lead to the reduction of the general productivity and change in species composition. The scale of influence depends upon the population density of wild boar.

One of the most common causes of damage by European wild boars is rooting and the destruction and/or damage to crops, pastures, farm ponds and watering holes for livestock. European wild boars have been particularly destructive of fragile plant communities in Great Smoky Mountain National Park in USA (Bratton, 1974).

Depredation of certain forest tree seedlings and agricultural crops by wild boar has been a concern of foresters in the South West USA (Wahlenberg, 1946). Wild boar dig up roots and tubers, eat grasses, fruits, berries, crawfish, frogs, salamanders, mice, snakes, the eggs and young of ground-nesting birds, the young of hares, even an occasional fawn. In Autumn acorns become a staple diet together with other available nuts (Elman, 1986).

Studies in Great Smoky Mountains National Park noted that in the winter of a poor mast year, wild boar consumed greater quantities of roots and tubers, invertebrates, and herbaceous material (Scott and Pelton, 1975). Analyses of stomachs from 47 wild boar collected in northern hardwood stands during spring and summer 1977 and 1978, contained by volume 55% herbaceous plant material, 40% roots, 3% fruit, and 2% vertebrates and invertebrates combined (Howe et al., 1981). The 5 most-consumed forbs declined in abundance from 30% cover in unoccupied areas to 3% in the 7-year area and 1% in the 20- and 24-27 year areas (Bratton, 1975b). All of this herbaceous reduction is not attributed to consumption, because many plants are broken or turned into the soil by rooting (Bratton, 1975a). Howe et al. (1981) concluded that wild boar significantly reduces herbaceous and subterranean forages in mesic herb communities within the northern hardwood forest type. Their exclosure studies suggested that substantial recovery of macroinvertebrates and herbs without perennial root systems may occur in as few as 3 years, but that plants with fine woody roots systems may not recover as quickly. Their data do not predict any plant extinctions, although observations by Bratton (1974) during initial invasion of a forest stand by wild boar suggested that certain lilies may be selectively eliminated during the first year.

A study conducted to determine fall food habits of European wild hogs in the Southern Appalachian Mountains found that plant food comprised 89.4%, by volume, of the foods eaten; animal food, 6.4%; and garbage 4.2%. Acorns were utilized more than any other plant or animal food source. Grapes ranked seventh in volume and seventh in frequency of occurrence. Utilization of grapes may depend on their availability and the availability of other food (Henry and Conley, 1972). If the mast crop is good, the constant shifting of the hogs will probably cover a range of less than 16 km² but in a poor year they may abandon a formerly good hunting area and show up to 80 km away (Elman, 1986).

Genov et al. (1995) examined the crop damage caused by wild boar and fallow deer in a Mediterranean area, the Maremma Regional Park, located along the Tyrrhenian coast in Central Italy. The area is dominated by Mediterranean maquis shrub, that includes *Quercus ilex*, *Q. pubescens*, *Arbutus unedo*, *Phyllirea latifolia*, *Erica multiflora*, *Pistacia lentiscus* and *Rosmarinus officinalis*. Crops are located in the outer part of the park and include wheat, barley, oat, hay, legumes, corn, sunflower and grapes. More than 90% of the fields are visited by the above two species which are depredating mainly wheat, corn, sunflower and grapes. The percentage of loss varies between 25% and 62% of the total production. In the years of reduced acorn production in the park the crop damages increase greatly. In addition, during the summer drought which reduces the green vegetation available to ungulates, crop damages reach a peak.

According to Palotas (1997) among the big game mammals of Hungary, wild boar has the highest rate of increase, and it occurs nearly in every habitat. It offers good hunting opportunities, but it is also the cause of agriculture and forest damages. Besides being an important agricultural pest, wild boar can cause serious losses to small game and protected ground nesting birds. Profitability of hunting in Hungary depends upon the intensive breeding of small game. Wild boar is "destroying the stocks of small wild ducks and pheasants." (Palotas 1997, Information from a poster presented at the XXXIIIrd congress of IUGB in Lyon France.)

Considering all the above, the damage or loss of endemic species from wild boar might be considerable, particularly in the Troodos Forest. The most vulnerable plants are probably the lilies, which might be selectively eliminated. It is unknown if the lower number of endemic plants in Limassol Forest (8), Pafos Forest (50), and Akamas Peninsula (38) compared to Troodos Forest (72) is due to their reduction by the pigs and the other domestic animals in the past, although it is possible.

In some parts of the pine forests the removal of the pine needle floor cover by wild boar digging, might create spots with increased floristic richness, as it was noted by Onipchenko and Golikov (1996). Although this might be possible, the risk of endangering or eliminating a number of species (Bratton, 1974; Bratton, 1975a; Howe et al., 1981; Kastdalen, 1982; Vrotov, 1993) or changing the species composition (Markov 1997) is a possibility and therefore cannot be risked.

In addition, if more animals are released in Pafos Forest, they are expected to compete with the Cyprus mouflon. Feral hogs killed and ate lambs on lambing grounds in New South Wales (Plant, 1977). Depredation to calves and lambs can be difficult to identify because these small animals may be killed and completely consumed leaving little or no evidence whether they were killed or were eaten after they had died of other causes (Bratton, 1974). In addition wild boar is expected to soil the waterholes in the forest and possibly transfer diseases to mouflon which use the waterholes for drinking.

I studied the diet of the Cyprus mouflon and I found that 95% of its diet is grass (Hadjisterkotis, 1993, 1996). The rest is fruit, asphodel *Asphodelus aestivus*, leaves etc. Asphodel leaves are one of the main items in the diet of mouflon in the summer. In addition, wild boar is expected to compete with mouflon for the fruit of *Styrax officinalis* and *Crataegus azarolus*. Depending on the quantity and quality of mast for a given year, competition for this resource may fluctuate insignificant in a good mast year, or acute competition in poor or fair mast years. In years with poor mast production competition will be expected to be severe for the tubers of asphodel. On June 15, I provided captive wild boar at Pareklisia with tubers, leaves and the seed bearing wooden stalks of asphodel. They ate everything. The propagation of asphodel was suggested by the mouflon management plan of Dr. Bider (1992) in order to increase food for mouflon in the forest. Wild boar is expected to reduce these plants.

Inside Pafos forest grass cover, particularly in the summer, is very limited. Measurements in August 1989 near Stavros tis Psokas Forest Station revealed that the grass cover of the forest floor is only about 2% (Own data). The wild boar is expected to compete for the limited grass and forbs with mouflon and probably hare. Wild boar have a wider range of diet than mouflon. They are able to dig up roots and tubers (elimination of roots and tubers means less plants for mouflon), and eat invertebrates and carrion. The result will most likely be an adjustment in numbers of the mouflon so that some kind of equilibrium is reached.

Pafos Forest being the unique habitat of the Cyprus mouflon, we should strive to preserve, maintain, or restore its natural ecosystem and natural processes to as nearly a pristine condition as possible. Its management should always take into consideration the needs of the Cyprus mouflon. So far Pafos Forest is threatened by habitat degradation, forest fires and lack of water. Water has been pumped for irrigation purposes, draining many artesian springs which were providing water for wildlife. Lack of water in combination with the lack of forage is driving the mouflon outside the forest bringing them into contact with domestic sheep and goats, which might be infected with diseases, such as pulmonary adenomatosis (Hadjisterkotis, 1999). Therefore, every effort should be made to keep wild boar away from Pafos Forest, because is expected to become a major competitor of the Cyprus mouflon. By introducing wild boar in Limassol Forest, or any other forest,

it means that if we would like to introduce mouflon to expand its range, the mouflon is going to meet competition from a new exotic species.

Besides disrupting the forest ecosystem and competing with mouflon, wild boar is expected to compete directly with wood pigeons *Columba palumbus* for acorns of *Quercus alnifolia* and *Q. coccifera*. Woodpigeons are of the main game birds of Cyprus, and in the period of the year during which acorns are available woodpigeons are plentiful in Pafos Forest.

The introduction of alien species by people transporting them across biogeographical boundaries has, along with habitat destruction, been a major cause of ecological change throughout the world in the past few hundred years (Clout and Lowe, 1997). Many alien species have become invasive, establishing in natural ecosystems, disrupting ecological processes and often causing widespread extinctions by competing with or preying on native species. Many of these extinctions have gone unrecorded, but there is now an increasing realization of the massive ecological costs of biological invasions through the irretrievable loss of native biodiversity, and greatly altered ecosystems. Biological invasions now threaten biodiversity on a global basis.

6. CONTROL OF WILD BOAR

Once wild pig populations are established, they can be very difficult to eradicate because they reproduce at a high rate (sows can produce 10-12 piglets/yr), adapt to a wide variety of climates, and quickly learn to avoid humans when pursued (Lloyd et al., 1987; Barret et al., 1988; Mauget, 1991; Waithman et al., 1999). Intensive eradication efforts have generally been successful only to the extent of temporarily reducing wild pig numbers (McIlroy et al., 1989; Wood et al., 1992; Choquenot et al., 1993).

The main method of controlling wild boar in every country is hunting. Robert Elman (1986) in his Hunter's Field Guide gives the following information concerning hunting wild boar in North America. A boar when chased can run up to 20 miles through almost impenetrable bushes, across creek bottoms and over wooded ridges. The hounds are fortunate if they quit or lose the trail, because a bayed hog or a hog that suddenly turns on the pack-can inflict terrible damage unless someone gets there fast with a gun. A reasonable short chase is more common. It ends when the boar decides to fight. A bayed hog is one of the most ferocious of beasts and one of the most intelligent. It often breaks off a fight with the dogs to turn on the more dangerous foe, the hunter. A boar can run at 30 miles an hour, and a hunter may not have a clear shot until he comes within 10 meters.

The shoulders of a European wild boar are shielded by a 2 cm plate of cartilage beneath a thick hide and bristly mane, which is problem to the hunter. A wounded boar seems to ignore a light or badly placed bullet and can kill several

dogs or a man after being shot. The best targets are the throat and the heart, low in the chest just behind the leg, or the spine, which is not an easy shot with a rifle. As mentioned above, a dogless hunter does not often come on a boar because this species will usually smell a man before he comes into view, and a wild boar's erect ears detect slight sounds far off. Cypriot hunters do not have the experience of wild boar hunting, or the right hounds, or the right guns. Therefore it is apparently impossible to eliminate them under the present conditions. The task of eliminating them is becoming more difficult with time, because the surviving animals are gaining more experience in avoiding hunters.

For an efficient control of wild boar on Cyprus where only shot guns are allowed and lead shot large enough to shoot hare, would be necessary to introduce new laws that will permit the appropriate rifle, or size of slugs for shotguns. However, if the introduction of such guns or slugs is permitted, they might be used for mouflon poaching. Poaching will be easier if free ranging wild boar enter or are released in Pafos Forest, and their hunting is permitted, since this is the sole habitat of the mouflon. The primary cause of mortality of the Cyprus mouflon is poaching (Hadjisterkotis, 1993; Toumazos and Hadjisterkotis, 1996). Therefore, it is better first to try methods other than hunting, such as trapping, to eradicate the wild boar. In the capture areas hunting should be interrupted for as long as it is necessary to capture the boar. Hunting might interfere with trapping by disturbing and dispersing the animals.

Since the Game Fund has so far completely failed to shoot or capture any of the animals, the campaign against wild boar should be assumed by the Department of Forestry, with special teams allocated specifically for the extermination of wild boar, in cooperation with the Ministry of Interior.

As soon as possible the range of the boar should be recorded, and indices of abundance based on the extent of signs (rooting, trails, tracks, and faeces) should be estimated. Baiting and trapping should start as soon as possible. Captured animals should be used for feeding habits analyses based on stomach examination. The age of each animal should be estimated for a demographic study of the population.

The wild boar should be exterminated as soon as possible before it is too late for many of the endemic species.

ACKNOWLEDGEMENTS

I would like to thank Dr. Paul Croft Prof. A. Legakis for critically reviewing this paper, P. Christodoulou for assisting in the description of the endemic plant species, Dr. C. Papachristoforou and C. Tsindidis for the information on wild boar in the Troodos area and Dr. M. Christodoulou for the information on the local legends, and N. Shamarias and G. Aristokleous for assisting with the designing of the maps.

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